



Government of
South Australia

South Australia's Hydrogen Action Plan

South Australia has the wind, sun,
land, infrastructure and skills to be a
world-class renewable hydrogen supplier.



www.hydrogen.sa.gov.au

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Our vision is a future in which hydrogen provides **economic benefits** to Australia through export revenue and new **industries and jobs**, supports the transition to **low emissions** energy across electricity, heating, transport and industry, improves **energy system resilience** and increases **consumer choice**.

Dr Alan Finkel
Australia's Chief Scientist
Briefing paper: *Hydrogen for Australia's Future*
Presented to COAG Energy Council in August 2018

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Front cover image: Starfish Hill Wind Farm, South Australia's first wind farm built in 2003 near Cape Jervis on the tip of the Fleurieu Peninsula



Foreword



South Australia is ideally suited to seize the huge opportunities created by the emerging global market for hydrogen and its many applications for energy generation, storage and transport.

Hydrogen allows the world to rethink ways to generate and store energy, power transport fleets and heat homes. Hydrogen fuel cells can power trains, trucks and buses to replace diesel as a fuel and hydrogen can supplement and replace natural gas in domestic gas networks that warm our homes and cook our meals.

The Council of Australian Governments Energy Council's National Hydrogen Strategy Working Group has already identified hydrogen as Australia's next multi-billion export opportunity. Modelling for the Australian Renewable Energy Agency has forecast Australian hydrogen exports could contribute \$1.7 billion and 2,800 jobs to the national economy by 2030. Our aim is to position South Australia to attract a substantial share of that potential economic activity.

With more than 50 per cent of the State's energy mix generated through renewable sources, new interconnection and storage technologies such as hydrogen will support South Australia to become a net 100 per cent renewable energy generator during the 2030s. We can then capture significant economic benefits from renewable energy exports.

With more than \$7 billion attracted in clean energy generation and storage, international investors already regard South Australia as an attractive investment destination. Through the production of renewable hydrogen, South Australia can help meet the world's energy demands while reducing emissions at home and abroad.

The hydrogen economy is a further step in the transition of South Australia's energy system as we integrate renewable energy into the grid to deliver more affordable, reliable and cleaner energy while also creating more jobs and investment in South Australia.

Hydrogen production presents additional benefits for regional South Australian communities, where projects are likely to be based.

Our expectation is that during the 2030s, South Australia will generate more clean power than required for local use, setting us up to become a national and global force in clean energy.

Now is the time to step up the development of a hydrogen economy. While South Australia is not alone in setting its sights on developing a hydrogen economy, the State has a first mover advantage.

We believe we can deliver green hydrogen to our trading partners to meet their ambitious plans. We are already working with the Commonwealth and all State and Territory Governments to develop a National Hydrogen Strategy for 2020-2030. This Hydrogen Action Plan will help South Australia be a supplier of choice for green hydrogen in Australia.

The Hydrogen Action Plan also aligns with the Marshall Liberal Government's Growth State Plan, which aims to sustain the State's annual economic growth rate at 3 per cent.

Our new trade offices in North East Asia, China and the United States and our long-standing Agent-General's office in the United Kingdom provide platforms to promote our hydrogen capabilities to international markets and facilitate trade and investment partnerships.

Beginning with Australia's largest electrolyser coming online in 2020 in metropolitan Adelaide, we are determined to unlock South Australia's renewable hydrogen potential.

Hon Steven Marshall MP

Premier of South Australia

Hon Dan van Holst Pellekaan MP

Minister for Energy and Mining
Government of South Australia



South Australia has a proud record as 'the State of Science'.

Research and education institutions across the state deliver world class STEM (Science, Technology, Engineering and Maths) education, research and innovation and work collaboratively with industry sectors and government agencies to translate innovation to deliver 'new to the world' products, processes and services.

South Australia has been at the forefront of energy innovation that has fuelled a remarkable increase in renewable energy generation to over 50% of total energy generation in the state.

South Australia's successful implementation of the world's largest lithium-ion battery and autonomous vehicle trials at the Tonsley Innovation District are recent examples that showcase the capacity of industry to harness innovation to drive the development of a STEM-enabled future workforce and deliver economic impact.

Innovation and Translation Neighbourhoods such as those at Tonsley, Mawson Lakes and Lot Fourteen in the heart of Adelaide represent sites where industry leaders can also access key information on the role of frontier technologies, such as machine learning, quantum communication, automation, sensors and new materials. Access to this information supports future-focussed industry sectors to be resilient and compete in changing world markets.

These Neighbourhoods are also 'sticky for talent', attracting global innovators and are where the next generation of innovation leaders work to solve industry problems to provide a leading edge for business partners. Against this backdrop, South Australia is positioned as an international leader for the development of renewable or 'green' hydrogen production to underpin a hydrogen economy built on domestic use and a significant global export potential

Professor Caroline McMillen

Chief Scientist of South Australia

South Australia has an opportunity to progress the development of renewable hydrogen projects at scale to meet the significant future hydrogen export requirement, in particular to the Asia-Pacific region.

With hydrogen production technologies from renewable energy and water already proven, the focus is now on achieving significant cost reduction through production at scale within a comprehensive regulatory framework. South Australia is well positioned for this next stage.

This will need close national and international engagement across the spectrum of renewable hydrogen activities. Once implemented, the actions outlined in this Plan will enable South Australia to become a national and global force in emission reduction as part of a global clean energy transition.

South Australia was the first Australian jurisdiction to work with industry to develop a plan to accelerate the transition to a hydrogen economy through the release of the Hydrogen Roadmap for South Australia in 2017.

Subsequent to this, the State provided support for four renewable hydrogen projects. The first of these projects will be in production in mid-2020, delivering a blend of hydrogen and natural gas to a local residential community in metropolitan Adelaide – an Australian first for its scale and nature.

This Action Plan is a major milestone for the continued development of a significant, clean, safe and economically beneficial hydrogen value chain in South Australia

Terry Burgess

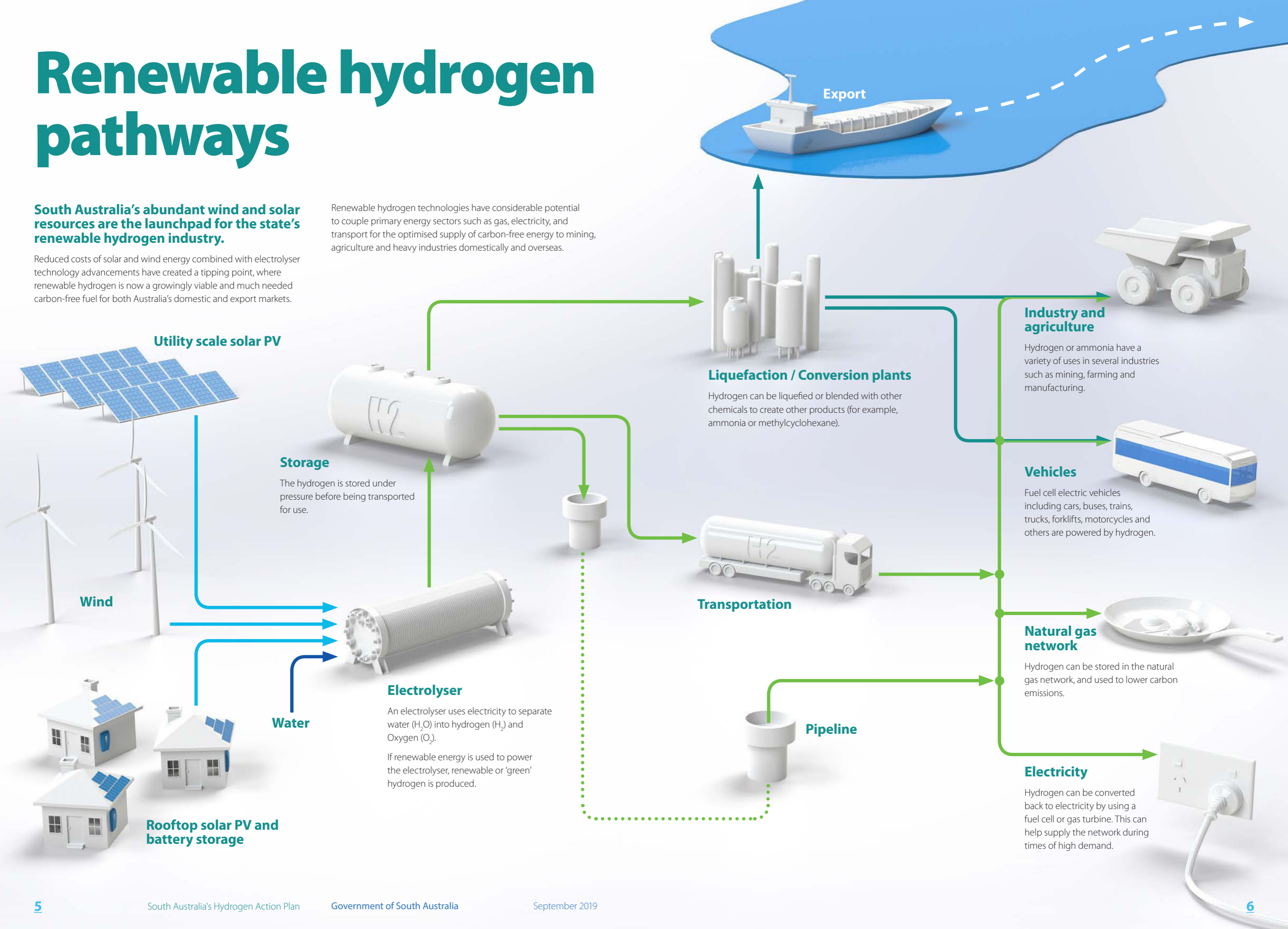
Co-chair, South Australian Government's
Hydrogen Economy Steering Committee

Renewable hydrogen pathways

South Australia's abundant wind and solar resources are the launchpad for the state's renewable hydrogen industry.

Reduced costs of solar and wind energy combined with electrolyser technology advancements have created a tipping point, where renewable hydrogen is now a growingly viable and much needed carbon-free fuel for both Australia's domestic and export markets.

Renewable hydrogen technologies have considerable potential to couple primary energy sectors such as gas, electricity, and transport for the optimised supply of carbon-free energy to mining, agriculture and heavy industries domestically and overseas.



Utility scale solar PV



Wind



Rooftop solar PV and battery storage



Storage

The hydrogen is stored under pressure before being transported for use.



Water



Electrolyser

An electrolyser uses electricity to separate water (H₂O) into hydrogen (H₂) and Oxygen (O₂).

If renewable energy is used to power the electrolyser, renewable or 'green' hydrogen is produced.

Liquefaction / Conversion plants

Hydrogen can be liquefied or blended with other chemicals to create other products (for example, ammonia or methylcyclohexane).



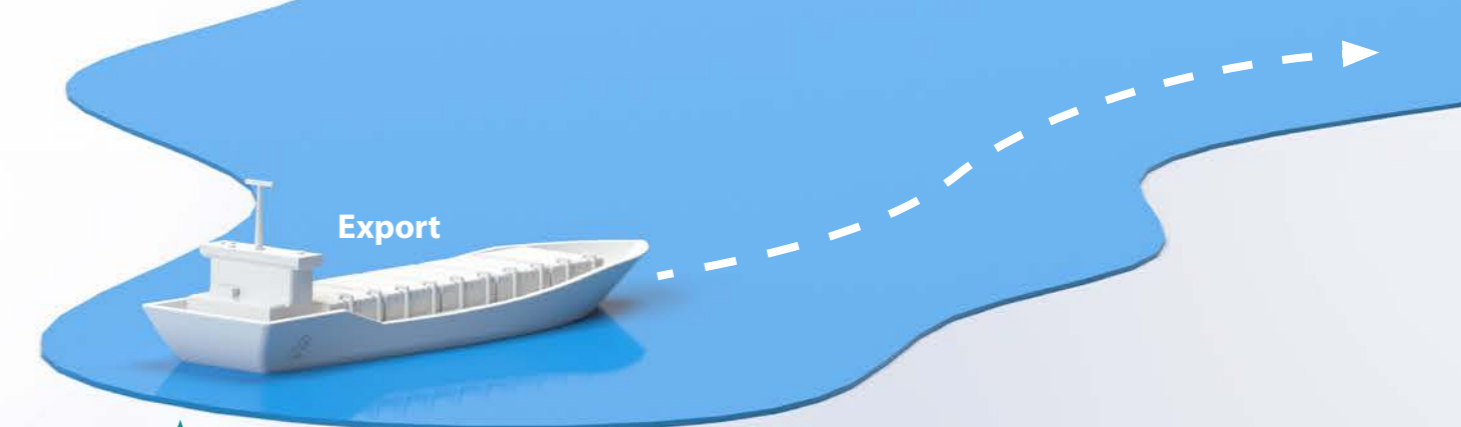
Transportation



Pipeline



Export



Industry and agriculture

Hydrogen or ammonia have a variety of uses in several industries such as mining, farming and manufacturing.



Vehicles

Fuel cell electric vehicles including cars, buses, trains, trucks, forklifts, motorcycles and others are powered by hydrogen.



Natural gas network

Hydrogen can be stored in the natural gas network, and used to lower carbon emissions.



Electricity

Hydrogen can be converted back to electricity by using a fuel cell or gas turbine. This can help supply the network during times of high demand.



South Australia's renewable hydrogen potential

South Australia is Australia's leading mainland state for renewable energy.

By 2025, it is predicted that 90 per cent of the state's electricity could be generated from renewable sources based on Australian Energy Market Operator (AEMO) data.

South Australia is almost 1 million square kilometres, four times larger than the United Kingdom, with expansive areas available for renewable energy generation projects.

South Australia can harness its renewable energy to produce renewable hydrogen, and the Government of South Australia is currently working with investors to realise the State's first suite of pilot and demonstration renewable hydrogen production projects.

The map on the right shows areas of South Australia with optimal conditions for wind, solar and co-located wind and solar generation – ideal for achieving high utilisation rates for electrolyzers powered entirely by low-cost renewable electricity.



South Australia currently has...



1 in 3 homes with rooftop solar

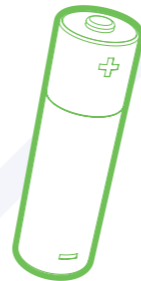


Over \$7bn invested in renewable energy with over \$20bn in the pipeline

A world class regulatory regime

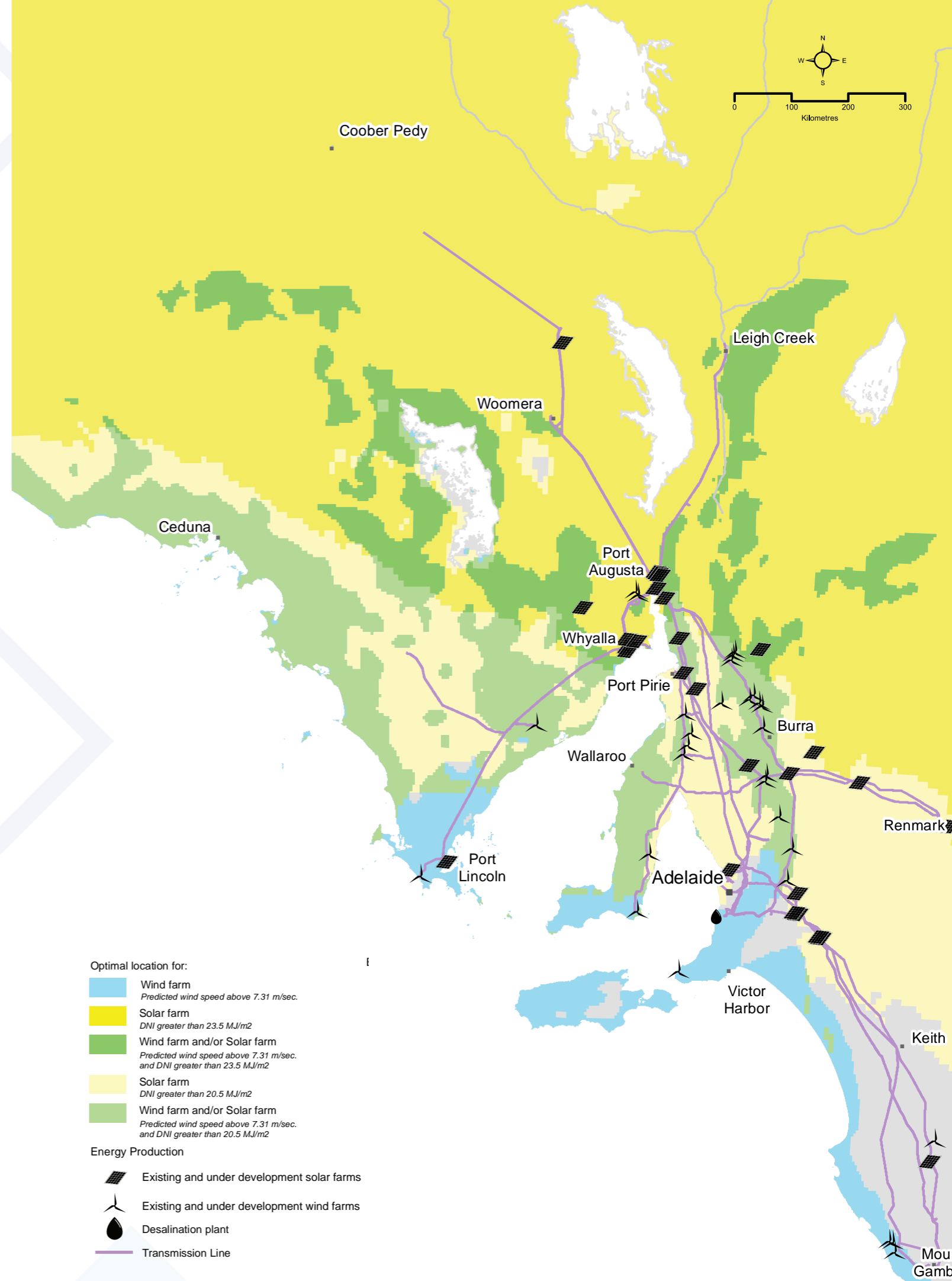
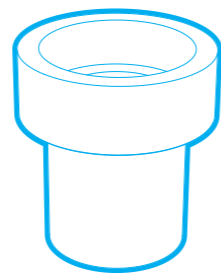


The worlds biggest lithium-ion battery



22 large scale wind farms currently operating

14 GW of renewable energy generation and storage projects in the pipeline



South Australia's hydrogen story so far...

June 2019
Hydrogen in gas networks report
 Government of South Australia initiates kick-start report on 10% hydrogen in domestic gas networks for input to final National Hydrogen Strategy.

December 2018
COAG Energy Council supports development of a National Hydrogen Strategy
 Energy ministers from all Australian jurisdictions accept a proposal from Australia's Chief Scientist Dr Alan Finkel to develop a National Hydrogen Strategy for 2020-2030.

November 2018
Hydrogen Research and Development in South Australia report released
 Identifying existing hydrogen research and development capabilities opportunities.

February 2018
More than \$17 million in grants and over \$25 million in loans committed to renewable hydrogen projects
 Government of South Australia commits funding to 4 hydrogen projects.

May 2017
Government of South Australia hosts hydrogen roundtable
 More than 100 stakeholders convene as part of the development of a South Australian hydrogen strategy.

December 2016
Adelaide hydrogen vehicle showcase
 Hyundai and Toyota showcase hydrogen vehicles in Adelaide CBD for leaders and the public.

April 2018
Government of South Australia joins Future Fuels Cooperative Research Centre (CRC)
 A \$90m industry-focussed research, design and development partnership supporting Australia's transition to a low carbon energy future.

August 2018
CSIRO National Hydrogen Roadmap released
 Co-sponsored by the Government of South Australia.

September 2017
Hydrogen Roadmap for South Australia released
 South Australia is the first Australian state to publish a hydrogen strategy.
South Australian Green Hydrogen Study released
 Commissioned by the Government of South Australia, the study identifies the cost and feasibility of producing renewable hydrogen in SA.
Government of South Australia attendance at the 2017 International Conference on Hydrogen Safety in Hamburg
 Adelaide announced as the host city for 2019.

July 2019
The Government of South Australia joins Green Ammonia Consortium
 An independent association under Japanese law with membership open to global entities with an interest in green (renewable) ammonia.

September 2019
International Conference on Hydrogen Safety 2019 held in Adelaide
 The International Association for Hydrogen Safety (HySafe) and the Government of South Australia host the 8th conference.
South Australian Hydrogen Export Modelling Tool announced
 Commencement of a landmark study of existing and potential infrastructure required for an international scale renewable hydrogen export value chain.



Renewable hydrogen export opportunities for South Australia

Nations, regions and industries are looking to hydrogen technologies to achieve deep cuts in carbon emissions over the coming decades.

Hydrogen can also address poor air quality, energy security, and provide energy for power generation and transportation.

Many of Australia's key trading partners in Asia have, or are developing, national strategies to advance the hydrogen economy, including clear targets and goals for the importation and use of hydrogen.

South Australia is actively exploring the supply of renewable hydrogen to these emerging hydrogen export markets, as well as its use by domestic primary energy industries.

South Australia believes that we can deliver green hydrogen to trading partners in line with their ambitious plans.

Republic of Korea

The *Hydrogen Economy Roadmap of Korea* is formalised by its Hydrogen Economy Act, outlining Korea's vision to lead a hydrogen-based economy. The strategy has various timeframes for its targets and goals, generally referencing 2022 and 2040. Core elements of the plan include:

- Building a hydrogen production and distribution system, using 70 per cent carbon-free hydrogen and reducing greenhouse gas emissions by 27 million tonnes by 2040.
- Increasing production and use of hydrogen fuel cell electric vehicles, including 6.2 million passenger vehicles, 40,000 buses and 1,200 refuelling stations by 2040.
- Increasing production and use of fuel cells for power generation, including a targeted 15GW for power generation and 2.1 GW for households by 2040.

China

China's *Hydrogen Fuel Cell Vehicle Technology Roadmap* is focused on establishing fuel cell vehicle technology at scale to enable widespread domestic production and use by 2030.

With timeframes for milestone objectives set for 2020, 2025 and 2030, highlights of the Roadmap include:

- Increased use of hydrogen derived from clean energies to more than 50 per cent by 2030.
- Commercial deployment of more than one million passenger and commercial vehicles by 2030.
- Technological progress in fuel cell systems, key materials and components including a near 90 per cent reduction by 2025 in fuel cell stack costs compared to 2015 prices.

Japan

Japan's *Basic Hydrogen Strategy* affirms its commitment to becoming "the first country in the world to realise a hydrogen-based society". Targets under the strategy identify short, medium and long-term goals and actions, with a view towards major achievement by 2050. Areas of focus under the Basic Hydrogen Strategy include:

- Increasing hydrogen's use in Japan from 200 tonnes to 300,000 tonnes a year in 2030, targeting carbon-free hydrogen use as part of its future picture.
- Developing international hydrogen supply chains including Australia, such as the development and demonstration of a liquefied hydrogen supply chain by the mid-2020's.
- Targeting the use of fuel cell electric vehicles including 800,000 passenger cars, 12,000 buses and 10,000 forklifts by 2030.

Singapore

In the first quarter of 2019, the Singapore Prime Minister's Office issued a tender for a consultancy study on the potential for hydrogen imports and downstream applications for Singapore.

Singapore is particularly interested in replacing liquefied natural gas for fuelling its power plants with alternatives such as hydrogen to eliminate 60 per cent of its emissions.



Hydrogen projects in South Australia

Port Lincoln Hydrogen and Ammonia Supply Chain Demonstrator



"South Australia is at the forefront of both renewable generation and hydrogen infrastructure developments and we are very pleased to be able to develop our project in this important market"

- Dr Attilio Pigneri, CEO H2U

The Hydrogen Utility™ (H2U) is a specialist developer of hydrogen infrastructure solutions for sustainable mobility and renewable energy storage applications.

H2U is developing a facility integrating more than 30 MW in water electrolysis and distributed ammonia production, near Port Lincoln in South Australia. The South Australian Government has provided \$4.7 million through a grant and additional loan funding to deliver the \$117.5 million project.

The plant will use 100 per cent wind and solar generation to produce up to 18,000 tonnes of green ammonia a year to supply the local agriculture and industry sectors. This is a globally significant demonstration project for the emerging hydrogen energy sector, being one of the first-ever commercial plants to produce carbon dioxide (CO₂)-free green ammonia from intermittent renewable resources, and to demonstrate the adoption of green hydrogen across multiple value chains.

The plant will also feature two 16 MW open-cycle gas turbines operating 100 per cent on hydrogen at the site to provide electricity

generation to the grid during periods of low wind or solar output. The project has capacity to provide a truly self-contained solution to firming renewable energy supply within the South Australia grid.

Considered one of the most prospective chemical carriers of hydrogen, green ammonia - a chemical compound of nitrogen and renewable hydrogen - is also a potential fuel for large-scale power stations, making it an attractive export opportunity.

Along with the Government of South Australia, H2U joined Japan's Green Ammonia Consortium in July 2019. The consortium comprises of more than 70 companies and institutions, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Australian Trade and Investment Commission.

In August 2019, H2U executed an agreement with Australian iron ore mining and exploration company Iron Road Limited to collectively develop a commercialisation pathway for a multi-user, multi-commodity deep water port at the proposed 1,100 hectare site (pictured below).

Hydrogen Superhub at Crystal Brook Energy Park

Neoen Australia is an Independent Power Producer specialising in renewable energy projects across multiple technologies including solar, wind and storage.

With more than 1 GW of assets under operation or construction in the country, Neoen is the owner and manager of the world's largest lithium ion battery located in South Australia, which uses Tesla Powerpacks to store up to 100 MW/129 MWh of energy.

The Crystal Brook Energy Park development is a \$500 million renewable energy project that combines storage, solar and wind, located about 3 kilometres north of Crystal Brook in South Australia's Mid-North. The park is a 275 MW renewable energy facility with up to 125 MW of wind generation comprising 26 turbines, 150 MW of solar PV and 130 MW/400 MWh of battery storage with a purpose built sub-station to deliver the power back into the South Australian grid.

"The Crystal Brook Energy Park in South Australia aims to change the role of renewables, from just providing power when available to providing firm power 24-hours a day. This is essential for long-term sustainability and it will be the first of its kind to offer that type of power service in Australia."

"The introduction of hydrogen as part of a next generation of clean energy storage technologies is highly prospective for South Australia's renewable energy industry."

- Garth Heron, Head of Development, Neoen Australia

The South Australian Government provided Development Approval to the Crystal Brook Energy Park in mid-2019, with construction aimed to begin in the second half of 2020.

The Crystal Brook Energy Park development aims to change the role of renewables from just providing power when available to providing firm power 24-hours a day. This is essential for long-term sustainability and it will be the first of its kind to offer this type of power service in Australia.

The South Australian Government has awarded a \$1 million grant to Neoen to conduct a study on the technical and economic feasibility of a hydrogen production facility at the Crystal Brook Energy Park. The proposed 50 MW Hydrogen Superhub would be the largest co-located wind, solar, battery and hydrogen production facility in the world, with the potential to produce about 25,000 kilograms of hydrogen a day using 100 per cent renewable energy.

NEOEN

Having completed the first stage of its feasibility study in late 2018, discussions are underway to optimise the hydrogen production facility, including through hydrogen production at the Crystal Brook Energy Park site or alternatively to construct a direct transmission line to a nearby port for potential export.

The Hydrogen Superhub has significant potential as a world-scale project that can produce large quantities of renewable hydrogen at a competitive price. At the time of awarding funds to Neoen for the feasibility study, the South Australian Government also committed to provide a further \$4 million grant and \$20 million in loans should the project proceed to financial close and construction.



Artist's impression for Iron Road's Cape Hardy Stage 2 Capesize Port. Image courtesy of Iron Road.



The Hornsdale Power Reserve developed and owned by Neoen, built by Tesla at Neoen's 309MW Hornsdale Wind Farm in South Australia

Hydrogen Park South Australia

Adelaide-based Australian Gas Networks (AGN), part of the Australian Gas Infrastructure Group (AGIG), owns gas distribution assets across Australia, including in South Australia.

Hydrogen Park South Australia (HyP SA) is an \$11.4 million demonstration project delivered and funded by AGN, supported by a \$4.9 million grant from the South Australian Government. The proposed facility comprises a 1.25 MW Siemens proton exchange membrane electrolyser, the largest of its kind installed in Australia.

Based at the Tonsley Innovation District in metropolitan Adelaide, HyP SA removes carbon from our gas supply as South Australia advances towards net-zero emissions by 2050. From mid-2020, for an initial period of five years, AGN will produce renewable hydrogen using renewable electricity¹ and water.

AGN will supply more than 700 properties in the nearby suburb of Mitchell Park with a blend of 5 per cent renewable hydrogen in natural gas, delivered through the existing gas network. Customers receiving the 5 per cent renewable gas blend will not notice any difference about the quality of gas received and are not required to make any change to their appliances. The amount paid for gas will be no different from the cost of 100 per cent natural gas.

The project will demonstrate the feasibility of blending hydrogen into the South Australian gas network and inform the South Australian Government's planning to transition the gas

distribution network. It will also show how integrating electrolysers into the electricity networks can support energy stability, as more renewable electricity generation capacity comes onto the grid.

Having completed the front-end engineering and design study and ordered the electrolyser, AGN is now working towards securing regulatory and development approvals and procuring land. Community and stakeholder consultation on the project began in July 2019.

HyP SA is considering installation of tube-trailer filling facilities as an expansion opportunity that will enable the transport of hydrogen so it can be blended into other points in the network, as well as hydrogen vehicle refuelling, industrial use and potentially export.

HyP SA is AGN's first step to lowering carbon emissions and is part of its broader aim to blend up to 10 per cent renewable hydrogen in South Australia and across the other regions AGN serve, before consideration of 100 per cent hydrogen conversion.

AGN is also actively working with Australian Governments, including the South Australian Government and industry, to establish the Australian Hydrogen Centre, that will externalise learnings from HyP SA and deliver feasibility studies related to increased hydrogen blending, and 100 per cent hydrogen conversion on Australian towns, cities and states.



Fabrication of Hydrogen Buffer Storage Vessel for the Hydrogen Park South Australia Project at Pipetech in Adelaide



1. AGN will purchase (and voluntarily surrender) large-scale Generation Certificates to offset the amount of electricity used and ensure the hydrogen produced is renewable.

Artist's impression of Hydrogen Park South Australia, a 1.25MW electrolyser, blending equipment and tube and trailer facility.



"We are delighted that South Australia will lead the way with this technology. Hydrogen Park SA provides an opportunity to develop an Australian-first integrated hydrogen project that paves the way for the commercial deployment of a hydrogen economy."

"And importantly, it propels South Australia's status as a leader in renewable technology and a first mover in hydrogen"

- Ben Wilson, Chief Executive Officer, Australian Gas Networks



University of South Australia's Renewable Energy Testbed



University of
South Australia

UniSA's Mawson Lakes campus will be transformed into a national testbed of renewable energy technologies through an \$8.7 million project to incorporate solar power, flow batteries, a hydrogen fuel cell stack and thermal energy storage.

The project – supported by a \$3.6 million grant from the South Australian Government – aims to produce data to support multi-disciplinary research projects (such as optimising performance, economics, and energy and emissions) in hydrogen, battery storage and solar technologies. Energy produced will supplement campus needs especially at periods of peak demand.

The project is at the forefront of UniSA's strategy to reduce its carbon footprint and embrace renewable energy technologies. The campus underlined its green credentials in

2015, launching the Research Node for Low Carbon Living, the State's premier hub for multidisciplinary, industry-driven research, exploring low carbon solutions.

The facility will feature solar panels on 18 buildings at Mawson Lakes, one hectare of ground-mounted solar panels, and thermal energy storage. Once completed in 2020, it will increase the availability of carbon-free renewable energy, reducing pressure on the local electricity network.

By partnering with Australian renewable energy companies, UniSA expects the facility to provide more than 250 MWh of electrical storage annually, reducing the peak electrical load by 43 per cent, cutting its emissions by 35 per cent and making renewable energy available on demand.

UniSA expects the project to achieve annual energy savings of about \$470,000.

"South Australia is already leading the world in the transition to renewable energy. This project will enhance that reputation and also show other organisations how they can move towards energy independence and contribute to a carbon neutral future."

- Professor David Lloyd, UniSA Vice Chancellor

"It will bring a host of new jobs and investment opportunities to the State as well as inspiring and developing the next generation of renewable energy professionals."

- Dr Stephen Berry, Renewable Energy and Decarbonisation Manager, UniSA

Solar PV array for University of South Australia's Renewable Energy System at its Mawson Lakes campus.

Australia's National Hydrogen Strategy

At the December 2018 Council of Australian Governments (COAG) Energy Council meeting, Energy Ministers from all Australian jurisdictions accepted a proposal from Australia's Chief Scientist Dr Alan Finkel to develop a National Hydrogen Strategy for 2020-2030.

South Australia is represented on the COAG Energy Council by The Honourable Dan van Holst Pellekaan MP, Minister for Energy and Mining.

South Australia is contributing to the development of a National Hydrogen Strategy with representatives across all work streams, and leading a Kick-start Project on blending up to 10 per cent hydrogen with natural gas in domestic gas networks.

Australia's National Hydrogen Strategy is scheduled to be presented to Energy Ministers for approval in December 2019.

South Australia's Hydrogen Action Plan will be the primary mechanism through which South Australia contributes to the implementation of a future National Hydrogen Strategy, with a focus on being a supplier-of-choice for certified renewable hydrogen.

"I am confident that Australia can play a part in the development of hydrogen as a fuel source that can contribute to the reduction of global greenhouse gas emissions."

Ideally, we need to plan and start now."

— Dr Alan Finkel
Australia's Chief Scientist
Unlocking the hydrogen future, Committee for the Economic Development of Australia, August 2019



South Australia's Hydrogen Action Plan

Vision:

South Australia leverages its wind, sun, land, infrastructure and skills to be a world-class renewable hydrogen supplier.

Objective:

Scale-up renewable hydrogen production for export and domestic consumption

Implementation

Key performance indicators to be monitored by the Hydrogen Economy Steering Committee:

- Annual volume of hydrogen produced in SA
- Annual volume of hydrogen exported overseas from SA
- Cumulative capital investment in hydrogen infrastructure
- Construction and ongoing jobs created



Facilitate investments in hydrogen infrastructure

Springboard from first renewable hydrogen production in 2020 towards a hydrogen economy

Actions:

- Deliver the South Australian Hydrogen Export Modelling Tool to inform the establishment of renewable hydrogen export supply chains
- Facilitate the development of hydrogen infrastructure projects in South Australia
- Develop a plan for the cost-effective application of hydrogen in domestic primary energy sectors
- Incorporate hydrogen into long-term infrastructure planning



Establish a world class regulatory framework

Deliver global best-practice hydrogen regulations that are simple and efficient, building community and investor confidence

Actions:

- Efficient, effective regulations supported by Hydrogen Regulatory Working Group
- Certification for South Australian renewable hydrogen
- Advocating for internationally harmonised codes and standards
- Educating the South Australian community and industry on hydrogen technologies for the future



Deepen trade relationships and supply capabilities

Establish robust relationships and value chains to supply renewable hydrogen to new and emerging trade partners

Actions:

- Promote renewable hydrogen through its global network of trade and investment offices
- Support inbound and outbound trade and investment missions
- Engage with international hydrogen consortia
- Facilitate hydrogen-related foreign direct investment, business migration and business expansion



Foster innovation and workforce skills development

Accelerate hydrogen innovation based on solid academic research and industry partnerships, and ensure South Australia has the workforce skills, capability and capacity to deliver

Actions:

- Leverage current and future hydrogen projects for training and innovation
- Skilling South Australia to support the expansion of new industries and a hydrogen economy
- Support and participate in Future Fuels Cooperative Research Centre
- Support and participate in the Australian Hydrogen Centre



Integrate hydrogen into our energy system

Understanding the value of hydrogen in our decarbonised energy system

Actions:

- Secure wider energy system benefits of hydrogen-led sector coupling to our renewable energy
- Facilitate knowledge sharing from the first hydrogen projects integrated into South Australia's energy system
- Identify any changes that might be needed to the National Energy Market Framework to ensure the efficient integration of hydrogen into energy systems
- Investigate hydrogen production and use in remote areas of South Australia

Facilitate investments in hydrogen infrastructure

Action theme 1

Springboard from first renewable hydrogen production in 2020 towards a hydrogen economy

South Australia's key challenge in realising a hydrogen economy is scaling up large-scale renewable hydrogen production to export-capable volumes as part of a sustainable value chain.

While building up to export-scale production is a long-term proposition, South Australia will methodically capitalise on its comparative advantages and build upon its existing investments in renewable hydrogen production infrastructure.

This will start with Australia's largest electrolyser planned to be operational in metropolitan Adelaide in 2020.

From South Australia's first demonstration projects to building scale

The South Australian Government has co-invested more than \$17 million in grants and \$25 million in loans to four hydrogen production projects.

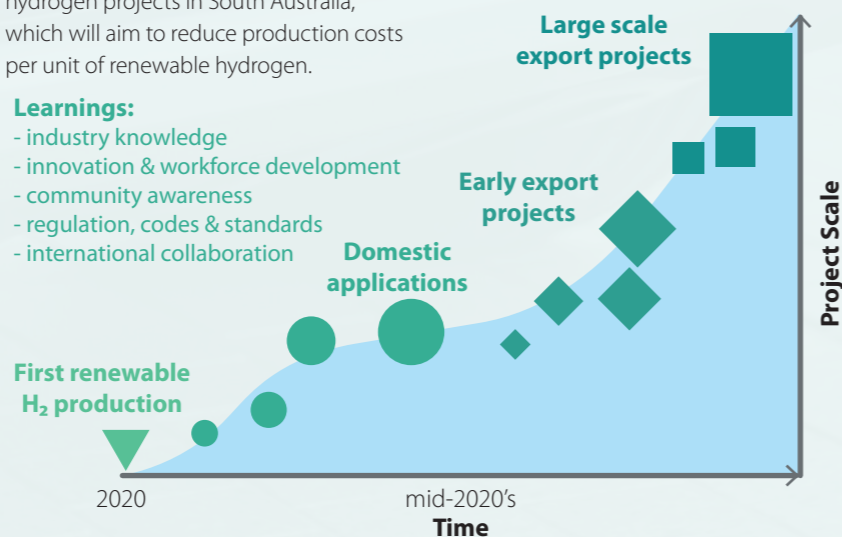
These projects will generate learnings for industry and regulators, grow community awareness and understanding, and develop workforce skills.

The projects are also key to establish South Australia as a credible supplier of renewable hydrogen supported by a local workforce in a real-life environment, and provide a platform for international collaboration in developing a renewable hydrogen value chain.

South Australia will leverage these projects to reduce investment risk in the next suite of large-scale renewable hydrogen projects in South Australia, which will aim to reduce production costs per unit of renewable hydrogen.

Learnings:

- industry knowledge
- innovation & workforce development
- community awareness
- regulation, codes & standards
- international collaboration



South Australia is on the move to facilitate investments in hydrogen infrastructure...

Deliver the South Australian Hydrogen Export Modelling Tool to inform the establishment of renewable hydrogen export supply chains

An interactive hydrogen map is available at www.hydrogen.sa.gov.au to enable international investors and project developers to identify ideal sites in South Australia for hydrogen infrastructure.

The South Australian Government will work with industry on a landmark study of existing and potential infrastructure required for an international-scale, renewable hydrogen-export value chain.

Its findings will be available across the worldwide network of South Australian trade and investment offices to inform key considerations such as locations for hydrogen production and conversion, volume of supply potential, and the landed cost of renewable hydrogen from South Australia.

Facilitate the development of hydrogen infrastructure projects in South Australia

The South Australian Government has co-invested more than \$17 million in grants and \$25 million in loans to four renewable hydrogen projects.

Led by the Department for Energy and Mining, the South Australian Government will continue to deepen its engagement with key hydrogen industry stakeholders and coordinate the State's efforts in scaling up its hydrogen industry.

Develop a plan for the cost-effective application of hydrogen in domestic primary energy sectors

The South Australian Government's existing renewable hydrogen pilots, projects and demonstrations are designed to build renewable hydrogen infrastructure, scale the domestic market, and help develop a substantial industry capable of export.

The South Australian Government is committed to identifying cost-effective applications for renewable hydrogen's wider use in gas networks, transportation and in industrial and remote applications; and developing a plan to guide investment in these areas. This will assist in achieving the state's aim of net zero emissions by 2050 by decarbonising other primary energy use.

Incorporate hydrogen into long-term infrastructure planning

Infrastructure SA is an independent agency responsible for framing *South Australia's 20-year Infrastructure Strategy*, which will inform a Capital Intentions Statement – a five-year rolling annual plan that will identify specific major projects to be undertaken as a priority.

Infrastructure SA has been engaged to consider hydrogen as part of its long-term infrastructure planning.

Adelaide hydrogen vehicle showcase in Victoria Square, Adelaide CBD



Establish a world-class regulatory framework



Action theme 2

Deliver global best-practice hydrogen regulations that are simple and efficient, building community and investor confidence

As one of the top regulatory regimes in the world for tight and shale gas, South Australia has a proven record of providing effective, transparent regulatory frameworks that facilitate economic growth.

The South Australian Government, through the Council of Australian Governments (COAG), works closely with other

Australian jurisdictions on regulatory standards and continues to contribute to the development of Australia's National Hydrogen Strategy for 2020-2030.

South Australia's regulatory expertise, close collaboration with the national and international hydrogen communities and our focus on safety provides a world-leading hydrogen regulatory regime designed to meet the needs of investors and the community.

International Association for Hydrogen Safety

The South Australian Government is a financial member of the International Association for Hydrogen Safety ("HySafe") and has developed close links with hydrogen safety experts operating across the world.

The 8th International Conference on Hydrogen Safety was held in Adelaide, South Australia in September 2019. The world's premier hydrogen-risk management event, the biennial conference provides an open platform for presenting and discussing new findings and information on hydrogen safety.



South Australia is on the move to establish a world-class regulatory framework...

Efficient, effective regulations supported by Hydrogen Regulatory Working Group

Ensuring our regulatory regime delivers outstanding levels of safety and trust, efficiently with clear and unambiguous objectives is essential for investors to enter the market with confidence.

The South Australian Government has established a cross-government agency Hydrogen Regulatory Working Group that includes first responders and all other workplace safety, environmental, planning and technical regulation authorities involved in the permitting of hydrogen facilities.

The Hydrogen Regulatory Working Group will continue to develop competency and awareness of hydrogen across government to ensure regulatory gaps are identified and addressed. It will continue to provide advice to proponents of hydrogen projects to ensure compliance with existing requirements.

Certification for South Australian renewable hydrogen

Renewable or 'green' hydrogen generally refers to hydrogen produced using electricity from renewable sources. This is distinct from 'brown' or 'grey' hydrogen, which generally means hydrogen produced using fossil fuels that emit carbon into the atmosphere.

Customers in both Australian and overseas markets seeking to reduce emissions recognise the difference between renewable and other forms of hydrogen. For South Australian renewable hydrogen to be attractive in these markets, it will be important for its origin to be guaranteed by a scheme that meets market requirements.

The South Australian Government will continue to work with Australian and international jurisdictions, including through the National Hydrogen Strategy, to develop an appropriate mechanism to guarantee the origin of South Australian hydrogen production for domestic use and export.

Advocating for internationally harmonised codes and standards

The South Australian Government will continue to maintain and further develop its strong international hydrogen network, including ongoing involvement in the International Association for Hydrogen Safety (HySafe), Centre for Hydrogen Safety (US) and other internationally respected organisations in the research and development of hydrogen technologies and its safe use.

Working in close collaboration with our international and national colleagues, we will advocate for best practice, harmonised codes and standards, making it simpler and more efficient for investors working across multiple locations and delivering consumer benefits.

Educating the South Australian community and industry on hydrogen technologies for the future

Public understanding and support for hydrogen is critical to its adoption and success. To help capture the value in the hydrogen economy, the South Australian Government will work proactively with the community and industry to increase knowledge and support for a growing green hydrogen industry.



Deepen trade relationships and supply capabilities

Action theme 3

Establish robust relationships and value chains to supply renewable hydrogen to new and emerging trade partners

By leading the nation in the uptake of renewable energy and pioneering grid-scale energy storage solutions, international companies have already begun to recognise South Australia as a destination for sustainable energy investment.

Hydrogen provides a further opportunity to build on the existing investment and the State's established record as a reliable supplier of commodities and adopter of new technologies.

Attracting investment and capturing a greater share of export markets is also the focus of the South Australian Growth Agenda led by the Department for Trade, Tourism and Investment.

New free trade agreements with our regional partners and the Commonwealth Government's commitment to developing a National Hydrogen Strategy also supports South Australia's aim of leveraging its advantages to open up new market opportunities.

South Australia is on the move to deepen its trade relationships and supply capabilities...

Promote renewable hydrogen through its global network of trade and investment offices

The South Australian Government is opening five new overseas trade and investment offices in strategic locations in China, northeast Asia, southeast Asia, the Middle East, and the United States of America to build on its existing overseas presence.

South Australia's trade office network will also work alongside the South Australian Agent General's Office in London and Austrade's global network to facilitate business connections and provide support to companies looking to enter international markets, and to overseas investors looking for opportunities in South Australia.

Support inbound and outbound trade and investment missions

The South Australian Government has increased support to attract major events and business conferences to Adelaide that provide a drawcard for overseas investors and buyers, for example the International Conference on Hydrogen Safety in Adelaide in September 2019.

The South Australian Government publishes an Annual Calendar of Inbound and Outbound Trade and Investment Missions that allows local companies to align their overseas engagement with target hydrogen markets.

Engage with international hydrogen consortia

South Australia is committed to engaging with international hydrogen consortia to share information and cooperate on the scale-up of the global hydrogen production and export industry.

South Australia's membership of the Green Ammonia Consortium of global entities with an interest in green (renewable) ammonia is an example of relationship building South Australia is pursuing.

Facilitate hydrogen-related foreign direct investment, business migration and business expansion

Securing overseas investment in new export-capable industries such as hydrogen will be a major contributor to achieving the South Australian Government's State Growth Plan of accelerating annual gross state product growth to 3 per cent.

The Department for Trade, Tourism and Investment is at the forefront of securing new investment in growth industries, and the hydrogen economy is one of the key export-oriented sectors that will contribute to meeting these State Growth Plan targets.

Expanding South Australia's modern industrial supply chain to offer the capability and workforce to support the multiple facets of a growing hydrogen economy, from the production of hydrogen (and other hydrogen derived products), to its storage, conversion (power-to-gas and gas-to-power) and its distribution, across both the energy and mobility sectors.

Bottom left: Representative Won-Wook Lee, member of Korean National Assembly, cooks on a Heatlie hydrogen barbecue during the H2Korea delegations visit to the Tonsley Innovation District, Adelaide

Bottom right: His Excellency the Governor Hieu Van Le AC, Minister for Trade, Tourism and Investment the Honourable David Ridgway MP and Commissioner, South Australia – Japan and Korea, Sally Townsend open the North East Asia Trade and Investment Office

South Australian hydrogen engagements in the Asia-Pacific

November 2018: Minister for Trade, Tourism and Investment the Hon. David Ridgway MP officially opened South Australia's new Shanghai Trade and Investment Office as the first of five strategic trade and investment offices.

February 2019: the Chief Executive of the Department for Energy and Mining Dr Paul Heithersay led a delegation of South Australian hydrogen industry representatives to the 2019 International Hydrogen and Fuel Cell Expo in Tokyo, Japan, as part of a "Team Australia" approach coordinated by Austrade.

March 2019: His Excellency the Governor the Honourable Hieu Van Le AC and Minister Ridgway participated in number of hydrogen meetings in Japan and the Republic of Korea as part of the North East Asia Trade Mission and Investment Office opening.

July 2019: Ms Sally Townsend, South Australia's Commissioner to Japan and Korea, represented South Australia at the inaugural meeting of the Green Ammonia Consortium in Tokyo. The Government of South Australia, Austrade and CSIRO have been invited to join as advisory members.

August 2019: an inbound delegation led by Representative Lee Won-Wook of Korean National Assembly and industry leaders visited Adelaide for meetings with South Australian industry and government, including lunch cooked over a locally-built barbecue fuelled by 100% hydrogen.

September 2019: an inbound delegation led by the University of Tokyo and comprising industry representatives from the Renewable Hydrogen Consortium visited Adelaide for meetings with South Australian industry and government.



Foster innovation and workforce development



Action theme 4

Accelerate hydrogen innovation based on solid academic research and industry partnerships, and ensure South Australia has the workforce skills, capability and capacity to deliver

South Australia combines traditional manufacturing capabilities in defence and automotive industries with emerging skills in space and energy sectors to create a thriving, vibrant innovation community.

South Australia's three main universities are all active in hydrogen and energy related research across the Centre for Energy Technology (University of Adelaide), the Institute for Nanoscale Science and Technology (Flinders University) to the Future Industries Institute (University of South Australia).

The rapid emergence of a hydrogen industry will create demand for skilled workers and tailor training programs that meet the demand for new specialist skills and promote opportunities for STEM students and graduates, particularly in regional areas where projects are likely to be based

Innovation and Translation neighbourhoods

Lot Fourteen, Adelaide

Located in the heart of Adelaide's CBD, Lot Fourteen is a creation and innovation neighbourhood bringing together members of the entrepreneurial ecosystem including the new Australian Space Agency, the Australian Cyber Collaboration Centre, and the Australian Institute for Machine Learning.

Also incorporating the Future Industries Exchange for Entrepreneurship (FIXE), Lot Fourteen provides an ideal platform for new companies connected to the new renewable hydrogen economy.

Tonsley Innovation District

The focal point of a 20-year master plan for the transformation of the former Mitsubishi car plant in metropolitan Adelaide, the Tonsley Innovation District has become Australia's most awarded innovation district and will host Australia's largest operational hydrogen electrolyser as well as up to 6 MW in on-site solar PV and battery storage.

Tonsley has become an innovation test bed for productive and sustainable working and living environment around future energy, mining, manufacturing and autonomous mobility.

Osborne Naval Shipyard

The Osborne Naval Shipyard is Australia's premier naval industry hub, home to many leading technology companies pursuing opportunities in the defence or commercial shipbuilding and ship sustainment projects. Osborne has close connections with the Edinburgh Defence Precinct and the Commonwealth Defence Science and Technology agency

South Australia is on the move to foster innovation and workforce development...

Leverage current and future hydrogen projects for training and innovation

The "Hydrogen Research and Development in South Australia" report to the South Australian Government identifies existing hydrogen research and development capability in the state and opportunities to extend this capability across local, national and international collaboration

South Australia will leverage its demonstration projects, such as AGN's Hydrogen Park South Australia at the Tonsley Innovation District and H2U's South Australian Renewable Hydrogen and Ammonia Supply Chain Demonstrator plant to provide a platform for rapid testing, development and commercial expansion of hydrogen related projects.

Skilling South Australia to support the expansion of new industries and a hydrogen economy

The South Australian Government is committed to supporting an additional 20,800 apprentices and trainees over four years through the Skilling South Australia initiative. The initiative is committed to ensuring these opportunities meet the state's skills needs both now and in the future.

Government will work with industry, vocational education and training provides and universities to leverage the Skilling South Australia and other initiatives to encourage apprenticeships and traineeships to support the hydrogen sector.

Support and participate in Future Fuels Cooperative Research Centre

More than \$90 million in government, industry and university cash and in-kind funding support the Future Fuels Cooperative Research Centre (CRC) work in transitioning Australia's multi-billion dollar energy sector to low-carbon fuels including hydrogen.

South Australia is the only Australian state to commit government funding to the Future Fuels CRC, and will actively assist the Centre's research during its seven-year lifetime.

Support and participate in the Australian Hydrogen Centre

The South Australian Government has committed to support the establishment of the Australian Hydrogen Centre led by Australian Gas Infrastructure Group.

Building upon the learnings from Hydrogen Park South Australia at the Tonsley Innovation District, the proposed Australian Hydrogen Centre will share knowledge on the feasibility of blending 10 per cent hydrogen into city and regional gas networks as a step toward 100 per cent conversion to hydrogen of the South Australian and other Australian jurisdictional distribution networks.

This will help inform a plan for the cost-effective use of hydrogen in this sector.



Integrate hydrogen into our energy system

Action theme 5

Understanding the value of hydrogen in our decarbonised energy system

South Australia's energy market is at the forefront of transitioning from fossil fuels to renewable energy.

The Australian Energy Market Operator (AEMO) forecast that in 2018-19 renewable energy production will comprise about 59.7 per cent of South Australia's total power generation. South Australia's aspiration is to be a net 100 per cent renewable energy producer in the 2030s.

Hydrogen offers an opportunity to ensure that the transition to cleaner energy is affordable and reliable for South Australian consumers. Once produced using renewable energy, hydrogen can be blended into gas networks, used in transport, or reconverted back to grid electricity when needed.

Electrolysers that produce hydrogen are also large highly flexible loads that can be ramped up and down to balance electricity supplied from renewable energy sources and provide ancillary grid services that can contribute to power system security.

Renewable hydrogen can be used to diversify and reduce reliance on traditional liquid fuels such as petrol and diesel, enabling its emissions-free use in a range of South Australian primary energy sectors such as gas, electricity and transportation sectors.

South Australia leads National Hydrogen Strategy Kick-start Project on hydrogen in gas networks

At the December 2018 Council of Australian Governments (COAG) Energy Council meeting, the South Australian Government along with all Australian jurisdictions accepted a proposal from Australia's Chief Scientist Dr Alan Finkel to develop a National Hydrogen Strategy for 2020-2030.

COAG Energy Council has established a Working Group to carry out the Strategy's development across six work streams that consider: hydrogen exports; hydrogen for transport; hydrogen in the gas network; hydrogen for industrial users; hydrogen to support electricity systems; and cross-cutting issues.

South Australia, in conjunction with the Future Fuels CRC, is leading a project on hydrogen in gas networks to identify technical and regulatory changes required to enable blending up to 10 per cent hydrogen into the domestic gas distribution network.

This work included a review of technical standards, safety and technical regulations, the national gas market regulatory framework and examines matters relating to gas quality, suitability of pipeline materials, blending location and impacts on network capacity and metering.



South Australia is on the move to integrate hydrogen into energy systems

Secure wider energy system benefits of hydrogen-led sector coupling

By coupling other sectors to our decarbonised electricity grid, we can improve security, reliability and affordability whilst reducing emissions.

Domestic hydrogen use could accelerate the development of large-scale energy storage in South Australia. The coupling of gas, electricity and transport sectors is expected to create wider benefits for the community and industry, with increased efficiencies and more flexibility.

For example, a mine site could reduce carbon emissions and increase its fuel security by producing renewable hydrogen on-site for use in mining vehicles as well as back-up power supply. Other South Australian industries that could benefit from improved fuel security and decarbonisation include defence, agriculture, heavy industries, space, as well as remote communities.

The South Australian Government will continue to lead and participate in projects, such as the Hydrogen in the Gas Networks kick-start project and the Future Fuels CRC, that investigate the more efficient delivery of energy to customers through the optimised use of energy networks and markets.

Facilitate knowledge sharing from the first hydrogen projects integrated into South Australia's energy system

South Australian Government has co-invested in pilots and demonstrations that will support familiarisation with hydrogen production systems and their interactions with energy systems.

These learnings will help industry, market bodies and governments better understand the services and value hydrogen technologies provide to energy systems, and inform future investment decisions. As they become available, the South Australian Government will facilitate the sharing of key learnings with relevant stakeholders.

Identify any changes that might be needed to the National Energy Market Framework to ensure the efficient integration of hydrogen into energy systems

As lead legislator for national energy law reforms and a member of COAG, the South Australian Government will work with other jurisdictions to identify any changes that might be needed to the national energy market framework to ensure the efficient integration of hydrogen into energy systems for the long-term interest of all consumers.

Investigate hydrogen production and use in remote areas of South Australia

With significant remote regions not connected to the National Electricity Market, the South Australian Government is responsible for overseeing the safe, reliable and cost effective supply of electricity to around 3,400 customers in 28 remote towns across the state.

Already being evaluated for the cost-effectiveness of implementing high penetration renewable energy solutions — for example, the Coober Pedy Hybrid Renewable Project — the South Australian Government will investigate the potential application of hydrogen electrolysis and fuel cell applications at sites to decarbonise existing diesel and LPG generators.

With world class mineral deposits being discovered in more remote parts of South Australia, the government will work with the minerals sector to investigate the opportunities for hydrogen in remote mining.

Acknowledgement of Country

We acknowledge and respect the Traditional Custodians whose ancestral lands we live and work upon and we pay our respects to their Elders past and present. We acknowledge and respect the deep spiritual connection and the relationship that Aboriginal and Torres Strait Islander people have to Country.

We also pay our respects to the cultural authority of Aboriginal and Torres Strait Islander people and their nations in South Australia, as well as those across Australia.



EDL Coober Pedy Renewable Hybrid Project

Further information

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