GOVERNMENT OF
WESTERN AUSTRALIA

Department of
Jobs, Tourism, Science and Innovation

Western Australian Renewable Hydrogen Strategy

H_2

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Premier's Foreword

Western Australia has a long, proud history of partnering with Asian economies to supply their energy needs. In the 1980s, the State partnered with industry to support the development of the North West Shelf Project. At the time, this was the largest LNG project in the world and kick-started the development of a new export market, creating tens of thousands of jobs for Western Australians.

Forty years later, we are still one of the global leaders in the sector and have built a reputation as a reliable partner with a highly capable workforce. Last year, we were the second largest exporter of LNG in the world.

Now, as the world moves to a lower carbon future, we have the ability to once again be a key player in value chains of new energy technologies, through our exports, expertise, technology and renewables potential. The Government is actively pursuing this vision, which will diversify our economy and create new, long term job opportunities for Western Australians.

In early 2019, the Government released its *Future Battery Industry Strategy* indicating our support and commitment to growing the State's role in the industry. But the future of energy technology is not limited to batteries.

Renewable hydrogen is another emerging technology that will play an important role in tomorrow's energy mix. This *Western Australian Renewable Hydrogen Strategy* builds on the State's renewables potential, technical expertise and global reputation to further position Western Australia as a key player in future energies. The Strategy will look at developing Western Australia's domestic production capabilities and opportunities for downstream processing. It will also look at ways to drive local content, so Western Australian suppliers are in the box seat to capitalise on the potential of hydrogen.

The Western Australian Government will actively support industry efforts to grow the renewable hydrogen industry in the State. Combined with the battery strategy, the *Western Australian Renewable Hydrogen Strategy* will contribute to the State Government's vision for a diversified economy that benefits all Western Australians.

I would like to thank the Western Australian Renewable Hydrogen Council for its input and I look forward to working with industry on the implementation of this Strategy.

The Honourable Mark McGowan

PREMIER OF WESTERN AUSTRALIA AND MINISTER FOR STATE DEVELOPMENT

Minister's Foreword

Western Australia has an extraordinary opportunity to become a leader in the emerging renewable hydrogen industry.

As a part of the McGowan Government's drive for innovation and economic diversification, the Western Australian Renewable Hydrogen Council was established in 2018. The Council, which attracted leading industry players, was tasked with providing strategic recommendations to assist the Western Australian Government respond to the growing global demand for hydrogen made from renewable energy sources.

The Council's analysis and recommendations have informed the development of this *Western Australian Renewable Hydrogen Strategy* which aims to support industry efforts to grow the emerging renewable hydrogen industry in practical and strategic ways.

As the world moves to a decarbonised future, a key challenge is to ensure the resilience of our State and its industries by transitioning and diversifying our resources sector towards a cleaner future.

Hydrogen provides a means to export our world-class solar and wind resources, assisting our international partners to meet emissions reduction goals and assisting our industries to transition to a lower carbon future. It also provides an opportunity to reduce our reliance on imported diesel for remote areas.

Although renewable hydrogen for export is a key opportunity for Western Australia, it will not occur without significant investment and lead times. To assist development, we need to build our domestic hydrogen market and our skill base. This will assist the transition for existing industries and capitalise on this opportunity for Western Australia's economy, supporting regional jobs and growth.

I look forward to working with local and international stakeholders to develop this new industry.

Hon Alannah MacTiernan MLC

MINISTER FOR REGIONAL DEVELOPMENT; AGRICULTURE AND FOOD; PORTS

Acknowledgements

The Western Australian Renewable Hydrogen Council was established to provide strategic advice on the opportunities and challenges for renewable hydrogen in Western Australia.

Western Australian Renewable Hydrogen Council members:

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KATHARINE MCKENZIE
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CSIRO provided comprehensive techno-economic analysis that has informed the development of this Strategy.

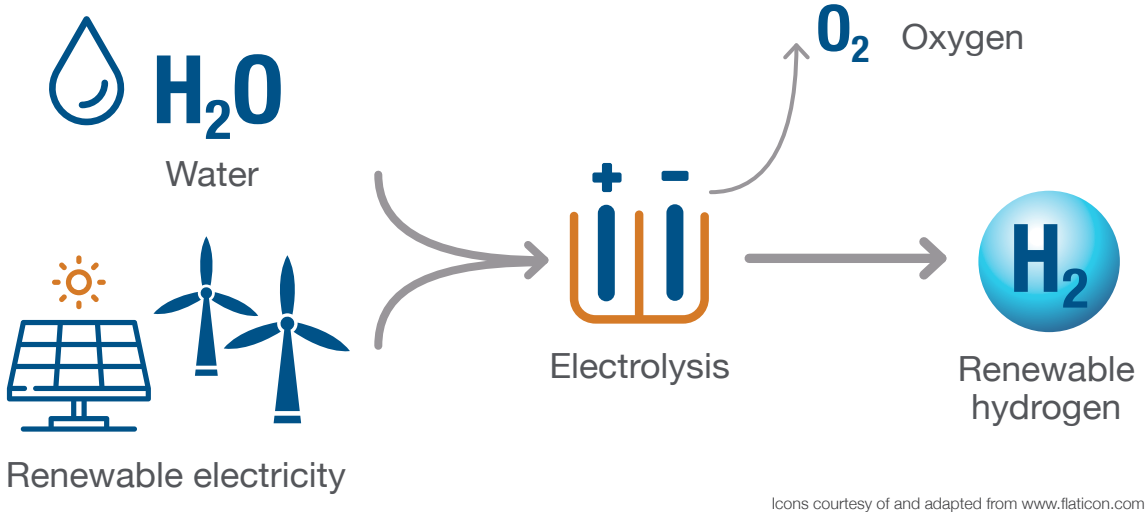
The Strategy and subsequent efforts are also aligned to the development of a National Hydrogen Strategy being led by Australia's Chief Scientist, Dr Alan Finkel AO for the Council of Australian Governments (COAG) Energy Council.

A New Industry for Western Australia

The world is moving to a low-carbon future. Hydrogen offers diverse applications as an energy carrier and chemical feedstock and has great potential to support decarbonisation of the world's energy and industrial sectors. Because of this, there is a growing global demand for renewable and low-emissions hydrogen.

Renewable hydrogen is defined as hydrogen produced using energy from renewable energy sources.

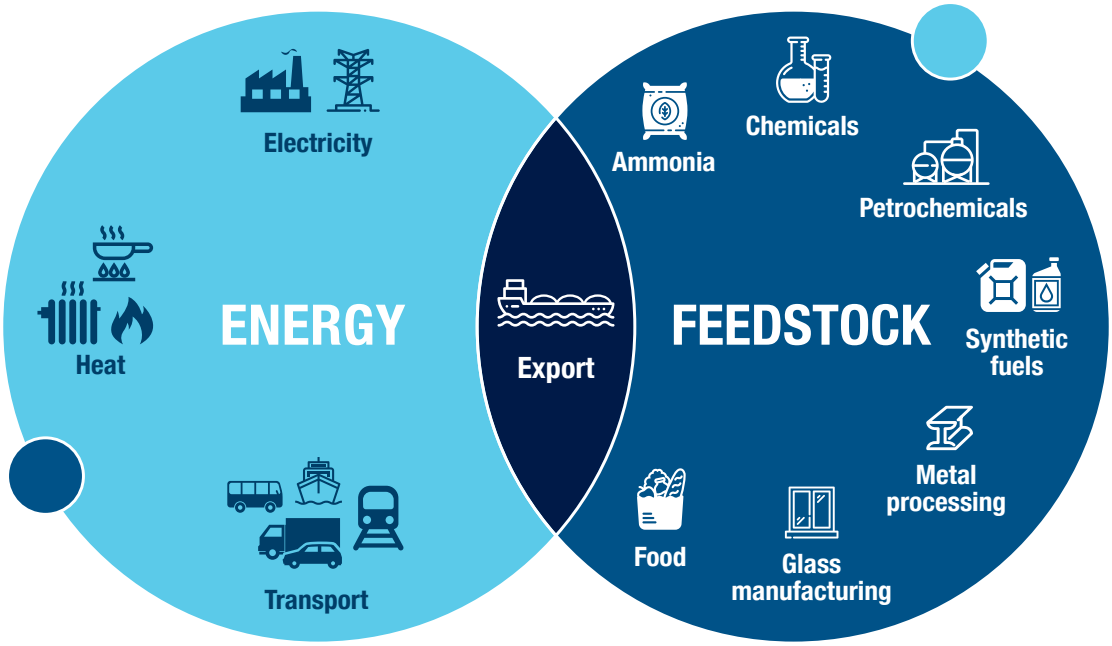
One pathway for producing renewable hydrogen is shown below.



Icons courtesy of and adapted from www.flaticon.com

Factors including reductions in renewable electricity costs, technology developments, the emergence of export markets and an increasing focus on decarbonising the global economy have created a growing demand for low-emissions hydrogen. By capitalising on its comparative advantages, Western Australia can establish itself as a leading participant in this rapidly developing global market.

As well as diverse applications as an energy carrier, renewable hydrogen has the potential to displace the use of fossil fuels in energy applications such as transport, heat and power generation. It can also provide a carbon-neutral feedstock for a wide variety of industrial processes, and provide energy storage and other services to support the reliability of the electricity grid.



The Opportunity

Growing demand

The current global demand for hydrogen is more than 70 million tonnes per year. The majority of this hydrogen is not produced through low-emissions methods and is mainly used for oil refining and chemical production.

The future global market for hydrogen is expected to focus increasingly on low-emission production methods with growing use for energy purposes. The International Energy Agency forecasts strong growth in demand for hydrogen over the next decade.

Countries such as Japan and South Korea have signalled an intention to import low-emissions hydrogen for energy and transport purposes.

The Japanese Government has a target to procure 300,000 tonnes of low-emissions hydrogen annually by 2030.

South Korea is aiming to produce 6.2 million hydrogen cars for domestic use and export, as well as build 1,200 refuelling stations by 2040.

The value of Australia's potential low-emissions hydrogen exports could reach $2.2 billion by 2030 and $5.7 billion by 2040.

Hazer Group is collaborating with the Water Corporation to explore the development of a hydrogen production facility at a wastewater treatment plant. Using biogas as the feedstock to produce hydrogen offers the potential to add value to a waste resource whilst realising significant carbon abatement.

Image source: Pilger

Global decarbonisation

Increased focus on decarbonising the global economy, particularly through the Paris Agreement under the United Nations Framework Convention on Climate Change, has created an opportunity for low-emissions and renewable hydrogen.

The production and export of renewable hydrogen represents an opportunity for Western Australia to support international decarbonisation efforts, while also supporting Australia's commitments to the Paris Agreement. Global decarbonisation efforts could enable the State to leverage its advantage in renewable resources by supporting the growth of a hydrogen export industry.

National drivers

An increasing number of projects across the country are seeking to demonstrate local use and export pathways for renewable hydrogen.

The COAG Energy Council has approved the development of a National Hydrogen Strategy, which is being led by Australia's Chief Scientist Dr Alan Finkel AO and is expected to be delivered by the end of 2019.

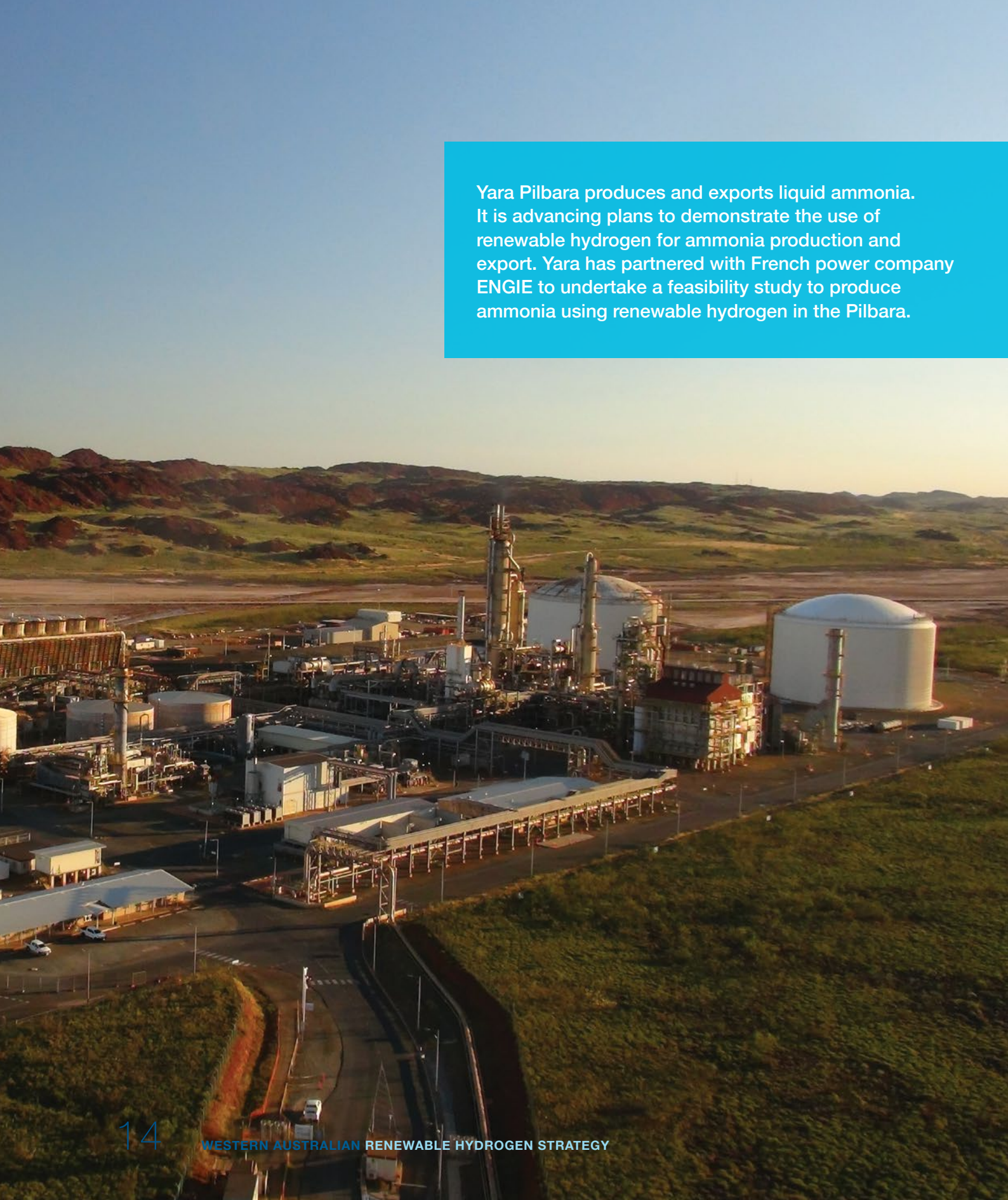
Western Australian drivers

The export of renewable hydrogen from Western Australia to countries that are highly dependent on imported energy supplies and lack sufficient domestic renewable energy resources represents a significant economic opportunity for the State.

The global market for low-emissions hydrogen will be competitive. By capitalising on its comparative advantages, Western Australia can establish itself as a leading participant in this rapidly developing global market.

The resource sector of Western Australia has historically been a major contributor to the GDP of the State and leading resource companies recognise that transition of their operations to a low-carbon future is necessary. This transition presents an opportunity to diversify the economy across a range of upstream and downstream activities. It will also provide local jobs, benefit regional communities, contribute to skills development and economic diversification as well as contributing to global efforts to reduce carbon emissions.

The Strategy recognises the fast pace of technological change and that there may be new developments in hydrogen production that are low-emissions. However, the word 'renewable' has been maintained in the title to signal the end goal and where Western Australia will have the strongest advantage.



Yara Pilbara produces and exports liquid ammonia. It is advancing plans to demonstrate the use of renewable hydrogen for ammonia production and export. Yara has partnered with French power company ENGIE to undertake a feasibility study to produce ammonia using renewable hydrogen in the Pilbara.

Western Australia's Infrastructure

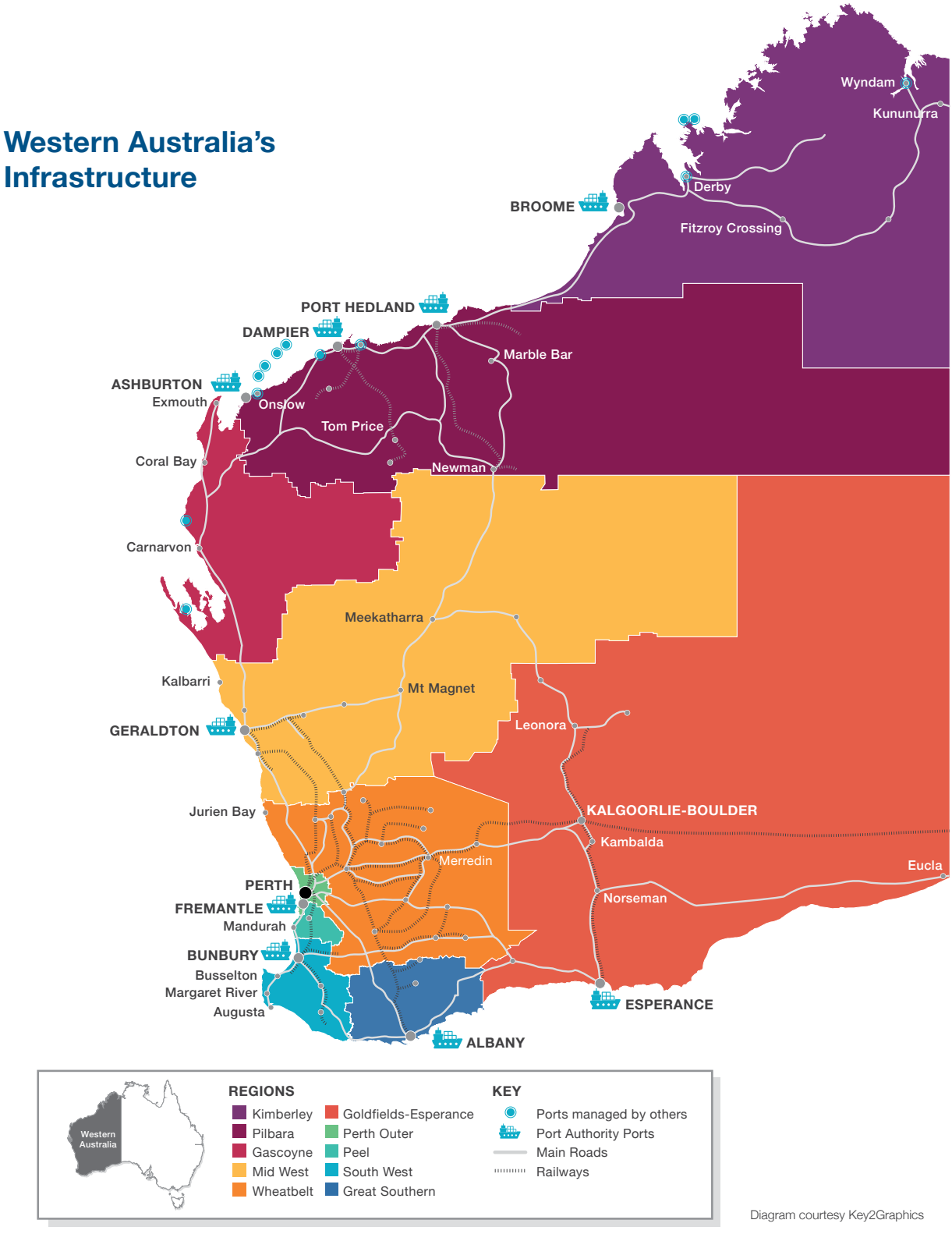


Diagram courtesy Key2Graphics

For more information please visit: www.jtsi.wa.gov.au/hydrogen

Western Australia's hydrogen advantage

Western Australia's world-class renewable energy resources, established energy production and export industry, and proximity to key international markets make it well placed to produce, use and export renewable hydrogen for economic and environmental benefit.

Western Australia has many attributes that provide a comparative advantage for the production, use and export of renewable hydrogen, including:

1. Renewable energy resources

Western Australia is home to high-intensity renewable energy resources. Western Australia's solar is amongst the highest irradiance in the world and, due to being on the western edge of the continent, it has excellent wind resources.

2. Land

With an area of 2.5 million km^2 (one-third of the Australian continent), low intensity land use combined with low population density, Western Australia is well placed to develop large-scale renewable energy generation.

3. Existing infrastructure

Western Australia has world-class industrial and export infrastructure that can accommodate the development of the hydrogen industry.

4. Strong existing industry presence

Because of Western Australia's established LNG industry and its ability to develop collaborative and globally competitive supply chains, many of the world's largest oil and gas companies have a local presence. Several major companies have expressed intentions to develop hydrogen projects in regional Western Australia.

5. Skilled workforce

Western Australia retains a technically skilled workforce with expertise across the energy sector and relevant research capabilities amongst various institutions. A skilled workforce will be essential to build a local hydrogen industry.

6. Access to markets

Another comparative advantage for Western Australia is its geographical proximity to Asia and its long-term presence in these markets. There is potential to further strengthen Western Australia's strong partnerships with Japan and South Korea which are key partners in the growing market for renewable hydrogen. This industry also presents opportunities for technology partnerships in Asia and Europe.

Vision, Mission and Goals

Vision

Western Australia will be a significant producer, exporter and user of renewable hydrogen.

Mission

Western Australia will develop industry and markets to be a major exporter of renewable hydrogen. To facilitate the export of renewable hydrogen, Western Australia will develop domestic production capabilities and applications of renewable hydrogen, improving the State's hydrogen industry expertise, contributing to global decarbonisation and decarbonising the State's economy. It will also contribute to improving air quality across the State.

Goals

By 2022

- A project is approved to export renewable hydrogen from Western Australia.
- Renewable hydrogen is being used in one remote location in Western Australia.
- Renewable hydrogen is distributed in a Western Australian gas network.
- A refuelling facility for hydrogen vehicles is available in Western Australia.

By 2030

- Western Australia's market share in global hydrogen exports is similar to its share in LNG today.
- Western Australia's gas pipelines and networks contain up to 10% renewable hydrogen blend.
- Renewable hydrogen is widely used in mining haulage vehicles.
- Renewable hydrogen is a significant fuel source for transportation in regional Western Australia.

The Asian Renewable Energy Hub is being developed by a consortium consisting of InterContinental Energy, CWP Energy Asia, Vestas and Macquarie Group. The proposed project consists of 11 gigawatts of renewable generation to provide power to Pilbara energy users and produce renewable hydrogen for export. The scale of the project has the potential to create new supply chains to reduce costs and provide significant new employment opportunities as well as diversify and grow the Pilbara economy.

Strategic Focus Areas

The Western Australian Renewable Hydrogen Council and techno-economic analysis by CSIRO has identified four Strategic Focus Areas for investment in Western Australia:

1. Export

2. Remote applications

3. Hydrogen blending in natural gas networks

4. Transport

While these strategic areas will be a focus because of their link to Western Australia's particular comparative advantages, the role that renewable hydrogen could play in stabilising the electricity network and in decarbonising industry is also acknowledged.

1. Export

The global market for renewable hydrogen is expected to grow significantly over the coming decades. Western Australia is well placed to capture a significant share of this market due to its excellent renewable energy resources, skilled oil and gas workforce, proximity to Asia, and export infrastructure.

In 2018, Western Australia was the second largest exporter of LNG in the world and has established a strong reputation internationally as a capable and reliable partner. The global market for renewable hydrogen is expanding, presenting an important economic opportunity for Western Australia and for the transition of its industries to a lower carbon future.

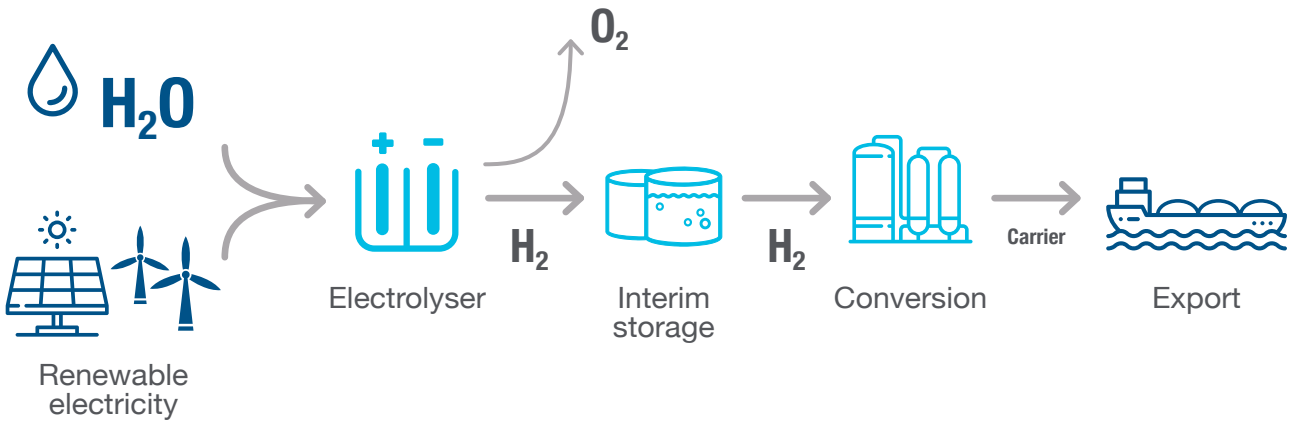
Given the amount of renewable energy needed to generate export quantities of hydrogen, access to land with strong renewable resource potential will be critical. Due to hydrogen's low volumetric density, it will also be important to convert it into a chemical carrier or liquefied form to enable large-scale export.

Recognising both the infancy and the potential of the renewable hydrogen industry, the State Government will work with industry to develop and promote Western Australia's ability to supply cost-competitive renewable hydrogen.

Inter-governmental relationships can also be further developed to firm international demand for renewable hydrogen exports and give industry confidence to form partnerships and invest in the required infrastructure.

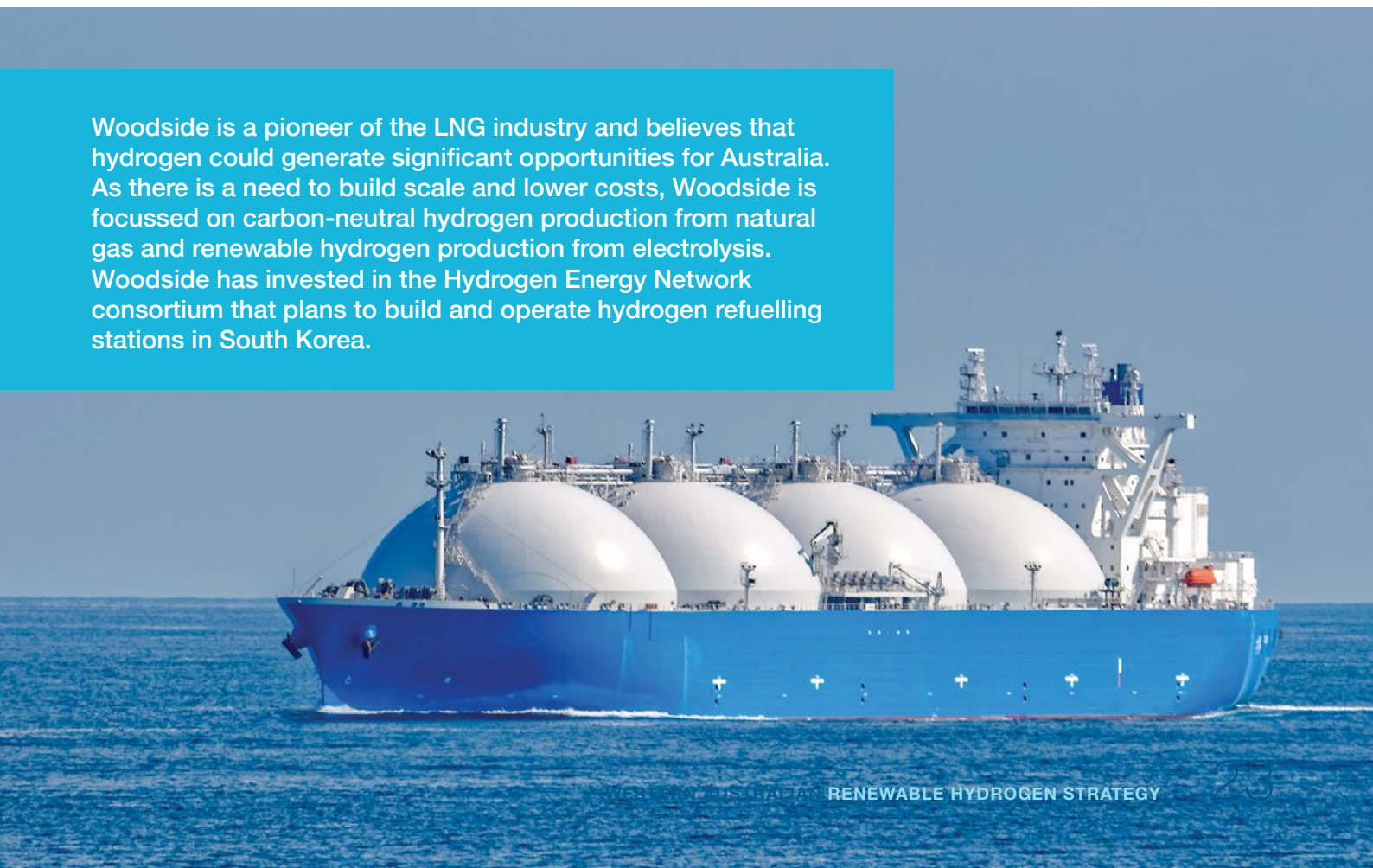
Financial support may be required until hydrogen export pathways are demonstrated to be technically and commercially viable. The Western Australian Government will allocate funds for early commercial projects that help advance the storage and transport of renewable hydrogen. The Western Australian Government will also support project proponents by helping them identify, navigate and leverage national support.

In collaboration with the Commonwealth and relevant industry bodies, the Western Australian Government will undertake further work to ensure appropriate standards and regulations are in place to support the renewable hydrogen industry.



Renewable hydrogen export value chain

Woodside is a pioneer of the LNG industry and believes that hydrogen could generate significant opportunities for Australia. As there is a need to build scale and lower costs, Woodside is focussed on carbon-neutral hydrogen production from natural gas and renewable hydrogen production from electrolysis. Woodside has invested in the Hydrogen Energy Network consortium that plans to build and operate hydrogen refuelling stations in South Korea.



2. Remote applications

Renewable hydrogen can reduce reliance on diesel for remotely located industries and communities.

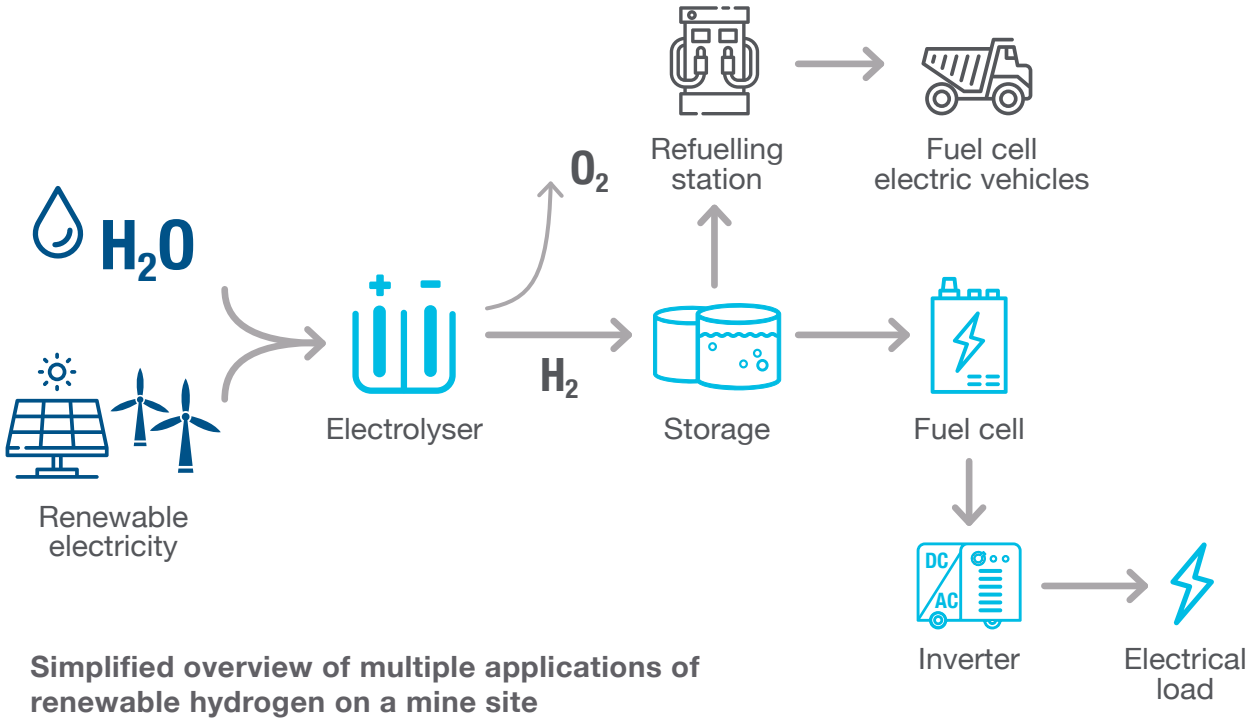
An advantage of hydrogen for remote applications is that there are potentially multiple end uses for the hydrogen produced. For example, renewable hydrogen could be used in fuel cells to power fixed and mobile plants, mining vehicles, combusted for heat, and potentially as a feedstock for industrial processes.

Hydrogen can also be used as an alternative to battery energy storage to provide dispatchable power and, in conjunction with batteries, to provide long term storage.

If the expected reductions in the cost of hydrogen and fuel cells can be achieved, renewable hydrogen based power systems could become commercially competitive with diesel generation before 2025. Hybrid systems using a combination of renewable energy, batteries, hydrogen for seasonal storage and back-up diesel may be a pathway to more competitive supply of power in remote areas.

Given the challenges involved in reducing emissions from heavy vehicles in mining, the Western Australian Government will facilitate discussions with industry to develop pathways and goals for reduced diesel consumption.

The Western Australian Government will ensure all relevant State Government agencies support the renewable hydrogen vision to assist proponents in seeking approvals and permits.



Simplified overview of multiple applications of renewable hydrogen on a mine site

3. Hydrogen blending in natural gas networks

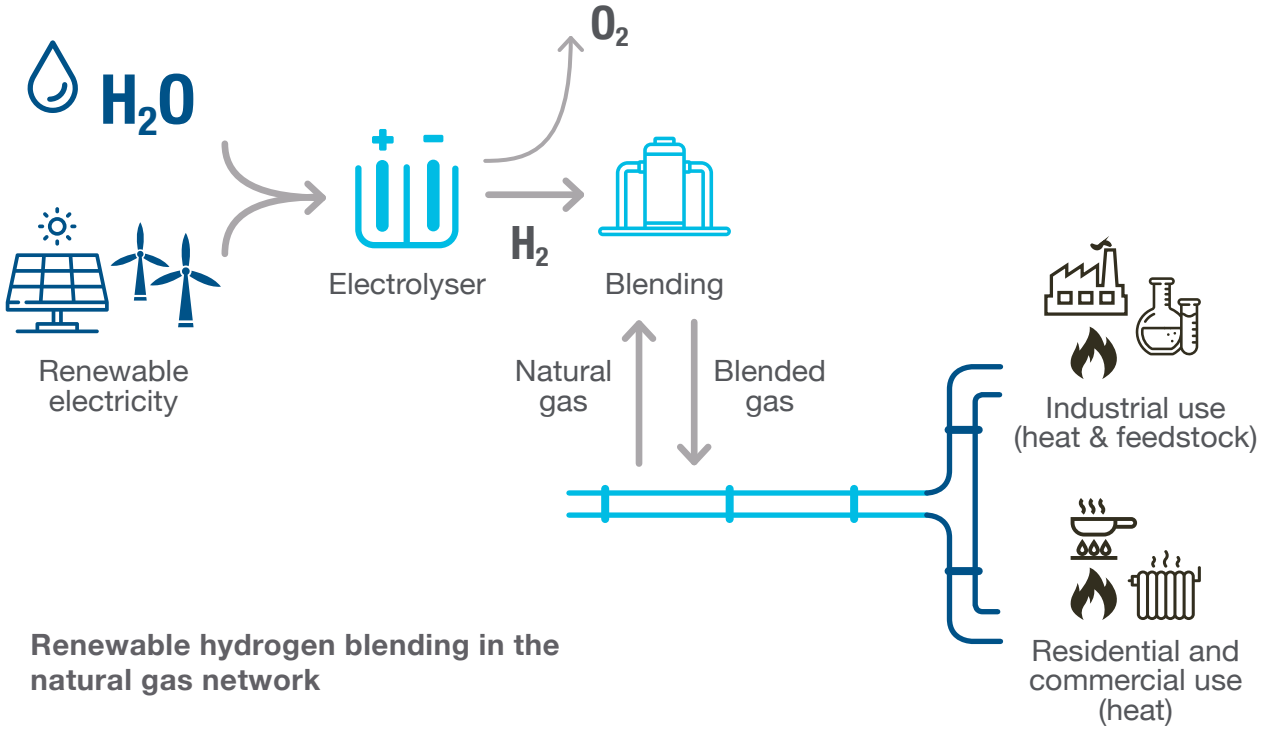
Blending low concentrations of hydrogen into natural gas networks provides an opportunity to partially decarbonise Western Australia's gas sector.

Western Australia has a vast gas reticulation network and a unique customer base. Blending up to 10% renewable hydrogen into the natural gas network could reduce the emissions intensity of gas combustion by up to 13%. This offers an opportunity to partially decarbonise gas consumption and a step towards deeper decarbonisation in the longer term.

Western Australia has high availability and low costs for natural gas. The Western Australian Government will consider supporting studies, trials and projects that demonstrate hydrogen blending in natural gas pipelines.

Electrolysers also have potential to provide security and reliability services to the electricity grid by absorbing surplus variable renewable energy generation or rapidly decreasing their demand to help balance electricity supply fluctuations (i.e. demand management).

The Western Australian Government, and the relevant licensing and regulatory bodies, have an important role to play in assessing the regulatory changes required to facilitate early-stage demonstration projects.



Renewable hydrogen blending in the natural gas network

ATCO delivers natural gas through 14,000km of pipelines across Western Australia. ATCO, with the support of ARENA, has developed the Clean Energy Innovation Hub at Jandakot. This test bed integrates solar, batteries, hydrogen production and natural gas to provide insights into clean energy research, safety and the skills required to support new energy technologies.

4. Transport

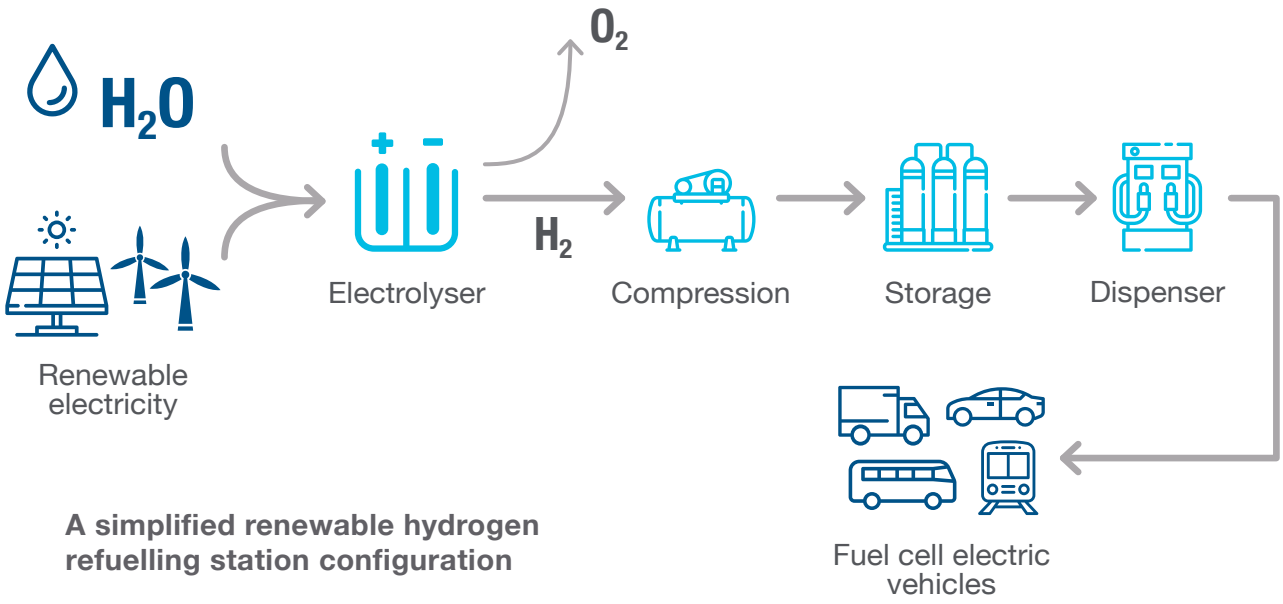
Fuel cell electric vehicles present an early opportunity for hydrogen utilisation for mobility and freight transport.

Western Australia's road network is almost 160,000 kilometres, with heavy reliance on roads for economic activity and social connectivity. By 2030, it is expected that Western Australia's road freight task will double in size from 2010 levels. With few choices to decarbonise, hydrogen for road freight could provide an attractive option.

While Battery Electric Vehicles (BEVs) have seen greater uptake to date, Fuel Cell Electric Vehicles (FCEVs) are another zero-emissions option particularly for vehicles that require longer ranges, shorter refuelling times, or are weight constrained.

The development of standards for hydrogen-related technology is being considered by Standards Australia. Most of the work required to develop appropriate standards and regulation supporting use of FCEVs and associated infrastructure is expected to be undertaken at the national level. Western Australia will remain engaged in national processes.

FCEVs have previously been deployed in Australia, including a government-led trial of hydrogen fuel cell buses in Perth. The Western Australian Government will support developing the industry and continue to assist industry in building public awareness of this technology.



A simplified renewable hydrogen refuelling station configuration

Fortescue Metals Group is a Pilbara iron ore producer and is examining hydrogen including potential export opportunities. Fortescue has partnered with CSIRO to develop and commercialise hydrogen technologies. Through this partnership, Fortescue will invest $20 million to support select CSIRO hydrogen technologies.

Implementation

The Western Australian Government will actively support industry efforts to accelerate the development of the renewable hydrogen industry in Western Australia. Government actions and investment in partnerships, seed funding and fit-for-purpose regulatory support as well as efficient approval processes will assist the hydrogen industry to overcome its economic, regulatory and technical challenges. This will diversify the economy, support regional development and create new, long-term jobs.

The key actions that the Western Australian Government will take to support industry efforts to accelerate the growth of a renewable hydrogen industry include:

1. $10 million Renewable Hydrogen Fund

The Western Australian Government will establish a $10 million Renewable Hydrogen Fund to facilitate private sector investment and leverage financial support to the renewable hydrogen industry.

2. Resourcing

The Western Australian Government will establish a dedicated Renewable Hydrogen Unit to coordinate the State's work on growing the industry, both domestically and for export. The Unit will be a central point of contact for industry and will coordinate activities across relevant Western Australian Government agencies to embed the Strategy's Vision.

3. Regulations and standards

The Western Australian Government will continue to work closely with the Federal Government and relevant bodies to support regulatory reform that will enable growth of the renewable hydrogen industry while ensuring strong safety and consumer protections. Work around certification of origin processes and potential for incentive programs will also be undertaken.

4. Relationships

The Western Australian Renewable Hydrogen Council will remain in place to continue to provide strategic advice on the development of the industry. The Western Australian Government will also continue to engage with industry, governments and research bodies to support and facilitate the development of the industry including through the National Hydrogen Strategy.

Western Australian Renewable Hydrogen Strategy

Vision

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Mission

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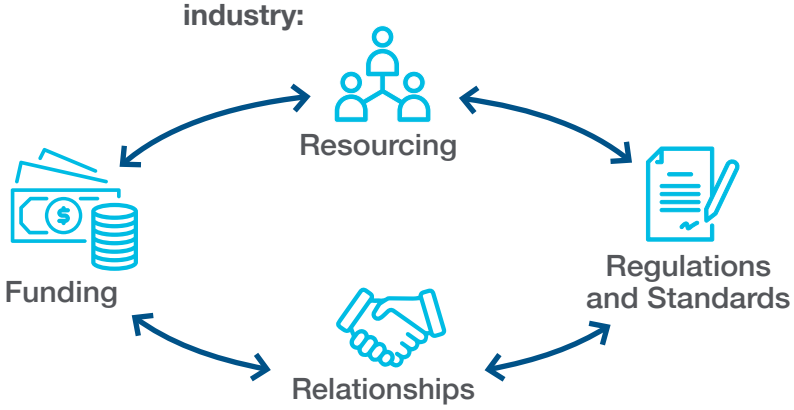
Strategic Focus Areas

Export | Remote applications | Blending in gas network | Transport

Implementation

The Western Australian Government will actively support industry efforts to accelerate the development of the renewable hydrogen industry:



For more information including references that informed this Strategy please visit:
www.jtsi.wa.gov.au/hydrogen

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