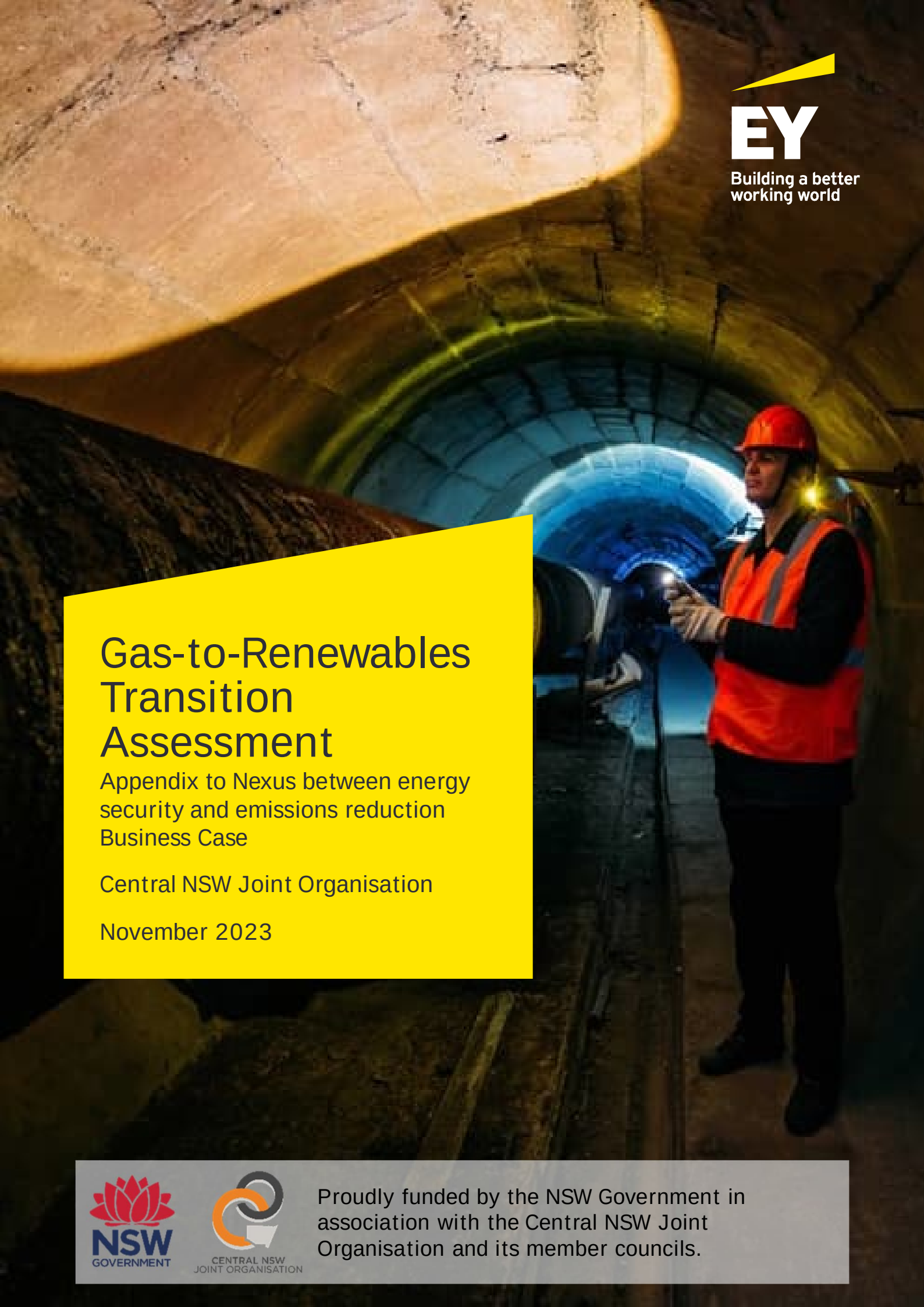

Gas-to-Renewables Transition Assessment

Appendix to Nexus between energy security and emissions reduction Business Case

Central NSW Joint Organisation

November 2023

Proudly funded by the NSW Government in association with the Central NSW Joint Organisation and its member councils.

NOTICE

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The results of Ernst & Young’s work, including the assumptions and qualifications made in preparing the report, are set out in Ernst & Young's report dated November 2023 ("Report"). The Report should be read in its entirety, the applicable scope of the work and any limitations. A reference to the Report includes any part of the Report.

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Our work commenced on 1 June 2023. No further work has been undertaken by EY since the date of the Report to update it, and EY has no responsibility to update the Report to take account of events or circumstances arising after that date. Therefore, our Report does not take account of events or circumstances arising after the 31 October 2023.

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Contents page

Key definitions

A summary of the key terms utilised throughout this report has been listed below.

Term	Definition
APA	APA Group – the gas transmission system owner and operator in the Central NSW region.
Business	'Business' refers to all non-residential natural gas connections / customers.
Capacity	'Capacity' for the purposes of this report refers to generator output, or the size of a generating project - its maximum power output.
Commercial	'Commercial' refers to all non-residential connections / customers excluding large industrial users.
DER	'Distributed Energy Resources' refer to small-scale energy resources that are connected to the distribution network that can produce electricity or actively manage demand. Examples of DER include residential solar PV, batteries, electric vehicles, demand response enabled appliances, etc.
GJ	'Gigajoules' is the unit of energy used to measure gas consumed or delivered.
Industrial	For the purposes of this report, 'industrial' customers are any large industrial operations with material consumption.
Jemena	The owners and operator of gas distribution networks in the Central NSW region.
LGA	'Local Government Area' refers to the individual council areas within NSW. The Central NSW Joint Organisation covers 11 LGAs and a county council.
LPG	Liquid petroleum gas is a blend of propane and butane. While this can also be delivered in reticulated networks, it is generally delivered to customers in 9kg or 45kg bottles or bulk supplied to onsite storage tanks.
Natural Gas	Fossil fuel derived methane gas. This is treated to pipeline specification and delivered by the transmission and distribution networks.
Network Constraint	For the purposes of this report 'Network Constraints' means limitations and challenges that can affect the operation and reliability of the electricity system caused by increase in user demand and technical limitations.
Renewable gas	Methane not derived from fossil fuel sources. This includes biogas produced through anaerobic digestion of organic material and then upgraded to pipeline specification and synthetic gas produced through chemical synthesis processes. These gases are considered to be low carbon intensity.
Renewable LPG	LPG derived from non-fossil fuel sources. This includes bioLPG produced during biofuel refining. This gas is considered to be low carbon intensity.
Rooftop solar PV	'Solar Photovoltaic (cells)' refers to solar panels that convert sunlight into electricity.

1

Executive Summary

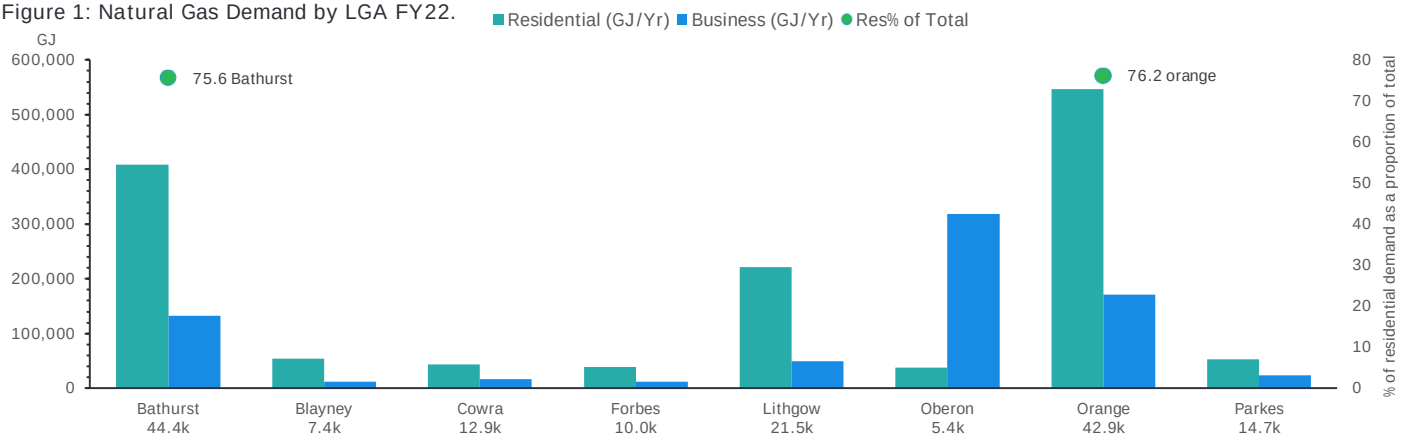
1 Executive Summary

The natural gas distribution network in Central NSW is operated by Jemena and services 8 of the 11 local government areas (LGAs), with any gas consumption in other LGAs or outside of towns met by liquefied petroleum gas (LPG) delivered by tanker or bottle. Current gas consumption is primarily concentrated in the larger population centres of Bathurst, Orange and Lithgow, as well as Oberon due to the large particleboard manufacturer that relies on gas for processing and electricity generation there. This report summarises the current and historical usage of natural gas in the Central NSW region, the available technologies that will enable a transition from natural gas to renewable sources, and the recommended priority opportunities to commence the transition.

The majority of natural gas consumption is concentrated in the more populous LGAs

Natural gas consumption is highest in the large population centres of Central NSW (Bathurst, Orange and Lithgow), where populations are more concentrated in towns where the natural gas distribution network exists. A notable outlier is Oberon; the LGA has one transmission-connected industrial customer, Borg, which is a particleboard and Medium Density Fireboard (MDF) manufacturing facility. The facility is estimated to consume approximately 306,000 GJ of natural gas annually or 14.3% of all consumption in Central NSW.[1] Natural gas contributes 86 tCO2-e per year to the region's emissions.[2]

Figure 1: Natural Gas Demand by LGA FY22.



Source: Jemena; Australian Bureau of Statistics

Business users are decreasing reliance on gas, while residential users are yet to make the switch

Figures 2 and 3 below highlight the trend that residential natural gas consumption has increased over the last 5 years while business consumption has declined, with only Cowra and Orange defying the broader pattern. Over the same period, wholesale gas prices have increased 71.1% in NSW, from $8.81 per GJ to $15.08 per GJ.[3] It is likely that as businesses have higher individual consumption, they are more responsive to fluctuations in gas prices, and will seek out commercially viable alternatives to natural gas.

Figure 2: Residential consumption FY 17 and FY 22.
Source: Jemena

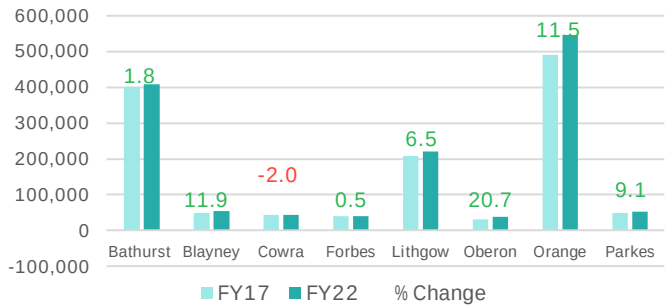
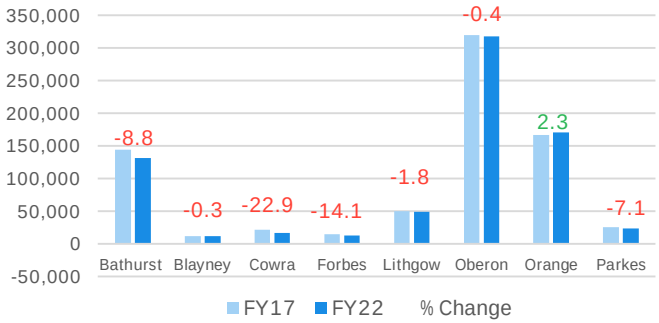


Figure 3: Commercial consumption FY 17 and FY22.
Source: Jemena



1. Borg FY22 consumption estimated based upon GHG Assessment of new Particleboard plant at Oberon, April 2016, Northmore Gordon Pty Ltd.
2. EY Analysis
3. AER, Wholesale Gas Prices (2023), Gas market prices | Australian Energy Regulator (aer.gov.au). Accessed August 2023.

1 Executive Summary

Analysis of alternative technologies to gas revealed residential applications as the likely priority candidates to transition away from gas

An assessment of the appropriate direct substitute technologies has been conducted for key customers of natural gas across the Central NSW region.[3]

Analysis considered the difficulty of installation relative to the current gas technologies, the relative cost of electric technologies to current gas ones, and the likely intensity of impact on the electricity network if technologies were to be adopted.

Table 1 shows that electric appliances for space heating and water heating offer the best opportunities for transition away from gas in both the residential and commercial sectors.

Borg in Oberon was noted in the analysis, but not assessed as a candidate for transition off natural gas due to a recent investment in a 4MW gas turbine to supplement the sites electricity demand.

The results of the analysis factored into identifying 3 key priorities actions, discussed below.

Table 1: Multi Criteria Assessment Summary [4]

	Use cases	Decarbonisation technology	Cost	Ease of implementation	Wider System impacts	Market Size (Customers)	Market Size (Consumption)	Market Size (Consumption per Customer)
Residential	Water heating	Electric heat pump	M	H	L	41,361	1,403,572 GJ	31 GJ/customer
		Solar hot water systems with electric back-up	M	L	L			
	Space heating	Electric heat pump	M	H	M			
		Reverse cycle chillers and air-conditioners	M	H	M			
	Cooking	Induction cooktops	L	H	M			
Commercial Services	Space heating	Electric heat pump	M	H	M	1,968	429,201 GJ	177 GJ/customer
	Water heating	Electric heat pump	M	H	L			
Commercial	Cooking	Induction Cooktop	H	M	M			
Food Production	Low-temperature process heat	Biomass boilers	M	H	L			
		High capacity heat pumps	H	M	M			
	High-temperature process heat High-temperature process heat	Biomass boilers	M	H	L			
		Heat recovery (and upgrading of temperature heat pumps)	H	L	H			
Industrial	Oberon MDF and Particleboard plant	Conversion of gas turbine to renewable MDF drying process conversion	H	L	H	1	306,000 GJ	306,000 GJ/ customer

There are 3 key priority opportunities to accelerate the gas transition in Central NSW

Residential opportunities include:

1. Encouraging existing gas customers to switch their space and water heating and cooking appliances to electric appliances, through information programmes and helping to connect residents with subsidy programmes.
2. Investigating the use of discounted property rates to incentivise households to transition away from gas.
3. Encouraging future residential developments to exclude gas through use of planning/building consent tools and targeted developer contributions.

Opportunities for the commercial and industrial sectors are to:

1. Encourage existing commercial gas customers to convert gas appliances through information provision, connection with state / federal subsidy programmes and rates incentive for conversion from gas.
2. Support large commercial users to convert low temperature process heat from gas through information provision, connection with state / federal subsidy programmes and connections with biomass supply.
3. Encourage commercial development precincts to exclude gas usage, reduced developer contributions for excluding gas, ban on new connections and use of building consents to exclude gas. (see the case study in Appendix 1 for information on Parkes SAP performance criteria).

The security of gas supply is also impacted by weather events that may affect underground pipelines, such as flooding, and extreme weather events are becoming more frequent due to climate change. This could increase the likelihood of gas infrastructure suffering damage, leading to unscheduled outages like the one experienced in Central NSW between November and December of 2022 (see the case study in Appendix 1). Prudent management of pipelines means operators, such as APA and Jemena, will need to consider climate risks going forward to identify mitigation measures that may be required to maintain security of supply for customers in the region.

4. Refer to Chapter 5 for Multi Assessment Criteria methodology and analysis.

2

Introduction

Background

Both the Commonwealth and NSW governments have committed to decarbonisation through legislated policy, targeting net-zero emissions by 2050. Central NSW aims to support the broader government agendas by achieving net-zero by 2050.[5]

Decarbonising the energy system is a core part of meeting our net-zero goals. The Central NSW Joint Organisation (CNSWJO) recognises that an orderly transition to a renewable energy future will require investment in infrastructure in the region. Therefore, CNSWJO is seeking to build the case for a targeted approach to energy infrastructure investment in the region to:

1. Increase energy security for the region; and

2. Reduce emissions, consistent with NSW Government net-zero goals.

To date, the energy transition has been led by the uptake of solar power, in which Australia is a global leader. Australia has the seventh largest installed capacity of solar photovoltaics (PV) and the highest capacity per capita.[6] In large part this is supported by the advanced uptake of rooftop PV on homes, with approximately 1 in 3 homes having installed rooftop solar.[7] However, the transition to renewable energy also requires investment in other variable renewable generation (such as wind) and firming technologies (flexible generation to ensure consistent energy supply, such as batteries) that can adequately substitute the role that coal-fired power generation currently plays (currently around two-thirds of NSW generation) while maintaining a secure and reliable electricity system. The current transmission and distribution networks were also not designed to accommodate the transition, and will need to be invested in.

This report supports the Business Case that identifies the required investment to address the nexus between emissions reduction and energy security in Central NSW.

Objectives

The objectives for this report are to:

- Understand current Central NSW natural gas consumption.
- Understand potential future demand and expected changes over time where possible.
- Understand the opportunities available for transition away from natural gas use.

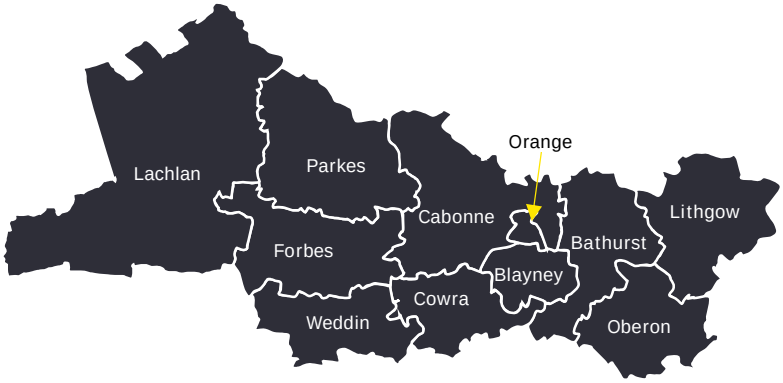
Scope

The scope of this report addresses item 9 of the overall scope of works. It includes the assessment of natural gas demand within the Central NSW region for the past 5 years. The LGAs covered in this assessment are Bathurst, Blayney, Cowra, Forbes, Lithgow, Oberon, Orange, and Parkes. Cabonne, Lachlan and Weddin are not discussed in the assessment due to not being connected to the natural gas distribution network. This report does not explicitly consider the demand for other energy sources.

Central NSW Region

The Central NSW area spans 11 councils in regional NSW, to the west of Greater Sydney. Member councils of the Joint Organisation (JO) are shown in Figure 4.

Figure 4: Map of the LGAs comprising the CNSWJO

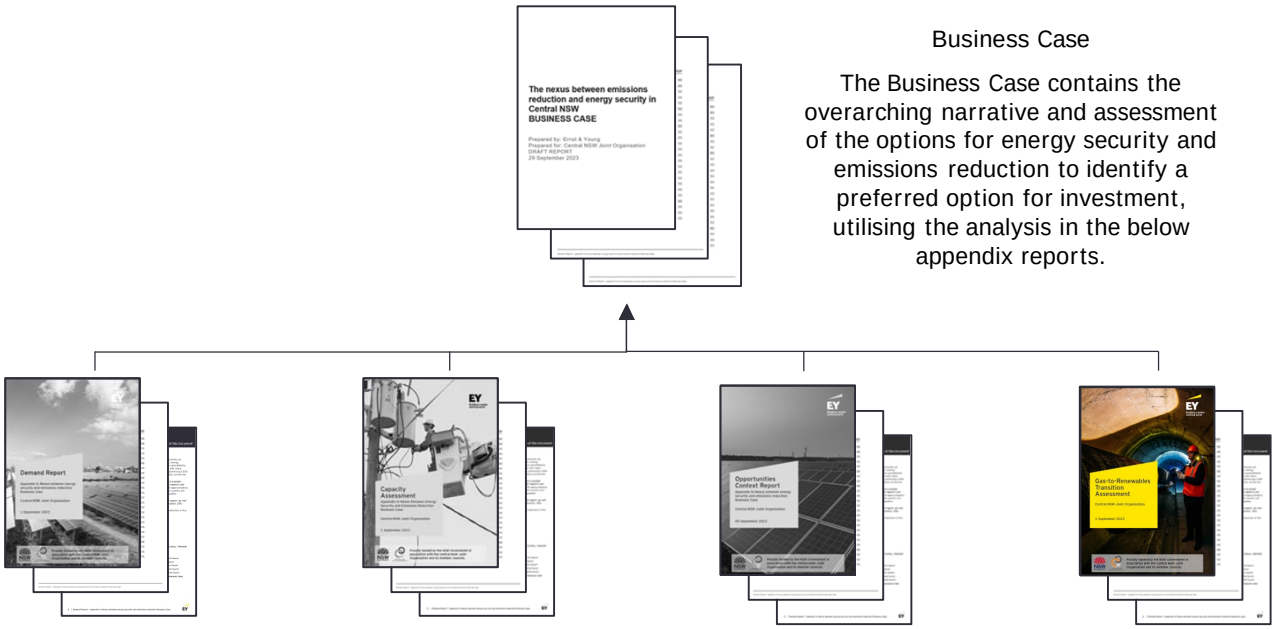


5. BP, Statistical Review of World Energy (2022) https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2022-full-report.pdf. Accessed August 2023.
6. Australian Trade and Investment Commission, Solar Energy: Australia's Renewable Energy Leader (2023), https://www.globalaustralia.gov.au/industries/net-zero/solar-energy. Accessed August 2023.
7. Ibid.

Alignment to other documents

This Gas-to-Renewables report (this report), has been developed in conjunction with three other reports, which cumulatively form the appendices documenting the analysis that supports the Business Case. Figure 5 illustrates the appendix reports produced for the Business Case and an overview of the content. This report should be read in conjunction with the Business Case and its appendices.

Figure 5: Overview of the appendix reports that support the Business Case



Business Case

The Business Case contains the overarching narrative and assessment of the options for energy security and emissions reduction to identify a preferred option for investment, utilising the analysis in the below appendix reports.

Demand Report

This appendix uses data gathered from publicly available sources and Distribution Network Service Providers (DNSPs) to develop a view of current and forecast electricity demand and on constraints in the distribution network.

Capacity Assessment

This appendix summarises an assessment of the region's renewable energy capacity and identifies key limits on the transmission system that could impede the transition.

Opportunities Context Report

This appendix summarises the potential opportunities to deploy distributed energy resource solutions in the Central NSW region that will meet the objectives of the Business Case.

Gas-to-Renewables Transition Assessment (this Report)

This report categorises gas usage in the region, identifies appropriate transition technologies, and prioritises the most impactful opportunities.

Purpose of this report

The purpose of this report is to identify priority actions to support the transition away from gas in the Central NSW region. This report summarises the research and analysis conducted to assess the region's large-scale natural gas consumption. This report draws on publicly available information to provide an overview of:

1. Current and historical gas usage in the LGAs.
2. Available technology to support the transition from gas.
3. Recommended priority opportunities to support the transition.

3

Central NSW Gas Network Infrastructure

3 Central NSW Natural Gas Network Infrastructure

Natural gas consumption is concentrated in eastern LGAs via Jemena's distribution network

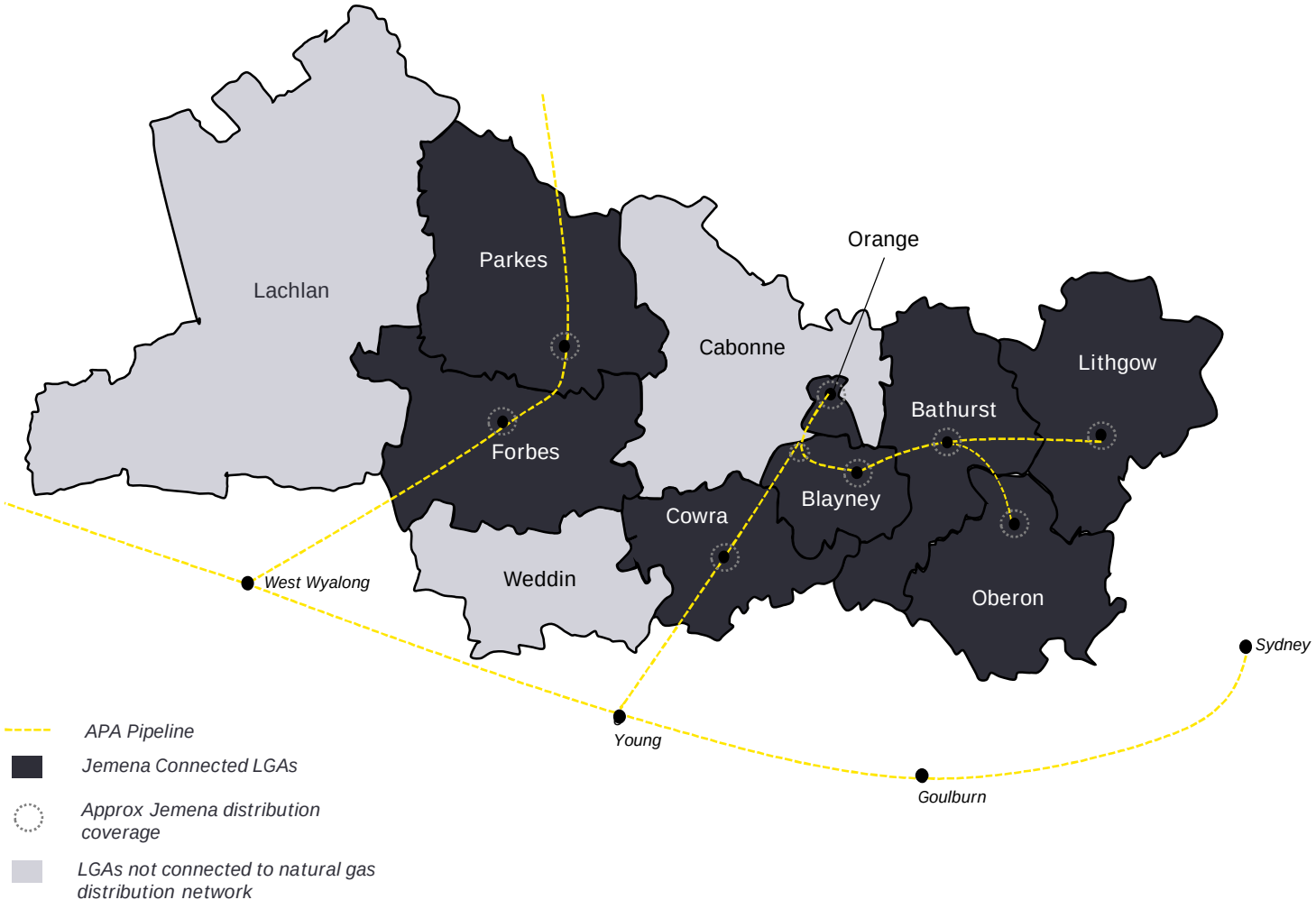
The gas distribution network

In the Central NSW region, there is a gas transmission pipeline owned and operated by the APA Group (APA) that connects to the Jemena distribution network in several of the LGAs. The APA pipeline extends from Sydney and travels west through to Young where the LGAs of Cowra, Orange, Blayney, Bathurst, Lithgow, and Oberon are connected. On the APA pipeline from Sydney, the line travels further north-west from Young to West Wyalong where Forbes and Parkes are also connected. This network is illustrated in Figure 6 below.

The western LGAs, including Lachlan, Cabonne and Weddin are not connected to any natural gas distribution networks. Bottled LPG may be in use in these areas for any domestic or commercial gas supplies. However, there is limited information on this market.

Due to confidentiality reasons, data on individual gas customers was not provided by Jemena.

Figure 6: Map of Key Natural Gas Network Infrastructure in CNSW Region



Source: APA (2023) and Jemena (2023)

Jemena is the sole distributor of natural gas in the central NSW region.

Assumptions

Due to confidentiality reasons, data on individual gas customer forecasts for large industrial businesses was not able to be provided by Jemena. However, the latest available data was provided for natural gas consumption by residential (total) and business user (total) within each LGA. In order to estimate the natural gas needs of residential and business customers, EY has made the following assumptions based upon information from Jemena's online connection portal:

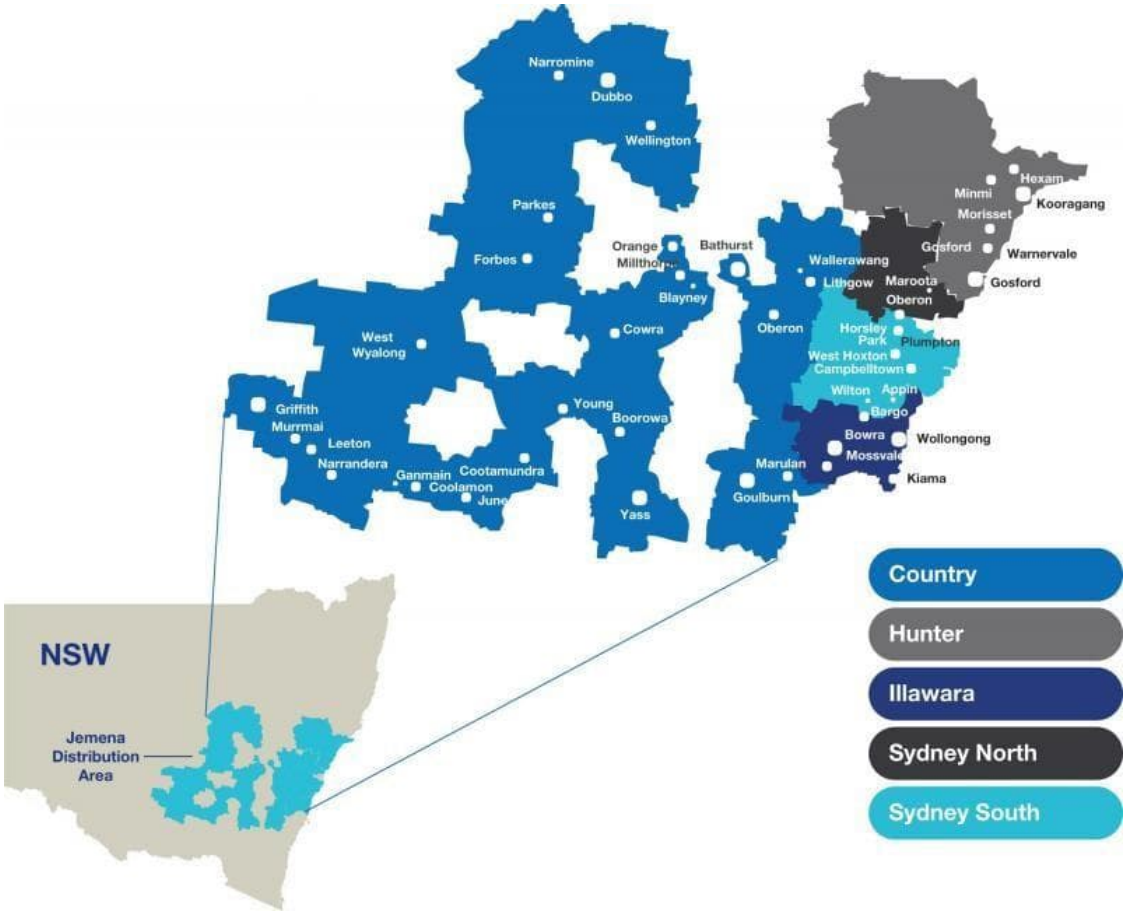
- Locations showing as 'no gas connection' in the online connection portal have been considered as not being connected to the natural gas distribution network.
- Any areas outside of the gas distribution network are assumed to be relying on bottled or stored LPG that is supplied by either Origin, Elgas or Supagas.

Due to the limited amount of publicly available gas usage data, this report does not include future gas usage forecasts. However we have used available data to make qualitative assessments of potential future trends.

Methods

In order to research potential gas use in the region, EY used Australian Bureau of Statistics (ABS) data on businesses in each LGA to identify if there were activities likely to consume gas located in a particular LGA. We then applied the above assumptions to further refine the analysis to understand whether it was possible that these were connected to a gas network. Except where data on aggregate usage has been provided by Jemena, the results of this investigation are therefore not a definitive assessment of gas usage in the region. They are rather an indication of potential gas-consuming activities in the region and their relative importance in terms of decarbonisation targets.

Figure 7: Map of the Jemena distribution network in the Central NSW Region



Source: Jemena.com.au, July 2023

4

Central NSW Natural Gas Consumption – Historic

4 Central NSW Natural Gas Consumption – Historic

Chapter overview

This chapter outlines historic natural gas consumption in the 8 LGAs connected to the gas distribution network. This chapter discusses the following topics:

- Historical natural gas use by LGA from 2017 - 2022 via the Jemena distribution network for business connections.
- Historical natural gas use by LGA from 2017 – 2022 via the Jemena distribution network for residential connections.
- Major gas users in the business community throughout the LGAs.
- Major business users that were excluded from the Jemena data provided.

The chapter does not contain any gas usage data for Cabonne, Lachlan and Weddin as they are not connected to the Jemena distribution network. It is assumed that the residents and businesses in the LGAs not connected to Jemena's distribution network are using bottled LPG. Provision of LPG gas usage data and forecasting is not included in the scope of this report.

4 Central NSW Natural Gas Consumption – Historic

Natural gas consumption is at its highest in more densely populated areas of the LGAs and largely driven by residential demand

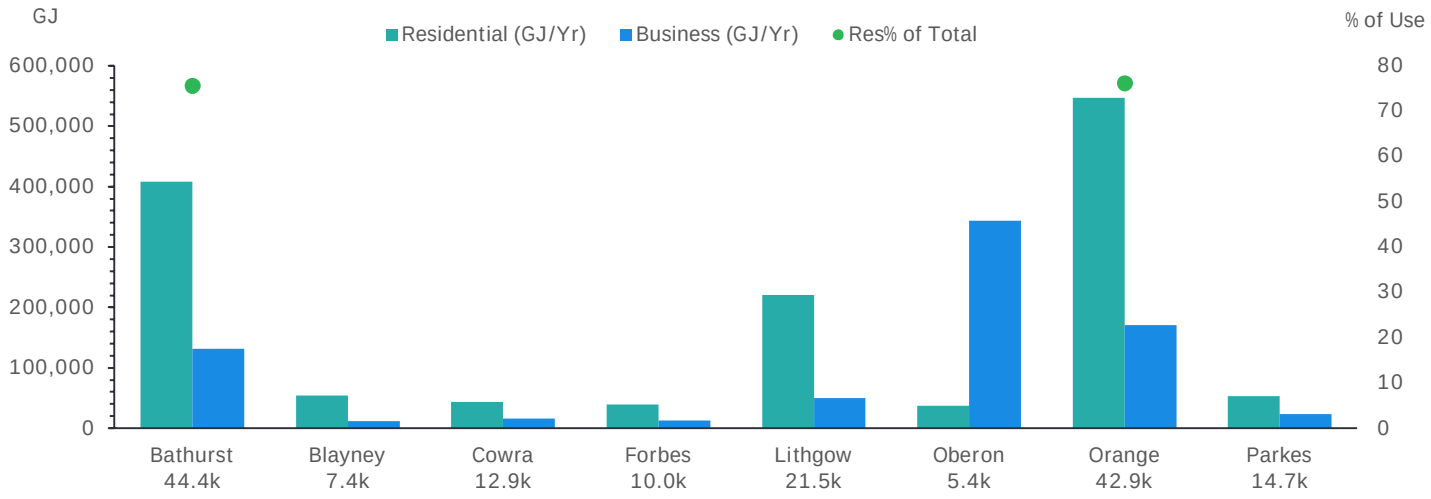
Overview of natural gas consumption across the region

Natural gas consumption in the Central NSW region is predominantly driven by residential customer demand. This is largely because natural gas supply is limited outside of major towns and is therefore unavailable to manufacturing, processing and mining facilities in the outer regions of the LGAs. Cabonne, Lachlan and Weddin do not have access to the Jemena natural gas distribution network and are therefore assumed to be solely relying on bottled or stored LPG.

Natural gas demand is highest in Orange, Bathurst, and Oberon. These trends largely follow population size with the exception of Oberon. Although Oberon has the lowest population in Central NSW, natural gas consumption is highest, due to the presence of Borg in Oberon (refer to the next page).

The share of residential consumption as a proportion of total consumption is lowest in Oberon at 6%, as shown in Figure 8 below. For all other councils connected to the Jemena network, the share of residential consumption is broadly consistent, ranging between 69% in Parkes to 82% in Blayney. The proportion of residential consumption to total consumption is illustrated in Figure 8 with green dots.

Figure 8: Natural Gas Consumption by LGA FY22



Sources: Data provided by Australian Bureau of Statistics, Jemena (2022) and greenhouse gas assessment of new particleboard plant at Oberon 2016.[8]

Table 2: Number of customers connected to Jemena distribution network 2022

LGA	Residential	Commercial / Industrial
Bathurst	12,704	583
Orange	13,800	584
Lithgow	5,915	244
Parkes	2,438	133
Cowra	2,335	160
Forbes	1,838	99
Blayney	1,414	77
Oberon	987	88
Total	41,431	1,968

Source: Jemena (2022)

Table 3: Total GJ natural gas consumed via Jemena distribution network 2022

LGA	Residential	Commercial / Industrial
Bathurst	408,307	131,845
Orange	546,756	170,878
Lithgow	220,984	49,717
Parkes	53,148	23,552
Cowra	43,104	16,470
Forbes	39,367	12,513
Blayney	54,595	11,732
Oberon	37,308	12,494
Total	1,403,573	1,310,252

Source: Jemena (2022)

8. Borg FY22 consumption estimated based upon GHG Assessment of new Particleboard plant at Oberon, April 2016, Northmore Gordon Pty Ltd.

4 Central NSW Natural Gas Consumption – Historic

Borg Manufacturing uses a gas-fired turbine for power generation supporting 20% of the sites' power consumption

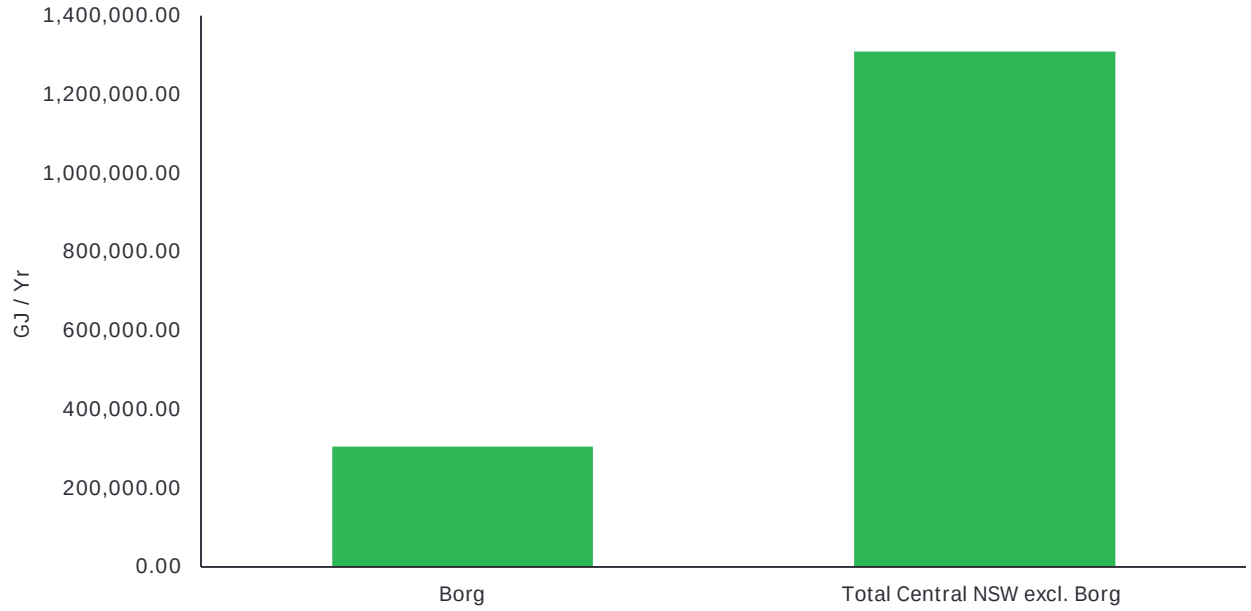
Industrial natural gas consumption

The Jemena natural gas consumption data provided did not include Borg as this company is directly connected to the APA gas transmission network. Borg is the only gas user connected directly to the APA transmission line in the Central NSW region. Borg's individual natural gas consumption is equivalent to 20% of all commercial natural gas consumption in Central NSW (including the balance of Oberon's smaller commercial natural gas connections). There are numerous mines in Central NSW that are not connected to the natural gas network (including Cadia Mine that consumed 872,219 GJ of LPG in FY22 for non-transport, haulage and production).[9]

A 4 MW gas turbine generator was installed on site in Oberon and commissioned in 2021. The installation has so far produced 20% of Borg's power needs. The initial 2016 assessment report estimated that the natural gas turbine would consume 306,000 GJ of natural gas per year.[10]

Borg's actual 2019 – 2022 consumption data is not publicly available. Borg's natural gas consumption data represented in the below graph is based on the estimate provided in the greenhouse gas assessment in 2016.[11]

Figure 9: Borg consumption and Central NSW business natural gas consumption



Sources: Jemena (2022) and greenhouse gas assessment of new particleboard plant at Oberon 2016

Table 4: Estimated total GJ natural gas consumed by business customers via Jemena and APA networks, 2022

Commercial / Industry	GJ/Yr
Central NSW consumption (exc Borg)	1,310,252
Borg	306,000
Total Central NSW consumption	1,616,252

Sources: Jemena (2022) and greenhouse gas assessment of new particleboard plant at Oberon 2016

9. The report confirms Newcrest's Cadia mine sites non reliance on the natural gas distribution network: 2022 Sustainability Report | Newcrest Mining Limited
10. Borg FY22 natural gas consumption GHG Assessment of new Particleboard plant at Oberon, April 2016, Northmore Gordon Pty Ltd.
11. Source of Borg's natural gas consumption: Refer to note 9.

4 Central NSW Natural Gas Consumption – Historic

Residential natural gas consumption has increased between 2017 and 2022 in all connected LGAs except for Cowra

Residential natural gas consumption

The data represented in Table 5 below illustrates an increase in residential gas connections across the 8 connected LGAs between 2017 and 2022. The data also indicates a nexus between the increase in connections and an increase in natural gas consumption, with the exception of Cowra that experienced a slight decline in residential gas consumption despite the additional new connections. Due to data restrictions, it was not possible to gain insight into drivers of the decline in gas use in Cowra relative to connection growth. However, there was an increase in electricity consumption between 2014 and 2022, which may indicate increased electrification.

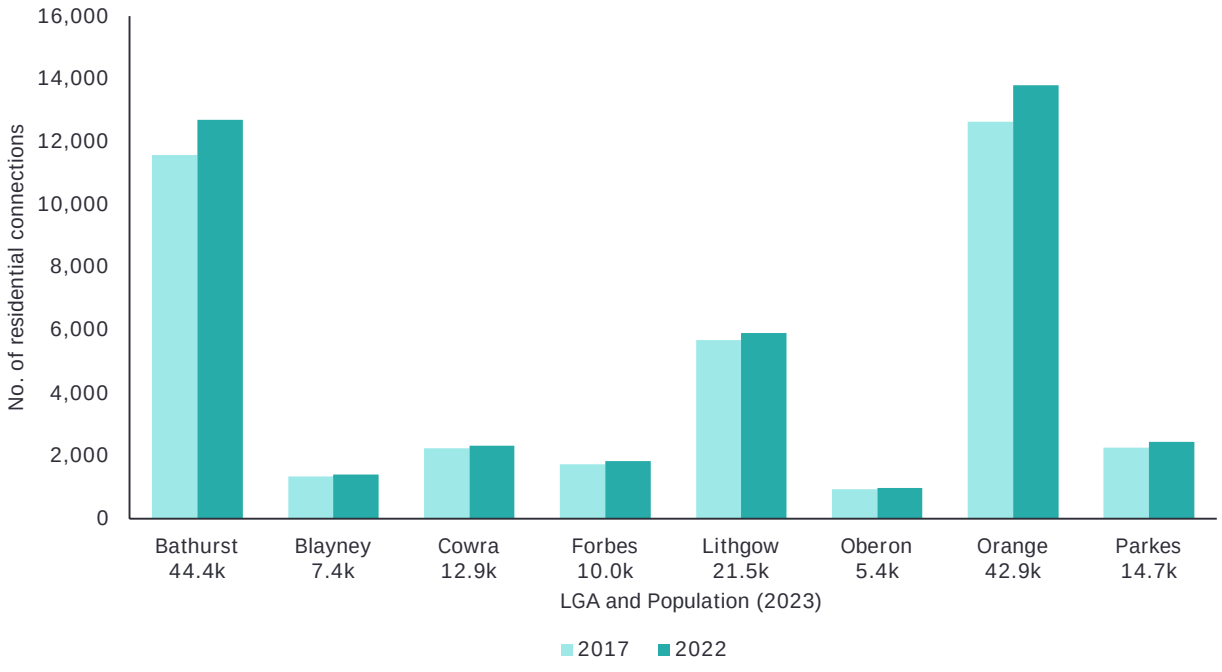
Table 5: Total annual residential GJ natural gas consumed via Jemena distribution network

LGA	# Connections 2017	# Connections 2022	% Inc in Connections	GJ Consumed 2017	GJ Consumed 2022	% Inc in Consumption
Bathurst	11,572	12,704	9.8	400,969	408,306	1.8
Blayney	1,346	1,414	5.1	48,805	54,594	11.9
Cowra	2,241	2,335	4.2	43,990	43,104	-2.0
Forbes	1,729	1,838	6.3	39,179	39,369	0.5
Lithgow	5,690	5,915	4.0	207,457	220,984	6.5
Oberon	931	987	6.0	30,899	37,308	20.7
Orange	12,645	13,800	9.1	490,246	546,756	11.5
Parkes	2,261	2,438	7.8	48,701	53,148	9.1

Source: Jemena (2017 and 2022)

Figure 10 below illustrates the change in residential customer connections between 2017 and 2022, with the 2023 population data for each LGA provided to give a sense of scale of the increases in connections over that period.

Figure 10: Residential gas consumption 2017 – 2022



Source: Australian Bureau of Statistics and Jemena provided data (2017 & 2022)

Commercial natural gas consumption

As noted previously, due to confidentiality restrictions, Jemena was unable to identify which business customers are high gas users. The information identifying whether a premises' location has access to the natural gas distribution system was established using the 'connection service' portal on the Jemena website.[12] The street address is entered into the portal which confirms gas access point availability. For every LGA in Central NSW, commercial and industrial gas connections increased between 2017 and 2022 (in the LGAs with access). However, this increase in connections has not resulted in a proportional increase in natural gas consumption, as shown in Table 6 below.

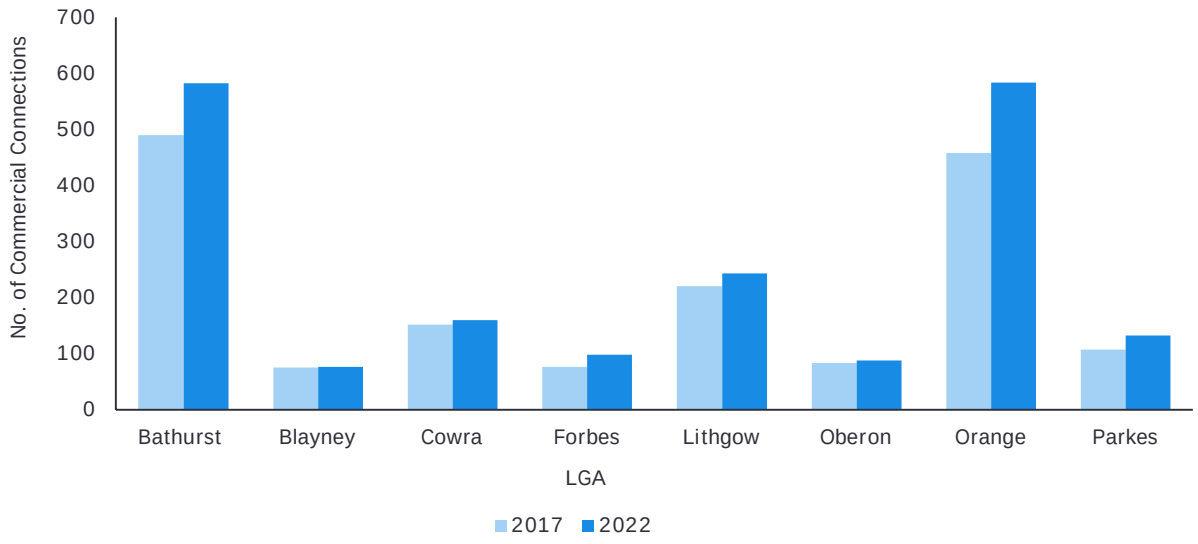
All of the LGAs, with the exception of Orange, have experienced a decrease in consumption despite the increase in new natural gas connections. Orange experienced a growth in connections and consumption, however the increase in consumption is considerably lower then the increase in the number of new connections. Table 6 shows Orange experiencing a 27% increase in new connections but only a 2% increase in actual natural gas consumption for the same time period. Due to data restrictions, there is no definitive data indicating the cause of demand decline in business consumption.

Table 6: Total annual GJ natural gas consumed via Jemena distribution network

LGA	# Connections 2017	# Connections 2022	% Increase in Connections	GJ Consumed 2017	GJ Consumed 2022	% Increase in Consumption
Bathurst	491	583	18.7	144,560	131,845	-9
Blayney	76	77	1.3	11,768	11,732	-0.3
Cowra	152	160	5.3	21,364	16,470	-23
Forbes	77	99	28.6	14,561	12,513	-14
Lithgow	221	244	10.4	50,613	49,717	-2
Oberon	84	88	4.8	13,731	12,494	-9
Orange	459	584	27.2	167,094	170,878	2
Parkes	108	133	23.1	25,358	23,552	-7

Source: Jemena provided data (2017 and 2022)

Figure 11: Commercial gas consumption 2017 – 2022



Source: Australian Bureau of Statistics Jemena provided data (2017 and 2022)

12. Go Natural Gas, Jemena connection portal (2023), Connection services | Go Natural Gas.

4 Central NSW Natural Gas Consumption – Historic

The summary identifies major gas users by LGA and insights developed from research and stakeholder engagement

Summary – major gas customers by LGA

Table 7 identifies the main gas-consuming industries in the region. These industries are likely to be the main drivers of natural gas consumption in each LGA connected to the distribution network. All 11 LGAs are listed, noting that only 8 are connected to the gas distribution network. Limited data is available regarding the categories of businesses and their gas consumption across the LGAs. Jemena was only able provide the number of residential and business connections within each LGA, and the average annual consumption per connection. The main categories of gas users in the LGAs have been identified through desktop research and consultations with councils that were held between 28 June and 21 July 2023.

Table 7: Summary of key gas customers and insights

LGA	2022 Residential use (GJ)	2022 Business use (GJ)	Potential gas consuming industries	Insights from consults and desktop research
Bathurst	408,306	131,845	• Food processing and food manufacturing. • Bathurst Hospital.	• The forthcoming residential development, Laffing Waters, will be connected to gas. • Food processing and packaging is a large industry in Bathurst, requiring large volumes of natural gas.
Blayney	54,594	11,732	• Hospitality (restaurants and bakeries). • Blayney Hospital. • Cadia Mine (LPG).	• Blayney has experienced a notable increase in residential natural gas consumption. • Business growth has largely been in sectors with low gas requirements, such as construction and wholesale trade.
Cowra	43,104	16,470	• Hospitality (restaurants and bakeries). • Cowra Hospital.	• Consultation revealed the abattoir, which relies on gas for their production processes, has installed a bio-digester to reduce their reliance on natural gas due to high prices.[13]
Forbes	39,369	12,513	• Hospitality (restaurants and bakeries). • Forbes Hospital. • Metal products manufacturers.	• Connected manufacturers predominantly produce metal componentry and are likely to have limited demand for natural gas.
Lachlan	N/A*[14]	N/A*	• Metal products manufacturers. • Agricultural producers.	• There is no access to the natural gas distribution network, resulting in high consumption of bottled gas or wood-fired heating. • Gas demands for manufacturing of metal products is likely to be limited to specialty gases required for welding and metal cutting processes.
Lithgow	220,984	49,717	• Hospitality (restaurants and bakeries). • Lithgow Hospital.	• Facilities such as medical clinics and hospitals are reliant on gas. • Feedback from the council stated that there is an interest in attracting energy-intensive industries.
Manildra	N/A*	N/A*	• Manildra Mill. • MSM Milling.	• In 2019, MSM Milling replaced their LPG boilers with a 5MW biomass fuelled boiler.
Oberon	37,308	318,494	• Hospitality (restaurants and bakeries). • Hospital. • Borg.	• Borg is a heavy gas user, and explored a bio-digester to which there were community objections. • The lack of information during a community consultation session to the community was noted as the key barrier.[15]
Orange	546,756	170,878	• Hospitality (restaurants, cafes and bakeries). • Orange Hospital. • Metal products manufacturers.	• Metal manufacturers generally focus on mining and agriculture component manufacturing which have minimal natural gas requirements.
Parkes	53,148	23,552	• Hospitality (restaurants and bakeries). • Parkes Hospital.	• Natural gas consumption at the forthcoming Parkes Special Activation Precinct is likely to be minimal, owing to the strong focus on sustainability and circular economy principles.
Weddin	N/A*	N/A*	• Agricultural producers • One industrial estate in Greenfell, with 14 sites.	• Heavy reliance on LPG use, due to lack of available natural gas.

13. Discussions held with Cowra Council.
14. *N/A usage applies to LGAs that are not connected to the Jemena natural gas distribution network and rely bottled LPG.
15. Borg Community Consultive Committee Agenda / Minutes (Borg Annual review 2022-2023).

Bathurst

The city of Bathurst and its surrounding suburbs have an extensive connection to the natural gas distribution network. In contrast to LGAs such as Parkes, Forbes, and Cowra, there are numerous businesses of differing sizes and categories that have access to the natural gas network.

Between FY17 and FY22 there was an increase in residential gas consumption in Bathurst by 1.2%, but not at the same pace that customer connections increased (10%). Gas consumption in the business sector decreased over the same period (-9%), while customer connections increased (19%), as can be seen in Figure 12.

Gas intensive businesses in Bathurst include:

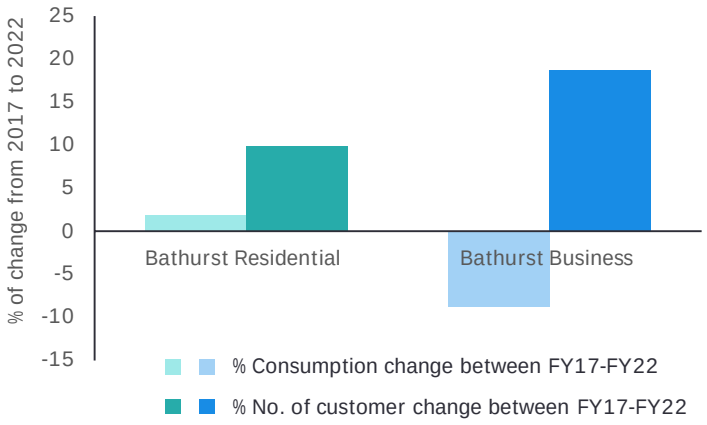
- Devro, a food manufacturer.
- Simplot, a frozen food manufacturer.
- Bathurst Crematorium.
- Bathurst Hospital.
- Walter Findlay.
- Mars Petcare.

Table 9 represent key business sectors in Bathurst.[16] Agriculture is the most dominant sector in numbers, but is unlikely to be connected to the distribution network due to the lack of access to the infrastructure. In contrast, the location of residential connections, food processing and packaging facilities in more densely populated areas have access to the network. The use of gas for running ovens and steam production equipment for canning means that the food processing and packaging industries are the most gas use intensive in Bathurst LGA.

DPE forecasts Bathurst's population to increase significantly out to 2049-50, potentially increasing the number of gas connections. Jemena data indicates an increase in connections with an overall decrease of consumption, potentially due to a switch towards electrified equipment in the business sector.

Bathurst Regional Council was consulted on 29 June 2023. The key insight relevant to the gas transition was that there are numerous planned residential developments which may have implications for residential gas consumption in future.

Figure 12: Bathurst - % change of customers and consumption between 2017–2022



Source: Jemena data (2017 & 2022)

Table 8: No. of connections, consumption and % change

	2017	2022	% Change 2017 - 2022 (Fig 11)
Population	42,558	44,812	5.3
Total Natural Gas consumption (GJ/Yr)	545,530	540,152	-1.0
- Residential	400,970	408,306	1.2
- Business	144,560	131,845	-8.8
No. of Customers	12,063	13,287	10.1
- Residential	11,572	12,704	9.8
- Business	491	583	18.7

Source: Australian Bureau of Statistics (2022) and Jemena provided data (2017 & 2022)

Table 9: Industry Categories

Key business sectors

Sector	No. of Businesses
Services	1,171
Construction	749
Agriculture	642
Retail and wholesale trade	294
Education and health	282
Manufacturing	142
Other	431
Total	3,711

Source: Australian Bureau of Statistics (2022)

16. ABS, Industry Categories: Data by region (2023) https://dbr.abs.gov.au. Accessed July 2023.

Blayney

Access to the natural gas distribution network is not available outside of the Blayney and Millthorpe town footprints. Blayney has experienced a notable increase in residential natural gas consumption. Any residential and business gas consumption outside of Blayney and Millthorpe is limited to bottled / stored LPG.

Residential gas consumption increased by 11.9% in Blayney between FY17 and FY22, despite customer connections increasing by only 5.1%. In the business sector, gas consumption decreased over the period while there was a modest increase in customer connections, as shown in Figure 13.

Energy intensive industries in Blayney include:

- Blayney SeaLink, a cold storage operation.
- Linfox, a transport, logistics and supply chain business.
- Nestle Purina Petcare, a pet food production plant.

We can confirm that Nestle Purina are connected to Jemena's gas distribution network.

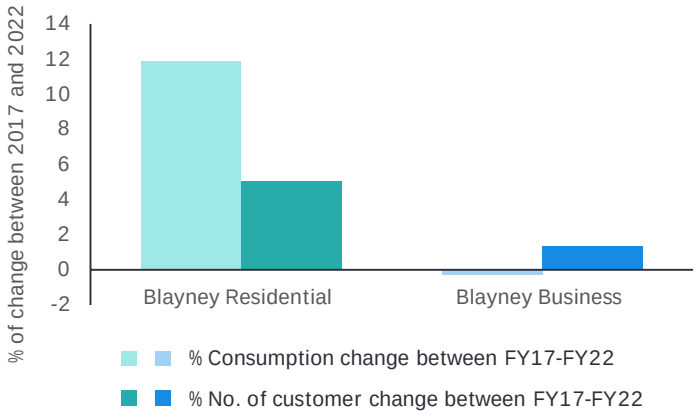
Most notable sector growth in the LGA[17] has been in low gas consumption sectors such as:

- Construction.
- Wholesale trade.
- Arts and recreation services and retail.

Blayney Shire Council was consulted on 19 July 2023. Some of the key insights include:

- There is a planned subdivision of 100 residential lots which could further increase the future natural gas connections in the LGA.
- The council is exploring battery storage options which could support a higher penetration of renewable energy and facilitate a future transition from natural gas use.

Figure 13: Blayney % change of customers and consumption between 2017–2022



Source: Jemena data (2017 & 2022)

Table 10: No. of connections, consumption and % change

	2017	2022	% Change 2017 - 2022 (Fig 12)
Population	7370	7588	2.9
Total Natural Gas consumption (GJ/Yr)	60,574	66,326	9.4
- Residential	48,806	54,595	11.9
- Business	11,768	11,732	-0.3
Customers	1,422	1,491	4.8
- Residential	1,346	1,414	5.1
- Business	76	77	1.3

Source: Australian Bureau of Statistics (2002) and Jemena provided data (2017 & 2022)

Table 11: Industry Categories

Key business sectors

Sector	No. of Businesses
Agriculture	362
Services	197
Construction	119
Retail and wholesale trade	47
Education and health	26
Manufacturing	25
Other	61
Total	837

Source: Australian Bureau of Statistics (2022)

17. ABS, Industry Categories: Data by region (2023) https://dbr.abs.gov.au. Accessed July 2023.

Cowra

Access to the natural gas distribution network is not available outside of the Cowra town footprint. Any residential and business gas consumption outside of the town is limited to bottled / stored LPG.

Increased residential and business gas connections were not matched with an increase in gas consumption. While consumption declined in both sectors, though at different rates, as shown in Figure 14, there were increases in customer connections.

Natural gas intensive businesses in Cowra include:

- Cowra Hospital.
- Retail.

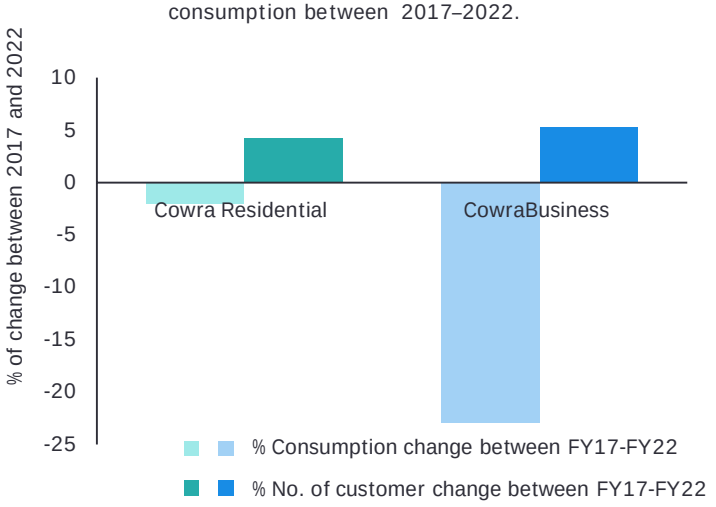
ABS data indicates that the majority of business natural gas consumption is in services, retail, education and heath industries.[18] Based on that profile it can be assumed that the natural gas use would be predominantly for water and space heating and commercial cooking processes.

ABS data shows that there has been a reduction in the number of accommodation and food services, whole sale trades and retail in the region. These industries would use gas for water and space heating and cooking and could be attributed to the decline in commercial gas consumption. There is no other definitive data indicating the cause of the commercial gas consumption decline. Over a similar period, business electricity consumption also decreased, suggesting that the decrease in business consumption of gas was not as a direct result of increases in electrification in that sector.

In the residential sector, while consumption of gas decreased, there was an increase in electricity consumption over a similar period (FY14-FY22) by 6.2%, more detail about this can be found in the Demand Report. This may suggest increased electrification in the residential sector in Cowra which could have contributed to the decline in gas use. However, without more detailed data, the cause of the decline in gas use can not be confirmed.

Cowra Council was consulted on 12 July 2023. The main insight relevant to the gas transition from that discussion was that there is a planned subdivision of 80 residential lots which could further increase the future natural gas connections in the LGA.

Figure 14: Cowra % change of customers and consumption between 2017–2022.



Source: Jemena data (2017 & 2022)

Table 12: No. of connections, consumption and % change

	2017	2022	% Change 2017 -2022 (Fig 13)
Population	12,689	13,013	2.5
Total Natural Gas consumption (GJ/Yr)	65,354	59,575	-8.8
- Residential	43,991	43,104	-2.0
- Business	21,364	16,470	-23.0
No. of Customers	2,393	2,495	4.2
- Residential	2,241	2,335	4.2
- Business	152	160	5.3

Source: Australian Bureau of Statistics (2022) and Jemena provided data (2017 & 2022)

Table 13: Industry Categories

Key business sectors

Sector	No. of Businesses
Agriculture	523
Services	335
Construction	136
Retail and wholesale trade	115
Education and health	74
Manufacturing	58
Other	141
Total	1,381

Source: Australian Bureau of Statistics (2022)

18. ABS, Industry Categories: Data by region (2023) https://dbr.abs.gov.au. Accessed July 2023.

Forbes

Access to the natural gas distribution network is not available outside of the Forbes town footprint. Any residential and business gas consumption outside of the town is limited to bottled / stored LPG.

Increases in residential and business connections was not matched with an increase in consumption between FY17 and FY22, as shown in Figure 15 opposite. While more customers connected, they were consuming less gas, which could be due to increased access to and uptake of renewable energy. For example, ABS data states that between 2018 and 2022, 838 solar panel installations were recorded in Forbes LGA.[19] In addition, manufacturers in the Forbes region would have limited demand for natural gas outside of water heating or space heating.

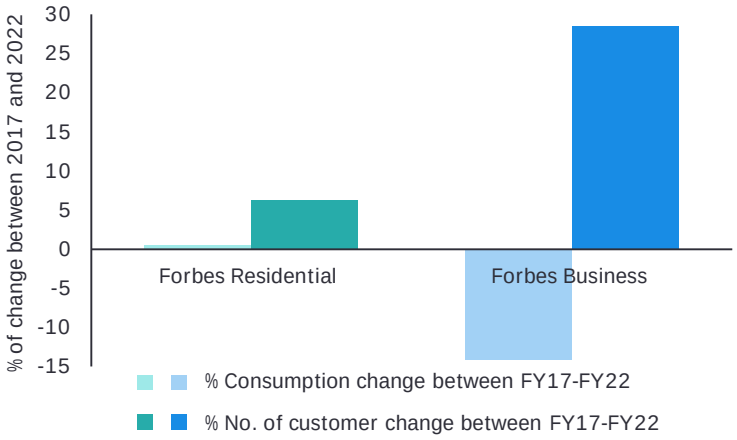
There is no access to the natural gas distribution network in a small section of Forbes town footprint north-east of Parkes Road. There is also no access outside of the main town footprint which has resulted in gas consumption being limited to bottled / stored LPG from Origin or Elgas.

Natural gas demand is unlikely to increase in future compared to electricity demand, due to the limited distribution network within the LGA.

In discussions with Forbes Shire Council on 4 July 2023, it was noted that:

- Natural gas demand from agricultural machinery manufacturers is limited to space and water heating.
- Industry growth is having a minimal impact on future natural gas demand.
- Moxey Farms has gone off-grid using a methane digester to produce biogas.
- Forbes is predominantly rural with over 500 cattle and sheep farms in the LGA.[20]

Figure 15: Forbes - % change of customers and consumption between 2017–2022



Source: Jemena data (2017 & 2022)

Table 14: No. of connections, consumption and % change

	2017	2022	% Change 2017 -2022 (Fig 14)
Population	9,720	10,216	5.1
Total Natural Gas consumption (GJ/Yr)	53,740	51,883	-.3.5
- Residential	39,179	39,370	0.5
- Business	14,561	12,513	14.1
No. of Customers	1,806	1,937	7.2
- Residential	1,729	1,838	6.3
- Business	77	99	29

Source: Australian Bureau of Statistics (2022) and Jemena provided data (2017 & 2022)

Table 15: Industry Categories

Key business sectors

Sector	No. of Businesses
Agriculture	493
Services	265
Construction	141
Retail and wholesale trade	93
Education and health	36
Manufacturing	25
Other	103
Total	1,156

Source: Australian Bureau of Statistics (2022)

19. Forbes Solar panel installation data: 2021 Forbes, Census All persons QuickStats | Australian Bureau of Statistics (abs.gov.au)
20. ABS, Industry Categories: Data by region (2023) https://dbr.abs.gov.au. Accessed July 2023.

Lithgow

The city of Lithgow and its surrounding suburbs have an extensive connection to the natural gas distribution network. In contrast to LGAs such as Parkes, Forbes, and Cowra, there are numerous business of differing sizes and categories that have access to the natural gas network.

Residential gas consumption in Lithgow increased at a faster rate than customer connections between FY17-FY22, shown in Figure 16. In the business sector, gas consumption decreased while customer connections increased.

Natural gas intensive businesses in Lithgow include:

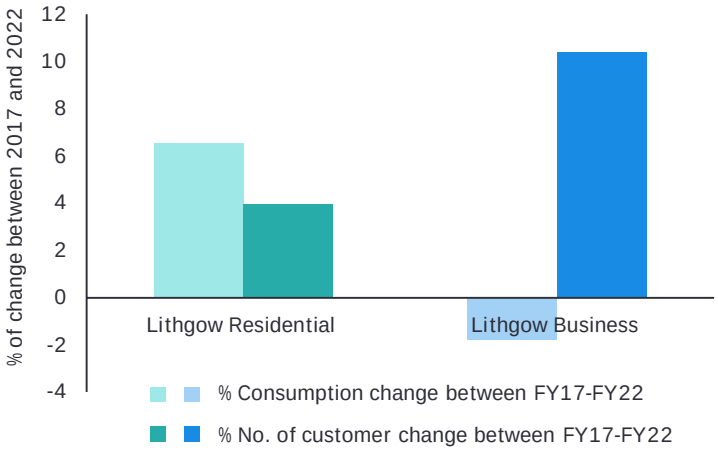
- Lithgow Hospital.
- The Ferrero confectionary factory.
- Defence manufacturing industries.
- Retail.

The population in Lithgow is expected to fall marginally between 2022-23 and 2049-50. The Mount Piper Coal Plant is expected to close in the next decade. This is expected to result in a transition of employment from the plant to the manufacturing sectors such as food manufacturing, defence manufacturing and advanced manufacturing sub-sectors. The reduction in population could lead to a reduction in new residential builds incorporating gas connections and a lowering of demand in consumption.

Lithgow City Council was consulted on 12 July 2023. Some of the key insights that informed the analysis include:

- Facilities and hospitals are reliant on gas.
- Community sentiment is slowly shifting in favour of renewables adoption.

Figure 16: Lithgow- % change of customers and consumption between 2017–2022



Source: Jemena data (2017 & 2022)

Table 16: No. of connections, consumption and % change

	2017	2022	% Change 2017 - 2022 (Fig 15)
Population	21,409	21,481	0.33
Total Natural Gas consumption (GJ/Yr)	258,070	270,701	4.9
- Residential	207,457	220,984	6.5
- Business	50,613	49,717	-1.8
No. of Customers	5,911	6,159	
- Residential	5,690	5,915	4.0
- Business	221	244	10.4

Source: Australian Bureau of Statistics (2022) and Jemena provided data (2017 & 2022)

Table 17: Jemena supplied connection data[21]

Key business sectors

Sector	No. of Businesses
Agriculture	228
Services	187
Construction	181
Retail and wholesale trade	28
Education and health	24
Manufacturing	-
Other	115
Total	763

Source: Australian Bureau of Statistics (2022)

21. ABS, Industry Categories: Data by region (2023) https://dbr.abs.gov.au. Accessed July 2023.

Oberon

Access to the natural gas distribution network is not available outside of the Oberon town footprint. Any residential and business gas consumption outside of the town will be limited to bottled / stored LPG.

In the residential sector, gas consumption increased by 21% between FY17 and FY22, compared to a smaller increase in customer connections over the same period (6%). Gas consumption in the business sector decreased over the same period (-9%), while customer connections increased (5%).

Borg, a manufacturer of panels, laminates, custom doors and wood-product manufacturing in Oberon, is the largest customer of natural gas in the region and the LGA. A 4MW gas turbine has been installed on the site which is fed by the APA transmission network.

Borg's consumption is not reflected in the Jemena data set provided for this analysis. Borg's natural gas consumption data is not publicly available, however the initial 2016 assessment report estimated that the natural gas turbine would consume 306,000 GJ of natural gas per year.[22] Borg is the only large, transmission-connected industrial customer of natural gas in the Central NSW region.

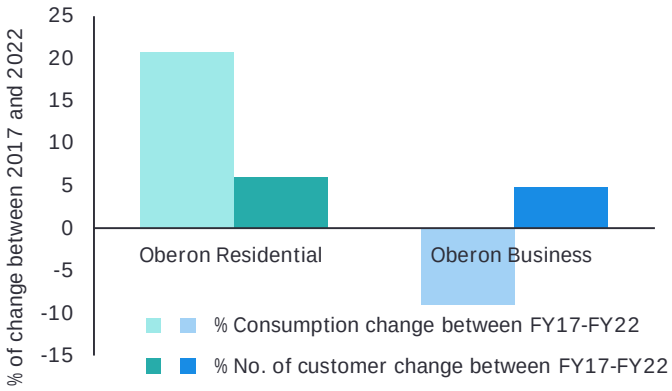
Borg has implemented changes to the production process in order to transition the plant's operations away from natural gas. Activities such as the installation of a dust blow line to assist in the reduction of natural gas use during a MDF production stage.[23] This is an example of how large industrial users can implement a staggered transition away from using natural gas.

Oberon's population is expected to be relatively steady in future, limiting residential natural gas demand growth in the area.

Oberon Council was consulted on 13 July 2023. Some of the key insights relevant to the gas transition include:

- Borg is a heavy gas user, and explored a bio-digester to which there were community objections. The lack of information to the community was considered the key barrier to adoption.[24]
- The second challenge for the gas transition in Oberon is that Borg have only recently commissioned the gas-fired turbine and will be looking for a return on the investment, potentially further delaying their complete transition away from natural gas.

Figure 17: Oberon-% change of customers and consumption between 2017–2022



Source: Jemena data (2017 & 2022)

Table 18: No. of connections, consumption and % change

	2017	2022	% Change 2017 - 2022 (Fig 16)
Population	5406	5429	0.4
Total Natural Gas consumption (GJ/Yr)	44,631	49,802	11.6 (exc. Borg)
- Residential	30,900	37,308	21.0
- Business exc Borg	13,731	12,494	-9.0
- Borg	Unknown	Est 306,000	
No. of Customers	1,015	1,075	5.9
- Residential	931	987	6.0
- Business (exc Borg)	84	88	5

Source: Australian Bureau of Statistics (2022) and Jemena provided data (2017 & 2022)

Table 19: Industry Categories[25]

Key business sectors

Sector	No. of Businesses
Agriculture	297
Services	135
Construction	70
Retail and wholesale trade	39
Education and health	28
Manufacturing	25
Other	57
Total	651

Source: Australian Bureau of Statistics (2022)

22. Borg, FY22 natural gas consumption GHG Assessment of new Particleboard plant at Oberon, April 2016, Northmore Gordon Pty Ltd.
23. Borg, Annual review detail facility improvements (2023), Title Page of Report Master document (borgs.com.au). Accessed August 2023.
24. Borg, Community Consultive Committee Agenda / Minutes (2022 - 2023).
25. ABS, Industry Categories: Data by region (2023) https://dbr.abs.gov.au. Accessed July 2023.

Orange

Orange is a significantly smaller LGA in area but one of the more densely populated. The city and surrounding suburbs have ready access to the distribution network. It is unlikely that there is any connection for the outer lying regional areas and will be limited to bottled / stored LPG.

Over the last 5 years, Orange has experienced an increase in both residential and business natural gas consumption due to population increases and business growth.

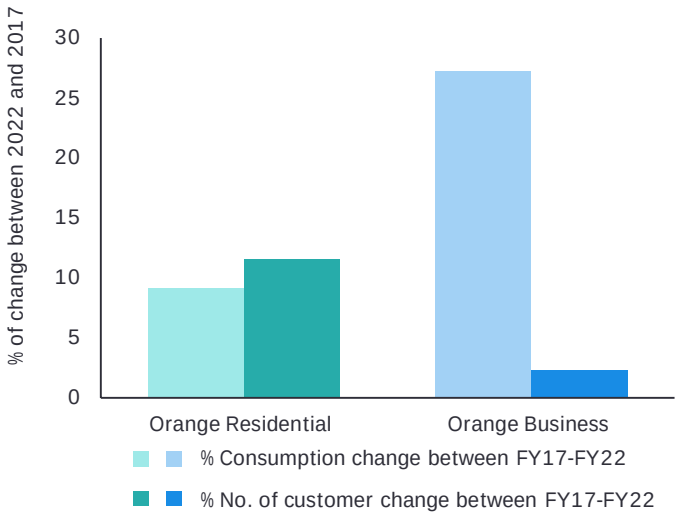
Natural gas intensive businesses in Orange include:

- Charles Sturt University.
- Orange Hospital.
- The NSW Department of Primary Industries.
- Orange Aquatic Centre.
- Various accommodation and hospitality providers.

Manufacturers in the immediate city footprint focus on mining and agriculture component manufacturing, which requires minimal natural gas application beyond water and space heating.

Orange City Council was consulted on 28 June 2023. Nothing relevant was identified for the gas-to-renewables assessment.

Figure 18: Orange-% change of customers and consumption between 2017–2022



Source: Jemena data (2017 & 2022)

Table 20: No. of connections, consumption and % change

	2017	2022	% Change 2017 - 2022 (Fig 17)
Population	41,778	43,769	4.7
Total Natural Gas consumption (GJ/Yr)	657,341	717,634	9.2
- Residential	490,247	546,756	9.1
- Business	167,094	170,878	27.2
No. of Customers	13,104	14,384	9.8
- Residential	12,645	13,800	11.5
- Business	459	584	2.3

Source: Australian Bureau of Statistics (2022) and Jemena provided data (2017 & 2022)

Table 21: Industry Categories[26]

Key business sectors

Sector	No. of Businesses
Agriculture	1,835
Services	1,439
Construction	1,017
Retail and wholesale trade	480
Education and health	442
Manufacturing	242
Other	662
Total	6,117

Source: Australian Bureau of Statistics (2022)

26. ABS, Industry Categories: Data by region (2023) https://dbr.abs.gov.au. Accessed July 2023.

Parkes

Access to the natural gas distribution network is not available outside of the Parkes town footprint. Any residential and business gas consumption will be limited to bottled / stored LPG.

Large natural gas customers in Parkes include:

- Residential.
- Accommodation.
- Hospitality / food services.
- Hospital / health services.

Figure 19, based on the Jemena data provided, shows that Parkes has seen an increase in residential and commercial gas connections between FY17 and FY22. In that same period, residential consumption has increased in proportion to the increase in new connections. However, Figure 18 also indicates that the overall business consumption has declined, despite the increase in customer numbers over the same period.

Over the coming decades, natural gas demand may be impacted by the Parkes Special Activation Precinct (SAP). If gas connection is made available, ongoing manufacturing growth and residential growth is expected. However, gas consumption is unlikely to grow at similar rates as electricity consumption due to the limited gas distribution infrastructure in the LGA.

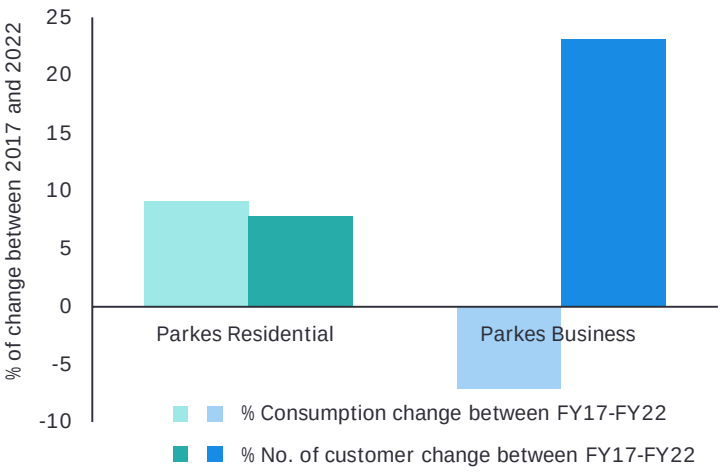
An example of increases in manufacturing / processing activities is the construction of one of Australia's largest plastic processing in Parkes which is expected to be commissioned in 2025.

Consultation with the Regional Growth NSW Development Corporation highlighted that entry criteria to the SAP requires full electrification of operations or where not currently feasible, establishment of an action plan to transition off gas when possible. To date, no natural gas users have been identified for the SAP.

In discussions with Parkes Shire Council on 21 July 2023, it was noted that:

- Historical industry growth has been predominantly in sectors that have a relatively low natural gas consumption rate.
- The majority of the gas consumption in Parkes is through residential consumption which is predominantly used for space and water heating.

Figure 19: Parkes- % consumption change between 2017–2022



Source: Jemena data (2017 & 2022)

Table 22: No. of connections, consumption and % change

	2017	2022	% Change 2017 - 2022
Population (no.)	14,886	14,612	-1.8
Total Natural Gas consumption (GJ/Yr)	74,060	76,700	3.6
- Residential	48,702	53,148	9.0
- Business	25,358	23,551	-7.0
No. of Customers	2,369	2571	8.5
- Residential	2,261	2,438	8.0
- Business	108	133	23.0

Source: Australian Bureau of Statistics (2022) and Jemena provided data (2017 & 2022)

Table 23: Industry Categories[27]

Key business sectors

Sector	No. of Businesses
Agriculture	556
Services	332
Construction	163
Retail and wholesale trade	103
Education and health	71
Manufacturing	56
Other	132
Total	1,413

Source: Australian Bureau of Statistics (2022)

27. ABS, Industry Categories: Data by region (2023) https://dbr.abs.gov.au. Accessed July 2023.

5

Central NSW Natural Gas – Transition Options Assessment

5 Central NSW Natural Gas - Transition Options Assessment

Chapter overview

This chapter outlines our assessment of potential transition options for gas customers in the Central NSW region. To build an understanding of the scope and nature of the assessment we have outlined:

- The potential gas transition options identified for customers.
- The criteria developed for assessment of transition options.
- How the criteria were applied to the potential transition options.
- The outcomes of the Multi Criteria Analysis (MCA).
- The resulting prioritised potential transition options.

The prioritised potential transition options from this assessment will be carried forward into the main Business Case for consideration alongside other energy system options.

Transition technology options assessment methodology

An assessment of the appropriate direct substitute technologies has been conducted for gas uses identified in the Central NSW region. This assessment has been based on three criteria:

- Cost.
- Ease of implementation.
- Wider impacts on the energy system in the Central NSW region.

The steps in the assessment were as follows:

1. The categories of gas use in the Central NSW region were identified.
2. The transition options for each use of gas use were identified.
3. Each transition option was rated against the assessment criteria listed above.

The combined rating against these criteria was compared against sector gas use (as a proxy for decarbonisation potential) to develop the prioritised list of transition options to be taken forward into the Business Case.

Criteria

Based on our understanding of the transition options and the wider region, we developed the three-point rating scales shown in Table 24 below.

Table 24: Assessment criteria rating

	User category	Low	Medium	High	Comments
Cost	Residential/ Commercial	$500 - $2,000	$2,000 - $5,000	>$5,000	None
	Large Industrial	<$50,000	$50,000 - $150,000	>$150,000	None
Ease of Implementation	Residential/ Commercial	Single tradesperson installation 1 day	Multiple trades installation 2-3 days	Multiple trades installation > 3 days	High impact installations may require remodelling of interiors (e.g. hot water cylinders) or structural changes (e.g. solar hot water on roofs)
	Large Industrial	Like for like replacement – no impact on wider process	Some impact on wider processes	End-to-end process redesign and factory refit	None
Wider Impacts	All users	Upgrade of household electricity connection	Impacts on peak consumption Upgrade of LV network	Upgrade of distribution/transmission network	The impacts of single customers have been assessed in the industrial context while for the residential context the impact of all users transition has been the basis for assessment

Gas use categories

From the analysis in the previous chapter, we identified the following key categories of gas use within the Central NSW region:

1. Residential.
2. Commercial - Services (office, retail, accommodation).
3. Commercial – Restaurants.
4. Industrial - Food Production.
5. Industrial – Manufacturing (Borg plant at Oberon).

Transition technology options

For each of the identified uses of gas identified in the Central NSW region, a set of transition technologies was identified. The criteria used in selecting technologies were as follows:

- The technology provides the same or comparable services to a gas appliance.
- The technology is commercially available in Australia (or likely to be commercially available within 10 years).
- The technology does not increase energy demand.

The last point is key in that, while resistance heating can replace gas applications, it is known to have several limitations in terms of efficiency, and use of these technologies would increase overall energy demand in the region (with associated operating cost increases). Heat pump technology provides energy efficiency benefits, is widely available and therefore we have preferred these technologies over resistance heating.

A literature review was undertaken to source potential technologies. The transition technology options are listed in Table 25 below. Key points from this analysis include:

- Blending of hydrogen, while likely to be able to be implemented without a change-out of appliances, only offers partial decarbonisation and could increase electricity consumption, it has not been considered further.
- Use of 100% hydrogen for space and water heating is not considered further due to the potential for increased electricity consumption and cheaper options being available.
- Use of 100% hydrogen for high temperature process heat is not likely to be commercial within 10 years and therefore has not been considered further.
- Transition options for the Borg plant are process-specific and are not considered in this generic list.

Moreover, it is important to note that in this analysis we have taken a user-centred view of options, focussing on disruptions at their premises and the need to change-out equipment. The use of renewable gases (biomethane, bioLPG and hydrogen) present additional options for decarbonisation. The supply chains for these gases are nascent and the gases are not at cost parity with natural gas from fossil fuel sources.

Table 25: Gas transition technology options

	Existing gas use case	Potential transition technology option
Residential	• Hot water.	• Electric heat pump hot water. • Solar hot water systems with electric back up.
	• Space heating.	• Electric heat pump heating. • Reverse cycle chillers and air-conditioners.
	• Cooking.	• Induction cook top.
Commercial Services	• Hot water.	• Electric heat pump hot water. • Solar hot water systems with electric back up.
	• Space heating.	• Electric heat pump heating.
Commercial Restaurants	• Cooking.	• Induction cook top.
Industrial – Food Production	• Low heat temperature processes 65 - 100ºC (e.g. food processing). • Gas boilers for steam production, sterilisation and chilling .	• Biomass boilers. • High capacity heat pumps.
	• High heat temperature process >100ºC • Gas fired kilns. • Gas heaters. • Gas boilers.	• Biomass boilers. • Heat recovery equipment and upgrading of temperature with heat pumps.

Transition technology options (contd.)

Renewable gases can be produced close to the user, or remotely, and potentially transported via existing gas networks to site, if compatible with existing pipelines. The use of gas certificate schemes can allow users to track the green credentials of gas produced remotely.[28] This allows the useful life of existing gas pipelines to be extended and be part of the decarbonisation journey. Most gas pipeline businesses, including Jemena and APA, are investigating or trialling green gas options.

Hydrogen has been a leading candidate for the transition away from gas. It has the potential to be blended with natural gas up to 20% by volume without changes to appliances becoming necessary.[29] However, this represents only a 6% reduction in carbon emissions. The use of 100% hydrogen in pipelines is potentially possible but there are material compatibility issues that make reuse of gas pipelines for 100% hydrogen technically complex. Hydrogen appliances for the home are becoming available, but the use of hydrogen for space and water heating may not be the most suitable application given the availability of other, lower cost options. [30] Appliances for industrial applications are emerging but the availability of these appliances depends on the specific process. Hydrogen has been identified as a decarbonisation pathway for high temperature process heat, which is difficult to electrify. However, these technologies are some way from being commercially available at this time.

BioLPG is produced as a by-product of the bio-refining process.[31] This gas is indistinguishable from conventional LPG and there is no modification of equipment required. While more bioLPG will become available in time, securing supply will be an issue as there are potentially higher value uses of bioLPG than combustion, such as petrochemical uses.

The final renewable gas option is biomethane, which is a renewable gas indistinguishable from natural gas from fossil fuels. Biogas is produced through the anaerobic digestion of organic matter. This can occur in controlled bioreactors (e.g. at a wastewater treatment plant) or uncontrolled at landfills. This gas is around 50% CO_2 and 50% methane. When upgraded through separation of the CO_2, the gas becomes pipeline specification-ready and is termed biomethane.

The technology for biogas production is well understood and plants have been in operation across Australia.[32] Bioreactors emit lower odour than composting facilities and improve water discharge quality as it is a controlled process. Bioreactor plant can co-exist in urban settings – like the bioreactor at the XXXX Brewery in Brisbane.[33] The use of the digestate (a by-product of the process) for fertilisers can displace chemical fertiliser usage and capture of the CO_2 can reduce the need for fossil fuel-derived CO_2. Use of organic waste as feedstock diverts this from landfill which extends landfill life and improves the environmental performance of landfills as uncontrolled anaerobic digestion at the landfill is avoided. Collection of animal manure or other farm waste can also improve environmental outcomes as these wastes might otherwise make their way into waterways through farm run-off. Hence there are multiple circular economy benefits from biogas/biomethane production. This is demonstrated through the Moxey Farms dairy biogas scheme in Forbes.[34]

A key issue for biomethane is scale and developing viable supply chains for sourcing organic waste. A recently opened plant in Reporoa, NZ, will take all of the city of Auckland's residential food waste as feedstock (1.5 million population). This waste will produce around 220,000 GJ of biomethane per annum.[35] But it would be difficult to create plants that produced enough gas to fully replace conventional fossil fuel gas. Moreover, the distance travelled to collect enough waste can make it cost prohibitive, and if transport is via conventional fossil fuel vehicles, it adds to the carbon footprint of the gas. However, these are issues that can be managed through the development of holistic strategies managing the whole of life carbon and environmental impacts. This could include a consideration of regional strategies and assessing the advantages of centralised versus decentralised production.

The investigation of how these alternative renewable gas supplies could support gas transition and could be considered alongside the opportunities identified in this report.

28 Renewable Gas Certification Pilot | GreenPower
29 Program 1 Future Fuel Technologies, Systems And Markets - Future Fuels CRC
30 The World's First Hydrogen Water Heater (rinnai.co.nz)
31 What is bioLPG? (liquidgaseurope.eu)
32 Biogas Opportunities for Australia - Australian Renewable Energy Agency (ARENA)
33 Biogas Plant Expansion (flexigen.co)
34 Moxey biodigester to power whole farm | Farm Online | Farmonline
35 Ecogas

Residential transition technology options assessment

Our assessment of residential transition technology options is shown in Table 26 below. From our research, the cost of installing gas appliances would have a medium impact, but would be disruptive. However, while there may be some risk to network capacity due to customers using appliances at once, if transitioned, these risks can be managed through shifting flexible load to non-peak times, which can be managed through education or use of software-enabled appliances.

Table 26: Options assessment residential transition from gas use

Use case	Transition option [36, 37]	Cost	Ease of implementation			Wider energy system implications	Market size
			New build install only	Existing building- decommission and install	Installation time		
Residential water heating	Electric heat pump	M	Plumber & Electrician	Plumber & Electrician	Short install time	Time distributed load – can be managed	41,431 Customers 31 GJ Ave / customer annually 1,403,572 GJ Combined total consumption in 2022
Residential water heating	Solar hot water systems with electric back up	M	Plumber & Electrician	Plumber & Electrician	1 – 4 week lead time	Lowered electricity system impact	
Residential heating	Electric heat pump	M	Electrician only	Plumber & Electrician	Short install time	High peak load potential	
Residential heating	Reverse cycle chillers and air-conditioners	M	Electrician only	Plumber & Electrician	Short install time	High peak load potential	
Residential cooking	Induction cooktops	L	Electrician only	Plumber & Electrician	Short install time	High peak load potential	

36. Department of Climate Change, Energy, the Environment and Water, Hot water systems (2023), Hot water systems | energy.gov.au. Accessed August 2023.

37. Department of Climate Change, Energy, the Environment and Water, Heating and Cooling (2023): Heating and cooling | energy.gov.au. Accessed August 2023.

Commercial and industrial transition technology options assessment

Our assessment of the gas transition options for commercial and industrial customers are shown in Table 27 below. For commercial customers, the considerations are similar to those for residential space and water heating and cooking. Adoption of induction cooktops is feasible for restaurants, but is more complex and higher cost than for residential customers.

Some areas of industrial gas use have ready pathways for transition – especially where the heat required is low temperature (<100C) or a biomass boiler can be used. For high temperature users, feasible pathways are limited to biomass at present and there will be a need to support development of biomass supply chains for users. The Borg plant also needs special consideration. Its use of gas to generate electricity is readily converted to renewables, but will place additional load on the network and transition technologies for MDF drying may not be readily available.

Table 27: Options assessment commercial and industrial transition from gas use

Use cases	Decarbonisation options	Cost	Ease of implementation	Wider energy system implications	Market size
Commercial Services - Space heating[38]	Electric heat pump[39]	M	Plumber & Electrician Short install time	Potential peak demand impacts	
Commercial Services - water heating	Electric heat pump hot water[40]	M	Plumber & Electrician Short install time	Time distributed load – can be managed	
Commercial Restaurants - Cooking	Induction cooktop	H	Plumber & Electrician Longer install time	Potential peak demand impacts	1,968 Customers
Food production – LT process heat	Biomass boilers	M	Specialty installers Can be inserted in current process Feedstock limitations	No impact on electricity system	177 GJ Ave / customer annually
	High capacity heat pumps	H	Specialty installers Likely process impacts	Likely upgrades required to distribution networks	429,201 GJ Combined total consumption in 2022
Food production – HT process heat	Biomass Boilers[41,42]	M	Specialty installers Can be inserted in current process Feedstock limitations	No impact on electricity system	
	Heat recovery (and upgrading of temperature with heat pumps)	H	Technology is still developing for >100° C with little uptake in Australia currently. Process impacts very likely	High load and impact on electricity networks	
Borg Plant at Oberon	Conversion of gas turbine to renewable MDF drying process conversion	H	Technology availability may be a limiting factor High process impacts	Conversion of gas turbine and process gas will have widespread implications for energy system	1 Customer 306,000 / year consumption

38. Department of Climate Change, Energy, the Environment and Water, Heaters and coolers (2023), Heating and cooling | energy.gov.au. Accessed August 2023.
39. Australian Alliance for Energy Productivity, High temperature heat pump technology developments and updates (2023), WATCH: 2023 high-temperature heat pumps update webinar with Dr Cordin Arpagaus (a2ep.org.au). Accessed August 2023.
40. Department of Climate Change, Energy, the Environment and Water, Hot water systems (2023), Hot water systems | energy.gov.au. Accessed August 2023.
41. ARENA, Biogas Boiler Case Study – Replacement of gas fired boilers (2023), Biomass starts to heat up down under - Australian Renewable Energy Agency (arena.gov.au). Accessed August 2023.
42. ARENA, Process Heat and Steam (2023) Biomass starts to heat up down under - Australian Renewable Energy Agency (arena.gov.au). Accessed August 2023.

Transition technology options assessment

Table 28 consolidates the findings from the MCA to provide a snapshot of the available options to transition from gas use for the five identified sectors in the LGAs. Our findings are that industrial customers will be the most impacted by cost, ease of implementation and having wider system impacts from transitioning. They will also require more detailed consideration of impacts on their process and the wider energy system to identify the most appropriate technology and approach to enable it. Options for the residential and commercial sectors may be easier to transition in the short to medium terms.

Tables 28: Multi Criteria Assessment summary

	Use cases	Decarbonisation technology	Cost	Ease of implementation	Wider System impacts	Market Size (Customers)	Market Size (Consumption)	Market Size (Consumption per Customer)
Residential	Water heating	Electric heat pump	M	H	L	41,361	1,403,572 GJ	31 GJ/customer
		Solar hot water systems with electric back-up	M	L	L			
	Space heating	Electric heat pump	M	H	M			
		Reverse cycle chillers and air-conditioners	M	H	M			
	Cooking	Induction cooktops	L	H	M			
Commercial Services (Office, retail, accommodation)	Space heating	Electric heat pump	M	H	M	1,968	429,201 GJ	177 GJ/customer
	Water heating	Electric heat pump	M	H	L			
Commercial Restaurants	Cooking	Induction Cooktop	H	M	M			
Food Production	Low-temperature process heat	Biomass boilers	M	H	L			
		High capacity heat pumps	H	M	M			
	High-temperature process heat High-temperature process heat	Biomass boilers	M	H	L			
		Heat recovery (and upgrading of temperature heat pumps)	H	L	H			
Industrial	Oberon MDF and particleboard plant	Conversion of gas turbine to renewable MDF drying process conversion	H	L	H	1	306,000 GJ	306,000 GJ/ customer

Transition opportunities – residential customer prioritised opportunities

Table 29 below identifies the available opportunities for the LGAs to support the transition away from gas. Residential gas consumption makes up the majority of the natural gas consumption across the LGAs. Focusing efforts on domestic appliance conversion to electric heating and cooking appliances could see a significant decline in natural gas consumption in the short to medium term.

Bathurst, Orange and Lithgow have the highest residential gas use and number of connections. Focusing efforts in these areas may have the greatest impact. The Bathurst, Cabonne, Cowra and Orange LGAs have significant planned subdivisions and developers could be encouraged to limit or exclude gas connections in these areas. Victorian and ACT governments have developed state-wide plans to exclude natural gas connections in new residential builds.[43, 44] Waverley Council Development Control Plan 2022 has revised their provisions to include the prevention of the installation of gas stoves, gas ovens and gas space heating in residential development. This will also enable these developments to reach net zero greenhouse gas emissions. This decision was based on Waverley Council's implementation of indoor air quality measures and their commitment to achieve community greenhouse gas emissions of net zero by 2035.[45] However, these powers may not be available to all LGAs.

The reference to 'network constraints' in this report refers to limitations and challenges that can affect the operation and reliability of the electricity system. These constraints can arise due to various factors, including physical limitations of the infrastructure, regulatory requirements, environmental considerations, and technical limitations. The transition away from natural gas will result in an increase on residential electricity demand, which needs to be taken into consideration in parallel with gas transition planning.

Table 29: Residential customer prioritised opportunities list

LGA	Option	Benefits	Barrier	Time Frame
All LGAs	Encourage existing residential users to convert gas appliances through: • Information provision. • Connection with state/federal subsidy programmes. Focus on Bathurst, Lithgow and Orange LGAs where gas use is highest.	High • Ready options for conversion. • Low cost of implementation.	• Cost of appliance conversion for residents. • Network constraints.	Short – Med Term (0-5yrs)
All LGAs	Investigate rates incentives for all electric homes. Focus on Bathurst, Lithgow and Orange LGAs where gas use is highest.	High • Strong incentive for switching.	• Cost of appliance conversion. • Targeted ratings may be challenged. • May be regressive on low income households.	Short to Med Term (0-5yrs)
Bathurst, Cabonne, Cowra and Orange	Encourage future residential developments to exclude gas usage: • Reduced developer contributions. • Ban on new connections. • Use of building consent tools to exclude gas.	Low • Will impact longer term demand reduction. • Wider government involvement required.	• Could deter new residents. • Targeted developer contributions / building standards may be challenged. • Ban on new connections could be challenged.	Long Term (10yrs +)

43. Department of Climate Change, Energy, the Environment and Water (2023), Renewable power incentives | energy.gov.au. Accessed August 2023.
44. ACT Government, (2023) Regulation to prevent new gas network connections coming soon - Build, buy or renovate (act.gov.au); Victorian government bans gas in new homes from 2024 - ABC News. Accessed August 2023.
45. Waverley Council's new Development Control Plan a win for the environment - Waverley Council (nsw.gov.au).

Transition opportunities – commercial and industrial customer prioritised opportunities

Jemena data from 2017 and 2022 shows a decline in commercial gas use in all LGAs except Orange where there was a 2% increase. At the same time, business gas connections increased across all LGAs. This could indicate a move away from gas in higher consumption industries. However, without detailed data it is difficult to state a definitive cause.

Table 30 below details opportunities for LGAs to support the small commercial business sector. For example, supporting restaurants, cafes, accommodation providers and supermarkets to convert from gas for space heating, water heating and cooking. This would be similar in nature to programmes for residential customers.

Based on review of ABS data we have been able to identify potential gas consuming industries using high temperature process heat in food production in Bathurst. Specialised assistance to these customers could be impactful as they may be large customers.

Finally, we have identified the new developments in Parkes and Bathurst that could be targeted to limit new gas uptake in the region.

For large industrials, such as the Borg in Oberon, the transition is likely to be costly and complex. Continuing to engage with these users will be important so they can participate when the time is right, and councils may be able to assist in a targeted way to help remove barriers to industrial users investing in the transition.

Table 30: Commercial and industrial opportunities prioritisation list

LGA of Focus	Option	Priority	Barrier	Time Frame
All LGAs	Encourage existing commercial users to convert gas appliances through: • Information provision. • Connection with state / federal subsidy programmes. • Rates incentive for conversion from gas.	High • Ready options for conversion. • Low cost of implementation.	• Cost of appliance conversion. • Network constraints. • Targeted ratings may be open to challenge.	Short – Med Term (0-5yrs)
Bathurst and Orange	Support large commercial users to convert low temperature process heat from gas through: • Information provision. • Connection with state / federal subsidy programmes. • Connections with biomass supply.	Med – High • Results in a positive impact in reduction of demand in the short term. • Ready options for conversion.	• Cost of compliance conversion. • Biomass supply chains may not be in place. • Network constraints.	Med to Long Term (5-10yrs)
Parkes and Bathurst	Encourage commercial development precincts to exclude gas usage: • Reduced developer contributions. • Ban on new connections. • Use of building consent tools to exclude gas.	Low – Medium • Results in a positive impact in reduction of demand in the long term.	• Targeted developer contributions / building standards may be challenged. • Ban on new connections could be challenged.	Med to Long Term (5-10yrs)

6

Report Summary

Report summary

Based on our analysis, there is significant scope for transitioning customers away from gas in the Central NSW region. This should focus on the following actions tailored to the residential and commercial sectors.

Residential alternatives to gas use are readily available, cost competitive, and is expected to have limited network impacts. Key actions that should be considered include:

1. Encouraging existing residential gas customers to switch their space and water heating and cooking appliances to electric appliances, through information programmes and helping to connect residents with subsidy programmes.
2. Investigate using discounted property rates for households for moving away from gas to incentivise switching.
3. Encouraging future residential developments to exclude gas through use of planning / building consent tools and targeted developer contributions.

Commercial and industrial gas use in the region is largely for space and water heating and cooking with low temperature heat use for food processing. Key actions that should be considered include:

1. Encouraging existing commercial users to convert gas appliances through information provision, connection with state / federal subsidy programmes and rates incentive for conversion from gas.
2. Support large commercial users to convert low temperature process heat from gas through information provision, connection with state/federal subsidy programmes and connections with biomass supply.
3. Encourage commercial development precincts to exclude gas usage and reduced developer contributions for excluding gas, ban on new connections, and use of building consents to exclude gas. (see the case study in Appendix 1 for information on Parkes SAP performance criteria).

For large industrial customers, such as the Borg manufacturing plant at Oberon, the transition is likely to be costly and complex. Continuing to engage with these users will be important so they can participate when the time is right. The role of the Central NSW Joint Organisation may be to support industrial customers to remove barriers preventing these businesses from transitioning away from gas and enabling them to make the necessary investments.

7

Appendix 1: Case Studies and Articles

New Victorian homes no longer required to have gas

The Age – 2 July 2022

'All incentives for residential gas products will be phased out during 2023. New incentives for residents to move away from gas are now being developed as part of the Victorian Energy Upgrades program.'

- New Victorian homes will no required to have gas (theage.com.au)

ACT to quit gas by 2045, shift to all electric homes and business

Renew Economy - 4 August 2022

'The ACT government has unveiled plans to phase out the use of fossil gas in Australia's capital territory by 2045, with the release of a paper modelling the transition to full electrification of homes and businesses over the coming two decades.'

- ACT to quit gas by 2045, shift to all-electric homes and business | RenewEconomy

Moxey Farms – Construction of Bio-digester

'Economic Moxey Farms is investing $50 million to install 18 new centre pivot irrigators, construct a 3MW Bio-Digester and continue expanding the dairy herd.'

- Moxey Farms case study (nsw.gov.au)

Brightmark is to construct an advanced plastics recycling plant in Parkes, NSW

Packaging News - Lindy Hughson - 1 March 2022

Parkes has been identified as the location for the largest plastics processing plant in Australia. There is limited data available detailing the process that will be used in the facility. The process '*operates in an anaerobic environment and uses the process of pyrolysis to break the chemical bonds in plastic in the absence of oxygen in place of incineration / combustion that would require heat and oxygen'* and is claimed to be 93% efficient.

- Landmark $260m investment in advanced recycling - PKN Packaging News

LM Hayter and Sons: at the cutting edge of saving energy

Low temperature heat pumps to run electric kilns that dry timber.

'*The use of heat pump technology in low temperature kilns has two main benefits:*

1. *Energy consumption is reduced because much of the thermal energy required to warm the kiln is extracted from the environment and from warm humid air that would have otherwise been vented.*
2. *Humidity is kept continually low by periodically cooling the air to condense the water out and reheating it again. Lower humidity means that drying can then be achieved either at a lower temperature, or more rapidly at conventional temperature levels – resulting in reduced energy demand.'*

Cheaper and more efficient process saving 12,000 a year in electricity costs while reducing drying time by 20%.

- Industrial Drying Case Study (nsw.gov.au)

Energy savings for Queensland meat processors

Typical energy demand, typical site energy consumption breakdown: Refrigeration = 59%, Compressed Air = 14%, Hot Water (gas) = 15%, Other = 12%, Total = 4,687 GJ p.a.

Post implementation total usage would reduce to 3807 GJ p.a. after electric CO2 heat pumps are introduced across three sites.

Action:

- Audits of site energy consumption evaluated:
  - CO2 heat pump installation
  - Refrigeration plant heat recovery system

Outcome:

Across all 3 sites a total site energy saving of an average of 16% would be achieved by implementing CO2 heat pumps.

IND08-ESPP-Meat-Processor-Heatpump.pdf (qff.org.au)

EDO advice regarding 'all electric developments'

Waverley Council's Development Control Plan 2022 requires all-electric cooking and heating systems in new homes (including alterations and additions). The installation of new gas appliances is not permitted. These provisions are to improve indoor air quality and will assist Waverly Council to meet its community greenhouse emissions reduction target of net zero by 2035.

Waverley Council's new Development Control Plan a win for the environment - Waverley Council (nsw.gov.au).

Parkes Special Activation Precinct

As a part of the Delivery plan, there is a requirement for the Parkes SAP to provide a Net Zero Ready Plan, and if this is not feasible provide Net Zero action plan which takes into account technological and financial feasibility. The precinct is planning for tenants with heavy natural gas reliance and is currently working with the RGDC to develop an action plan for continuous improvement towards achieving net zero over time.

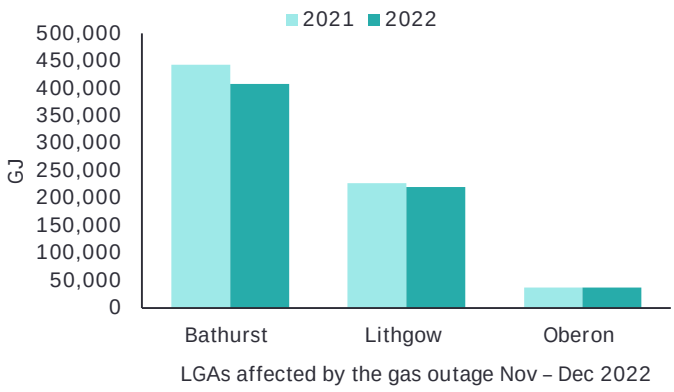
Parkes Special Activation Precinct Delivery Plan (nsw.gov.au)

Gas outage summary November 2022 – December 2022

On Wednesday 2 November 2022, a leak was detected in the Young Lithgow Pipeline and reported to the APA. Flooding of the Macquarie River at White Rock caused damage to the APA pipeline that runs under the river and led to an extended gas outage for Bathurst, Lithgow, Oberon, and to some extent Forbes.[46] On 3 November, the APA issued an update stating that the restoration of natural gas supply to the affected regions could take 'weeks'. In the initial days of the outage, it was estimated that over 20,000 people were impacted. The outage lasted from 3 November 2022 until 19 December 2022, when gas supply was fully restored to Lithgow and Oberon. During the outage, customers were served via a liquid natural gas (LNG) tanker to top-up supply. However, rationing of gas was required and customers were not able to use gas as they normally would.[47]

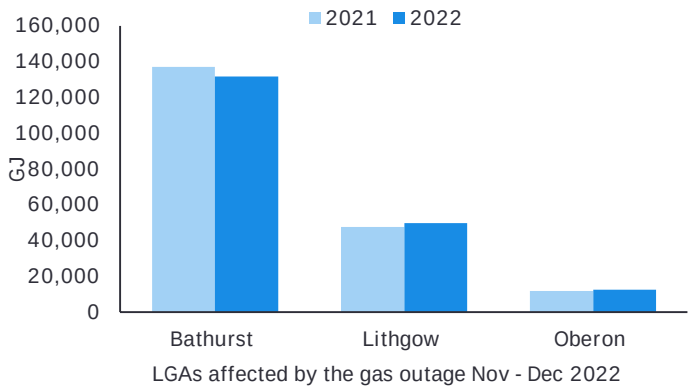
Data from Jemena for 2021 and 2022 shows a decline in total residential gas consumption in Bathurst, Lithgow and Oberon. This is in contrast to the overall increase in demand for gas in the residential sector between 2017 and 2022. Gas consumption from businesses in Lithgow and Oberon increased in 2021 and 2022, whereas it decreased slightly in Bathurst. Looking at this data, it is difficult to determine whether there was a change in consumption that can be directly attributed to the gas outage.

Figure 20: Residential gas consumption 2021 and 2022



Source: Jemena

Figure 21: Business gas consumption 2021 and 2022



Source: Jemena

Gas distribution networks are generally reliable, and unscheduled gas outages are rare. Since most gas infrastructure is underground, it is protected from weather and surface interference. However, gas pipelines are vulnerable to changes in ground conditions caused by erosion, flooding or earthquakes.

The Australian Energy Regulator Gas Network Performance report notes that in 2021, there was an average of 0.015 outages per customer.[48] This translates to a customer experiencing an unscheduled gas outage once every 66 years. The rarity of gas outage events does not dimmish the seriousness of the impacts of the outage on customers. Recovery from gas outages is also more difficult because prior to reconnection, each appliance must be checked by a gasfitter.

However, extreme weather events are becoming more frequent due to climate change. This could increase the likelihood of gas infrastructure suffering damage, leading to unscheduled outages like the one experienced in Central NSW between November and December of 2022. Prudent management of pipelines means operators, such as APA and Jemena, will need to consider climate risks going forward to identify mitigation measures that may be required to maintain security of supply for customers.

46. Bathurst, Lithgow, Oberon without gas as floods likely cause of damaged pipe (smh.com.au)
47. (Gas supply outage update: Bathurst, Lithgow, Oberon, and Wallerawang | APA Group); Gas Outage Updates – Jemena
48. AER - 2022 Gas Network Performance Report - December 2022_2.pdf page 47

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