NSW Gas Demand Analysis

Report Prepared for Climate Council of Australia

23 July 2021

Northmore Gordon Pty Ltd
ABN 44 136 798 519
132 Cremorne St
Cremorne VIC 3121
enquiries@northmoregordon.com

Northmore Gordon is a climate change consulting firm specialising in energy efficiency, renewable energy and greenhouse gas management for the manufacturing and mining sectors.

For further information, please visit our website at http://www.northmoregordon.com

Executive Summary

The Climate Council of Australia has engaged Northmore Gordon to undertake an analysis of the NSW gas market and the potential for gas demand measures to eliminate the need for additional gas supply in NSW.

This study includes an assessment of the current NSW gas demand, identification of opportunities to reduce gas demand such as efficiency measures and fuel switching/electrification, and analysis of the impact of Government support programs on reducing gas demand in the state.

Gas supply assessment

NSW does not currently have any of its own gas production and is a net importer from South Australia via the Moomba to Sydney Pipeline (MSP) and Victoria via the Eastern Gas Pipeline (EGP). The eastern states gas market has undergone a significant structural change in recent years with the introduction of LNG production and export capability and the development of unconventional gas sources. Victorian off-shore gas fields, which have traditionally supplied southern eastern states for the last three decades, are declining rapidly. Gas from newer unconventional fields in QLD (as well as a significant portion of SA's production) are mostly contracted to LNG producers and southern states will continue to have to compete with international markets to access this gas. Despite these pressures on southern states gas users, fears of shortfalls have eased with the projected new supply from the Port Kembla Gas Terminal (PKGT), which has obtained development approval. With PKGT and upgrades to the EGP and MSP, NSW can move from a net importer of gas to a net exporter with 395 TJ/day capability from 2023 onwards.

NSW gas demand forecast

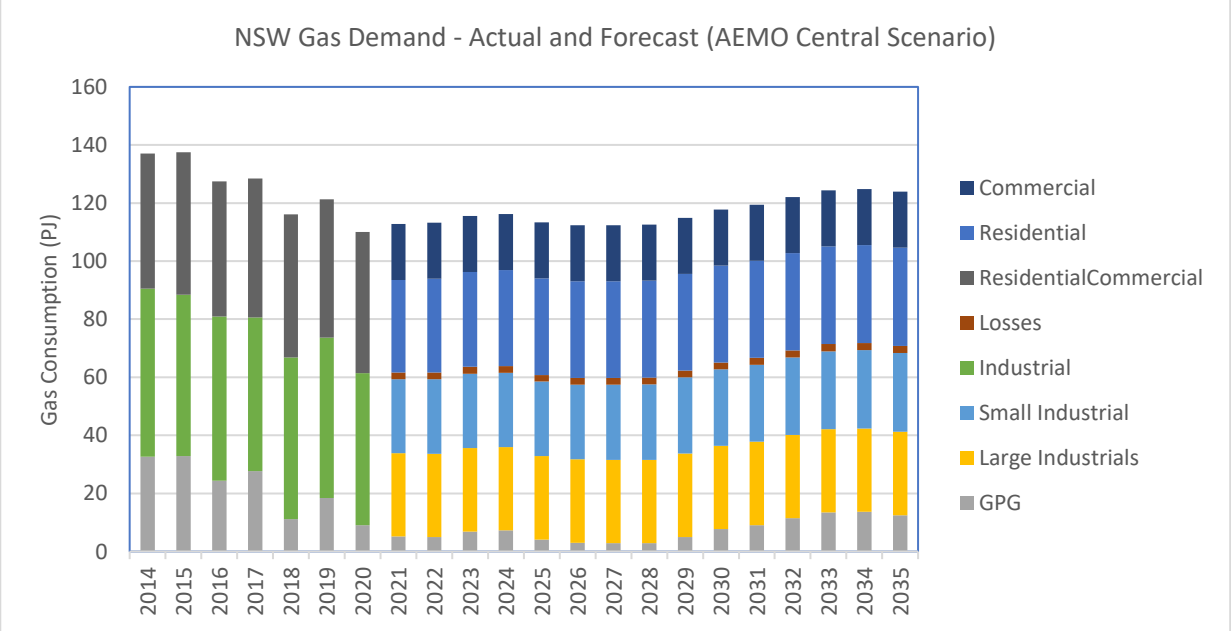


Figure 1: AEMO Gas demand forecasts for NSW (GSOO, 2021)

The Australian Energy Market Operator (AEMO) which operates Australia's gas markets, provides robust estimates of NSW gas usage and forecasts in their annual Gas Statement of Opportunities. The latest forecasts for gas usage in NSW by sector are presented in Figure 1. The total NSW gas consumption in 2021 is approximately 113 PJ, which is comprised of 54 PJ

for large and small industrial facilities, 19 PJ for commercial services, 32 PJ for residential, 5 PJ for Gas Powered Generation (GPG) and 2 PJ in losses. Note that AEMO incorporates the Australian Capital Territories gas consumption within NSW's figures. Excluding GPG and losses the forecast gas consumption to 2035 remains relatively flat should current policy settings remain in place unchanged, with only a 3 to 4% growth over the 15 years. However the 2021 GSOO does flag that their modelling highlights some uncertainties in the longer term that predict gas consumption is more likely to decline than grow, primarily due to the uptake of energy efficiency and fuel switching activities.

NSW Government Programs

In March 2020, the NSW Government committed to an emissions reduction target of 35% by 2030 and net zero emissions by 2050. In 2020 it also signed a Memorandum of Understanding with the Commonwealth government for $2 billion in energy and emissions reduction projects. This included a $450 million "Emissions Intensity Reduction Program" to support industry in transitioning to low emissions as well as a commitment to inject an additional 70 petajoules (PJ) of gas per year into the NSW market. The NSW Government has subsequently released details of their Net Zero Industry and Innovation Program, which includes three streams:

1. Clean Technology Innovation: $195 millionmillion for investing in research, development and commercialisation of low emissions technologies.
2. New Low Carbon Industry Foundations: $175 million to support new low carbon industries to establish in NSW, particularly supporting hydrogen hubs in the Illawarra and Hunter regions.
3. High Emitting Industries: $380 million to assist the deployment of low emissions technologies and infrastructure in high emitting industrial facilities in NSW.

The NZIIP is still being designed, and no detailed modelling has yet been done on its potential impact on gas consumption in NSW.

In addition, other support programs exist to incentivise reducing greenhouse emissions in NSW, including the Sustainability Advantage program, the Climate Change Fund, and the Energy Saving Scheme.

Gas Reduction Opportunities

Drawing on publicly available data, reports, and Northmore Gordon's existing industry knowledge, a further breakdown of gas usage into industrial and commercial sub-sectors was undertaken. Residential gas end use was estimated based on publicly available data. Subsequent to this Northmore Gordon assessed potential gas reduction opportunities for those sub-sectors. Acknowledging that industrial gas usage represents nearly 50% of NSW's gas usage, particular attention was made to zero emissions alternatives to existing industrial processes.

Whilst many opportunities for electrification of industrial processes exist, much of the gas feedstock and higher temperature process heating opportunities require considerable investment and further commercialisation development before they can be broadly adopted.

Consequently opportunities are presented in a staged framework for adoption, representing:

- Short term: 0 to 5 years time
- Medium term: 5 to 15 years time
- Longer term: > 15 years

Short term opportunities are those where the technology is readily available, demonstrated, and implementable without retooling the facility. Medium term opportunities are those where there are no known technical barriers to implementation, but adoption still requires significant investment and re-tooling of the facility. Longer term opportunities are those that require further research, development and deployment, and significant lead times for planning.

Section 5 of this report presents the identified gas reduction opportunities in detail and are summarised in Table 1, along with the applicable sectors, gas reduction potential in those sectors and timeframe for implementation.

Table 1: Identified gas reduction opportunities and timeframe for implementation

Gas Reduction Opportunity	Applicable Sectors	Reduction potential (per sector)	Timeframe
Heat recovery	Non metallic mineral, timber and wood products, pulp & paper, other industrial facilities	10-25%	Short term
Electrification of ladle heating and lower temp furnaces	Steel	3%	Short term
Furnace improvements (inc burner upgrades)	Steel, non metallic mineral	10-25%	Short term
Building upgrades and efficient boilers	Commercial services and residential	10-25%	Short term
Low temperature heat pumps (<90)	Food and beverage, timber and wood products, textile, commercial services and residential	50-100%	Short to Medium term
Reverse cycle chillers and air conditioners	Commercial services and residential	15-60%	Short to Medium term
Electric induction + resistance furnaces	Steel and iron manufacturing	80%	Medium term
Biomass and biogas	Non metallic mineral, timber and wood products, pulp & paper, food and beverage, textiles	100%	Medium term
High temperature heat pumps (>90)	Food and beverage, textile	50-100%	Medium term
Hydrogen and electrification	Ammonia, Iron smelting	100%	Long term
Microwave + resistance kilns	Non metallic mineral	100%	Long term
Infrared drying	Paper	100%	Long term
Plasma arc	Steel	10%	Long term

NSW Gas Decarbonisation Roadmap

Applying the opportunities to the appropriate sub-sectors and according to the relevant timeframe delivers the roadmap for gas decarbonisation in NSW shown in Figure 2.

The roadmap illustrates a potential pathway for NSW to reduce its gas consumption by 25% within 5 years, 70% in 10 to 15 years, and entirely eliminate it by mid century. By 2035 this equates to a reduction in Scope 1 greenhouse gas emissions of 3.8 million tonnes of CO_2e and 5.4 million tonnes of CO_2e by 2050.

Within the framework of Australia's Paris commitments, and the NSW Government Net Zero Emissions targets, there is a clear impetus to decarbonise energy systems. As the electricity sector decarbonises, the attention is naturally turning to other sources of greenhouse gas emissions. Similarly, investors and consumers are increasingly seeking to preference lower carbon products and services. Achieving zero emissions in Scope 1 emissions can require significant capital investment and engineering expertise to implement. The decarbonisation roadmap in this report sets out several viable approaches that contribute to achieving the State goal.

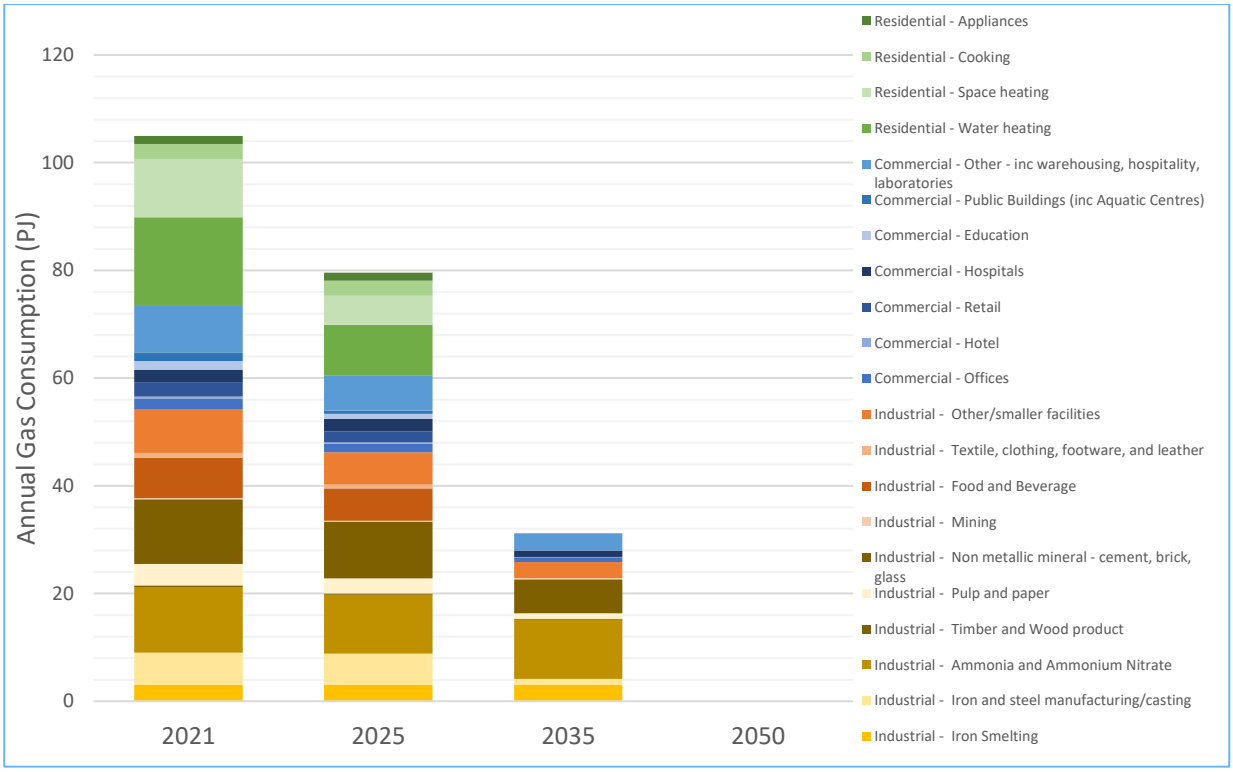


Figure 2: NSW Gas Decarbonisation Roadmap

Contents

Executive Summary 3

Contents 7

1 Introduction 8

1.1 Background 8
1.2 Objectives 8
1.3 Our Approach 9
1.4 Study Limitations 9

2 NSW Supply Assessment 10

2.1 International Competition for Gas 10
2.2 Southern States Supply Adequacy 11
2.3 Business as Usual Gas Demand 13

3 NSW Government Programs 16

3.1 NSW Climate Change Fund 16
3.2 Sustainability Advantage 16
3.3 Net Zero Industry and Innovation Program 17
3.4 NSW Energy Security Safeguard 18

4 Gas Reduction Opportunities 19

4.1 Industrial 19
4.1.1 Ammonia and Explosive Manufacturing 20
4.1.2 Iron Smelting and Steel Manufacturing 21
4.1.3 Non Metallic Mineral – brickmaking, tile, cement, and glass 22
4.1.4 Sawmill and Wood Products 23
4.1.5 Pulp and Paper 24
4.1.6 Food and Beverage 25
4.2 Commercial Services 25
4.2.1 Commercial Offices 26
4.2.2 Retail 27
4.2.3 Aquatic and Recreation Centres 28
4.2.4 Hospitals and Aged Care 30
4.3 Residential 31

5 NSW Gas Decarbonisation Roadmap 34

6 References 37

Appendix A. NSW Decarbonisation Roadmap Detailed 39

7 Document Control Sheet 40

Document information 40
Revision history 40
Distribution history 40

1 Introduction

1.1 Background

Since the 2015 Paris Agreement, government jurisdictions, businesses, and civil society has recognised the importance of keeping global warming well below 2 degrees and taken action to set emissions reduction targets and develop strategies for achieving these targets.

The NSW Government in 2019 established a Net Zero Emissions Target for 2050 and an interim target of 35% reduction on 2005 levels by 2030. By way of comparison the Victorian Government has legislated the same net zero emissions target for 2050, but established a higher interim target of 45 to 50% reduction by 2030 on 2005 levels.

Australia is a resource rich country, both in minerals and fossil fuel reserves and is home to some of the greatest renewable energy resources in the world. In 2015 major fossil fuel consortiums established a capability in the eastern states of Australia to liquify and export gas. This new LNG export capability developed alongside a shift in the production of gas from conventional sources in the southern states, namely Victoria and South Australia, to unconventional gas sources in Queensland, with future unconventional gas development earmarked for NSW. Consequently, production of gas in the eastern states increased significantly, with much of that gas contracted for export as LNG.

Australian manufacturing and heavy industry, which had already declined steadily since the 1970s, experienced significant energy price shocks because of this structural change in the eastern states gas markets. Historic wholesale gas prices below $4/GJ gave way to prices north of $10/GJ. Domestic gas consumers had to compete with LNG producers for access to Australian gas, leading many to investigate alternatives and cost saving measures. These same manufacturing businesses are now recognising the competitive advantage offered by establishing net zero emissions targets and strategies and are embarking on ambitious plans to decarbonise fossil fuel supplied processes.

Despite the apparent outcome of these policy and market changes being an overall reduction in domestic gas demand, the Commonwealth Government has promoted a “gas fired recovery” to the COVID pandemic. This is hinged on unlocking new gas fields for production and removing barriers for domestic gas consumers to compete with the LNG export market. Whilst some analysis has been conducted on the merit of this approach there has been little analysis on the overall potential of demand side activity on the NSW gas market. This lack of analysis is particularly striking given the Memorandum of Understanding between the NSW and Commonwealth Governments, includes the requirement for NSW to add an additional 70 PJ of gas supply.

1.2 Objectives

The Climate Council of Australia has engaged Northmore Gordon to undertake an analysis of the potential for gas demand measures to eliminate the need for additional gas supply in NSW. This included an assessment of the current NSW gas demand, identification of opportunities to reduce gas demand such as efficiency measures and fuel switching/electrification, and analysis of the impact of Government support programs on reducing gas demand in the state.

The stated objectives of the analysis are:

- to provide an analysis of gas demand in NSW and to identify opportunities for demand reduction to avoid a potential shortfall in gas supply

- to propose potential NSW government policy to assist industry, businesses, and residential gas users to minimise their gas use
- to identify and demonstrate the potential gas demand savings that could be made in NSW and Victoria.

1.3 Our Approach

Northmore Gordon has built on its previous Victorian study and conducted a dedicated analysis for the NSW gas market. Our approach for the NSW Gas Demand Analysis piece involved:

- Assessing the international impact of COVID-19 and the shift away from fossil fuels on LNG demand.
- Reviewing recent publicly available reports into the supply adequacy in NSW, accounting for business-as-usual trends in gas demand, volumes from existing developed gas fields, and the impact of the Port Kembla Floating Storage and Regasification Unit (FSRU).
- Understanding key NSW government policies and programs incentivising industry to reduce emissions intensity and decarbonise and estimating the potential fossil gas demand reduction these will facilitate.
- Identifying opportunities to reduce gas demand through either efficiency measures or fuel switching (e.g. electrification), particularly focussing on industrial processes which represents nearly 50% of NSW annual gas consumption.
- Combining the gas supply assessment with the government programs and gas reduction opportunities piece Northmore Gordon will prepare a high-level forecast on NSW gas demand.

1.4 Study Limitations

The focus of this study is an overall assessment of the sectors and end uses that consume gas in NSW, and identification of high level opportunities for decarbonisation of these uses. Based on Northmore Gordon's experience of energy systems for industrial and built environment facilities, a potential roadmap has been developed for decarbonisation of gas usage in NSW. The study undertaken is not a Cost Benefit Analysis and does not incorporate detailed assessment of the potential costs for implementation and valuation of the benefits.

To confirm the validity of this roadmap and study of decarbonisation opportunities, additional work would need to undertaken including:

- Engagement with hard to abate sectors about the identified opportunities and discussions to understand prospective timeframes for implementation
- Modelling of upstream and downstream impacts of decarbonisation of gas usage, specifically the additional electrical load which the National Electricity Market and distribution and transmission infrastructure will need to carry to accommodate
- Modelling and analysis of impacts of gas prices on uptake of decarbonisation measures.
- Modelling and analysis of demand for zero carbon products and potential value premium they may attract, e.g. zero emissions cement, steel, bricks.
- The potential value of NSW gas decarbonisation on other states, particularly Victoria which will experience a constrained gas market in the next five to ten years.

2 NSW Supply Assessment

Apart from a small gas field supplying the Wilga Park power station, NSW does not produce any of its own gas and imports all of its gas from the Cooper Eromanga Basin in South Australia (via the Moomba to Sydney pipeline) or the Gippsland Basin in Victoria (via the Eastern Gas Pipeline). Nearly half of all demand for gas in NSW is from manufacturing and industrial users, with residential and commercial comprising the second largest user of gas. In 2020 the Port Kembla LNG import and regasification terminal was approved for construction and this has the capacity to import and inject into the NSW gas network 100 PJ of gas. Similarly in late 2020 the Narrabri Gas Project obtained conditional Development Approval to proceed by the NSW Government, however the project is yet to reach Final Investment Decision and requires approval of a dedicated pipeline in order to proceed.

2.1 International Competition for Gas

In practice there is no shortfall of gas to serve the domestic market, with 1990 PJ of gas production servicing the international LNG market and 470 PJ servicing the domestic gas market.

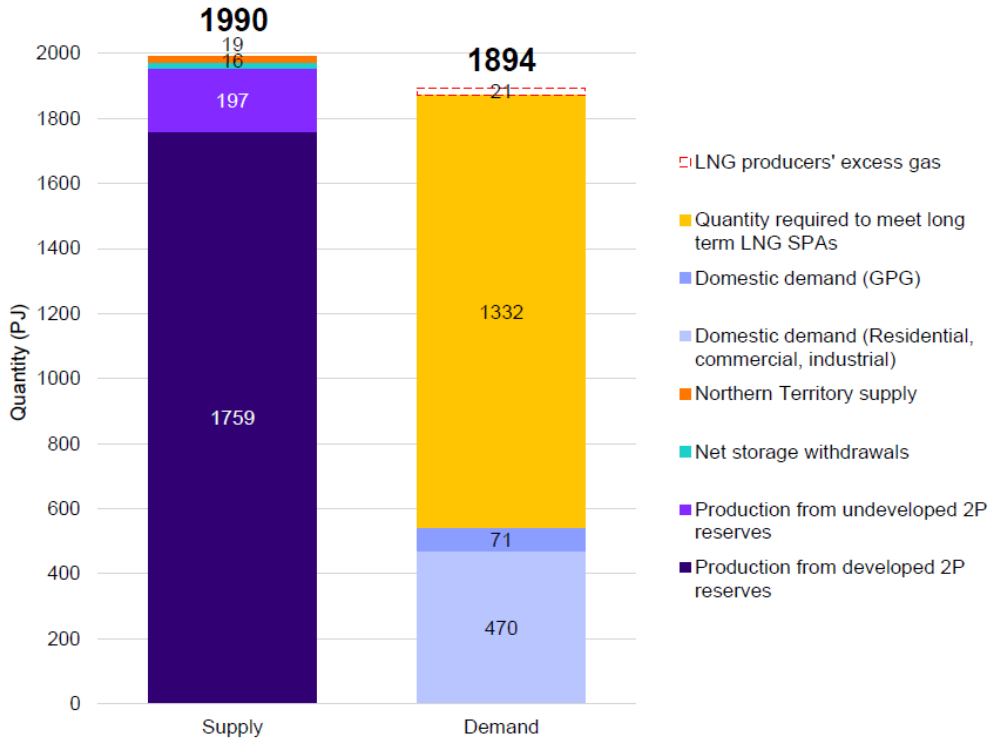


Figure 3: Forecast supply-demand balance in the east coast gas market (including supply from the Northern Territory) for 2021, ACCC Gas Inquiry January 2021

Australia is now the largest exporter of LNG in the world, overtaking Qatar and Northern America, and principally supplies into the Pacific Basin which services LNG import markets of China, Japan, Taiwan, and Korea.

The March 2021 Issues paper by the ACCC on the LNG netback price series discusses the growth in global liquification facilities which it suggests will continue to grow nearly doubling the total capacity available by 2040. Whilst Australia is currently the largest exporter of LNG globally, the United States and Qatar are both ramping up LNG production with both predicted

to outstrip Australia well before 2040 as the largest global exporters of LNG. Qatar has the lowest cost of production of all the major LNG producers and can easily switch between the European and Asian markets. Several development proposals have been submitted for LNG import terminals in Australia, which have alluded to the option of importing LNG from Qatar and other international players due to their anticipated lower price of supply. This included the recently withdrawn Crib Point facility proposed by AGL.

As of May 2021, the price of Brent crude oil (a strong indicator for gas prices) has rebounded from the low pricing of 2020 USD $41.69 to a forecast price average of USD $62.26 in 2021 and a 2022 forecast of USD $60.74. Short-term forecast prices are not at pre-Covid levels but have rallied in relation to 2020. This increase in the Brent crude price will put additional upward price pressure on forward LNG pricing.[1]

A significant portion of eastern states gas production is contracted to LNG producers for supply into the international LNG market. The Gas Supply Agreements (GSAs) governing the terms of these contracts are generally longer term and are indexed to international oil and gas prices. The impact of the COVID pandemic led to a contraction in global economies and a consequent reduction in LNG demand.

The International Energy Agency Gas 2020 Report reviewed the impact of COVID 19 and where the forecast of global gas demand has settled post 2020. While gas demand followed the previous 2019 IEA outlook, there was a sharp decline in gas demand in 2020 across most regions globally. Demand dropped from 2019 to 2020 by 4%, but production didn't initially match the decrease so during 2020 the global gas market had an excess of supply that led to downward price pressure on global gas markets.

As noted in the January 2021 Gas Inquiry Report by ACCC this has created the perverse situation where spot LNG prices are lower than contracted domestic gas prices.

Post 2020, in the period from 2021-2025 the IEA expects LNG demand to rebound globally by 1.5% per annum. The Asia Pacific region will drive most of the global growth predominantly through China and India's individual demand increases, noting that this assumption is based on the continued growth of their domestic markets and the increased demand for the industrial goods.

2.2 Southern States Supply Adequacy

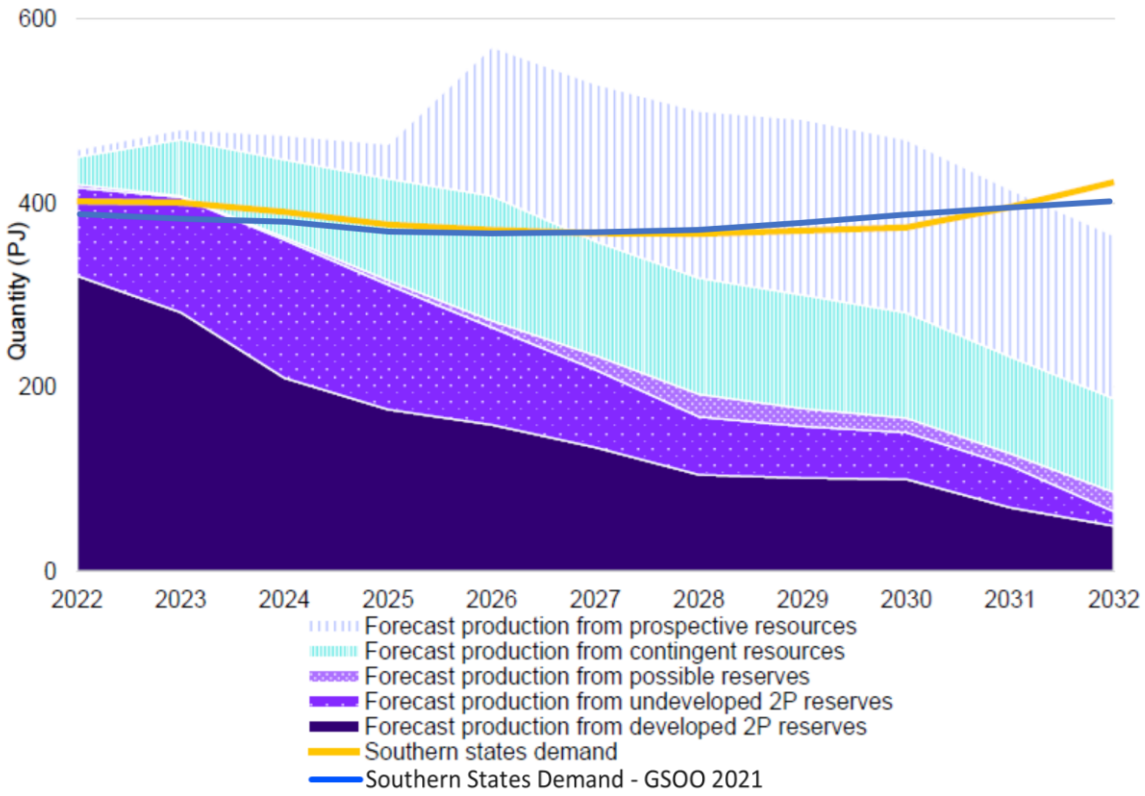
The 2021 AEMO Gas Statement of Opportunities (GSOO) clearly identifies that the state of the current gas market is under immense pressure to change. Notably AEMO stated "this GSOO also highlights that the gas sector in eastern and south-eastern Australia is on the cusp of transformation, with changes in consumption patterns forecast and alternate supply sources being actively developed."

Since the late 1970s Victoria's Gippsland Basin has supplied over 1,000 TJ/day into the southern states supplying the gas consumption needs of Victoria, NSW, Tasmania, and parts of South Australia. The highest proportion of gas demand in Victoria is winter space heating in residential and commercial buildings, with peak winter demand over 1,200 TJ/day. By contrast domestic consumption in Queensland and NSW is dominated by industrial consumption, although residential consumption does introduce a seasonal element. Despite the crisis headlines in 2019 of a looming gas supply shortfall in Victoria and other southern states the latest gas planning reports have softened concerns of a supply shortfall on an annual basis. While the latest GSOO doesn't include a specific southern region supply adequacy chart, the

[1] https://knoema.com/infographics/yxptpab/crude-oil-price-forecast-2021-2022-and-long-term-to-2050#:~:text=(13%20May%202021)%20Brent%20crude,Energy%20Information%20Administration%20(EIA).

January 2021 ACCC Gas Inquiry Report did, albeit with the 2020 forecasts for demand. This is presented below, with latest 2021 gas demand estimates overlaid on it.

Chart 1.7: Forecast gas supply compared to forecast gas demand, southern states, 2022–2032



The latest Victorian Gas Planning Report illustrates that gas supply from the Gippsland Basin is declining rapidly, with maximum daily production capacity reducing by 58%, from 1,012 TJ/d in 2021 to 428 TJ/d in 2025. However, this fall is offset by projected new supply from the Port Kembla Gas Terminal (PKGT), which has obtained development approval. With PKGT and upgrades to the EGP and MSP, NSW can move from a net importer of gas to exporting gas into Victoria, with 395 TJ/day capability from 2023 onwards.

According to AEMO's Gas Statement of Opportunities 2021, system resilience is becoming a key issue. The tight timeframe for the development of the Port Kembla Gas Terminal (PKGT) is a potential concern to the market especially as the southern fields decline. On a Business As Usual basis, i.e. not accounting for adoption of demand side measures, the current expected timeframe for a shortfall is 2026, see Figure 4. According to the GSOO central forecast if the PKGT is delayed and nothing else changes to shift the balance of supply and demand in southern states, short term availability constraints could cause issues earlier - in Winter 2023. Infrastructure upgrades will help the situation as the Eastern Gas Pipeline (EGP) will complement the PKGT by compression enabling the bi-directional supply between NSW & Victoria. Potential constraints on the South West Pipeline (SWP) will make the reliance on the PKGT and the EGP upgrade critical as this constraint has the potential to impact the Victorian market access to the Iona Underground Storage (UGS) particularly during the southern winter peaks. Focus on demand side measures, such as those outlined in this report, are likely to play a critical role in alleviating annual and daily supply constraints

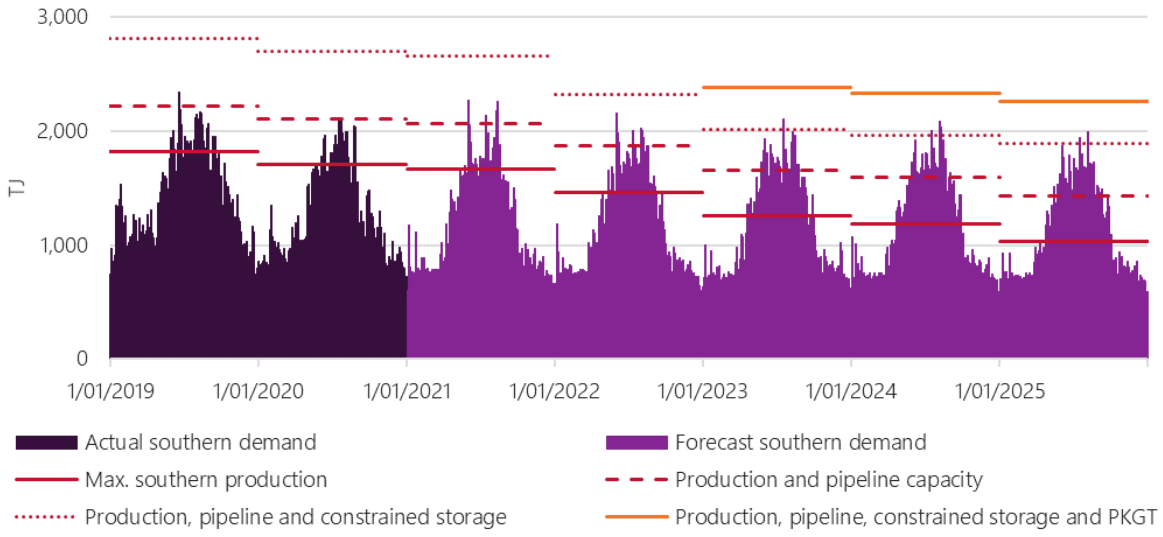


Figure 4: 2025 Forecast 1 in 20 year demand in Southern States and varying supply scenarios to peak time demand (AEMO, 2021)

2.3 Business as Usual Gas Demand

The AEMO National Electricity and Gas Forecasting Portal provides robust forecasts of gas consumption broken down by state and customer type.

Gas demand is differentiated by tariff categories, with Tariff D representing large gas consumers billed by consumption (over 10 TJ per annum) and Tariff V customers representing residential and small commercial billed by consumption (under 10 TJ per annum). Tariff D customers are differentiated between Large and Small Industrials (although the latter categories include facilities usually designated as commercial e.g., hospitals, shopping centres), with Tariff V customers being Residential and Commercial buildings. Discussions with representatives at the NSW Department of Planning Industry and Environment yielded the information that there are 400 Tariff D customers in the state with the top 20 comprising half of this category's gas usage.

Gas Powered Generation is a different category of demand, this is also provided Figure 3 along with losses through the system.

Figure 5 presents the historic and forecast gas consumption in NSW (incorporating ACT) taken from the 2021 GSOO[2]. Northmore Gordon has used publicly available data from the 2015 Residential Energy Baseline Study for historic residential gas consumption to infer the breakdown between residential and commercial. Assuming commercial gas consumption remains fixed over the analysis period, yields the predicted breakdown between residential and commercial gas usage from 2021 onwards. It is noted that the Australian Energy Statistics gives a value for the "Commercial and Services", which encompasses traditional commercial building facilities, of 11.4PJ for (2018-19). This is 7.8 PJ less than the estimate derived by Northmore Gordon using the AEMO and Residential Energy Baseline Study. The recent "Achieving Low Energy Existing Commercial Buildings" report by EY highlighted that the AES dataset is approximate only and that there are known issues with this dataset. It is also possible that AEMO data incorporates some small manufacturing facilities and other small gas users that would not ordinarily be classified as "commercial".

[2] Note this excludes ethane consumption at the QENOS Botany facility

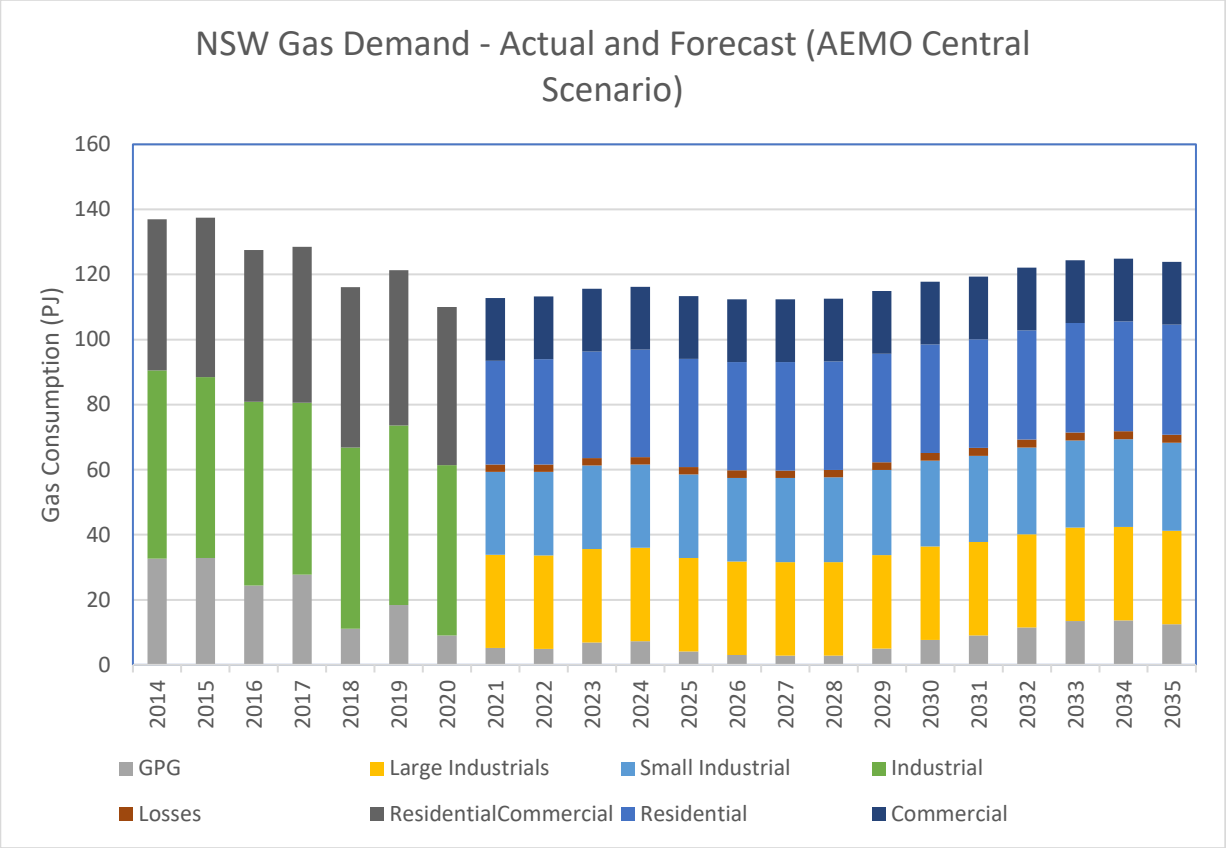


Figure 5: NSW Gas Demand - AEMO GSOO 2021 Actual and Central Scenario

It is important to note that NSW gas consumption incorporates ACT gas consumption.

Under AEMO central scenario, gas consumption is forecasted to remain flat. However, the 2021 GSOO does flag that their modelling highlights some uncertainties in the longer term that predict gas consumption is more likely to decline than grow:

- ongoing investment in energy efficiency and fuel switching
- hydrogen development as an alternative to gas
- growth in residential and commercial gas use being offset by efficiency improvements
- industrial users closing operations based on gas price increases
- declining annual demand for Gas Powered Generation (GPG) as alternate fuel and storage technologies increases
- demand for GPG being event driven (market volatility)

Industrial demand for gas is not forecast to grow in the next 10 years and could potentially reduce significantly as industrial users in the gas sector start to decarbonise. Surveyed industrial users indicated their demand is unlikely to increase, even if prices fall. Their current view remains that gas price reductions alone would not drive significant increases in their consumption but would reduce the risk of industrial closures. The potential impact of sustained lower prices on new manufacturing demand was not modelled by AEMO.

AEMO's assessment is that gas will continue to play a role in the electricity sector particular during periods of low renewable energy generation or prolonged coal-fired generation outages. While the volume of gas consumed for generating electricity is forecast to decline in all scenarios, the value of that generation is expected to increase in line with the growth of renewable energy and the retirement of coal generation. Trends and forecasts in NSW Gas Powered Generation under different AEMO scenarios is presented in the figure below.

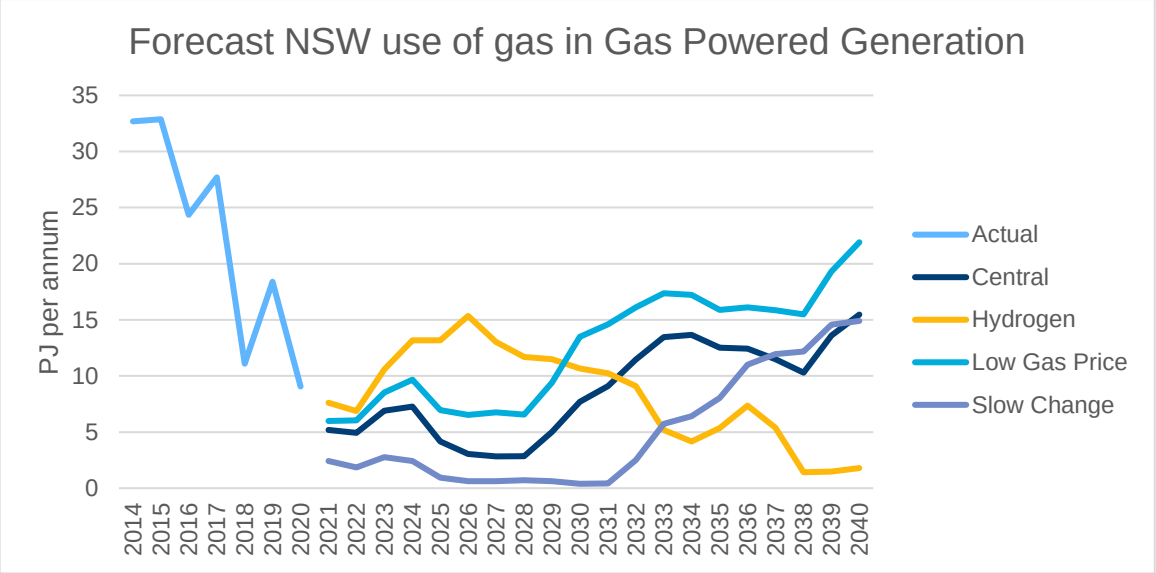


Figure 6: Forecast GPG consumption under different scenarios (AEMO, 2021)

3 NSW Government Programs

In January 2020, the NSW and Commonwealth governments signed a Memorandum of Understanding for $2 billion in energy and emissions reduction projects. Whilst this included a $450 million “Emissions Intensity Reduction Program” to support industry in transitioning to low emissions, the MoU included a commitment to inject an additional 70 petajoules (PJ) of gas per year into the NSW market.

In March 2020, the NSW Government committed to an emissions reduction target of 35% by 2030 and net zero emissions by 2050. It also released the Net Zero Plan Stage 1: 2020 to 2030 report outlining the high-level vision for achieving emissions reduction and the priority areas for the next ten years. The Victorian Government released in May 2021 its emissions reduction targets, which were notably higher than NSW, namely 45 to 50% by 2030 and a legislated target of net zero emissions by 2050. These targets by both state governments are a big step forward in supporting businesses to adopt their own emissions reduction targets and invest in carbon reduction projects. This is particularly relevant as these businesses are coming under supply chain and investor pressure to demonstrate they have a strategy for carbon reduction.

It is worth noting however that both targets fall well short of the 75% emissions reduction target by 2030 and net zero in 2035 proposed by the Climate Council for Australia to align with international ambition on climate change and to maintain temperature rise well-below two degrees.

3.1 NSW Climate Change Fund

The NSW Climate Change Fund is the primary fund through which energy and greenhouse abatement activities are supported in NSW. Each year, all NSW electricity distribution businesses are required to pay contributions to the fund, and these in turn are passed through to electricity consumers. The purposes of the fund include to support activities that reduce greenhouse gas emissions and the impacts of climate change, to stimulate investment in innovative energy savings measures and to raise public awareness about climate change. The NSW Climate Change Fund has been operational since 2007 and is leveraged to fund specific energy and climate related programs throughout the state, with funding allocated in 5 year programs. The latest program phase, which began in 2017 and will continue until 2022, included programs such as the Energy Saver for Business and the Emerging Energy program.

Northmore Gordon delivered energy efficiency support projects funded by the NSW Government under the Energy Saver for Business program, including energy audits, energy management system support projects, compressed air and steam assessments, and Manufacturing Efficiency Funding grants for capital and metering projects. In 2017 a dedicated “Gas efficiency funding” stream was also offered which supported industrial users to reduce gas consumption.

The Emerging Energy program has provided grant funding and support to the development of dispatchable electricity projects in NSW.

3.2 Sustainability Advantage

The NSW Department of Planning Industry and Environment operates the Sustainability Advantage (SA) program, which offers specific sustainability training modules and dedicated support in various areas of sustainability to member businesses. Membership is low cost and offers one on one support and networking opportunities to environment and sustainability managers at participating businesses. Training modules have included:

- Carbon leadership
- Business planning for sustainability
- Climate change risk and adaptation
- Sustainable supply chain management

The program also includes support to assess a business's overall sustainability, identify gaps, and develop a plan for improvement. This improvement plan includes accessing up to 30 hours from an expert panel of sustainability consultants, to implement changes.

In 2021 the SA team has been overseeing a pilot program to develop Net Zero Emissions Pathways for member businesses. This pathway development work includes the preparation of an emissions baseline (Scope 1 and 2, and relevant Scope 3), identification of carbon reduction opportunities, setting net zero emissions targets, and developing potential pathways for achieving this target. It is anticipated that this program will move beyond the pilot phase in the second half of 2021.

3.3 Net Zero Industry and Innovation Program

In March 2021, the NSW Government announced a $750 million "Net Zero Industry and Innovation Program" (NZIIP). This is funded from the Climate Change Fund and commitment of Commonwealth Government funding under the MoU. This program expands on the Net Zero Plan and established the key pillars of how the government will achieve the 35% reduction by 2030. These key pillars are:

1. Clean Technology Innovation: $195 million for investing in research, development and commercialisation of low emissions technologies
2. New Low Carbon Industry Foundations: $175 million to support new low carbon industries to establish in NSW
3. High Emitting Industries: $380 million to assist the deployment of low emissions technologies and infrastructure in high emitting industrial facilities in NSW.

The NSW Department of Planning, Industry and Environment (DPIE) opened a Registration of Interest (ROI) process to hear stakeholder feedback on the proposed Net Zero Industry and Innovation Program. Northmore Gordon and the Climate Council submitted a ROI response with the aim of holding a meeting to discuss the implications of the program on reducing gas demand. Independently Northmore Gordon contacted DPIE to coordinate a meeting to understand the potential for targeted government programs to reduce fossil gas demand. Whilst Northmore Gordon and Climate Council didn't receive a formal response to their ROI submission, informal discussions were held with representatives of DPIE involved in the program design.

The advice provided by DPIE was that the New Low Carbon Industry Foundations and High Emitting Industries streams will directly support businesses to reduce gas usage (as well as other sources of emissions).

The focus of the New Low Carbon Industry Foundations is supporting consortia to establish hydrogen and low emissions hubs in the Hunter and Illawarra regions. These consortia will connect hydrogen producers, other low emissions technology providers, and large energy using industry in the region with a particular focus on those industries whose processes have historically relied on gas, e.g. steel, cement, brickmaking, chemical manufacturing.

The High Emitting Industries stream is expecting to deliver the heavy lifting in emissions reduction in the state on the recognition that the top 55 largest industrial facilities in the state are responsible for 29% of NSW's emissions. This program is offering capital funding for facilities with greater than 90 kilotonnes of carbon emissions per annum in hard to abate sectors. This program will be critical to support the design and implementation of emerging alternatives to existing production techniques that rely on fossil fuels, for example high

temperature process heating, replacing coking coal and gas used in steel manufacturing, and green ammonia and ammonium nitrate production. Projects will need to be completed by 2030, meaning a significant reduction in NSW's industrial gas consumption could be achieved by the end of the decade. Northmore Gordon is of the view that, given the very small number of eligible businesses, effective program oversight is critical to ensuring funds are efficiently allocated and that businesses just below this threshold with more commercially viable carbon reduction opportunities are not excluded from accessing government support.

DPIE were asked if any detailed modelling had been conducted on the resulting impacts of the NZIIP, including impacts on industrial gas consumption. Northmore Gordon were informed that the Australian Alliance for Energy Productivity (A2EP) had conducted some modelling for DPIE, but not on the resulting reduction in gas consumption. Northmore Gordon are a member of A2EP and informal discussions were held with the organisation to better understand the nature of this modelling. Based on A2EP's extensive knowledge of commercial thermal and industrial process heating requirements they have built a model of fossil fuel heating demand in key sectors and the resulting electricity grid impacts under various scenarios. It is understood that DPIE who have access to detailed National Greenhouse and Energy Accounts data for the state of NSW are then able to apply this model against the NGER dataset to assess the resulting statewide impact. Neither A2EP or Northmore Gordon have access to this dataset.

Whilst the NZIIP has the potential to deliver real emissions reduction in the state it remains to be seen exactly what this will look like and who will benefit from the funding available.

3.4 NSW Energy Security Safeguard

The NSW Energy Saving Scheme (ESS) is a government program to reduce energy consumption by creating incentives for organisations to invest in energy saving activities. Activities are delivered by Accredited Certificate Providers (ACPs) to help NSW households and organisations save energy from a range of approved activities. Energy Saving Certificates (ESCs) are registered by ACPs and sold to Energy Retailers on the market to provide the incentive funding. Northmore Gordon Environmental is accredited under the ESS to register ESCs from a wide range of activities.

The design of the ESS is to incentivise energy saving activities at the end user and thus reduce the need for additional generation, transmission or distribution infrastructure. Until 2016 it did not support gas saving activities, when a review of the scheme recommended the inclusion of gas into the scheme.

Whilst it includes the objective of reducing greenhouse gas emissions, unlike other certificate schemes, it is not an emissions abatement scheme but an end use scheme. Specifically, the quantity of ESCs is calculated from electricity savings in MWh multiplied a grid factor (1.06) and/or gas savings in MWh multiplied by 0.39 (0.11 per GJ). The gas conversion factor was calculated by comparing the ratios of primary to delivered energy between electricity and gas combusted on the premises. Fuel switching is allowed so long as they don't lead to a net increase in greenhouse gas emissions.

ESCs can be created from several energy saving activities, but the most relevant for gas savings are the measurement and verification approaches - the Project Impact Assessment with Measurement and Verification (PIAM&V) method or Metered Baseline Method (MBM).

The NSW government has proposed a significant change to the ESS, including increasing the target for energy savings and expanding the scheme to incentivise demand response. This expanded program has been renamed as the Energy Security Safeguard, and several consultations are underway for rule changes on the target increase, inclusion of new activities, and design of the demand reduction scheme.

4 Gas Reduction Opportunities

4.1 Industrial

As a sector, industrial facilities are the largest consumers of gas in NSW, accounting for ~55PJ of usage in 2019 (48% of the total). Unfortunately, there is very limited publicly available data for the contributions from key sub-sectors in the industrial category. Northmore Gordon was, however, able to infer the gas consumption of key sub-sectors using several publicly available datasets, including the National Pollution Inventory (NPI), the latest Australian Energy Statistics Table F (for NSW and Australia), 2019 Pipe Flow data from the AEMO Gas Bulletin Board, and the ABS Energy Use and Electricity Generation, Australia, 2017-18 dataset. The estimated breakdown of gas usage by industry sectors is given in Table 2

Table 2 Breakdown of industrial gas usage for NSW

Industry	Facilities in NSW	Estimated gas consumption	Source
Iron Smelting	1	3 PJ	NPI, GBB
Iron and Steel Manufacturing/Casting	6	6 PJ	NPI, NG estimates
Ammonia and Ammonium Nitrate	1	12.2 PJ	Grattan Report
Timber and Wood Product	6	0.3 PJ	NPI, NG estimates
Pulp and Paper	3	4 PJ	NPI, AES, NG estimates
Non Metallic Mineral - Cement, Brick, Glass	25	12 PJ	NPI, AES
Mining	110	0.22 PJ	NPI, AES
Food and Beverage	96	7.5 PJ	NPI, AES
Textile, Clothing, Footware, and Leather	3	0.9 PJ	NPI, AES
Other/smaller facilities		8 PJ	Estimated
Total		54.12	

The bulk of gas usage in industrial facilities is in process heating, with a smaller percentage of gas used as a chemical feedstock. Figure 7. taken from the 2019 ARENA study presents a breakdown of process heating energy use (all energy sources) by industry sub-sector and temperature ranges.

Gas reduction opportunities for the above industrial sub-sectors was taken from a range of sources including Northmore Gordon's experience in industrial energy systems and publicly available reports. Northmore Gordon also recently contributed to the Industrial Reference Group (IRG) for the RACE for 2030 Cooperative Research Council. The IRG supported research efforts into opportunities for transitioning industrial process heating to renewable energy alternatives, with an initial focus on opportunities below 150°C.

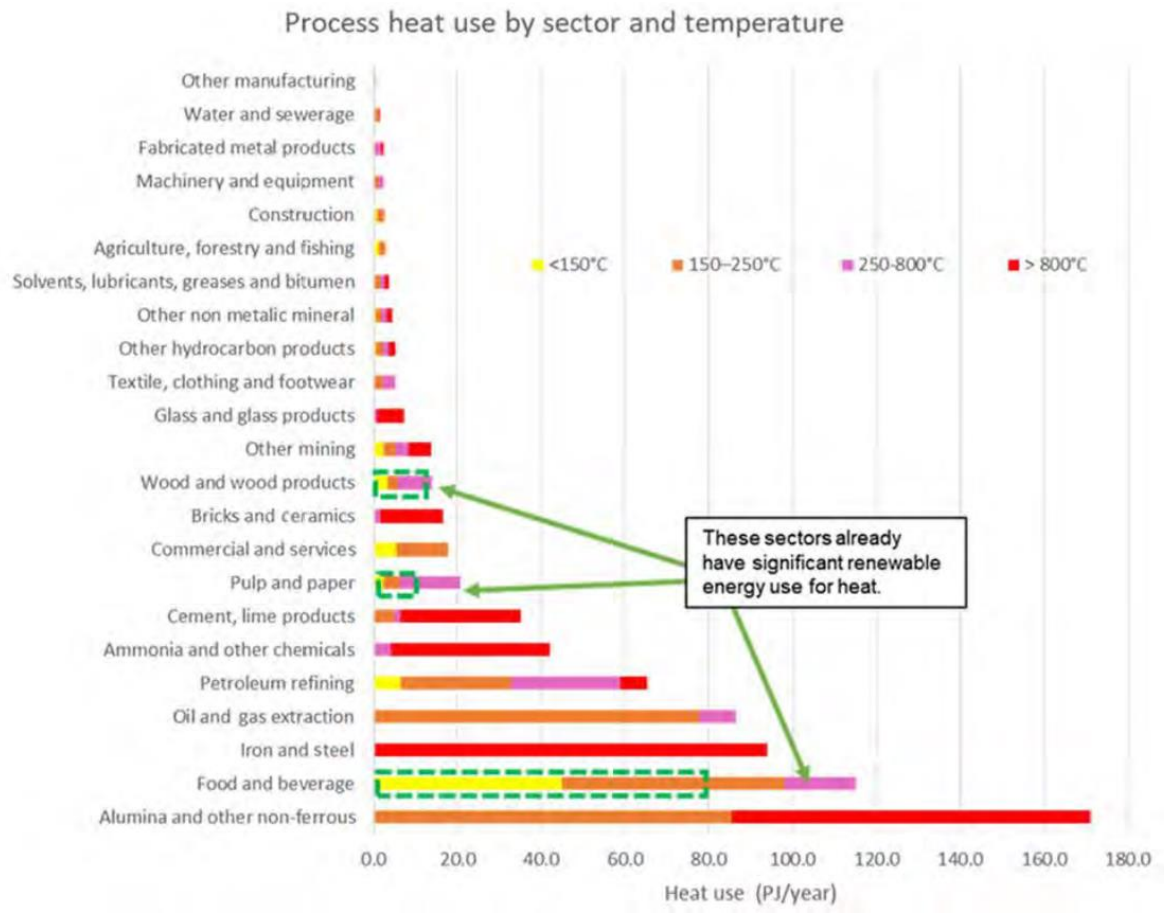


Figure 7: Industrial process heating by temperature range and sector (IT Power, 2019)

Whilst many opportunities for electrification of process heating exist, several for heavy industry have only been demonstrated on a small scale or not at all. Much of the higher temperature process heating opportunities require considerable investment and further commercialisation development before they can be broadly adopted. Consequently opportunities are presented in a staged framework for adoption, representing:

- Short term: 0 to 5 years time
- Medium term: 5 to 15 years time
- Longer term: > 15 years

Short term opportunities are those where the technology is readily available, demonstrated, and implementable without retooling the facility. Medium term opportunities are those where there are no known technical barriers to implementation, but adoption requires significant investment and re-tooling of the facility. Longer term opportunities are those that require, as yet proven technologies and significant rebuilding of the facility to implement. These longer term opportunities require further research, development and deployment, and significant lead times for planning.

4.1.1 Ammonia and Explosive Manufacturing

A significant amount of NSW gas usage is at the Orica Kooragang ammonia and ammonium nitrate manufacturing plant. Here gas is used as a chemical feedstock (60 to 70% of the gas supplied) and process heating and to drive mechanical processes (30 to 40% of supplied gas). The facility produces ammonia using steam methane reforming (SMR) where high pressure steam and methane are reacted in the presence of a catalyst. The process generates additional heat, captured in the form of steam, which is subsequently re-used in the facility.

Long term options

An alternative pathway for manufacturing ammonia is using hydrogen produced from electrolysis and combined with Nitrogen using the standard Haber Bosch process. This "green" ammonia approach is already the subject of significant research and development, for example ARENA co-funded a $2.89 million feasibility study for Queensland Nitrates (QNP) in 2019. In practice the widescale conversion from SMR to electrolysis hydrogen, is constrained by the price of hydrogen. The COAG Energy Council National Hydrogen Strategy identified that clean hydrogen could be cost competitive with the gas used in the SMR process at less than $2.5 per kg. Noting that clean hydrogen in this context includes production of hydrogen from fossil fuels and the use carbon capture and storage of resulting CO_2, the predicted timeframe for achieving clean hydrogen in this price range with targeted government support is 2030. As a consequence the conversion of NSW ammonia manufacturing to green ammonia is considered a long term measure.

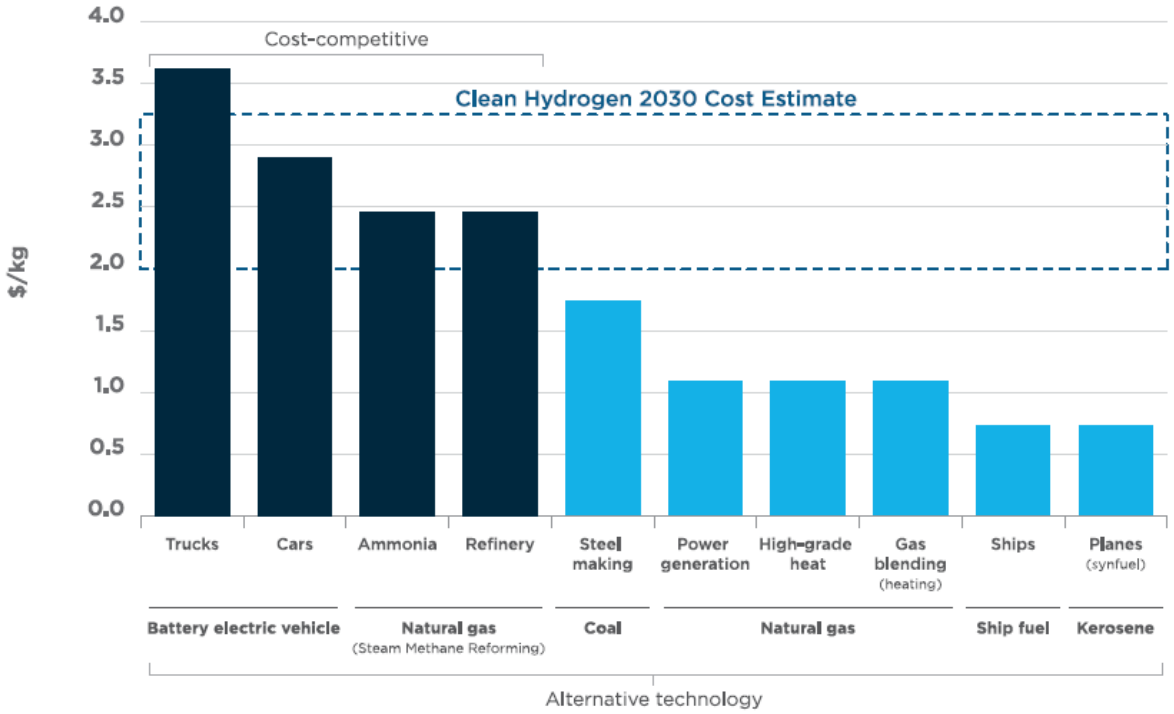


Figure 8: Estimated breakeven points for clean hydrogen to compete with existing processes (National Hydrogen Strategy, 2019).

4.1.2 Iron Smelting and Steel Manufacturing

NSW has one iron smelting company, Bluescope at Port Kembla, and 5 major manufacturing facilities, including Bluescope (manufacturing at Port Kembla), Molycop Waratah, Infrabuild Sydney Steel Mill, and the Infrabuild Rod Mill and Wire Mill facilities. Iron smelting and steel manufacturing is a significantly energy intensive process and currently rely heavily on fossil fuels. The primary energy input for iron smelting is coking coal and the resulting coke ovens gas and blast furnace gas generated in the iron smelting process. Gas is used as a supplementary fuel to coke oven gas and blast furnace gas in the blast and reheat furnaces. For the casting and steel manufacturing facilities the primary source of heat are electricity and gas for melting, and gas for reheating steel.

Short term options

In the steel making and foundry industries gas fired ladle pre-heaters can be replaced with off the shelf electric heaters however it is not an economically viable investment. Typical gas consumption by the ladle heaters is 3% of the site total consumption.

Most heat treatment of steel is performed at approximately 900°C and requires temperature uniformity. This is currently often done with high velocity burners. Conversion of all gas fired heat treatment furnaces to pulse firing would be a way to make inroads in the short term and achieve reduction in gas consumption of typically 25% to 30% (in heat treatment furnaces).

Electrification of heat treatment furnaces at lower temperatures (e.g. tempering) is easily done using electric resistance heating of the recirculating air.

Medium term options

Heating of steel billets in structural steel manufacturing facilities currently use gas fired heat furnaces which can be converted to electric induction. This has been done at some steel plants internationally. The footprint of this process is likely to be larger and a different shape to existing furnaces so may be difficult to retrofit and the correct design is required to avoid metallurgical issues. Significant feasibility work and capital investment is required to implement while the operating cost remains similar, so there is little incentive to pursue this without significant subsidies.

Some steel requires slow heating through some temperature ranges, and a “soaking” period. In these cases either a resistance heating approach or a combination of induction and resistance heating would be required.

Northmore Gordon recently conducted a feasibility study on electrification of gas fired equipment for a large iron and steel manufacturing business. The feasibility study identified around thirty gas fired processes and investigated replacing these with electric alternatives, namely induction, resistance, and plasma (arc). The resulting gas savings were in the range of 1 PJ for that single facility.

Long term options

Iron smelting can be converted to zero emissions through an alternative process known as Direct Reduced Iron and the use of green hydrogen as the chemical reducing agent. The resulting pig iron can be further processed into steel using Electric Arc Furnaces, which can be designed for the purpose. The existing EAFs in Australia are secondary steel manufacturing processes, and those are not suitable for refining of pig iron.

Conversion of an iron smelting facility like Bluescope’s at Port Kembla would involve a few $100 million of government funding to justify the infrastructure. A pilot plant is currently being built in Sweden and another being considered for Germany, however at present it hasn’t been done commercially and a further 5 years is anticipated before proponents plan to build a full scale plant.

Electric arc furnaces for scrap recycling also have gas burners. These burners could be replaced with plasma arc technology, however there are no commercial examples and a significant amount of R&D and feasibility work would be required.

There is similar potential for plasma arc technology use for billet cutters on steel continuous casting machines. This would apply to 2 sites in NSW.

4.1.3 Non Metallic Mineral – brickmaking, tile, cement, and glass

NSW has a large portion of Australia’s cement and brick manufacturing facilities, with Austral Bricks and CSR having nine brick making facilities and Boral having three large cement manufacturing facilities in the state. Brick firing occurs in long tunnel kilns which are heated to over 1000°C, typically through combustion of gas. The Austral Bricks facilities in Horsley Park are co-fired with biogas from the nearby Cleanaway Erskine Park landfill facility, but still uses

appreciable quantities of gas for process heating. Accounting for a portion of biogas co-firing at Austral, an estimate of 3PJ for NSW brick manufacturing was estimated.

Short term options

Whilst kilns already employ a considerable amount of heat recovery, there are further opportunities for gas reduction through heat recovery. An additional heat recovery opportunity is pre-heating the combustion air via a recuperator on the flue gas or diverting excess (clean) hot gas streams. Lower cost options involve increasing combustion air temperature from ambient to the rated temperature of the burners, however higher temperatures are possible with more capital upgrades on the burner systems. 10 to 15% savings are possible for kiln gas consumption. Another short-term option is the use of oxygen fuel burners rather than air, to remove non-combustible gases from the combustion air.

Medium term options

Cement manufacturing involves the production of clinker from limestone in kilns that are heated to 1450°C. Process heating is typically fuelled by gas or coal, with biomass in use in some facilities. Cement is considered a hard to abate sector, however demand for zero emissions cement has been driven by the construction industry. The current approach being investigated by cement manufacturing businesses involves the use of biomass or process engineered fuels like that supplied by the Cleanaway Wetherill Park waste recovery plant. Likewise in other non-metallic mineral plants the use of bioenergy is an effective short to medium term opportunity for decarbonisation of gas use.

Long term options

Both the Renewable Process Heating Report and BZE Electrifying Industry Report identify an opportunity for microwave assisted kiln firing of bricks. Microwave heating is an established alternative to combustion based process heating, and is already used in some industries, albeit at smaller scales. Brick and tile kilns will need additional heat supplied to meet the temperature required and this can be supplied with electric resistance heating. However, to ensure uniformity of firing, the kilns will need to be rebuilt to a different shape.

4.1.4 Sawmill and Wood Products

The RACE for 2030 study identified 5.5 PJ of process heating for temperatures below 150°C, across Australia. There are four large timber sawmill facilities in NSW and multiple small operations. The state also has some wood products manufacturing businesses, producing particleboard and medium density fibreboard (MDF), including the large operations in Oberon of Borg Panels and Highland Pine Products.

Short term options

NSW has several timber sawmill and wood product manufacturing facilities. Saw mills use gas and wood by-products for various stages in the process, as shown in the diagram below. The largest energy consuming process in saw mills is kiln drying which accounts for 70% of the process heating requirements. Kiln heat consumption can readily be reduced by the adoption of heat recovery processes, particularly from exhaust air. The RACE for 2030 work estimates integrated kiln dryers can reduce energy consumption by up to 35%.

The wood products manufacturer Borg, which accounts for between half and two thirds of the gas consumption in this industry sector, has undertaken work in heat recovery improvements across their facility. The company also has significant plans underway to continue to reduce gas usage at the site..

Medium term options

It is also possible to introduce active dehumidification and heating using heat pump technology into a sawmill kiln, as shown in Figure 9. Northmore Gordon is already aware of

some sawmills which use heat pump for kiln heating as replacement for electric resistance heating.

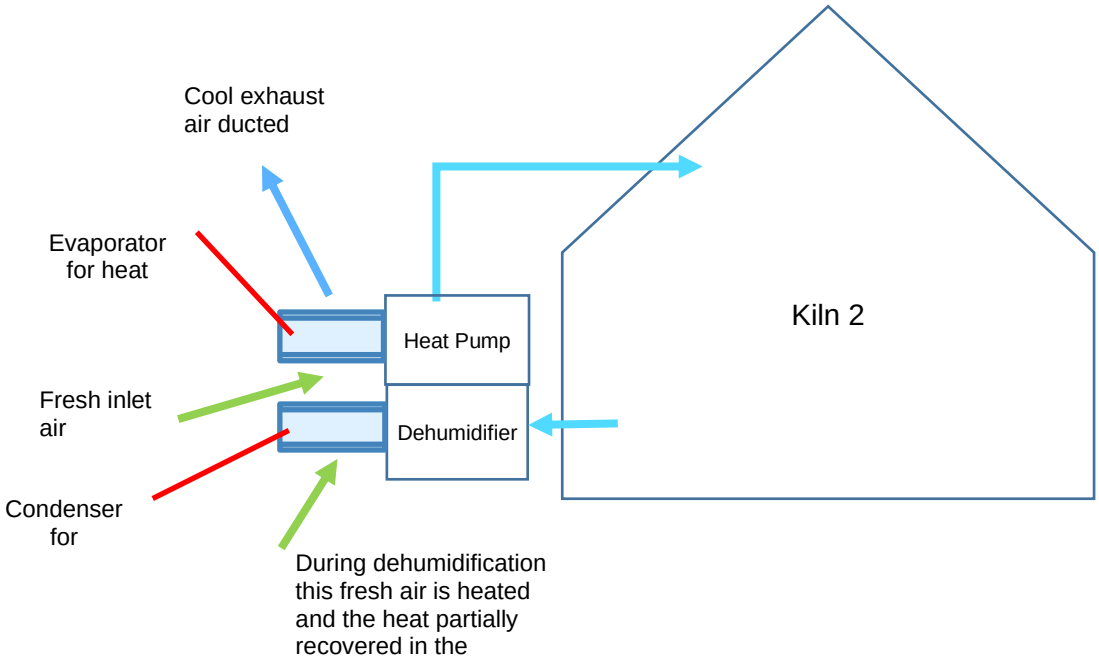


Figure 9: Heat pump dehumidification of a saw mill kiln

Decarbonisation of wood product manufacturing can utilise some technologies like electrification technology such as microwave heating, but these are still in the R&D phase. In the medium term the use of biomass is a more likely alternative to gas.

4.1.5 Pulp and Paper

Until recently NSW was home to two of Australia's five pulp mill facilities, producing pulp directly from timber/woodchip – Visy in Tumut, and Norske Skog in Albury. In 2019 Norske Skog announced the closure and sale of their facility to Visy, however it is not currently operational. Visy also operates a paper mill facility in Smithfield which produces paper from recycled paper, as well as paperboard. There are other paper manufacturing facilities, including the Opal Packaging mill in Botany.

Most wood fed pulp mill facilities use the Kraft method which generates black liquor as a biomass by-product which is then re-used at the facility in Combined Heat and Power plants to generate steam and electricity. Gas is used to supplement the CHP plants, as well as for process heating in lime kilns which are part of the pulp process. Paper and board manufacturing occurs by taking the resulting pulp, spreading it evenly across moving screens, pressing it, and then drying it as it is fed along rollers.

Short term options

Similar to brickmaking, and wood product manufacturing there is significant heat recovery opportunities at pulp mill facilities. The process generates high amounts of heat dissipation, and only some of this heat is recovered and used. There are opportunities to optimise the existing process heating flows and reduce the amount of gas and biomass used.

Medium term options

Opportunities exist for reducing gas usage in the pulping process, primarily through the adoption of additional biomass/biogas. Controlling the electrical output from the CHP plants to

the maximum amount of black liquor available is also an option to avoid the requirement for gas top up.

The recent RACE for 2030 work proposed that complete decarbonisation of the pulp sector is achievable by 2035, primarily through the optimised use of biomass and bioenergy in the process.

Long term options

Process heating in paper and board manufacturing is entirely below 150°C and alternatives such as infrared drying has been investigated. The Electrifying Industry Report by BZE presents a case study for electrifying paper using infrared technology. In this study a conventional steam drying system with 48 steam heated cylinders was assessed for replacement with an electric infrared drying system with 47,000 individual infrared emitters producing at a similar capacity. The transition from steam driven paper manufacturing to infrared would require significant capital investment, which is realistically only possible through government financial support or significant market pressure and paper price increases to transition to a zero emissions alternative.

4.1.6 Food and Beverage

The food and beverage manufacturing industry in Australia is the largest sector in manufacturing by employment and turnover. In NSW it contributes to ~7.5 PJ of gas consumption which, as shown in the graphic below, is almost entirely used for process heating below 250°C. The food and beverage sector is under pressure across the supply chain to set emissions reduction targets and demonstrate action towards decarbonisation. Whilst food and beverage manufacturing covers a diverse range of product types, the overall processes are such that decarbonisation is easier than hard to abate industrial sectors. Gas is generally used to fire steam boilers and hot water generators, or produce hot air.

Short term options

Air sourced heat pumps supplying hot water at 90°C or below are already commercially available and being adopted in specific applications.

Co-firing biogas in boilers from anaerobic wastewater treatment systems and the use of biomass as a fuel for steam boilers is commonplace and several food and beverage businesses have invested in these systems in recent years in response to high gas prices.

Medium term options

For higher temperature applications waste heat driven heat pumps and mechanical vapour recompression systems can be utilised to displace systems that traditionally relied on low-cost steam. Microwave and electric resistance heating are also suitable in direct heating applications. Successful adoption of these technologies requires detailed assessment of heat flows in the facility and increased availability of “off the shelf” heat pump systems that are suited to these higher temperatures. The sector is the subject of considerable attention for electrification of <250°C processes, however it will be at least 5 to 10 years before it becomes economical for businesses to do so.

Regardless based on Northmore Gordon’s experience and considering targeted government support, complete decarbonisation of the sector’s scope 1 emissions (and elimination of gas usage) is achievable within 10 to 15 years.

4.2 Commercial Services

The commercial services sector, particularly offices, retail, healthcare, and accommodation has had considerable attention in recent years on energy performance through schemes such as National Australian Built Environment Rating System (NABERs) and associated

Compulsory Building Disclosure, Section J of the National Construction Code, and state based targets and schemes. The Council of Australian Governments (COAG) in 2019 established the Trajectory for Low Energy Buildings, with a target for 40% energy productivity improvement target by 2030 and aiming to achieve zero energy and carbon ready buildings by 2030.

In 2019 EY and Strategy.Policy.Research (SPR) prepared a detailed study for "Achieving Low Energy Existing Commercial Buildings in Australia", which assessed policy measures to support the Trajectory for Low Energy Buildings. This work included an estimate of the energy intensities of non-residential buildings using a range of data sources. This is provided below in Table 3.

Table 3: Gas energy Intensity of commercial buildings (EY, 2019)

MJ/m²	NSW	VIC	QLD	WA	SA	NT	TAS	ACT
Class 2 common areas	14	106	26	49	120	23	8	28
Accommodation	89	422	27	173	256	29	3	23
Offices	88	215	16	95	145	0	22	175
Retail	116	363	125	177	227	42	22	186
Warehouses	26	108	0	23	4	4	0	1
Laboratories	55	167	39	68	86	2	3	7
Healthcare	450	887	198	550	733	185	37	525
Education/Assembly	83	209	121	176	216	130	14	78
Aged care	97	271	113	294	290	447	15	212

Limited up to date data is available about the actual commercial services stock in NSW, with the 2012 "Baseline Energy Consumption and Greenhouse Gas Emissions - In Commercial Buildings in Australia" by Pitt and Sherry being the most up-to-date source. This report provides estimated floor area projections for 2020 in NSW as shown in Table 4. Note that "Accommodation" in the EY study is taken to be equivalent to Hotels in the Pitt and Sherry study.

Table 4: NSW commercial building stock estimates (Pitt and Sherry, 2012)

Category	Offices	Hotel	Retail[3]	Hospitals	Education	Public Buildings
Floor area in '000m2	24,182	3,921	23,278	4,397	19,351	1,183[4]
Est. Gas Usage (PJ)	2.1	0.35	2.7	2.3	1.6	1.6[5]

4.2.1 Commercial Offices

Approximately 50% of gas usage in commercial offices is used in Heating Ventilation and Air Conditioning (HVAC), 10% is domestic hot water, about 5% in cooking, and the remainder in specialised equipment. Gas is used in HVAC for boilers servicing hot water loops for space

[3] Does not include hospitality venues
[4] Floor area estimates for Public Buildings only includes Museums, Galleries, Libraries, Law Courts, and Correctional Centres - it does not include the floor area of aquatic centres as this data is unavailable.
[5] Calculated energy use for Public Buildings is derived from a nominal 88 MJ/m² gas intensity and the listed floor area. Aquatic Centre energy consumption was added into this category based on the estimate of aquatic centre usage provided in Section 4.2.3.

conditioning systems, such as fan coil units or air handling units, and used in gas storage and instantaneous domestic hot water systems.

Short term options

Energy efficiency has delivered significant dividends in commercial office buildings, and while the higher grade (as classified by the Property Council of Australia) building stock has seen a range of improvements spurred on by schemes such as NABERs there are still significant opportunities in lower grade offices. Energy efficiency includes retrofitting building fabric upgrades, such as improved insulation, as well as installing more efficient condensing boilers for space heating.

The EY "Achieving Low Energy Existing Commercial Buildings in Australia" report already demonstrates a prevalent trend in fuel switching from gas to electricity in Australia's commercial buildings. This report identified an implied average reduction gas intensity (MJ/m^2) of 3.7% per year. A short term gas reduction from efficiency improvements of 25% is estimated.

Medium term options

As described in Northmore Gordon's Victorian Gas Demand Side Study, gas boilers supplying hot water used in space heating can be replaced with either heat pumps or reverse cycle chillers in the following two ways:

1. For systems that can be converted to lower temperature hot water (~40 to 60 degrees), boilers can be replaced with lower temperature reverse cycle chillers or direct expansion air-to-air units.
2. For systems that can't easily be converted to lower temperature and need to service high temperature hot water (80 degrees), boilers can be replaced with CO_2 heat pumps

Using the data in Table 3 and Table 4 we estimate commercial office gas usage in NSW to be ~2.1 PJ. Factoring in the percentage of gas usage in HVAC and hot water, and considering targeted incentives to support conversion of gas boilers to heat pump or reverse cycle chillers, an estimate of 1.25 PJ gas saving by 2035 is achievable in the medium term.

Longer term options

As the availability of electric alternatives for specialised equipment increases it is expected that these can be converted from gas beyond 2035. There is a need for redundancy in offices to support essential services, such as fire pumps and backup generators. As battery technology improves this can be addressed via Uninterrupted Power Supplies (UPS) and Battery Energy Storage Systems.

4.2.2 Retail

Retail facilities – shopping centres, supermarkets, and small strip shop retail are often high energy users compared to others sectors within the built environment. As shown in the pie-chart below from the EY report, HVAC is the highest load, although refrigeration is a significant energy user particularly in supermarkets to service fridges and freezers.

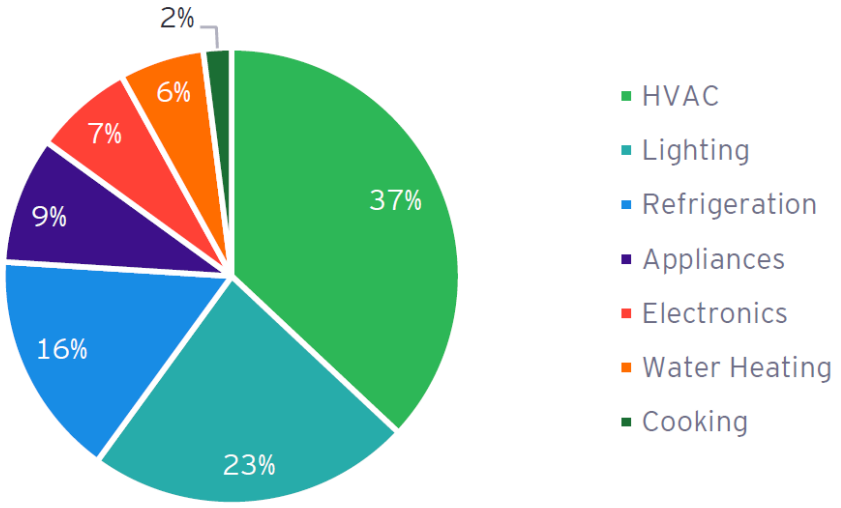


Figure 10: Retail energy use breakdown for whole of Australia (EY, 2019)

Short term options

Major supermarket chains have invested significantly in energy efficiency in recent years, and while there is always room for improvement much of the low hanging fruit has been addressed. The most likely area for benefit is in smaller facilities and facilities in less population dense regions. The 2013 Zero Carbon Australia Buildings Plan by Beyond Zero Emissions identified that if the measures already implemented by the best performing supermarkets were implemented across the remaining building stock energy improvements of 35 to 50% were achievable. There are interactive effects between different energy systems in supermarkets and energy efficiency measures can create unintended impacts on other energy systems. For example, putting doors on open refrigeration cabinets reduces the heating load in conditioned spaces, yet replacing inefficient lighting with LED increases the heating load as the old lights are no longer a source of heat. This introduces some uncertainty as to the level of gas savings that can be achieved by energy efficiency measures. Assuming a conservative 25% gas reduction would lead to a 0.68 PJ reduction across the sector.

Medium term options

Larger retail facilities are typically conditioned via electrically driven packaged units, with minimal gas usage. Gas use will be more dominant in smaller retailer facilities in space heating, domestic hot water, and cooking. Consequently, fuel switching via the adoption of heat pumps for domestic hot water and reverse cycle chillers for space conditioning systems can yield significant reduction in gas usage. With sufficient incentives it could be possible to decarbonise retail gas usage by 2035.

4.2.3 Aquatic and Recreation Centres

Aquatic Centres are typically the largest energy consuming facility for a local government, and are excellent candidates for electrification via heat pump systems. Northmore Gordon has extensive experience working with Aquatic Centres, having audited over 10 facilities since 2016 and preparing the “Energy efficient water heating technology guide for aquatic centres” for the NSW government in 2019.

Pool water heating is typically 60 to 80% of an aquatic centres energy usage and while some facilities in NSW operate with heat pump and cogeneration systems, the predominant heating technology is gas boilers supplying a secondary heating circuit. Table 5 is taken from the NSW Aquatic Centre guide prepared by Northmore Gordon and shows the comparison between different heating technologies for pool heating. Solar thermal provides an effective

source of renewable heat but cannot be used as the sole source of heat. While the table shows gas fired cogeneration having a superior greenhouse emissions performance, this is based on comparison with grid electricity purchases and corresponding Scope 2 emissions taken from 2018 emissions factors. Electric heat pumps offer the best energy efficiency and, based on 2018 emissions factors, a superior emissions performance than gas boilers. Given the Renewable Energy Zones set out in the NSW Electricity Infrastructure Roadmap and other policies on energy and emissions, it is forecast that emissions factors will fall significantly in the next decade, leaving heat pump systems with a superior carbon performance across the board.

Table 5: Heating technology comparison for aquatic centres (NSW DPIE, 2019)

Heating technology	Rated efficiency[3]	Energy Source	To generate 1 GJ of heat			Maintenance costs
			Energy input (GJ gas or GJ electricity/ GJ heat)	Energy cost[4]($/ GJ heat)	GHG emission[5] (kg CO2/GJ heat)	
Gas Boiler	85%	Gas	1.18	$20.59	61	$
Electric heat pump	COP: 4	Electricity + Air/Water/ Ground...	0.25	$10.07	58	$$
Biomass boiler	80%	Biomass	1.25	$10.00	0	$$$
Solar thermal	50%	Sun	0.00	free	0	$
Gas fired co-generation (at 100% heat recovery)	45% thermal 30% electricity 75% overall	Gas	2.22	$12.04	-396	$$$

Based on data from Northmore Gordon's prior energy audits of NSW aquatic centres, the average gas consumption is ~ 9,600 GJ. There are 128 Local Government Areas in NSW, including 24 with a population greater than 100,000 people. Assuming the 24 largest LGAs have an average of 3 aquatic centres operating all year round, large regional LGAs have one aquatic centre operating all year round, and the remaining LGAs have one seasonal aquatic centre, and accounting for privately owned aquatic centres results in an estimated gas consumption of 1.5 PJ.

Short term options

Gas consumption can be reduced by a combination of measures, including tuning of equipment and improved controls. Northmore Gordon typically estimates 10% reduction in energy consumption from low to no cost measures in aquatic centres. Replacement of non-condensing gas boilers in these aquatic centres (only a small number of facilities have condensing gas boilers which are of higher efficiency) with heat pump hot water systems, has the potential to remove 1 PJ of gas consumption.

Medium term options

A wholesale program to replace gas boilers in aquatic centres with heat pumps would be capital intensive, with suitable commercial heat pumps in the range of $200-400k. Installing heat pumps to replace gas boilers and cogeneration system will deliver annual energy cost savings and typically delivers a payback in the range of 4 to 8 years without incentives. It is worth noting, that a similarly capital intensive program occurred in the second half of the 2000s, with Commonwealth Government funding supporting the implementation of cogeneration systems. Many of these cogeneration systems are ageing and have been plagued with difficulties due to poor integration into the pool heating systems. A program encouraging adoption of modern heat pumps may be timely given the need to replace these systems and plan for growth in population.

4.2.4 Hospitals and Aged Care

Based on the data in Table 3 and Table 4 hospitals consume another 2 PJ of gas usage in NSW. Aged Care stock is not included in the 2012 Pitt and Sherry study but estimates for the national aged care floor area are contained in the 2013 BZE report. Using the EY energy intensity and an approximation of aged care floor area in NSW of 3,000,000 m^2 yields a further 0.3 P.

Medium term options

Hospitals are complex facilities with utilities servicing critical functions, including surgical theatres. Like commercial office buildings, gas supplies hot water loops for space conditioning systems. These can be retrofitted in a similar manner with heat pump or reverse cycle chillers. Some older hospitals have reticulated steam systems for sterilisation, which can be removed entirely to make way for standalone autoclave sterilisations systems.

Longer term options

Whilst challenges exist in upgrading energy using equipment at hospitals, they are typically government owned and are expected to align with state government emissions reduction targets. The advocacy organisation Healthcare without Harm recently released the Roadmap for Healthcare Decarbonisation prepared by the consultancy Arup. For Australia it was assigned to a steep decline trajectory, requiring immediate, aggressive action to implement a rapid and deep decrease in emissions. This recognises that wealthier countries can do the heavy lifting initially, allowing for healthcare in low- and middle-income countries to grow in the short term.

The seven high impact actions for decarbonising health care are:

1. Power health care with 100% clean, renewable electricity
2. Invest in zero emissions buildings and infrastructure
3. Transition to zero emissions sustainable travel and transport
4. Provide healthy sustainably grown food and support climate resilient agriculture
5. Incentivise and produce low carbon pharmaceuticals
6. Implement circular health care and sustainable health care waste management
7. Establish greater health system effectiveness

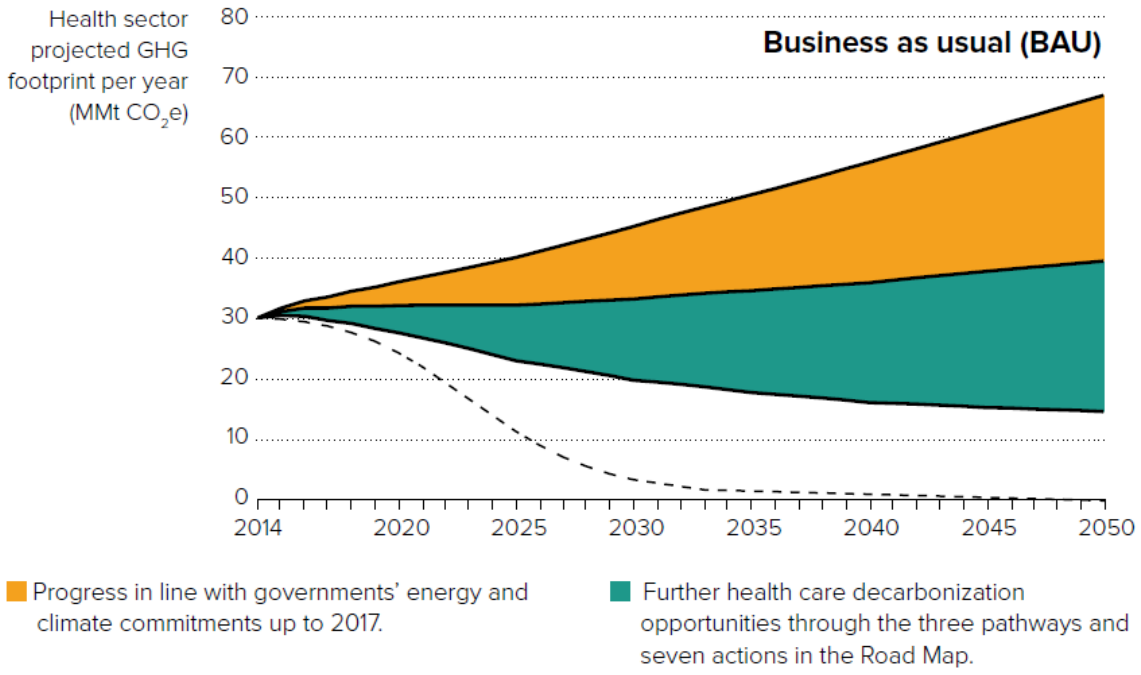


Figure 11: Australian healthcare sector decarbonisation roadmap (HCWH, 2021). The dotted line represents the proposed target trajectory for Australia.

4.3 Residential

Residential gas consumption in NSW broken down by end use is presented in Figure 12. Unlike Victoria and ACT, most of the residential gas usage is in hot water systems.

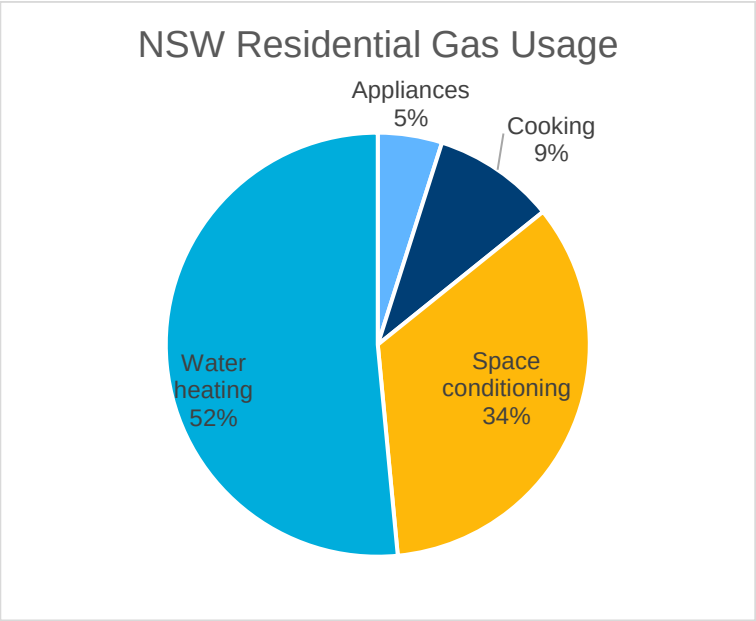


Figure 12: Estimated breakdown of residential energy consumption (EnergyConsult, 2015)

Short term options

Residential space heating in NSW is only a small portion of gas usage compared to Victoria, where gas usage in residential dwellings accounts for 35% of the entire state's gas consumption.

Importantly, air-conditioning ownership in NSW is high, with 2.6 million air conditioners (ducted and non-ducted) for 3.2 million households (81%). Northmore Gordon estimates that 50% of these units are reverse cycle and not currently utilised for space heating. With a simple communication program the NSW government can encourage those households to use their existing reverse cycle air-conditioners to provide space heating, rather than ducted or non-ducted gas heaters. This will require no upfront cost by households and minimal change to overall energy bills.

Table 6: Residential space conditioning ownership in NSW (EnergyConsult, 2015)

Space condition systems	Ownership Numbers	Energy Used (PJ)
Air Conditioners	2,645,549	7.16
Electric Resistive	2,913,213	3.45
Mains gas ducted	77,537	3.07
Mains gas non-ducted	485,662	4.31
LPG non-ducted	99,495	0.65
Wood heaters	244,770	4.89

Medium term options

The number of hot water heaters estimated for NSW are given in Table 7.

Table 7: Hot water ownership in NSW (EnergyConsult, 2015)

Hot water heaters	Ownership Numbers	Energy Used (PJ)
Electric Storage	1,766,744	13.26 (elec)
Mains Gas instant	604,280	5.95
Mains Gas Storage	467,148	5.10
LPG instant	62,614	5.95
LPG Storage	42,084	0.46
Heat pump	57,551	0.18 (elec)
Solar	233,661	0.63 (elec + gas)
Wood	8,355	0.05 (wood)

A program to replace inefficient gas and electric storage hot water heaters with high efficiency heat pump could displace 5PJ of mains gas usage and a further 0.5 PJ of LPG usage.

Heat pumps for domestic hot water have a negative perception in parts of NSW and ACT due to a first generation of products being adopted by households in the late 2000s. These first generation heat pump systems that were incentivised by the Small Renewable Energy Scheme, which offered Small Technology Certificates for solar hot water systems, did not perform well in cold climates. Second generation heat pump hot water systems have experienced significant performance improvements in cold climate conditions. CO_2 heat

pumps work best with a large temperature delta (the difference between the ambient water temperature and the refrigerant temperature), which ensures superior performance for colder climates.

A program to replace electric storage hot water heaters will also allow for a significant quantity of inefficient electric units to be replaced with highly efficient heat pumps. While a heat pump uses electricity to operate, the electricity only drives a compressor and fans and is not the primary source of heat, whereas an electric storage hot water system operates like a kettle – the electric current gives off heat directly to the water. A typical domestic hot water heat pump has a Coefficient of Performance of 3 to 4, whereas an electric storage unit will only be ~1. That means an electric hot water system can be replaced by a heat pump using a ¼ of the electricity to operate. In addition, a program to replace electric storage hot water systems will have the benefit of alleviating peak electricity demand on the network. This can offset the additional electric demand required by fuel switching gas hot water systems to electric.

Instantaneous gas systems are more efficient than storage systems and ought to be a secondary priority for replacement. Nonetheless they can readily be replaced with heat pump storage systems or solar hot water with electric instantaneous boosting.

5 NSW Gas Decarbonisation Roadmap

Combining the gas reduction opportunities assessed in Section 4 and considering the remaining (smaller) gas consuming sectors, yields the overview presented in Table 8.

Table 8: Identified gas reduction opportunities and timeframe for implementation

Gas Reduction Opportunity	Applicable sectors	Reduction potential (per sector)	Timeframe
Heat recovery	Non metallic mineral, timber and wood products, pulp & paper, other industrial facilities	10-25%	Short term
Electrification of ladle heating and lower temp furnaces	Steel	3%	Short term
Furnace improvements (inc burner upgrades)	Steel, non metallic mineral	10-25%	Short term
Building upgrades and efficient boilers	Commercial services and residential	10-25%	Short term
Low temperature heat pumps (<90)	Food and beverage, timber and wood products, textile, commercial services and residential	50-100%	Short to Medium term
Reverse cycle chillers and air conditioners	Commercial services and residential	15-60%	Short to Medium term
Electric induction + resistance furnaces	Steel and iron manufacturing	80%	Medium term
Biomass and biogas	Non metallic mineral, timber and wood products, pulp & paper, food and beverage, textiles	100%	Medium term
High temperature heat pumps (>90)	Food and beverage, textile	50-100%	Medium term
Hydrogen and electrification	Ammonia, Iron smelting	100%	Long term
Microwave + resistance kilns	Non metallic mineral	100%	Long term
Infrared drying	Paper	100%	Long term
Plasma arc	Steel	10%	Long term

Applying the opportunities to the appropriate sub-sectors and according to the relevant timeframe delivers the roadmap for gas decarbonisation in NSW shown in Figure 13.

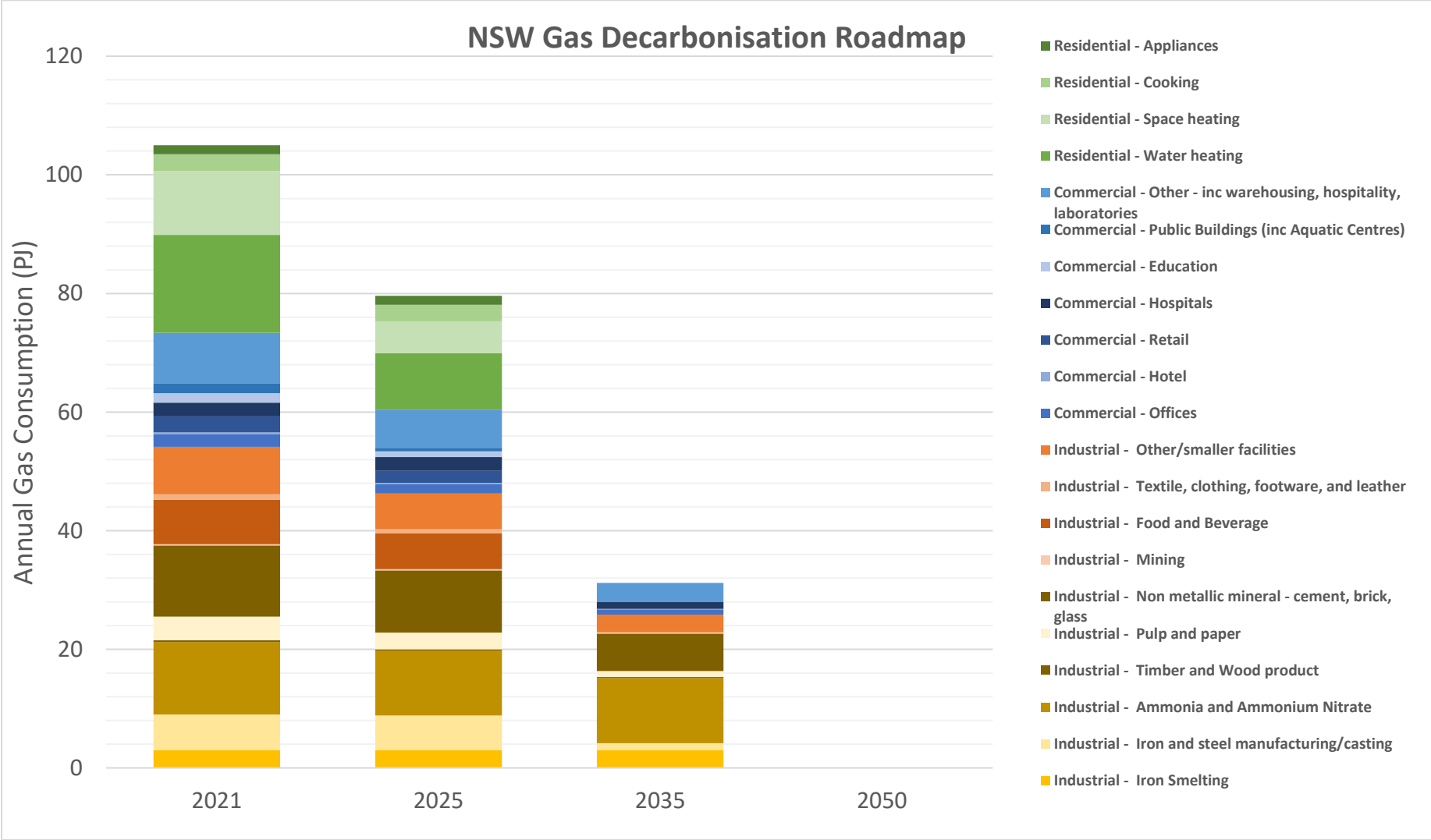


Figure 13: Gas Decarbonisation Roadmap for NSW

The roadmap illustrates a potential pathway for NSW to reduce its gas consumption by 25% within 5 years, 70% in 10 to 15 years, and entirely eliminate by mid century. By 2035 this equates to a reduction in Scope 1 greenhouse gas emissions of 3.8 million tonnes of CO_2e and 5.4 million tonnes of CO_2e by 2050. Whilst the reduction in gas usage in NSW will lead to an increase in electricity consumption in the state, the electricity grid is rapidly decarbonising as lower cost renewable energy generation and storage is being introduced. There is significant attention from energy market operators and regulators in ensuring an orderly transition of the electricity market, with some jurisdictions supporting renewable energy penetrations of 50% and higher by 2030.

The NSW Net Zero Industry and Innovation Program has the potential to effectively target hard to abate sectors, for which decarbonisation relies on further development of the technology and rebuild of entire factories to enable. With significant funding and government support, opportunities that this report identifies as 15 or more years away from implementation could be brought forward to be achieved within a faster timeframe. Key examples include the use of low cost hydrogen in ammonia production and iron smelting, as well as conversion of high temperature kilns and furnaces to electric alternatives.

Unfortunately there are, as yet, no announced support mechanisms in NSW for facilitating decarbonisation of less technologically complex decarbonisation opportunities. Of particular focus needs to be the Food and Beverage, Textile, Timber and Wood Products, and Commercial Services industries, which show good promise for utilisation of industrial heat pumps at low and high temperatures. The combined gas usage of these sectors comprises nearly 20% of the total statewide consumption and with targeted assistance could achieve significant steps towards decarbonisation within a 10 to 15 year timeframe.

For households, given the significant uptake in solar PV and lower electricity grid emissions factors, replacement of inefficient domestic hot water units with heat pump technology is a no regrets approach. The introduction of heat pump hot water storage units has the added benefit of allowing a form of energy storage, which can mitigate high daytime export from behind the meter solar systems also. The revamped Energy Security Safeguard has the potential to be a key mechanism for incentivising such replacements, and indeed there is consideration of new deemed energy saving activity for installation of heat pump hot water heaters in households, as well as commercial and industrial facilities. As the electricity grid decarbonises the balance between electricity and gas energy savings, i.e. the conversion factors applied, should be altered to better incentivise fuel switching from electricity to gas. The similar environmental certificate scheme in Victoria, the Victorian Energy Upgrades program has already seen such a shift, although that scheme operates using emissions factors, rather than primary energy factors.

Within the framework of Australia's Paris commitments, and the NSW Government Net Zero Emissions targets, there is a clear impetus to decarbonise energy systems. As the electricity sector decarbonises, the attention is naturally turning to other sources of greenhouse gas emissions. Similarly, investors and consumers are increasingly seeking to preference lower carbon products and services. From an individual facility standpoint achieving zero emissions electricity supply is a relatively simple proposition, achieved through the contracting 100% renewable energy electricity. Achieving zero emissions in Scope 1 emissions requires significant capital investment and engineering expertise to facilitate. The decarbonisation roadmap in this report sets out several viable approaches that contribute to achieving this goal.

6 References

Australian Bureau of Statistics, Energy Use and Electricity Generation 2017-18, July 2019

Australian Competition and Consumer Commission, ACCC review of the LNG netback price series Issues Paper, March 2021

Australian Competition and Consumer Commission, Gas Inquiry 2017 to 2025 Interim Report, January 2021

Australian Energy Market Operator, Gas Bulletin Board Pipe Flow Data 2019, data supplied by AEMO in June 2021

Australian Energy Market Operator, Gas Demand Forecasting Methodology Information Paper Supplement to GSOO, 2021

Australian Energy Market Operator, Gas Statement of Opportunities, 2021

Australian Energy Market Operator, National Electricity and Gas Forecasting portal, http://forecasting.aemo.com.au/Gas/AnnualConsumption/Total, accessed May 2021

Australian Energy Market Operator, Victorian Gas Planning Report, 2021

Beyond Zero Emissions, Electrifying Industry Report, 2018

Beyond Zero Emissions, Zero Carbon Australia Buildings Plan, 2013

COAG Energy Council, Australia's National Hydrogen Strategy, November 2019

COAG Energy Council, Trajectory for Low Energy Buildings, 2019

Commonwealth Department of Agriculture Water and the Environment, National Pollutant Inventory Emissions dataset, accessed via https://data.gov.au/dataset/ds-dga-043f58e0-a188-4458-b61c-04e5b540aea4/details on May 2021.

Commonwealth Department of Industry, Sciences, Energy and Resources, Australian Energy Statistics, 2020

EnergyConsult, Residential Energy Baseline Study: Australia, 2015

EY, Achieving Low Energy Existing Commercial Buildings in Australia – Final Report, October 2019

Grattan Institute, Flame Out - The Future of Natural Gas, November 2020

Health Sector Emissions Fact Sheet, May 2021

Healthcare without Harm, Global Roadmap for Health Care Decarbonization - Australia

International Energy Agency, Gas 2020 Report, June 2020

IT Power and ARENA, Renewable Energy Options for Industrial Process Heat, 2019

Northmore Gordon, Victorian Gas Market Demand Side Study, 2020

NSW Department of Planning Industry and Environment, Energy efficient water heating technology guide for aquatic centres, 2019

NSW Department of Planning Industry and Environment, Net Zero Industry and Innovation Program launch publication, March 2021

NSW Department of Planning Industry and Environment, Net Zero Plan Stage 1: 2020–2030, March 2020

Pitt and Sherry, Baseline Energy Consumption and Greenhouse Gas Emissions – In Commercial Buildings in Australia, 2012

Reliable Affordable Clean Energy (RACE) for 2030 Cooperative Research Council, Draft Report Research Theme B3: Electrification & Renewables to Displace Fossil Fuel Process Heating, May 2021

Appendix A. NSW Decarbonisation Roadmap Detailed

Sector	Sub-sector	Gas Usage			
		2021	2025	2035	2050
Industrial	Iron Smelting	3	3	3	0
Industrial	Iron and steel manufacturing/casting	6	5.82	1.16	0
Industrial	Ammonia and Ammonium Nitrate	12.2	10.98	10.98	0
Industrial	Timber and Wood products	0.3	0.21	0.2	0
Industrial	Pulp and paper	4	2.8	1	0
Industrial	Non metallic mineral - cement, brick, glass	12	10.5	6.3	0
Industrial	Mining	0.22	0.22	0.22	0
Industrial	Food and Beverage	7.5	6	0	0
Industrial	Textile, clothing, footware, and leather	0.9	0.72	0	0
Industrial	Other/smaller facilities	8	6	3	0
Commercial	Offices	2.1	1.58	0.85	0
Commercial	Hotel	0.35	0.26	0.11	0
Commercial	Retail	2.7	2.02	0	0
Commercial	Hospitals	2.3	2.3	1.15	0
Commercial	Education	1.6	0.96	0	0
Commercial	Public Buildings (inc Aquatic Centres)	1.6	0.6	0	0
Commercial	Other - inc warehousing, hospitality, laboratories	8.60	6.45	3.23	0
Residential	Water heating	16.5	9.5	0	0
Residential	Space heating	10.8	5.4	0	0
Residential	Cooking	2.8	2.8	0	0
Residential	Appliances	1.5	1.5	0	0
Totals		**104.97**	**79.61**	**31.19**	**0**

7 Document Control Sheet

Document information

Engagement	NSW Gas Demand Analysis		
Client organisation	Climate Council of Australia		
Client contact	Louis Brailsford		
Report prepared by:	Trent Hawkins, Dave Harvey	Date:	15 June 2021
Reviewed by:	David Blyth, Andrew Clarke	Date:	25 June 2021
Authorised by:	Ed Smith	Date:	10 July 2021

Revision history

Version	Status/Description	By	Chk	App	Date
0	First Draft	TAH			15 June 2021
1	Final	TAH	ES	ES	20 July 2021

Distribution history

Organisation	People	Date	Rev
CCA	Louis Brailsford, Tim Baxter	5 July 2021	0
CCA	Louis Brailsford, Tim Baxter	20 July 2021	1