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STANDING COMMITTEE ON STATE DEVELOPMENT

Development of a hydrogen industry in New South Wales

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Terms of reference

That the Standing Committee on State Development inquire into and report on the current state of, and opportunities for, the development of a hydrogen industry in New South Wales, and in particular:

1. The size of the economic and employment opportunity created by the development of a hydrogen industry in NSW, in particular those opportunities for regional NSW, including having regard to:
   (a) the emerging domestic and international trends in the production and demand for hydrogen, including in South Korea, the Netherlands, Japan and other Australian states and territories; and
   (b) NSW's existing and potential linkages to those markets.
2. The State's existing hydrogen capabilities, including:
   (a) NSW's research and development capacity for all elements of the hydrogen supply and demand chain, including existing research and development work of the Government, academic and private sector; and
   (b) The State's energy and industrial infrastructure which could support the production, storage, distribution, use and export of hydrogen.
3. The capacity of and barriers to NSW becoming a major production, storage and export hub for hydrogen, including NSW's capacity to:
   (a) develop and commercialise hydrogen technologies;
   (b) manufacture and export hydrogen production componentry, including electrolysis componentry;
   (c) manufacture and export hydrogen storage and transport infrastructure, including in heavy transport and shipping vessels;
   (d) generate green hydrogen through renewable energy sources;
   (e) use hydrogen for transport;
   (f) use hydrogen in its own industrial processes, such as in steel, aluminium and chemical production;
   (g) use hydrogen for electricity generation, including the feasibility of retrofitting existing and proposed electricity generation assets to use hydrogen; and
   (h) manage the safety and safeguarding of hydrogen utilisation.
4. The economics of hydrogen's use in different sectors of the economy, including emerging opportunities to use hydrogen in industrial processes and as a feedstock.
5. The infrastructure, technology, skills, workforce capabilities and other things needed to realise the economic opportunities of hydrogen as and when it becomes commercial in different sectors of the economy.
6. The actions needed of the public and private sectors, to support the development of a hydrogen industry in NSW and to realise the associated economic opportunities, including actions to manage any safety risks in the hydrogen industry.

7. The potential for jobs in New South Wales, both directly in the hydrogen industry and in other industries powered by hydrogen.

8. Any other pertinent matters the Committee wishes to draw to the Government's attention in this regard.

The terms of reference were referred to the committee by the Hon Matt Kean MP, Minister for Energy and Environment on 19 November 2020. The committee adopted these terms of reference on 8 December 2020.[1]

[1] *Minutes*, NSW Legislative Council, 16 February 2021, pp 1907-1908.

Committee details

Committee members

Hon Catherine Cusack MLC**	Liberal Party	*Chair*
Hon Mick Veitch MLC	Australian Labor Party	*Deputy Chair*
Hon Mark Banasiak MLC	Shooters, Fishers and Farmers Party	
Hon Wes Fang MLC	The Nationals	
Hon Sam Farraway MLC*	The Nationals	
Hon John Graham MLC	Australian Labor Party	
Hon Natasha Maclaren-Jones MLC	Liberal Party	
Hon Taylor Martin****	Liberal Party	
Hon Mark Pearson MLC	Animal Justice Party	
Mr David Shoebridge MLC ***	The Greens	

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* The Hon Sam Farraway MLC replaced the Hon Taylor Martin MLC as a member and as Chair of the committee on 17 February 2021 (*Minutes*, NSW Legislative Council, 17 February 2021, p 1936)

** The Hon Catherine Cusack MLC replaced the Hon Sam Farraway MLC as Chair of the committee on 15 March 2021 (*Minutes*, NSW Legislative Council, 16 March 2021, p 1994)

*** Mr David Shoebridge MLC was a participating member for the duration of the inquiry

**** The Hon Taylor Martin MLC was a participating member for the duration of the inquiry.

Chair's foreword

With recent increased interest in hydrogen around the world, including by the Australian Government, this is a timely report. New South Wales has some key building blocks for a hydrogen industry, including an abundance of wastewater and renewable energy resources to produce hydrogen, and the ports and infrastructure to transport hydrogen internationally and domestically. Hydrogen presents an opportunity for the NSW Government to achieve its goal of net zero emissions by 2050, as well as a significant export opportunity as many countries around the world begin to pivot away from fossil fuel industries. Considering these opportunities, now is the time for New South Wales to support its emerging hydrogen industry.

The inquiry into the development of a hydrogen industry in New South Wales was referred to the Standing Committee on State Development by the Minister for Energy and Environment in the context of the Electricity Infrastructure Roadmap. The Roadmap seeks to deliver a modern electricity system for New South Wales that is cheap, clean and reliable. In doing so, it identified the potential for a hydrogen industry to provide substantial economic opportunities for the state.

Notwithstanding the potential opportunities, the lack of viable storage options in the state and the significant cost of hydrogen throughout the supply chain present barriers to creating a commercially viable hydrogen industry. Stakeholders called for more support from the NSW Government, without which the state risks falling behind others.

Our key recommendation is that the NSW Government prioritise finalising and publishing its hydrogen strategy. This is where the government can really drive the development of this industry to a commercial scale and to create momentum and certainty for industry players. A strategy would signal the state's plans, identify and prioritise projects in the state, provide needed funding, attract private investment and ensure that the industry is well planned and safe.

Further recommendations seek to address the key barriers to achieving a commercially viable hydrogen industry. These include addressing any cross-sector regulatory barriers, commissioning a study into alternative large scale storage options for hydrogen, supporting hydrogen hubs in the Illawarra and Hunter regions, investing in demonstration projects, creating local demand and preparing for the transition of the workforce to a hydrogen industry.

On behalf of the committee, I would like to thank the stakeholders who shared their expertise with us through submissions and at the committee's hearing. I also thank my committee colleagues for their contributions to the inquiry and acknowledge the Hon Taylor Martin who was the Committee Chair when this inquiry was established. Finally, thank you to the committee secretariat and Hansard reporters for their support, and the Parliamentary Research Service for preparing an issues paper into hydrogen energy.

The Hon Catherine Cusack MLC
Committee Chair

Recommendations

Recommendation 1 **32**

That the NSW Government prioritise finalising and publishing a hydrogen strategy that includes its intentions for funding, policy and regulation.

Recommendation 2 **33**

That the NSW Government establish a cross-sector taskforce from across the government to support the state's hydrogen strategy, address any cross-sector barriers and engage with the National Hydrogen Project Team.

Recommendation 3 **33**

That the NSW Government commission a study into alternative large scale storage options for hydrogen.

Recommendation 4 **33**

That the NSW Government continue to support and monitor the development of hydrogen hubs in the Illawarra and Hunter regions.

Recommendation 5 **34**

That the NSW Government invest in demonstration projects with priority given to diesel replacement projects.

Recommendation 6 **34**

That the NSW Government create local demand for hydrogen by:

- developing and publishing a policy pathway for gas blending
- considering the use of hydrogen fuel cell vehicles in the public transport network.

Recommendation 7 **35**

That the NSW Government prepare for the transition of the workforce to meet the needs of an emerging hydrogen sector by conducting a study to:

- understand the current skills base
- identify the gaps that may need to be addressed by future training
- develop the appropriate safety standards.

Conduct of inquiry

The terms of reference for the inquiry were referred to the committee by the Hon Matt Kean MP, Minister for Energy and Environment on 19 November 2020.

The committee received 45 submissions including one supplementary submission, and held one public hearing at Parliament House in Sydney.

Inquiry related documents are available on the committee's website, including submissions, the hearing transcript and answers to questions on notice.

Chapter 1 Background

Before considering the potential for a hydrogen industry in New South Wales, this report begins with background information about production, storage and transport, the demand and opportunities for hydrogen, and the policy and funding framework relating to hydrogen in Australia. The chapter starts with a brief summary explaining what hydrogen is and how it can be used.

Hydrogen and its uses

1.1 Hydrogen is the most abundant and simplest element on earth. However, hydrogen does not exist on its own in nature and must be produced from sources that contain hydrogen. For this reason, it is considered an energy carrier, not an energy source.[2] Sources of hydrogen include water, which is the most abundant source of hydrogen, fossil fuels and biomass.[3]

1.2 Hydrogen can be used to generate heat and electrical energy. In both cases, the only other input required is oxygen and the only output is water.[4]

1.3 Hydrogen has a broad range of current and potential uses, as summarised below.

- **Domestic uses:** Hydrogen could be used in the natural gas network for home heating, cooking and water heating, replacing up to 13 per cent of the natural gas distributed by the network without having to modify appliances, existing pipeline infrastructure and gas meters. Currently, energy for heating comes from the direct combustion of fossil fuels, mainly natural gas, or from the generation of electricity.[5]
- **Transport:** Hydrogen can be used across transportation systems, including cars, buses, trucks, trains, ships, aircraft and spacecraft. In most cases, hydrogen is used to produce electricity in fuel cells that power electric motors. Trials are underway as to whether hydrogen can be combusted instead of fossil fuels in internal combustion engines such as those used in ships. In addition, as Australia is reliant on imports for 91 per cent of oil used in transport, the use of hydrogen as a transport fuel could improve Australia's domestic fuel security.[6]
- **Electricity generation:** As New South Wales and the National Electricity Market shift to renewable energy, hydrogen can help ensure the reliability and security of National Electricity Market. Renewable energy, such as solar or wind energy, can be intermittent as it is dependent on the weather and excess energy cannot be stored for future use when

2 See, Evidence, Dr Fiona Simon, Chief Executive Officer, Australian Hydrogen Council, 21 June 2021, p 13.

3 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 3.

4 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 3.

5 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 5.

6 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, pp 6-13.

energy output cannot meet demand. However, surplus renewable energy could be used to generate hydrogen using electrolysis which can be stored for future use.[7]

- **Industrial uses:** Hydrogen has a range of existing industrial uses, most of which is in the chemical industry. This includes the manufacturing of ammonia and the refining of petrochemicals. Hydrogen used by industry is mostly produced using fossil fuels. Renewably sourced hydrogen could power industrial processes that require high temperatures.[8]

Hydrogen production

1.4 There are a number of ways that hydrogen can be produced. Each process results in varying amounts of greenhouse gas emissions. A colour categorisation system has been developed to distinguish between the emissions produced by the various production processes. Each colour represents the means of hydrogen production and its level of greenhouse gas emissions. The focus for the international community is on blue and green hydrogen, as states begin to look towards renewable sources of energy.[9] Below is a table summarising the various categories.

Table 1 Hydrogen categories based on the emission of greenhouse gases

Brown	Hydrogen produced from coal with emissions released into the atmosphere
Grey	Hydrogen produced from natural gas with emissions released into the atmosphere
Blue	Hydrogen produced from natural gas with emissions subject to carbon capture and storage
Turquoise	Hydrogen produced using the process of methane pyrolysis, which then produces solid carbon as a by-product with zero direct emissions
Pink	Hydrogen produced from electrolysis using nuclear energy with zero direct emissions
Green	Hydrogen produced from electrolysis using renewable energy with zero direct emissions
Yellow	Hydrogen produced from electrolysis using a mix of renewable and non-renewable electricity, but can also refer to hydrogen produced from electrolysis using only solar energy
White	Naturally occurring hydrogen gas

Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, Hydrogen Energy: Briefing Paper No 2/2021, June 2021, p 17.

1.5 This section details the processes that can produce hydrogen, as well as a comparison of the production costs and emissions produced as part of the various processes.

7 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, pp 13-16.

8 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 16.

9 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, pp 18-19.

1.6 Currently, 95 per cent of hydrogen is produced through thermochemical processes involving fossil fuels, namely gas, oil and coal. The remaining 5 per cent of hydrogen is produced through electrolysis, which can be powered by renewable energy, fossil fuels or nuclear energy.[10]

1.7 To deal with carbon emissions generated from the burning of fossil fuels in thermochemical processes, carbon capture and storage (CCS) is a process that captures, concentrates, transports and permanently stores carbon dioxide gas in underground reservoirs. Carbon Capture Utilisation and Storage (CCUS) is a similar process except that carbon is either used as an input in other industrial process or permanently stored. [11]

1.8 The Australian Government views large-scale deployment of CCS as an opportunity for new low emission industries including hydrogen production using thermochemical processes. On 1 March 2021, the government opened applications to the Carbon Capture, Use and Storage Development Fund. Similarly, the NSW Government has also indicated its support for CCS, developing the NSW CO_2 Storage Assessment Program to identify geological storage sites in New South Wales for the safe and secure storage of carbon dioxide. However, CCS opponents argue that the ability of CCS to effectively capture and permanently store carbon dioxide emissions underground has not been proven.[12]

1.9 The focus for this inquiry is the production of green hydrogen through electrolysis, a chemical process that uses electricity to split water molecules into hydrogen and oxygen gases. This process occurs in a device called an electrolyser. [13]

1.10 A continuous supply of water is required for electrolysis amounting to nine kilograms of water for every one kilogram of hydrogen produced. The Hydrogen Working Group, set up by the Council of Australian Governments Energy Council to develop a National Hydrogen Strategy, found that less than 2.5 per cent of Australia's annual water consumption would be required to produce enough hydrogen to match the energy content of Australia's Liquefied Natural Gas exports in 2019.[14]

1.11 In 2018, the CSIRO published the *National Hydrogen Roadmap*. As part of this roadmap, the CSIRO compared the emissions produced by hydrogen production technologies as well as the costs of these technologies.

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10 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 17.

11 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, pp 20-21.

12 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, pp 21-22.

13 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, pp 22-23.

14 Hydrogen Strategy Group, *Hydrogen for Australia's future: A briefing paper for the COAG Energy Council,* August 2018, p 16 cited in Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 24.

1.12 In relation to emissions, the CSIRO found that producing hydrogen using thermochemical processes produce between 0.71 kg and 0.76 kilograms of carbon dioxide. In contrast, hydrogen production through electrolysis using renewable energy produced no carbon dioxide.[15]

1.13 While electrolysis produced no carbon emissions, the CSIRO calculated that the cost of hydrogen per kilogram using electrolysis was up to approximately $5 dollars more than the production of hydrogen using thermochemical processes. [16]

1.14 The Australian Government's *Technology Investment Roadmap* states that hydrogen becomes competitive as an industrial feedstock, transport fuel and in electricity generation when it is $2 per kilogram or less.[17]

Hydrogen storage and transportation

1.15 Because hydrogen gas has a low physical density, the energy carried by hydrogen by volume is also relatively low. Hydrogen's physical and volumetric energy density therefore needs to be increased for its storage and transportation to be practical and economical. Some ways to increase density include compressing hydrogen gas at high pressures in tanks, pipelines or underground, liquefying hydrogen or converting hydrogen into another chemical that contains hydrogen such as ammonia.[18] The table on the next page provides an overview of hydrogen storage technologies, and their advantages and disadvantages.

15 CSIRO, *National Hydrogen Roadmap,* 2018, p 67, cited in Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 24.

16 CSIRO, *National Hydrogen Roadmap,* 2018, pp 13 and 20, cited in Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 24.

17 Australian Government, *Technology Investment Roadmap: First Low Emissions Technology Statement 2020,* 2020, p 18, cited in Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 25.

18 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 28.

Table 2 Hydrogen storage technologies

TECHNOLOGY	DESCRIPTION[48, 49]	DIS/ADVANTAGES
Compression		
Low pressure tanks	No additional compression needed from hydrogen production. Only used for stationary storage where lower quantities of hydrogen are needed relative to available space.	+ Established technology - Poor volumetric energy density
Pressurised tanks	A mechanical device increases the pressure of the hydrogen in its cylinder. Hydrogen can be compressed and stored in steel cylinders at pressures of up to 200 bar. While composite tanks can store hydrogen at up to 800 bar[49], pressures typically range from 350 to 700 bar. Compression is used for both stationary storage and transport of hydrogen.	+ Established technology - Low volumetric energy density - Energy intensive process
Underground Storage	Hydrogen gas is injected and compressed in underground salt caverns which are excavated and shaped by injecting water into existing rock salt formations.[50] Withdrawal and compressor units extract the gas when required.	+ High volume at lower pressure and cost + Allows seasonal storage - Geographically specific
Line packing	A technique used in the natural gas industry, whereby altering the pipeline pressure, gas can be stored in pipelines for days and then used during peak demand periods.	+ Existing infrastructure + Straightforward hydrogen storage technique at scale
Liquefaction		
Cryogenic tanks	Through a multi-stage process of compression and cooling, hydrogen is liquefied and stored at -253˚C in cryogenic tanks. Liquefaction is used for both stationary storage and transport of hydrogen.	+ Higher volumetric storage capacity + Fewer evaporation losses - Requires advanced and more expensive storage material
Cryo-compressed	Hydrogen is stored at cryogenic temperatures combined with pressures approaching 300 bar.	+ Higher volumetric storage capacity + Fewer evaporation losses - Requires advanced and more expensive storage material
Material based		
Ammonia (NH_3)	Hydrogen is converted to ammonia via the Haber Bosch process. This can be added to water and transported at room temperature and pressure. The resulting ammonia may need to be converted back to hydrogen at the point of use.	+ Infrastructure is established + High hydrogen density (17.5% by weight) - Almost at theoretical efficiency limit - Plants need to run continuously - Energy penalty for conversion back to hydrogen - Toxic material

CSIRO, National Hydrogen Roadmap, 2018, p 27 (footnotes omitted) cited in Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, Hydrogen Energy: Briefing Paper No 2/2021, June 2021, p 28.

1.16 In its roadmap, the CSIRO made the following observations on storage options:

- underground storage and line packing are the most cost effective storage methods but may not always be available options
- storage through liquefaction is the most energy intensive
- by 2025, compressing hydrogen in tanks will cost 3 cents per kilogram in contrast with liquefying hydrogen which is expected to cost $1.59 to $1.94 per kilogram, and hydrogen stored with ammonia which could cost $1.10 to $1.33 per kilogram.[19]

[19] CSIRO, *National Hydrogen Roadmap,* 2018, pp 28, 29 and 31, cited in Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 29.

1.17 With regard to hydrogen transportation, hydrogen can be transported by truck, rail or ship in either compressed gas or liquid forms, or in pipelines as a compressed gas.[20] Emissions and costs from transportation also affect the total emissions and costs of hydrogen. The table below provides an overview of the hydrogen transportation modes and comments on their use.

Table 3 Hydrogen transportation methods

VEHICLE	STORAGE TYPE	INDICATIVE DISTANCES	DESCRIPTION/USE
Truck (Virtual pipelines)	Compression, liquefaction, ammonia	<1000km[65]	Transport of liquefied and compressed hydrogen as well as ammonia is available commercially. Ammonia is less likely as a hydrogen carrier here given the scale requirements and need to convert back to hydrogen for use. Higher pressures/liquefaction are typically used for trucking distances greater than 300km.
Rail	Compression, liquefaction, ammonia	>800-1100km[66]	As per trucks but for greater distances travelled
Pipeline	Compression	1000-4000km	More likely to be used for simultaneous distribution to multiple points or for intercity transmission
Ship	Ammonia, liquefaction	>4000km	Unlikely to use compression storage for shipping given cost of operation, distance and lower hydrogen density. Likely vehicle for export.

CSIRO, National Hydrogen Roadmap, 2018, p 27, cited in Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, Hydrogen Energy: Briefing Paper No 2/2021, June 2021, p 32.

Demand and opportunities for hydrogen

1.18 According to the International Energy Agency (IEA), there has been recent increased interest in hydrogen globally as more attention has turned to reducing emissions and the wide range of benefits hydrogen can offer in this space. The IEA estimated that by mid-2019 there were about 50 targets, mandates and policy incentives in place to directly support hydrogen.[21] Japan, the European Union, the United States and Canada are examples of some countries that have developed a hydrogen strategy.[22]

1.19 In a report published in 2021, the Hydrogen Council estimated that governments across the world have committed more than US$70 billion to support the hydrogen industry. The Hydrogen Council identified 228 hydrogen projects globally: 128 in Europe, 46 in Asia, 24 in

20 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, pp 29 and 31.

21 International Energy Agency, *The Future of Hydrogen: Seizing today's opportunities,* June 2019, pp 19-20, cited in Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 33.

22 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 33.

Oceania, 19 in North America, 8 in the Middle East and Africa, and 5 in Latin America. Most projects were in large-scale industrial usage.[23]

1.20 Reports indicate that clean and low-carbon hydrogen will account for a significant part of the energy mix by 2050. For example, in an analysis of technology options to reach net zero emissions by 2070, the IEA found that low-carbon hydrogen, produced either through fossil fuels with CCS or through electrolysis, would play a key role in the energy mix, with hydrogen use to expand to all sectors and reaching a 13 per cent share in final energy demand in 2070.[24]

1.21 Looking to the benefits of hydrogen for Australia, the Hydrogen Strategy Group identified three key opportunities that hydrogen can offer for the country:

- export, as many countries in the world look to decarbonise energy systems
- domestic economy including replacing natural gas as well as use in industrial processes and transport
- energy system resilience to support the electricity security and reliability.[25]

1.22 In relation to exports, the Hydrogen Strategy Group referred to the Japanese and South Korean markets which respectively currently import 94 per cent and 81 per cent of their energy, and have signalled their intention to incorporate hydrogen in their energy systems.[26]

1.23 Australia has a number of advantages to enable a hydrogen export industry. These include the availability of 'natural resources … to make hydrogen, a track record in building large-scale energy industries, and an established reputation as a trusted energy supplier to Asia'.[27] More specifically, New South Wales also has a number of advantages including an abundance of renewable sources, ports and transport links that can be used for hydrogen transport and many university research and development programs looking at hydrogen production, storage and use.[28] However, in 2017, the United States was the leading exporter of hydrogen with trade valued at $2.2 billion, in contrast with Australia's $130 million.[29]

1.24 As at early May 2021, there were 61 hydrogen-related projects in Australia, five of which were in New South Wales. The most advanced project in New South Wales is the $15 million Western

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23 Hydrogen Council, *Hydrogen Insights: A perspective on hydrogen investment, market development and cost competitiveness – February 2021,* January 2021, pp iv and 6.

24 International Energy Agency, *Energy Technology Perpectives 2020*, 2020, p 66, cited in Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, pp 34-35.

25 Hydrogen Strategy Group, *Hydrogen for Australia's future: A briefing paper for the COAG Energy Council,* August 2018, pp 6-7, cited in Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 39.

26 Hydrogen Strategy Group, *Hydrogen for Australia's future: A briefing paper for the COAG Energy Council,* August 2018, p 2, cited in Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 39.

27 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, pp 39-40

28 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 41.

29 Submission 5, Regional Development Australia – Illawarra & Sydney, p 6.

Sydney Green Gas Project, a renewable gas five-year trial that will convert solar and wind power into hydrogen gas which then will be stored for use in the natural gas network.[30]

Policy and funding framework in Australia

1.25 The following sections provide a summary of the strategies and funding commitments made by the Australian and New South Wales Governments.

Commonwealth

1.26 The Australian Government adopted the National Hydrogen Strategy in November 2019. Led by Australia's Chief Scientist Dr Alan Finkel, the strategy was developed by the Hydrogen Strategy Working Group for the COAG Energy Council. The strategy lists 57 actions for Australian governments centred around seven themes: national coordination; developing production capacity, supported by local demand; responsive regulation; international engagement; innovation, and research and development; skills and workforce; and community confidence.[31]

1.27 A key element for Australia to achieve scale and become a globally competitive supplier will be creating hydrogen hubs, namely regions where producers and users of hydrogen are co-located, to 'allow for efficiencies from scale, foster innovation, facilitate the sharing of expertise and services and promote sector coupling'. [32] The development of hydrogen hubs is discussed in more detail in Chapter 3.

1.28 Since the release of the strategy, a number of funding commitments have been made by the Australian Government and other agencies, as set out below.

- Two funds were created following the release of the strategy, the $300 million Clean Energy Finance Corporation Advancing Hydrogen Fund and the $70 million Australian Renewable Energy Agency (ARENA) Hydrogen Deployment Funding Round (later increased to $100 million).
- In September 2020, the Australian Government released the *Technology Investment Roadmap: First Low Emissions Technology Statement* which includes hydrogen as one of five priority low emissions technologies. The statement was accompanied by a $1.9 billion funding package including $1.6 billion for ARENA to invest, $75 million for a Future Fuels Fund which aims to address barriers to the roll-out of new vehicle technologies, and $70 million to set up a hydrogen export hub.
- In February 2021, National Resources Energy Australia announced that it would invest $1.9 million in 13 regional hydrogen technology clusters across Australia.

30 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, pp 53-54.

31 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 47.

32 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 47.

- In April 2021, the Australian Government announced a $276 million funding package to assist in the development of four hydrogen hubs in regional Australia and to implement a clean hydrogen certification scheme.
- The May 2021 national budget included $25 million over three years to assist new gas generators to become hydrogen ready, and up to $30 million for work on the proposed dual fuel power station at Port Kembla, to be fuelled by gas and green hydrogen.[33]

1.29 Separate to the funding announcements, actions that occurred in 2020 in relation to the national strategy included:

- consultation with industry on a hydrogen certification scheme
- government engagement with other countries including Japan, South Korea, Singapore and Germany
- coordination of a review by the COAG Hydrogen Project Team of state, territory and federal regulations relevant to hydrogen safety and industry development, and a review of activities to support the use of hydrogen in Australian gas networks.[34]

New South Wales

1.30 The NSW Government has indicated that it is currently working on a hydrogen strategy that will align with the National Hydrogen Strategy, to be published once it is completed.[35]

1.31 The National Hydrogen Strategy outlines priorities for each jurisdiction. The priorities for New South Wales include:

- developing the supporting infrastructure and capability for a hydrogen industry
- planning approval and infrastructure development
- regulatory oversight
- support for business, and research and development.[36]

1.32 While New South Wales has yet to finalise its strategy, hydrogen has been considered in other plans and policies such as the government's goal of net zero emissions by 2050. In March 2020, the government released the *Net Zero Plan Stage 1: 2020-2030*. One of the priorities in this plan is to invest in emissions reduction with a key focus on low-emissions hydrogen.

1.33 The plan states that the NSW Government will set up a Hydrogen Program that will help scale up the use of hydrogen in energy and as feedstock. The program will offer competitive grants for demonstration, research and development, and commercialisation projects. In addition, the

33 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, pp 47-48.

34 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 48.

35 *Questions and Answers Paper,* NSW Legislative Council, 7 August 2020, p 2825.

36 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 49.

plan sets out an aspirational target of up to 10 per cent hydrogen in the gas network by 2030.[37] Gas blending is considered in further detail in Chapter 3.

1.34 In November 2020, the NSW Government released the *NSW Electricity Infrastructure Roadmap*, which seeks to 'create renewable energy zones, deliver energy storage infrastructure and harness opportunities for industry from the supply of cheap, reliable and low emissions electricity'. The creation of a hydrogen industry is one of the opportunities set out in the roadmap.[38] The *Electricity Infrastructure Investment Act 2020,* which gives effect to the roadmap, includes a $50 million commitment from the Climate Change Fund between 2021 and 2030 to develop the green hydrogen sector.

1.35 Finally, in March 2021, the NSW Government announced $750 million in funding under the Net Zero Industry and Innovation Program to help achieve the *Net Zero Plan Stage 1: 2020-2030*. At least $70 million of the funding package is set to support the establishment of hydrogen hubs in the Hunter and Illawarra.[39]

37 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 49.

38 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 49.

39 Lenny Roth and Tom Gotsis, NSW Parliamentary Research Service, *Hydrogen Energy: Briefing Paper No 2/2021*, June 2021, p 50.

Chapter 2 The potential for a hydrogen industry in New South Wales

This chapter focuses on some of the key resources and infrastructure required for hydrogen production, storage and transportation. It begins with a discussion of the existing resources and infrastructure in New South Wales that can readily support an emerging hydrogen industry, including around water, energy and transport. The chapter also considers the key challenges raised by stakeholders in developing the industry, including the lack of large scale hydrogen storage options and the high cost of hydrogen production.

Existing capability

2.1 The overwhelming majority of stakeholders to this inquiry were supportive of the development of a hydrogen industry for New South Wales. Many argued that New South Wales is well positioned to develop a hydrogen industry based on the availability of existing infrastructure and resources appropriate for hydrogen production and distribution.[40]

2.2 National public sector geoscience research agency, Geoscience Australia, shared that their analysis of hydrogen production potential across the country found that large parts of New South Wales 'were prospective for renewable hydrogen production'.[41]

2.3 Honorary Professorial Fellow and Director at the University of Newcastle's Energy Futures Network, Mr Ty Christopher, pointed to the state's existing infrastructure and resources, and expressed the view that New South Wales has 'significant advantages' over other states.[42] Similarly, the Australian Hydrogen Council suggested that New South Wales can not only play a key role in Australia's emerging hydrogen industry, but could 'even establish itself as a leader'.[43]

2.4 Stakeholders referred to the following resources available in the state that can support a hydrogen industry, which places New South Wales and Australia at an advantage over other jurisdictions:

- an abundance of water resources to produce hydrogen
- electricity resources to power electrolysers including sufficient renewable energy resources and access to the state's electricity network
- existing transport infrastructure including ports for export and freight routes for domestic transportation.

2.5 These are discussed in turn below.

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40 See, for example, Submission 4, Geoscience Australia, p 5; Submission 18, Jemena Gas Networks (NSW) Ltd, p 4; Evidence, Mr Ty Christopher, Honorary Professorial Fellow and Director, Energy Futures Network, University of Newcastle, 21 June 2021, p 26; Submission 15, University of Newcastle, p 2; Submission 34, Australian Hydrogen Council, p 5.

41 Submission 4, Geoscience Australia, p 4.

42 Evidence, Mr Ty Christopher, Honorary Professorial Fellow and Director, Energy Futures Network, University of Newcastle, 21 June 2021, p 26.

43 Submission 34, Australian Hydrogen Council, p 5.

Water resources

2.6 As explained in Chapter 1, hydrogen production requires large volumes of water with at least nine tonnes required for each tonne of hydrogen produced using renewable energy and electrolysis. The National Hydrogen Strategy identified seawater desalination and wastewater recycling as the most sustainable sources of water, especially for large scale hydrogen exports.[44] Geoscience Australia explained that groundwater resources were not considered in the National Hydrogen Strategy due to the competition for these resources and the scale of water needed for hydrogen production.[45]

2.7 New South Wales has vast wastewater resources. Putting this into context, Geoscience Australia explained that to produce 18 megatonnes of hydrogen 'under the most ambitious 2050 scenario for national hydrogen production' as per the National Hydrogen Strategy, an estimated 207 gigalitres of water is required each year. This amounts to less than half of the treated wastewater discharged annually from Sydney.[46]

2.8 Geoscience Australia further outlined that using wastewater provides an opportunity to use excess treated wastewater that may otherwise be difficult to dispose of. Wastewater must be treated to reduce pollutants in the water before it is released back into the environment. However, in some cases treatment and disposal options may be limited. For example, Dr Andrew Feitz, Director, Low Carbon Geoscience and Advice, Minerals, Energy and Groundwater Division, Geoscience Australia, highlighted that for inland wastewater treatment plants, there are issues around the nutrient levels in the wastewater and the level of treatment required before the water can be discharged into inland receiving systems. Using wastewater for hydrogen would decrease the load on those receiving systems.[47]

2.9 Speaking about the capability for hydrogen production in the Illawarra, Mr Christopher supported the use of recycled wastewater for hydrogen production, noting that desalination is more energy intensive, less efficient and more expensive.[48]

Energy resources

2.10 To produce hydrogen from water, electricity is essential for electrolysis which is the process which splits water into hydrogen and oxygen. More specifically, green hydrogen is produced through electrolysis using renewable energy. Inquiry participants outlined that New South Wales has considerable access to both solar and wind renewable energy.[49]

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44 Submission 4, Geoscience Australia, p 6.

45 Evidence, Dr Andrew Feitz, Director, Low Carbon Geoscience and Advice, Minerals, Energy and Groundwater Division, Geoscience Australia, 21 June 2021, p 3.

46 Submission 4, Geoscience Australia, p 6.

47 Evidence, Dr Andrew Feitz, Director, Low Carbon Geoscience and Advice, Minerals, Energy and Groundwater Division, Geoscience Australia, 21 June 2021, p 3. See also, Submission 4, Geoscience Australia, p 6.

48 Evidence, Mr Ty Christopher, Honorary Professorial Fellow and Director, Energy Futures Network, University of Newcastle, 21 June 2021, p 21.

49 See, Submission 18, Jemena Gas Networks (NSW) Ltd, p 4.

2.11 Geoscience Australia referred to their work with Monash University quantifying Australia's renewable energy resources. Geoscience Australia found that in New South Wales there are abundant solar resources located in Western New South Wales with lower solar generation capacity along the eastern seaboard, as well as significant wind resources along the Great Dividing Range.[50]

2.12 Furthermore, the research agency noted that regions that can harness both solar and wind energy provide the highest capacity for electrical output, thus allowing for hydrogen operation to increase in scale. This is because a site that can generate solar energy during the day can then supplement this with wind energy at other times. In turn, this increases the overall renewable energy generation possible at a single location.[51]

2.13 In New South Wales, these regions are located in the north-west, central west and along the Great Dividing Range. Geoscience Australia argued that the availability of both wind and solar energy resources at locations such as the Great Dividing Range, in relatively close proximity to the coast and potential hydrogen ports 'indicates that New South Wales could host a large scale hydrogen export industry'.[52]

2.14 In addition to the availability of significant solar and wind energy resources, Geoscience Australia provided an analysis of the potential access to the electricity network for future hydrogen facilities. The research agency explained that any future renewable energy-based hydrogen facility will require access to the electricity grid to purchase renewable energy or access to land to develop a renewable energy facility to power the hydrogen plant's electrolyser. Access to electricity networks would also facilitate the use of hydrogen in the electricity network during periods of low renewable energy generation.[53]

2.15 Based on an analysis of existing electricity transmission lines, Geoscience Australia found that the state has good access to transmission lines in most of the south and east. However limited access in the west and north-west means that off-grid renewable energy plants would be required for green hydrogen production in those regions.[54]

2.16 The Maritime Union of Australia and the South Coast Labour Council suggested offshore wind resources as an accessible renewable energy option to produce hydrogen. Offshore wind refers to wind farms situated in bodies of water. According to the Maritime Union of Australia, New South Wales has 'outstanding offshore wind resources' close to the coast with average wind strengths of 10 meters per second. To contextualise this, the union explained that this is windier than most parts of the European North Sea, matched only by wind off the far north of Scotland.[55] The South Coast Labour Council also highlighted that offshore wind patterns are stronger than most locations on shore.[56]

50 Submission 4, Geoscience Australia, pp 7-8.

51 Submission 4, Geoscience Australia, pp 7-8.

52 Submission 4, Geoscience Australia, pp 7-8.

53 Submission 4, Geoscience Australia, p 12.

54 Submission 4, Geoscience Australia, p 12.

55 Submission 43, Maritime Union of Australia (MUA), p 15.

56 Submission 40, South Coast Labour Council, p 3.

2.17 The Maritime Union of Australia pointed to some of the benefits of using offshore wind, including the potential to avoid the need for transmission and cost of using electricity from the grid, thus bringing down the cost of hydrogen production. The union also explained that offshore renewable energy infrastructure 'virtually eliminates the climate risks of high temperature and bushfires' to the energy system, compared with other facilities which are proposed to be built in areas with high climate risks.[57]

Transport infrastructure

2.18 Finally, in addition to the natural resources available in the state to produce hydrogen, stakeholders highlighted that New South Wales has existing transport infrastructure to facilitate export and domestic transportation of hydrogen.

2.19 As highlighted in Chapter 1, there is an emerging demand for hydrogen internationally, providing Australia with a significant export opportunity. Therefore, ports will play a central role in any emerging hydrogen industry. Geoscience Australia referred to a technical study which identified potential liquid hydrogen export locations across Australia. According to this study, the minimum port infrastructure requirements for selecting suitable ports include the ability to use the site for liquid hydrogen transport without significant modification to ensure lower development costs. The study identified a number of suitable sites in New South Wales, namely Newcastle, Port Botany/Kurnell and Port Kembla.[58]

2.20 Geoscience Australia noted that the sites are located within urban areas in close proximity to potential domestic markets for hydrogen such as gas blending or transport. In turn, the research agency explained that the use of port facilities as production sites for hydrogen can lead to the development of hydrogen hubs which can help reduce the production and transportation costs of hydrogen.[59] This is discussed further in Chapter 3.

2.21 In relation to domestic transport, Geoscience Australia indicated that key freight routes in New South Wales 'are well distributed across the state, connecting potential hydrogen production facilities on the coast with regional centres in New South Wales'. These freight routes also have 'good connectivity with neighbouring states', enabling interstate transport.[60]

Barriers

2.22 While New South Wales has the natural resources and infrastructure to produce and transport hydrogen, stakeholders noted that the biggest barriers in realising the state's potential include:

- the availability of large scale hydrogen storage options
- the high costs of hydrogen throughout the supply chain.

57 Submission 43, Maritime Union of Australia (MUA), p 15.

58 Submission 4, Geoscience Australia, p 9.

59 Submission 4, Geoscience Australia, p 10.

60 Submission 4, Geoscience Australia, p 10.

Storage

2.23 Geoscience Australia explained that large scale hydrogen storage is key 'to balancing variable hydrogen production from renewable energy with domestic and export demand'. While pipeline storage, solid state hydrogen storage technology and above ground tanks can enable small scale storage, underground hydrogen storage is the only viable option to facilitate large scale storage.[61]

2.24 According to Geoscience Australia, salt caverns are 'the most optimal' for large scale storage. A salt cavern is constructed by drilling a well into a thick sequence of salt rock, dissolving out the salt and leaving a cavern for gas storage. Globally, all commercially produced hydrogen stored underground is stored in salt caverns, with the majority of planned storage facilities also targeting salt caverns. Geoscience Australia indicated that salt storage in New South Wales may not be possible as there are no known underground thick salt resources in the state.[62]

2.25 The research agency also considered depleted gas reservoirs as an option. While there are no international examples of large scale hydrogen storage using depleted gas reservoirs, they are 'a promising possibility' with several field trials proposed or underway. However, this is unlikely to be a possibility for New South Wales, as there is only one depleted gas field in northern New South Wales, which is located hundreds of kilometers from potential hydrogen ports and pipelines such as those in Wollongong and Newcastle.[63]

2.26 With limited access to salt storage and depleted gas reservoirs, Geoscience Australia explained that New South Wales will need to consider alternative storage options to facilitate large scale hydrogen storage, such as aquifer storage, hard rock caverns and abandoned mines.[64] Both Geoscience Australia and the Australian Hydrogen Council argued that further research is required to determine how best to store hydrogen on a large scale.[65] This is explored further in Chapter 3.

2.27 One stakeholder specialising in hydrogen storage technology recognised the limitations for hydrogen storage and proposed an alternative option. Ardent Underground submitted that it is developing a technology solution which 'consists of storing compressed hydrogen in modular underground purposely built cavities'. The technology is based on the concept of vertical shaft blind boring, a process which excavates vertical shafts downwards from the ground's surface.[66]

2.28 According to Ardent Underground, the proposed technology 'occupies minimal space above ground, can be readily duplicated, is cost effective, [is] safe and does not suffer from cycling degradation over time'.[67]

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61 Submission 4, Geoscience Australia, p 15.

62 Submission 4, Geoscience Australia, p 15.

63 Submission 4, Geoscience Australia, p 16. See also, Dr Andrew Feitz, Director, Low Carbon Geoscience and Advice, Minerals, Energy and Groundwater Division, Geoscience Australia, 21 June 2021, p 4.

64 Submission 4, Geoscience Australia, pp 17-18. See also, Dr Andrew Feitz, Director, Low Carbon Geoscience and Advice, Minerals, Energy and Groundwater Division, Geoscience Australia, 21 June 2021, p 4.

65 Submission 4, Geoscience Australia, p 18. Submission 34, Australian Hydrogen Council, pp 14-15.

66 Submission 6, Ardent Underground, p 3.

67 Submission 6, Ardent Underground, p 6.

Cost

2.29 Inquiry participants also identified the costs involved in the hydrogen supply chain as another significant barrier to realising the potential for a hydrogen industry. The main costs identified by stakeholders were the cost of producing hydrogen via electrolysis, the capital cost of electrolysers, the cost of electricity and costs associated with transport.[68]

2.30 As outlined in Chapter 1, hydrogen production will need to cost $2 per kilogram to become commercially viable. Policy Director Energy Generation at Clean Energy Council, Ms Anna Freeman noted that hydrogen currently costs $6 per kilogram. Referring to analysis conducted by the Australian Renewable Energy Agency, Ms Freeman provided a breakdown of the cost as follows: 36 per cent as the cost of the electrolyser, 43 per cent as the cost of electricity and 20 or 21 per cent as the cost of operational expenditure.[69]

2.31 Dr Fiona Simon, Chief Executive Officer of the Australian Hydrogen Council highlighted that electrolysers are currently manufactured in a bespoke manner but that large scale manufacturing in factories is 'starting to grow globally' which would reduce electrolyser costs. However, both Dr Simon and Ms Freeman contended that reducing the cost of hydrogen production will mostly depend on reducing electricity prices. Ms Freeman explained that the price of renewable energy is currently between $45 and $55 a megawatt hour, and that this will need to be reduced to $20 a megawatt hour. She argued that to reduce this cost, there will need to be investment in renewable energy zones and a reduction in the risk profile of renewable energy projects.[70] Ways to address the high cost of hydrogen production are discussed in more detail in Chapter 3.

2.32 In addition to production costs, Geoscience Australia outlined that hydrogen transport can 'add significantly to the overall cost of the hydrogen supply chain'.[71] In evidence, Dr Feitz, Director at Geoscience Australia explained that 'it is more likely more cost-effective' to produce hydrogen at the coast where there is abundant water for production, a port nearby for export and to have the electricity produced at the coast rather than to produce hydrogen at a location further away from the coast and transporting hydrogen to the port for export.[72]

2.33 While most stakeholders outlined ways in which the cost of hydrogen production can be reduced, the Australian Energy Council argued that 'there should be no unrealistic expectation that a hydrogen plant can run continuously, or near-continuously, with low prices'. The council explained that although there is an expectation that average electricity prices will reduce in the future, 'the horizon of such forecasts is near, and there can be no certainty that any substantial

68 Evidence, Dr Andrew Feitz, Director, Low Carbon Geoscience and Advice, Minerals, Energy and Groundwater Division, Geoscience Australia, 21 June 2021, p 6; Evidence, Ms Anna Freeman, Policy Director Energy Generation, Clean Energy Council, 21 June 2021, p 9; Evidence, Dr Fiona Simon, Chief Executive Officer, Australian Hydrogen Council, 21 June 2021, p 10; Submission 18, Jemena Gas Networks (NSW) Ltd, p 4. See also, Submission 30, BlueScope, p 10.

69 Evidence, Ms Anna Freeman, Policy Director Energy Generation, Clean Energy Council, 21 June 2021, p 10.

70 Evidence, Ms Anna Freeman, Policy Director Energy Generation, Clean Energy Council, 21 June 2021, p 11.

71 Submission 4, Geoscience Australia, p 10.

72 Evidence, Dr Andrew Feitz, Director, Low Carbon Geoscience and Advice, Minerals, Energy and Groundwater Division, Geoscience Australia, 21 June 2021, p 5.

reduction in average prices is likely to be sustained'. According to the council's submission, a business case for a hydrogen plant would need to accommodate variations in prices.[73]

Committee comment

2.34 The committee agrees with stakeholders that there is a genuine opportunity for New South Wales to not only pursue the development of a hydrogen industry but to become a leader in this space. We have the water to produce hydrogen, the renewable energy resources to power electrolysers, the ports to export hydrogen internationally where there is a clear demand, and the freight routes for domestic transport.

2.35 While we acknowledge the challenges associated with hydrogen storage and the overall cost in the hydrogen supply chain, we heard from a wide range of stakeholders who expressed a clear will and enthusiasm to develop a hydrogen industry. At this stage, it is up to the NSW Government to enable industry participants to develop this emerging industry by providing the appropriate tools.

2.36 The next chapter will consider the ways in which the NSW Government can harness the state's existing capabilities, address the barriers raised by stakeholders and provide the support and leadership required to realise the state's potential for a hydrogen industry.

[73] Submission 8, Australian Energy Council, pp 1-2.

Chapter 3 The way forward

This final chapter considers the measures that the NSW Government can implement to take a leading role in supporting and developing a hydrogen industry in New South Wales. These measures centre around policy and funding, research and development, local demand, hydrogen hubs, and workforce and skills.

The NSW Government's role in developing a hydrogen industry

3.1 Given hydrogen's wide range of uses, the development of a hydrogen industry provides an opportunity to transition to clean renewable energy sources to help meet the state's target of net zero emissions by 2050. It also provides substantial export opportunities for countries who are moving away from fossil fuel industries.[74]

3.2 However, while the resources and infrastructure to produce and transport hydrogen are largely available, inquiry participants identified that the state cannot fully realise its potential to develop a hydrogen industry without government input. These stakeholders recognised that there is support for a hydrogen industry by the government, but that the level of government involvement to date has been piecemeal and insufficient to grow the hydrogen industry to a large, commercial scale.

3.3 Stakeholders recommended that the government take a lead role in the development of a hydrogen industry to create a hydrogen market and attract private investment by:

- introducing a state strategy, increasing funding and developing a policy and regulatory framework
- focusing on research and development by conducting studies to determine best practice and supporting industry research and project demonstrations
- creating local demand for hydrogen
- investing in regional hydrogen hubs, particularly in Wollongong and Newcastle
- providing support for workforce transition and training.

3.4 The following sections provide a summary of these proposed government initiatives.

Policy and funding

3.5 Inquiry participants argued that a comprehensive policy and strategic framework and increased funding are essential to enable the hydrogen industry to reach commercial scale, attract private investment and compete with fossil fuel industries.[75]

3.6 Stakeholders pointed out that New South Wales is the only state in Australia without a hydrogen strategy, with some contending that the state risks falling behind others. Ms Anna Freeman,

74 See, Submission 17, Clean Energy Council, p 1.

75 See, Submission 18, Jemena Gas Networks (NSW) Ltd, p 9; Submission 32, Coregas, p 4; Evidence, Ms Anna Freeman, Policy Director Energy Generation, Clean Energy Council, 21 June 2021, p 8.

Policy Director Energy Generation at the Clean Energy Council highlighted that the 'renewable hydrogen sector is eagerly anticipating the state's forthcoming hydrogen strategy'.[76] Many inquiry participants supported the call for a hydrogen strategy, noting that such a strategy would:

- signal the government's plans and drive the development of the hydrogen industry
- position New South Wales for international hydrogen opportunities
- identify and prioritise strategic projects in the state
- attract private investment, and provide confidence and certainty to industry participants
- ensure that the industry is properly planned, safe and provides quality jobs.[77]

3.7 The Australian Hydrogen Council also expressed its support for the NSW Chief Scientist and Engineer's recommendation that the NSW Government develop a strategy that sets out its own 'approach and trajectory for all government assets and procurement to meet its 2050 net zero target'.[78]

3.8 On the issue of funding, the committee heard evidence that government funding is one of the key ways to support the development of a hydrogen industry to a commercial scale. The Australian Hydrogen Council explained that industry requires governments to act as 'partners to share risk and commercialise projects to scale'.[79] The council further highlighted that public funding and policies to fill the investment gap between hydrogen and fossil fuels 'can then unlock several times their value from the private sector', estimating that government funding 'might be expected to unlock at least three times as much private investment'.[80]

3.9 Looking to the situation in New South Wales, the Australian Hydrogen Council contended that current levels of funding for the hydrogen industry is 'unlikely to unlock' private investment to reach commercial scale.[81] The Clean Energy Council similarly stated that while one-off grants are helpful in the short term, they are unlikely to 'deliver the least-cost development of the industry or build the necessary scale to realise the state's full potential', due to the piecemeal nature of the funding.[82]

3.10 The Australian Hydrogen Council suggested that this could be improved by a commitment to co-investing in local projects to help draw in private investment.[83] Based on an estimated cost of $50 million for a hydrogen project, the Australian Hydrogen Council recommended that the NSW Government commit $400 million for hydrogen production and associated infrastructure in three parts over the next decade:

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76 Evidence, Ms Anna Freeman, Policy Director Energy Generation, Clean Energy Council, 21 June 2021, p 8.

77 Submission 17, Clean Energy Council, p 3; Submission 29, LAVO, p 3; Submission 43, Maritime Union of Australia, p 5; Submission 26, Hyundai, pp 8-9; Submission 38, Hunter Business Chamber, p 5.

78 Submission 34, Australian Hydrogen Council, p 14.

79 Submission 34, Australian Hydrogen Council, p 6. See also, Submission 37, ENGIE, p 3.

80 Submission 34, Australian Hydrogen Council, p 10.

81 Submission 34, Australian Hydrogen Council, p 10.

82 Submission 17, Clean Energy Council, pp 3 and 6.

83 Submission 34, Australian Hydrogen Council, p 10.

- **2021-2024:** $100 million in two hubs or precincts
- **2025-2028:** $100 million as required to support current and new projects, with a focus on getting fuel cell electric vehicles to market including government-managed transport
- **2029-2030:** $200 million as required to support new projects.[84]

3.11 In addition to funding, the committee heard that policy can also play a significant role in reducing the investment gap. The Australian Hydrogen Council suggested that government policies can support the supply side of markets to reduce the cost of production and delivery, or the demand side to reduce the cost of purchase and create market pull.[85] Some examples provided by stakeholders include:

- exempting hydrogen from electricity network tariffs in recognition of the benefits electrolysers can bring to the electricity grid, or introducing electrolyser-specific tariffs to reflect the cost structures and economics of electrolysers[86]
- underwriting common use infrastructure such as refueling stations for fuel cell electric vehicles[87]
- tax, credit and financing incentives to attract private investment[88]
- support for green consumer initiatives such as carbon pricing, zero emission vehicle rebates, interest free loans for the purchase of zero emission vehicles and an accredited certification system for green, renewable or net zero hydrogen to link consumer choice and demand. [89]

3.12 Related to policy, stakeholders also argued that major hydrogen projects and participants in the hydrogen industry require regulatory certainty and consistency. The versatility of hydrogen means that it connects different parts of the economy and regulatory regimes which can vary between industries, levels of government and jurisdictions. Consequently, the Australian Hydrogen Council argued that the hydrogen industry requires 'integrated governance' to ensure that regulatory regimes across different sectors such as electricity, gas and water; different issues such as safety, environmental protection and training; and different parts of the various value chains such as production and transportation for different uses, are 'suitability consistent and do not unnecessarily hinder market development'. [90]

3.13 To this end, the Australian Hydrogen Council recommended that the NSW Government establish a cross-sector taskforce comprising stakeholders from across government to 'identify

84 Submission 34, Australian Hydrogen Council, p 12.

85 Submission 34, Australian Hydrogen Council, p 12. See also, Submission 35, BOC Limited, p 7.

86 Submission 34, Australian Hydrogen Council, p 12.

87 Submission 34, Australian Hydrogen Council, p 13.

88 Submission 34, Australian Hydrogen Council, p 12; Submission 29, LAVO, p 4; Submission 32, Coregas, p 4.

89 Submission 34, Australian Hydrogen Council, p 12; Submission 29, LAVO, p 4; Submission 32, Coregas, p 4; Submission 26, Hyundai, p 10; Submission 32, Coregas, p 4.

90 Submission 34, Australian Hydrogen Council, p 13. See also, Submission 18, Jemena Gas Networks (NSW) Ltd, p 9; Submission 37, ENGIE, p 2; Submission 36, Committee for the Hunter, p 3.

and eliminate any unnecessary cross-sectoral barriers' and to work with the National Hydrogen Project Team. [91]

3.14 More broadly, inquiry participants called for planning and coordination of policy and regulation across states and territories.[92] The Australian Hydrogen Council noted that they have requested a national Hydrogen Market Development Plan be developed that 'works toward hydrogen production at less than $2 per kilogram of hydrogen by 2030 and involves a cross-jurisdictional group of regulators to inform and help deliver the necessary regulatory component'. [93]

Research and development

3.15 The committee heard evidence on the value of research and development at this early stage of the hydrogen industry's development. Stakeholders called for the NSW Government to conduct studies into specific issues and to support research and development efforts by universities and industry, including demonstration projects.

3.16 As outlined in Chapter 2, the lack of large scale hydrogen storage options in the form of salt or depleted gas reservoirs presents one of the biggest barriers to realising a commercially viable hydrogen industry. Despite this, the Australian Hydrogen Council noted that 'storage has not received much attention to date'.[94]

3.17 Both the Australian Hydrogen Council and Geoscience Australia called for research into the state's storage needs. Geoscience Australia suggested that New South Wales should first assess the degree of storage required and the potential storage gap, then support research efforts in collaboration with industry to identify suitable aquifers and possibly hard rock caverns or abandoned mine conversions.[95]

3.18 Other research needs identified by stakeholders included:

- an overarching study into the infrastructure, workforce, and regulatory and investment requirements for a multi-faceted hydrogen ecosystem including export, industrial and residential domestic use, and research and development[96]
- economic research to identify how to minimise hydrogen supply chain costs and maximise economic benefits for the state[97]
- a study into the potential of offshore wind in New South Wales to benefit the electricity system and produce hydrogen, for inclusion in the New South Wales Renewable Energy Plan[98]

91 Submission 34, Australian Hydrogen Council, p 14.

92 Submission 34, Australian Hydrogen Council, p 14; Submission 37, ENGIE, p 2; Submission 22, Hyzon, p 3.

93 Submission 34, Australian Hydrogen Council, p 14.

94 Submission 34, Australian Hydrogen Council, p 15.

95 Submission 4, Geoscience Australia, p 18; Submission 34, Australian Hydrogen Council, p 15.

96 Submission 24, Star Scientific, p 14.

97 Submission 4, Geoscience Australia, p 18.

98 Submission 43, Maritime Union of Australia (MUA), p 17.

- a study to understand the existing local skills base, the ability of this existing workforce to meet the needs of an emerging hydrogen sector and any gaps to be addressed through skills development and training over the next decade.[99]

3.19 In addition to commissioning research, inquiry participants recommended that the NSW Government monitor and support research and development conducted by industry and universities.[100]

3.20 The committee heard evidence on the NUW Alliance, a research alliance between the University of Newcastle, University of New South Wales, University of Wollongong and more recently Western Sydney University. One of their major research collaborations is in the energy space.[101]

3.21 Representatives from the University of Newcastle and the University of Wollongong spoke to the role of research and development in the emerging hydrogen industry. Highlighting that research covers not only the technical aspects but also the economics of hydrogen, Mr Ty Christopher of the University of Wollongong emphasised that the NUW Alliance is building a 'holistic view across all of the energy transformation environment'.[102]

3.22 In their submissions, the University of Newcastle, University of New South Wales and University of Wollongong encouraged the NSW Government to draw on their resources and expertise in research to identify the best opportunities for the emerging hydrogen industry. The University of Newcastle and the University of Wollongong also referred to their proximity to relevant industry players and infrastructure in their respective regions.[103]

3.23 The University of Newcastle argued that the following areas should be prioritised for research, pilots, trials and demonstration projects:

- Switching current industrial hydrogen users to clean hydrogen
- Investigating new opportunities for clean hydrogen such as clean ammonia exports, clean fertiliser 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 fuel for heavy-duty mining vehicles
- Opportunities for backup power supply, such as for mobile phone towers, hospitals and other critical infrastructure
- Blending of hydrogen with natural gas and eventual use of 100% hydrogen in gas networks
- Using hydrogen for transport, including heavy/long-range road transport, rail and shipping

99 Submission 17, Clean Energy Council, 7.

100 See for example, Submission 4, Geoscience Australia, p 18; Submission 3, Southern Green Gas, p 6

101 https://www.nuwalliance.edu.au/home; Submission 12, University of Wollongong, p 4.

102 Evidence, Mr Ty Christopher, Honorary Professorial Fellow and Director, Energy Futures Network, University of Wollongong, 21 June 2021, p 22.

103 Submission 12, University of Wollongong, p 6; Submission 41, UNSW Sydney, p 1; Submission 15, University of Newcastle, p 7.

- 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 technologies that reduce the cost of making, moving, storing and using hydrogen
- Using water from sustainable sources like wastewater or seawater for hydrogen production
- Developing cross-sector linkages and deriving value from sector coupling.[104]

3.24 Many stakeholders expressed support for demonstration projects in particular, and encouraged the NSW Government to engage in these. A demonstration project refers to a small scale project which aims to show how a new technology can be used. With the cost of hydrogen production presenting a key barrier to the development of hydrogen industry at a large scale, stakeholders outlined a number of benefits that demonstration projects bring, namely:

- understanding and removing technical risk
- generating lessons for other users
- allowing researchers to explore efficiencies in operation and cost
- building community support and confidence
- enabling development of appropriate regulatory frameworks
- attracting private investment.[105]

3.25 When asked about which areas the NSW Government should prioritise for demonstration projects, Ms Anna Freeman of the Clean Energy Council identified diesel replacement as the top priority as it is cost-effective.[106] Dr Fiona Simon, Chief Executive Officer at the Australian Hydrogen Council explained that hydrogen is cost-competitive with diesel as a fuel, which is used extensively in remote applications in mining and agriculture, and to power remote communities. However, the issue for these industries is that the infrastructure and vehicles do not exist to support hydrogen as diesel replacement. Dr Simon explained that the benefit of starting with diesel is that it does not require an ongoing subsidy, but rather a one-off cost for the infrastructure.[107]

3.26 In addition, the Australian Hydrogen Council's submission outlined that the development of hydrogen remote applications would also generate jobs in the design, construction and operation of these systems and provide a 'much-needed training ground to develop local knowledge and experience in the industry'. The Australian Hydrogen Council therefore

104 Submission 15, University of Newcastle, p 11.

105 Evidence, Professor Alex Zelinsky, Vice Chancellor and President, University of Newcastle, 21 June 2021, p 27; Evidence, Ms Anna Freeman, Policy Director Energy Generation, Clean Energy Council, 21 June 2021, p 13; Submission 31, HunterNet Co-Operative Limited, p 31.

106 Evidence, Ms Anna Freeman, Policy Director Energy Generation, Clean Energy Council, 21 June 2021, pp 15-16.

107 Evidence, Dr Fiona Simon, Chief Executive Officer, Australian Hydrogen Council, 21 June 2021, p 12. See also, Submission 31, Australian Hydrogen Council, p 15.

recommended that the NSW Government 'consider a new direct compensation measure to replace diesel standalone power systems'.[108]

3.27 One stakeholder expressed some concern about demonstration projects. Jemena Gas Networks, which is developing the state's first renewable hydrogen project, highlighted that hydrogen research and development has focused heavily on demonstration thus far. The gas operator cautioned that there is a 'risk that the research and development becomes too conceptual and constrained by the lack of a functioning hydrogen market which can innovate and begin to scale up to meet growing demand'.[109]

Creating local demand

3.28 Similar to demonstration projects, some inquiry participants highlighted that the use of hydrogen in gas blending and transport initiatives provide opportunities for the NSW Government to help kick start the hydrogen industry and create local demand.

Gas blending

3.29 Gas blending refers to the process of mixing hydrogen gas into the natural gas distribution network. Geoscience Australia explained that volumes of up to 10 per cent of hydrogen gas can be safely blended into the existing natural gas network without significant impacts on, or implications to, gas quality, safety and risk, materials and network capacity.[110] The University of Newcastle highlighted that there is potential to increase the concentration of hydrogen in gas networks with further research and testing.[111]

3.30 In addition to being a strategic action in the National Hydrogen Strategy, stakeholders identified that gas blending helps to create an early market for hydrogen producers, demonstrate the benefits of hydrogen in decarbonisation, and can provide domestic offtake support to the emerging hydrogen export industry without significant additional investment in infrastructure.[112]

3.31 Stakeholders demonstrated that there is potential for gas blending in New South Wales. Based on an analysis of gas pipeline network in New South Wales, Geoscience Australia observed that gas pipelines are well connected to potential hydrogen ports with major gas transmission lines connecting to Newcastle and Wollongong.[113] The Clean Energy Council noted that in 2019 the Minister for Energy and Environment announced 'an aspiration for New South Wales to blend 10 per cent renewable hydrogen with the state's gas distribution networks'.[114]

3.32 The council also pointed to the Western Sydney Green Gas Project, run by Jemena Gas Networks, to inject renewable hydrogen into a small part of Jemena's gas network. The council argued that if the project is successful, the NSW Government 'should consider establishing a

108 Submission 31, Australian Hydrogen Council, p 15.

109 Submission 18, Jemena Gas Networks (NSW) Ltd, p 6.

110 Submission 4, Geoscience Australia, p 8.

111 Submission 15, University of Newcastle, p 13.

112 Submission 4, Geoscience Australia, p 8; Submission 34, Australian Hydrogen Council, p 15; Submission 17, Clean Energy Council, p 6; Submission 38, Hunter Business Chamber, p 5.

113 Submission 4, Geoscience Australia, p 8.

114 Submission 17, Clean Energy Council, p 6.

fund to expand the trial to build knowledge, experience and confidence' in gas blending across both metropolitan and regional centres.[115]

3.33 However, the Australian Hydrogen Council explained that the policy and regulatory framework does not currently encourage gas networks to pursue gas blending. Without government input, gas networks cannot 'make rate cases to their regulator without policy endorsement for expenditure', and the current regulatory framework which does not account for hydrogen creates uncertainty for gas networks. The council recommended that the 'most valuable support' at this stage would be for the NSW Government to legislate its 10 per cent gas blending target 'as soon as possible' and to set a clear policy pathway to achieve this.[116]

3.34 Furthermore, the Australian Hydrogen Council also expressed the view that it is important to begin planning for eventual natural gas substitution to ensure that the mix of hydrogen and natural gas produced matches the capabilities of the end user.[117]

3.35 In contrast, the Australian Energy Council expressed reservations about gas blending, particularly as a pre-cursor to complete natural gas substitution. The council argued that 'unless there are compelling product differences or economic benefits, the success of encouraging local hydrogen usage is not assured'. The council made the following observations:

- data which shows that the average household consumption of gas is declining with only slight increases in the long term
- the magnitude of changing the natural gas transmission systems, distribution systems and customer appliances to hydrogen, highlighting that it took 14 years for the AGL Gas Networks to convert more than 500,000 customers in Sydney from towns gas to natural gas
- technical limitations such as the embrittlement of steel pipelines and meter replacement requirements.[118]

3.36 In the Legislative Council Questions and Answers Paper, the Leader of the Government in the Legislative Council, representing the Minister for Energy and Environment explained that the NSW Government is reviewing the regulatory framework for accepting hydrogen in the natural gas network. The Minister also stated that the NSW Government is working with the National Hydrogen Project Team to ensure consistency with natural gas providers who are undertaking demonstration projects that will help inform the government's approach to reaching the 10 per cent target.[119]

Transport

3.37 As with gas blending, inquiry participants referred to transport as an opportunity to encourage private investment and build confidence, with the added benefit of having a public profile. In

115 Submission 17, Clean Energy Council, p 6. See also, Submission 18, Jemena Gas Networks (NSW) Ltd, p 3.

116 Submission 34, Australian Hydrogen Council, p 16.

117 Submission 34, Australian Hydrogen Council, p 15.

118 Submission 8, Australian Energy Council, pp 2-3.

119 NSW Legislative Council, *Questions and Answers Paper,* 7 August 2020, p 2825.

addition, as noted earlier in the discussion on demonstration projects, hydrogen is a cost-effective replacement for diesel which is used in heavy vehicles. [120]

3.38 According to the Australian Hydrogen Council, transport is Australia's second largest emitter of greenhouse emissions, making it an essential piece of the puzzle in bringing the state's carbon footprint down.[121] The council contended that decarbonisation in the transport sector will only occur with a mix of batteries and hydrogen fuel cells, with hydrogen having particular value in the heavy transport sector. This is because hydrogen fuel carries more energy than the equivalent weight of batteries which is particularly useful for buses, trucks and ships that carry heavy loads and travel long distances.[122] In addition, hydrogen fuel cells are lighter, less bulky and faster to recharge than batteries.[123]

3.39 To this end, the Clean Energy Council expressed their support for the NSW Government's announcement that it will transition Sydney's bus fleet of about 8,000 to electric buses by 2030 to support its goal of net zero emissions by 2050. However, both Hyundai Motor Company Australia and the Clean Energy Council called for the NSW Government to also include hydrogen fuel cell vehicles in the technology mix, and not just battery electric vehicles.[124]

3.40 The Clean Energy Council argued the demand that would be created from a share of the 8,000 buses if they were powered by hydrogen fuel cells 'would be sufficient to underpin significant investment over time in local renewable hydrogen production facilities'. Based on this, the council suggested that the state's diesel powered trains and ferries could also be converted to hydrogen fuel to create further demand.[125]

3.41 In addition to public transport, stakeholders identified the following measures that the NSW Government could implement to increase hydrogen demand in the transport sector:

- procurement of hydrogen fuel cell vehicles for government and departmental light vehicle fleets
- investment in refueling infrastructure to incentivise private investment, help drive down the price of hydrogen and to provide access to fuel
- development of policy, regulation and incentives to encourage the adoption of hydrogen fuel cell electric vehicles into existing transport fleets (this is also discussed in the section above on policy and funding).[126]

120 See, Submission 34, Australian Hydrogen Council, p 16; Evidence, Ms Anna Freeman, Policy Director Energy Generation, Clean Energy Council, 21 June 2021, p 14; Submission 18, Jemena Gas Networks (NSW) Ltd, p 6; Evidence, Mr Ty Christopher, Honoary Professorial Fellow and Director, Energy Futures Network, University of Wollongong, 21 June 2021, p 21.

121 Submission 34, Australian Hydrogen Council, p 16.

122 Submission 34, Australian Hydrogen Council, p 16.

123 Submission 17, Clean Energy Council, p 5.

124 Submission 17, Clean Energy Council, p 5; Submission 26, Hyundai Motor Company Australia (HMCA), p 10.

125 Submission 17, Clean Energy Council, p 5.

126 Submission 34, Australian Hydrogen Council, p 17; Submission 26, Hyundai Motor Company Australia (HCMA), p 10; Submission 22, Hyzon, p 3.

3.42 From a local government perspective, Lake Macquarie City Council emphasised that local government can act as a platform to pilot and scale up technology. One example includes councils using hydrogen vehicles such as garbage trucks to partner with industry to provide refueling stations in areas that could be utilised by other hydrogen vehicles such as long-haul freight.[127]

Hydrogen hubs

3.43 The committee also heard evidence that investment in hydrogen hubs in locations with abundant renewable energy sources, electricity networks and gas pipelines, transport routes and a skilled workforce presents an opportunity to lower the cost of hydrogen production and use, making hydrogen commercially viable.[128] Stakeholders also pointed out that hydrogen hubs are a key element recognised in the National Hydrogen Strategy to build scale and the capacity of the industry to service domestic markets in the first instance, building to international exports by 2030.[129]

3.44 As noted in Chapter 2, Newcastle, Port Botany/Kurnell and Port Kembla were identified as suitable export locations with the potential to become hubs.[130] The committee heard from several stakeholders based in the Hunter and Illawarra regions advocating for the establishment of a hub in their region.

3.45 Stakeholders from the Illawarra expressed support for Port Kembla as an ideal location for a hydrogen hub for the following reasons:

- availability of wastewater to produce hydrogen and renewable energy to power electrolysers
- access to transport infrastructure including road and rail
- access to gas pipelines
- an industrialised precinct for 24/7 operations
- an existing supply chain and skills base that can transition to support large-scale hydrogen production
- proximity to Sydney and existing global trade connections for export
- access to customers across industrial, heavy transport, electricity generation and gas network sectors
- a community that welcomes industry and connections to research and development at the University of Wollongong.[131]

127 Submission 19, Lake Macquarie City Council, p 2.

128 See, Evidence, Dr Fiona Simon, Chief Executive Officer, Australian Hydrogen Council, 21 June 2021, p 10; Submission 15, University of Newcastle, p 6; Submission 12, University of Wollongong, p 4.

129 See, Submission 12, University of Wollongong, p 5; Submission 16, Wollongong City Council, p 2.

130 Submission 4, Geoscience Australia, p 9.

131 Submission 12, University of Wollongong, p 5; Submission 13, Illawarra Business Chamber, pp 1-2; Submission 16, Wollongong City Council, p 4.

3.46 Wollongong City Council highlighted that the Department of Regional New South Wales 'is coordinating a regional effort with a vision to create Australia's first large scale 5-gigawatt hydrogen hub to service domestic and export markets by 2030 at Port Kembla'. The hub seeks to facilitate over $2.5 billion of major hydrogen energy projects at Port Kembla, support demonstration projects and educate the community about the benefits of a hydrogen economy.[132]

3.47 The Illawarra Business Chamber argued that one of the key factors in realising the Illawarra's potential as a hydrogen hub will be investment in transport and infrastructure. The chamber advocated for the upgrade of rail capacity in the Illawarra to support the future expansion of Port Kembla, as a matter of priority.[133]

3.48 Stakeholders from the Hunter/Central Coast region also advocated for a hydrogen hub centred around the port in Newcastle, citing the following reasons:

- a mix of manufacturing industries and large scale energy users
- significant energy generation networks and infrastructure
- a highly skilled workforce
- access to port facilities including global trade connections for export
- regional coordination and leadership on hydrogen through the Hunter Hydrogen Taskforce and the Hunter Hydrogen Technology Cluster
- research institutions at the CSIRO and University of Newcastle.[134]

3.49 The University of Newcastle highlighted that National Energy Resources Australia awarded Hydrogen Cluster funding to a local industry consortium to accelerate the transition to a hydrogen economy and create the ideal environmental or investment, growth and jobs. As the only cluster to receive the funding, the university stated that the funding 'signals the central role the region will play in developing a hydrogen industry'.[135]

3.50 In terms of how to determine the best locations for hydrogen hubs in the state, Ms Freeman of the Clean Energy Council referred to a pre-feasibility study conducted in South Australia which examined potential hub sites in that state. She explained that the study took a holistic approach and considered the anticipated cost of green hydrogen and blue hydrogen for a range of different sites. Based on this, the study determined the most cost-effective hub sites for the government to direct its funding. Ms Freeman suggested that work of this kind in New South Wales 'could be really important in directing' government funding for hubs.[136]

3.51 Ms Freeman also recognised that $70 million of the NSW Government's $750 million Net Zero Industry and Innovation Program has been 'earmarked to support at least two hydrogen hubs,

132 Submission 16, Wollongong City Council, pp 2-3.

133 Submission 13, Illawarra Business Chamber, p 3.

134 Submission 15, University of Newcastle, p 2; Submission 38, Hunter Business Chamber, p 4; Submission 19, Lake Macquarie City Council, p 1.

135 Submission 15, University of Newcastle, p 10.

136 Evidence, Ms Anna Freeman, Policy Director Energy Generation, Clean Energy Council, 21 June 2021, p 9.

in the Hunter and Illawarra regions'. She commented that the funding sends 'an important signal to industry that the state is ready to partner with the private sector on major projects'. [137] The program is a government plan to support and partner with industry to help NSW businesses prosper in a low carbon world.[138]

Workforce and skills

3.52 Finally, many inquiry participants highlighted that one of the advantages for the state in developing a hydrogen industry is that the workforce, training and skills which already exist, particularly in the energy sector, can be readily transferred to a hydrogen industry.[139] A number of stakeholders also referred to data which suggests that for a medium growth scenario, a hydrogen industry could create up to 788 direct and indirect jobs by 2025, reaching 2,787 jobs by 2030 and 7,142 jobs by 2040. [140]

3.53 To enable this jobs growth and to take advantage of the existing skills base, stakeholders argued that the government will need to play a role in training and upskilling, developing appropriate safety standards and ensuring that the transition does not disproportionately affect existing industries.

3.54 Highlighting that training and upskilling tradespeople will take years, the Clean Energy Council contended that planning for such training should 'begin without delay to ensure that a lack of localised skills does not prove a barrier to the growth of the sector'.[141] The council pointed out that, under the National Hydrogen Strategy, South Australia has been 'designated as the lead state in developing nationally consistent training materials and guidelines' for procedures regarding hydrogen production, handling, transport and use. To complement this work, the council subsequently recommended that New South Wales should conduct a study to understand the current skills base in the state and how well it can meet the needs of the emerging hydrogen industry, and to identify any gaps that may be need to be addressed through skills development and training programs.[142]

3.55 The Maritime Union of Australia advocated for a 'just transition' to a low emissions economy, including the hydrogen industry. The union argued that 'existing jobs in fossil fuels industries tend to be good secure union jobs' and that new jobs should be of a similar quality to ensure a just transition. Measures to ensure a just transition include:

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137 Evidence, Ms Anna Freeman, Policy Director Energy Generation, Clean Energy Council, 21 June 2021, p 9.

138 NSW Government, Energy Saver, Net Zero Industry and Innovation, <https://www.energysaver.nsw.gov.au/reducing-emissions-nsw/net-zero-industry-and-innovation>.

139 See, Evidence, Ms Kristina Anastasi, Branch Head Advice, Investment Attraction and Analysis, Minerals Energy and Groundwater Division, Geoscience Australia, 21 June 2021, p 4; Submission 15, University of Newcastle, p 16; Evidence, Mr Ty Christopher, Honorary Professorial Fellow and Director, Energy Futures Network, University of Wollongong, p 19.

140 See, Submission 15, University of Newcastle, p 16; Submission 38, Hunter Business Chamber, p 3.

141 Submission 17, Clean Energy Council, p 7. See also, Submission 22, Hyzon, p 3.

142 Submission 17, Clean Energy Council, p 7.

- prioritising local jobs by ensuring that procurement plans maximise Australian production capacity
- guaranteeing good employment conditions, union agreements and responsible contracting policies are in place
- ensuring a job guarantee and no forced redundancies for workers in fossil fuel industries, looking to the German job guarantee model
- carrying out a detailed skills and training assessment to ensure that local training providers are in place and adequately funded, with training to be conducted by TAFE rather than private providers
- reducing inequality by ensuring that the hydrogen industry has apprenticeship programs with minimum ratios including recruitment of workers from disadvantaged backgrounds
- ensuring local community engagement and development
- working with SafeWork NSW and other training agencies to develop safety codes of practice and qualifications for the hydrogen industry at a national level.[143]

3.56 On the issue of safety, stakeholders maintained the importance of developing consistent safety standards nationally. Gas operator, BOC Limited argued that the absence of minimum standards and safety requirements 'will likely lead to less investment or delays in investment'.[144]

3.57 Recognising that hydrogen is dangerous to transport, particularly if transported as ammonia, the Maritime Union of Australia called for shipping in and from Australia to occur with Australian flagged and crewed ships, governed by Australian work health and safety, and fatigue standards.[145]

3.58 While there was broad support for transition to a hydrogen-based sector, some stakeholders warned that there is a need to consider the impact on traditional energy and manufacturing industries.

3.59 The Hunter Business Chamber stated that 'we should not lose sight of the cost of losing existing jobs if we fail to provide solutions to challenges around the supply of reliable and affordable energy and the question of lowering carbon emissions over the long term'. The chamber argued that job losses are a 'real prospect' in places like the Hunter where current industry players will be forced to close as a result of costs being too great to easily adapt.[146]

3.60 Using green steel as an example, the Illawarra Business Chamber similarly observed that while visions for a 'rapid transition' to green steel, fueled by green hydrogen, is 'laudable', there is a 'need to be realistic in our expectations of the pace of change'. The business chamber, along with major steel manufacturer BlueScope Steel, highlighted that green hydrogen in steel production is far from being a commercially viable option at this early stage. The Illawarra Business Chamber therefore cautioned 'that too rapid a transition to hydrogen may create significant, and potentially avoidable, economic disruption, that if not properly managed, will

143 Submission 43, Maritime Union of Australia (MUA), pp 6-8.

144 Submission 35, BOC Limited, pp 7-8.

145 Submission 43, Maritime Union of Australia (MUA), p 8.

146 Submission 38, Hunter Business Chamber, p 6.

disproportionately affect communities with substantial mining and steel production sectors, such as the Illawarra'.[147]

3.61 Stakeholders referred to the importance of consistent policy and regulatory initiatives and co-investment by government, as discussed earlier in the chapter, to ensure that the transition to a hydrogen industry considers the needs of all relevant industry players including traditional industries.[148]

Committee comment

3.62 As noted in the previous chapter, the committee strongly supports the development of a hydrogen industry in New South Wales. With the resources and infrastructure available, it is clear that hydrogen presents economic opportunities for the state as well as a way to help realise the state's goal of net zero emissions by 2050. The committee heard from a range of stakeholders who shared their knowledge and expertise with us, on how best the NSW Government can support our emerging hydrogen industry going forward.

3.63 Given the opportunities that a hydrogen industry presents, we believe that the NSW Government needs to move ahead with greater urgency or risk falling behind other states. The first step that the government should take is to finalise and publish its hydrogen strategy as a matter of priority. This is where the government can play an important role in not only supporting but also driving the development of this industry to a commercial scale. While different parts of the sector, from universities to industry players to peak bodies, all have an important role to play, these stakeholders are looking to the government for an overall strategy and the momentum and certainty that would come with it.

3.64 This will signal to industry participants that the government is serious about developing the industry and will provide a level of confidence to potential investors. From here, the government should seriously consider funding initiatives and develop appropriate policy and regulatory frameworks.

3.65 It was clear to the committee that some of the key actions the government can take to encourage private investment is to provide direct funding to the emerging hydrogen industry in order to share risk, and to develop a policy and regulatory framework to provide certainty and consistency for potential industry players and to incentivise investment. A hydrogen strategy should therefore encompass funding, policy and regulatory frameworks.

Recommendation 1

That the NSW Government prioritise finalising and publishing a hydrogen strategy that includes its intentions for funding, policy and regulation.

3.66 Hydrogen's versatility means that its uses cross several layers of policy and regulation over different sectors and levels of government. In order for the state to harness the full benefits of

147 Submission 13, Illawarra Business Chamber, p 5. See also, Submission 30, BlueScope.

148 See, Submission 13, Illawarra Business Chamber, p 5; Submission 30, BlueScope; Evidence, Mr Adam Zarth, Executive Director, Business Illawarra, p 21; Hunter Business Chamber, p 5.

a hydrogen industry, efforts should be made to identify and eliminate any cross-sector barriers. The NSW Government should therefore establish a cross-sector taskforce, including stakeholders from across the government, to support the state's forthcoming strategy, address any cross-sector barriers and engage with the National Hydrogen Project Team.

Recommendation 2

That the NSW Government establish a cross-sector taskforce from across the government to support the state's hydrogen strategy, address any cross-sector barriers and engage with the National Hydrogen Project Team.

3.67 While there are resources and infrastructure that the state can capitalise on to develop a hydrogen industry, there are areas where further study is required to understand and address barriers. As outlined in Chapter 2, a lack of salt storage and depleted gas reservoirs in New South Wales presents a key barrier to growing hydrogen production to a large scale. Further research is required to investigate and determine alternative options such as aquifer storage, hard rock caverns and abandoned mines.

Recommendation 3

That the NSW Government commission a study into alternative large scale storage options for hydrogen.

3.68 The second significant barrier was around the cost of hydrogen production and transport. Stakeholders identified that one way to help reduce this cost is by investing in hydrogen hubs in locations where there are renewable energy sources, water resources, transport and distribution infrastructure, export facilities and an existing workforce and skills base. We heard from many stakeholders that the Hunter and Illawarra regions around the port of Newcastle and Port Kembla respectively encompass the features that could make these regions suitable for hydrogen hubs.

3.69 The committee recognises that the government has already committed $70 million to support hydrogen hubs in these two locations as part of its $750 million Net Zero Industry and Innovation Program. We encourage the government to continue to support and monitor the development of hydrogen hubs in the Illawarra and Hunter regions.

Recommendation 4

That the NSW Government continue to support and monitor the development of hydrogen hubs in the Illawarra and Hunter regions.

3.70 Considering that the hydrogen industry is still in its early stages, research and development efforts will be critical to growing the industry. The committee understands that significant work is being conducted at a number of universities and research centres across the state, from both an economic and technological point of view. The NSW Government should monitor and

support these efforts but also invest in demonstration projects. The committee heard evidence that these projects offer an opportunity to demonstrate and understand new technology, generate lessons for others, attract private investment, build community confidence and allow researchers to explore cost efficiencies. Considering that hydrogen can replace diesel as a fuel now, stakeholders told us that diesel replacement in remote applications presents a cost-effective option for an initial demonstration project.

Recommendation 5

That the NSW Government invest in demonstration projects with priority given to diesel replacement projects.

3.71 As with demonstration projects, the committee was interested to hear of the ways in which the government can support the emerging hydrogen industry now, to help create local demand. Stakeholders informed the committee that gas blending and transport are areas in which the government can begin incorporating hydrogen into the energy space at a large scale.

3.72 The committee understands that the NSW Government has previously announced its intentions to blend up to 10 per cent of hydrogen into the natural gas networks. The committee believes that the government should create and communicate a policy pathway to achieve this.

3.73 In addition, the committee is aware that the NSW Government has committed to converting Sydney's fleet of over 8,000 diesel powered buses to electric buses by 2030. However, stakeholders outlined that at least a portion of these buses should be powered by hydrogen fuel cells and not just electric batteries as is the current intention. In addition, the government should not only consider hydrogen fuel cell vehicles in its bus fleet but also in broader public transport applications.

Recommendation 6

That the NSW Government create local demand for hydrogen by:

- developing and publishing a policy pathway for gas blending
- considering the use of hydrogen fuel cell vehicles in the public transport network.

3.74 Finally, the committee appreciates that New South Wales has a workforce and skills base that can readily transition to a hydrogen industry with the appropriate supports. We see value in planning for this transition at this early stage, to ensure that a workforce is readily available as the industry begins to scale up to a commercial level. This planning should also consider safety requirements for handling hydrogen. The NSW Government should conduct a study to identify training needs for the industry as well as the relevant safety standards.

Recommendation 7

That the NSW Government prepare for the transition of the workforce to meet the needs of an emerging hydrogen sector by conducting a study to:

- understand the current skills base
- identify the gaps that may need to be addressed by future training
- develop the appropriate safety standards.

Appendix 1 Submissions

No.	Author
1	Mr Michael Faulkner
2	Mr Russell Chiffey
3	Southern Green Gas
4	Geoscience Australia
5	Regional Development Australia - Illawarra & Sydney
6	Ardent Underground
7	Ms Josephine Morehead
8	Australian Energy Council
9	Protect Our Water Alliance
10	i3net (Illawarra Innovative Industry Network)
11	Name suppressed
12	University of Wollongong
13	Illawarra Business Chamber
14	H2X Australia
15	University of Newcastle
16	Wollongong City Council
17	Clean Energy Council
18	Jemena Gas Networks (NSW) Ltd
19	Lake Macquarie City Council
20	Youth for Conservation
21	SMR Nuclear Technology Pty Ltd
22	HYZON Motors
23	Tyagarah Green Energy Pty Ltd (TGE)
24	Star Scientific Limited
25	NSW Ports
26	Hyundai Motor Company Australia (HMCA)
27	Black Pages Business Alliance et al.
28	Globo Hydrogen Power Australia Pty Ltd TA Hydrogen2Power
28a	Globo Hydrogen Power Australia Pty Ltd TA Hydrogen2Power
29	LAVO
30	BlueScope
31	HunterNet Co-Operative Limited

No.	Author
32	Coregas
33	Institute of Automotive Mechanical Engineers
34	Australian Hydrogen Council
35	BOC Limited
36	Committee for the Hunter
37	ENGIE
38	Hunter Business Chamber
39	APA Group
40	South Coast Labour Council
41	UNSW Sydney
42	Australian Alliance for Energy Productivity
43	Maritime Union of Australia (MUA)
44	Australian Gas Infrastructure Group
45	The Australian Workers' Union

Appendix 2 Witnesses at hearing

Date	Name	Position and Organisation
Monday 21 June 2021 **Macquarie Room** **Parliament House**	Ms Kristina Anastasi *(via videoconference)*	Branch Head, Advice, Investment Attraction and Analysis, Minerals Energy and Groundwater Division, Geoscience Australia
	Dr Andrew Feitz *(via videoconference)*	Director, Low Carbon Geoscience and Advice, Minerals, Energy and Groundwater Division, Geoscience Australia
	Dr Fiona Simon *(via videoconference)*	Chief Executive Officer, Australian Hydrogen Council
	Ms Anna Freeman *(via videoconference)*	Policy Director – Energy Generation, Clean Energy Council
	Mr Ty Christopher	Honorary Professorial Fellow, University of Wollongong
	Mr Mark Grimson	Economic Development Manager, Wollongong City Council
	Mr Adam Zarth	Executive Director, Business Illawarra
	Professor Alex Zelinsky AO *(via videoconference)*	Vice-Chancellor and President, University of Newcastle
	Professor Alan Broadfoot	Director, Newcastle Institute for Energy and Resources, University of Newcastle
	Mr Sean Lucy *(via videoconference)*	General Counsel, Lake Macquarie City Council
	Mr David Hughes *(via videoconference)*	Director Built and Natural Assets, Lake Macquarie City Council
	Mr Bob Hawes *(via videoconference)*	Chief Executive Officer, Business Hunter

Appendix 3 Minutes

Minutes no. 12
Tuesday 8 December 2020
Standing Committee on State Development
Room 1043, Parliament House, Sydney at 9.32 am

1. Members present
Mr Martin, *Chair* (via videoconference)
Mr Veitch, *Deputy Chair*
Mr Banasiak
Mr Farlow (substituting for Mr Fang) (via videoconference)
Mr Farraway
Mr Graham (via videoconference)
Mrs Maclaren-Jones (from 9.33 am) (via teleconference)
Mr Pearson (from 9.34 am)

2. Previous minutes
Resolved, on the motion of Mr Veitch: That draft minutes no. 11 be confirmed.

3. Correspondence
The committee noted the following items of correspondence:

Received

- 19 November 2020 – Letter to Chair from the Hon Matt Kean MP, Minister for Energy and Environment, requesting the committee consider terms of reference for an inquiry into the development of a hydrogen industry in New South Wales.

4. Consideration of ministerial terms of reference
The Chair tabled the following terms of reference received from the Hon Matt Kean MP, Minister for Energy and Environment on 19 November 2020:

Inquiry into the development of a hydrogen industry in New South Wales

That the Standing Committee on State Development inquire into and report on the current state of, and opportunities for, the development of a hydrogen industry in New South Wales, and in particular:

1. The size of the economic and employment opportunity created by the development of a hydrogen industry in NSW, in particular those opportunities for regional NSW, including having regard to:
   (a) the emerging domestic and international trends in the production and demand for hydrogen, including in South Korea, the Netherlands, Japan and other Australian states and territories; and
   (b) NSW's existing and potential linkages to those markets.
2. The State's existing hydrogen capabilities, including:
   (a) NSW's research and development capacity for all elements of the hydrogen supply and demand chain, including existing research and development work of the Government, academic and private sector; and
   (b) The State's energy and industrial infrastructure which could support the production, storage, distribution, use and export of hydrogen.
3. The capacity of and barriers to NSW becoming a major production, storage and export hub for hydrogen, including NSW's capacity to:

(a) develop and commercialise hydrogen technologies;

(b) manufacture and export hydrogen production componentry, including electrolysis componentry;

(c) manufacture and export hydrogen storage and transport infrastructure, including in heavy transport and shipping vessels;

(d) generate green hydrogen through renewable energy sources;

(e) use hydrogen for transport;

(f) use hydrogen in its own industrial processes, such as in steel, aluminium and chemical production; and

(g) use hydrogen for electricity generation, including the feasibility of retrofitting existing and proposed electricity generation assets to use hydrogen.

4. The economics of hydrogen's use in different sectors of the economy, including emerging opportunities to use hydrogen in industrial processes and as a feedstock.

5. The infrastructure, technology, skills, workforce capabilities and other things needed to realise the economic opportunities of hydrogen as and when it becomes commercial in different sectors of the economy.

6. The actions needed of the public and private sectors, to support the development of a hydrogen industry in NSW and to realise the associated economic opportunities, including actions to manage any safety risks in the hydrogen industry.

7. Any other pertinent matters the Committee wishes to draw to the Government's attention in this regard.

Resolved, on the motion of Mr Graham: That the Minister for Energy and Environment be requested to amend the terms of reference by adding the following paragraph after paragraph 6: 'The potential for jobs in New South Wales, both directly in the hydrogen industry and in other industries powered by hydrogen.'

Resolved, on the motion of Mr Pearson: That the Minister for Energy and Environment be requested to amend the terms of reference by adding the following subparagraph under paragraph 3: 'manage the safety and safeguarding of hydrogen utilisation'.

Resolved, on the motion of Mr Banasiak: That the committee adopt the terms of reference as amended, subject to the Chair writing to Hon Matt Kean MP, Minister for Energy and Environment, seeking a revised terms of reference which include the following additional matters:

- adding the following paragraph after paragraph 6: 'The potential for jobs in New South Wales, both directly in the hydrogen industry and in other industries powered by hydrogen.'
- adding the following subparagraph under paragraph 3: 'manage the safety and safeguarding of hydrogen utilisation'.

5. Conduct of the inquiry into the development of a hydrogen industry in New South Wales

5.1 Proposed timeline

Resolved, on the motion of Mr Veitch: That the committee adopt the following timeline for the administration of the inquiry:

- Submissions close: 26 February 2021
- Hearings/site visits: That the timeline for hearings and site visits be considered by the committee following the receipt of submissions, and that hearing dates be determined by the Chair after consultation with members regarding their availability.

5.2 Stakeholder list

Resolved, on the motion of Mr Veitch: That the secretariat circulate to members the Chairs' proposed list of stakeholders to provide them with the opportunity to amend the list or nominate additional stakeholders, and that the committee agree to the stakeholder list by email, unless a meeting of the committee is required to resolve any disagreement.

5.3 Advertising

All inquiries are advertised via Twitter, Facebook, stakeholder letters and a media release distributed to all media outlets in New South Wales.

It is no longer standard practice to advertise in the print media. The committee should pass a resolution if it wishes to do so.

6. Adjournment

The committee adjourned at 9.44 am, *sine die*.

Sharon Ohnesorge
Committee Clerk

Minutes no. 13
Monday 21 June 2021
Standing Committee on State Development
Macquarie Room, Parliament House, Sydney at 9.01 am

1. Members present

Ms Cusack, *Chair*
Mr Veitch, *Deputy Chair*
Mr Banasiak
Mr Fang (from 9.02 am)
Mr Farraway
Mr Franklin (substituting for Mrs Maclaren-Jones)
Mr Graham (until 1.15 pm)
Mr Pearson (from 9.03 am)
Mr Martin (participating for the duration of the inquiry into the development of a hydrogen industry in New South Wales) (from 9.02 am)
Mr Shoebridge (participating for the duration of the inquiry into the development of a hydrogen industry in New South Wales) (from 10.04 am)

2. Previous minutes

Resolved, on the motion of Mr Banasiak: That draft minutes no. 12 be confirmed.

3. Correspondence

The committee noted the following items of correspondence:

Received

- 15 December 2020 – Letter from the Hon Matt Kean MP, Minister for Energy and Environment to the Chair, confirming the revised terms of reference for the hydrogen industry inquiry
- 10 May 2021 – Email from Mr Canio Fierravanti, Director, Government Relations, University of Wollongong, inviting the committee to the university to view and discuss the university's initiatives relating to hydrogen
- 18 May 2021 – Letter from Mr Paul Scully MP, Member for Wollongong to the Chair, inviting the committee to hold a hearing in Wollongong for the hydrogen industry inquiry

- 22 April 2021 – Email from Mr Matthew Hingerty, Director, Chief of Communications & Government Relations, Star Scientific Limited, to the Chair, requesting to hold a briefing with the Chair on the work of Star Scientific.

Sent

- 8 December 2020 – Letter from the Chair, to the Hon Matt Kean MP, Minister for Energy and Environment, requesting that the terms of reference for the hydrogen industry inquiry be revised.

4. Inquiry into the development of a hydrogen industry in New South Wales

4.1 COVID safety at the hearing

The committee noted the most recent public health restrictions and applicability of the face mask mandate, and noted that the hearing would proceed on the basis of a hybrid socially distanced / videoconference hearing.

4.2 Public submissions

The following submissions were published by the committee clerk under the authorisation of the resolution appointing the committee: submission nos. 1-5, 7-22, 24-28, 28a, 29-31, 33-45.

4.3 Partially confidential submissions

Resolved, on the motion of Mr Veitch: That the committee authorise the publication of submission nos. 6, 23 and 32 with the exception of sensitive information which is to remain confidential, as per the request of the authors.

4.4 Provision of documents to participating members

Resolved, on the motion of Mr Fang: That Mr Shoebridge and Mr Martin, who have advised that they intend to participate for the duration of the inquiry into the development of a hydrogen industry in New South Wales, be provided with copies of meeting papers, unpublished submissions and copies of inquiry related documents.

4.5 Report deliberative

Resolved, on the motion of Mr Graham: That the committee hold the report deliberative on Monday 27 September 2021.

4.6 Allocation of questioning

Resolved, on the motion of Mr Banasiak: That the allocation of questions be left in the hands of the Chair.

4.7 Public hearing

The committee proceeded to take evidence in public.

Witnesses, the public and the media were admitted.

The Chair made an opening statement regarding the broadcasting of proceedings and other matters.

The following witnesses were sworn and examined:

- Ms Kristina Anastasi, Branch Head, Advice, Investment Attraction and Analysis, Minerals Energy and Groundwater Division, Geoscience Australia (via videoconference)
- Dr Andrew Feitz, Director, Low Carbon Geoscience and Advice, Minerals, Energy and Groundwater Division, Geoscience Australia (via videoconference).

The evidence concluded and the witnesses withdrew.

The following witnesses were sworn and examined:

- Dr Fiona Simon, CEO, Australian Hydrogen Council (via videoconference)
- Ms Anna Freeman, Policy Director – Energy Generation, Clean Energy Council (via videoconference).

The evidence concluded and the witnesses withdrew.

The following witnesses were sworn and examined:

- Mr Ty Christopher, Honorary Professorial Fellow, University of Wollongong

- Mr Mark Grimson, Economic Development Manager, Wollongong City Council
- Mr Adam Zarth, Executive Director, Business Illawarra.

The evidence concluded and the witnesses withdrew.

The following witnesses were sworn and examined:

- Professor Alex Zelinsky AO, Vice-Chancellor and President, University of Newcastle (via videoconference)
- Professor Alan Broadfoot, Director, Newcastle Institute for Energy and Resources, University of Newcastle
- Mr Sean Lucy, General Counsel, Lake Macquarie City Council (via videoconference)
- Mr David Hughes, Director Built and Natural Assets, Lake Macquarie City Council (via videoconference)
- Mr Bob Hawes, CEO, Business Hunter (via videoconference).

The evidence concluded and the witnesses withdrew.

The public hearing concluded at 1.17 pm.

The public and the media withdrew.

4.8 Site visits

The committee discussed the possibility of conducting informal site visits for those members interested in taking part.

5. Adjournment

The committee adjourned at 1.22 pm, until Monday 27 September 2021, Room 1043, Parliament House (report deliberative).

Shaza Barbar
Committee Clerk

Draft minutes no. 14
Monday 27 September 2021
Standing Committee on State Development
Via videoconference at 10.04 am

1. Members present

Ms Cusack, *Chair*
Mr Veitch, *Deputy Chair*
Mr Banasiak
Mr Fang
Mr Farraway
Mr Graham
Mr Martin (substituting for Mrs Maclaren-Jones)
Mr Pearson

2. Apologies

Mr Shoebridge (participating for the duration of the inquiry into the development of a hydrogen industry in New South Wales)

3. Previous minutes

Resolved, on the motion of Mr Pearson: That draft minutes no. 13 be confirmed.

4. Correspondence

The committee noted the following items of correspondence:

Received

- 9 September 2021 – Email Ms Zoe de Saram, Director, Performance Audit, Audit Office of New South Wales, offering to hold a virtual briefing to brief members on the Auditor-General's 2021-2022 Annual Work Program.

5. Inquiry into the development of a hydrogen industry in New South Wales

5.1 Answers to questions on notice

The committee noted that the following answers to questions on notice were published by the committee clerk under the authorisation of the resolution appointing the committee:

- answers to questions on notice from Clean Energy Council, received on 14 July 2021
- answers to questions on notice from University of Wollongong, received on 19 July 2021
- answers to questions on notice from Geoscience Australia, received on 22 July 2021
- answers to questions on notice from University of Newcastle, received on 22 July 2021.

5.2 Consideration of Chair's draft report

The Chair submitted her draft report entitled 'Development of a hydrogen industry in New South Wales', which, having been previously circulated, was taken as being read.

Resolved, on the motion of Mr Martin: That:

The draft report be the report of the committee and that the committee present the report to the House;

The transcripts of evidence, submissions, answers to questions on notice and correspondence relating to the inquiry be tabled in the House with the report;

Upon tabling, all unpublished attachments to submissions be kept confidential by the committee;

Upon tabling, all unpublished transcripts of evidence, submissions, answers to questions on notice, and correspondence relating to the inquiry, be published by the committee, except for those documents kept confidential by resolution of the committee;

The committee secretariat correct any typographical, grammatical and formatting errors prior to tabling;

The report be tabled on Thursday 30 September 2021;

The Chair to advise the secretariat and members if they intend to hold a press conference, and if so, the date and time.

6. Adjournment

The committee adjourned at 10.12 am, *sine die*.

Shaza Barbar
Committee Clerk