Decarbonising Australia's gas networks

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Energy Networks Australia

APGA

GAMAA

About Gas Vision 2050

Gas Vision 2050 was developed by Australia's peak gas industry bodies and demonstrates how gas can continue to provide Australians with reliable and affordable energy in a low carbon energy future.

The vision outlines how Australia's gas supply and infrastructure can be a national advantage as our energy mix continues to evolve. A plan for the longer term, Gas Vision 2050 balances energy security, reduction of greenhouse gas emissions and affordable energy.

Gas is widely used as an energy source across the economy. From heating Australian homes to domestic and commercial cooking, transport, and industrial processes. It is also an essential input for Australia's manufacturing industry, particularly plastics and fertiliser manufacturing. These industries cannot continue without gas.

Deployment of new technology will drive the decarbonisation journey of gas.

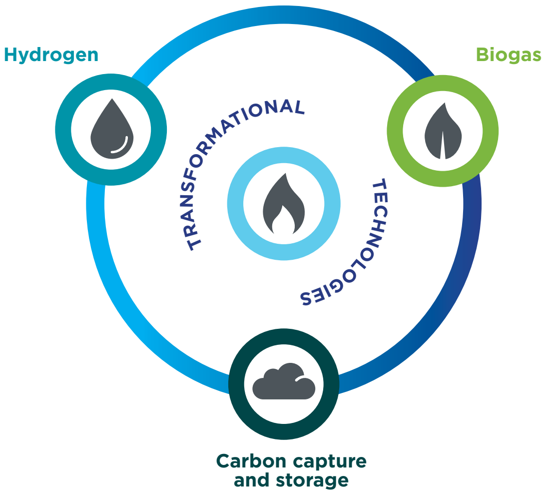
Figure 1: Gas Vision 2050 (Source: Energy Networks Australia)

Decarbonisation pathways

Decarbonisation pathways for gas include the three transformational technologies identified in Gas Vision 2050.

For gas networks, current activities are focussed on gaining practical experience with technologies and identifying opportunities to decarbonise the networks over the longer term. The pathway and ultimate mix of decarbonised gas will consider regional energy advantages and technological developments.

Figure 2: Transformational Technologies in Gas Vision 2050 (Source: Gas Vision 2050)

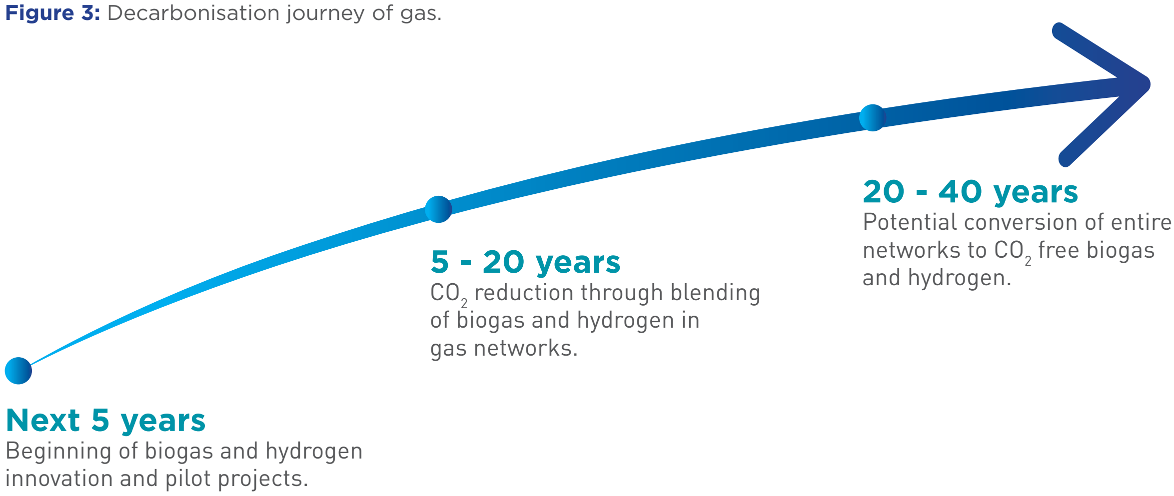


Biogas production – Biogas consists of methane and is already produced from municipal solid waste. Significant potential exists to produce biogas for injection into networks. It emits net zero CO_2e, and is treated as part of the natural carbon cycle under the Australian national greenhouse gas accounting framework.

Hydrogen: Hydrogen can be produced from natural gas or through electrolysis. Hydrogen creates opportunities for clean energy for households, businesses or transport and can also generate zero emissions electricity using fuel cells or gas turbines. Hydrogen is emissions neutral when produced from renewable energy or steam methane reforming coupled with carbon capture and storage.

Carbon capture and storage (CCS) refers to the process of producing decarbonised hydrogen from gas, coal, or biogas to remove carbon dioxide from the carbon cycle. The carbon dioxide is then stored in geological formations. Gas has its own decarbonisation journey.

Figure 3: Decarbonisation journey of gas.



Decarbonisation technology cost reduces over time

All decarbonised energy technologies will become more cost efficient over time.

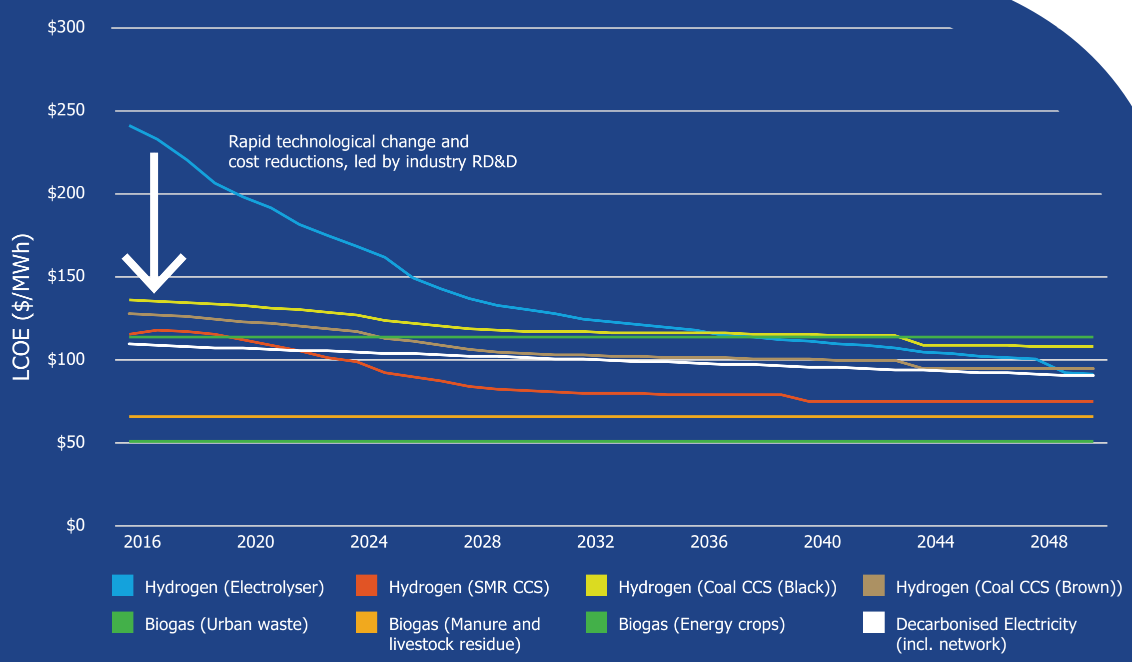
Biogas from urban waste is already commercially competitive. Similarly, hydrogen production from natural gas is currently competitive with decarbonised electricity. Modelling by Deloitte Access Economics[2] indicates that by 2050 the production costs of hydrogen from electrolysis, steam methane reforming with CCS or coal gasification with CCS will be competitive with decarbonised electricity.

Additional benefits can be realised by integrating electricity and gas networks through hydrogen production from electrolysis. This process allows surplus renewable energy to be stored as hydrogen in the gas network and can be conserved and for later use converted back to electricity or used for domestic or industrial heat.

A study[3] on the German energy system found that "*A 100% renewables-based energy system with power-to-gas would cost €12-18 billion per year less compared to an energy systems without power-to-gas.*"

The cost projections to 2050 are considered conservative compared to the cost reductions experienced in solar PV and battery technologies. Hydrogen production costs could be further reduced by optimising production facilities, more cost effective transportation and harnessing surplus renewable energy as high levels of electricity generation are achieved.

Figure 4: LCOE of Decarbonisation approaches to 2050
(Source: Deloitte Access Economics (2017))



Secure, reliable and affordable energy system

The focus of Australian energy policy to-date has been on decarbonising the electricity sector.

Whilst this is a key priority, the scope for the energy sector is broader.

Decarbonising transport and the use of gas as a direct fuel in the home and industry is a significant opportunity. Decarbonising electricity while maintaining reliability and affordability is a challenge. Adding to the complexity is the likelihood of more electrified transport in the coming decades.

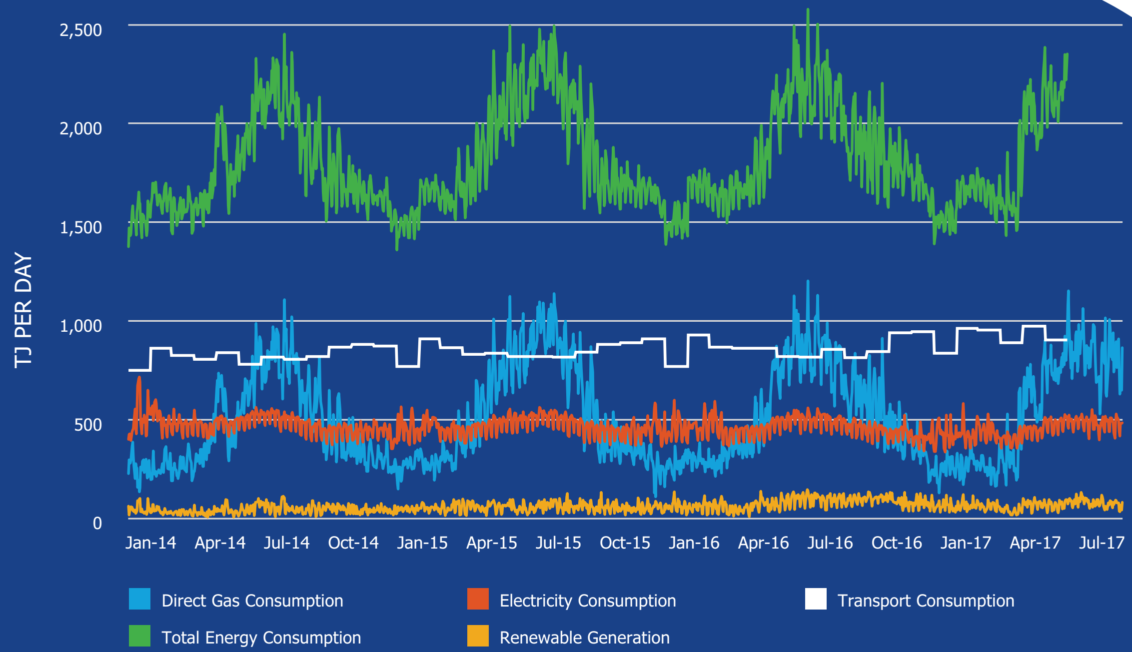
Gas is a seasonal fuel, especially for heating in the home. In Australia's colder regions, roughly three times as much gas is used in winter compared to summer.[4] Peak gas use in winter coincides with peak electricity demand.

The electricity required to replace the energy provided by the gas network will require vast upgrades to electricity generation, transmission and distribution infrastructure as well as additional investment in electricity storage. This raises important questions about practicality and cost.

Decarbonising the gas network in parallel with the electricity network would use existing infrastructure. Additionally, our gas infrastructure and networks have the capacity to store unused renewable electricity to manage hourly, daily and seasonal fluctuations in variable renewable supply and demand providing energy security and reliability.

Using both the gas and electricity networks for decarbonising the energy sector capitalises on existing infrastructure so that new investment isn't necessary and in turn, provides best outcome for consumers in the longer term.

Figure 5 Victoria's daily energy consumption (Source: Energy Networks Analysis based on AEMO data (2017)).



Nationwide opportunities

There is significant potential across the country to support all three transformational technologies. The exact mix and resources used will be dependent on the geographical advantages.

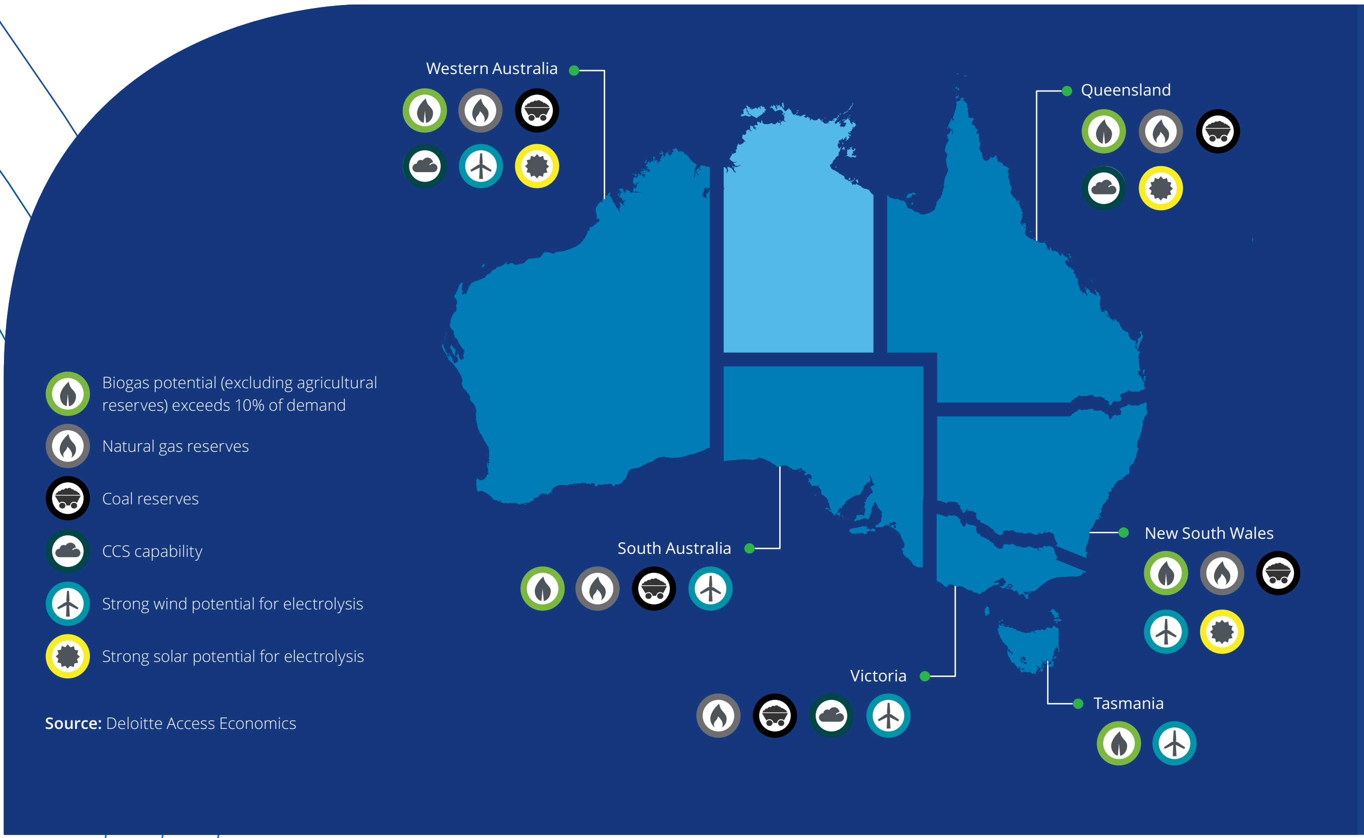
Deloitte Access Economics found that the total national biogas potential exceeds the current gas consumption from the distribution network and is more than double the total residential consumption.

Extensive solar and wind resources are available throughout Australia to produce hydrogen from renewable energy. The amount of water required is immaterial compared to current water usage.[2]

Hydrogen can be produced from natural gas or coal and extensive resources are available throughout Australia. Linking these resources with carbon capture and storage supports the production of low emission hydrogen.

Long term plans for each region will be different, based on individual regional advantages.

Figure 6: Regional advantages
(Source: Deloitte Access Economics (2017))



Networks are ready

Australia may look to Europe as a successful case study of hydrogen injection into networks, with 70 power-to-gas projects already realised or underway[3].

Modern Australian distribution networks using plastic pipeline materials are compatible with hydrogen and there are no known complications associated with injecting volumes of up to 30% in these networks.[5] Many existing residential appliances are tested to operate under limited conditions with hydrogen at levels of 13%.

As industry progresses to conversion of entire networks to high levels (perhaps 100%) of pure hydrogen, testing of materials will be required. Transmission pipelines may need modification to ensure operational safety of high pressure pipelines. Current appliances will require modification or replacement. Presently, there isn't global demand for hydrogen appliances, however the technical benefits of such devices are well understood and it is expected that hydrogen appliances will come to market around 2019 - 2020.[7]

Figure 7: Summary of technical issues related to hydrogen injections (Source: Energy Pipelines CRC (2017))

Consideration		Outcome
Pipes/Fittings	✓	H_2 compatible: Low carbon steel (at least to 30%), PE/non metallic, copper, cast iron, seals and gaskets.
	✗	Not H_2 compatible: High strength steels at high pressures >2,000kPa
Meters	✗	Turbine meters may require retuning for gas density
	✓	No influence of 17% H_2 on leather and plastic diaphragm meters
Leakage	✓	H_2 permeation coefficient 5 times CH_4 but leakage remains very low
Residential Appliances	✓	Approximately 5% H_2 blend easily achievable with minor modifications to some appliances required up to around 15%.
Network Safety	✓	No material safety impact using blends under consideration
Odorisation	✓	No chemical incompatibility between H_2 and common odorants
Leak Detection	✓	Semiconductor-based detectors suitable for H_2
	✗	Flame ionisation, infrared sensors do not detect H_2

Regulation

The injection and distribution of natural gas in Australia is supported by a legal Commonwealth framework and supporting jurisdictional legal instruments and regulations.

A review of the legal framework demonstrated:

- Injection of hydrogen or biogas into the gas distribution network by a gas distributor is not of itself prohibited under gas legislation
- Organisations will need to ensure that injections comply with quality and safety standards and other conditions in State or Territory gas legislation
- Conditions vary by jurisdiction
- Some jurisdictions recognise hydrogen and biogas while other regions only recognise natural gas
- Conversion to 100% hydrogen or biogas will require updated legislation that currently only addresses natural gas.

Biogas can easily be cleaned after production to meet network specifications and can thus be used interchangeably with natural gas in networks.

Blending small amounts of hydrogen with natural gas would still meet the gas specifications. Blending higher amounts or indeed, injecting pure hydrogen, would require the specifications (and subsequent appliance use specification) to be updated.

Figure 8: Australian network gas specification (Source: AS4564-2005: Specification for general purpose natural gas)

Specification Limits		
Characteristics and components		**Limit**
Wobbe Index	Minimum Maximum	46.0 MJ/m^3 52.0 MJ/m^3
Oxygen	Maximum	0.2 mol %
Hydrogen sulfide	Maximum	5.7 mg/m^3
Total Sulfur	Maximum	50 mg/m^3
Water content	Maximum	Dewpoint 0˚C at the highest MAOP in the relevant transmission system (in any case, no more than 112.0 mg/m^3
Hydrocarbon dewpoint	Maximum	2.0˚C at 3500kPa gauge
Total inert gases	Maximum	7.0 mol %

Industry led development

Achieving long term decarbonisation will require coordinated effort from policy makers, industry, appliance manufacturers, retailers and researchers.

Industry is leading a range of demonstration projects using hydrogen, biogas and hybrid systems across the country.

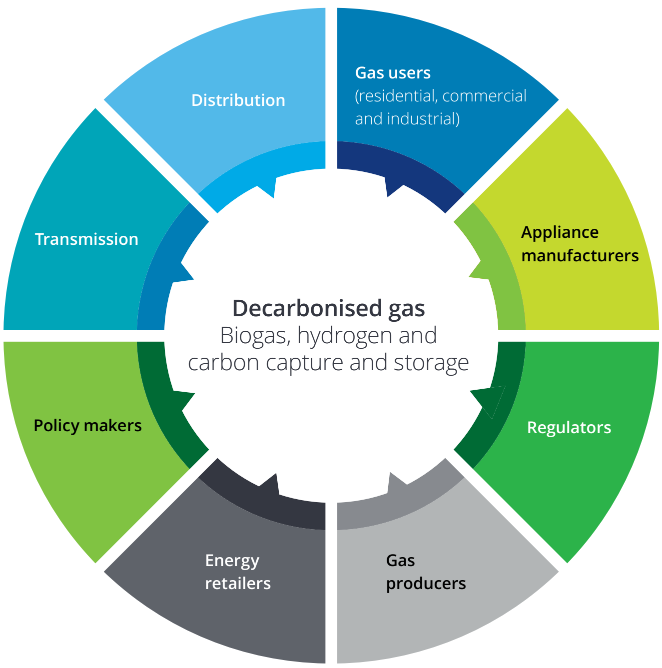
- GasSola by ATCO Gas Australia in Western Australia is demonstrating how natural gas generators, solar PV panels and batteries can be used in a hybrid system to provide reliable and affordable energy at the fringe of grid.
- A collaboration with AquaHydrex and Australia Gas Networks received $5 million of funding from ARENA in late 2017. While the focus of this project is the development of new hydrogen production technology, part of the project examines how this hydrogen can be injected into the network.
- Evoenergy is developing a biogas demonstration using municipal solid waste in the ACT to produce biogas for injection into the local network. Estimated to cost $35 million, construction is expected by 2020.
- Jemena is leading a power to gas project in Wollongong using renewable energy to create hydrogen for network use and for refuelling hydrogen vehicles.
- AusNet Services has partnered with Deakin University to develop a $30 million smart microgrid energy system and research platform at the University's Geelong Waurn Ponds Campus that will provide critical guidance for future distributed energy development including the use of hydrogen.

These projects provide practical experience with technologies and identify long term opportunities.

Industry has also committed over $25 million to the Future Fuels Cooperative Research Centre to provide applied RD&D supporting the decarbonisation of networks

In 2018, Energy Networks Australia, APGA, CSIRO and industry partners are developing a national hydrogen roadmap to support a domestic hydrogen industry that has export potential.

Figure 9: Coordinated effort required for a credible pathway to decarbonise gas (Source: Deloitte Access Economics (2017)).



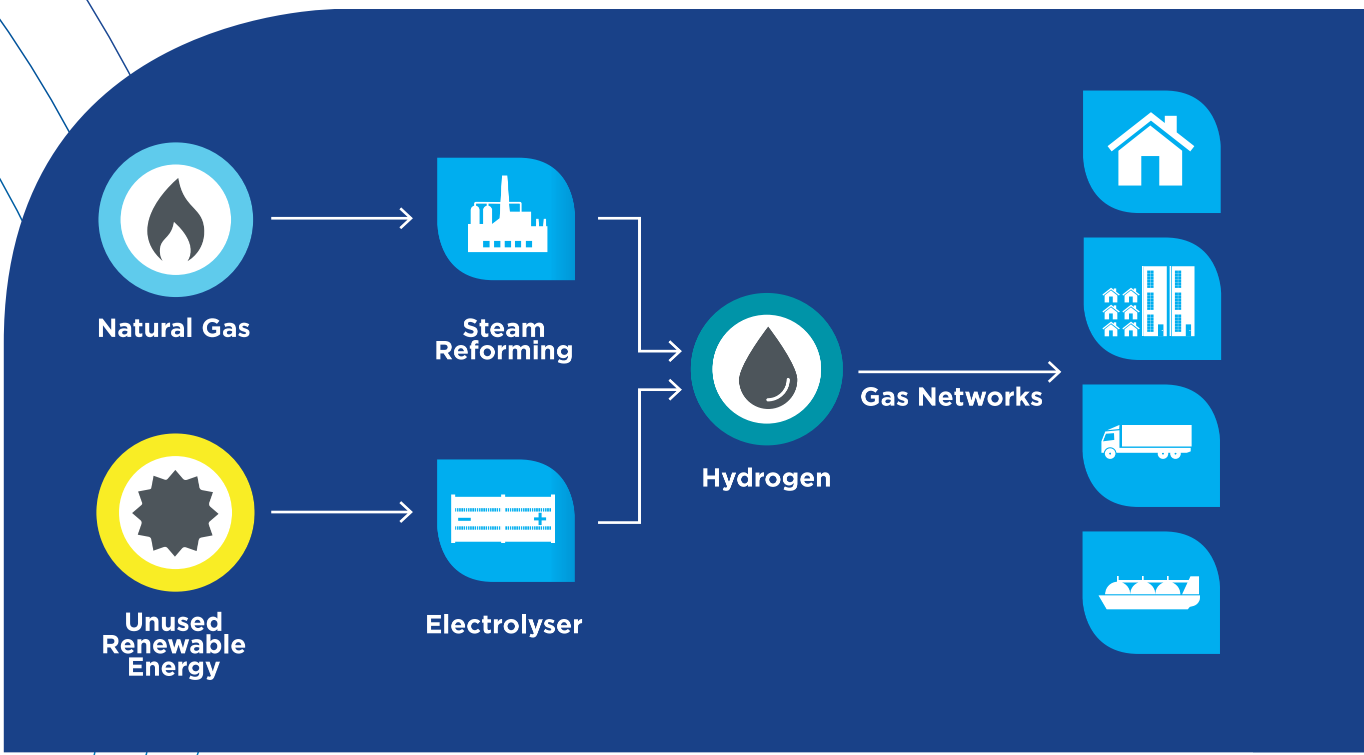
Additional benefits

Decarbonising gas networks supports decarbonisation of the energy sector.

Additional benefits include:

- Increased consumer choice and flexibility. Customers can make informed choices about the energy they use, balancing costs, reliability, cleanliness and utility.
- Coupling gas infrastructure with electricity networks to store electricity through electrolysis. This could improve the utilisation and integration of renewable generation.
- Converting gas supplies with hydrogen may provide spill over benefits for hydrogen fuel-cell transport.
- New energy export industries in the form of hydrogen or ammonia.

Figure 10: Hydrogen pathways creating additional benefits (Source: Gas Vision 2050).



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Australian Gas Industry Trust

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