Department of Planning, Industry and Environment

NSW Hydrogen Strategy

Making NSW a global hydrogen superpower

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Minister's foreword

The world is decarbonising and that creates huge opportunities for NSW. Green hydrogen will be a crucial part of the story. It is a fuel with the power to drive the deep decarbonisation of industries across NSW, to transform our big emitters and future-proof their place in the global economy. It is the key to overcoming some of the hardest obstacles we will face on our journey towards net zero.

Embracing the potential of hydrogen is not just about doing the right by the environment. It is also about doing right by the businesses and families of NSW. Green hydrogen will not only protect the industries and jobs that NSW families rely on in a changing global economic environment, but fuel their growth and expansion.

Our State has the potential to become a global green hydrogen superpower, supplying the world with the clean fuels and zero-emissions products it increasingly demands. Realising this potential will cement NSW's position as the economic powerhouse of Australia well into the future.

Our Hydrogen Strategy is a plan to support our scientists, researchers and industries, to rapidly increase the scale and competitiveness of green hydrogen in NSW. It's a plan to halve the cost of production of green hydrogen in NSW. This Strategy will provide up to $3 billion in support for the hydrogen industry by waiving government charges on green hydrogen production, providing a 90% exemption to network charges for electrolysers that connect to parts of the electricity network with spare capacity, investing $70 million in hydrogen hubs in the Illawarra and Hunter, incentivising green hydrogen production and rolling out hydrogen refuelling stations.

But—at its heart—our Hydrogen Strategy is a promise—a promise to embrace the future and harness human ingenuity and creativity to do the right thing by our planet and leave no one behind. And, above all, it is a promise to never stop imagining a better and more prosperous NSW to leave to future generations.

The Hon. Matt Kean MP
Minister for Energy and Environment

1. Summary

Ambition

The NSW Hydrogen Strategy brings together the NSW Government's existing and new policies into a framework to support the development of a commercial hydrogen industry in NSW. Our ambition with this Strategy is to develop low emissions industries that sell clean fuels and products to the world. We will deliver on this ambition by supporting industry to rapidly achieve scale and increase the competitiveness of hydrogen against existing emissions intensive fuels and technologies. This will trigger a virtuous cycle of investment, technology development and cost reductions that will enable market forces to drive deep decarbonisation and transformation of industries across the NSW economy.

It is widely acknowledged that international competition for hydrogen market share, supply chains and expertise will intensify over the next 5 to 10 years. First movers will position themselves now to capture early market share and build supply chains that shape the development of the hydrogen industry for decades to come. The presence of clear and favourable policy settings will factor into investment decisions by these first movers and influence where they invest capital. By putting in place ambitious policies that capitalise on our natural strengths, we aim to set NSW apart from other jurisdictions and position the State to become a regional leader in green hydrogen.

By 2030, we aim to be producing 110,000 tonnes of green hydrogen per annum from 700 MW of electrolyser capacity for under $AU2.80 per kg.

Achieving these stretch targets will transform NSW into Australia's largest consumer of green hydrogen, create up to 10,000 new jobs and position the State to become a hydrogen export superpower.

To get there, this Strategy provides up to $3 billion of incentives to commercialise hydrogen supply chains and reduce the cost of green hydrogen by an estimated $5.80 per kg. With this Strategy, we will support industry to adopt green hydrogen, develop hydrogen hubs at our major ports, build a hydrogen refuelling network for heavy vehicles along major highways, create a market led framework to drive demand for green hydrogen and waive a wide range of taxes and charges to dramatically reduce the cost of green hydrogen.

2030 stretch targets

H_2

Green hydrogen produced
110,000 tonnes per annum

Electrolyser capacity
700 MW

Hydrogen vehicles
10,000

Gas network blending
10% (by volume)

Renewable energy capacity
12 GW

Hydrogen price
Under $AU2.80 per kg

Refuelling stations
100

NSW Government heavy vehicle fleet
20% hydrogen vehicles

Lead policies

This Strategy is built on three strategic pillars—enable industry development, lay industry foundations and drive rapid scale. We are delivering a total of 60 actions across these pillars that are designed to support development of the full hydrogen value chain. This includes support for initial industry development and deployment of hydrogen technologies and infrastructure through to commercial-scale operations. This section summarises the key actions for each pillar. The full list of actions is set out in the Appendix.

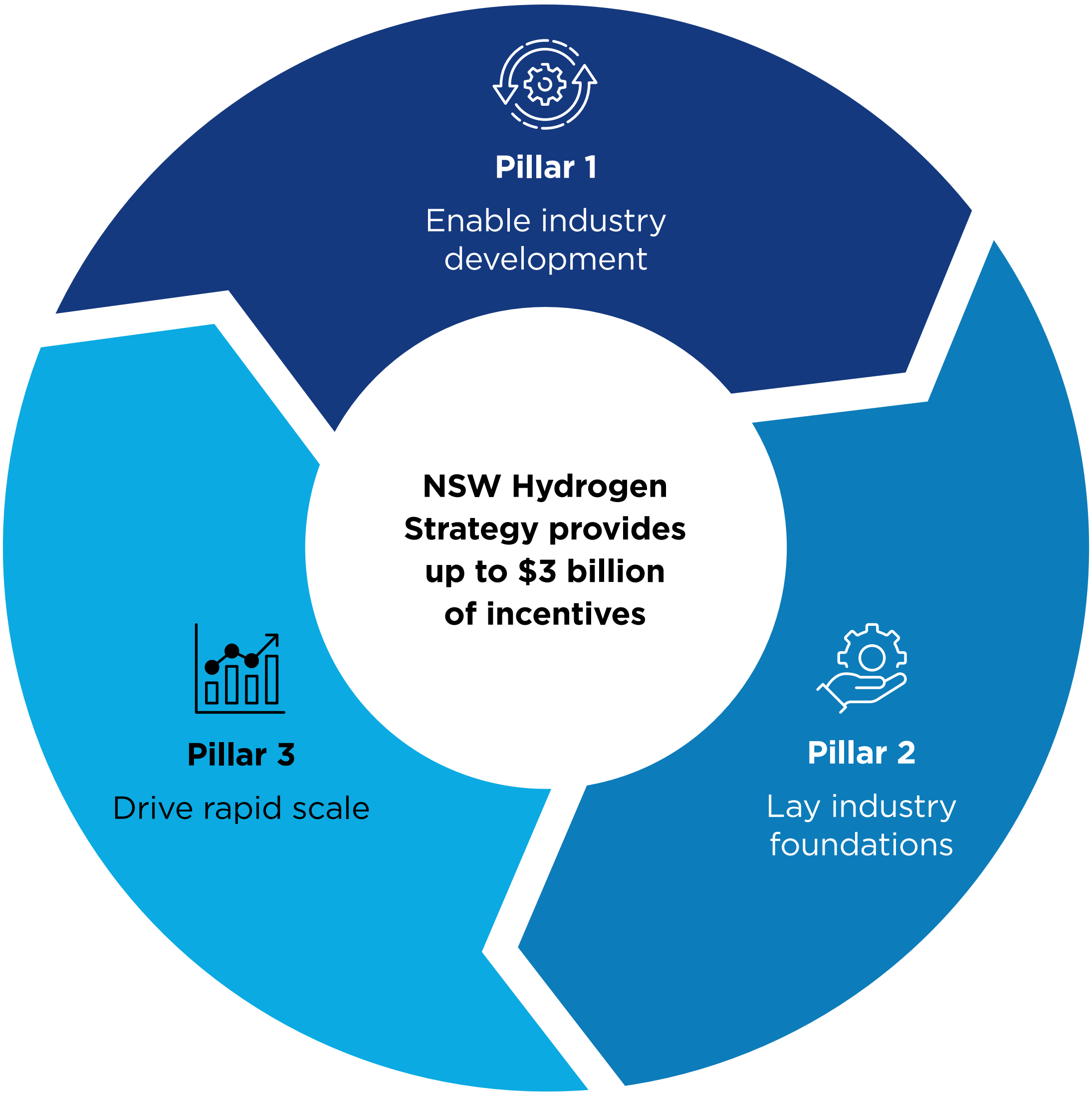


Figure 1
NSW Hydrogen Strategy pillars.

PILLAR 1

Enable industry development

Under Pillar 1, the NSW Government will work with industry and academia to build the critical ecosystems, skills and regulatory frameworks needed to establish and grow the green hydrogen industry. Key actions under this pillar include:

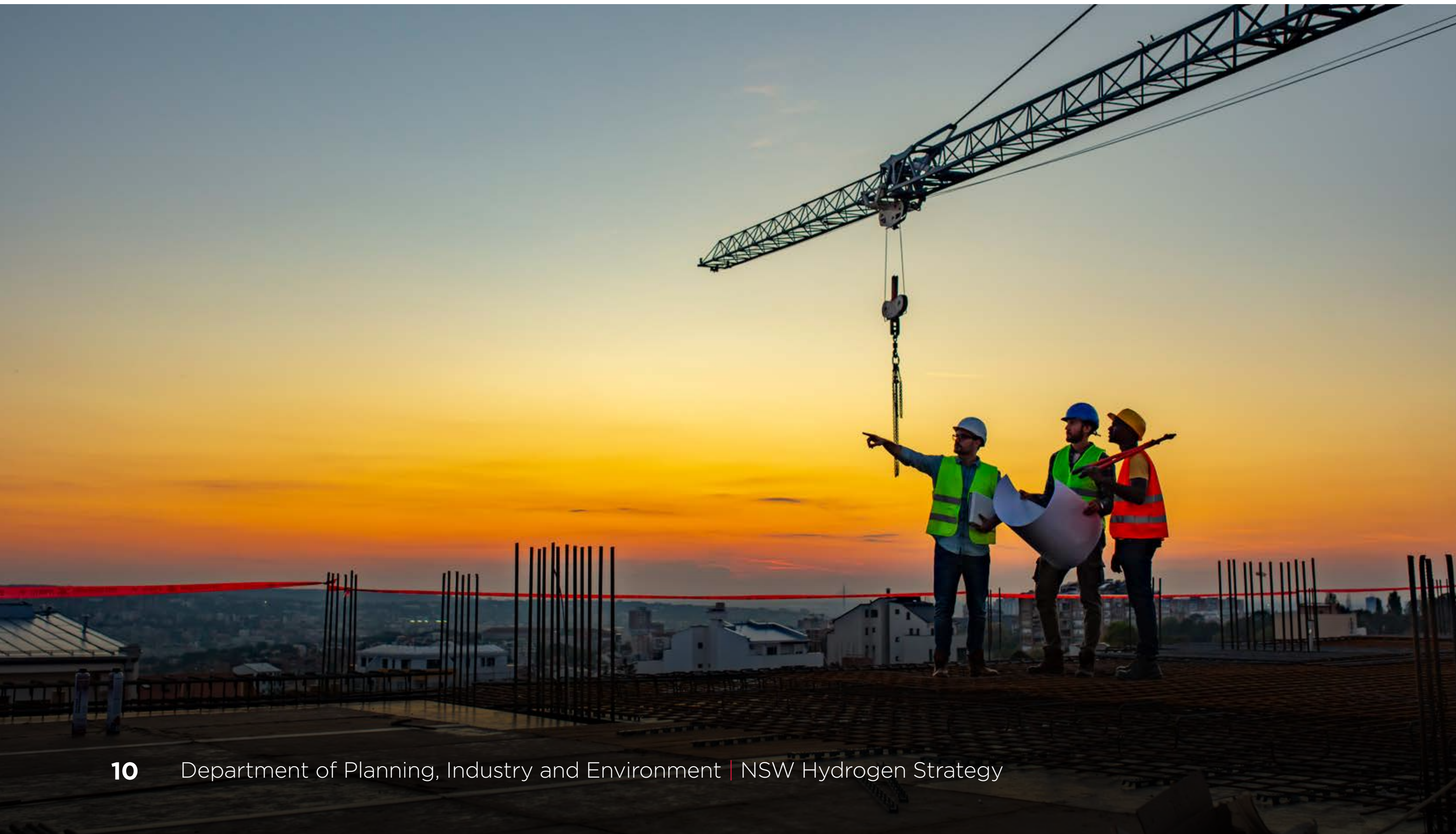
- **State-wide strategic hydrogen infrastructure masterplan**—undertaking a state-wide study examining different scenarios for industrial scale production, storage and distribution of hydrogen across NSW, including assessments of electricity infrastructure needs.
- **Upfront strategic planning and port infrastructure assessments**—completing upfront strategic land use planning and other assessment processes for major hydrogen generation projects and hydrogen hubs, including port infrastructure assessments and the necessary studies for early-stage planning determination of export projects.
- **Hydrogen-ready regulatory frameworks**—reviewing relevant state-based legislation to identify and make any necessary updates to enable the safe production, distribution and use of hydrogen across our economy.
- **Skills development**—engaging with industry and training institutions to develop a complementary and holistic approach to hydrogen industry skills development and training.
- **Hydrogen innovation**—providing support for research projects and testing facilities to leverage hub infrastructure and resources to maximise industry, technology and hub development and keep NSW at the forefront of hydrogen innovation.

PILLAR 2

Lay industry foundations

Under Pillar 2, the NSW Government will partner with industry to financially support the development of foundational infrastructure, supply chains and technology demonstration projects. This will lay the foundations of the green hydrogen sector while building the confidence and technical skills needed to achieve scale. Key actions under this pillar include:

- **Developing hydrogen hubs**—investing $70 million to establish hydrogen hubs, starting with the Hunter and Illawarra. These hubs will concentrate capital, infrastructure and skills in strategic regions across NSW to create the foundation on which our new green hydrogen industry will grow.
- **Rolling out a hydrogen refuelling network**—providing funding support for a hydrogen refuelling network along key strategic freight routes across NSW.
- **Developing precinct decarbonisation roadmaps**—releasing precinct decarbonisation roadmaps for the Hunter and Illawarra that will guide industry planning and investment out to 2030.
- **Supporting Australia's first green hydrogen and gas power plant**—providing $78 million funding support to create a foundational hydrogen offtake at the new gas/green hydrogen powered Tallawarra B power station.



PILLAR 3

Drive rapid scale

Under Pillar 3, the NSW Government will support industry to rapidly scale, delivering economies of scale and cost reductions across the hydrogen supply chain. Key actions under this pillar include:

- **Network concessions**—provide new electrolysers in operation by 2030 with partial concessions (approximately 90%) to network use of system charges. These concessions will incentivise the use of existing spare capacity in our network infrastructure to support industry in these crucial early stages of development. This action will significantly reduce the cost of hydrogen by about $1.33 per kg and incentivise investment at scale to reduce costs even further. By limiting the concessions to parts of the network with existing capacity, this mechanism will support the hydrogen industry to grow, while minimising impacts on other consumers.
- **Electricity scheme exemptions**—provide green hydrogen production with exemptions from charges for the NSW Energy Savings Scheme, Peak Demand Reduction Scheme, Electricity Infrastructure Roadmap and GreenPower program. Together, we estimate these exemptions will reduce the cost of producing hydrogen by a further $0.80 per kg.
- **Setting a hydrogen target in the Energy Security Safeguard**—extending the Energy Security Safeguard to provide financial incentives for green hydrogen, with targets gradually increasing to 67,000 tonnes (or 8 million GJ) by 2030.
- **Supporting transformative industry projects**—support high emitting facilities to develop long term transformative hydrogen projects under our Net Zero Industry and Innovation Program. This includes extending the program at its current average annual funding rate to supplement the existing support available in the 2020s. This will create the opportunity to provide financial support or risk sharing beyond 2030 for transformative projects delivered this decade. This extension will target projects that can deliver deep decarbonisation while transforming or creating a major new industry in NSW, such as green steel, ammonia or cement.
- **Market engagement model**—periodically engaging with the market to identify and aggregate emerging sources of hydrogen demand and providing funding support for the competitive supply of hydrogen to these consumers.
- **NSW Government hydrogen fleet target and trials**—setting a target of 20% hydrogen vehicles by 2030 in the NSW Government heavy vehicle fleet which aims to put approximately 1,800 hydrogen heavy vehicles on the road by 2030, creating demand for 10,000 tonnes of hydrogen per annum or around 70 MW of electrolyser capacity.

Impact of NSW Hydrogen Strategy

As shown in Figure 2, the actions set out in this Strategy are expected to dramatically reduce the cost of green hydrogen production by an estimated $5.80 per kg to reach our stretch target of under $AU2.80 per kg by 2030. Further cost reductions can also be achieved through technology innovations and the falling cost of renewable energy to put us within reach of $2 per kg by the end of the decade.

Delivering this cost of green hydrogen will make NSW one of the cheapest suppliers of hydrogen in the region and position the state to capture early domestic and international market share.

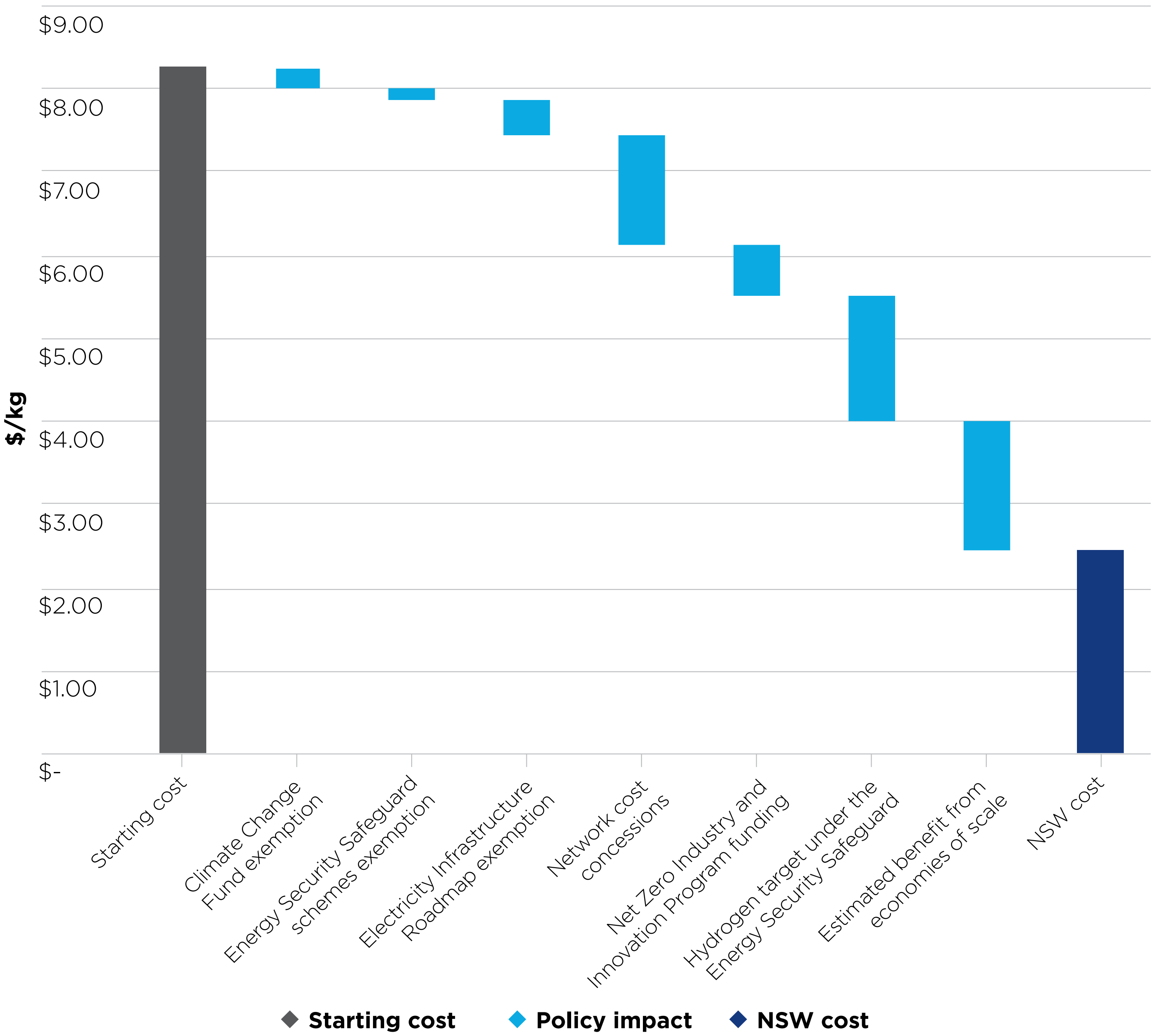
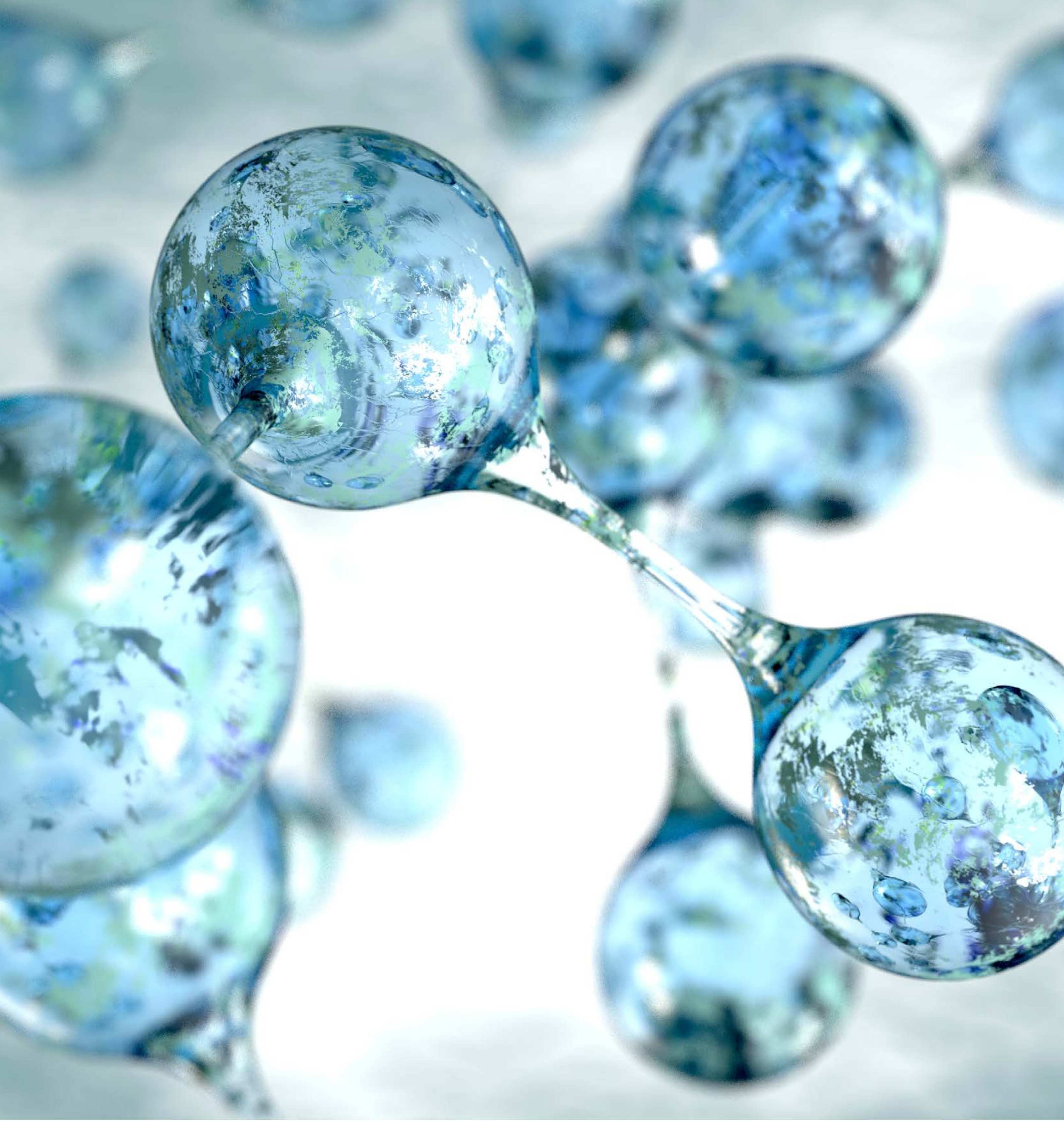


Figure 2
NSW Hydrogen Strategy impact on levelised cost of hydrogen.

Photography
Moree Solar Farm, Moree.



2. Context

What is hydrogen?

Hydrogen molecules are a versatile energy carrier and feedstock, derived primarily by splitting water (electrolysis) or by reacting fossil fuels with steam through a process called steam methane reformation (SMR). Most hydrogen produced today comes from SMR, which releases carbon emissions.

About 70 Mt of pure hydrogen is produced and used globally each year, mostly as a feedstock for oil refining and ammonia production.[1] Ammonia, which is used primarily for fertiliser and explosives, is made by combining hydrogen with nitrogen extracted from the air.

If produced using low or zero emissions sources, hydrogen can enable decarbonisation across the hard-to-abate segments of the energy, transport and industrial sectors that currently account for around 18% of NSW's annual emissions.[2]

Low emissions hydrogen can be produced using several methods. These include the electrolysis of water using renewable electricity or using responsibly sourced renewable biogas in the SMR process. This is commonly referred to as "green" hydrogen. It can also be produced from fossil fuels with carbon capture and storage (CCS), which can store up to 90% of carbon emissions. This is commonly referred to as "blue" hydrogen.

In the short to medium term our actions and strategy focus on support for green hydrogen production and use for the following reasons:

- **Timing**—blue hydrogen production is unlikely to be operational in NSW prior to 2030 and action is needed now to kickstart the hydrogen industry. While geological surveys have identified potential CCS sites in NSW, further investigations are required before any projects can commence construction, which typically have long lead times for completion.[3]
- **Pricing**—by the time blue hydrogen production is operational in NSW, it is unlikely to have a price advantage over green hydrogen. Hydrogen production forecasts expect green hydrogen to be competitive with blue hydrogen around 2030.[4]
- **Market demand**—in the absence of a clear price advantage, export trading partners and domestic consumers will generally prefer green hydrogen over blue hydrogen as it supports deeper decarbonisation.
- **Modularity**—CCS deployment is needed at large scale to be economically viable.[5] Green hydrogen production through electrolysis has the advantage of being modular and can therefore be flexibly scaled to respond as demand grows.
- **Carbon capture efficiency**—commercial carbon capture success rates for blue hydrogen generally do not exceed 90%.[6] Additional cost from carbon offsetting will therefore be required to make blue hydrogen carbon neutral.

1. International Energy Agency 2019, *The Future of Hydrogen*
2. National Greenhouse Gas Accounts 2021
3. See for example the Gorgon Gas Development Project in Western Australia, which was approved in 2009 and commenced operations in 2019. The CarbonNet Project in Victoria is not expected to be operational until 2030.
4. BloombergNEF 2020, *Hydrogen Economy Outlook*
5. CSIRO 2019, *National Hydrogen Roadmap*
6. International Energy Agency 2019, *The Future of Hydrogen*

How can hydrogen be used?

While hydrogen has historically been used for industrial processes, its versatility allows it to be used across a range of applications with water as the only by-product. Figure 3 outlines the full potential of the hydrogen supply chain.

Like fossil fuels, hydrogen can be combusted for industrial and residential heating. When combined with a fuel cell (the reverse process of electrolysis), hydrogen generates electricity that can power our grid, homes, remote off-grid sites and transport applications. Hydrogen can also be used as a feedstock to create synthetic fuels to power aircraft and ships and as a reductant to replace coking coal to manufacture steel.

As an energy carrier, hydrogen or products made using hydrogen like ammonia, liquid organic hydrocarbons or steel can be used to transport energy overseas and over long distances more easily than electricity.

Photography
Agricultural factory, Moree.

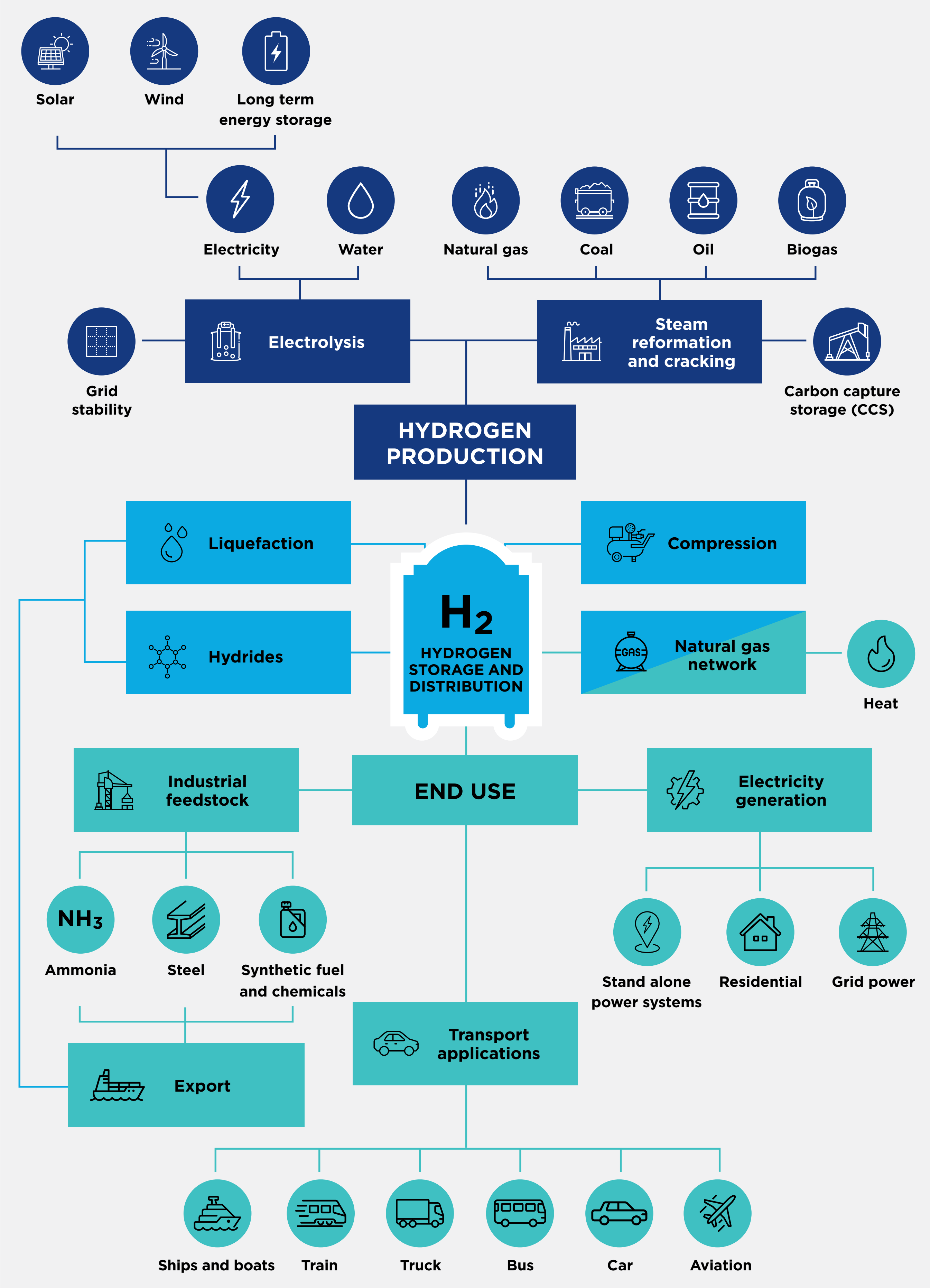


Figure 3

Hydrogen supply chain.

Movement towards global decarbonisation

Governments and industry around the world are moving to decarbonise. The changing climate is one of the most significant global challenges of the 21st century and presents both risks and opportunities for our economic prosperity and way of life. Globally, governments, industries, investors and communities are recognising these risks and are making commitments to reduce emissions. To date, 195 countries have signed the Paris Climate Agreement which agrees to limit global warming to between 1.5 and 2 degrees Celsius.[7]

The NSW Government has committed to net zero emissions by 2050 and we are not alone. There has been a significant acceleration in net zero emissions commitments announced by governments, with an increasing number enshrined in law. As of April 2021, 44 countries and the European Union have stated policies or legislation to meet a net zero emissions target by mid-century. In total these jurisdictions account for around 70% of global CO_2 emissions and Gross Domestic Product (GDP).[8]

Importantly for NSW, these countries include the United States, China, Japan and South Korea, four of our largest trading partners who also rely on significant energy imports.

There has also been a rapid rise in net zero emissions announcements from companies in recent years. According to the International Energy Agency, around 60-70% of global production of heating and cooling equipment, road vehicles, electricity and cement are from companies that have announced net zero emissions targets. Nearly 60% of gross revenue in the technology sector is also generated by companies with net zero emission targets. In other sectors, net zero pledges cover 30-40% of air and shipping operations, 15% of transport logistics and 10% of construction.[9]

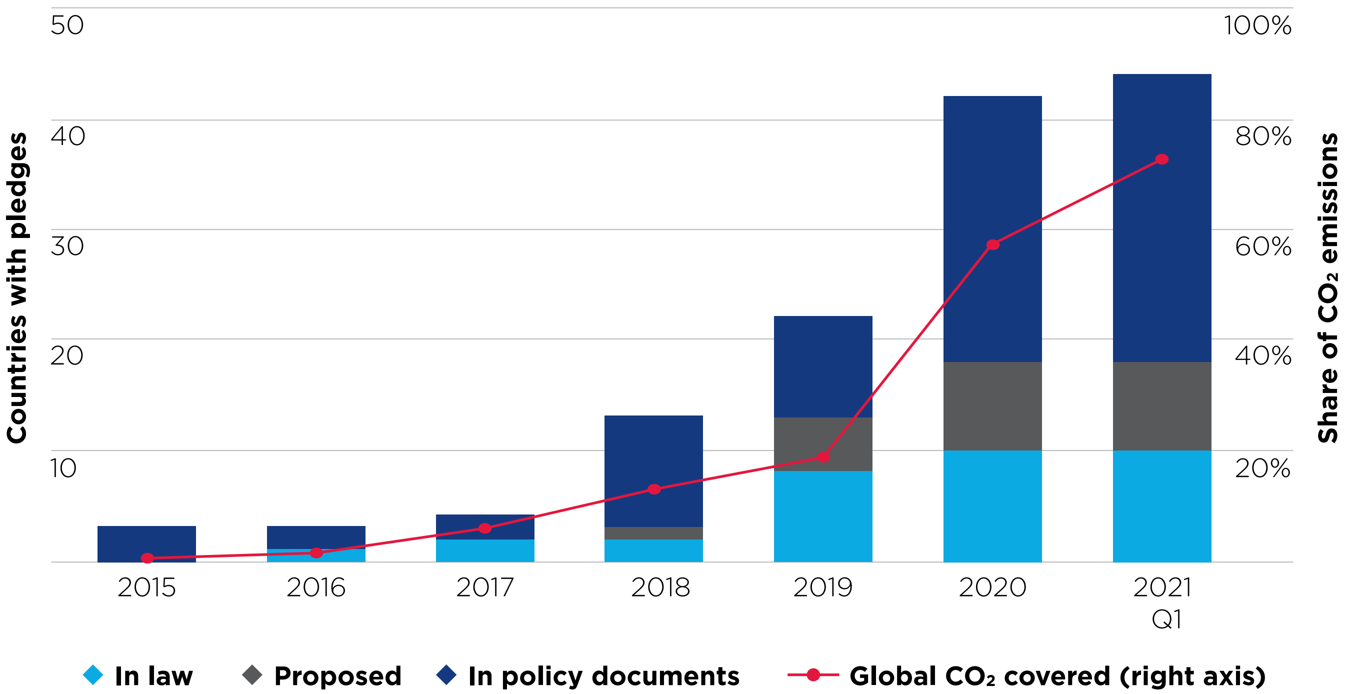


Figure 4
Number of national net zero pledges and share of global CO_2 emissions covered.

7. United Nations Treaty Collection 2021, *Paris Agreement*
8. International Energy Agency 2021, *Net Zero by 2050: A Roadmap for the Global Energy Sector*
9. International Energy Agency 2021, *Net Zero by 2050: A Roadmap for the Global Energy Sector*

Hydrogen is essential to reach net zero emissions

The increased global focus on achieving net zero emissions has highlighted the challenge of decarbonising hard-to-abate sectors where electrification powered by renewable electricity is either too costly or faces technical barriers.

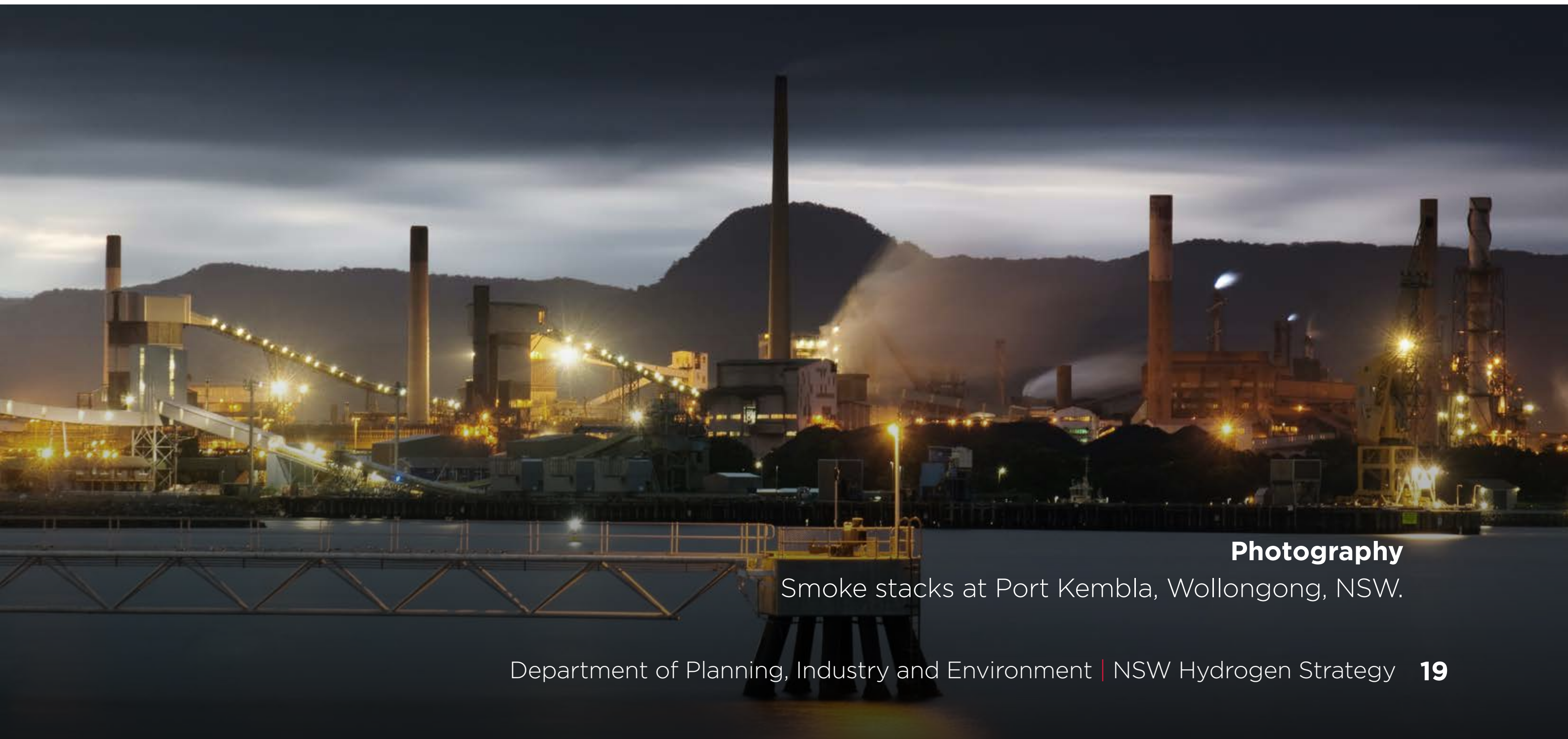
These sectors include iron and steel production, chemical manufacturing, high-temperature industrial heat, long distance and long-haul transport, shipping, aviation and agriculture. In NSW, these sectors account for around 24 Mt or 18% of NSW's annual emissions.[10]

Hydrogen is a leading option to decarbonise these hard-to-abate emissions because it is a low-carbon chemical energy carrier that can replace many of the fossil-based energy carriers that are presently used in these sectors. Chemical energy is attractive because it can be stored and transported in a stable way, as is done today with oil, coal, biomass and natural gas. Hydrogen molecules can be stored for long periods, transported across the sea in ships, burned to produce high temperatures, and used in existing infrastructure and business models designed for fossil fuels. Hydrogen can also be combined with other elements such as carbon and nitrogen to make hydrogen-based fuels that are easier to handle than electricity and can be used as feedstock in industry.

Without hydrogen, a decarbonised energy system based entirely on electricity would be more flow based requiring demand and supply to be constantly matched in real time, across wide distances. This can be vulnerable to disruptions of supply. As chemical energy, such as hydrogen, can be stored more easily it can contribute to energy system resilience and stability.[11] In addition, exporting renewable energy as electricity (in batteries or undersea cables) has considerable barriers to scale, compared with exporting hydrogen and hydrogen derived products.

Commitment to hydrogen as a critical component of the world's future energy mix continues to build domestically and internationally. To date, 19 governments have national hydrogen strategies and commitments to hydrogen targets, including, Australia, Japan, the UK, the Netherlands, Germany, France, the European Union and the US.[12]

10. National Greenhouse Gas Accounts 2021
11. International Energy Agency 2019, *The Future of Hydrogen*
12. KPMG 2020, *Industry Opportunities Enabled by Clean, Cheap and Reliable Electricity*



Photography
Smoke stacks at Port Kembla, Wollongong, NSW.

International jurisdictions spotlight

GERMANY

Germany's National Hydrogen Strategy has 38 measures across the hydrogen value chain to support its 5 GW electrolyser capacity target by 2030. These measures include a total of €8 billion in funding support for 62 large scale projects and €900 million to subsidise 40,000 tonnes of annual hydrogen imports by 2030.[13]

JAPAN

Japan's Green Growth Strategy and Roadmap for Fuel Ammonia set targets of 3 million tonnes of hydrogen and ammonia consumption by 2030 and 20 million tonnes of hydrogen and 30 million tonnes of ammonia consumption by 2050. To achieve these targets, the Japanese Government is providing 370 billion Yen in grants to hydrogen projects, 1.7 trillion Yen in tax incentives and is establishing a 1 trillion-Yen scheme to subsidise finance interest.[14]

KOREA

Korea's Hydrogen Energy Roadmap outlines their goal of producing over 6 million hydrogen vehicles and building over 1,200 refuelling stations by 2040. In addition, their plan seeks to roll out 2,000 hydrogen buses by 2022 towards a 41,000 target by 2040. In terms of the energy sector, the roadmap outlines an objective to supply 15 GW of fuel cells for power generation by 2040.[15]

UNITED KINGDOM

In its Hydrogen Strategy, the United Kingdom has committed to a target of 5 GW of low carbon hydrogen production capacity by 2030. The strategy includes a range of key commitments, including £240 million for government co-investment in production capacity through the Net Zero Hydrogen Fund (NZHF), a hydrogen business model to secure private sector investment and plans for a revenue mechanism to provide funding for the business model. These key commitments are being supported by various policy measures such as funded competitions, calls for evidence and planning for energy system transition and industrial decarbonisation.[16]

FRANCE

France has set a target of 6.5 GW of installed electrolyser capacity by 2030. To achieve this target, the French government is issuing a range of calls for proposals for hydrogen hubs, supply chains, technology research and manufacturing facilities. These calls for proposals will be supported by €2 billion between 2020-2022 and a total of €7 billion in public support to 2030.[17]

EUROPEAN UNION

Collectively, the European Union (EU) has an aspirational vision of installing at least 6 GW of electrolyser capacity in the EU by 2024 and 40 GW by 2030. The EU is supporting this target through a range of measures including pilot programs and projects for the rollout of hydrogen production, storage, distribution and refuelling infrastructure, the establishment of hydrogen markets and incentives and support for hydrogen technology innovation.[18]

13. German Federal Government 2020, *The National Hydrogen Strategy*
14. Ministry for Economy, Trade and Industry 2021, *Japan's Green Growth Strategy*
15. Government of Korea 2019, *Hydrogen Economy Roadmap*
16. Her Majesty's Government 2021, *UK Hydrogen Strategy*
17. French Government 2020, *National strategy for the development of decarbonised and renewable hydrogen in France*
18. European Commission 2020, *A hydrogen strategy for a climate-neutral Europe*

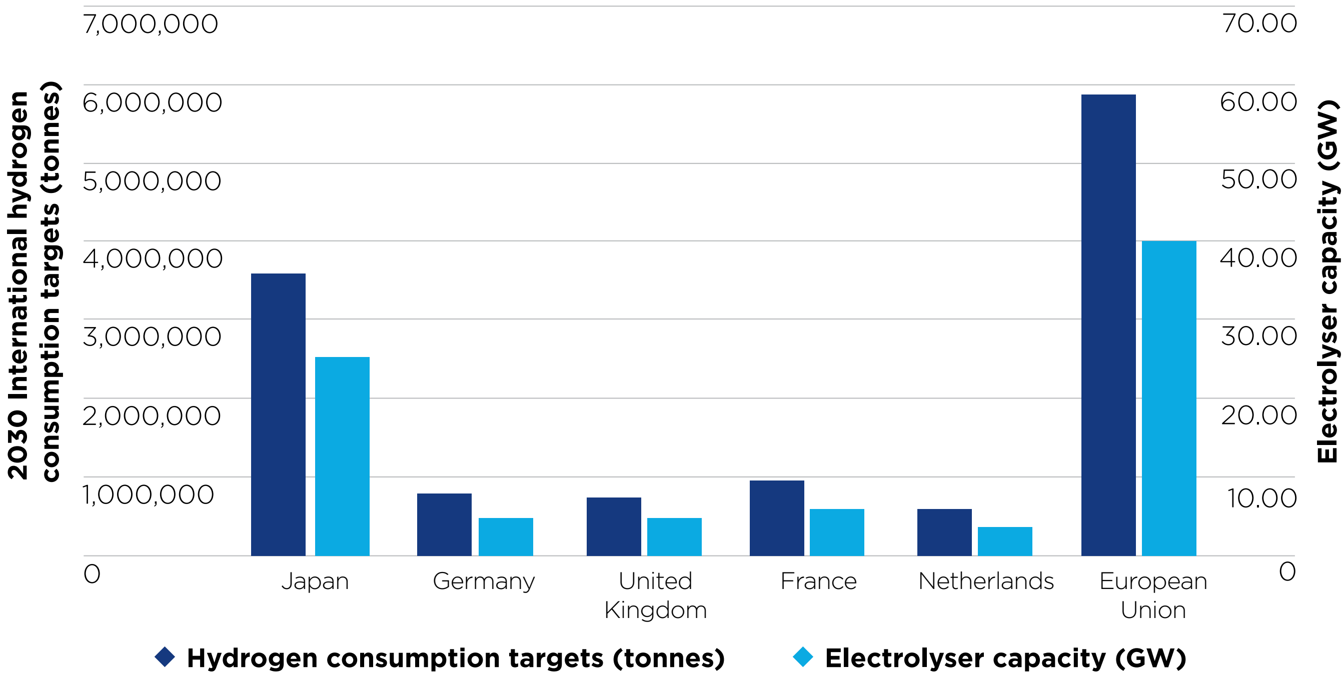


Figure 5
International hydrogen consumption targets and electrolyser capacity.

Industry spotlight

HEAVY TRANSPORT

Internationally, heavy transport operators are adopting hydrogen in applications where electrification is not feasible due to mileage, refuelling time and electrical infrastructure constraints.

In New Zealand, a $20 million government grant is helping Hiringa Energy roll out a chain of hydrogen fuelling stations. These stations will support 20 fuel-cell electric vehicle Hyzon trucks in 2021 and up to 1,500 trucks by 2026.[19]

In Switzerland, a coalition of fleet operators has deployed 50 Hyundai hydrogen trucks and plan to have 1,600 trucks in operations by 2025.[20]

In Germany, two Coradia iLint hydrogen trains built by train manufacturer Alstom are servicing 100 km routes between the towns normally serviced by diesel trains.[21]

The heavy transport sector in NSW has started to test hydrogen. Supported by a NSW Government grant, Coregas is scheduled to deploy hydrogen powered prime movers with a hydrogen refuelling station at its Port Kembla facility in 2022.[22]

GREEN STEEL

Hydrogen technologies are at the heart of international efforts by major steel manufacturers to decarbonise the steel sector.

In 2016, SSAB, LKAB and Vattenfall joined forces to create HYBRIT—a $260 million initiative that will replace coking coal for steel production with hydrogen. The result will be the world's first fossil-free steel-making technology, with virtually no carbon footprint. In 2018, work started on the construction of a pilot plant in Luleå, Sweden, targeting commercial scale operations by 2035.[23]

In August this year, the project delivered its first green steel to the Volvo Group. Their goal is to deliver fossil-free steel to the market and demonstrate the technology on an industrial scale as early as 2026.[24]

Europe's largest steel manufacturer, Arcelor Mittal has committed €300 million towards a series of industrial-scale hydrogen projects that will deliver substantial CO_2 emissions savings in the next five years and support its goal of 30% emissions reductions by 2030. These projects include the use of hydrogen in blast furnaces and direct reduction of iron ore to deliver 30,000 tonnes of low carbon steel in 2020. Operations are being scaled to reach 120,000 tonnes in 2021 and 600,000 tonnes by 2022.[25]

SHIPPING

Ammonia and methanol produced from green hydrogen are the leading fuel alternatives to decarbonise the international shipping sector.

A.P. Moller—Maersk, the world's largest integrated shipping company, has announced it will have its first carbon neutral vessel, operating on methanol, by 2023 and is currently developing a dual fuel engine for ammonia.[26]

To support the fuel supply chain, A.P Moller—Maersk is leading a consortium of the world's largest maritime and ammonia companies, including Fleet Management Limited, Keppel Offshore & Marine, Maersk Mc-Kinney Moller Centre for Zero Carbon Shipping, Sumitomo Corporation and Yara International ASA, to conduct a feasibility study into establishing a green ammonia supply chain for ship-to-ship bunkering at the Port of Singapore, the largest bunkering port in the world.[27]

19. Hiringa Energy 2020, *Hiringa Energy and HYZON Motors to deploy fuel cell-powered heavy trucks in New Zealand in 2021*
20 Hyundai 2021, *Hyundai Hydrogen Mobility Grabs 'Watt d'Or 2021' for Advancing Swiss Decarbonization Efforts*
21. CSIRO 2019, *National Hydrogen Roadmap*
22. Coregas 2021, *Australia's first hydrogen-powered trucks to be delivered to Coregas by Hyzon Motors*
23. SSAB 2019, *HYBRIT: SEK 200 million invested in pilot plant for storage of fossil-free hydrogen in Luleå*
24. SSAB 2021, *The world's first fossil-free steel ready for delivery*
25. Arcelor Mittal 2020, *Climate Action in Europe*
26. Maersk 2021, *Maersk backs plan to build Europe's largest green ammonia facility*
27. Maersk 2021, *Maritime industry leaders to explore ammonia as marine fuel in Singapore*

The evolving economics of hydrogen

Currently, green hydrogen costs up to $8.75 per kg to produce,[28] however that cost is expected to fall significantly over the decade. The 3 key trends that will drive the improving economics of green hydrogen production are:[29]

- the reduction in the capital cost of electrolysers, which currently accounts for approximately 30-40% of the cost of green hydrogen production, through technology improvement and mass manufacturing
- the falling price of renewable electricity, which currently accounts for approximately 60-70% of the cost of green hydrogen production
- large-scale local deployment, which optimises local supply chain efficiency and delivers economies of scale in both renewable energy input prices and electrolyser capital costs.

Declining capital costs from technology development

As global hydrogen markets and technologies mature, the price of electrolysers is expected to follow a similar trajectory to that seen in solar and wind technology. The capital cost of electrolysers and fuel cells are expected to reduce significantly by 2050 as a result of technology improvements and mass manufacturing.

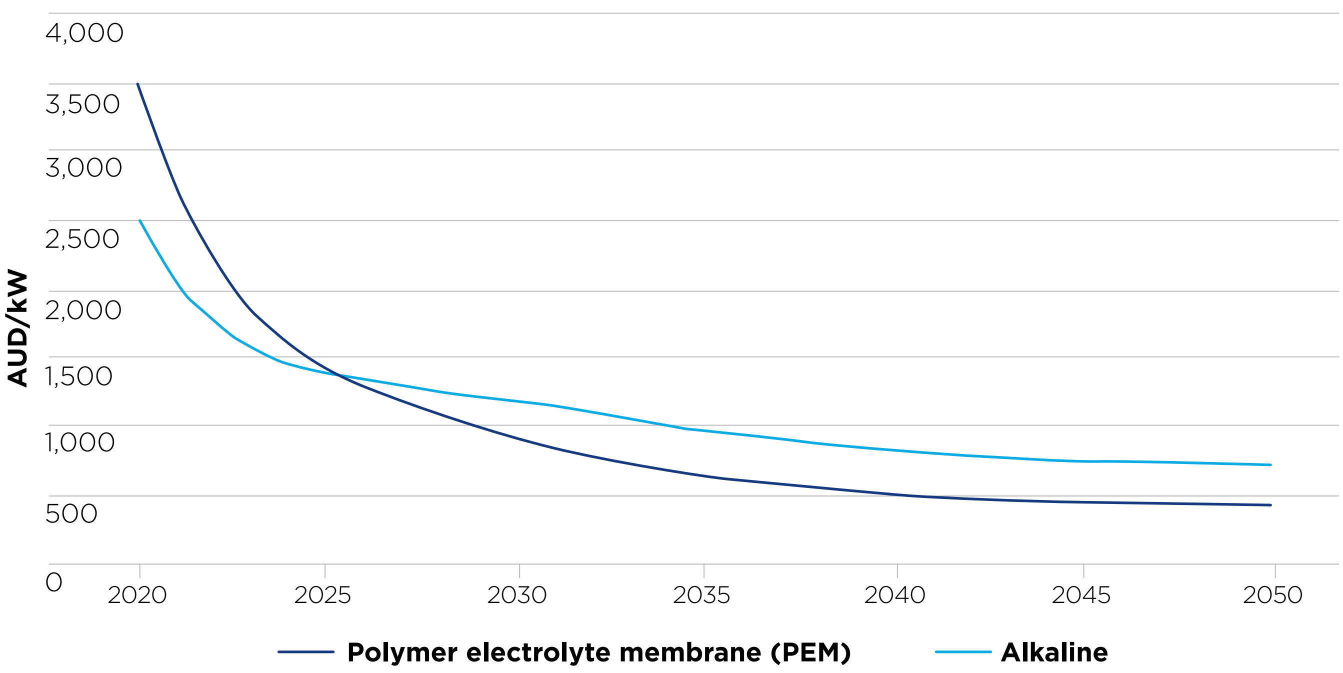


Figure 6
Projected technology capital costs for alkaline and PEM electrolysers.[30]

28. Advisian 2021, *Australian hydrogen market study for the Clean Energy Finance Corporation*
29. KPMG 2020, *Industry Opportunities Enabled by Cheap, Clean and Reliable Electricity*
30. CSIRO 2021, *GenCost 2020-21, figure 4.18*

Declining cost of renewable energy

The increasing economic viability of hydrogen in recent times has been driven by the rapidly declining cost of renewable energy, which has entered a cycle of falling costs, increasing deployment and accelerated technological progress.

Solar photovoltaic module prices have fallen by around 90% since the end of 2009 alone, while wind turbine prices have fallen by 55-60% since 2010.[31] The cost of renewables is expected to fall even further over the next ten years as shown in Figure 7 below.

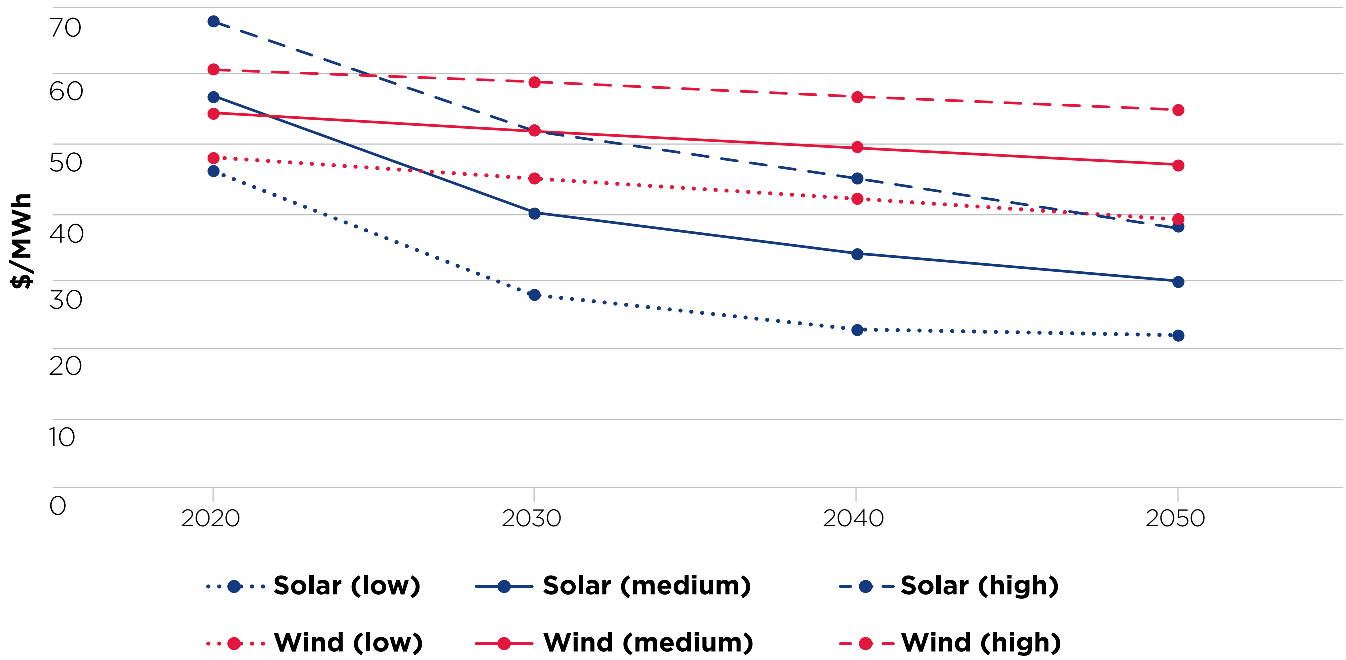


Figure 7
Projections for levelised cost of renewable energy.[32]

31. International Renewable Energy Agency 2020, *Data, research and resources on renewable energy costs*
32. CSIRO 2021, *GenCost 2020-21*, medium scenario calculated as average of low and high projections in Table B.9

Photography
Solar panels at Moree Solar Farm. Moree, NSW.

Achieving economies of scale

Both the cost of the energy input and the capital cost of electrolysers can be significantly improved through scale. As shown in Figure 8, electricity input prices can be substantially reduced by using large-scale behind-the-meter renewable energy and connecting to the transmission network to minimise network service charges.[33] Figure 9 shows the potential decrease in electrolyser capital costs that can be achieved by increasing the module size of electrolyser deployment.

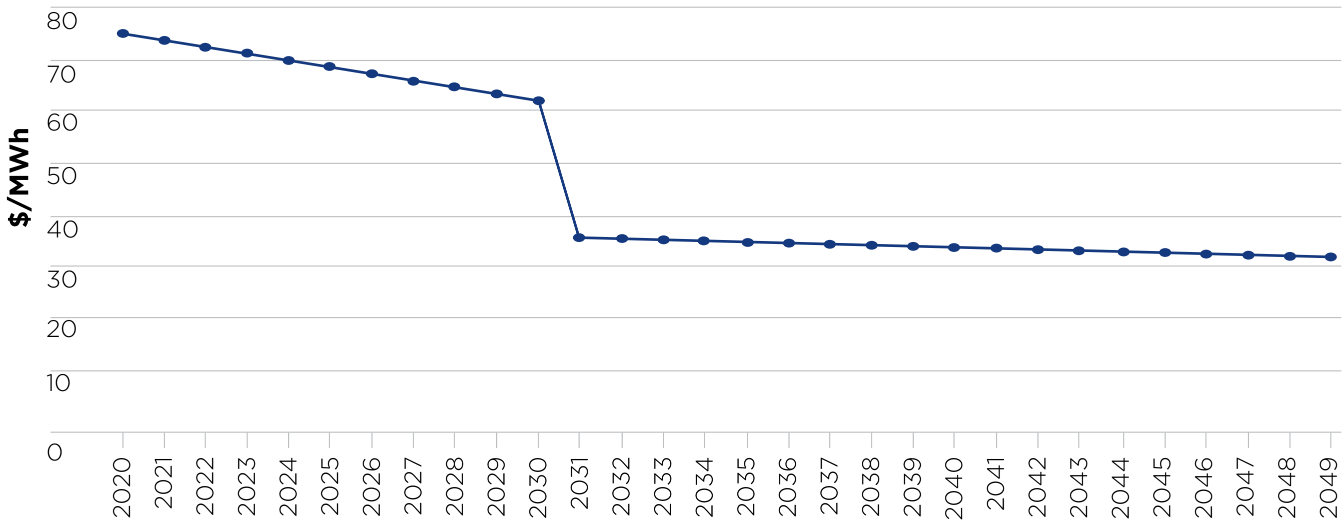


Figure 8
Potential electricity costs with scaling over time.

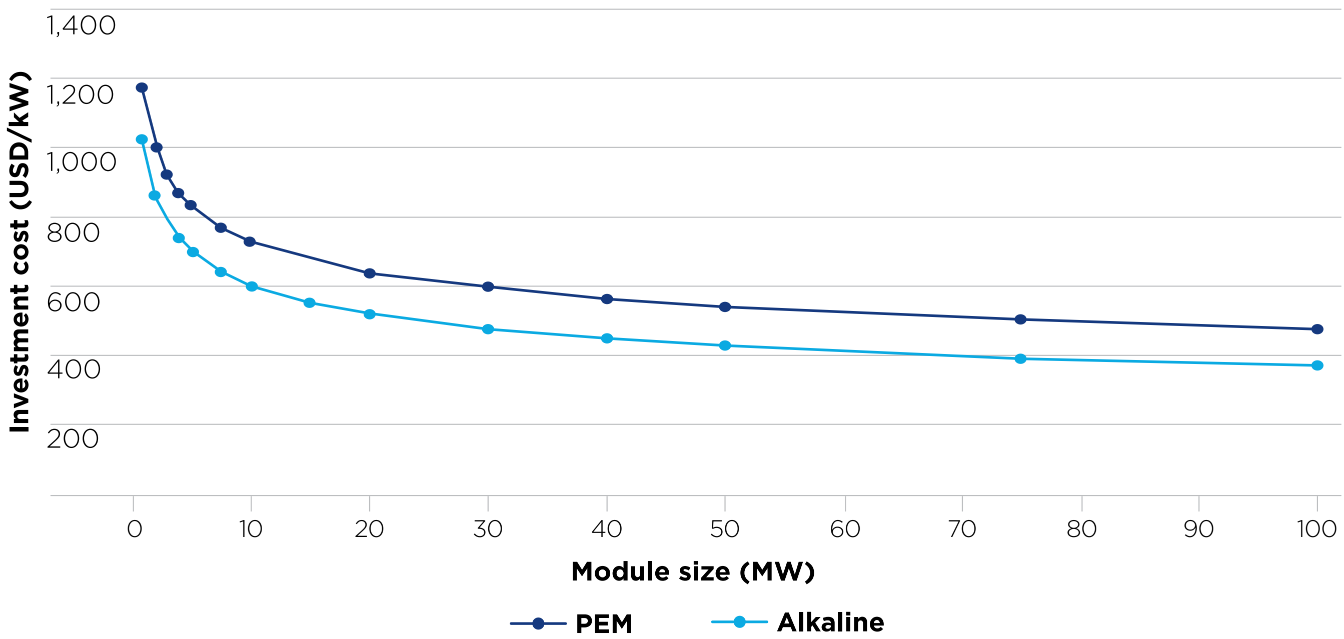


Figure 9
Electrolyser investment cost as a function of module size for various technologies.[34]

33. KPMG 2020, *Industry Opportunities Enabled by Cheap, Clean and Reliable Electricity*
34. IRENA 2020, *Green Hydrogen Cost Reduction*

Progress to price parity

Together, these trends will drive substantial cost savings and improve the competitiveness of hydrogen against existing carbon-based fuels. By 2030, green hydrogen is expected to be competitive with diesel in heavy transport such as road freight and agricultural machinery, and with hydrogen produced from natural gas used in ammonia production and oil refining. Beyond 2030, these factors will continue to reduce the cost of green hydrogen and position it to compete in other hard-to-abate sectors such as steel, shipping and aviation.

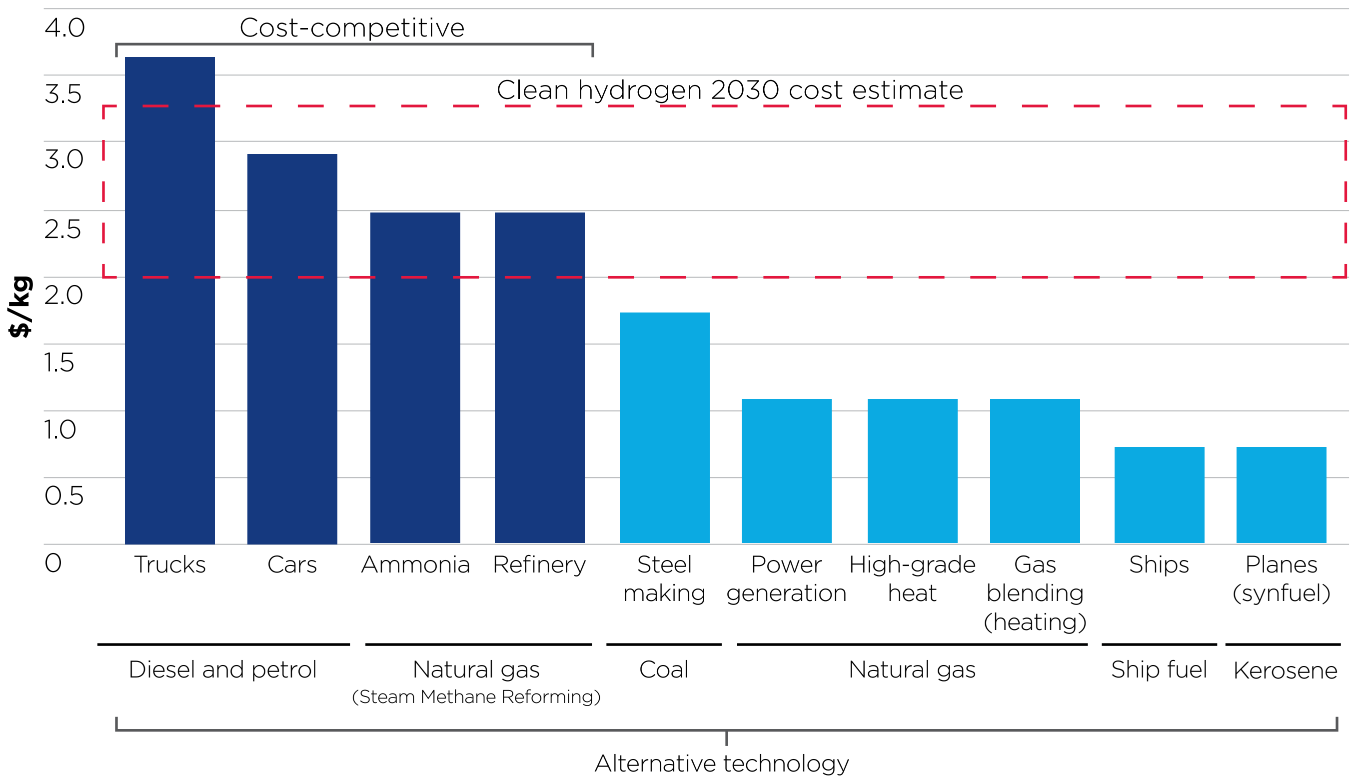


Figure 10
Breakeven cost of hydrogen against alternative technology for major applications in 2030.[35]

35. COAG Energy Council 2019, *National Hydrogen Strategy*

The hydrogen opportunity for NSW

The NSW Chief Scientist & Engineer has highlighted the benefits of a hydrogen industry to grow and decarbonise our economy while creating new jobs and positioning NSW to compete in decarbonised global markets.[36]

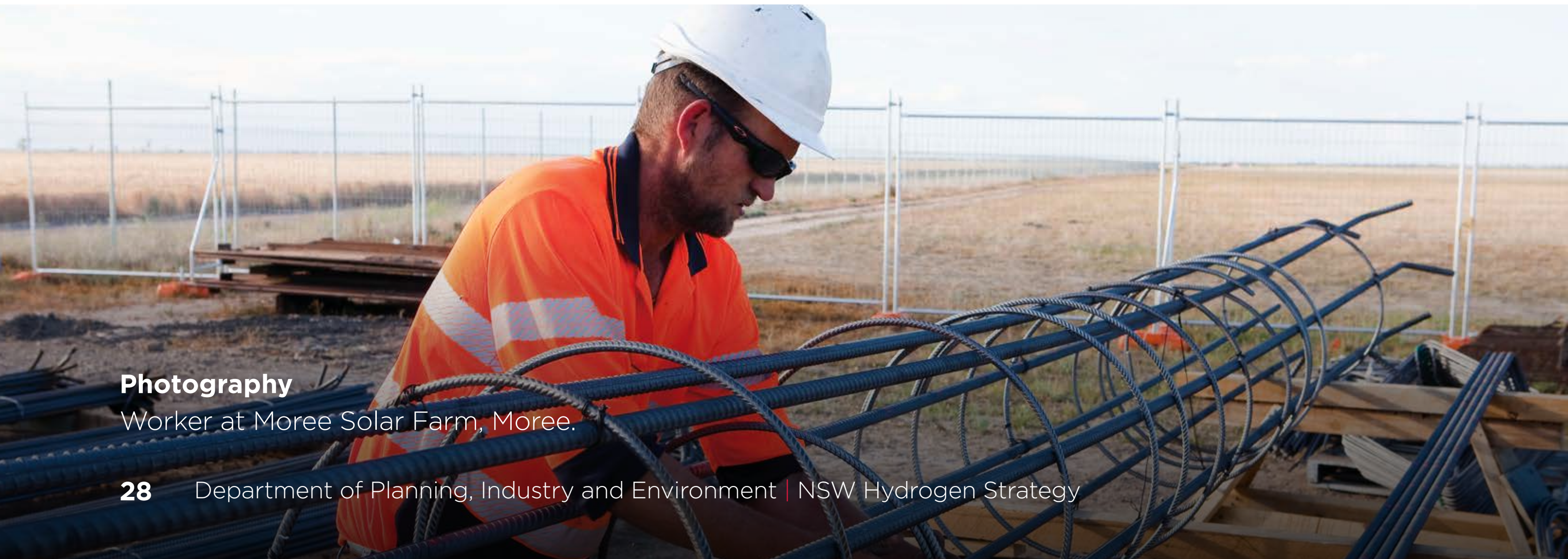
Jobs and economic opportunity

A green hydrogen industry will help NSW capture the flow of capital towards clean technology to create new industries, grow our economy, increase our exports and support jobs. At a national level, a hydrogen industry could add up to $26 billion per year in gross domestic product by 2050.[37] In NSW, by 2030 we could see up to 10,000 new jobs.

As the green hydrogen industry grows, we will see tangible benefits across our economy such as:[38]

- **Zero emissions trucks**—by 2030, the total future operating costs of trucks may reduce by up to $103.1 million per annum, with savings projected to grow annually as hydrogen truck costs continue to decrease.
- **Zero emissions buses**—by 2030, the total future operating costs of buses may be up to $234.8 million lower than internal combustion engine bus operating costs.
- **Green ammonia**—every percentage point of global market share in green ammonia captured by NSW is worth approximately $102 million in today's dollars. Global demand for green ammonia is expected to increase by 65% by 2050, with opportunities in the domestic market for fertiliser and in international markets. For example, NSW could expand domestic fertiliser production, using ammonia made in NSW. Internationally, the Japanese government has announced plans to commence 20% co-firing of ammonia in coal power stations in the second half of this decade, achieving large scale co-firing and commercial expansion during the 2030s.[39]
- **Green steel**—every percentage point increase in industry output relative to current levels could deliver up to an additional $20 million in annual revenues and up to $7 million in annual direct and indirect wages in today's dollars.
- **Sustainable chemical and synthetic fuel production**—markets for chemicals and synthetic fuels that require hydrogen as an input, such as ethanol and methanol, are worth tens of billions of dollars and are expected to grow domestically and internationally as demand and use applications increase.

36. See State of NSW (NSW Treasury) 2019, *NSW 2040 Economic Blueprint*; NSW Chief Scientist and Engineer 2020, *Opportunities for prosperity in a decarbonised and resilient NSW*; KPMG 2020, *Industry Opportunities Enabled by Cheap, Clean and Reliable Electricity*
37. Deloitte 2019, *Australian and Global Hydrogen Demand Growth Scenario Analysis*
38. KPMG 2020, *NSW: Clean Energy Superpower Industry Opportunities Enabled by Cheap, Clean and Reliable Electricity*
39. Ministry of Economy, Trade and Industry 2020, *Japan's Green Growth Strategy for 2050 Carbon Neutral Society*



Photography
Worker at Moree Solar Farm, Moree.

Sustainability opportunity

Green hydrogen and hydrogen-enabled low emissions products can reduce our emissions across the hard-to-abate transport, industrial and energy sectors. These sectors currently account for 24 Mt or 18% of our annual emissions.[40]

For example, as a flexible and versatile form of energy storage, hydrogen can support the transformation of the electricity system—our largest source of emissions—to 100% renewable energy by providing firming services, flexible loads and long-term energy storage.

Furthermore, the full decarbonisation of the transport sector enabled by green hydrogen can substantially improve liveability. For example, eliminating tailpipe emissions in the heavy transport sector alone could avoid up to $2.8 billion in public health costs from particulate matter emissions.[41] Substantially reduced noise pollution will also enhance housing location profiles and allow truck operators to travel in off-peak hours, reducing congestion on our roads and improving productivity.

Export opportunity

Many overseas jurisdictions have announced hydrogen targets, representing a significant economic export opportunity for NSW. Japan and South Korea have announced targets of over 3 million tonnes of hydrogen consumption by 2030 and 5 million tonnes by 2040 respectively.[42] As these countries will rely significantly on imports to meet their targets, we can capture a share of these new markets and attract investment in large-scale hydrogen production within NSW.

Germany has also announced plans to become an international leader in hydrogen technologies and is jointly funding an Australian-German renewable hydrogen export supply chain feasibility study. The study is being led by the University of NSW and is expected to be complete in 2022.[43] The German government has also launched its €900 million H2Global initiative, which will act as a subsidised reverse auction for hydrogen imports to improve the price competitiveness for consumers.[44]

Low-cost finance opportunity

There are two trends underway in financial markets that will help businesses using green hydrogen to access low-cost finance.

1. The Taskforce on Climate-Related Financial Disclosures has developed a framework for the disclosure of climate related financial risks. Adopted by financial regulators around the world, the framework is putting pressure on businesses and banks to disclose and manage their climate related financial risks.[45]
2. Investors including BlackRock, Goldman Sachs, Wells Fargo, JPMorgan Chase and HSBC are increasingly applying Environmental, Social and Governance (ESG) principles to investment decisions. For example, JPMorgan Chase aims to facilitate over $USD2.5 trillion over the next 10 years to address climate change and contribute to sustainable development.[46]

Green hydrogen allows businesses to benefit from these trends as it does not give rise to the same climate-related financial risks as carbon intensive fuel sources. Businesses that use green hydrogen as a major feedstock or fuel source will therefore be able to reduce their investment risk and associated borrowing costs, access ESG capital pools and leverage opportunities from enabling upstream decarbonisation for other businesses.

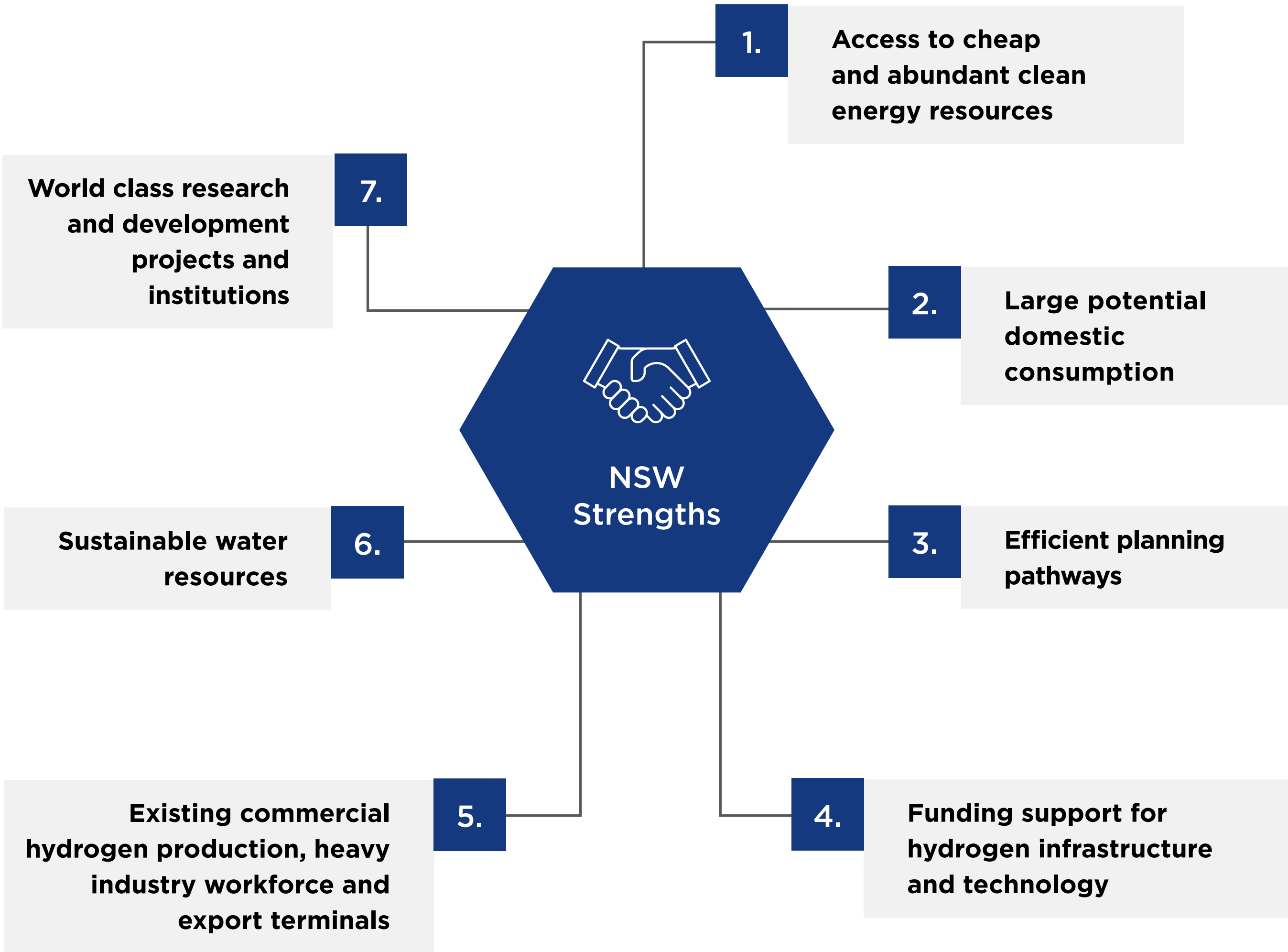
Energy security opportunity

Since 2011, Australia has consumed more diesel than electricity and in NSW we are entirely dependent on fuel imports.[47] A green hydrogen industry can increase our domestic fuel production capacity, decreasing our reliance on international imports and reducing exposure to international price fluctuations and supply constraints.

40. National Greenhouse Gas Accounts 2021
41. Department of Planning, Industry and Environment modelling
42. Ministry for Economy, Trade and Industry 2021, *Japan's Green Growth Strategy; and Government of Korea 2019, Hydrogen Economy Roadmap*
43. Australian Embassy Germany 2020, *Hydrogen: the energy resource of the future*
44. German Federal Government 2021, *New H2Global funding instrument launched*
45. Task Force on Climate-related Financial Disclosures 2020, *2020 Status Report*
46. JPMorgan Chase April 2021, *JPMorgan Chase Targets More Than $2.5 Trillion over 10 Years to Advance Climate Action and Sustainable Development*
47. Department of Industry, Science, Energy and Resources 2020, *Australian Energy Statistics 2020 Energy Update Report*

NSW's strengths for a green hydrogen industry

NSW is well placed to become a global leader in the green hydrogen industry by building on our existing strengths and resources, and moving to early capture market share.



1. Access to cheap and abundant clean energy resources

Access to cheap renewable electricity is a critical input for a successful green hydrogen industry. Our ground-breaking [NSW Electricity Infrastructure Roadmap] ensures hydrogen producers in NSW will have access to abundant and cheap renewable energy, falling within the lowest 10% of industrial electricity prices in the OECD.[48]

To achieve this, the NSW Government is supporting the development of generation and transmission infrastructure that will deliver five dedicated [Renewable Energy Zones] (REZ) in the Central-West Orana, New England, South West, Hunter-Central Coast and Illawarra regions of NSW.

Collectively, the REZs will support up to 12 GW of renewable energy generation by 2030 and deliver the associated transmission infrastructure to make sure that energy gets to where it is needed. The first REZ in the Central-West Orana region will unlock up to 3 GW of new transmission capacity by the mid-2020s. We are also providing hydrogen producers with exemptions to some of the costs associated with delivering the REZs. This will result in some of the cheapest green hydrogen in the world.

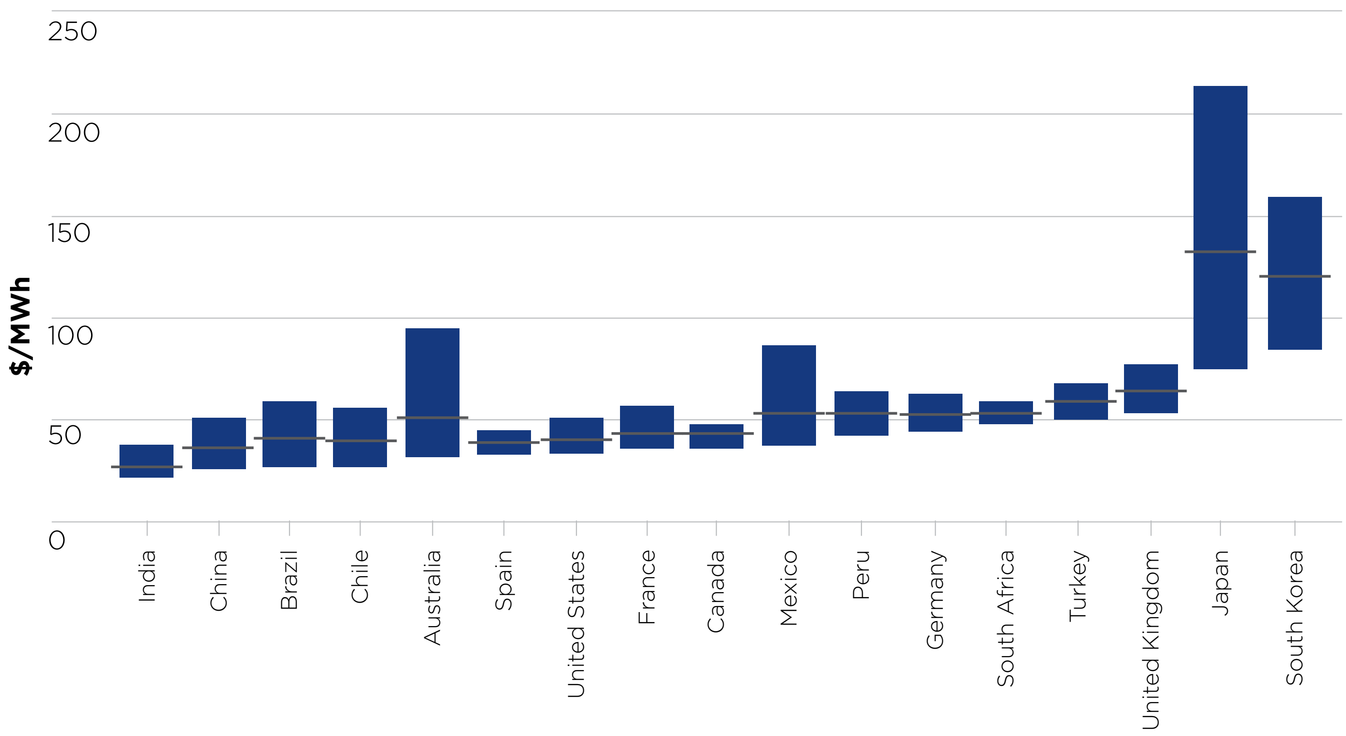


Figure 11
Current levelised cost for solar photovoltaic energy ($/MWh).[49]

48. NSW Department of Planning Industry and Environment 2020, *NSW Electricity Infrastructure Roadmap.*
49. BloombergNEF 2021, *Levelized Cost of Electricity 1H 2021*

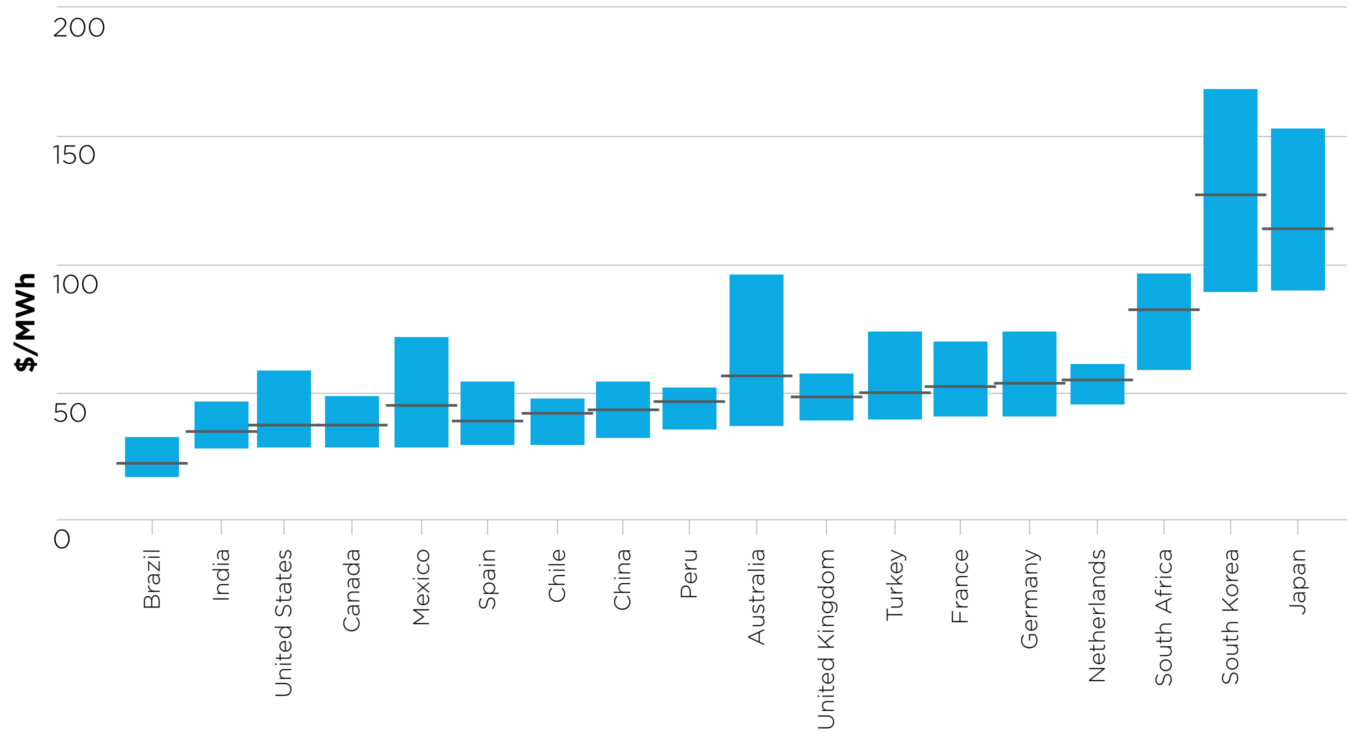


Figure 12
Current levelised cost for wind energy ($/MWh).[50]

50. BloombergNEF 2021, *Levelized Cost of Electricity 1H 2021*

Photography
Windmills, Boco Rock Wind Farm.

2. Large potential domestic consumption

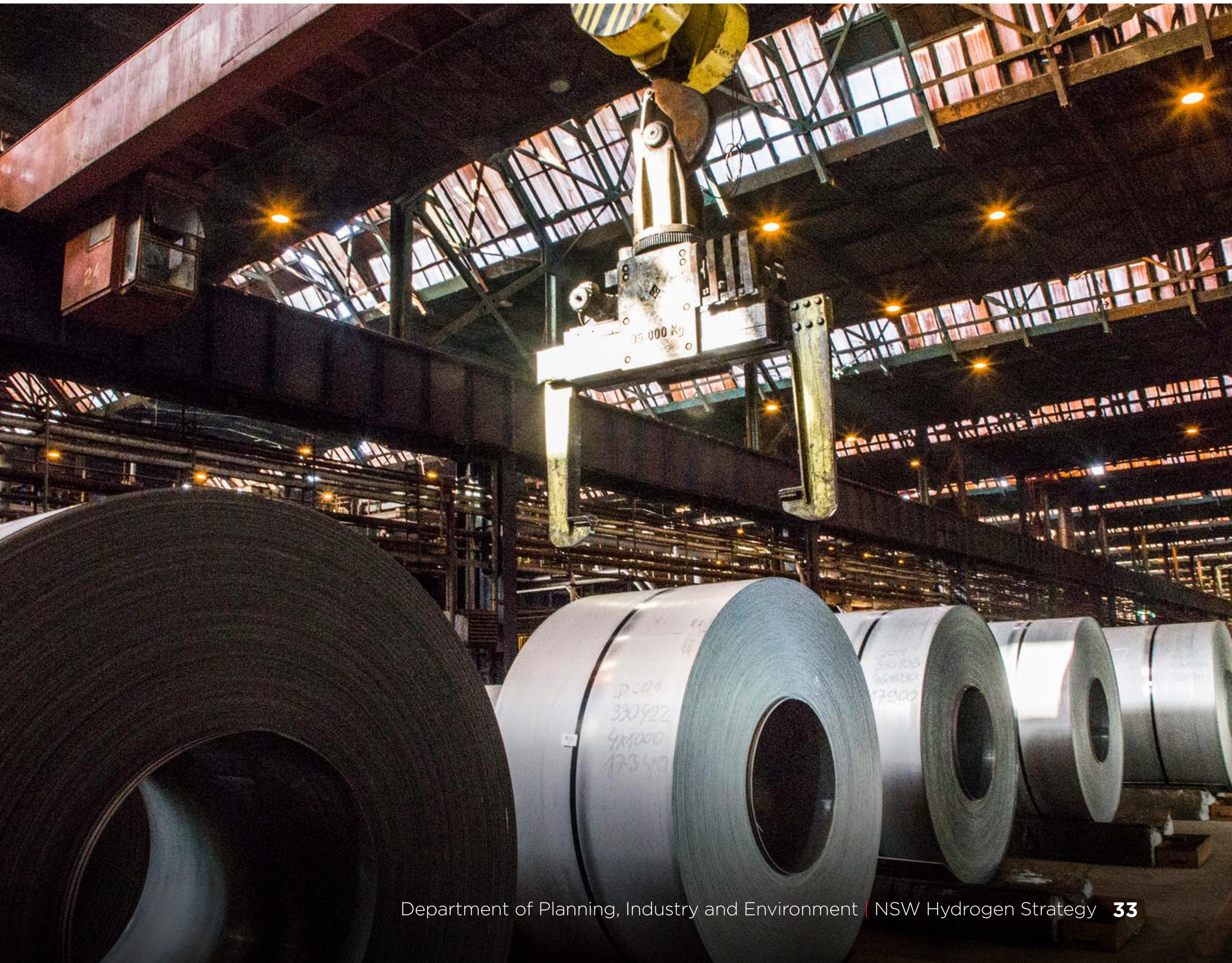
A strong domestic market for green hydrogen is crucial to establish supply chains, support industry development and secure investment in infrastructure.

There is the potential for large domestic consumption of green hydrogen in NSW. For example, the ammonia production facility at the Port of Newcastle currently consumes approximately 40,000 tonnes of hydrogen per annum. NSW's consumption of green hydrogen could double by 2030 with just 3,500 heavy duty trucks or 15% of NSW's articulated truck fleet moving to hydrogen.

By 2050, NSW's entire heavy-duty truck fleet could support offtake of up to 500,000 tonnes per annum from hydrogen producers.

Port Kembla is home to one of Australia's two fully integrated steelworks. A facility of this size using hydrogen as a feedstock could increase NSW's consumption of green hydrogen by another 430,000 tonnes per annum.[51]

51. Department of Planning, Industry and Environment modelling



3. Efficient planning pathways

The NSW Government has earmarked six priority growth areas as economic development zones called Special Activation Precincts (SAPs). The SAPs are in Wagga Wagga, Parkes, Moree, Williamtown, Snowy Mountains and Narrabri.

In addition to the Hunter and Illawarra, the SAPs are promising locations for new hydrogen hubs, as they will bring together planning and investment support services to enable industrial and commercial infrastructure projects. The SAPs will benefit from government-led studies, efficient planning determinations, government led development and infrastructure investment. Planning pathways within the SAPs will enable planning determinations for low risk and appropriately scaled hydrogen related projects in under 30 days.[52]

The NSW Government is investigating how hydrogen production, distribution and use will be integrated into the development of the SAPs. As this work progresses, industry can consider how to leverage different strengths and opportunities within each SAP to develop hydrogen hubs.

For example:

- Wagga Wagga is an existing industrial precinct that also operates as an intermodal freight and logistics hub.
- Parkes is home to the National Logistics Hub and is located at the only junction of Australia's two rail spines, the Inland Rail and the Trans-Australia Railway.
- Moree, located in the middle of the most productive grain region in Australia with connections to the Inland Rail route and Newell Highway, will create new opportunities for agribusiness, logistics and food processing industries.

The NSW Government is also working to integrate hydrogen into the regulatory planning framework, including consideration of hazards and risks of hydrogen developments, and how they will interact with key planning policies such as the *State Environmental Planning Policy No 33 Hazardous and Offensive Development.*

There are also opportunities to streamline planning processes for appropriate hydrogen-based developments inside and outside of SAPs and in ports by undertaking upfront land use suitability studies or quantitative risk assessments that would inform where hydrogen development could be undertaken safely and with minimal land use conflicts.

52. Only once the Planning Secretary has completed their obligations and subject to satisfying relevant safety requirements.

4. Funding support for hydrogen infrastructure and technology

The Net Zero Industry and Innovation Program is the NSW Government's plan to support and partner with industry to reduce emissions and help NSW businesses prosper in a low carbon world. By accelerating the development of clean technology and decarbonisation, we will grow the economy, support jobs and significantly reduce emissions. The program has $750 million available across three key focus areas of Clean Technology Innovation, New Low Carbon Industry Foundations and High Emitting Industries.

Important investments in hydrogen will be supported across all three focus areas including the establishment of hydrogen hubs that will rapidly deliver scale and cost reductions and the formation of a Powerfuels and Hydrogen Innovation Network to drive collaboration between industry, research organisations and government.

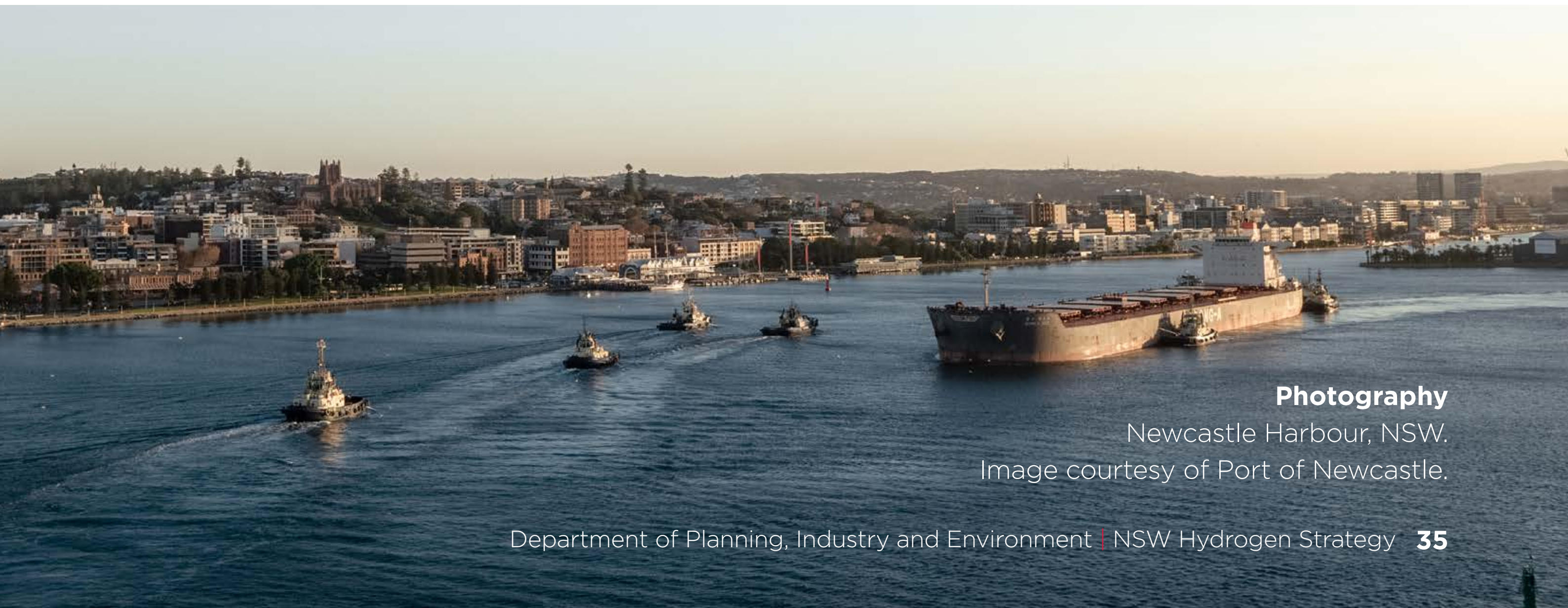
The NSW Government is also funding common-use hydrogen infrastructure in the SAPs under the $4.2 billion Snowy Hydro Legacy Fund. The Regional Growth NSW Development Corporation has already committed to funding a hydrogen reticulation network to supply industrial customers in the Wagga Wagga precinct and is investigating opportunities for the reticulation network's hydrogen supply.

5. Existing commercial hydrogen production, heavy industry workforce and export terminals

NSW already safely produces and uses commercial quantities of hydrogen in Port of Newcastle and Port Kembla. Both regions have well established bases in safe materials handling and ammonia, steel and heavy manufacturing, with access to over 34,000 skilled workers in the Hunter and 8,000 skilled workers in the Illawarra.[53]

Existing export terminals and trade relationships and proximity to existing electricity transmission infrastructure and the planned Illawarra and Hunter-Central Coast REZs creates opportunities for exporting hydrogen. These sites will form part of our first two green hydrogen hubs in the Hunter and Illawarra, delivering economies of scale, concentrating resources and driving industry development. Working groups with potential investors, equipment manufacturers, research institutions, suppliers and users are currently operating in both regions to grow hydrogen hubs.

53. Department of Planning Industry and Environment analysis of Australian Bureau of Statistics EQ06 data (2021)



Photography
Newcastle Harbour, NSW.
Image courtesy of Port of Newcastle.

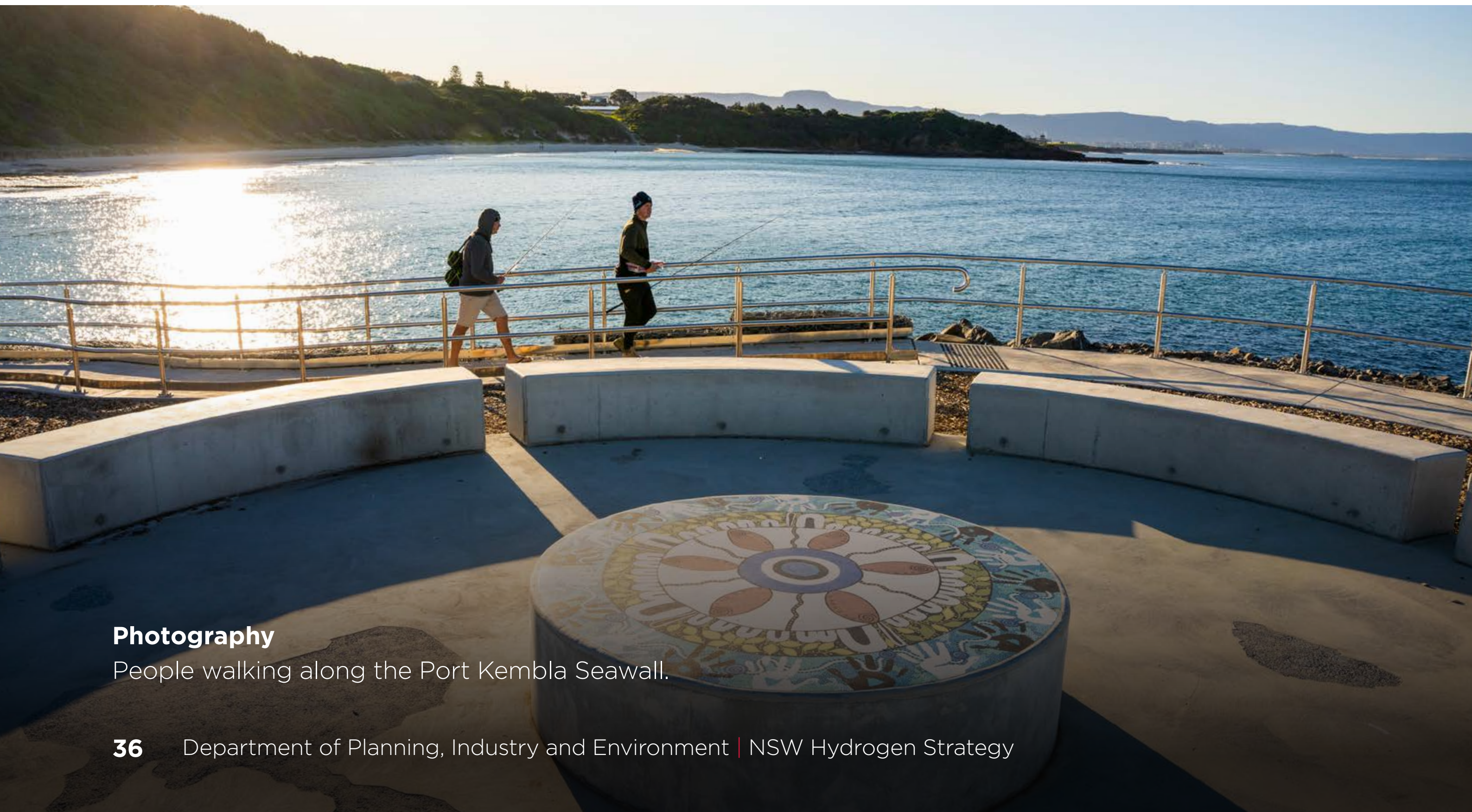
6. Sustainable water resources

Water consumption for hydrogen production will be relatively small in comparison to other sectors. Under the National Hydrogen Strategy's uptake scenarios, water usage for hydrogen in NSW could range between 1,400-2,200 ML per annum by 2030 and 18,000-23,000 ML per annum by 2050.[54] Under these scenarios, the likely maximum water used by a commercial hydrogen industry in 2050 to produce 2.5 million tonnes of hydrogen would be equivalent to only 0.14% of NSW's current water use. By comparison to other industries in NSW, water use for hydrogen production in NSW would be equal to, at most, 24% of water used in manufacturing, 16% used in mining and 0.7% used in agriculture.[55]

However, it is important for the industry's growth and longevity to use sustainable water sources and balance competing priorities for water usage, particularly in regional areas that have existing Regional Water Strategies and Water Sharing Plans in place.

NSW is home to world-class water treatment facilities that discharge large volumes of high-quality recycled water that can be used to meet our hydrogen production needs. Hunter Water facilities discharge approximately 55,000 ML of water per annum and Sydney Water facilities discharge 85,000 ML of water per annum, 18,000 ML of which is available at Port Kembla alone.[56] Other potential sustainable water sources include desalinated water and innovative hydrogen production technologies that use saline water directly.[57]

54. Department of Planning, Industry and Environment modelling of NHS uptake scenarios in NSW assuming 9 litres of water per kg of hydrogen
55. Australian Bureau of Statistics 2020, *Water Account*
56. Sydney Water 2021, *Recycled water network* and *Hunter Water 2021, Wastewater Treatment Works*
57. International Energy Agency 2019, *The Future of Hydrogen*



Photography
People walking along the Port Kembla Seawall.

7. World class research and development projects and institutions

NSW has a proven track record in delivering world class technology research and development that can be leveraged to drive growth of the hydrogen industry and benefit investment partners.

University of Wollongong

The University of Wollongong's (UOW) Australian Institute for Innovative Materials has fabricated a high-performance electrocatalyst using a low-cost metal to improve the efficiency of hydrogen production from electrolysis. A new company, Hysata, has been set up by UOW to commercialise this breakthrough technology using $5 million in funding led by IP Group, with support from the Clean Energy Finance Corporation. The Hysata technology has the potential to significantly shift the economics of green hydrogen production, bringing the Australian Government's $2 per kg target within reach. The University is also a research partner in the national Future Fuels Cooperative Research Centre, which is supporting the pivotal role fuels such as hydrogen and biogas will play in decarbonising Australia's energy needs.

University of New South Wales

The University of New South Wales Sydney is home to a range of exciting research projects and initiatives across the hydrogen supply chain, including:

- Australian Research Council (ARC) Industrial Transformation Training Centre for the Global Hydrogen Economy
- ARC Research Hub for Integrated Energy Storage Solutions
- Particles and Catalysis (PartCat) Research Laboratory
- Materials Energy Research Laboratory in Nanoscale (MERLin)
- Hydrogen Energy Research Centre
- Nano Electro Chemistry (NEC) Laboratory.

UNSW's hydrogen research is supporting new companies developing hydrogen storage solutions and hydrogen batteries.

University of Newcastle

The Newcastle Institute for Energy and Resources (NIER) has developed the 'Hydro Harvester', which produces water extracted from air and, when coupled with an electrolyser, produces hydrogen. A pilot project testing the technology is underway at a Southern Green Gas and APA Group demonstration plant. NIER has also developed a chemical looping-based technology platform for conversion of biosolids to hydrogen and a 2 tonne per day pilot plant has been commissioned at the NIER precinct in Newcastle.

University of Sydney

The University of Sydney is progressing cutting-edge Australian Research Council funded projects to improve the efficiency of hydrogen production, including the development of breakthrough catalysts for higher efficiency water electrolysers and fuel cells.

University of Technology Sydney

The Hydrogen Energy Program at the University of Technology Sydney brings together leading experts with transdisciplinary skills across the hydrogen value chain to take a whole-of-system approach to hydrogen technology development. The program includes world class research in large-scale hydrogen storage and cutting-edge data science that optimises the integration of electricity, water, transport and export infrastructure.

Macquarie University

Macquarie University is tackling challenges with the safe application of hydrogen across a range of projects. One project focuses on fast fuel cell electric vehicle hydrogen refuelling and using simulation data and machine learning tools to develop storage and handling protocols for fuel cell electric vehicles. Outcomes from the project will inform recommendations for refuelling system manufacturers, service delivery offices and equipment manufacturers.

Photography
Portside factories in Port Kembla.

3. The plan

Design principles

The NSW Government applied the following principles for the development of the NSW Hydrogen Strategy and will use them to guide its implementation.

Principle 1 – The role of government is to create the conditions that will enable the private sector and market forces to drive large scale investment.

Principle 2 – Sector coupling and the development of hubs will concentrate resources to drive scale and deliver cost efficiencies.

Principle 3 – Scaling generates a virtuous cycle of investment, efficiency, technology development and cost reductions.

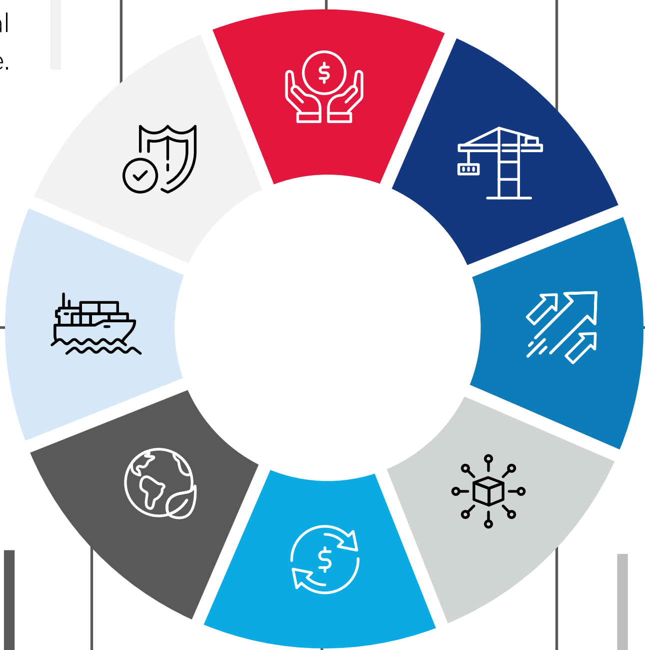
Principle 4 – Growing a commercial green hydrogen industry requires the development of the entire hydrogen value chain and new business ecosystems.

Principle 5 – The NSW Government will lead by example, using its purchasing decisions to stimulate local demand and grow supply chains.

Principle 6 – The hydrogen value chain must work towards being environmentally sustainable, addressing carbon emissions and water consumption.

Principle 7 – An active domestic market for hydrogen will lay the foundations for future success and enhance our export capabilities.

Principle 8 – Community safety is paramount and industry must use safe storage and handling practices to obtain social license and operate at scale.



Stretch targets

The NSW Government is adopting the following stretch targets for development of the hydrogen industry in NSW. These targets are based on the uptake rates set out in the National Hydrogen Strategy and are designed to reflect the NSW Government's objective to reach net zero by 2050. In line with the adaptive framework supported by the National Hydrogen Strategy, these targets will be reviewed periodically to ensure they remain appropriate and responsive to market conditions.

2030 stretch targets

Green hydrogen produced 110,000 tonnes per annum	**Renewable energy capacity** 12 GW
Electrolyser capacity 700 MW	**Hydrogen price** Under $AU2.80 per kg
Hydrogen vehicles 10,000	**Refuelling stations** 100
Gas network blending 10% (by volume)	**NSW Government heavy vehicle fleet** 20% hydrogen vehicles

The NSW Government is aiming to achieve a green hydrogen production cost in NSW under $2.80 by 2030, achieved through scaling, technology efficiency improvements and increased access to cheap renewable energy under our Electricity Infrastructure Roadmap. Delivering this green hydrogen production cost will:

- make hydrogen more cost competitive than diesel fuel, incentivising scaling and widespread market uptake in heavy transport and remote power system applications
- close the commercial gap between hydrogen and gas in the industrial and heating sectors to enable scaling
- increase market momentum towards the Australian Government's economic stretch goal of clean hydrogen under $2 per kg, which will in turn enable broader uptake in the industrial, heating, steel, electricity and synthetic fuel sectors
- in conjunction with a strong and active domestic market for hydrogen, position NSW to compete in international export markets.

Summary of key actions

This Strategy is based on three interconnected pillars that are designed to dramatically lower the cost of hydrogen production in NSW, help to meet our 2030 stretch targets and set the State up to commence green hydrogen exports. This section sets out the key actions under each pillar, with a full list of the Strategy's 60 actions set out for each sector in the Appendix.

Photography
Solar Farm, Moree.

PILLAR 1

Enable industry development

As an emerging industry that is expanding into new sectors and uses, green hydrogen needs a range of policy support to ensure the necessary industry ecosystems are in place. Actions under Pillar 1 will accelerate the development of these ecosystems, supporting industry development across the hydrogen value chain.

State-wide strategic hydrogen infrastructure masterplan

Building on the work of our Electricity Infrastructure Roadmap, we will complete a study examining different scenarios for industrial scale production, storage and distribution of hydrogen across NSW. The study will compare the relative merits of locations for large-scale green hydrogen production, including consideration of hazards and risks associated with hydrogen-based developments, and the different storage, pipeline and distribution options for potential demand centres. It will also include assessments of electricity infrastructure needs. This study will help guide and prioritise government and private sector investment in hydrogen supply chains.

Upfront strategic planning and port infrastructure assessments

We will undertake upfront strategic land use planning and other assessment processes for major hydrogen generation projects and hydrogen hubs. We will also review and develop, where necessary, planning pathways and appropriate assessment criteria in the planning system to facilitate the safe and rapid roll out of small-scale and lower risk hydrogen distribution, storage and refuelling stations.

We will also facilitate and fund port infrastructure assessments and the necessary studies for early-stage planning determination of export projects. This will streamline export activities and investment decisions for international trade consortiums and position NSW to capture international hydrogen market share.

Hydrogen-ready regulatory frameworks

We will complete a comprehensive review of all relevant state-based legislation to identify and make any necessary updates to enable the safe production, distribution and use of hydrogen across our economy. This program of works will complement standards development underway and ensure there is a supportive regulatory environment for uptake of hydrogen in NSW.

Skills development

We will engage across industry, universities and Vocational Education and Training providers to develop a complementary and holistic approach to hydrogen industry skills development and training in NSW. We will support the skills sector to update and deliver relevant curriculum for hydrogen occupations, ensuring that NSW maintains and grows its highly skilled workforce across its regions.

Hydrogen innovation

As part of the Clean Technology Innovation focus area of our Net Zero Industry and Innovation Program, we will invest in hydrogen research and development projects and testing facilities. Coordinated support for these projects will aim to leverage hub infrastructure and resources where appropriate to maximise industry, technology and hub development and keep NSW at the forefront of hydrogen innovation.

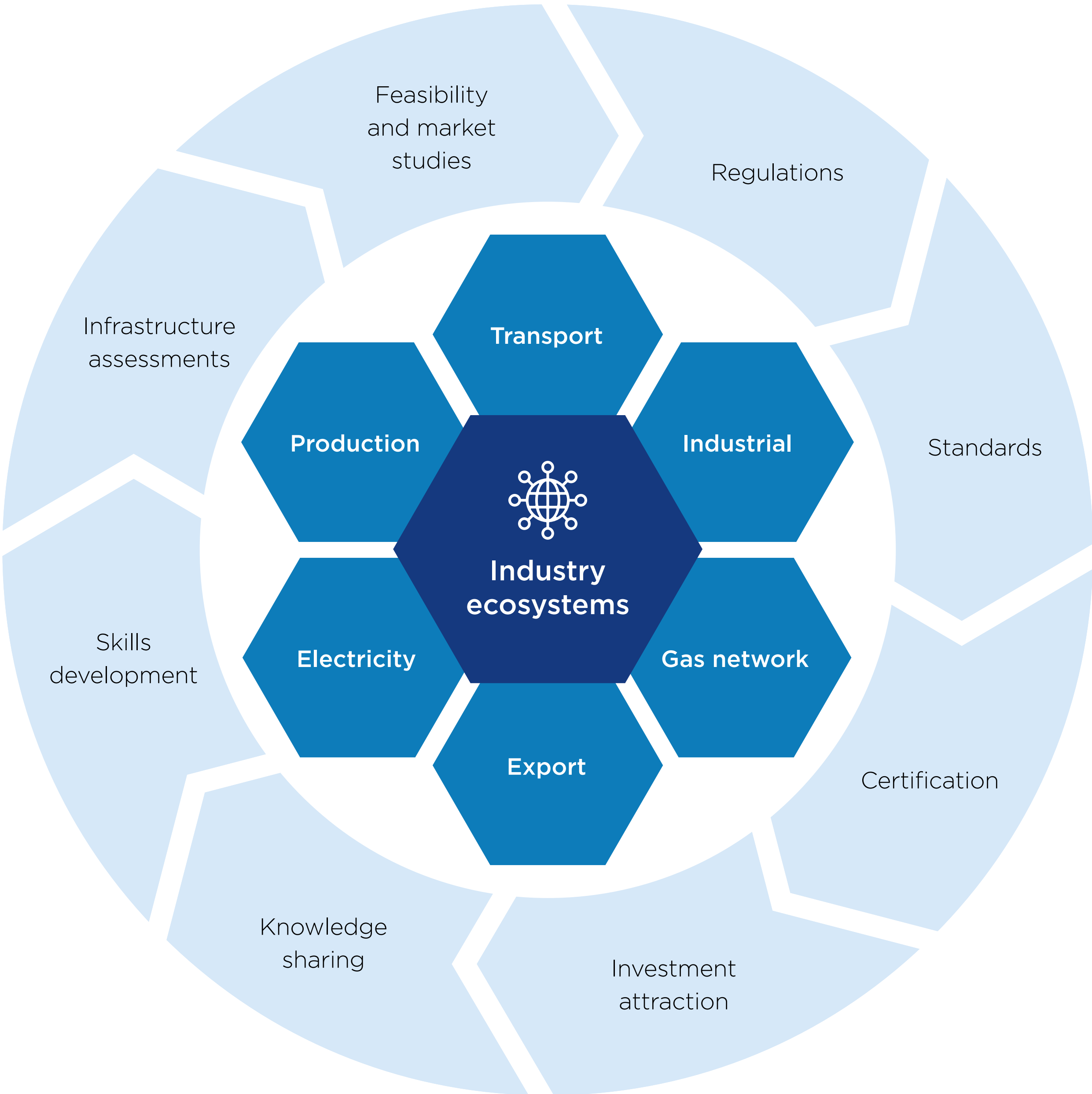


Figure 13
Pillar 1—Enable industry development.

Lay industry foundations

To kickstart the green hydrogen industry, we need the private sector to build infrastructure that will unlock supply chains and demonstrate technology. This foundation will test commercial models, support industry to 'learn by doing' and provide a bedrock upon which to realise future scale and secure investment decisions.

Hydrogen hubs

Hydrogen hubs are regions where various users of hydrogen across industrial, transport and energy markets are co-located. Hubs can also provide a central point of hydrogen production, which is supplied to 'spokes' that extend out from the hub. Research and development projects and facilities can also be attached to hubs, leveraging hub infrastructure and sharing knowledge (see Figure 14) to deliver technology innovation, efficiency improvements and cost reductions.

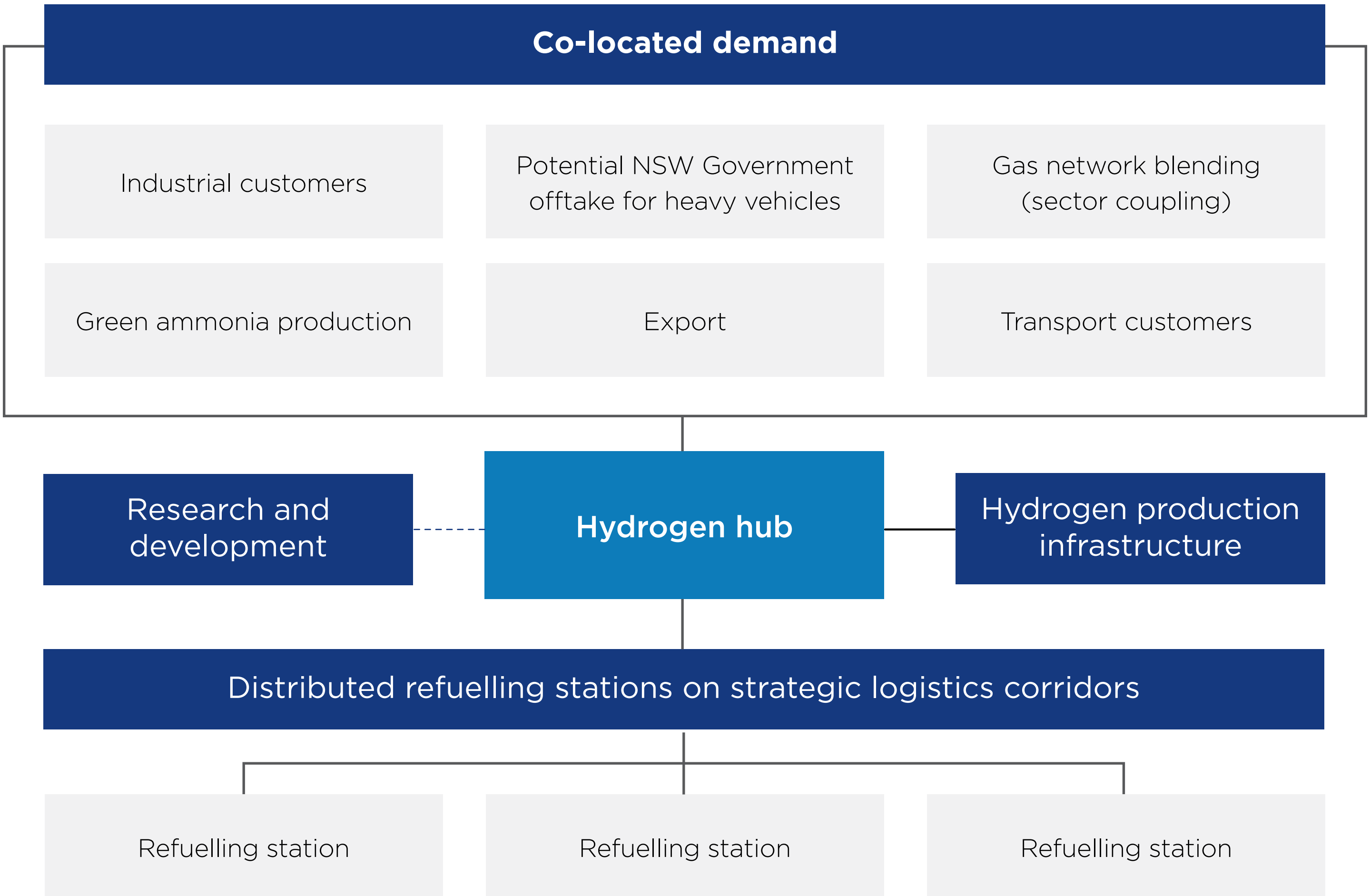


Figure 14
Hydrogen hub concept.

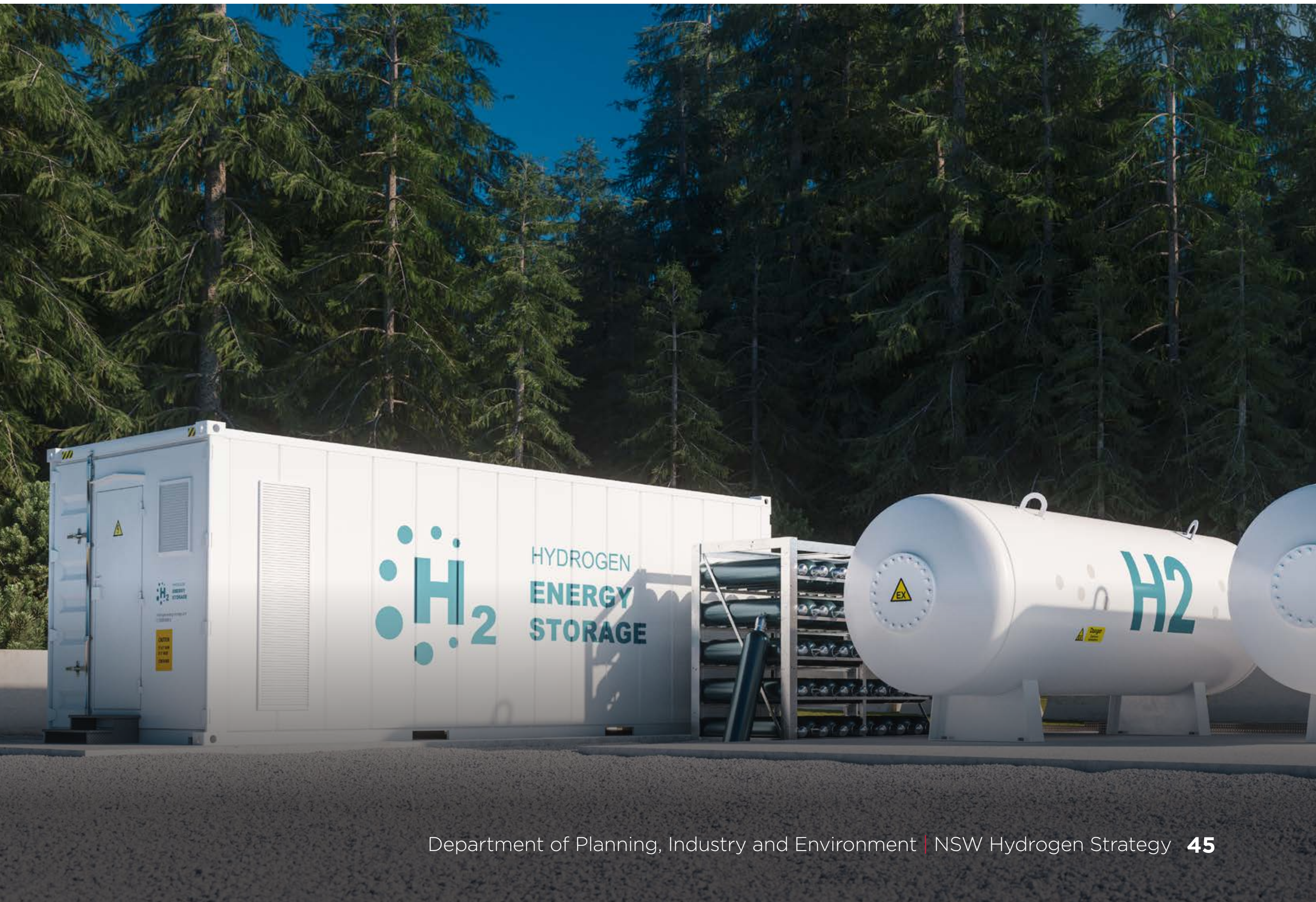
Establishing hubs minimises the cost of infrastructure—such as power lines, pipelines, water supply, storage tanks, refuelling stations, ports, roads or railway lines—and supports economies of scale in producing and delivering hydrogen to end users.

Hubs also help focus efforts for innovation, cultivate industry ecosystems and build a 'hydrogen ready' workforce. Coordinated action between industry and government can solve the dilemma where high costs and lack of access to infrastructure result in low demand, which prevents large-scale investment to reduce costs. Our hydrogen hub initiative will break this cycle, drive scale, reduce costs, activate new markets for hydrogen in the transport sector and move existing markets to cleaner hydrogen options.

Developing hydrogen hubs now will enable NSW to decarbonise its heavy transport fleet, support the diversification of our regional economies and capture longer-term opportunities for hydrogen in the export, steel, electricity and synthetic fuel markets.

The NSW Government is investing $70 million into the Hunter and Illawarra through the hydrogen hub initiative. Further support may be made available by government for additional hydrogen hubs in other strategic regions such as our Special Activation Precincts (SAPs), like Wagga Wagga, and our Renewable Energy Zones (REZ). Hydrogen hubs will generally have proximity to the following:

- existing and large potential future hydrogen demand
- logistics corridors and/or export terminals for international trade
- renewable energy resources and/or electricity transmission network connections
- sustainable water resources
- gas network infrastructure
- skilled workforce and research capabilities.



Snapshot of planned and potential NSW hydrogen hubs

Annual hydrogen production capacity from waste water (Mt)

Location	Mt	Location	Mt
Moree	0.6	Hay	0.6
Narrabri	0.1	Wagga Wagga	1.2
Armidale	0.6	Hunter	8.8
Dubbo	0.7	Illawarra	11.7
Parkes	0.6		

Figure 15
Snapshot of planned and potential NSW hydrogen hubs.

* This map is a visual guide only and does not represent REZ or hydrogen hub boundaries. For more information on the REZs, please visit energy.nsw.gov.au/government-and-regulation/electricity-infrastructure-roadmap

Hydrogen hubs

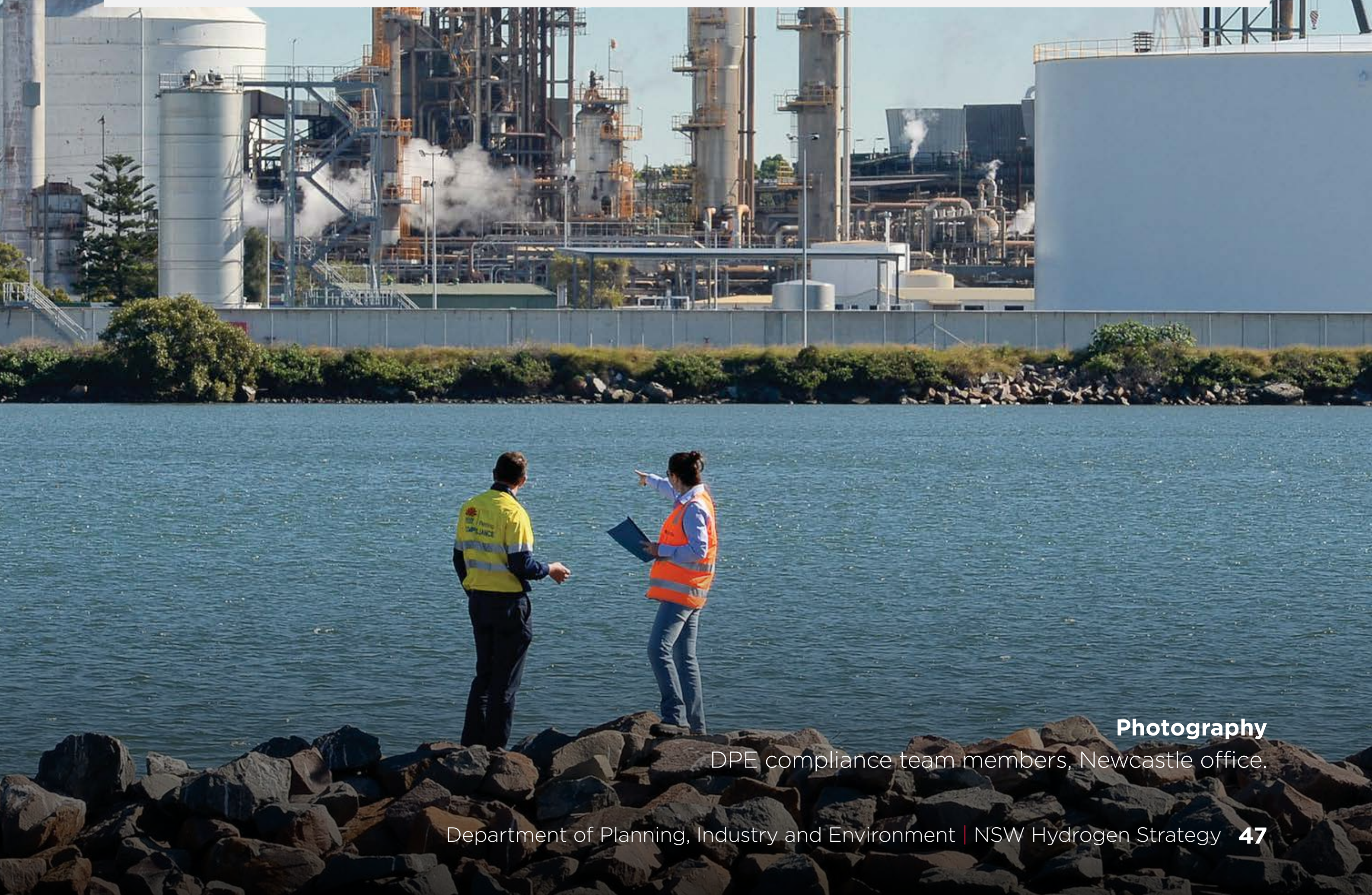
Hunter

The Hunter is primed to be one of Australia's largest hydrogen hubs. The Hunter has access to existing high voltage transmission infrastructure and the NSW Government is in the early stages of planning the Hunter-Central Coast REZ. The Hunter has a workforce of 34,000 skilled workers, is home to large hydrogen demand centres and has access to one of the world's largest energy export terminals at the Port of Newcastle. Port of Newcastle has existing commercial scale production and use of hydrogen at Orica's ammonia facility, which already exports around 130,000 tonnes of ammonia per annum.[58]
The port is also a major freight and logistics centre, has access to existing high voltage transmission infrastructure and supplies existing commercial relationships with international energy trade partners.

Illawarra

The Illawarra is the second hydrogen hub in our $70 million hydrogen hub initiative and is set to be one of Australia's largest domestic markets for hydrogen. The Illawarra has access to existing high voltage transmission and the NSW Government is in the early stages of planning the Illawarra REZ. The Illawarra has a workforce of at least 8,000 skilled workers, is home to one of Australia's only integrated steel works and has access to existing export infrastructure at Port Kembla. Port Kembla is a major freight and logistics hub and is implementing Australia's first hydrogen truck project and NSW's second hydrogen refuelling station.

58. Port of Newcastle 2020, *Trade Report*



Photography
DPE compliance team members, Newcastle office.

Other strategic hydrogen locations

Wagga Wagga

The Regional Growth NSW Development Corporation has committed to funding a hydrogen reticulation network to supply industrial customers across the SAP and is investigating opportunities for the reticulation network's hydrogen supply. Wagga Wagga will capitalise on its strategic location servicing the Riverina-Murray agricultural region to establish a world-class enterprise zone and hydrogen hub, targeting the freight and logistics, advanced manufacturing, recycling and renewable energy sectors.

Central-West Orana Renewable Energy Zone

The state’s first REZ will be in the Central-West Orana region around Dubbo and Wellington. The REZ is expected to be shovel-ready by the end of 2022 and unlock up to 3,000 MW of new electricity capacity by the mid-2020s.

New England Renewable Energy Zone

The early stages of planning are underway for a REZ in the New England region. The REZ will deliver up to 8,000 MW of new transmission capacity by 2030. New England has some of the best natural energy resources in Australia and some of the state’s finest potential sites for pumped-hydro development, as well as strong investor interest in the region.

South-West Renewable Energy Zone

The early stages of planning are underway for a REZ in the South-West region of NSW around Hay. The region is close to the EnergyConnect project that is proposed by TransGrid and ElectraNet. EnergyConnect would link the SA and NSW markets and help to transport energy from the South-West REZ to energy consumers.

Hunter-Central Coast and Illawarra Renewable Energy Zones

The early stages of planning are underway for REZs in these regions, which have access to existing transmission, port and transport infrastructure and skilled workforces.

Moree Special Activation Precinct

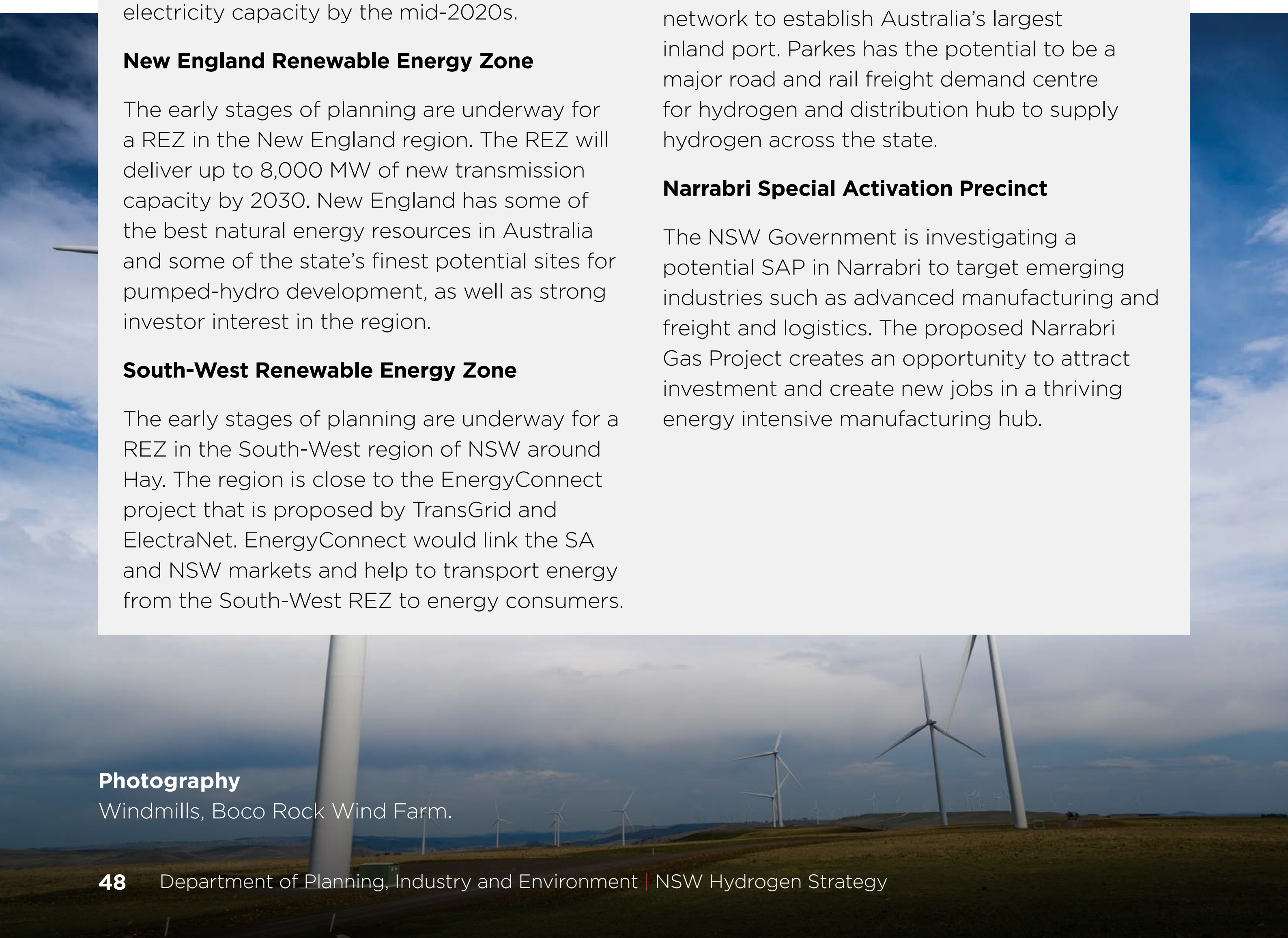
The NSW Government is aiming to establish the Moree precinct as a new business and intermodal hub specialising in high-value agriculture, logistics and food processing. Moree has the potential to be a major hydrogen demand centre for agricultural and transport applications.

Parkes Special Activation Precinct

The Parkes precinct will leverage its strategic location within NSW’s freight and logistics network to establish Australia’s largest inland port. Parkes has the potential to be a major road and rail freight demand centre for hydrogen and distribution hub to supply hydrogen across the state.

Narrabri Special Activation Precinct

The NSW Government is investigating a potential SAP in Narrabri to target emerging industries such as advanced manufacturing and freight and logistics. The proposed Narrabri Gas Project creates an opportunity to attract investment and create new jobs in a thriving energy intensive manufacturing hub.



Photography
Windmills, Boco Rock Wind Farm.

Hydrogen refuelling network

Unlocking new demand for hydrogen will be critical to establish hydrogen supply chains and support large-scale investment in green hydrogen production infrastructure. As a new potential market for hydrogen, heavy transport has the benefit of being technologically proven, commercially competitive and scalable.

Hydrogen trucks are already in commercial operation overseas, with additional models expected to become available in NSW over the next twelve months.[59] Hydrogen in heavy transport applications is projected to reach commercial parity with diesel and internal combustion engines as early as the mid-2020s and to deliver net cost savings by the end of the decade.[60] Targeted support now can prepare industry and investors to rapidly adopt hydrogen technology as costs reduce throughout the decade.

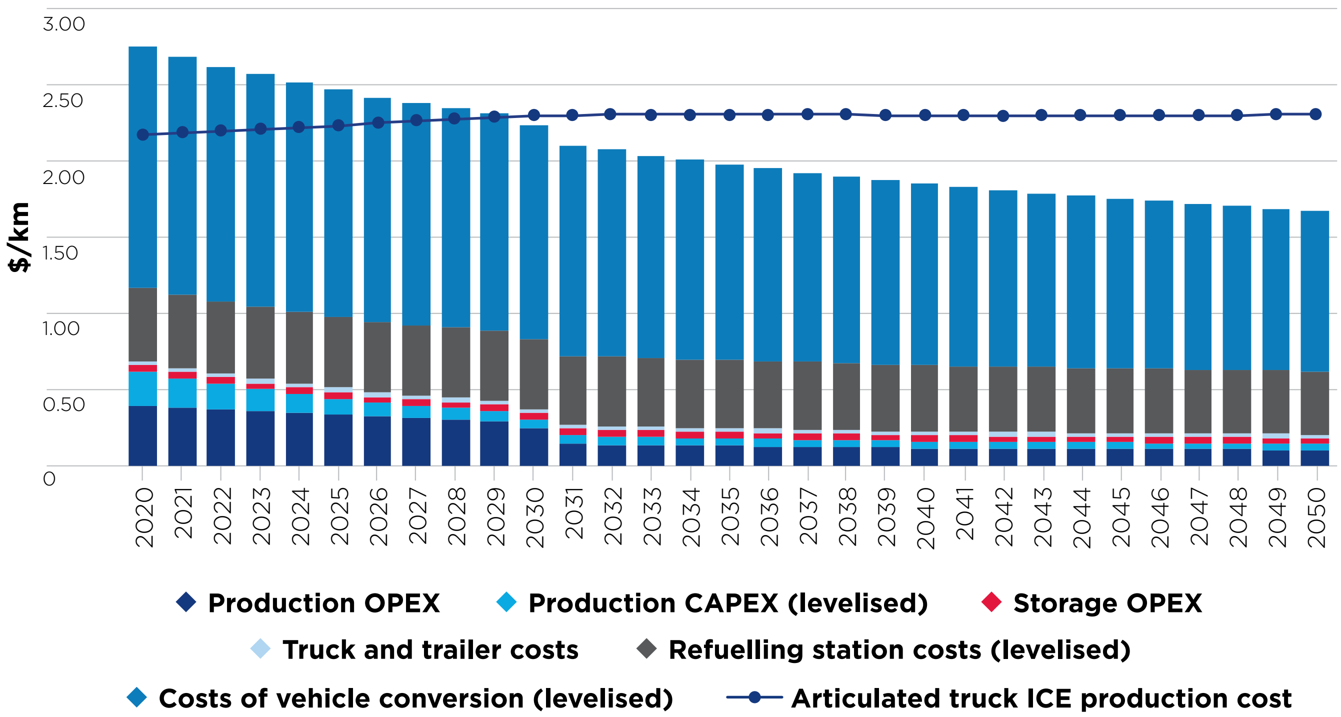


Figure 16
Levelised cost of hydrogen articulated trucks.[61]

However, government support is needed to break a chicken and egg problem where fleet operators will not buy hydrogen trucks until they have access to refuelling networks, and refuelling operators will not invest in refuelling stations until there are enough hydrogen trucks on the road. Government can help industry break this cycle by supporting uptake in logistics where pre-defined driving routes provide certainty of refuelling requirements.

59. Hyundai Motor Group 2020, Hyundai XCIENT Fuel Cell Heads to Europe for Commercial Use, New Zealand Government 2020, *Low-emissions options for heavy transport a step closer, New Zealand Government 2021, Government supports more low emission vehicle options*
60. KPMG 2020, *Industry Opportunities Enabled by Cheap, Clean and Reliable Electricity; CSIRO 2018, National Hydrogen Roadmap;* Advisian 2021, *Australian hydrogen market study*
61. KPMG 2020, *Industry Opportunities Enabled by Cheap, Clean and Reliable Electricity*

Unlocking the heavy transport market for hydrogen has the potential to act as a catalyst for the hydrogen industry. Fuel supply for just 3,500 heavy duty hydrogen trucks (15% of the NSW fleet) would consume approximately 40,000 tonnes of hydrogen per year. This level of demand for hydrogen is around the same as 10% hydrogen blending in the gas network and the hydrogen already used to produce ammonia in NSW. By 2050, the heavy-duty truck sector in NSW is expected to grow to around 50,000 vehicles, creating a market for up to 500,000 tonnes of hydrogen per annum or 2.6 GW of electrolyser capacity.[62]

Heavy transport applications and support for the rollout of a hydrogen refuelling network are therefore focus areas under this Strategy. These initial supply chains will provide the foundation to capture the substantial opportunities in the export, energy, steel and synthetic fuel markets as hydrogen technology and economics improve.

We will support industry to deliver an integrated refuelling network that can supply hydrogen fuel along the major logistics corridors connecting the east coast states. To implement this initiative, we will seek proposals through a competitive application process for grant funding to install hydrogen refuelling stations and operate heavy hydrogen vehicles along a key freight corridor.

We aim to support a range of logistics operators and Original Equipment Manufacturers (OEM) to test hydrogen trucks within their operations. Our goal is to initially fund 4-5 scalable refuelling stations along a trial corridor and support between 25-50 hydrogen trucks. Funding for this refuelling corridor will be available under the $175 million New Low Carbon Industry Foundations focus area of our Net Zero Industry and Innovation Program.

The application process and funding approach will be flexible to enable participation in the corridor from individual fleet operators and OEMs demonstrating small numbers of vehicles to fully integrated refuelling supply chains delivered by industry consortiums.

Precinct decarbonisation roadmaps

We are supporting the development of Clean Manufacturing Precincts (CMP) to accelerate the deployment of emerging low-carbon technologies and infrastructure that open decarbonisation pathways for industrial energy consumers. CMPs are geographic areas with co-located companies representing either one or more industries that do or can share common infrastructure. Taking a coordinated approach to planning and investment across the precinct can increase the pace and scale of deploying low carbon infrastructure by aggregating demand, sharing risk, and pooling resources. For example, one company's wastewater can be another company's feedstock for hydrogen production, creating a circular economy within the CMPs.

We are funding at least two decarbonisation roadmaps for CMPs that show a pathway to achieve low to zero carbon industrial emissions in the Hunter and Illawarra. The roadmaps will be developed through a strategic partnership with the region's industries, supply chains, local businesses and community organisations. Together, we will use these roadmaps as a strategic blueprint to inform and prioritise the allocation of capital and accelerate the deployment of enabling infrastructure and technologies that will enable the decarbonisation of our hard-to-abate sectors.

62. Department of Planning, Industry and Environment modelling

Australia's first green hydrogen and gas power plant

NSW is set to become home to Australia's first dual fuel hydrogen/gas power plant under a $78 million funding agreement from the NSW Government for the Tallawarra B project in the Illawarra.

Tallawarra B will provide over 300 MW of dispatchable capacity for NSW customers in time for the summer after the Liddell power station retires. Delivering enough electricity to power around 150,000 homes at times of peak demand, the project is expected to deliver a $300 million boost to the economy and support about 250 jobs during construction.

The project sets a new benchmark for how gas generators can be consistent with NSW's plan to reach net zero emissions by 2050 by using green hydrogen and offsetting residual emissions. Under the funding agreement, EnergyAustralia will offer to buy enough green hydrogen equivalent to over 5% of the plant's fuel use from 2025 (200,000 kg of green hydrogen per year) and will offset direct carbon emissions from the project over its operational life. EnergyAustralia will also invest in engineering studies on the potential to upgrade Tallawarra B so it can use more green hydrogen in its fuel mix in the future.

New demand for hydrogen that is scalable will be critical to support the initial establishment and scaling of our hydrogen hubs. Hydrogen for the Tallawarra B power station will provide foundational demand that can support the establishment of the Illawarra hydrogen hub.

PILLAR 3

Drive rapid scale

The primary barrier to uptake of hydrogen is its cost in comparison to incumbent fuel. If costs can be reduced and hydrogen shifted down the cost curve, demand for hydrogen will increase and generate a virtuous cycle of technology improvements, scaling and cost reductions that will enable additional uptake.

In addition to grant funding delivered through our Net Zero Industry and Innovation Program, we will transform the market for hydrogen by implementing economy wide incentives that will significantly reduce the cost of producing hydrogen. These incentives will close the commercial gap between hydrogen and incumbent fuels and help build critical mass to move hydrogen down the cost curve.

Network concessions and scheme exemptions

The largest cost input to produce green hydrogen by electrolysis is the price of delivered electricity, which when sourced from the grid is comprised of:

- electricity prices (wholesale and retail)
- network use of system charges (known as tariffs)
- environmental and electricity schemes.

With our ground-breaking Electricity Infrastructure Roadmap, we will enable the market to access up to 12 GW of low-cost wholesale renewable energy.

Under this Strategy, we will provide temporary concessions for hydrogen producers from network use of system charges and exemptions to environmental and electricity schemes. Access to these concessions will be available for electrolyser capacity installed by 2030, subject to conditions set out below, and will be in place for a period of 12 years.

We will review these timeframes and conditions in 2027 to ensure they remain appropriate. Collectively, we estimate these concessions will reduce the cost of producing hydrogen by $2.13 per kg.

Network cost concessions

The price of delivered electricity includes charges for the electricity transmission and distribution networks that transport electricity from our power plants to electricity customers. These charges recover the cost of the capital investment in network infrastructure and its on-going operation and maintenance. All electricity customers contribute to the recovery of these costs, which can account for as much as half of electricity bills.

Across the state and in our hydrogen hubs, there are parts of our electricity networks where we have more capacity than we currently use. This spare capacity could host electrolysers to produce green hydrogen and support the growth of new green industries, but the cost of grid electricity is too high at this early stage of industry development. To make the most of our existing electricity infrastructure in these critical early stages, the NSW Government will provide temporary concessions (approximately 90%) to hydrogen producers for network use of system charges where they connect to parts of the network with spare capacity. This approach means that we can support hydrogen deployment, better use our existing infrastructure and do so in ways that limit the impact on other consumers' bills.

These concessions will be available subject to the following conditions:

1. electrolysers must be placed in parts of the network where there is existing spare capacity up to a state-wide cap of 750 MW
2. network businesses and the electricity market operator will be able to direct the electrolyser to turn off if required during a peak event
3. hydrogen producers will be required to pay a portion of network use of system charges (approximately 10%), which will account for the marginal cost of their use of the network and help reduce costs for other consumers when the electrolysers connect
4. the concessions will only be available for electrolyser capacity installed by 2030 and for a period of 12 years, after which the hydrogen producer will revert to paying the full charges.

We will work with the electricity network businesses to determine the most effective way to implement these concessions and ensure they are available to the market by 2024.

Scheme exemptions

In NSW, the price of delivered electricity also includes charges for the Electricity Infrastructure Roadmap, Climate Change Fund, Energy Security Safeguard and GreenPower (if certified as 'green'). These charges are levied on customers to increase renewable energy generation capacity, fund policies to deliver our decarbonisation objectives and reduce the cost of energy infrastructure.

A commercial green hydrogen industry supports the realisation of these objectives by delivering a new zero emissions fuel that is produced using flexible electricity loads. These flexible loads can help drive additional investment in renewable generation capacity while increasing the fleet of responsive demand that can be used to manage grid stability.

Accordingly, in these early stages of industry development while hydrogen competes with incumbent carbon-based fuels, we will provide exemptions for hydrogen producers from contributing to these schemes. These exemptions will be in place for at least the same time period as the network cost concessions and may be extended for new capacity installed from 2031 onwards based on our review in 2027.

Including a hydrogen target in the Energy Security Safeguard

As part of a suite of energy reforms in 2020, we introduced the NSW Energy Security Safeguard to deliver schemes that improve the affordability, reliability and sustainability of energy through the creation of financial incentives. The Safeguard builds on the success of our Energy Savings Scheme, which provides incentives in the form of tradeable certificates to help overcome barriers for energy efficiency projects.

We will expand the Energy Security Safeguard to support hydrogen with a market-based scheme that provides financial incentives for green hydrogen production. The scheme will support industry to grow new supply chains that can improve the affordability, reliability and sustainability of green hydrogen in NSW and prepare our industries to remain competitive in decarbonised markets.

The scheme target will commence in 2024 and gradually increase to 8 million GJ of hydrogen (or 67,000 tonnes) by 2030. The scheme could support an additional $6.4 billion in gross state product (GSP) and $212 million in emissions reduction benefits in present value terms and is expected to support the State's annual GSP to increase by $637 million in 2030. The scheme will provide a critical financial incentive for industry to bring forward investment in transformative projects and position NSW to capture first mover advantage for the State's regional economies. The scheme will be reviewed every 5 years to ensure its major design elements remain appropriate and reflect current market conditions.

Transformative industry projects

NSW is already home to a range of heavy industry and manufacturing that can drive large scale demand for hydrogen. For some industries, hydrogen is currently the only viable decarbonisation pathway either as a feedstock or to combust for high temperature process heating. Supporting these industries to move to hydrogen, where it makes sense for their operations, is a no-regrets action that can keep jobs in NSW while enabling the creation of new hydrogen-based industries.

Existing demand for hydrogen in ammonia production and new demand from steel manufacturing in NSW could support up to 470,000 tonnes of hydrogen per annum or 2.5 GW of electrolyser capacity by 2050.[63] This demand along with additional potential demand from process heating in our paper and pulp, aluminium, cement and other major industries can provide anchor offtakes through to 2030 and beyond that will drive scale and reduce costs. Given the scale of operations at these facilities, even relatively small uptake will help drive significant scale in the short term. These cost reductions can flow through to and enable new hydrogen industries in NSW. For example, green fertiliser and hydrogen fuel for heavy machinery and remote power generation can support our agriculture sector. Synthetic fuels can decarbonise our aviation and shipping sectors and can also be exported to international markets.

We have already committed $380 million of funding under the High Emitting Industries focus area of our Net Zero Industry and Innovation Program to support existing, high-emitting facilities to significantly reduce their emissions and strengthen their resilience into the future. For many of these facilities, hydrogen is a possible decarbonisation pathway, and the program will support them to overcome the technical and commercial barriers to adopt green hydrogen.

The NSW Government will also extend the Net Zero Industry and Innovation Program beyond 2030. This will be at its current average annual funding rate from the Climate Change Fund and will supplement the existing support available in the 2020s. This will provide financial support or risk-sharing beyond 2030 for projects delivered this decade. By taking risk over the first 10 to 15 years of the life of a capital-intensive project, NSW can support the deployment of new innovative technologies in ways that reduce the cost of capital and can avoid the costs associated with traditional grants.

63. Department of Planning, Industry and Environment modelling

This funding support for the 2020s and beyond 2030 will be available for major decarbonisation and hydrogen projects that satisfy a range of criteria to ensure they align with NSW Government strategic objectives, including:

- constitutes a rare or significant opportunity to deeply decarbonise the State's economy (excluding electricity), a major NSW industry or regional economy, or a major value chain
- is of a type that will likely be needed for the state to achieve net zero emissions in ways that support the state's economy
- has major economic benefits for the state's economy, including by reducing climate-related financial risk
- supports substantial private sector co-contribution, involving credible private sector partners such as technical experts, off-takers and financiers
- would transform or create a major NSW industry
- can justify the commercial need for NSW Government support
- delivers value for taxpayers' money
- is globally or regionally cutting edge.

Examples of the types of projects that could be supported include one of the first green steel mills in the Asia-Pacific or the first commercial scale ultra-low carbon cement-works.

Market engagement model

After the initial establishment of the hubs and refuelling networks, the next step is to support industry scale these supply chains. As part of the delivery of our $750 million Net Zero Industry and Innovation Program, we will periodically engage with the market to identify and aggregate emerging sources of hydrogen demand and then support the competitive supply of hydrogen for these consumers.

Depending on the prevailing market conditions and scope of demand identified, outcomes from the strategic partnerships and precinct decarbonisation roadmaps, this may include competitive grant applications, contracts for difference, reverse auctions and/or underwriting.

Where possible, we will align these market engagements with milestones from our transformative industrial projects to maximise scale. By aggregating emerging demand for hydrogen, this rolling market engagement model will help the market achieve step changes in economies of scale and bring forward supply chain cost reductions.

NSW Government hydrogen fleet target and trials

The NSW Government will lead by example and support industry to scale, using our purchasing decisions to effect change in the market. We operate a large fleet of heavy vehicles that can generate significant demand for hydrogen and provide suppliers with a high value revenue stream for transport fuel.

We have set a stretch target of 20% of our heavy vehicle fleet to be hydrogen fuel cell electric vehicles by 2030 and are developing plans for small- and large-scale deployment of hydrogen vehicles as part of our zero-emissions fleet transition strategy. We currently either own or contract for approximately 9,000 heavy vehicles. Achieving our target will put 1,800 hydrogen heavy vehicles on the road by 2030, creating demand for 10,000 tonnes of hydrogen per annum or around 70 MW of electrolyser capacity.

We are also completing a feasibility study with Alstom on trialling a hydrogen train on the NSW train network as part of our broader objective to decarbonise our rolling stock. The study will improve our understanding of hydrogen fuel for rail and assess what is required for a trial in terms of infrastructure, standards and accreditation.

Photography
Northern Rivers NSW. Image courtesy of Destination NSW.

4. How to get involved

Green hydrogen has enormous potential to drive deep decarbonisation across our transport, energy and industrial sectors. At the same time, it will create jobs and economic growth, diversify our regional economies, improve fuel security, improve the resilience of our energy system and create more choice for businesses.

This Strategy outlines our ambition and approach to transform NSW into Australia's largest domestic market for hydrogen and position our economy to capture the substantial opportunities in the green hydrogen export market.

We will be engaging with industry over the coming months to implement the Strategy, including consultation on regulatory updates and seeking applications for funding for different hydrogen initiatives.

Detailed information on hydrogen initiatives, including funding rounds and consultation processes, will be made available on the following website:

energy.nsw.gov.au/renewables/renewablegeneration/hydrogen

For further information please contact:

hydrogen@planning.nsw.gov.au

Appendix: Detailed actions by sector

Economy wide actions
1. Develop a state-wide strategic hydrogen infrastructure masterplan to compare the relative merits of locations for large-scale hydrogen production and the different storage and distribution options for potential demand centres.
2. Pursue upfront strategic land use planning and other assessment processes for major green hydrogen generation projects and hydrogen hubs.
3. Support the next wave of hydrogen innovation, including research and development projects and testing facilities, through the $195 million Clean Technology Innovation focus area of our Net Zero Industry and Innovation Program. Green hydrogen research and development across the supply chain, including production, storage, distribution and all hydrogen end use sectors will be eligible for funding support.
4. Establish green hydrogen hubs, starting with the Illawarra and Hunter, through our $70 million hydrogen hub initiative, which we will deliver through a competitive grant funding round.
5. Develop Clean Manufacturing Precincts that can produce sustainable chemicals and fuels by delivering precinct decarbonisation roadmaps. Starting with the Hunter and Illawarra, the roadmaps will guide industry planning and investment to 2030 and identify opportunities for economies of scale in hydrogen deployment.
6. Through the Net Zero Industry and Innovation Program, implement an ongoing market engagement model, which will periodically engage with the market out to 2030 to identify and aggregate emerging sources of hydrogen demand and support the competitive supply of green hydrogen for these consumers. Depending on the prevailing market conditions, outcomes from the precinct decarbonisation roadmaps and scope of demand identified, this may include competitive grant applications, contracts for difference, reverse auctions and/or underwriting.
7. Extend the Energy Security Safeguard to hydrogen to deliver a target of 8 million GJ (or 67,000 tonnes) of green hydrogen by 2030.
8. Provide green hydrogen producers with concessions (90%) for electricity transmission and distribution network use of system charges. Hydrogen producers will be able to lock in these concessions for electrolyser capacity installed by 2030 for a period of 12 years if they connect to parts of the network with spare capacity.
9. Exempt the production of green hydrogen from liability for electricity schemes established under the Energy Security Safeguard (i.e. the Energy Savings Scheme and the Peak Demand Reduction Scheme).
10. Exempt the production of green hydrogen from liability for contribution orders issued under the *Electricity Infrastructure Investment Act 2020*.
11. Exempt the production of green hydrogen from green electricity certification fees under the GreenPower program.
12. Establish industry collaboration groups for potential hydrogen hub locations and a dedicated digital collaboration platform to facilitate connections between potential international and domestic supply chain partners, provide access to knowledge sharing resources and aggregate hydrogen demand.
13. Increase access to low-cost renewable energy for green hydrogen producers by delivering Renewable Energy Zones under the NSW Electricity Infrastructure Roadmap.

Economy wide actions
14. Incorporate hydrogen production, distribution and use within the planning frameworks for relevant Special Activation Precincts to enable project approval (if all documentation and appropriate information has been provided, including final designs), within 30 days. This approval will be subject to satisfying relevant safety requirements specified in the Activation Precinct State Environmental Planning Policy.
15. Dedicate resources to the Australian Hydrogen Council to support their program of works related to skills and training, standards, technical regulatory policy development and social licence.
16. Dedicate resources to research organisations, Standards Australia and the National Hydrogen Project Team to accelerate the development of national standards for safe hydrogen production, storage, handling, distribution and use that are contemporary, best practice and enable access to cost-effective supply chains.
17. Provide hydrogen projects with access to financial incentives for relevant activities under the NSW Energy Savings Scheme and the Peak Demand Reduction Scheme.
18. Fund common use hydrogen related infrastructure within the Special Activation Precincts under the $4.2 billion Snowy Hydrogen Legacy Fund.
19. Support the development of a national hydrogen certification of origin scheme through the National Hydrogen Project Team, including pilots to trial scheme implementation.
20. Secure NSW hosting rights for leading international hydrogen industry conferences.
21. Publish guidance material to assist hydrogen project proponents understand planning approval requirements.
22. Foster partnerships between industry, universities and Vocational Education and Training providers, including TAFE NSW, and support hydrogen skills development through the NSW Smart and Skilled Program and the National Hydrogen Strategy skills and training actions.
23. Coordinate research institution applications to state and national research programs to maximise funding support and establish the Powerfuels and Hydrogen Innovation Network to encourage the growth of research, industry and government collaboration.
24. Undertake targeted investor engagement and support bilateral trade negotiations through Austrade, Global NSW Trade Commissioner networks, consular offices and inbound trade missions, foreign language collateral and investment support programs to attract foreign investment in NSW green hydrogen supply chains.
25. Use resources from the Coal Innovation Fund to improve understanding of carbon capture and storage sites in NSW's Darling Basin.
26. Conduct a review of the legislative framework for carbon capture and storage and investigate legislation to enable geo-sequestration of carbon dioxide in NSW, if viable and subject to commercial interest.
27. Provide strategic policy direction, access to resources and information developed through our strategy initiatives and, where required, financial support to training institutions to expand hydrogen related Units of Competency and implementation of training programs.
28. Extend the Net Zero Industry and Innovation Program to provide financial support or risk sharing beyond 2030 to enable transformative projects to be delivered this decade.

Transport actions
29. Provide grant funding to support industry complete initial proof of concept testing for hydrogen truck operation and refuelling at the Coregas facility in Port Kembla.
30. Support the rollout of a hydrogen refuelling network along strategic freight corridors in NSW. This initiative will start with a competitive funding round for hydrogen refuelling stations and trucks along a major freight corridor. We will provide funding support for hydrogen refuelling stations and heavy vehicles along these corridors under the $175 million New Low Carbon Industry Foundations focus area of our Net Zero Industry and Innovation Program.
31. Prioritise grant funding under our $70 million hydrogen hub initiative for projects including heavy transport applications and refuelling stations that can support the rollout of a hydrogen refuelling network.
32. Implement a zero emissions transition strategy for the NSW Government's fleet of 8,000 buses, which identifies opportunities for hydrogen buses in our zero emissions fleet transition that can support hydrogen industry development.
33. Complete feasibility, trials and proof of concept testing of NSW Government hydrogen buses, trucks and trains and establish models for large-scale deployment and fleet transition to achieve our 20% heavy vehicle target by 2030. This includes a feasibility study on trialling a hydrogen train on the NSW train network to improve understanding of hydrogen fuel for rail and assessing what is required for a trial in terms of infrastructure, standards and accreditation.
34. Identify and make any necessary updates to NSW legislation and regulations relevant to the safe use and distribution of hydrogen in transport applications at scale. This includes the Dangerous Goods Act (Road and Rail) Act 2008, Heavy Vehicle (*Adoption of National Law Act) Act 2013* and *Transport Administration Act 1988*.
35. Review and, if needed, develop planning pathways and appropriate assessment criteria in the planning system to ensure the rapid and safe roll out of small-scale hydrogen distribution and storage at refuelling stations.
36. Publish a NSW refuelling network map with existing refuelling stations, including modelling results for station deployment staging based on freight and logistics traffic volumes.
37. Investigate possible incentive structures to encourage the uptake of hydrogen vehicles.
38. Advocate for national vehicle standards that permit efficient access to cost-effective supply chains.
39. Develop and implement NSW Government heavy transport sector market engagement and advocacy plan to build awareness, improve access to hydrogen vehicles from Original Equipment Manufacturers (OEMs) and help drive demand and scaling through to 2030.

Industry

40. Work with our major industrial facilities to develop decarbonisation pathways including transformative large-scale long-term green hydrogen projects. These projects will act as anchor offtakes to drive scale and deliver hydrogen cost reductions that will flow through to other potential consumers. Funding support for these projects will be eligible under the $380 million High Emitting Industries focus area of our Net Zero Industry and Innovation program.

41. Prioritise grant funding under our hydrogen hub initiative for projects using green hydrogen at scale in industrial applications, within either existing industrial facilities or in greenfield projects.

42. Provide grant funding for engineering, feasibility and policy studies to switch existing processes in steel manufacturing to hydrogen. We will consolidate findings from these studies to develop pathways and future NSW Government policy support for green steel.

43. Conduct a green ammonia market study in partnership with industry to inform investment in new ammonia production plants.

44. Investigate options for government procurement of green steel.

Gas Network

45. Fund a 100% hydrogen reticulation gas pipeline in the Wagga Wagga Special Activation Precinct through the $4.2 billion Snowy Hydro Legacy Fund.

46. Enable hydrogen gas network blending projects to apply for funding support under our hydrogen hub initiative.

47. Review and make any necessary amendments to NSW legislation to enable the safe use of hydrogen in the gas network, including the:

    a. *Gas Supply Act 1996, Gas Supply (Safety and Network Management) Regulation 2013* and *Gas Supply (Natural Gas Retail) Regulation 2014*
    b. *National Gas (New South Wales) Act 2008 and National Gas (NSW) Law*
    c. *Pipelines Act 1967 and Pipelines Regulation 2013*
    d. *Gas and Electricity (Consumer Safety) Act 2017* and *Gas and Electricity (Consumer Safety) Regulation 2018.*

48. Contribute to the National Hydrogen Project Team's gas blending work program. This will include a review of legislation, determining the maximum blending limit for hydrogen and developing a hydrogen certification scheme.

49. Investigate opportunities for trialling a 10% hydrogen gas blend in regional towns or islanded networks.

50. Provide financial support to research and industry organisations investigating safety, standards, injection requirements and economics of hydrogen blending in the gas network.

51. Provide financial support to GreenPower to include hydrogen in its Renewable Gas Certification pilot and integrate with other hydrogen certification trials, enabling consumers to drive demand for hydrogen by voluntarily purchasing green gases.

Export

52. Facilitate and fund port infrastructure assessments and the necessary studies for timely and considered planning determination of export projects to streamline activities and investment decisions for international trade consortiums.

53. Market NSW as a location for hydrogen export investment and engage with potential domestic and offshore trade and investment partners to establish international bilateral trade agreements and large scale export capabilities.

54. Provide access to grant funding for world leading research and development and novel hydrogen technology projects across the supply chain that grow intellectual property assets.

Electricity

55. Provide funding support for the Tallawarra B power plant to use 200,000 kg of green hydrogen per year from 2025 and support development of the Illawarra hydrogen hub.

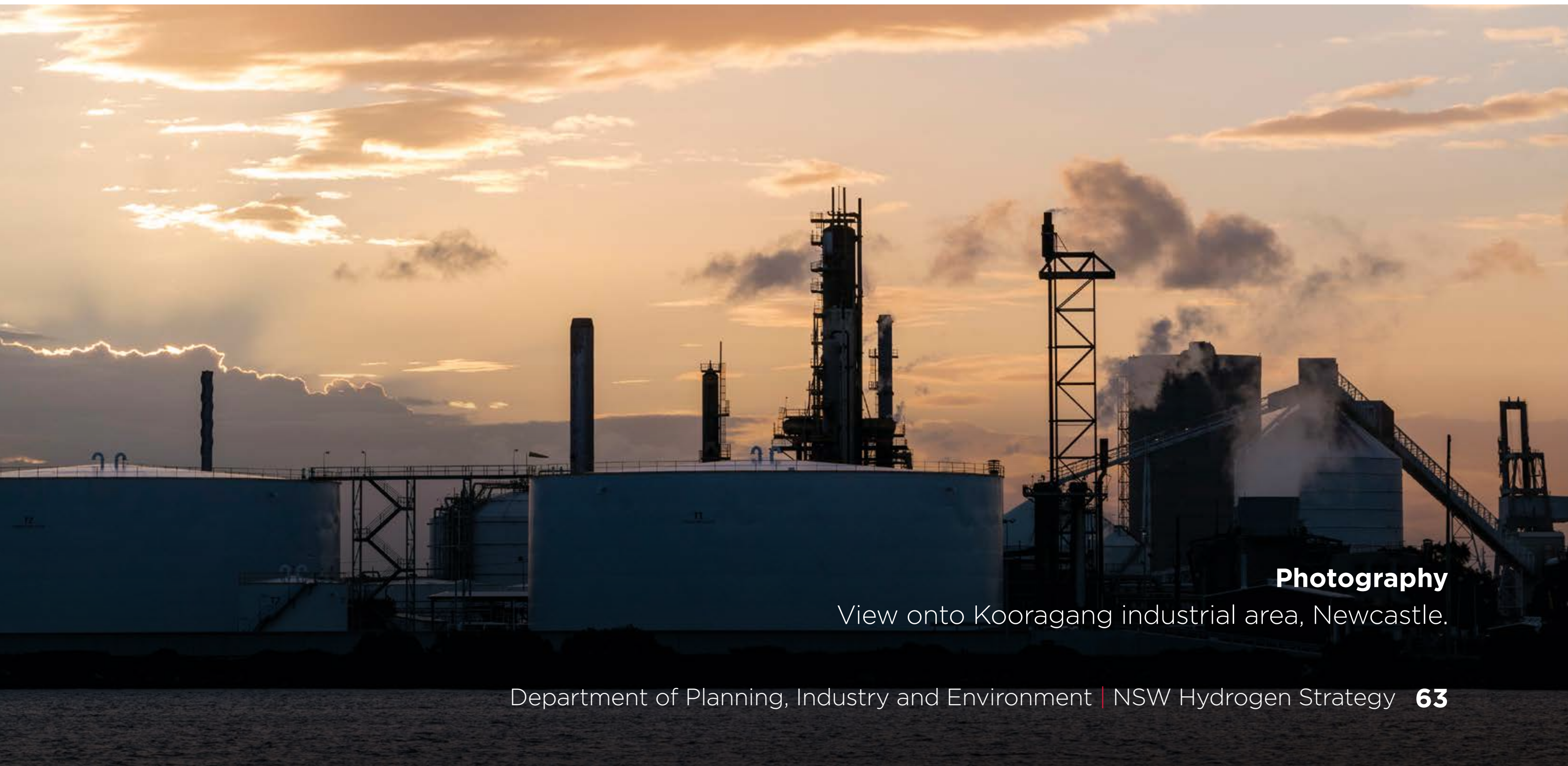
56. Enable innovative hydrogen storage and stationary energy deployment projects in regional NSW to apply for grant funding under our $750 million Net Zero Industry and Innovation Program.

57. Progress state-based regulatory reforms to enable operation of standalone power systems within NSW distribution networks and investigate opportunities for hydrogen energy storage with Distribution Network Service Providers.

58. Investigate opportunities for hydrogen energy storage and backup power generation in government owned assets.

59. Share knowledge and data from hydrogen hub deployment projects with National Electricity Market (NEM) regulators to support integration of electrolysers for flexible load management and frequency control services within existing and emerging markets under the NEM.

60. Incorporate impact of large-scale hydrogen production and use into planning and development of the NSW Renewable Energy Zones.



Photography
View onto Kooragang industrial area, Newcastle.

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