LETA

Low Emission Technology Australia

Submission to the Department of Climate Change, Energy, the Environment and Water National Hydrogen Strategy Review Consultation Paper

JULY 2023

Foreword

Low Emission Technology Australia (LETA) is a A$700 million fund established in 2006 by the Australian black coal industry to invest in technologies that significantly reduce emissions and support the transition to a low emission global economy, in line with the Paris Agreement.

LETA partners with government, research institutions, universities and industry locally and internationally to develop projects that reduce and remove greenhouse gas emissions from largescale industrial processes such as power generation, steel and cement manufacturing, mining, and future energy sources such as clean (low-carbon) hydrogen. Further information about LETA can be found on our website, at www.letaustralia.com.au.

LETA welcomes the opportunity to provide a submission to the Department's *National Hydrogen Strategy Review Consultation Paper, July 2023* (Consultation Paper).

LETA's submission addresses specific aspects of the Consultation Paper, focussing on those areas/questions that are particularly important for the development and implementation of a clean hydrogen industry in Australia, the role of low emission technology and the contribution it can make to reducing emissions in Australia and across the Asia–Pacific region.

LETA is also a member of the Australian Hydrogen Council (AHC) and has contributed to the preparation of the AHC submission to the Consultation Paper.

Key points

1.

The development of a clean hydrogen industry globally and in Australia has the potential to play an important role in a cleaner energy future. This is both in achieving reductions in greenhouse gas emissions consistent with the Paris Agreement while maintaining energy security and supporting economic development and industry growth. In doing so, the development of a clean hydrogen industry can form a direct and important part of Australia's achieving the strategic objectives established in the Consultation Paper.

2.

Australia's large energy resource base; our established and long-standing commercial relationships with both domestic customers and trading partners; significant onshore and offshore CO_2 storage potential; and technical expertise and experience mean that Australia is well placed to see its comparative advantage in energy and resource production and export utilised to develop a competitive clean hydrogen industry.

3.

It is vital a technology-neutral approach be continued in the updated National Hydrogen Strategy. While there have been a range of developments in the global and domestic industry since the 2019 Strategy, a technology-neutral approach, which focusses on all possible pathways to hydrogen development (both domestically and for exports), remains vitally important to Australia achieving the best outcomes from this technology.

4.

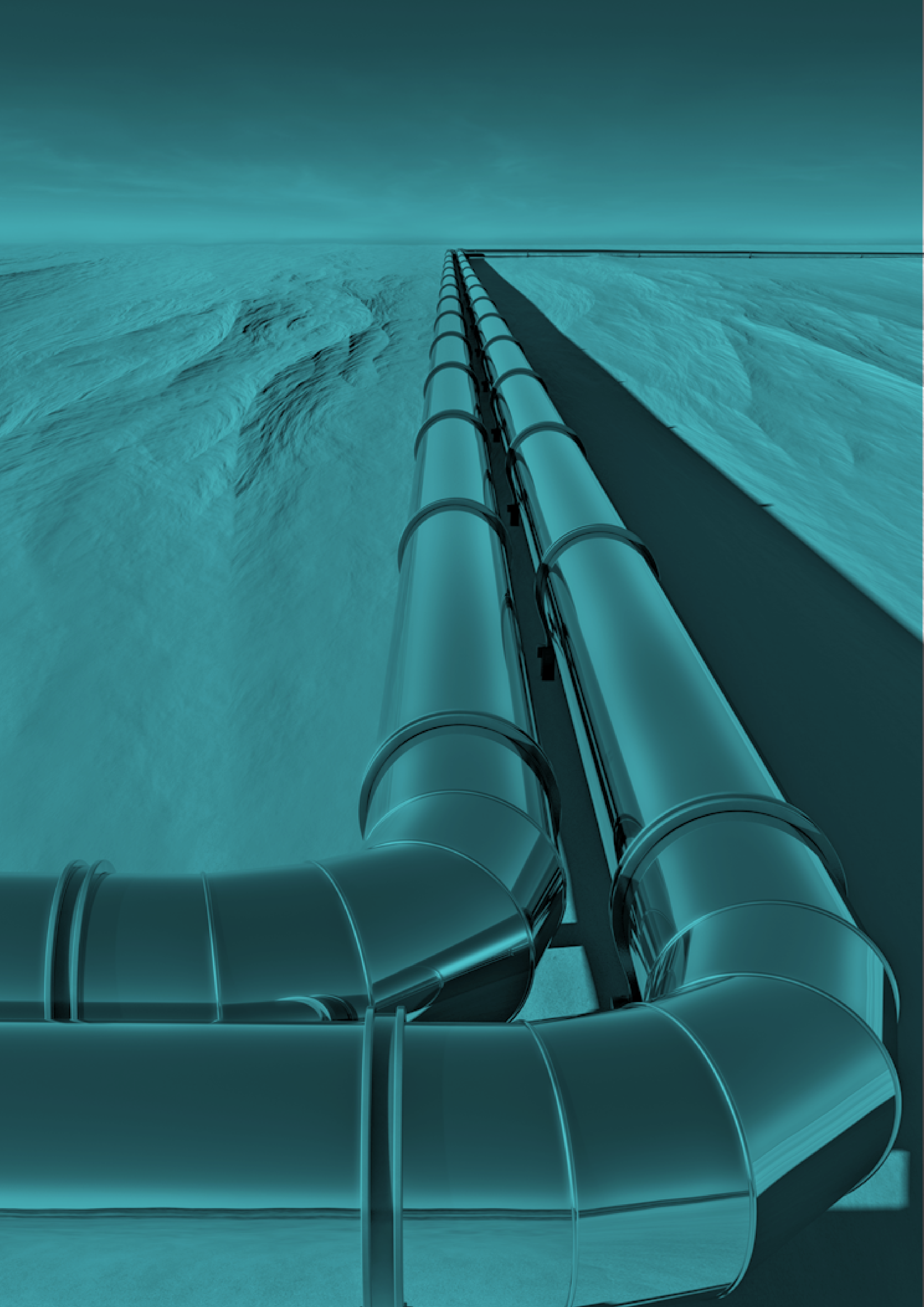
To provide the best opportunity for the new National Hydrogen Strategy to achieve its stated objectives, active policy and regulatory support from government in Australia would serve to facilitate clean hydrogen investment and development at the required scale and drive innovation.

5.

Importantly, the National Hydrogen Strategy represents an opportunity to work with industry to develop and implement a more timely and efficient regulatory approval process to condense, without compromising, project approval processes for clean hydrogen (and CCS) projects, both onshore and offshore. This can facilitate the timely development and implementation of clean hydrogen projects to directly support the development of Australia's clean hydrogen industry.

6.

To complement the National Hydrogen Strategy, the Australian Government should also work with industry to develop a National CCUS Strategy, one that complements the development of a renewed and technology-neutral National Hydrogen Strategy. A National CCUS Strategy could analyse the domestic and global state of CCUS projects and developments and work with industry to develop a streamlined, efficient and effective policy and regulatory framework to facilitate the development of the industry in Australia (both onshore and offshore).



1.

Introduction

Low Emission Technology Australia (LETA) is a A$700 million fund established in 2006 by the Australian black coal industry to invest in a range of technologies that significantly reduce greenhouse gas emissions and support the transition to a low emission global economy, in line with the Paris Agreement.

LETA partners with government, research institutions, universities and industry locally and internationally to develop projects that reduce and remove greenhouse gas emissions from large scale industrial processes such as power generation, steel and cement manufacturing, mining, and future energy sources such as clean (low carbon) hydrogen.

LETA's submission addresses specific aspects of the Consultation Paper, focussing on those questions/areas that are particularly important for the development and implementation of low emission technology, with a particular focus on clean hydrogen[1] (and associated carbon capture, utilisation and storage (CCUS)[2] technologies) in Australia and the significant contribution it can make in the future to reducing emissions in Australia and, by working with Australia's key trading partners, across the Asia-Pacific region.

2.

The development of an Australian clean hydrogen industry

The Consultation Paper (page iii) sets out three strategic objectives for the updated National Hydrogen Strategy:

Australia is on the path to be a global hydrogen leader by 2030.

Enable domestic decarbonisation through the development of the hydrogen industry.

Ensure economic benefit for all Australians through the development of the hydrogen industry.

The development of a clean hydrogen industry globally and in Australia has the potential to play an important role in a cleaner energy future, both in achieving reductions in greenhouse gas emissions consistent with the Paris Agreement while maintaining energy security and supporting economic development and industry growth. In doing so, the development of a clean hydrogen industry can form a direct and important part of Australia's pathway to achieving the strategic objectives established in the Consultation Paper.

According to the IEA, and as highlighted in its *Global Hydrogen Review 2022*, global demand for all forms of hydrogen is set to increase rapidly and substantially from about 94 million tonnes of hydrogen per year (MtH2pa) in 2021 to more than 500 MtH2pa year by 2050.[3] Meeting this demand for low-emission hydrogen will require the rapid scaling up of its production capacity in a short period of time. As highlighted by the IEA, this clean hydrogen can come from renewable-powered water electrolysis, coal gasification with CCUS and natural gas steam methane reforming (SMR) or autothermal reforming (ATR) with CCUS. As is considered further below, when the best available technologies are adopted, hydrogen production from coal gasification with CCUS or natural gas with SMR or ATR can have lifecycle environmental impacts comparable to the production of renewable hydrogen.[4]

Clean hydrogen production from coal and natural gas with CCUS can be a lower cost option to hydrogen produced by electrolysis in regions with abundant low-cost gas and/or coal resources and CO_2 storage capacity.

CCS can facilitate the production of clean hydrogen from natural gas or coal and provide a secure and competitive source of hydrogen. This provides an opportunity to bring low-carbon hydrogen into existing and new markets in the near-term at competitive prices. This is particularly relevant considering coal and natural gas (without CCS) were the source of 93 Mt of the 94 Mt of global hydrogen production in 2021.[5] This means, as well as supporting the development of a clean hydrogen industry in Australia and globally, introducing CCS technologies to existing production may represent a near-term opportunity to significantly reduce the emissions profile of existing hydrogen production.

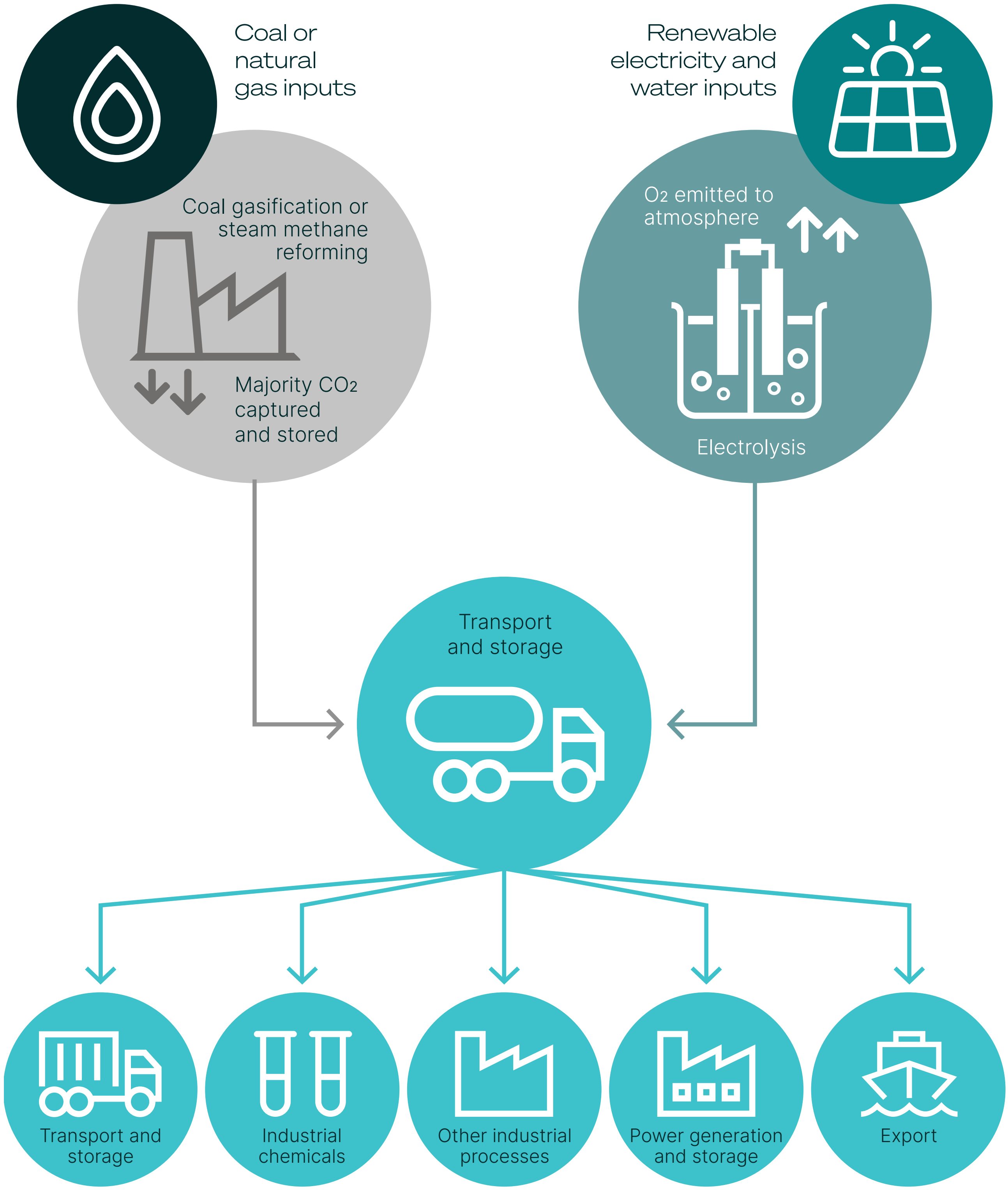
As the IEA has found,[6] clean hydrogen production from coal and natural gas with CCUS can be a:

> …lower cost option to hydrogen produced by electrolysis in regions with abundant low-cost gas and/or coal resources and CO_2 storage capacity…

Australia's large energy resource base (our coal and natural gas resource endowment is a key and longstanding part of Australia's 'world class energy resources' highlighted in Figure 2 on page ii of the Consultation Paper); our established and long-standing commercial relationships with both domestic customers and trading partners (Australia's successful coal and natural gas international trading relationships span generations and as a result of this success, Australia is the world's largest metallurgical coal exporter, second largest thermal coal exporter, and largest exporter of natural gas,[7] with exports of coal and natural gas totalling $216 billion in export revenue in 2022–2023[8]); significant onshore and offshore carbon dioxide (CO_2) storage potential (considered further below); and technical expertise and experience mean that Australia is well placed to see its comparative advantage in energy and resource production and export utilised to develop a competitive clean hydrogen industry.

Figure 1 highlights the various pathways to clean hydrogen production that can underpin the development of a leading clean hydrogen industry in Australia.

Figure 1: Clean hydrogen production pathways



SOURCE: GLENCORE (2022)

The role of clean ammonia

Hydrogen can also be converted to a hydrogen carrier such as ammonia. Ammonia is more energy dense by volume than compressed or liquefied hydrogen which means it can be easier and cheaper to transport and to store. At its destination, the ammonia can be 'cracked' to release the hydrogen or used directly as a fuel.

There are three main technological pathways for ammonia production: SMR, coal gasification, and water electrolysis. Existing ammonia production is predominantly natural gas or coal-based using the Haber–Bosch process and is generally unabated (that is, it does not utilise CCS). Utilising SMR and coal gasification combined with CCS provides the means to increase, in the relatively short-term, production of clean (low carbon) ammonia.

As the Consultation Paper notes on page 2:

> Both fuel security concerns and decarbonisation ambition is generating strong near-term interest from Japan and South Korea to import hydrogen chemical derivatives like methanol and ammonia and from Australia.

One of the key areas of focus for both Japan and Korea is the use of clean ammonia to co-fire with natural gas or coal in existing gas-fired or coal-fired power stations. This development sees energy security maintained, while decreases in power generation related emissions can be achieved.

With this in mind, the Consultation Paper on page 6 asks:

1. **Is prioritising the decarbonisation of ammonia production the most prospective way to achieve both hydrogen industry growth and industrial decarbonisation in the short-term?**

   While LETA does not necessarily see a 'prioritisation' as necessary, it is the case that there is an important opportunity for Australia to build on its existing trading relationships with key trading partners such as Japan, China and Korea — relationships the industry has built over generations with a focus on secure and competitive supply of Australian-produced energy and resource commodities (particularly coal and natural gas) — to see Australian-produced clean ammonia supplied to those same markets. Clean and competitively produced ammonia has the potential to become a key element of a net-zero emissions energy mix, especially in energy-intensive sectors. It also offers significant export opportunities for Australia, building on our long-established comparative advantage in the production and export of traditional energy resources.

   The following, drawn from the 2022 report by the International Centre for Sustainable Carbon (ICSC), entitled *The Potential Role of Ammonia in a Clean Energy Transition*,[9] highlights some of the clean ammonia co-firing work underway in some of Australia's largest trading partners:

   - The Chugoku Electric Power Company of Japan conducted demonstration tests of coalammonia cofiring at the 156-megawatt (MW) Unit 2 of its commercial coal-fired Mizushima Thermal Power Station.[10] The test results showed that the ammonia was completely burnt with no ammonia being detected outside the plant. Nitrous oxide (NO_x) emissions were not significantly different from those of 100 per cent coal-firing, and Japanese environmental standards were met. The most significant achievement of the demonstration was the confirmation that the coal-ammonia cofiring technology can be applied to coal-fired power plants in commercial operations as a measure to reduce CO_2 emissions.

- Following this demonstration, IHI Corporation developed a coal-ammonia cofiring burner that can be attached to an existing coal-fired boiler and can minimise incremental NO_x emissions.[11] The test results showed that NO_x emissions could be reduced to the level that occurs with 100 per cent coal combustion, and the heat collection performance of the boiler did not change significantly. At a 20 per cent ammonia/coal cofiring ratio, CO_2 emissions decreased by 20 per cent. In addition, an evaluation based on these test results concluded that cofiring ammonia with coal is a low-cost CO_2 reduction technology as it does not require major system modifications including NO_x control equipment.[12]
- Japan's JERA Co and IHI Corporation are working together on a demonstration project to cofire 20 per cent ammonia at the large, commercial coal-fired Hekinan Thermal Power Station. The project will run for approximately four years from June 2021 to March 2025. Ammonia cofiring tests at a lower ratio began in October 2021 at the 1,000 MW Unit 5 of the Hekinan plant to develop cofiring burners for use in later, higher ratio ammonia cofiring tests at the 1,000 MW Unit 4. JERA and IHI will progress through the steps of the demonstration project to achieve an ammonia cofiring rate of 20 per cent at Hekinan Unit 4 during 2023.[13]
- In a parallel eight-year project started in January 2022 and founded by the New Energy and Industrial Technology Development Organization (NEDO) under the Green Innovation Fund programme, JERA has teamed up with Japan's Mitsubishi Heavy Industries Group (MHI) to develop and demonstrate dedicated ammonia burners that can increase the ammonia cofiring rate to 50 per cent or more for coal boilers manufactured by MHI.[14] The project aims to develop an ammonia single-fuel burner suitable for coal-fired boilers by 2024 and to demonstrate the operation of the burner at actual coal boilers. By 2028, the developers aim to verify cofiring with at least 50 per cent ammonia at two units with different types of boilers.
- In China, China Energy Investment Corporation has recently demonstrated cofiring 35 per cent ammonia with coal at a 40 MW coal power unit.[15] NO_x emissions were reportedly lower than burning pure coal, and only 0.01 per cent of ammonia fuel was left unburnt.

The updated National Hydrogen Strategy provides an important opportunity to support the development of clean ammonia for use both in Australia and to build on our existing trading relationships with key trading partners in Asia.

3.

Challenges to deploying a clean hydrogen economy

Hydrogen production and use is an emerging industry. Currently, the gap between expected demand growth for hydrogen and projected renewable hydrogen production capacity is significant. Thus diverse sources of hydrogen will be needed to help countries achieve their net-zero ambitions at least cost. Meeting this growing demand for hydrogen will require rapid scaling up of hydrogen production capacity. However, the cost of low-emission hydrogen (including production, transport and storage) is very high, which is the main barrier to its widespread application.

While Australia has significantly opportunities to be a major exporter of hydrogen and hydrogen carriers like ammonia, there remain a number of challenges to deploying a clean hydrogen economy, including: production at scale, infrastructure, securing significant levels of capital investment from both domestic and international investors (an issue raised on page 19 of the Consultation Paper) in an increasing competitive global investment environment, bulk storage of hydrogen, distribution systems for hydrogen into both the domestic and export markets, ensuring fit-for-purpose safety arrangements are a core feature of the industry and, very importantly, how to grow simultaneous demand and supply for hydrogen technologies.

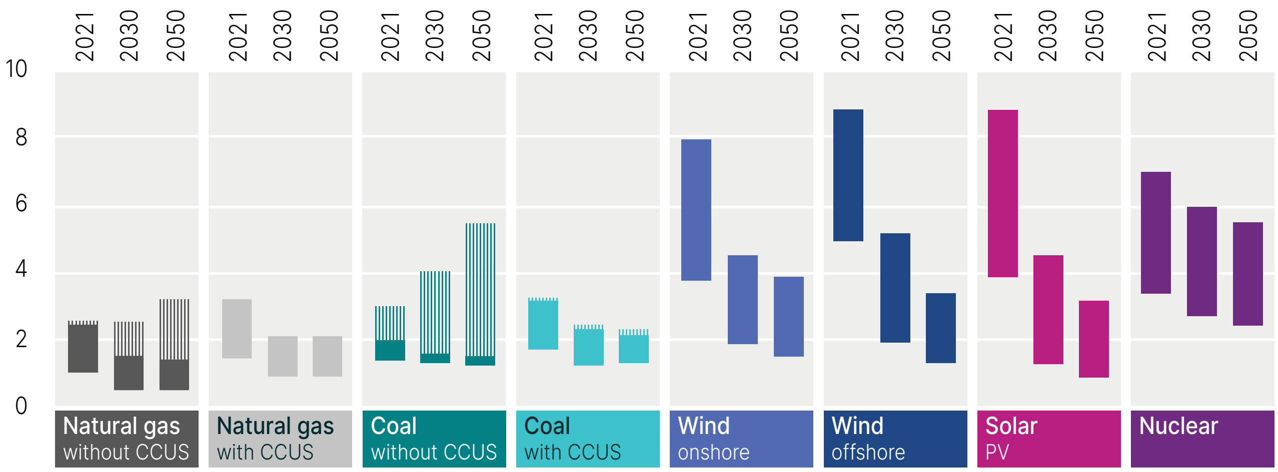
However, even considering these challenges, Australia’s competitive advantage in energy and natural resource developments puts the nation in a strong position to take advantage of any scale of hydrogen demand now and into the future. This also means there are two essential next steps in the success a clean hydrogen industry: creating markets to build scale, and bringing technology costs down.

Hydrogen production costs

Australia must be a low-cost producer to be a competitive supplier if we are to capture our share of growing global markets. While there are numerous modelling exercises available that seek to examine the future cost profile(s) for existing and future hydrogen production pathways, and the Consultation Paper highlights one modelling exercise from 2021 on page 12,[16] Figure 2 below is drawn from extensive analysis by the IEA and illustrates that hydrogen produced from coal with CCS is commercially competitive now and remains competitive out to 2050, meaning clean hydrogen production can play a key role in a cleaner energy future and achieving net-zero emissions.

In addition, Table 1 below, reproduced from a report by the ICSC[17] and drawn from analysis by Argus,[18] shows that there are large regional variations in the production costs of hydrogen. Table 1 shows the costs of renewable hydrogen are generally higher than clean (low-emission) hydrogen from coal or gas with CCUS. In Europe, renewable hydrogen costs twice as much as low-emission hydrogen from gas SMR with CCUS. Canada and USA can produce hydrogen from gas with CCUS at very low costs due to the low gas prices in internal markets. In comparison, the costs of renewable hydrogen are substantially higher, by a factor of 5.5 for Canada and 3.0 for the USA. For Australia, Argus estimates hydrogen from coal with CCUS ranges from $US3.36–$US5.60, natural gas with CCUS at $US3.62 and renewable hydrogen at $US5.03.

Figure 2: Cost of hydrogen production by technology in 2021 and in the net-zero emissions by 2050 scenario, 2030 and 2050 (US$/kgH2)[19]



SOURCE (IEA 2022)

Table 1: Cost of hydrogen by technology and by region, $US per kilogram of hydrogen (kgH2), November 2022

Coal gasification with CCUS

Region	Coal of	Including Capex	Excluding Capex
Australia	5,500 kcal/kg	3.36	2.61
	6,000 kcal/kg	5.60	4.65
China	3,800 kcal/kg	3.66	3.09
	5,500 kcal/kg	3.94	3.17
Indonesia	3,800 kcal/kg	3.34	2.50
	5,500 kcal/kg	3.77	2.94
South Africa	4,800 kcal/kg	3.52	2.52
	6,000 kcal/kg	4.08	3.07
US East Coast		4.19	3.45

Natural gas reforming with CCUS

Region	SMR	Including Capex	Excluding Capex
Australia	New	3.62	3.10
	Retrofit	n/a	3.05
Canada	New	1.17	0.65
	Retrofit	n/a	0.69
Middle East average	New	4.65	4.13
	Retrofit	n/a	n/a
Northeast Asia average	New	5.82	5.29
	Retrofit	n/a	n/a
Northwest Europe average	New	3.67	3.15
	Retrofit	n/a	n/a
US Gulf Coast	New	1.73	1.22
	Retrofit	n/a	1.19
North America average	New	1.45	0.94
	Retrofit	n/a	n/a

Renewable powered electrolysis

Region	Category	Including Capex	Excluding Capex
Australia	Diurnal+PEM	5.03	3.18
China	Offshore wind+PEM	6.43	4.51
Indonesia	Diurnal+PEM	4.73	2.85
Middle East average	Renewables+PEM	5.55	3.69
Northwest Europe average	Renewables+PEM	7.31	5.32
South Africa	Diurnal+PEM	5.90	3.73
US West Coast	Grid+alkaine	10.86	9.71
	Grid+PEM	11.32	9.49
	Diurnal+PEM	5.12	3.29

SOURCE: ICSC (2023) DRAWN FROM ARGUS (2022)

In addition, more recent (May 2023) analysis by the same organisation quoted in the Consultation Paper (BloombergNEF), in their *New Energy Outlook: Australia* report found that:

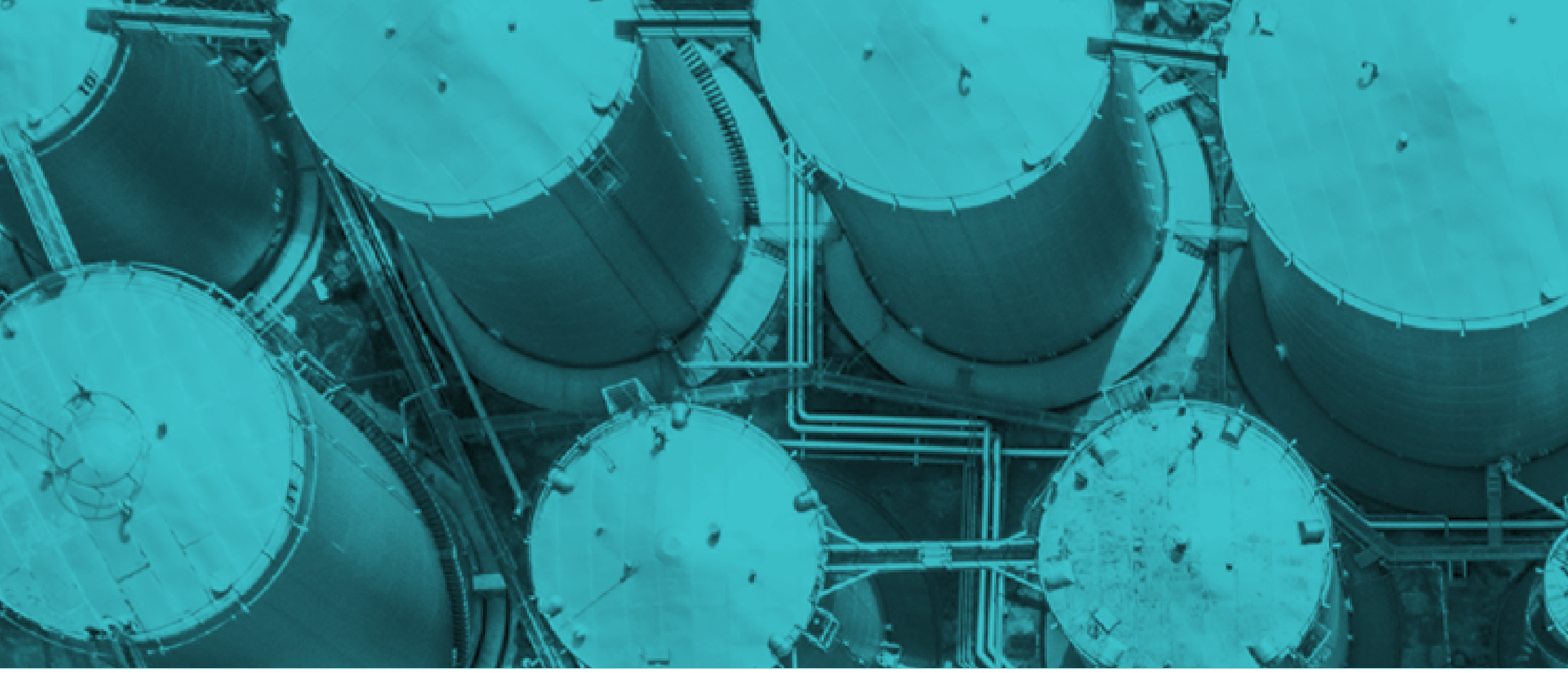
> … new technologies, **such as carbon capture and storage (CCS) as well as low-carbon hydrogen are essential in decarbonizing Australia's hard-to-abate sectors, especially heavy industry. The Net Zero Scenario sees CCS capacity for domestic market usage peak at around 55 million tons per year by 2050.** Hydrogen is a critical technology in applications where it is unfeasible or uneconomic to electrify. In the Net Zero Scenario, clean hydrogen production to meet domestic needs rises to around 3.7 million metric tons by 2050. In the Hydrogen Export Scenario, this figure soars to around 28.5 million metric tons.

Through leveraging and investing in Australian industry's existing skills, expertise and commercial relationships, as well as existing technology and infrastructure, Australia has what it takes to be a world leader in clean hydrogen production.

It is notable that under the IEA's Net Zero by 2050 Scenario, almost 40 per cent of hydrogen in 2050 will come from natural gas and coal utilising CCUS.

Similarly in Australia, the Net Zero Australia (NZAu) project final report,[20] *Modelling Summary Report*, released in April 2023, found that in one of its scenarios, clean hydrogen produced with CCS could play a very significant role, alongside renewables and other technology options, in ensuring Australia reaches net zero by 2050.

Australia has what it takes to be a world leader in clean hydrogen production



Greenhouse gas emission intensity of hydrogen production pathways

As will be considered in detail below, a key focus for any updated National Hydrogen Strategy should be a focus on the emissions associated with hydrogen production rather than on any particular hydrogen production pathway.

Supported by a consistent international emissions measurement methodology and the Hydrogen Guarantee of Origin (GO)[21] scheme, this can allow hydrogen consumers to make informed choices and support the development of a deeper and more liquid market for hydrogen and hydrogenrelated products.

> LETA has played an active role in the development of the GO scheme and looks forward to its finalisation and launch.

With that in mind, Figure 3 compares the estimated emission intensities of different hydrogen production pathways.

It shows hydrogen production using natural gas SMR with CCUS has an emissions intensity of 0.52 $kgCO_2/kgH_2$, while hydrogen production from coal gasification with CCS has an emissions intensity of less than 1.5 $kgCO_2/kgH_2$.

Coal gasification with a 98 per cent rate of capture (technically feasible)[22] has an even lower carbon intensity, below 0.4–0.6 $kgCO_2/kgH_2$.[23]

The CO_2 intensity of electrolysis depends on the CO_2 intensity of the electricity input. While electrolysers powered by 100 per cent renewable (or nuclear energy) emit no CO_2, electrolysers driven by grid electricity that has a large proportion of coal- or natural gas-fired power generation (such as in Australia, particularly the National Electricity Market (NEM)) would result in higher carbon intensities. Implementing CCUS substantially lowers the CO_2 emissions of both natural gas- and coal-based hydrogen production, reducing their carbon intensity by more than 90 per cent (commercially available) with higher reduction technically feasible over time.

The lifecycle greenhouse gas emissions of hydrogen production include emissions from raw material extraction, processing and transport, energy supply and use, fugitive gas emissions, and capex-related emissions. Thus, lifecycle emissions can represent a more complete footprint of hydrogen from different production pathways.

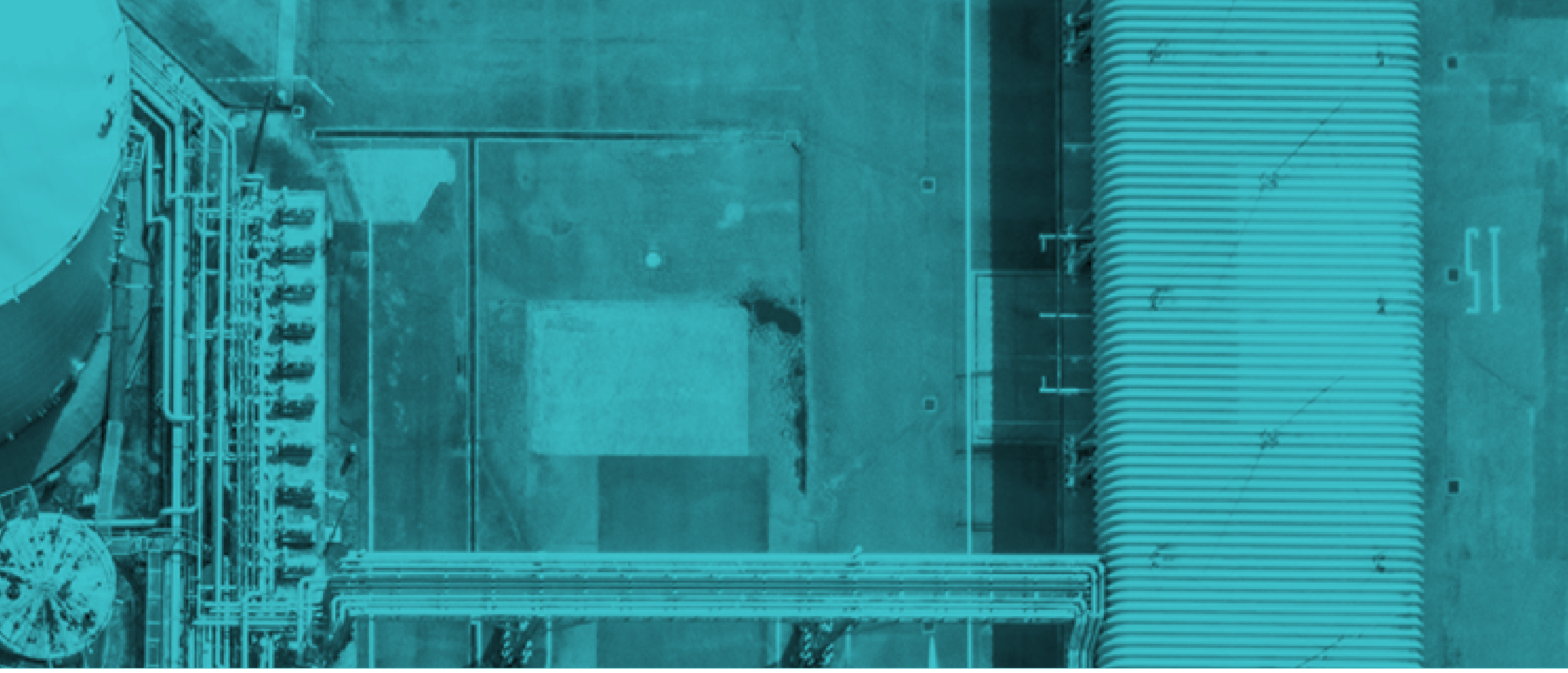
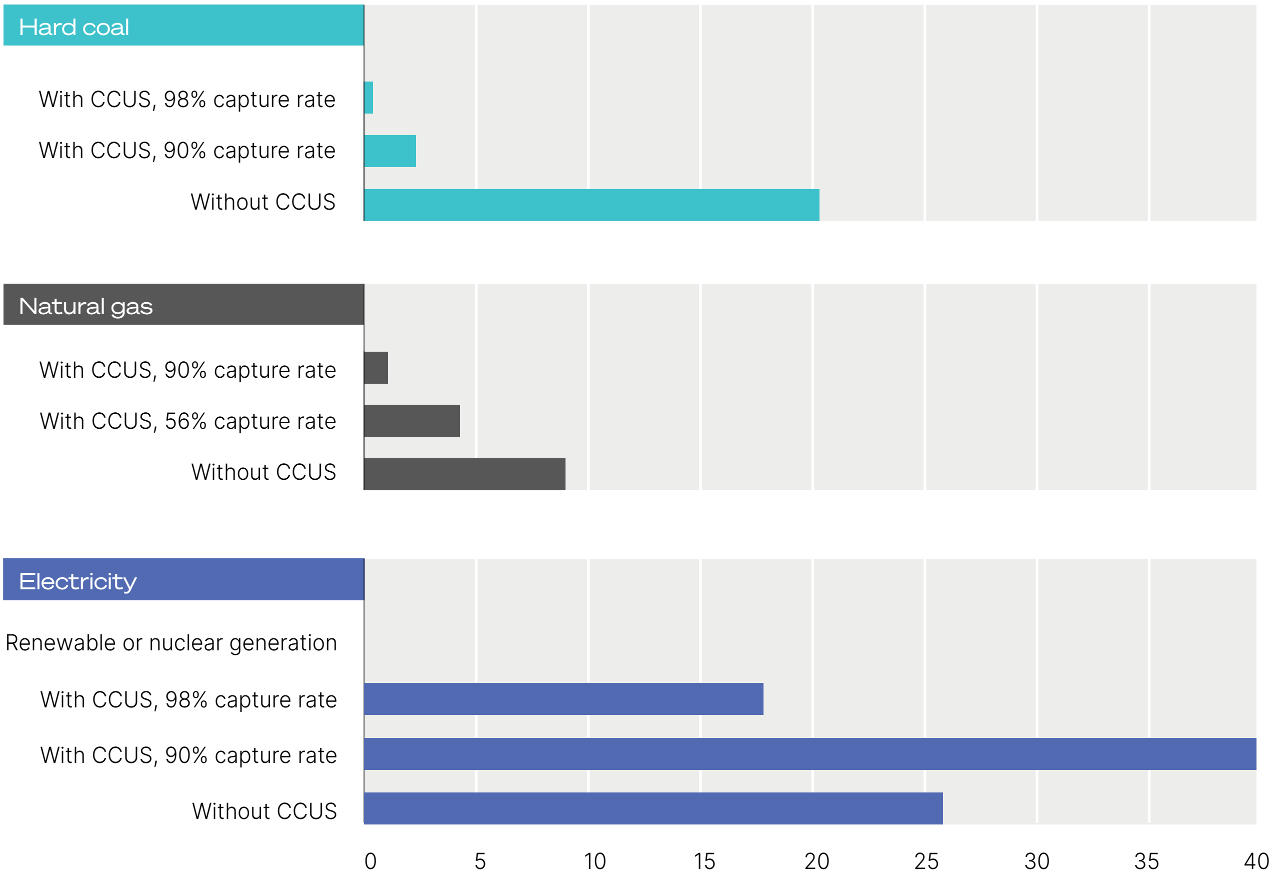


Figure 3: Greenhouse gas emission intensity of hydrogen production pathways (kgCO_2/kgH_2)



1. Capture rate of 56% for natural gas with CCUS refers to capturing the feedstock-related CO_2, whereas for 90% capture rate CCUS is also applied to the fuel-related CO_2 emissions. Note that capture rates approaching 100% have been shown to be technically feasible (Feron and others, 2019).
2. CO_2 intensities of electricity taking into account only direct CO_2 emissions at the electricity generation plant: world average 2017 = 491gCO_2/kWh; gas fired power generation = 336g/kWh;coal-fired power generation = 760g/kWh.
3. The CO_2 intensities for hydrogen also do not include CO_2 emissions linked to the transmission and distribution of hydrogen to end users.

SOURCE: ICSC (2022)

In the United States, a 2022 study by the US National Energy Technology Laboratory (NETL)[24] analysed and compared the lifecycle greenhouse gas emissions (as CO_2e) for six study cases (specifically, natural gas SMR with and without CCUS, natural gas ATR with CCUS, coal gasification with and without CCUS and coal/biomass co-gasification with CCUS).

Table 3 summarises the NETL study findings. It shows coal gasification-based hydrogen plant without CCUS had the largest carbon footprint of 20 $kgCO_2e/kgH_2$, while the coal/biomass co-gasification plant with CCUS had the lowest carbon footprint of -1.0 $kgCO_2e/kgH_2$ (that is, the NETL analysis finds coal/biomass co-gasification plant with CCUS can be emissions negative). The average lifecycle greenhouse gas emissions of the SMR and ATR plant with CCUS were 4.65.7 $kgCO_2e/kgH_2$.

Analysis by the Hydrogen Council in 2021[25] utilised a lifecycle analysis approach to evaluate the emissions intensity of hydrogen produced from various pathways. The analysis included geographical variations, production technologies, midstream transmission and distribution vectors, and end-use applications. The results are summarised in Figure 4. They concluded that low-emission hydrogen derived from fossil fuels can have low lifecycle emissions and support cleaner energy developments when best available technologies and operational practices are used

Table 3: Average lifecycle greenhouse gas emissions of hydrogen from different production pathways

Lifecycle GHG emissions	
Production pathway	($kgCO_2e/kgH_2$)
SMR	10
SMR+CCUS	4.6
ATR+CCUS	5.7
Coal gasification	20
Coal gasification with CCUS	4.1
Coal/biomass co-gasification with CCUS	-1.0

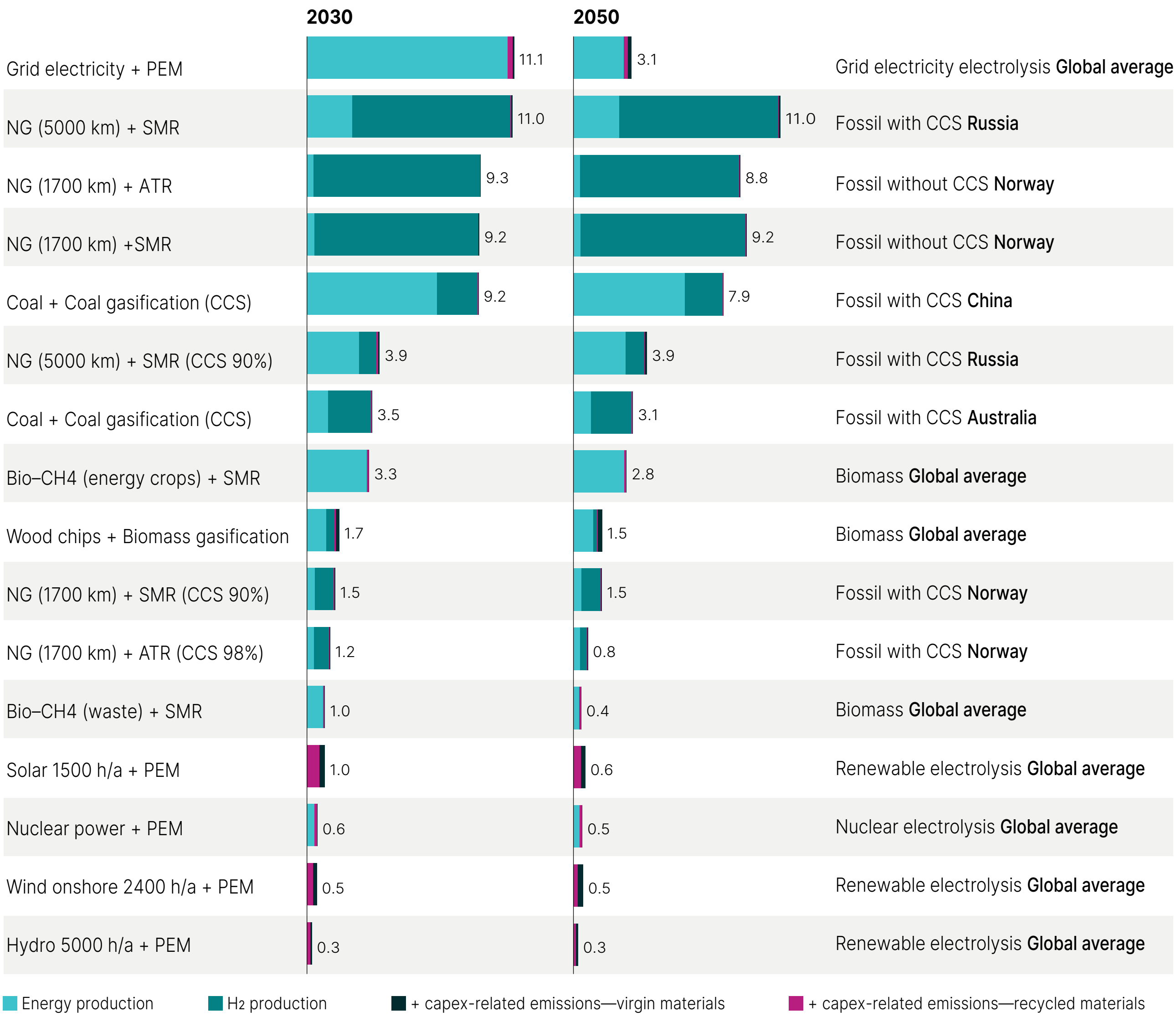
SOURCE: NETL (2022)

along with the high CO_2 capture rates (98 per cent is used in the analysis).

In addition to greenhouse gas emissions, there are other factors to consider in technoeconomic comparisons of low-emission hydrogen produced either from coal gasification or from electrolysis. A case study looking at water, land, critical minerals and electricity requirements for coal gasification with CCUS compared to PEM with an onshore wind farm or solar PV suggests gasification could provide an innovative, cost-effective and environmentally conscious solution to the safe production of low-emission hydrogen.[26]

Figure 4: Lifecycle greenhouse gas emissions by hydrogen production pathways in 2030 and 2050

GHG emissions, kg/kgH2, LHV— resulting figures refer to virgin material use



SOURCE: HYDROGEN COUNCIL (2021)

4.

The importance of a technology-neutral National Hydrogen Strategy

The 2019 National Hydrogen Strategy (the Strategy) was underpinned by a technology-neutral approach, and included a broad range of potential hydrogen production pathways in the Strategy.

The Consultation Paper on pages 12–13 asks:

18. When would it be appropriate to take a 'tech neutral' approach to developing hydrogen, and when would a more directed approach be warranted?

It is vital a technology-neutral approach be continued in the updated National Hydrogen Strategy.

While there have been a range of developments in the global and domestic industry since the 2019 Strategy, a technology-neutral approach, which focusses on all possible pathways to hydrogen development (both domestically and for exports), remains vitally important to Australia achieving the best outcomes from this technology. LETA recommends the Strategy reinforce the importance of a technology-neutral approach to hydrogen development.

A technology-neutral approach should be a key principle that underpins the development of the National Hydrogen Strategy to ensure it achieves the strategic objectives outlined above (that is, Australia is on the path to be a global hydrogen leader by 2030; enable domestic decarbonisation through the development of the hydrogen industry; and ensure economic benefit for all Australians through the development of the hydrogen industry) and set out on page iii of the Consultation Paper.

An approach that focusses exclusively on particular hydrogen production pathways (characterised in the Consultation Paper as a more 'directed' approach), and does not pursue a technology-neutral approach that would focus on emission reduction outcomes rather than favouring particular technologies, would represent a very significant missed opportunity to invest in technologies that will play a critical role in meeting Australian and global emissions reduction targets.

Such an approach risks failing to provide economcally efficient and environmentally effective support for industry development in Australia. It is vital that the development of the new National Hydrogen Strategy seize the opportunity to focus on all of the hydrogen production pathways outlined in Figure 1 above, including clean hydrogen using coal, gas or biomass with CCS.

A technology-neutral approach, one that focusses on emissions outcomes and not on particular production pathways, would also be consistent with the approach taken internationally, by both key trading partners and key sources of the future international investment that will be required to develop what will be a capital-intensive industry. International approaches to clean hydrogen development are considered below.

In much the same way, LETA recommends the National Hydrogen Strategy play a role in leading the Australian hydrogen discussion away from the use of terminologies based on 'colours' (grey, blue, green and so on) or other terms that are largely impractical for the contracts that underpin investment.

Much as the IEA has recently found,[27] the adoption of a framework based on the emissions intensity of hydrogen can bring transparency, facilitate 'interoperability' and encourage a deeper and more liquid market for hydrogen.

5.

International approaches to hydrogen development

As the Department's *State of Hydrogen 2022* highlighted, over thirty governments have introduced, or are formulating, hydrogen strategies, and more than 40 countries have released, or are about to release, hydrogen roadmaps for developing a hydrogen economy and related technologies. Table 2, prepared by the ICSC, provides an overview of the status of national hydrogen strategies.

The Consultation Paper on page 19 asks:

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32. How can agreements with other nations best support rapid growth to Australia's hydrogen industry?

The following sections provide an overview of key international hydrogen policies. Importantly, Australia's global competitors and trading partners (for example, both Japan and Korea have engaged extensively with Australian industry to pursue opportunities to build on Australia's longstanding trade relationships for traditional fuels to explore clean hydrogen export pathways) in many cases remain neutral with regards to the type of technology used to produce hydrogen, and focus on the associated emissions. Australia needs to be exploring all potential pathways to build global hydrogen markets and to maximise opportunities for the emerging industry here.

Table 2: The development status of national hydrogen strategies[28]

Region	Development status		
	Policy discussions, official statements, initial demonstration projects	**Strategy in preparation**	**Strategy available**
Africa	Burkina Faso Cape Verde Mali Nigeria South Africa Tunisia	Egypt Morocco	
Asia–Pacific	Bangladesh Hong Kong (China)	New Zealand Singapore Uzbekistan	Japan (2017) Australia (2019) South Korea (2019) China (2022) India (2023)
Europe	Bulgaria Croatia Denmark Estonia Finland Georgia Greece Iceland Latvia Lithuania Luxembourg Malta Romania Serbia Slovenia Switzerland Ukraine	Austria Belgium Poland Sweden Slovakia	EU (2020) France (2020) Germany (2020) Italy (2020) Netherlands (2020) Norway (2020) Portugal (2020) Spain (2020) Russia (2020) Czech (2021) Hungary (2021) UK (2021) Turkey (2023)
Central and South America and the Caribbean	Argentina Bolivia Costa Rica Mexico Panama Paraguay Peru Trinidad and Tobago	Brazil Uruguay	Chile (2020) Colombia (2021)
Middle East	Israel UAE	Oman Saudi Arabia	
North America		USA	Canada (2020)

SOURCE: ICSC (2023)

United States of America[29]

The USA established an Energy Hydrogen Programme in the mid-2000s, which has included R&D on hydrogen production, infrastructure, storage, fuel cells, and other applications across many sectors. More recently, the US *National Clean Hydrogen Strategy and Roadmap*, released in June 2023, sets out a national framework for facilitating large-scale production, processing, delivery, storage, and use of clean hydrogen to help meet decarbonisation goals across the US economy.

The Strategy and Roadmap will be updated at least every three years. Several government-funded programs are available to support the uptake and scale-up of hydrogen technologies including an $8 billion Regional Clean Hydrogen Hubs, $1 billion for R&D, and the $500 million Hydrogen Supply Chain Initiative.

Importantly, the US through the *Inflation Reduction Act 2022*[30] provides significant support for all forms of clean hydrogen production and for CCS. The Section 45V Hydrogen Production Tax Credit is designed to support the domestic (US) production of clean hydrogen. The Tax Credit is available for all types of hydrogen production, regardless of the production technology, and focuses on the emissions profile of the hydrogen produced.

Figure 5 provides an overview of the Strategy and Roadmap's actions and milestones for 2022–2025, 2026–2029 and 2030–2035. Notably, the focus is on clean hydrogen production, demonstrating replicable and scalable production of all forms of hydrogen, including for example coal and natural gas with CCS. Amongst other objectives, the Roadmap and Strategy sets objectives to achieve, by 2025, 10 MtH2pa production capacity and a $US1/kgH2 target.

Figure 5: US Strategy and Roadmap's actions and milestones

	2022–2025		2026–2029		2030–2035
Clean hydrogen production	Catalyse RD&D in electrolysis thermal conversion and new pathways to meet hydrogen shot	Demonstrate replicable, scalable production from renewables, nuclear, and fossil and waste with CCS	Deploy gigawatt-scale electrolysers and develop domestic supply chains	Scale up electrolyser manufacturing and recycling/ reuse capacity	Achieve 10MMT production capacity and $1/kg target
Delivery and storage infrastructure	Identify and prioritise barriers to infrastructure rollout	Initiate supporting infrastructure for regional hubs	Demonstrate advanced and efficient infrastructure	Develop sustainable regional clean hydrogen networks	Deliver hydrogen at scale
End uses and market adoption	Engage regulators to lay groundwork for strategic adoption across sectors	Initiate industrial projects and develop offtake agreements	Deploy regional clean hydrogen hubs	Deploy technologies that lower pollution and provide resiliency	Scale up hydrogen hubs and prepare export opportunities
Enablers	Engage stakeholders; address safety codes and standards; develop critical supply chains	Develop and expand workforce, talent pools and apprenticeship programs	Ensure 40% of benefits flow to disadvantaged communities impacted by DOE-funded	Demonstrate business cases and activate private capital	Achieve Justice 40, create good-paying jobs and ensure public health and safety

SOURCE: US DOE (2023)

Canada

Development of a large-scale, clean hydrogen economy, which aims to diversify Canada's future energy mix, generate economic benefits and achieve net-zero greenhouse gas emissions by 2050, has been established by the Canadian Government as a strategic priority for Canada. The *Canadian Hydrogen Strategy* has a target to produce 25 MtH$_2$pa by 2050 with a 30 per cent share of hydrogen in end-use energy with more than 50 per cent hydrogen in natural gas and dedicated hydrogen pipelines. Canada's target is to reduce the cost of low-emission hydrogen to $C1.5$C3.5/kgH2.[31]

The focus of both Canada and the USA is on advancing production hubs for clean hydrogen with CCUS and electrolysis based on renewables or nuclear power. End-use plans include low-emission hydrogen use in industrial processes, road transport, and grid balancing.

United Kingdom

Other countries are also exploring the use of low-emission hydrogen to achieve policy goals. A key focus of the UK *Ten-point Plan for a Green Industrial Revolution*[32] is to drive the growth of low-emission hydrogen for use across the economy with the aim of reaching 5 gigawatts (GW) of hydrogen production capacity by 2030.

As part of new plans to gain energy independence in response to the Russian invasion of Ukraine, the UK Government has raised its ambition for domestic low-emission hydrogen production from 5 GW to 10 GW by 2030 with half to be clean hydrogen.[33]

Also following the Russian invasion, the UK government commissioned an independent review of net zero tasked with assessing the government's approach to net zero to ensure it was still pursuing the most economically efficient path to meeting its climate change commitments. In its 2023 response to the review, the government agreed with the review's conclusion that net zero is the growth opportunity of the 21st century. It noted that other countries, such as the USA with the *Inflation Reduction Act 2022*, are moving quickly and stated that the UK must do the same including by kick starting CCUS to take advantage of the country's natural comparative advantage.

Scotland has announced in its December 2022 *Hydrogen Action Plan*[34] targets of 5 GW of low-emission hydrogen (defined in the Action Plan as hydrogen produced *"… via reforming natural gas or biogas in conjunction with carbon capture with high capture rates and is very low-carbon"*) by 2030, and at least 25 GW by 2045.

European Union

In July 2020, the European Commission (EC) published the *Hydrogen Strategy for a Climate-Neutral Europe,*[35] which includes a three-phase roadmap. The objective of Phase one, from 2020 to 2024, is to install at least 6 GW of renewable-powered electrolysers for 1 MtH$_2$pa production in the EU. In Phase two, from 2025 to 2030, the aim is to scale-up hydrogen production, distribution and use with the installation of at least 40 GW of electrolysers producing up to 10 MtH$_2$pa. Phase three, from 2030 onwards, has the objective to mature and use renewable hydrogen technologies in all sectors that are difficult to decarbonise. The EU recently raised the target for hydrogen in the EU energy mix to 20 MtH$_2$pa by 2030, 50 per cent of which is to be met by imports.

Individual EU countries have their own approaches and hydrogen targets. For example, Germany, France and Italy have announced specific budgets to achieve 5.0, 6.5 and 5.0 GW electrolyser capacity by 2030, respectively. The development of hydrogen capacity in the Netherlands (3–4 GW by 2030) and Spain (4 GW by 2030) will be financed by investment from the private sector, government budgets and EU funds. More recently, in July 2023, Germany updated[36] its *National Hydrogen Strategy* to place emphasis on clean hydrogen imports from Denmark and Norway, including utilising natural gas with CCS.

Japan

Japan's Sixth Strategic Energy Plan[37] (SEP), published in October 2021, set targets of 1 per cent of hydrogen and ammonia in both the primary energy mix and the electricity supply mix in 2030, consistent with the country's 2030 goal of reducing greenhouse gas emissions by 46 per cent from 2013 levels. Japan's hydrogen roadmap promotes the use of hydrogen and ammonia in Japan in thermal power plants and as a transport fuel. It aims to reduce hydrogen costs to ≤$US3/kg$H_2$ by 2030 and to ≤$US2/kg$H_2$ by 2050 to promote the competitiveness of the Japanese economy.

The Japanese Ministry of Economy, Trade and Industry (METI) invested over $US1 billion in 2022–2023 to accelerate the use of hydrogen and ammonia, including RD&D of ammonia-coal cofiring at an existing coal-fired power plant, and fuel cell and water electrolysis technology at ports and factories.

Japan has also invested in an Australian integrated clean hydrogen project known as the Hydrogen Energy Supply Chain (HESC) Project38, in Victoria's Latrobe Valley. Hydrogen production, which started early in 2021, was successfully produced from brown coal via coal gasification and refining. In January 2022, liquid hydrogen was loaded onto a dedicated ship, the first of its kind, the *Suiso Frontier*, and arrived at the Port of Kobe, Japan on 25 February 2022. In March 2022, after a review of several potential projects in Australia and around the world, Japan Suiso Energy (JSE) confirmed it had chosen to allocate the Japanese Government's Green Innovation Fund[39] grant of ¥220 billion (approximately $A2.35 billion) to the commercial demonstration phase of the HESC Project.

The commercial demonstration project will be delivered by two consortia:

- J-POWER and Sumitomo Corporation, who will form a joint-venture to produce clean hydrogen via extraction from Latrobe Valley coal with CCS in the offshore Gippsland Basin.
- JSE, comprised of Kawasaki Heavy Industries and Iwatani Corporation, who will purchase clean hydrogen from the J-POWER/Sumitomo Corporation project and will be responsible for liquefaction at the TPort of Hastings and trans-oceanic shipment from Victoria to Japan.

The project website highlights:

> … at a potential future scale of 225,000 tonnes per year, the HESC Project has the potential to reduce global CO_2 emissions by 1.8 million tonnes/year, equivalent to taking approximately 350,000 petrol engine cars off the road and create about 1,000 jobs per year in Victoria.

Following evaluation of the pilot phase a commercialisation demonstration phase is proposed from 2026–2030 after which a decision will be made to proceed to commercial operation, anticipated by 2030. In this case, CCUS technologies will be employed.

South Korea

The South Korean Government has announced plans for hydrogen to become the country's largest single energy carrier in 2050, accounting for one-third of total energy consumption. It also aims to have 200,000 fuel cell electric vehicles by 2025 as part of its *Green New Deal*. In particular, South Korea aims to be a global leader of hydrogen-powered vehicles and is focused on potential export markets.

Both Japan and South Korea are actively exploring hydrogen and ammonia imports with various supplier countries such as Australia and the Gulf States.

China

In China, hydrogen has been recognised as one of the six industries of the future in China's 14th Five-Year Plan (2021–2025).[40] In March 2022, the Chinese government released its *Medium- and Long-Term Plan for the Development of the Hydrogen Energy Industry* (2021–2035). The plan sets out a national strategy with a phased approach to developing a domestic hydrogen industry, technologies and manufacturing capabilities.[41]

India

India launched a National Hydrogen Mission (NHM) in August 2021, to articulate the government's vision, intent and direction for hydrogen and to outline a strategy. The NHM has four core elements:[42]

- SIGHT programme: Under the Strategic Interventions for Green Hydrogen Transition programme (SIGHT), two distinct financial incentive mechanisms—targeting domestic manufacturing of electrolysers and production of green hydrogen—will be provided.
- Pilot projects: NHM will also support pilot projects in emerging end-use sectors and production pathways. Regions capable of supporting large scale production and/or utilisation of hydrogen will be identified and developed as green hydrogen hubs.
- R&D projects: a public–private partnership frame-work for R&D (Strategic Hydrogen Innovation Partnership—SHIP) will be facilitated under NHM.
- Skill development: A coordinated skill develop-ment program will also form part of the NHM.

The NHM aims to see hydrogen production at 5 MtH2pa with an associated renewable energy capacity addition of about 125 GW by 2030.

To maintain a technology-neutral approach to hydrogen production and development, and to stand alongside the approach taken in many hydrogen development strategies, particularly countries like the US, Canada, the UK, Japan and Korea, LETA recommends the National Hydrogen Strategy take a technology-neutral approach to hydrogen production pathways and pursue the development of a clean hydrogen industry, both for domestic use and for export, one that encompasses renewable hydrogen developments, and hydrogen developments utilising coal, natural gas and biomass with CCUS, as well as remaining open to new and innovative production pathways.

6.

To support clean hydrogen developments and reduce emissions, policy and regulatory reforms are required

To provide the best opportunity for the new National Hydrogen Strategy to achieve its stated objectives, active policy and regulatory support from government in Australia would serve to facilitate clean hydrogen investment and development at the required scale and drive innovation.

This would provide support to key industries to reduce their carbon footprint, provide opportunities for Australia to play a role domestically and across the region to reduce emissions and represent key corporate action to 2030 and beyond.

In that context, LETA recommends that the Australian Government, through the National Hydrogen Strategy:

- Work with industry to develop and implement a more timely and efficient regulatory approval process to condense, without compromising, project approval processes for clean hydrogen (and CCS) projects, both onshore and offshore. This can facilitate the timely development and implementation of clean hydrogen projects to directly support the development of Australia's clean hydrogen industry:
    - streamlining across regional boundaries to support investor decision-making and develop infrastructure and generation investment propositions to attract capital investment. A range of funding support packages and programs have already been announced by Australian governments, particularly aimed at renewable energy projects. As well as refocussing that funding to a more technology-neutral basis, a 'one stop shop' approach should be developed
    - there is at present no mechanism for a streamlined approach to applying for programs, coordinated regulatory approvals or applications for funding that can combine grant and loan applications. A one stop shop could facilitate more efficient and effective permitting support and packaging to support investor decision-making and develop infrastructure and generation investment propositions to attract investment capital.
- Ensure clean hydrogen developments, are eligible (and indeed encouraged) through Major Project Status, which can be used to enable strategically significant projects that can face complex regulatory challenges to get extra support and coordinated approvals.[43]
- Work with industry to develop proposals to support carbon hubs that can support multi-user CCS projects, including those linked to clean hydrogen developments. Proposals could focus, amongst other things, on regulatory frameworks and the development of common-user infrastructure.

As is considered further in below, the Australian Government should also work with industry to develop a National CCUS Strategy, one that complements the development of a renewed and technology-neutral National Hydrogen Strategy. A National CCUS Strategy could analyse the domestic and global state of CCUS projects and developments and work with industry to develop a streamlined, efficient and effective policy and regulatory framework to facilitate the development of the industry in Australia (both onshore and offshore).

7.

The vital role of CCUS in developing a clean hydrogen industry

A core driver in the development of a hydrogen industry lies in the commitments of almost all advanced economies globally to reach net-zero greenhouse gas emissions by 2050 (or earlier). This means that clean hydrogen developments, utilising CCUS, also have a key role to play.

The IEA has found that reaching net zero without CCUS will be *"… virtually impossible"*.[44] The Intergovernmental Panel on Climate Change (IPCC) and others have also pointed to the absolute need for CCUS technologies if we are to have a chance of limiting the impacts of climate change.[45]

In Australia, the Climate Change Authority's recent *Reduce, remove and store: The role of carbon sequestration in accelerating Australia's decarbonisation* policy insights paper found:[46]

> … sequestration is a necessary part of any rapid, urgent decarbonisation and represents a huge opportunity for Australia.

CCS in Australia can both support future clean hydrogen production and reduce emissions from industrial facilities.

This is the case for both key Australian export industries, such as coal and natural gas, and for key Australian domestic industries, such as cement and steel. This means CCS is a key way to reduce—at scale—emissions from these and other key industrial facilities as they reduce their emissions in the short- to medium-term in line with a trajectory to reduce their emissions to net zero by 2050 (or earlier).

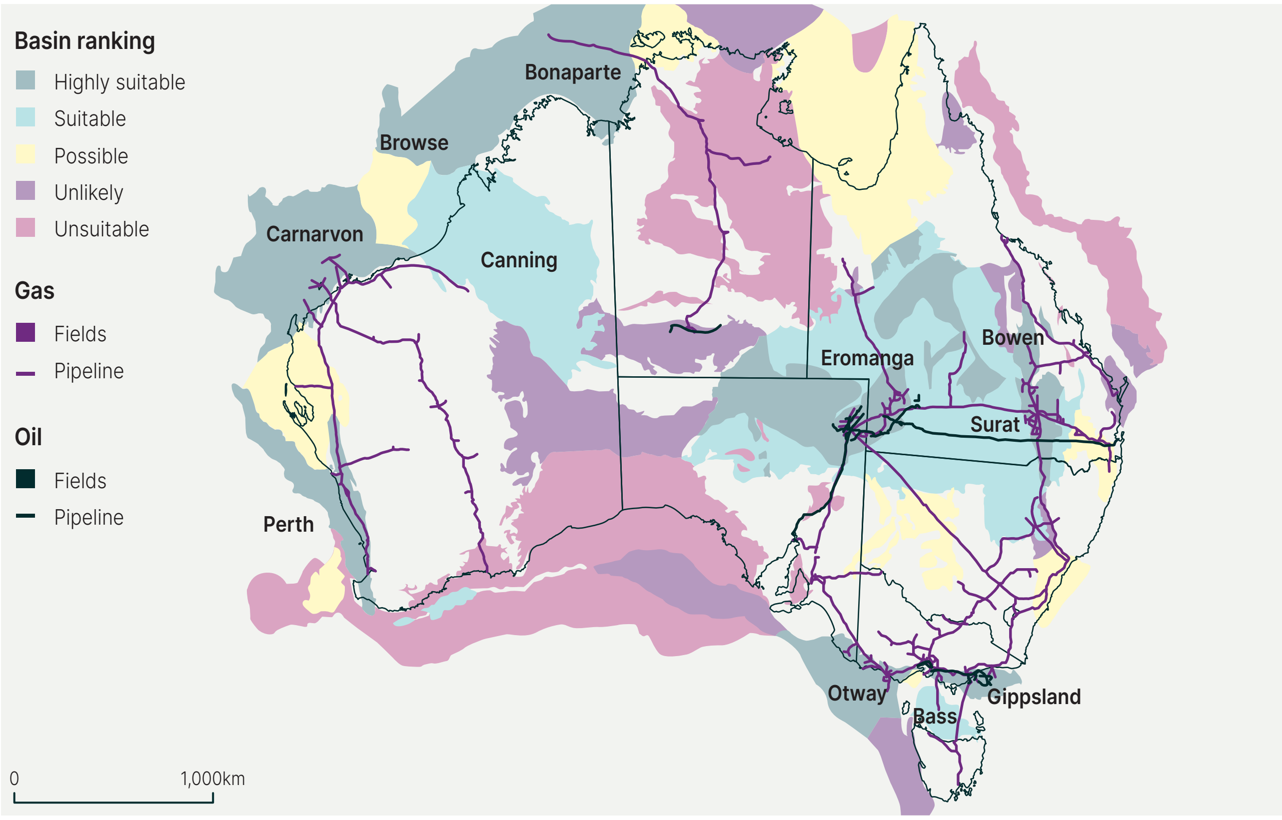
Australia has a natural competitive advantage to implement CCS with known high-quality, stable geological storage basins, existing infrastructure, world-class technical expertise and regulatory regimes (including environment protection, greenhouse and energy accounting and reporting, financial services).

As the Climate Change Authority's policy insights paper found, CCUS is not new technology and includes a suite of technologies that since 1972 have been used to capture, compress and transport CO_2 to be used in a range of applications or for injection into geological formations where it is trapped and permanently stored.

There are four crucial ways in which CCUS technology can contribute to a cleaner energy future, including the development of clean hydrogen:

1. It enables the production of low-carbon hydrogen from coal and natural gas, a least-cost option in several regions around the world.
2. It can be retrofitted to power and industrial plants.
3. It can tackle emissions in sectors with limited other options, such as cement, steel and chemicals manufacturing, and in the production of synthetic fuels for long-distance transport.
4. It can remove CO_2 from the atmosphere by combining it with bioenergy or direct air capture (DAC) to balance emissions that are unavoidable or technically difficult to avoid.[47]

Figure 6: National and basin scale assessment of Australia's potential for CCS



SOURCE: CARBON STORAGE TASK FORCE (2009)

Australia's CCS storage potential

A range of studies[48] that have examined Australia's CCS storage potential[49] have identified excellent potential for geological storage in Australia.

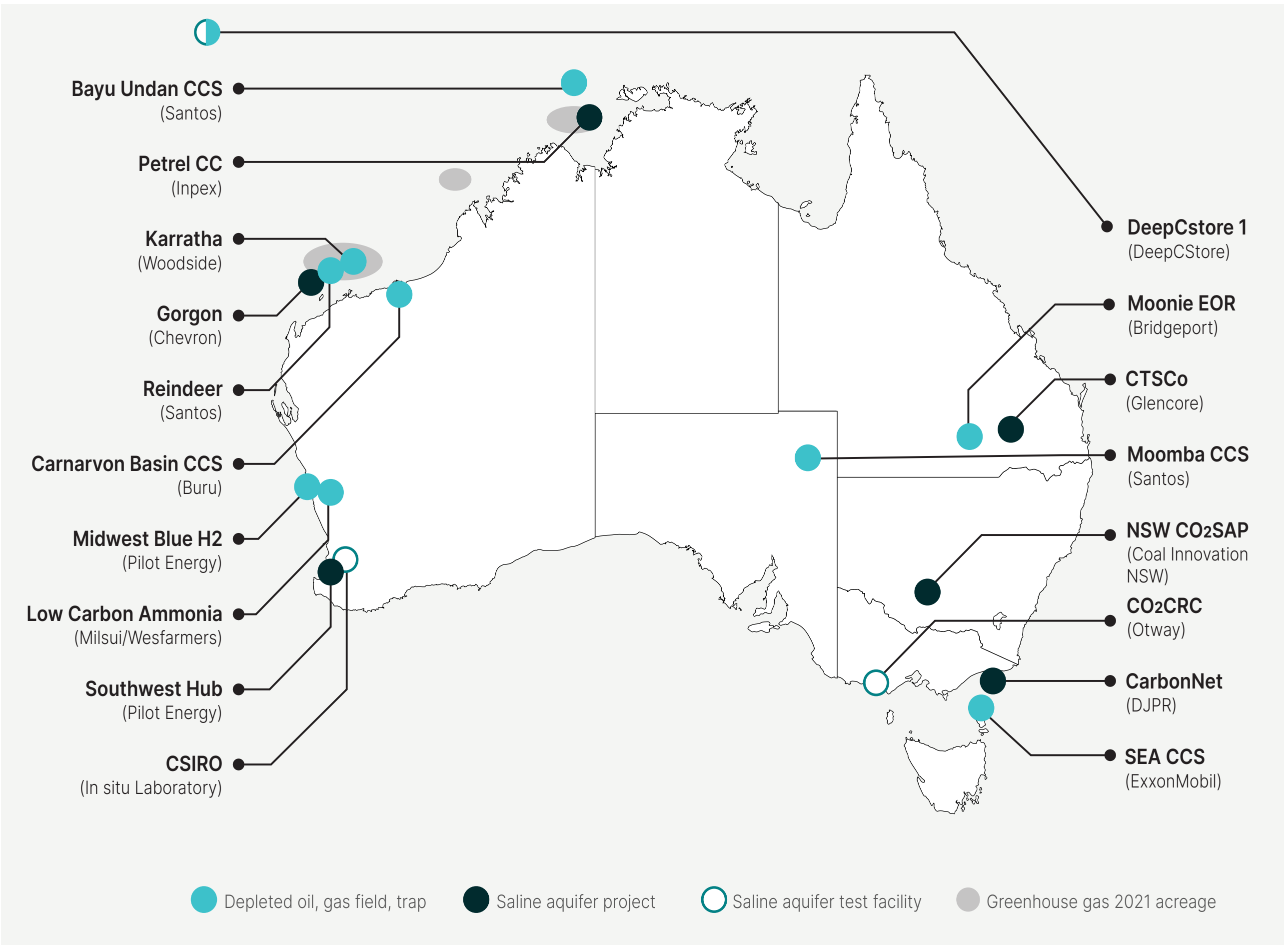
Geoscience Australia, the University of NSW[50] and the University of Queensland[51] have all completed extensive analysis. Figure 6, produced by Geoscience Australia from work by the Carbon Storage Task Force, identifies potential storage locations at a national and basin level.

A benchmark study from 2004 found that at a regional scale Australia has a CO_2 storage potential in excess of 1,600 years of annual total net emissions.[52] More recently, the CSIRO's *CO_2 Utilisation Roadmap* also confirms that Australia is well positioned to become a CCUS leader, particularly if Australia responds to global demand for cleaner carbon-based products in the medium term.

The one large-scale operating CCUS project in Australia (which is the world's largest CCS system) is the Gorgon Project.[53] The Moomba CCS Project is under construction.[54] In addition, there is a range of CCUS projects in the development stage around Australia. These projects are illustrated in Figure 7. A number of these CCS projects are directly linked to hydrogen developments or could form storage hubs for a range of industrial developments, including clean hydrogen.

Many countries are looking towards Australia, with our favourable geology, to take advantage of this technology. For example, in 2022 IEA Executive Director Dr Fatih Birol singled out hydrogen, CCS and renewable energy as areas that Australia should be prioritising.[55]

Figure 7: Australian CCS Projects, 2023



SOURCE: LETA (2023), BASED ON CSIRO (2022)

To support clean hydrogen developments and reduce emissions, policy and regulatory reforms are required to see CCS fulfil its potential.

As with the development of clean hydrogen and the policy support recommendations outlined in Section 6, active policy support from government in Australia would serve to facilitate CCUS investment and development at the required scale and drive innovation. This would provide support to key industries to reduce their carbon footprint, provide opportunities for Australia to play a role domestically and across the region to reduce emissions and represent key corporate action to 2030 and beyond.

In that context, LETA recommends, to complement the development of the National Hydrogen Strategy and to ensure clean hydrogen, along with CCS, plays a role in developing a large-scale and competitive hydrogen industry, that the Australian Government:

- Work with industry to develop a *National CCUS Strategy*, one that complements the development of a renewed and technology-neutral National Hydrogen Strategy. A National CCUS Strategy could analyse the domestic and global state of CCUS projects and developments and work with industry to develop a streamlined, efficient and effective policy and regulatory framework to facilitate the development of the industry in Australia (both onshore and offshore).
- Reconsider the funding cuts to CCUS programs announced in the October 2022 Budget[56] and work with industry to develop a new, fit for purpose funding program.
- Work with industry to develop and implement a more timely and efficient regulatory approval process to condense, without compromising, project approval processes for CCS projects, both onshore and offshore. This can facilitate the timely development and implementation of CCUS projects that can directly support the development of Australia's clean hydrogen industry.
- Ensure CCS projects, including those linked to clean hydrogen developments, are eligible (and indeed encouraged) through Major Project Status, which can be used to enable strategically significant projects like CCS that can face complex regulatory challenges to get extra support and coordinated approvals.[57] Similar processes should be mirrored at the state or territory level for onshore CCUS projects.
- Work with industry to develop proposals to support carbon hubs that can support multi-user CCS projects, including those linked to clean hydrogen developments. Proposals could focus, amongst other things, on regulatory frameworks and the development of common-user infrastructure.

8.

CCS and clean hydrogen projects in Australia:

Surat Basin CCS Project and Surat Hydrogen Project

The Consultation Paper (page ii) notes, based on data from BloombergNEF, that Australia has a hydrogen project investment pipeline valued from $230 billion to $300 billion. Data from DISR in its *Resources and energy major projects* report[58] found that in 2022, hydrogen projects accounted for an estimated $266 billion worth of potential investment.

One of the most progressed and important projects LETA is supporting is the Carbon Transport and Storage Company (CTSCo) Surat Basin CCS Project onshore in the southern Surat Basin in Queensland.[59] An important element of this project will be to prove up hundreds of millions of tonnes of potential CO_2 storage and de-risk investment decisions for other potential projects to decarbonise a wide range of Australian industries.

A successful Surat Basin CCS Project will help enable future industries including clean hydrogen and carbon recycling and foster international collaboration and leadership on technology and emissions reduction, including clean hydrogen developments.

The Surat Basin CCS Project will be able to facilitate a commercial-scale hydrogen and ammonia project in Queensland known as the Glencore Surat Hydrogen Project.[60] Glencore's investment of $A40 million will fund pre-feasibility studies into the use of coal as feedstock to produce hydrogen and ammonia. The project will use ammonia, which is a hydrogen carrier, to economically and safely store and transport the hydrogen for use in Australia and exported to customers overseas.

CCS technology will be used to capture the majority of the emissions produced as part of the process. The emissions will be captured, transported and stored deep underground at the Surat Basin CCS Project.

9.

Clean hydrogen and international trade

The Consultation Paper on page 19 asks:

33. How should Australia ensure that the necessary foreign investment in hydrogen industry, and export projects leads to lasting benefits for all Australians?

As outlined above, many of Australia's largest trading partners have announced target dates to achieve net-zero greenhouse gas emissions, such as Japan, South Korea and Vietnam in 2050, China in 2060 and India in 2070. A key goal for each of these nations is achieving their emissions reduction targets at the lowest cost possible while taking advantage of the opportunities arising from emissions reduction and maximising energy security, which includes security of critical supplies and grid stability.

Many of these trading partners have rapidly growing economies that depend on coal and natural gas and have relatively 'young' generation, steel, alumina and cement plants, meaning that there is an important role for low-emission technologies to assist in reducing emissions in these hard-to-abate sectors.

Clean hydrogen incorporating CCUS will become increasingly important to enable the ongoing energy security delivered by traditional energy sources while providing lower emission sources of power, steel, cement and chemicals at competitive cost. Due to the nature of storage opportunities and infrastructure networks for transport, regional solutions to meet growing demand are also likely to become important.

In other words, in order to reach a country's net-zero goal at least cost while maintaining economic growth a range of solutions, both local and regional, will be required:

- Local: harnessing cost-effective storage if available while taking into account CO_2 point sources, transport options and geological storage capacity.
- Regional: some countries have limited storage, but they could still use hydrogen and other feedstocks from fossil fuels with the storage occurring where the coal and natural gas reserves are located (in Australia or Indonesia, for example) as part of attaining net zero.[61]

For example, it is likely that the majority of hydrogen, ammonia and other derivative cleaner energy sources for Japan, South Korea and Taiwan will need to be imported by those economies.

10.

Other issues

LETA offers the following comments on some of the other issues raised in the Consultation Paper.

Should Australian governments adopt national hydrogen production, use and/or export targets for hydrogen?

Questions 7–9 on page 9 of the Consultation raise the idea of targets and/or regulatory mandates to drive the development of the Australian hydrogen industry.

LETA does not support the use of mandates or targets enforced by regulatory requirements to drive the development of the industry. Rather, LETA supports a technology-neutral Strategy that can ensure the development of an industry for both domestic use and exports is market-based and underpinned by an efficient and effective regulatory regime and an investment environment that is encouraging of and attractive to international investment into what is a capital-intensive industry.

Targets for production, use and/or export targets for hydrogen can however, be useful guideposts for developing policy, legal and regulatory frameworks, to assess progress and to consider improvements to the Strategy's approach.

Is there a need to consider a hydrogen reserve, price cap or other fuel security measures

The hydrogen industry in Australia (and internationally) is an early stage of development. As is the case for the rest of the Australian resources and energy industries, the hydrogen industry, particularly the export industry, will require significant international investment and engagement with Australia's trading partners to ensure its success.

At this early stage in the industry's development, market interventions like a reservation scheme, price cap or other measures (such as a hydrogen version of the Australian Domestic Gas Security Mechanism (ADGSM)) could only serve to undermine the attractiveness of Australia as investment destination, and risk impeding the development of the Australian hydrogen industry (and before that development has begun in earnest).

The gas market interventions outlined on page 15 of the Consultation Paper have served to undermine investment in the Australian gas industry and endanger Australia's hard-won reputation as a secure place to invest and as a reliable trading partner. Such mistakes should not be repeated for an emerging hydrogen industry, particularly when the industry will need to secure significant levels of international investment in a very competitive market to achieve any of its growth aspirations.

The National Hydrogen Infrastructure Assessment

The Consultation Paper (page 17) asks:

27. How can the National Hydrogen Infrastructure Assessment be delivered to maximise the value to governments and industry?

The first *National Hydrogen Infrastructure Assessment* (NHIA),[62] released in April 2023. envisaged updated NHIA's would be produced at least every five years.

Given the early stage of development of the industry and fast changing commercial and policy landscape, both in Australia and internationally, there is an argument that a new NHIA should be produced more frequently than every five years.

Updates could align with, and complement, other energy planning and infrastructure implementation planning such as the AEMO Integrated System Plan, Electricity Statement of Opportunities and Gas Statement of Opportunities and broader federal and jurisdictional energy planning and infrastructure planning processes.

The Consultation Paper also asks whether there should be specific areas of focus in the next NHIA.

As well as a general update of the existing NHIA, LETA recommends the next NHIA include an examination of the infrastructure needs of clean hydrogen development and how those needs can complement and be aligned with CCS-related infrastructure developments.

11.

Conclusion/next steps: taking the National Hydrogen Strategy forward

To conclude, the development of a clean hydrogen industry globally and in Australia has the potential to play an important role in a cleaner energy future. This is both in achieving reductions in greenhouse gas emissions consistent with the Paris Agreement while maintaining energy security and supporting economic development and industry growth. In doing so, the development of a clean hydrogen industry can form a direct and important part of Australia's achieving the strategic objectives established in the Consultation Paper.

It is vital a technology-neutral approach be continued in the updated National Hydrogen Strategy. While there have been a range of developments in the global and domestic industry since the 2019 Strategy, a technology-neutral approach, which focusses on all possible pathways to hydrogen development (both domestically and for exports), remains vitally important to Australia achieving the best outcomes from this technology.

LETA looks forward to its continued participation in the development of the National Hydrogen Strategy and looks forward to ongoing consultation ahead of the release of the revised Strategy in early 2024.

Endnotes

1 Clean hydrogen, consistent with the approach used by the International Energy Agency (IEA) (see, for example www.iea.org/fuels-and-technologies/hydrogen) is produced from renewables, nuclear (noting nuclear-based hydrogen is not an option in Australia at present) or coal and natural gas with CCUS. The terms clean hydrogen, low-carbon hydrogen and low-emission hydrogen are used interchangeably throughout this submission.

2 In this submission CCUS and CCS are used interchangeably but represent the relevant suite of technology options.

3 IEA (2022), *Global Hydrogen Review 2022* (available at www.iea.org/reports/global-hydrogen-review-2022).

4 See also International Centre for Sustainable Carbon ICSC) (2023), *Hydrogen economy and the role of coal* (available at www.sustainable-carbon.org/report/hydrogen-economy-and-the-role-for-coal-ciab-report).

5 IEA (2022), *Global Hydrogen Review 2022* (available at www.iea.org/reports/global-hydrogen-review-2022).

6 IEA (2022), *Global Hydrogen Review 2022* (available at www.iea.org/reports/global-hydrogen-review-2022).

7 Department of Industry, Science and Resources (DISR) (2023), *Resources and Energy Quarterly* June 2023 (available at www.industry.gov.au/sites/default/files/2023-07/resources-and-energy-quarterly-june-2023.pdf).

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14 JERA, MHI (2022), 'JERA and MHI Start a Demonstration Project to Develop Technology to Increase the Ammonia Cofiring Rate at Coal-fired Boilers,' Press Release (available at www.mhi.com/news/22010702.html).

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16 BloombergNEF (2023), *New Energy Outlook: Australia*, (available at about.bnef.com/new-energy-outlook-series and about.bnef.com/blog/report-shows-pathway-and-cost-for-australia-to-meet-climate-goals-and-become-major-hydrogen-exporter).

17 ICSC (2023), *Hydrogen Economy and the Role For Coal* (ICSC–CIAB), (available at www.sustainable-carbon.org/report/hydrogen-economy-and-the-role-for-coal-ciab-report).

18 Argus (2022), *Hydrogen and future fuels—Price series*, Argus Media (available at www.argusmedia.com/en/power/argus-hydrogen-and-future-fuels).

19 IEA (2022), *Global Hydrogen Review 2022* (available at www.iea.org/reports/global-hydrogen-review-2022).

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21 See www.cleanenergyregulator.gov.au/Infohub/Markets/guarantee-of-origin for more information.

22 ICSC (2023), *Hydrogen Economy and the Role For Coal* (ICSC–CIAB), page 11 (available at www.sustainable-carbon.org/report/hydrogen-economy-and-the-role-for-coal-ciab-report).

23 See ICSC (2022), *The role of low emission coal technologies in a net zero Asian future* (available at www.sustainable-carbon.org/report/the-role-of-low-emission-coal-technologies-in-a-net-zero-asian-future). The carbon intensities shown in Figure 3 represent total CO_2 emissions from a hydrogen production process and do not include emissions linked to the transmission and distribution of hydrogen to the end consumers. The capture rate of 56 per cent for natural gas with CCUS refers to capturing only process CO_2, whereas for the 90 per cent capture rate, CCUS is applied to both process and utility CO_2 emissions. CO_2 intensities of electricity consider only direct CO_2 emissions at the power plant.

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61 A number of these regional solutions were discussed in the recent House of Representatives Standing Committee on Climate Change, Energy, Environment and Water Inquiry Into the 2009 and 2013 Amendments to the 1996 Protocol to The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (London Protocol), which reported in June 2023 (see www.aph.gov.au/Parliamentary_Business/Committees/House/Climate_Change_Energy_Environment_and_Water/LondonProtocol/Report) and the Senate Standing Committee on Environment and Communications Inquiry into Environment Protection (Sea Dumping) Amendment (Using New Technologies To Fight Climate Change) Bill 2023 [Provisions] which reported in July 2023 (see www.aph.gov.au/Parliamentary_Business/Committees/Senate/Environment_and_Communications/SeaDumpingBill/Report). Both Committees recommended the Australian Government ratify both the 2009 and the 2013 amendments to the London Protocol. The 2009 amendment enables the export of CO_2 streams from a 'Contracting Party' to another country for the purpose of sequestration in sub-seabed geological formations. The Australian Government subsequently introduced into Parliament on 22 June 2023 the Environment Protection (Sea Dumping) Amendment (Using New Technologies to Fight Climate Change) Bill 2023 (see www.aph.gov.au/Parliamentary_Business/Bills_Legislation/Bills_Search_Results/Result?bId=r7052 for more information).

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