Gas Vision 2050

Delivering a Clean Energy Future

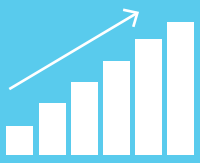
September 2020
Executive Summary

Australian Gas Industry Trust
APGA
appea
the voice of australia's oil and gas industry
Energy Networks Australia
GAMAA
Gas Energy Australia

Gas is essential for Australia

Gas provides around 21 per cent of Australia's end-use energy consumption

almost 1/4



5.2 million connections to gas networks – growing at 100,000 per year

Gaseous fuels are essential to provide high temperature heat and feedstock to manufacturing

79%

of Victorian homes kept warm during winter with gas

2020

First green hydrogen to residential customers

Flexibility of gas enables **higher levels of renewable** electricity

2 million

Australian households use LPG indoors which is supplied through virtual pipelines

$5.8 billion

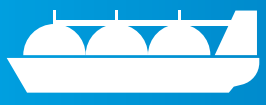
paid in taxes and royalties in 2017-18 to support essential infrastructure and services such as hospitals, schools and roads

$180 million

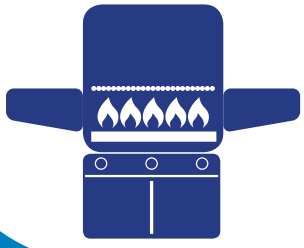
invested to future fuels research and projects

$47 billion

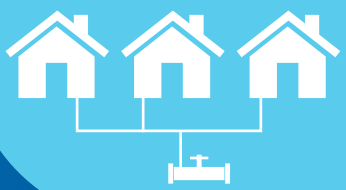
of export trade resulting in cleaner air in our region



Over 18.1 million gas and LPG appliances.



Gas infrastructure delivers more energy than the electricity infrastructure



Australia is on a pathway to decarbonise the gas sector to help meet our nation's emission reduction commitments under the Paris Agreement on climate change.

Today, residential and commercial customers use gas for cooking, space heating and hot water, and in industrial processes gas is used to provide heat and is a major feedstock to produce common goods such as plastics and fertilisers. Gas also plays a significant role in the reliability and stability of our power system by providing peak generation to back up renewable electricity. Gas is one of Australia's most important exports, contributing $47 billion to our economy in 2019-20.

The value of the infrastructure that delivers this energy should not be overlooked. Continuing to use gas infrastructure can reduce emissions at half the cost to customers than electrifying the services provided by gas. This is because electrification will impose massive system-wide costs for grid reinforcements on customer bills.

In the three years since the launch of Gas Vision 2050, the need to reduce emissions has continued to gain community support and many energy supply businesses are offering carbon-neutral products in response to this demand. There is a growing domestic and international interest to decarbonise gas. Industry has responded by leading the development of research, pilot and commercial scale projects to demonstrate this.

Gas Vision 2050

In the next few years, natural gas, LPG and LNG will be supplemented by other gaseous fuels such as hydrogen, biomethane and renewable gas, creating exciting new opportunities. Indeed, in 2020, the first Australian homes will receive a blend of green hydrogen in their gas. The work we are doing aims to minimise impacts to customers while creating additional options to reduce emissions. Initially this will involve blending at low concentrations, followed by scaling up as we learn by doing.

We are on this pathway, but more work needs to be done. In this document we describe the strong progress that has been made in advancing the transformational technologies outlined in Gas Vision 2050 and outline key steps for the next decade to decarbonise Australia's gas sector.

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Executive Summary

Individuals, councils, governments and businesses have proactively implemented net-zero emission targets. While most of the focus has been to reduce emissions from electricity use, attention is also turning to what leadership in reducing emissions from gas use looks like.

Strong support has emerged from residential and commercial customers for cleaner gas options. In turn, energy businesses are offering low emissions energy solutions and demonstrating new zero-emissions technologies.

Published in March 2017, Gas Vision 2050 set its sights on what gas use in our homes, cities, industrial centres and power generators would need to look like in the year 2050.

This is a need, not a want. In line with the 2015 Paris Agreement on climate change, gas must decarbonise and adapt. We have now embarked on this journey and it's creating significant new opportunities in the energy sector.

The Vision

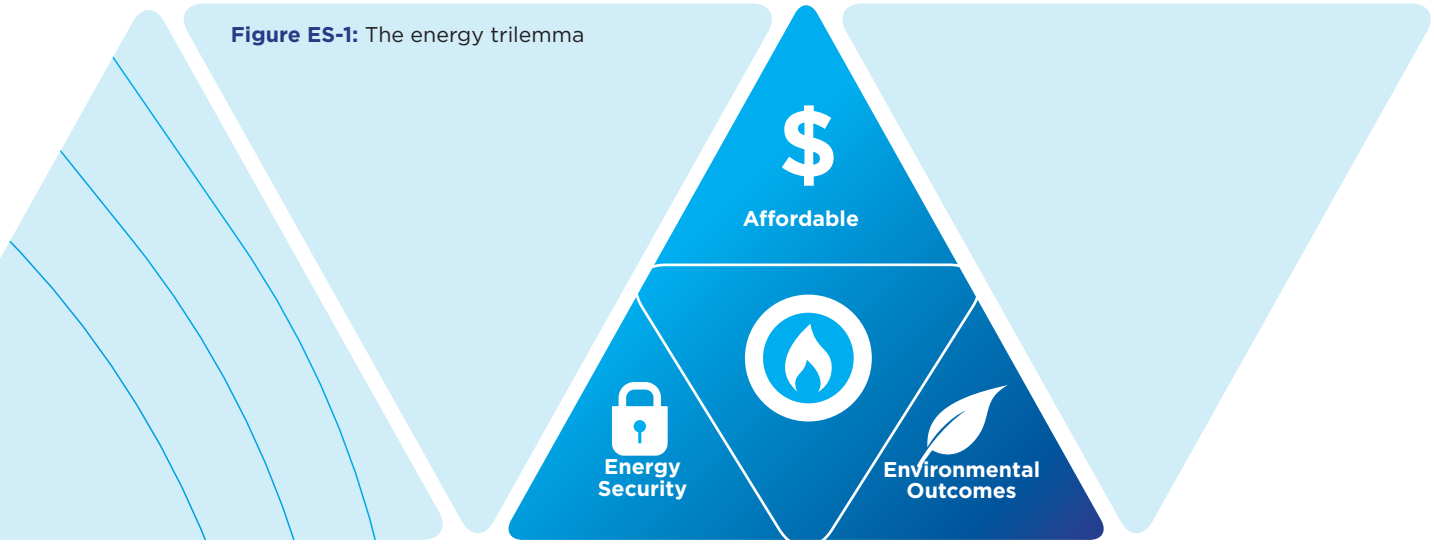
The Vision is for Australia to continue to turn its gas resources into products and services that will enhance national prosperity while achieving carbon neutrality. It identifies how gas and gas infrastructure can be used to solve the energy trilemma by balancing energy affordability, energy security and environmental outcomes. A strategic approach to reducing emissions can utilise developing technologies to also deliver jobs, growth and export benefits for Australia.

Customers are seeking a clean energy future and are engaged in achieving emissions reduction from gas use. This is to be achieved through the widespread deployment of transformational technologies, including biogas, hydrogen and carbon capture and storage. These innovative technologies, alongside renewable electricity, energy efficiency and others, will be used across the economy to decarbonise gas.

A recent joint letter by the Australian Hydrogen council and Bioenergy Australia calling for supportive policy settings for hydrogen and biogas was supported by many businesses and associations across the energy supply chain including customers, technology providers, and energy companies.

Significant progress has been made to achieve the Vision.

Figure ES-1: The energy trilemma



This report provides an update on the progress of this journey made since the launch of Gas Vision 2050 and identifies key priority areas.

Table ES-1: The Vision articulated how technologies would be adopted in different sectors of the economy.

	**Gas in a 2050 home** is one where distributed energy resources and sustainable gas work in harmony. During the day, households generate much of their own electricity through solar PV. Hydrogen fuel-cell or battery electric vehicles are the main mode of family transportation. Zero-emission hydrogen – via the distribution network from the local hydrogen production facility – provides the home with fuel flexibility and powers the family's hydrogen vehicles. Alternatively, zero-emission methane, produced from biogas and hydrogen, could meet home energy requirement with appliances similar to what we have today.
	**Gas in cities in 2050** envisions city blocks as an integrated energy system where excess electricity generated from solar PV on buildings can be exported to charge utility-scale batteries or be converted to hydrogen and zero-emissions methane, which can also be produced from biogas. These gases can then be used to power transport around the city or be converted back to electricity. Hydrogen and/or zero-emissions methane production facilities can be located on the edge of cities allowing gas to be injected back into the distribution network for cooking or heating to restaurants, businesses and entertainment venues.
	**Gas for industrial uses in 2050** will see carbon capture and storage used to ensure that the CO_2 from industry and gas production is not emitted into the atmosphere. This will mean cleaner energy can be exported to our neighbours in Asia as LNG. Alternatively, the CO_2 is used to manufacture specialty chemicals and materials, resulting in zero emissions from industry. Waste materials from the food, agricultural and forestry sectors are processed to produce biogas that is shipped around the country for use in remote regions such as camping or remote mine sites, or for portable use around the home and city. Natural gas can be used directly or as hydrogen as an important feedstock and energy source for materials manufactured domestically, such as fertiliser to support the growing agricultural sector, or plastics, cement and metals to support a growing construction sector.
	**Gas for 2050 power generation** will be decarbonised and widely distributed using a wide range of technologies. While houses and cities generate their own power, the electricity grid provides additional resilience and connects the electrical demand of cities with power generation including large scale hydro, wind, solar thermal and gas. Energy is stored in utility-scale batteries, as hydrogen gas (produced from electrolysis of excess renewable energy), biogas and in traditional pumped hydro. Along with natural gas, these provide frequency and peaking support for the grid during times of high demand. These technologies combine to provide secure, lowest cost and low emissions electricity for use across the economy.

Delivering on the vision

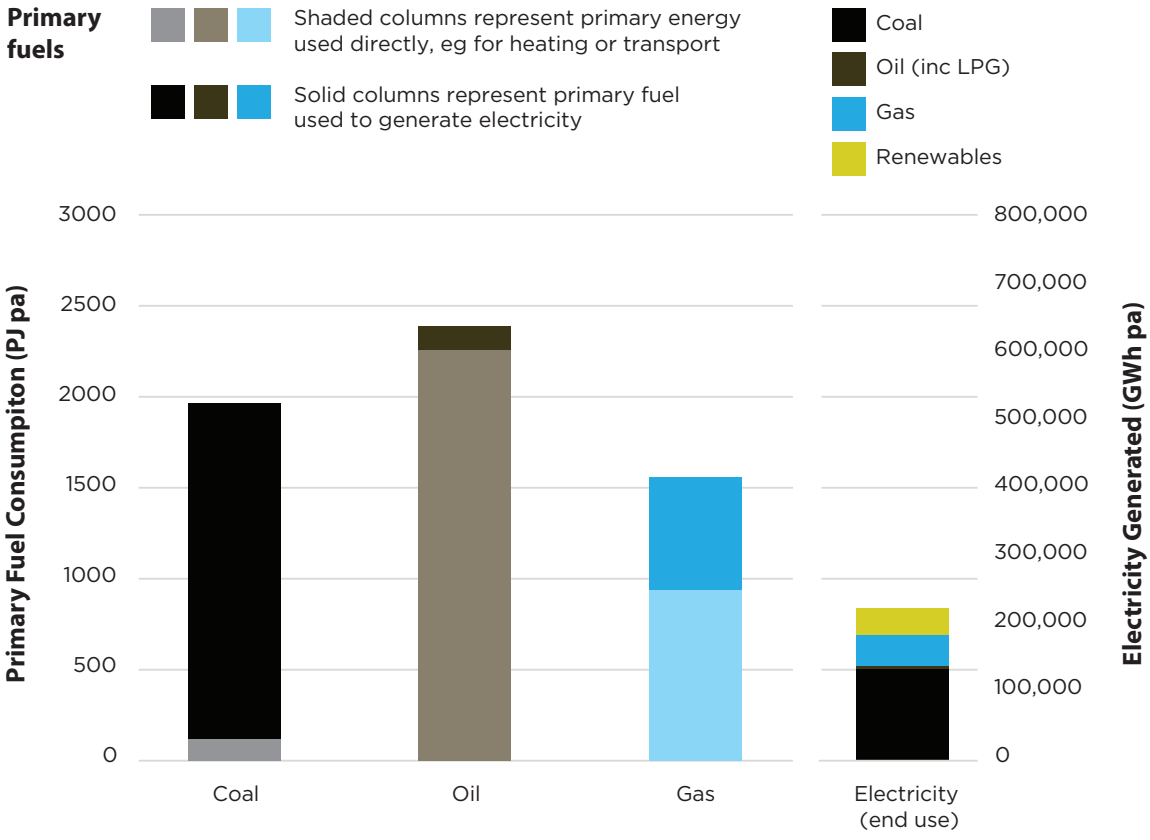
The world has agreed to make efforts to reduce emissions. Most countries, including Australia, ratified the Paris Agreement in 2016 and all Australian states and territories have set targets to achieve net zero emissions by 2050.

While most effort to date has been on reducing emissions from electricity, that effort is mostly about replacing coal fired generation with renewables. Coal provided 1,961 PJ of primary energy to Australia in 2017/18, mostly for power generation. Gas, on the other hand, provided 1,555 PJ of primary energy with 39 per cent of this used for power generation and the remaining 943 PJ as direct end-use.

This direct-use of energy of natural gas exceeds Australia's total electricity end-use of 835 PJ. **Natural gas has the broadest application of all primary fuels being used directly in households, businesses and industry as well as to generate 21 per cent of Australia's electricity and its use as a fuel in transport.**

Natural gas provides many other benefits besides fuel. The Australian oil and gas exploration and production sector supports 80,000 direct and indirect Australian jobs and hundreds of thousands more in the manufacturing sectors that rely on natural gas. Downstream, **there are many jobs reliant on natural gas** including energy and appliance retailers, gas fitters, appliance manufacturing and also those industries that use natural gas such as hospitality. As a feedstock, it is used by many manufacturing industries.

Figure ES-2: Australia's energy consumption (2017/18)



Through our exports, similar economic and job benefits are provided in other countries. Moreover, when natural gas in used to replace coal in power generation, it provides cleaner air in those countries providing better health for those populations, as well as reducing greenhouse gas emissions.

Transformational technologies to realise gas decarbonisation are being adopted by industry, including hydrogen, biogas, bio-LPG, renewable methane and carbon capture and storage (CCS). Hydrogen can be produced through renewable electricity in electrolysis to produce green hydrogen or from natural gas combined with CCS to produce blue hydrogen.

While these are different processes, they both provide decarbonised gas. Industry is already investing and moving beyond the research and development phase with demonstration projects underway to deploy a broad range of these technologies as well as commercial-scale CCS project at Gorgon Carbon Dioxide Reinjection Project in Western Australia.

Some of the achievements to date are shown in Table ES-2

Table ES-2: Gas Vision 2050 key achievements to date

Hydrogen

- The progress in hydrogen has been the most publicised – led by the development of Australia's National Hydrogen Strategy as well as strategies by each state. The development of the strategy and the Future Fuels CRC have been highly influenced by Gas Vision 2050. Hydrogen offers opportunities in many sectors and Australia's gas infrastructure is well placed to decarbonise residential and commercial gas use by adopting hydrogen. While hydrogen is already produced commercially, its current role has been limited as a feedstock and not as an end use fuel in appliances.
- The gas industry has invested in demonstrating renewable hydrogen production facilities and supporting research through the Future Fuels CRC to accelerate the uptake of hydrogen in the economy.
- Producing renewable hydrogen is already being demonstrated in Canberra and Perth, and soon two more projects – in Adelaide and western Sydney – will come online. Across these projects, more than 2 MW of hydrogen production capacity will be installed that will deliver renewable hydrogen to households. A further hydrogen blending project is planned for the city of Gladstone in Queensland allowing hydrogen to be provided to both residential, commercial and industrial customers.
- The Australian Hydrogen Centre was established in early 2020 to develop feasibility studies on 10 per cent renewable hydrogen in the gas distribution networks of South Australia and Victoria and develop a pathway to make the transition to 100 per cent hydrogen networks.
- Governments are backing hydrogen projects. The Commonwealth government has allocated a further $370 million towards scaling up hydrogen electrolysis projects and all states and territories are also making funding available to advance hydrogen.

Table ES-2: Gas Vision 2050 key achievements to date (continued)

Natural Gas

- The Future Energy Exports Cooperative Research Centre (FEnEx CRC) will execute cutting-edge, industry-led research, education and training to help sustain Australia's position as a leading LNG exporter, and enable it to become the leading global hydrogen exporter. The CRC is a national collaboration of 28 industry, government and research partners. Over the next decade, the collaboration will develop new knowledge and demonstrate innovative technologies aimed at making LNG and hydrogen production more efficient while also lowering their emissions.
- Carbon offsets are already being widely used by supporting activities that reduce emissions in other parts of the economy. Residential, commercial and industrial natural gas users can purchase offset certificates on the market to achieve net-zero emissions from gas use.

Carbon capture and storage

- In carbon capture and storage, the Gorgon project commenced its CO_2 Injection Project in 2019. It is the biggest CO_2 storage project in the world, storing 3.4 to 4.0 million tonnes of CO_2 per year. Research supported by the gas industry is ongoing at CO2CRC and in various parts of Australia to identify and develop suitable geological storage opportunities that can be used to decarbonise Australia's energy sector.

Bio-methane

- A bioenergy roadmap is under development by the Commonwealth Government, which will outline the opportunities of bioenergy to decarbonise the economy. Biogas is already produced in Australia but is generally directed towards producing renewable electricity as that is incentivised through the Renewable Energy Target. Biogas – easily upgraded to biomethane or bio-LPG - has an opportunity to decarbonise the use of gas. The technology is well proven overseas and Australian gas utilities are developing projects to demonstrate the technology locally.

Renewable gas

- The production of renewable gas is a new decarbonisation technology. This builds on the production of renewable hydrogen but continues its reaction to produce methane, which is completely compatible with natural gas. The technology is being demonstrated by industry.

Value of gas and gas infrastructure

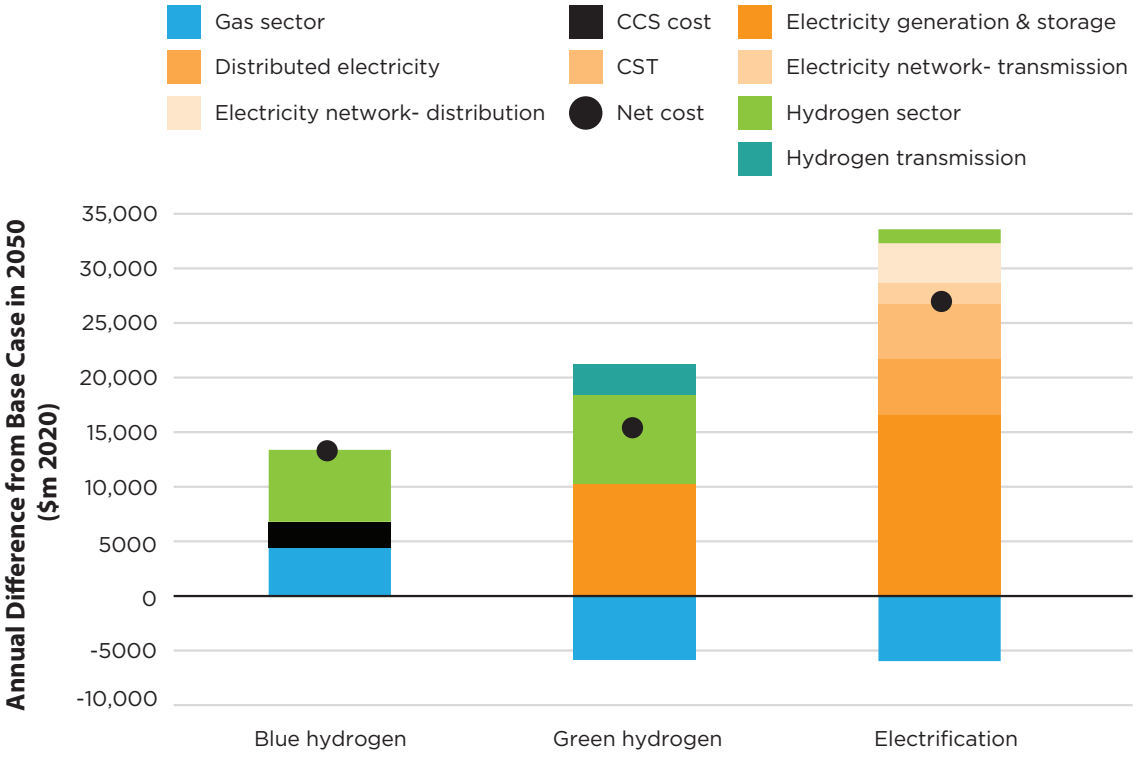
Deploying transformational technologies using existing gas infrastructure is also more economically favourable than electrification.

Frontier Economics completed a study to investigate and evaluate options of the roles of gas and gas infrastructure to achieve a net-zero economy by 2050. The study focused on ongoing capital and operating costs in 2050 assuming a transition to a decarbonised economy was made by then.

The annual costs of different decarbonisation scenarios were modelled. These scenarios were compared to a base case where the electricity sector reached net zero emissions in 2050 while unabated gas use continued to supply heat and feedstock to industry. These scenarios achieved net-zero emission from gas use and included blue hydrogen, green hydrogen and electrification.

- **The blue hydrogen scenario is lowest cost at a net increase of $13.3 bn compared with the base case.** This reflects that more gas is used in this scenario than the base case and that there are extra costs for CCS. The ongoing use of the gas transmission and distribution networks means there are no additional costs for upgrades for electricity generation and the electricity transmission and distribution networks.
- **The green hydrogen scenario ranks second at a net increase of $15.3 bn compared with the base case.** This reflects additional costs of electricity production, and hydrogen production storage and hydrogen transmission. Ongoing use of the gas distribution networks in this scenario means that there are no additional costs of electricity distribution in this scenario.

Figure ES-3: Net cost of decarbonising gas by scenario



- **The most costly scenario is electrification at a net increase of $27.5 bn compared with the base case.** Similar to the green hydrogen scenario, there are savings in the cost of gas supply but additional costs for electricity generation, storage, transmission and distribution. Further, this scenario also incurs costs for hydrogen production to provide feedstock to industrial processes.
- **Moreover, the blue and green hydrogen scenarios are conservative and further cost reductions could be achieved by including the opportunities provided by:**
  - **low cost biogas;**
  - **cost improvements in electrolysis technology; or**
  - **the repurposing of natural gas pipelines to transport hydrogen.**

  These opportunities were not considered in the analysis.

The major conclusions from this scenario analysis are:

- **Net-zero emissions can be reached with hydrogen at half the cost of electrification.**
- Making continued use where possible of existing gas transmission and distribution networks to deliver energy can help avoid the material costs of building new assets such as augmentation of the electricity transmission and distribution networks.
- The finding that both the blue and green hydrogen scenarios are lower cost than electrification suggests that there is value in continuing to make use of Australia's gas infrastructure and Australia's natural gas resources to deliver gaseous fuels to end-use customers.
- This finding also suggests that policies to achieve net zero emissions should be broad-based and not focus solely on promoting the electrification of all stationary energy end-use.

The next decade – accelerating decarbonisation of gas

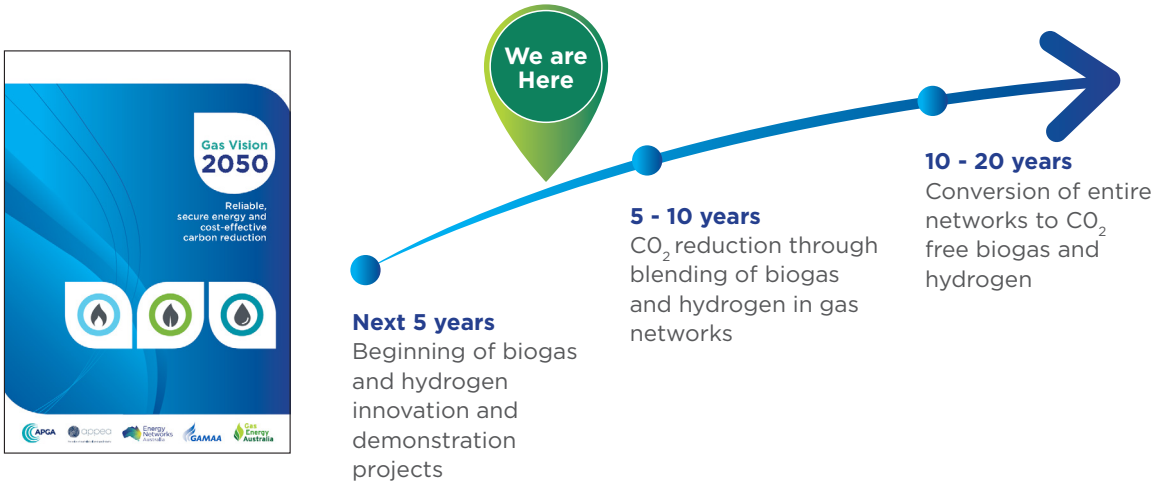
Gas provides major services to customers and to the economy and these services need to be decarbonised. There are a range of options available and the gas industry is continuing to lead the development and demonstration of these technologies. This is balanced with customers seeking options to voluntarily reduce their emissions.

While CCS and carbon offsets are commercially mature, the focus has been on the transformational technologies of hydrogen and biogas, which are still at an early level of commercial development. Hydrogen and biogas for gas are the wind and solar PV for electricity. We are well on track to demonstrate these technologies, showing customers the possibilities of reducing emissions from gas use and are progressing towards demonstrating blending in gas networks.

The next decade must focus on key activities so we are in a position to convert entire networks in the 2030s to hydrogen and biogas. Key steps include:

- developing a certification scheme for low carbon biogas and hydrogen allowing it to be recognised and traded as an emission free product;
- establishing blending and technology targets;
- establishing zero emissions gas contracting arrangements – similar to power purchase agreements for electricity – to create a market for hydrogen and biogas;
- scaling up the production of low carbon gases, through the use of blending in networks, leading to major cost reductions that will ensure conversions of entire network to zero emissions gas;
- continuing research and development of new technologies, or applications of existing technologies to accelerate the reductions of emissions;

Figure ES-4: Pathway to decarbonise gas networks



- demonstrating the safe use of hydrogen in appliances;
- sharing the learnings from the diverse range of demonstration projects underway and use these learnings to inform market and policy settings;
- in conjunction with the broader industry, undertaking large scale demonstrations of transformational technologies to demonstrate their emission reduction potential across the industry; and
- deploying transformational technologies in early commercial opportunities.

Achieving net-zero by 2050 is essential if we are to make a meaningful contribution to global efforts to avoid the worst impacts of climate change. And it is something our customers want us to focus on.

Decarbonising the gas sector requires a long-term focus and a systems approach to energy production, transportation and consumption. Alternative options to decarbonise gas also exist through carbon offsets, energy efficiency and electrification.

In practice, all will be needed to decarbonise the economy, but the transformational technologies being pursued in Gas Vision 2050 provide a wider range of options and additional flexibility to decarbonise the sectors dependent on gas.

For the gas sector, this requires the ongoing development and demonstration of a range of technologies, supported by the right policy and market settings. Industry is dedicated to continuing to progress the transformational technologies to the commercial scale, supported by research, development and demonstration projects. Completing key steps in the 2020s through setting blending and technology targets for 2030 will allow large scale deployment to achieve the desired outcomes in line with the Paris Agreement on climate change. The right policy settings will be required to ensure commercial take-up of those technologies.

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