Gas Vision 2050

Delivering the pathway to net zero for Australia – 2022 Outlook

April 2022

Energy Networks Australia

APGA

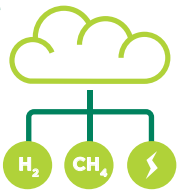
Gas networks and pipelines readying to deliver renewable decarbonised gas

Hydrogen

Bio and renewable methane

Features of renewable and decarbonised gas

All pathways require hydrogen or a similar renewable fuel



Biomethane offers early emission reductions opportunities

Blending renewable gas into the networks can build supply and lower costs

Utilising gas infrastructure with hydrogen can achieve **decarbonisation at half the additional cost** of full electrifications

Customer choice remains at the centre of reducing emissions

The long term transition needs **policy support**

Foreword

Gas Vision 2050 is the gas industry's commitment to lowering carbon emissions in line with the aims of the Paris Agreement on climate change. The recently held climate conference in Glasgow (COP26) in late 2021 continues to show global support for rapid decarbonisation.

Repurposing existing pipelines and networks with the use of renewable hydrogen and methane is the best solution to reaching net-zero emissions.

Actions across all sectors of the economy are required. Natural gas provided 17.4 per cent of Australia's total energy consumption in 2019-20. It is used in 49 per cent of homes across Australia for heating, cooking and hot water. Gas also supports Australia's commercial sector, and in high-temperature industrial processes and feedstock. Gas provided 21 per cent of Australia's electricity generation in 2019-20 and is enabling a growing level of wind and solar power generation.

Gas infrastructure businesses are adopting internal targets to reach net-zero emissions by 2050 or earlier and major progress has been made towards providing renewable gas to customers. For the purposes of this report, we are adopting a national renewable gas target of at least 10 per cent by 2030 and a 100 per cent renewable gas target by 2040 to 2050. Individual businesses are setting their own more ambitious targets.

The gas industry is taking practical steps towards net-zero emissions by:

- Engaging with customers to better understand their energy needs and aspirations,
- Investing in research and development of new technologies,
- Building projects to demonstrate how renewable gas can meet customer needs, and
- Advocating for the development of technology-neutral policies.

As seen in the electricity sector, transitioning to fully renewable energy is a multi-decade process. Similarly, early progress in renewable gas is creating a pathway to reach net zero emissions.

Targeted policies and incentives are needed to drive major cost reductions for renewable gas technologies that will enable the overall energy sector to reach 100 per cent renewables in the coming decades.

Gas pipeline and distribution network businesses are on a pathway for a transition towards renewable gas, focusing on hydrogen and renewable methane. We have worked with DNV GL to identify key actions required this decade to successfully transition to net zero emissions in line with global targets. Our assessment shows we are making strong progress towards renewable gas in Australia's gas pipelines and distribution networks.

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Why gas is changing?

Natural gas supports Australia across many parts of the economy.

It is used as a feedstock and fuel in industrial processes to support the agricultural and manufacturing sectors. It is used in businesses and homes to provide services such as heating, hot water and cooking. While natural gas is already a low emission fuel, the global move towards net zero emissions means that we need to reduce emissions from gas even more.

All Australian states and territories have set themselves net-zero emission targets by or before 2050 and many businesses are also making similar commitments. Prior to COP26, the Australian Government adopted a commitment to achieve net zero emissions by 2050.

Australian gas pipelines and distribution networks businesses are actively identifying and completing the actions they can take to contribute to these commitments, with most already having adopted net zero targets. These businesses are working to make gas networks and pipelines ready to accommodate any form of renewable and decarbonised gas to reduce emissions.

All Australian states and territories have set themselves net-zero emission targets by or before 2050 and many businesses are also making similar commitments.

Box 1: Gas pipeline and distribution network businesses that have adopted net zero emission ambitions and targets (April 2022)

Jemena bringing energy to life

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ATCO

Australian Gas Infrastructure Group

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Technology pathways

There are many technologies to reduce emissions including energy efficiency and carbon offsets. But to reach net-zero, the fuel itself needs to be replaced by renewable and decarbonised gases or could also potentially be replaced with renewable electricity.

The three available pathways are:

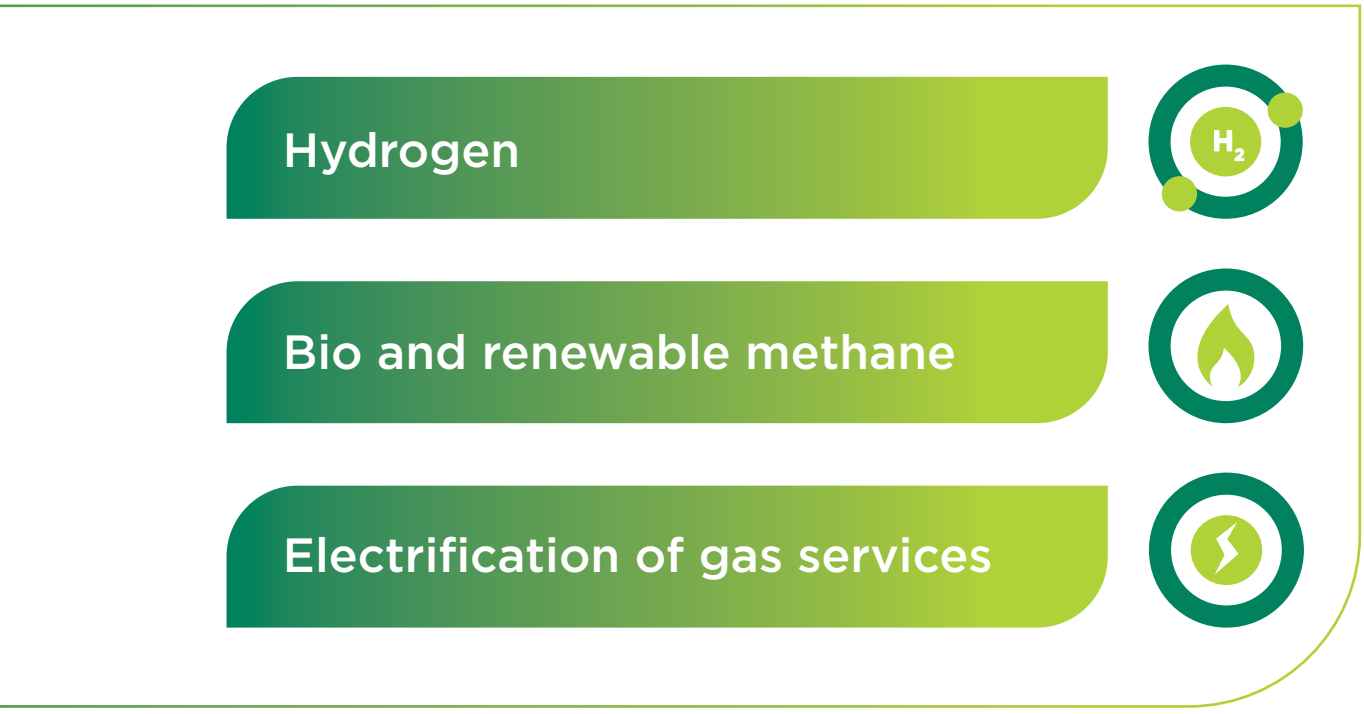
- Bio- and renewable methane, which provides a carbon neutral equivalent to natural gas and includes biomethane and synthetic renewable methane.
- Hydrogen, which produces no greenhouse gases when used as a natural gas substitute.
- Direct electrification, which substitutes natural gas use with electrical alternatives, can result in lower emissions when the electricity grid is decarbonised.

Due to the size of the transformation of the energy sector, and especially when considering the totality of electricity supply, gas supply and liquid fuel supply, all of these pathways will contribute towards reaching net zero emissions. The challenge is to find the right mix of these pathways to reach net zero emissions while ensuring energy security and minimising the overall cost of the energy system.

The Gas Vision 2050, Delivering a Clean Energy Future[1], showed that a decarbonised energy system that continues to utilise existing gas infrastructure is a cheaper option than full electrification and decommissioning the gas network. Gas networks and pipeline businesses are preparing to be ready to deliver renewable and decarbonised gases to contribute towards Australia's emission reduction goals.

In this report, we explore the pathways for decarbonising gas using either hydrogen or bio and renewable methane. We identify key actions that need to be addressed, as well as note progress against these. There are also cross cutting and interrelated policy issues that need to be addressed to develop a renewable and decarbonised gas market.

Figure 1: Decarbonising pathways for natural gas.



1 Energy Networks Australia (2019), Gas Vision 2050: Delivering a Clean Energy Future, available from www.energynetworks.com.au/projects/gas-vision-2050

An orderly transition, underpinned by a level playing field across decarbonisation pathways, will work in the best interests of consumers.

Whilst the need to transition is unified across all Australian states, the pathways will likely differ between jurisdictions. The pathways described in this report are generic in nature and can be used by individual gas pipelines and distribution networks businesses to inform their own decarbonisation plans. Three goals are used to provide structure to the bio- and renewable methane and hydrogen pathways. These are:

- Enabling blending of at least 10 per cent renewable and decarbonised gas by 2030;
- Enabling a 100 per cent renewable and decarbonised gas supply to new residential developments by 2030; and
- De-risking conversion to 100 percent renewable and decarbonised gas supply by 2050 across all networks.

Reaching 100 per cent renewable and decarbonised gas requires ongoing actions by gas pipelines and distribution networks businesses, customer representatives, government agencies, market bodies, appliance manufacturers, energy retailers and the emerging renewable and decarbonised gas production industry.

An orderly transition, underpinned by a level playing field across decarbonisation pathways, will work in the best interests of consumers.

Purpose of this report

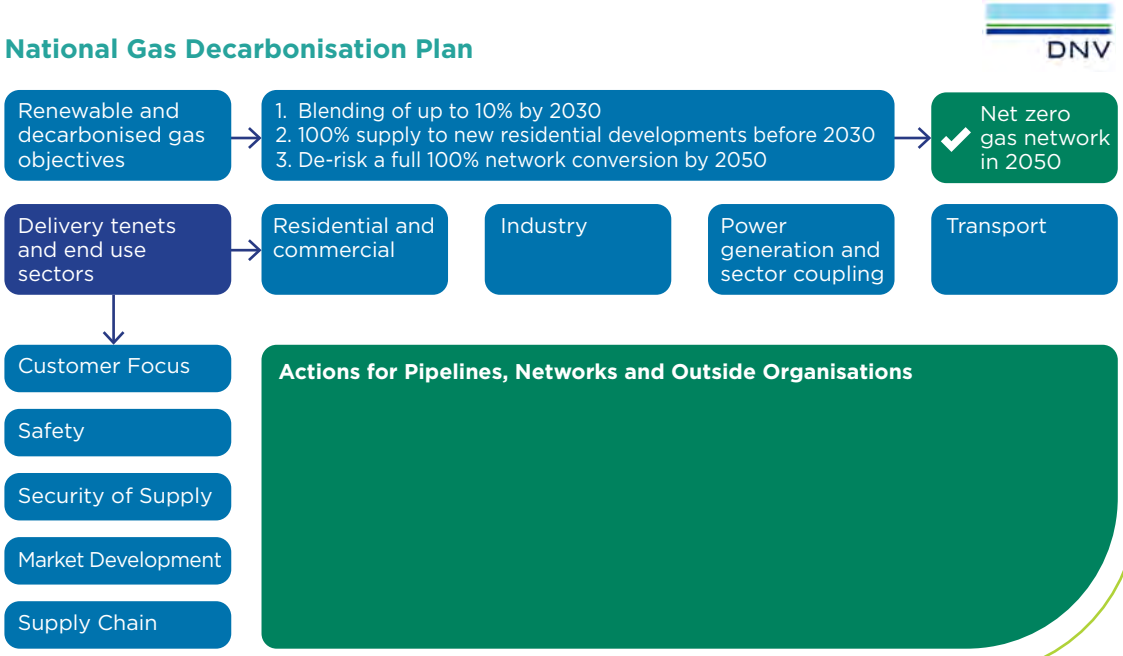
This report provides a high-level summary of the detailed action plan[2] that was developed by DNV GL on behalf of Energy Networks Australia and the Australian Pipelines and Gas Association.

That plan was designed to identify the range of actions to deliver the three goals outlined above. Actions were reported for each of those goals across five tenets and four end uses, as noted in Figure 2. The tenets are:

- **Customer Focus**: Consumers today benefit immensely from cost-effective and convenient gas supplies, and rely on gas for a range of services, including cooking, hot water, space heating, power generation and industrial heat and feedstock. The transition must support consumers in the residential and commercial, industrial, power generation and transport sectors to decarbonise in a cost-effective and convenient way, keeping disruption to a minimum.
- **Safety**: The high safety standards that exist for the current gas networks need to be maintained, through the development of the best technology and procedures for renewable and decarbonised gases across the Australian gas system, including the high-pressure transmission pipelines, the low-pressure distribution network, and end-user appliances.
- **Security of Supply**: A renewable and decarbonised gas network needs to maintain the high security of supply standards that currently exist, with very rare unplanned interruptions, including through ensuring sufficient physical network capacity, efficient and safe system operation, and access to sufficient renewable and decarbonised gas production and storage capacity.
- **Market Development**: To achieve net zero, the gases in the network need to be certified as genuinely renewable and low carbon, enabling producers to produce renewable and decarbonised gases at a competitive price, with customer contracts forming the basis for project and long-term operational financing, together with appropriate market incentives.
- **Supply Chain**: The supply chain and skilled workforce needs to be available at the right scale and with sufficient agility to deliver the renewable and decarbonised gas transition on time, including the provision of enough appliances and other equipment, and to carry out the installations, connections, and asset upgrades safely and smoothly.

2 DNG GL (2021), *National Gas Decarbonisation Plan – Decarbonising Australia's gas pipelines and networks*, available from www.energynetworks.com.au

Figure 2: National Gas Decarbonisation Plan Structure (Source: DNV GL).



The detailed actions identified in the Plan have been aggregated and reported here as either cross cutting actions applicable to all renewable and decarbonised gases, or specific actions for bio- and renewable methane or hydrogen. Significant progress against these actions is reported in the tables below and a traffic light system is used to make a qualitative assessment of this progress.

It should be noted that more work will be required in all the areas identified to reach to goals of a 10 per cent blend or 100 per cent renewable and decarbonised gas. The metrics provide an indication of current progress and planned work to reach the goals.

A green metric indicates good progress to date and a solid work program is underway to reach the goals. Orange and red metrics reflect a lower level of progress compared to areas marked with a green metric. The intention is to draw attention to these areas and to develop new activities to progress those areas.

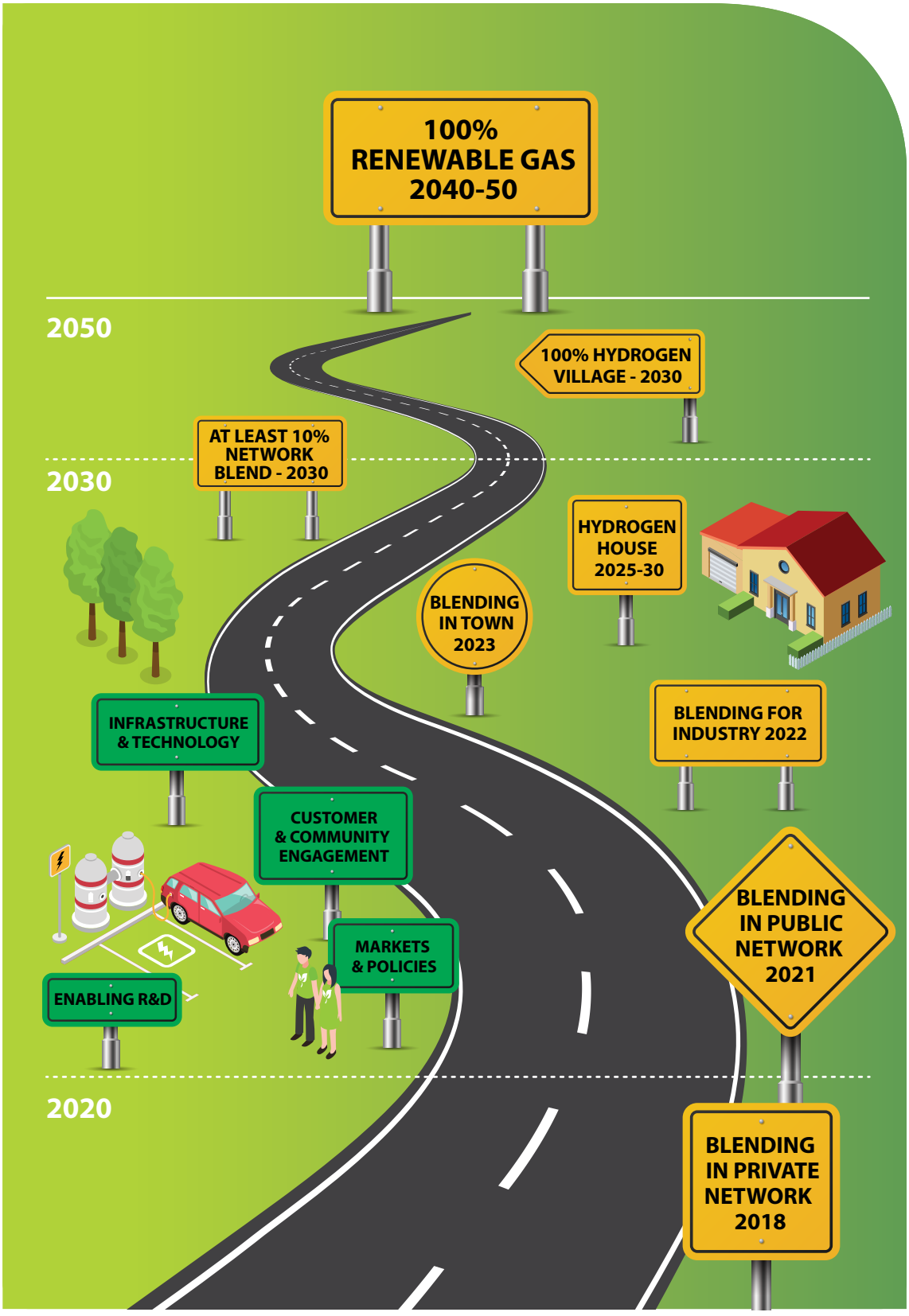
The metrics used are:

Figure 3: Qualitative assessment metrics used.

Flag	Definition
	Good progress has been made to date and a solid forward work plan is underway.
	Some progress has been made to date and increased focus on a forward work program is needed.
	Limited work has been completed and a major focus on this area is required.

This report focusses on the main activities to progress renewable and decarbonised gas in pipelines and distribution networks but is not a detailed stock take of all the activity underway across research organisations, government agencies, regulators and industry.

Figure 4: High level roadmap to reach 100 per cent renewable gas by 2040 to 2050.



A supportive policy environment

To reach the 10 per cent blend target by 2030 and the 100 per cent renewable and decarbonised gas target by 2040 to 2050 will require ongoing support and focus across industry and from governments, businesses and customers.

Governments need to continue to support the decarbonisation of gas through the following range of complementary no-regret policies, many of which are already in place.

For renewable and decarbonised gases, comprising both hydrogen and bio and renewable methane:

- Continue supporting demonstration and commercial scale projects.
- Encouraging market development via renewable and decarbonised gas targets, certification schemes and incentives.
- Enter into "reverse auctions" or "gas purchase agreements" for renewable and decarbonised gas to encourage its take up in the market, similar to actions undertaken via the Victorian Renewable Energy Target and local council actions.
- Enable gas networks to offer renewable and decarbonised gas opportunities in new residential developments, which will fast-track the development of 100 per cent renewable gas and ensure gas costs remain affordable for all gas users.
- Continue decarbonising electricity supply, which will be needed to produce renewable hydrogen.
- Encourage technical regulators to work collaboratively with industry in developing safety cases for demonstration projects, similar to the process adopted by the Health and Safety Executive in the UK, which is an enabling regulator that works with industry to ensure renewable gas projects can be safely deployed.

Hydrogen focussed policies.

- Support blending projects to gain technical and regulatory experience, customer acceptance and a pathway to commercial opportunities for hydrogen.
- Support the development of renewable hydrogen to support decarbonisation of industrial processes.
- Support local appliance manufacturers to provide accredited hydrogen appliances.
- Enabling opportunities for network businesses to deliver hydrogen to new residential developments.

Bio and renewable methane focussed policies.

- Identify the resource potential of biomethane, either from local biomass resources, or from interstate resources that can be shipped using existing transmission pipelines.
- Facilitate collaboration with gas networks, technology vendors, and resource providers to develop commercially viable biomethane projects.
- Support policies to recognise the value of circular economy benefits.

Cross cutting actions

Significant progress has been made since the launch of Gas Vision 2050 to develop renewable and decarbonised gas options.

The transition to clean energy is complex process that requires strategic and cross-sectoral thinking to consider the broad range of energy sources and their diverse applications.

Significant progress has been made since the launch of Gas Vision 2050 to develop renewable and decarbonised gas options.

While the final mix of these renewable and decarbonised gases in each network is yet to be determined, there are a number of cross-cutting actions that are critical, whatever the future gas mix or pathway. Additional actions for the different pathways are described in the following sections.

Table 1: Cross cutting actions to decarbonise gas networks.

Action	Progress	Flag
Consumer Engagement Comprehensive public, property developer and industry engagement to build support for the renewable gas transition and ensure that consumers and the supply chain are ready.	All pipeline and network businesses are undertaking consumer engagement on renewable gases, including as part of their access arrangement proposals. FFCRC: 10 research projects focusing on community engagement.	
Joint planning With varying renewable electricity, biomethane feedstock, CCS availability and other factors in different regions, the mix of renewable hydrogen and methane in the transition will vary across networks. Joint planning, including with renewable gas producers, electricity generators and electricity networks, will help to ensure the most cost-effective and sustainable transition in each region	Australian Hydrogen Centre prefeasibility studies on blending. AEMO's draft Integrated System Plan (2022) includes a hydrogen scenario and considers the impacts of electricity transmission requirements. The South Australian government has developed a hydrogen modelling tool that considers other resources. https://hydrogenexport.sa.gov.au	
Business case Ultimately, markets need to be developed for renewable gases, as they have been for renewable electricity generation. A joint business case should therefore be developed for both renewable methane and hydrogen, complementing the joint planning described above, to demonstrate to outside organisations how renewable gas can be developed and substantial emissions reductions achieved cost-effectively.	Frontier Economics (2020), *The benefits of gas infrastructure to decarbonise Australia.* Clean Energy Finance Corporation (2021), *Australian Market Hydrogen Study.* Australian Hydrogen Centre (2022), Feasibility studies on 10 % hydrogen blend and 100% conversion for South Australia and Victoria. Individual studies for 10 MW blending projects in WA and VIC being progressed.	

Action	Progress	Flag
Regulatory changes. Removing regulatory roadblocks formed through historical regulation which didn't consider renewable gases and setting in place regulatory frameworks within which a renewable gas economy can develop, will be key to forming a foundation from which renewable hydrogen and biomethane industries can grow.		
Technical regulation Update gas quality regulations for renewable methane and hydrogen and agree billing methodology for blends. A hydrogen specification will be needed, and policy decisions will need to be made on new and converted 100 per cent hydrogen networks, including mandating hydrogen-ready appliances.	FFCRC Regulatory mapping project completed and identified gaps in technical, environmental and economic regulation for renewable gases. A new subcommittee on hydrogen technologies has been established under Standards Australia. Australian Standard AS/NZS4564-2018 – gas distribution network management has included scope to allow hydrogen blends.	
Environmental regulation Develop environmental management and land use regulations for renewable gas, including water supplies and bio feedstocks. National Greenhouse Energy Reporting Scheme (NGERS) and other relevant schemes should also recognise renewable gases in energy and emissions reporting frameworks.	FFCRC Regulatory mapping project completed and identified gaps in technical, environmental and economic regulation for renewable gases.	
Economic regulation Updates to the National Gas Law to allow it to cover renewable gases.	Johnson Winter & Slattery (2017), *A report on the injection of hydrogen and biogas into gas distribution networks*. FFCRC Regulatory mapping project completed and identified gaps in technical, environmental and economic regulation for renewable gases. Australian Energy Regulator (2021), *Regulating gas pipelines under uncertainty – information paper.* DISER and market bodies undertaking reforms to the National Gas Regulatory Framework to support renewable gas blending – draft report published March 2022.	

Action	Progress	Flag
Market development. A renewable gas market will be key to enabling the development of green gas uptake through gas networks and pipelines.		
Certification Green gas certification schemes are required to give customers confidence they are purchasing a green product.	The Clean Energy Regulator is commencing trials for a Hydrogen Guarantee of Origin (GO) scheme. (11 Dec 2021) GreenPower is progressing a certification pilot scheme for biomethane, which is expected to be running in 2022	
Renewable gas target A renewable gas target, similar to the existing renewable energy target for electricity, would help to underpin investment in renewable methane and hydrogen and support the market creation renewable gases.	Oakley Greenwood (2019), *Renewable gas blending scheme*. NSW has established a 10 per cent renewable hydrogen blend goal in networks by 2030, with regulations in place. WA has an aspirational target of 10 per cent by 2030. FFCRC: Renewable gas target modelling project commencing in early 2022.	
Market access Market access is needed to enable renewable gas demand to access supply through pipelines and networks. This includes the development of green gas standards and tradeable certificates.	Energetics (2021), *Renewable gas certification pilot design*. Commercial arrangements between renewable gas production projects and offtakers (eg Hydrogen Park SA and other projects in various stages of development).	
Early asset financing Early market supply can be seeded through existing government financing frameworks. Access to lower risk financing will be key to enabling first supply into potential renewable gas markets, after which market forces can take over.	ARENA has supported hydrogen R&D, hydrogen demonstration projects and allocated $103.3 million towards three commercial-scale renewable hydrogen projects with electrolyser capacity over 10 MW (May 2021). ARENA funding of $33.5 million to further support Australia's bioenergy sector (Nov 2021). Clean Energy Finance Corporation - $300 m Advancing Hydrogen Fund (2021). Emission Reduction Fund methods being updated for biomethane blending in networks. State government funding schemes (e.g. NSW Hydrogen Strategy[4]).	
Market incentives If the renewable gas market does not take off in line with emissions reduction targets, additional financial or retail market incentives could be developed to stimulate the market.	Australia's technology roadmap sets a target of $2/ kg for clean hydrogen production.	

4 www.energy.nsw.gov.au/renewables/renewable-generation/hydrogen

Bio and renewable methane pathway

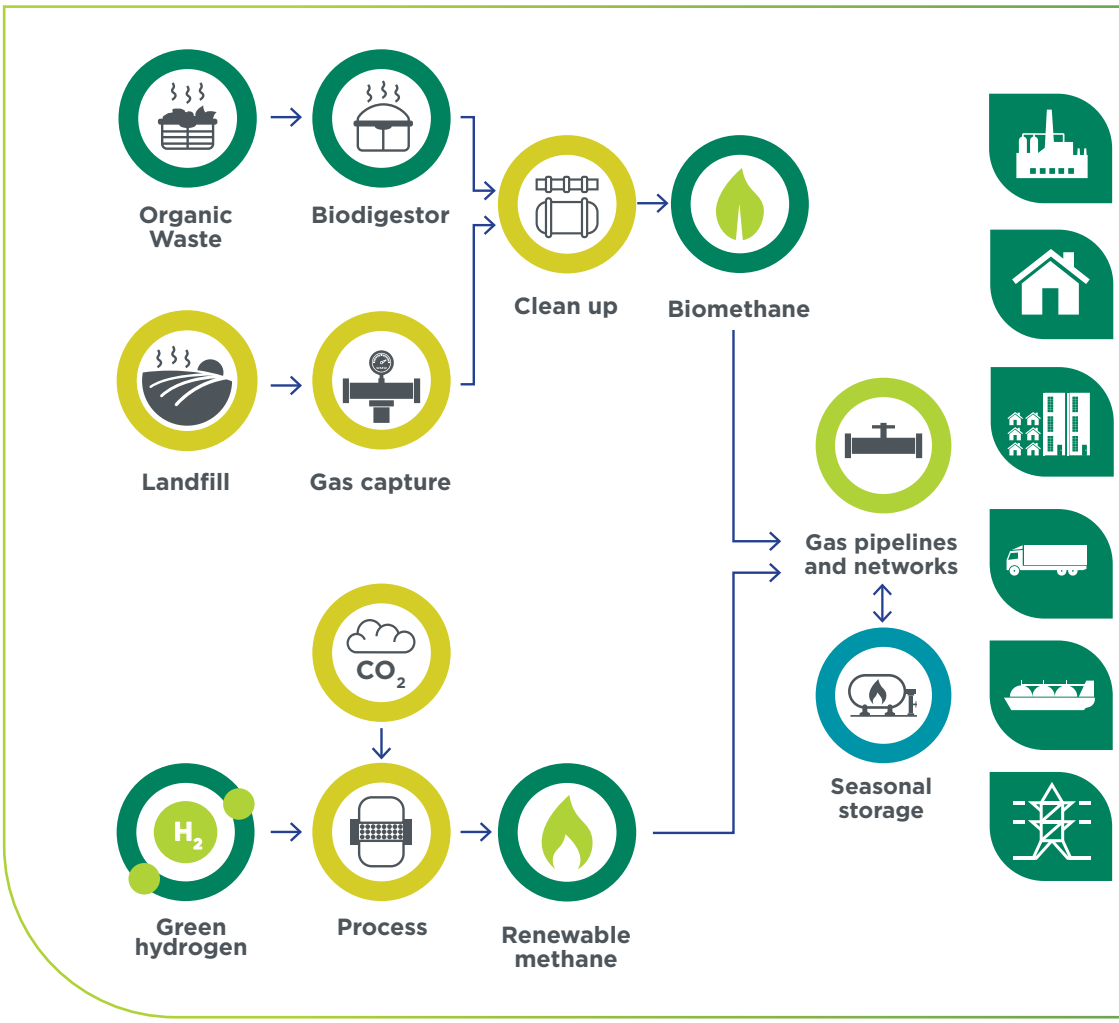
Bio and renewable methane is the renewably produced equivalent of natural gas.

It can readily be produced in biodigesters that convert organic feedstock to a mix of methane, carbon dioxide and water[5], or a synthetic process using hydrogen. Additional processing may be required to ensure that the final product meets the natural gas quality specification. This can then be odourised, compressed and blended into the gas pipelines and distribution networks.

Alternatively, biogas produced from landfill or wastewater facilities which is either flared or used to generate renewable electricity could also be processed to meet natural gas specifications and then blended into the networks.

Synthetic renewable methane can also play a role to complement the availability of organic feedstock. This involves reacting renewable hydrogen with carbon dioxide to produce synthetic renewable methane. This technology is at early stages of commercialisation but can complement the natural availability of renewable methane.

Figure 5: Bio and renewable methane pathway



5 Some other components may also be present.

Replacing natural gas with 100 per cent bio and renewable methane can be achieved by incrementally increasing the bio and renewable methane blend into the gas pipeline or distribution networks as new supply sources are developed. Bio and renewable methane plants are more widely distributed compared to traditional natural gas field and as such will require more blending units into the gas infrastructure system.

Blending bio and renewable methane into the gas network is already widely practiced in Europe, and rapidly progressing in Australia.

The main advantage of this pathway is that no changes are required to pipelines, networks or appliances. But the biomethane pathway relies on supplying enough organic feedstock to replace the current volumes of natural gas. This requires an improved understanding of the biomass potential that can be collected and processed. A high-level estimate by Deloitte Access Economics[6] found potentially 371 PJ of biogas could be produced per year from collecting organic feedstocks across Australia, including municipal waste, food processing waste and agricultural cropping waste.

Blending renewable methane into the gas network is already widely practiced in Europe, and rapidly progressing in Australia

A more recent estimate by ARENA[7] found the total theoretical resource potential across Australia is over 2,600 PJ pa. In comparison, gas networks provided 166 PJ of natural gas to residential and commercial customers in 2019/20.

There is a significant difference between the theoretical resource potential and the resources that are technically, commercially and sustainably accessible. More detailed analysis needs to be completed for individual regions.

Given the broad range of feedstocks and processes, the cost of producing biomethane can vary significantly between regions. Future Fuels CRC has developed an assessment framework for bio methane injection into gas networks and identified how cost parity with natural gas can be achieved (see Box 2).

Developing the bio and renewable methane pathway

Due to the similarity between natural gas and bio and renewable methane, no changes will be required for transporting or using the bio and renewable methane. The same safety measures as for natural gas can continue to be used. Developing the bio and renewable methane pathway requires focus on the supply side, covering the availability of organic feedstock and appropriate policy and market developments to incentivise the industry. The table below identifies the key actions to progress the bio and renewable methane pathway.

6 Deloitte Access Economics (2017), *Decarbonising Australia's gas distribution networks, a report for Energy Networks Australia*.

7 ARENA (2021), *Australia's Bioenergy Roadmap*.

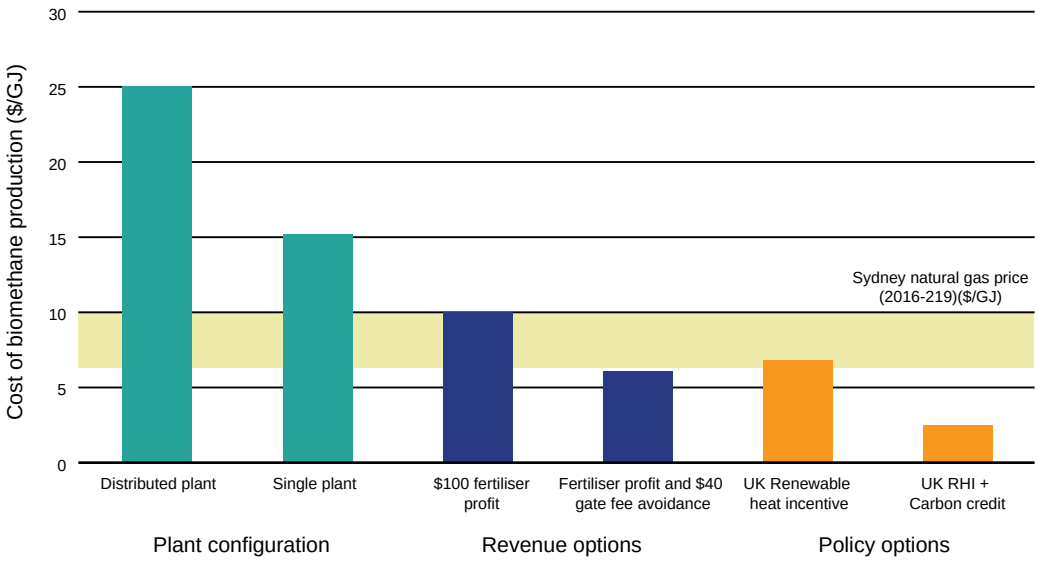
Box 2: Achieving cost parity of biomethane with natural gas

An assessment by Future Fuels CRC[8] demonstrated combining resources into a single larger facility compared to multiple smaller facilities achieves major cost savings for biomethane production. This production cost can approach the price of natural gas in Australia, when biogas plants can offset their operational costs with the other product streams such as profits from the digestate used to produce fertiliser, or the inclusion of avoided land fill "gate fees" for feedstock diverted to produce renewable methane.

Alternatively, or in addition, renewable heat incentives or carbon credits such as those used in Denmark or the UK can also help achieve cost parity if applied in Australia. Appropriate policy support for the development of the renewable methane industry in Australia is a significant factor in achieving cost parity with natural gas and making renewable methane a commercially competitive option.

The assessment demonstrates that renewable methane production can be commercially competitive with natural gas when other revenue options or supportive policy mechanisms are introduced.

Figure 6: Revenue options and policy schemes can reduce biomethane production costs to reach gas price parity (Source: Future Fuels CRC, ENA Analysis)



8 Future Fuels CRC (2020), *RP1.2-03: Assessment framework for bio-methane injection in gas networks.*

Table 2: Bio and renewable methane pathway actions

Action	Progress	Flag
Securing the biomass supply chain. The feedstock needed for biomethane production is diverse and variable across the year. The quality of feedstock will depend on the process adopted to produce biomethane. Any feedstock used should be sustainable and not compete with other agricultural and forestry resources. Securing supply chains for appropriate biomass feedstock is one of the biggest technical challenges.	The ARENA Bioenergy Roadmap indicated a theoretical biomass potential of over 2,600 PJ pa across Australia. This roadmap identifies assessing the economically recoverable biomass as a priority. Jemena has completed an assessment of biomethane potential in NSW and estimated there is at least another 30,000 Terajoules of biomethane that has the potential to be unlocked around NSW's gas infrastructure. That's enough to supply current residential customers in NSW with biomethane. Detailed project studies have been completed by FFCRC for Griffith (NSW) and Adelaide (SA).	
Connecting a diverse range of biomethane producers to the network. The introduction of smaller biomethane producers coming into the market will require a better understanding of how pipeline network flows can be maintained to ensure reliable supply of gas to customers.	FFCRC project: Integrated model for bio-methane injection in gas networks FFCRC project: FutureNet: Connecting and managing Renewable Gas projects across Australian gas. FFCRC project: Regional case studies on multi-energy system integration. Biomethane Injection guideline under preparation by the Renewable Gas Alliance of Bioenergy Australia.	
Quality specification Some biomethane feedstocks may result in additional constituent components compared to the natural gas specification. Further work is required to determine whether these components create any safety concerns.	FFCRC project: Biomethane injection into the gas network: impact of impurities on the performance of end use.	

Demonstration projects

- Jemena Malabar wastewater biomethane project, Sydney, operational in 2022.
- Southern Green Gas - Wallumbilla Renewable Methane Demonstration Project, operational in 2022.

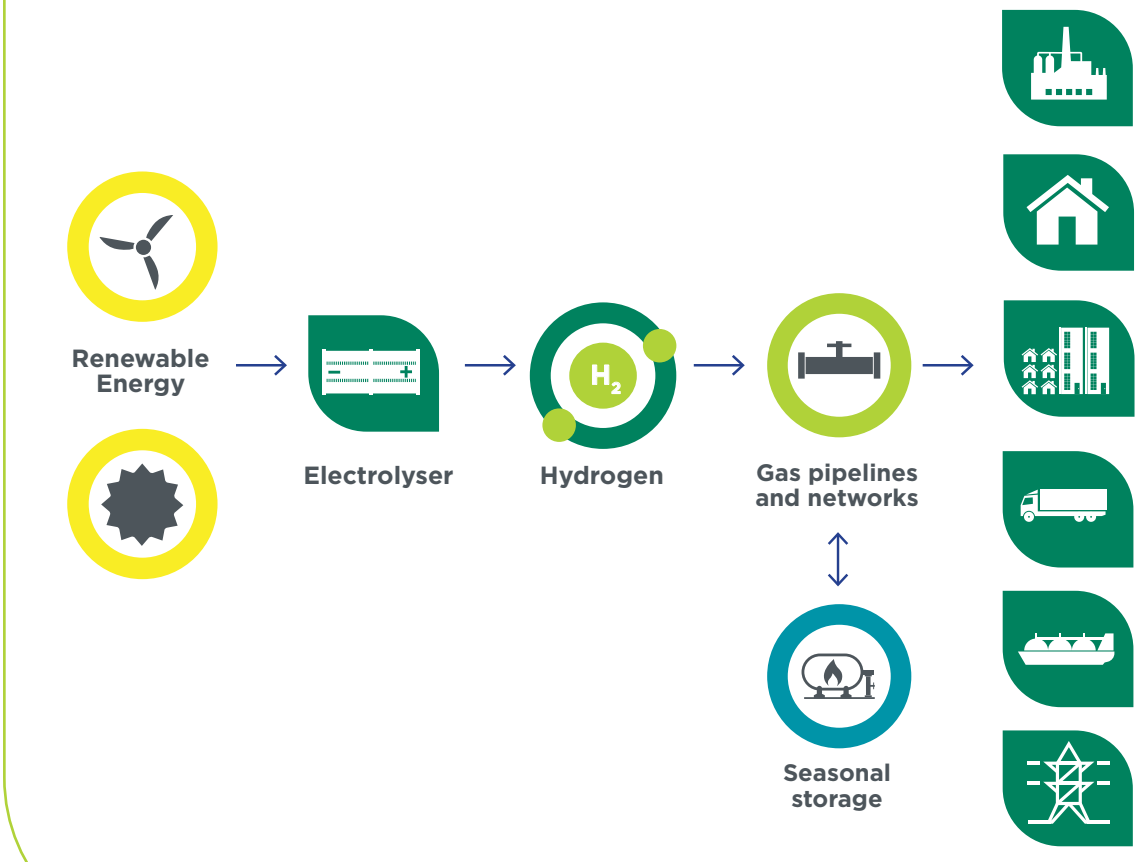
Hydrogen pathway

On its own, hydrogen creates opportunities to directly replace natural gas. But hydrogen has a broader role and an essential component in any of the decarbonisation options. In the renewable methane pathway, hydrogen is a key material to produce synthetic renewable methane to compliment biomethane.

In an electrification pathway, hydrogen will be used as an industrial feedstock and to supply those very high temperature industries.

The hydrogen pathway is much broader than replacing gas with hydrogen in pipelines and distribution networks.

Figure 7: Renewable hydrogen production.



The potential is that it creates opportunities across many sectors of the economy, such as:

- Improved utilisation of renewable electricity generation by being able to use curtailed electricity to produce hydrogen,
- Supporting stability of the electricity grid through both long term storage and being a variable load that can be switched off quickly but also by being a fuel that can be used to generate electricity during low renewable generations (similar to the role of natural gas peakers today),
- Being an industrial feedstock where hydrogen can be used instead of natural gas,
- Utilising geological energy storage to meet seasonal heating demands in colder regions,
- Mobility options including freight and passenger vehicles,
- Replacing diesel in stand-alone remote power options, and
- Creating renewable energy export opportunities for Australia.

There are a variety of technologies to produce hydrogen. Renewable hydrogen is created from splitting water using renewable electricity and produces green hydrogen. The process of electrolysis is well understood but the cost of green hydrogen is not yet competitive with the fuels it would substitute. The Australian government[9] has set a production target of $2/kg hydrogen. At this price point, hydrogen becomes commercially competitive for a number of industries where natural gas is used as a feedstock. With further improvements in technology and reductions in renewable electricity costs (the main cost input for hydrogen), cost will decrease further so hydrogen becomes a commercially competitive option to displace natural gas for heating (Box 3).

Developing the hydrogen pathway

Reaching 100 per cent hydrogen in networks will be achieved in two stages. The first one is to blend at least 10 per cent into the network, followed by a second stage of conversion of the network to 100 per cent hydrogen.

The main objective of the blending stage is about engaging with customers, building scale and preparing for a conversion to 100 per cent including assessments of infrastructure suitability, scaling up hydrogen production and developing a local manufacturing capability for hydrogen appliances. The second stage would involve making modifications to infrastructure to ensure safe operation, replacing natural gas appliances with hydrogen appliances and replacing the fuel in pipelines and networks with hydrogen. Introducing the right policy options at the right time will be important to facilitate that conversion, for example, enabling the introduction of hydrogen ready appliances before the conversion is planned to take place.

The hydrogen pathway will require actions across the whole supply chain, supported by market development settings and supportive policy options.

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9 Australian Government (2020), *First Low Emissions Technology Statement - 2020*

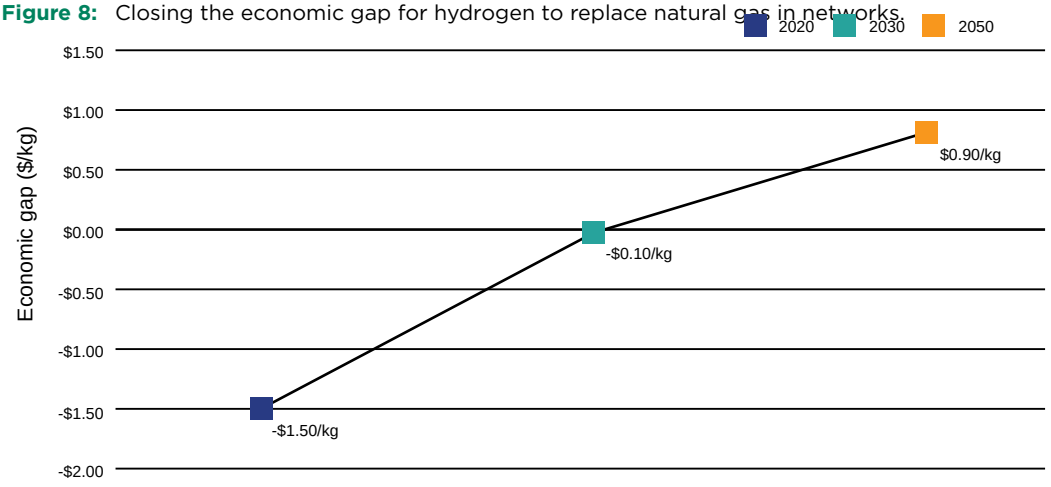
BOX 3: Renewable hydrogen's opportunity to become competitive with natural gas.

The present cost of renewable hydrogen production means it is only economically competitive against incumbent fuels in a small proportion of industries. The Clean Energy Finance Corporation[10] (CEFC) found that remote power, line haul vehicles, materials handling and return to base vehicles were the only opportunities that represented a net economic benefit for hydrogen based on 2020 data. This primarily reflects the high fuel costs of those industries. Reducing the cost of hydrogen production through reductions in electrolysers manufacturing costs, bringing down the cost of renewable electricity and optimising the capacity factors of electrolysis plants makes the economic benefits of those sectors greater and creates new economic opportunities for other sectors.

Using the CEFC data, there is an economic gap to replace natural gas with hydrogen in gas networks. This is partly due to the much higher production cost on a $/GJ of hydrogen compared to natural gas but also does not recognise the potential economic benefit from reduction in carbon emissions when using renewable hydrogen. As renewable hydrogen technology develops, the economic gap for hydrogen in networks reduces to reach parity with natural gas in the early 2030's.

Blending hydrogen in gas pipelines and distribution networks by 2030 will create the background knowledge and establish the correct policy settings to support a conversion to 100 per cent hydrogen. There will be a need for supportive policy settings and short-term incentives during this blending phase as the technology develops and the economic gap disappears.

Figure 8: Closing the economic gap for hydrogen to replace natural gas in networks



10 Clean Energy Finance Corporation (2021), *Australian hydrogen market study – sector analysis summary*

Progress against key hydrogen actions

The next five years are critical to the renewable hydrogen transition – this is when the 10 per cent blending trials and the preparatory work for 100 per cent trials in new property developments needs to take place.

Hydrogen is a different gas compared to methane and has some differing properties that need to be considered. There are concerns about the potential of hydrogen embrittlement in steel pipelines, and its performance in appliances. There is extensive work underway across a variety of projects to test these issues. The table below identifies the major actions that should be progressed for hydrogen.

Table 3: Hydrogen pathway actions

Action	Progress	Flag
Safety: Gas distribution networks. The use of hydrogen in modern gas distribution networks, which are mostly made of plastic materials, is considered safe. Formal testing and safety cases need to be provided prior to blending up to 10 per cent hydrogen or conversion to 100 per cent hydrogen.	Australia's gas networks are being replaced with plastic materials as part of an ongoing safety program. These will make networks compatible with hydrogen. Specific safety cases have been prepared for hydrogen blending in the Hydrogen Park SA project in Adelaide, and the Western Sydney Green Hydrogen Hub (WSHH) in Sydney. Other safety cases are under development for blending. Active research and testing program at Future Fuels CRC on plastic material research. Test facility assessing the suitability of network materials from all of Australia's gas distribution. The Australian Hydrogen Centre is completing feasibility studies of blending and 100 per cent conversion in SA and VIC.	**10% Blend**  **100%** 
Safety: High pressure transmission pipelines. The use of hydrogen in steel transmission pipelines has the potential to affect the ductility, toughness and fatigue life of the steel through a process known as hydrogen embrittlement. The National Hydrogen Strategy[11] recommended not allowing any hydrogen in these pipelines unless testing was completed. Formal testing and safety cases need to be undertaken before hydrogen is injected into transmission pipelines as part of blending programs.	Active research and testing program at Future Fuels CRC for steel pipeline materials. GPA Engineering report completed on the potential to repurpose existing pipelines with hydrogen. APA is completing a test program to enable the conversion of 43km of the Parmelia Gas Pipeline in WA into a hydrogen ready pipeline. A new pipeline is being used for hydrogen storage as part of the WSHH project. AGIG has completed a feasibility study of blending hydrogen into the Dampier Bunbury Pipeline in WA[12].	**10 % Blend**  **100%** 

11 COAG Energy Council (2019), *Australia's National Hydrogen Strategy, Action 3.15.*

12 www.mediastatements.wa.gov.au/Pages/McGowan/2022/01/New-reports-help-power-Western-Australias-hydrogen-future.aspx

Action	Progress	Flag
Appliances The performance of existing gas appliances with a hydrogen blends needs to be confirmed for both residential, commercial and industrial appliances. Hydrogen appliances have been developed in other markets (e.g. UK) but are not yet available in Australia. For 100 per cent hydrogen, new appliances need to be developed and tested in Australia.	Active research on hydrogen blend impacts on gas appliances at Future Fuels CRC for residential, commercial and industrial facilities. Safety cases of using natural gas blends on existing residential appliances have been completed as part of the existing blending projects. A safety case for blending using industrial appliances is underway for Hydrogen Park Gladstone.	**10% Blend**  **100%** 
Security of supply Hydrogen can be produced via a number of pathways. Producing green hydrogen, from renewable electricity, will require growth in renewable electricity generation. The integration opportunities and system wide benefits for hydrogen to link the electricity and gas infrastructure are one of the key advantages that increase the reliability of electricity while also meeting the seasonal energy load provided by gas.	FFCRC has modelled the opportunity for using curtailed electricity to produce hydrogen and to model a uniform blend across the network. Integration of electricity supply and electrolyser operation considered in business cases for blending projects. The Australian Hydrogen Centre is developing high level plans for rolling out 100 per cent hydrogen in South Australia and Victoria.	

Demonstration projects

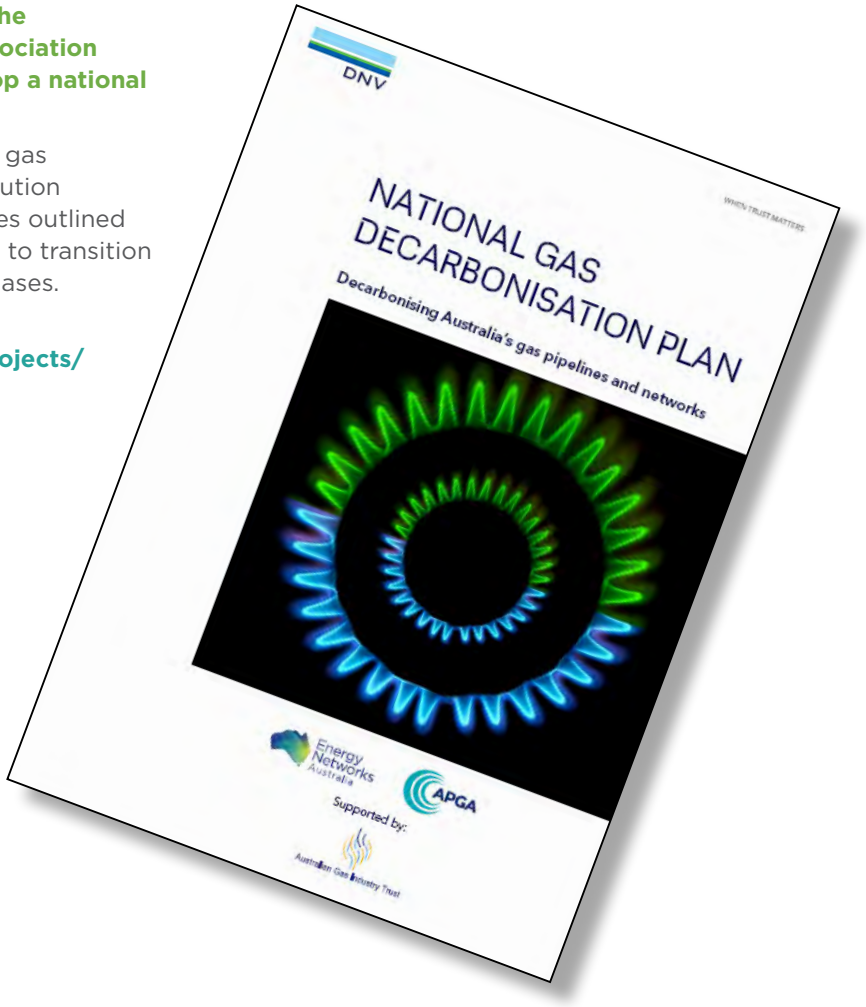
- ATCO, Clean Energy Innovation Hub, Perth – operational since 2018
- AGIG, HyP SA, Adelaide – operational since 2021
- Jemena, Western Sydney Green Hydrogen Hub project, Sydney – operational since 2021
- AGIG, HyP Gladstone, QLD – under construction/ operational in 2022
- AGIG, HyP Murray Valley – prefeasibility
- AGIG & ATCO, Clean Energy Innovation Park, WA - prefeasibility
- APA – Parmelia pipeline conversion, WA – prefeasibility study

Learn more

Energy Networks Australia and the Australian Pipelines and Gas Association commissioned DNV GL to develop a national gas decarbonisation plan.

This plan sets out how Australia's gas transmission pipelines and distribution networks will deliver the objectives outlined in the Gas Vision 2050 document to transition to renewable and decarbonised gases.

The report is available from **www.energynetworks.com.au/projects/gas-vision-2050**



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Australian Gas Industry Trust

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