Victorian Gas Market – Demand Side Measures to Avoid Forecast Supply Shortfall

Report Prepared for Environment Victoria

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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 industrial and large commercial customers.

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

Executive Summary

The 2019 Gas Statement of Opportunities (GSOO) and Victorian Gas Planning Reports (VGPR) prepared by AEMO flagged a gas supply shortfall from 2024 onwards due to:

- Falling production levels from existing southern gas fields
- Uncertainties around southern prospective resources (un-explored but estimated to exist) accessible by existing pipeline and processing infrastructure
- Moderately increasing gas demand, driven mainly by population growth driving new gas connections.

Northmore Gordon have been engaged to undertake a study into the forecast gas shortfall in Victoria and review the potential for demand side measures to eliminate this shortfall. This includes understanding what alternatives to natural gas exist for residential, commercial, and industrial customers and what programs and policies, if adopted, could encourage their adoption.

Using data from the 2019 GSOO and modelled Victorian gas demand for each sector Northmore Gordon have estimated the annual surplus or shortfall in Victoria until 2030. Forecast production estimates were taken from existing, committed, and anticipated projects, but did not include any available supply from northern regions transported via gas pipeline to Victoria. This was done to focus the investigation on whether Victoria can meet its own demand with its own production. To address uncertainty in long term gas demand forecasts and to investigate the potential for demand side measures to mitigate supply shortfalls, a constant gas demand between 2020 and 2030 was modelled.

<u>Our analysis found that, on an annual basis, there is enough supply capacity in Victoria until 2027, however from 2027 until 2030 there is a shortfall of between 26 PJ and 85 PJ</u>.

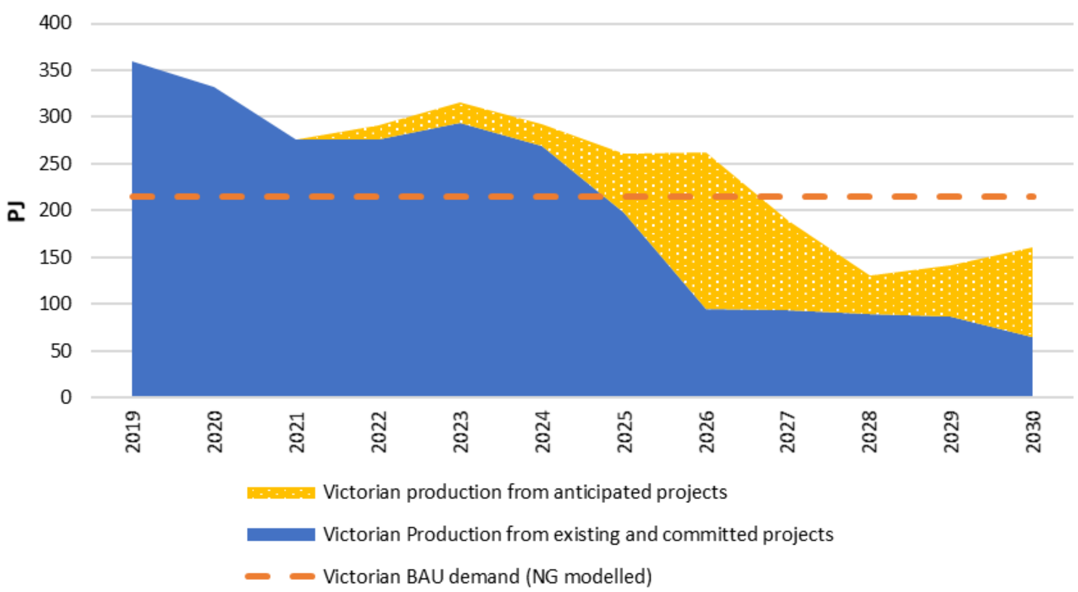


Figure 1 - Estimated Victorian gas supply surplus/shortfall until 2030

A review of gas demand measures was conducted for residential and commercial buildings, and industrial facilities. This review was based on existing published literature and previous work by Northmore Gordon for commercial and industrial clients. Measures were selected that were considered generally applicable and achievable in the next 5 to 10 years with current technology and targeted economic support. The key measures identified were:

- Replacement of ageing ducted gas heating systems in residential dwellings
- Improving building insulation in residential buildings

- Encouraging households with existing reverse cycle air-conditioners to preferentially use it for space heating
- Replacement of gas hot water systems with heat pump hot water
- Replacement of gas cooktops at end of life with electric induction
- Adoption of heat pump space heating in commercial buildings
- Low cost energy efficiency activities and waste heat recovery for industrial gas systems
- Fuel switching of gas fired process heating to renewable electric and bioenergy
- Implementation of high temperature heat pumps for industrial hot water use

On an annual basis, the potential avoided gas consumption from these measures (98 to 113 PJ) is greater than the forecast shortfall facing Victoria (26 to 85 PJ). Ranked measures and their associated projected gas reduction are shown in Table 1.

Table 1 - Summary of gas demand reduction measures

#	Technology	Sector	Ease of implementation	Cost	Applicability	Anticipated gas reduction (PJ/annum)
1	Replace ageing ducted gas heating systems	Residential	Easy	Low-Moderate	Broad	48 PJ
2	Improving building insulation[1]	Residential	Easy	Low	Broad	> 10 PJ
3	Use existing air-conditioners for space heating	Residential	Very easy	Zero cost	Some	5-15 PJ
4	Heat pump hot water	Residential	Easy	Low	Broad	10 PJ
5	Heat pump space heating	Commercial	Moderate	Moderate	Broad	7.75 PJ
6	Industrial gas efficiency	Industrial	Easy	Low	Broad	2.5 PJ to 5.5 PJ
7	Renewable process heating	Industrial	Moderate to hard	High	Some	13.6 PJ
8	High temperature heat pumps	Industrial	Moderate	Moderate	Some	1 PJ to 3.5 PJ
9	Induction cooktops	Residential	Easy	Moderate	Some	0.5 PJ
Total gas demand reduction					**98.35 PJ to 113.85 PJ**	

To assess the ability of the proposed measures and policy drivers to eliminate the forecast shortfall, a simplified time series analysis was conducted. Assuming a linear adoption of proposed measures and mapping this gas demand reduction for each of the sectors (residential, commercial, and industrial) against the forecast supply adequacy presented in Figure 1, delivers the outcome shown in Figure 2.

[1] Gas demand reduction is not necessarily additive with other residential measures

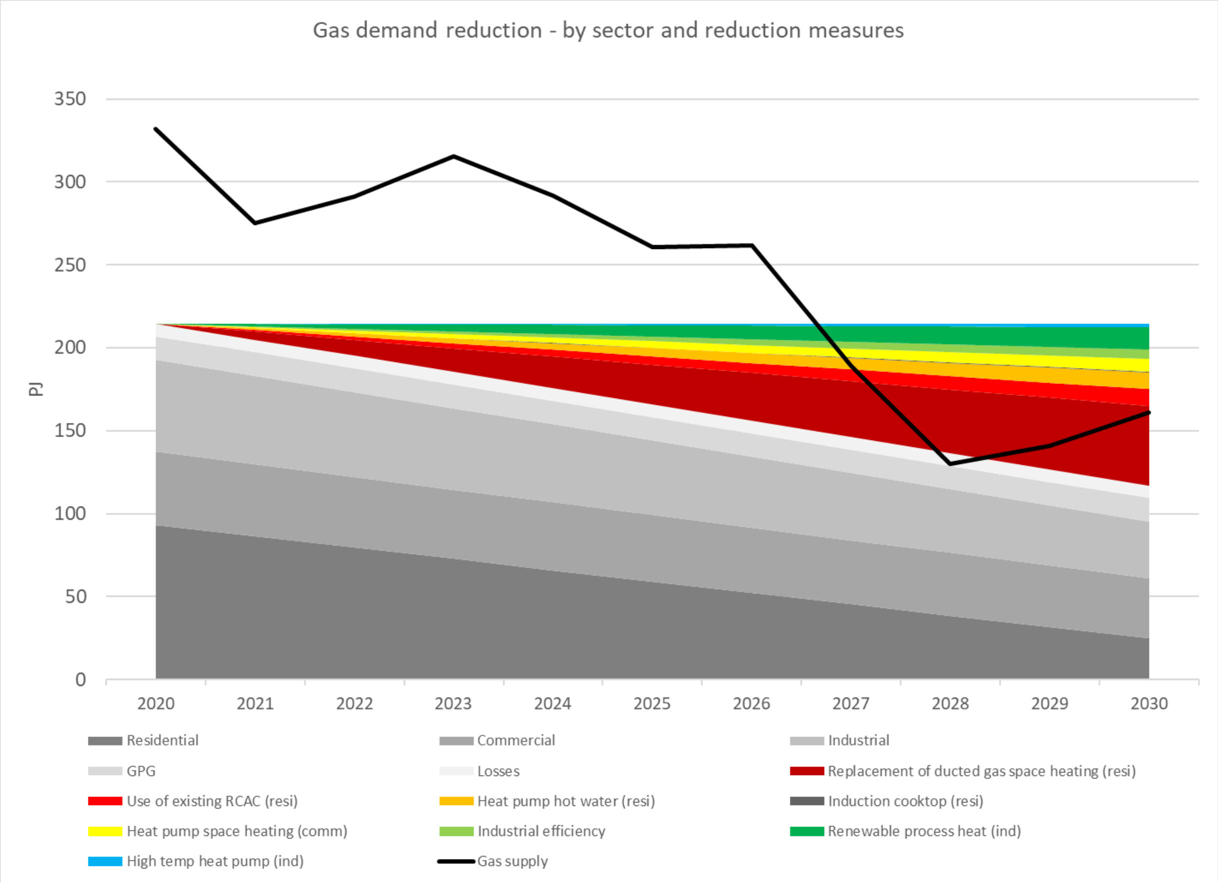


Figure 2 - Modelled gas demand reduction from proposed measures

This figure shows the actual gas demand in grey, diminishing over time by application of the proposed gas demand reduction measures in colour, against the forecast gas supply from existing, committed, and anticipated gas projects. <u>This demonstrates that the adoption of gas demand reduction measures, such as energy efficiency and fuel switching entirely eliminates the forecast shortfall, with the exception of 2028 which has a minor 6.5PJ modelled shortfall</u>. Furthermore, the analysis presented is conservative, because:

- It does not include any potential gas supply that could be provided by northern states via gas pipeline
- Modelled savings are generally taken as the mid-point of values presented and does not include any gas savings from improved insulation to avoid double counting.
- Our review of gas demand reduction measures is by no means exhaustive, and additional short to medium term gas demand reduction was identified but not modelled in the analysis. An example of this is commercial buildings, with significant potential gas reduction beyond the modelled 7.75PJ.

This study has assessed the potential 10-year Victorian gas supply shortfall, evaluated viable gas demand reduction measures, and reviewed effective policy drivers to support their implementation. The analysis conducted in this study supports the following conclusions:

1. Victorian gas production is slated to decline in the near future, however considerable gas reserves in northern Australia provide a supply buffer.
2. AEMO modelled growth in gas demand, is almost entirely driven by new residential gas connections and forecast reliance on Gas Power Generation post exit of coal generators. Both areas of growth seem contrary to trends in government policy and the energy market.
3. Whilst shortfalls in gas supply of between 26 and 85 PJ are observable, our modelling indicates this is not experienced until 2027 and there is sufficient time for policy makers and the energy market to respond.

4. Despite not receiving attention in the public debate on the forecast gas shortfall, demand side measures can eliminate this shortfall.
5. A range of gas demand measures were identified that have wide applicability and are economically viable with targeted support. These measures will also support households, business, and industry to transition to a low carbon economy and access lower cost energy.
6. A more detailed analysis is required to confirm peak day supply adequacy, however the residential demand side measures explored lead to a 73.4% reduction in annual residential gas demand. This will have a significant impact on winter peak demand, which is almost entirely driven by residential consumption.

Importantly these conclusions draw into question the merit of any new Victorian gas supply projects and LNG import terminals. Similarly public planning in the gas market and activities of regulated bodies urgently need to include consideration of demand side measures, rather than focussing entirely on gas production and supply.

A number of policy drivers were identified in the study and are summarised in Section 4. The key policy drivers warranting particular attention by policy makers include:

- Amendment of Victorian Energy Upgrades (VEU) activities to remove support for fuel switching from electric to gas
- Introduction of new VEU activities to incentivise replacement of gas hot water systems and gas space heating systems with electric heat pump and reverse cycle air-conditioners.
- Amending the Victorian Building Authority Minimum 6 star energy provisions to include heat pumps as acceptable solar hot water systems
- Establishing a Sustainability Victoria led training program, coupled with VEU support, to engage and educate relevant trades, developers, and building owners on all-electric homes
- Establishment of a new energy efficient business program, similar to the NSW Business Energy Saver Program within the Victorian Department of Environment Water Land and Planning (DEWLP) or the Department of Jobs Precincts and Regions (DJPR).
- Provide Victorian government backing and joint funding to the ARENA renewable process heat program.

These policy changes are particularly timely in the light of proposed changes to significantly reduce the electricity emissions factor in the VEU program and the need to continue supporting industry transformation in a low carbon economy future.

Contents

1 Introduction

The 2019 Gas Statement of Opportunities prepared by the Australian Energy Market Operator (AEMO) highlighted a potential gas supply shortfall to the southern states by 2025. This was based on the forecast supply from existing southern and northern production facilities and future committed projects. AEMO later published the 2019 Victorian Gas Planning Report, which elaborated on the identified shortfall indicating that:

- output from existing Victorian gas producers is forecast to decline
- Victoria is forecast to have just enough production to supply forecast demand on an annual basis, however,
- peak winter demand is up to three times higher than summer gas demand and as such there is a risk of a winter shortfall come 2023
- “without additional gas supply capacity, restrictions and curtailment of GPG may be necessary in 2023 on a 1-in-20-year peak system demand day”

This forecast shortfall was responded to with calls for immediate government action to facilitate new gas production wells and other measures to increase supply. Some measures currently being considered include developing gas fields at Narrabri in New South Wales, the recent decision to lift the conventional onshore gas moratorium in Victoria, and a number of proposed gas import terminals (or floating storage and regasification units), including at Port Kembla in NSW and Crib Point in Victoria.

While many voices are calling for additional gas supplies, there has been considerably less attention on the potential for measures that reduce gas demand to serve as a solution to the forecast gas shortfall.

Environment Victoria has engaged Northmore Gordon to undertake a study into the forecast gas shortfall and review the potential for demand side measures to eliminate this shortfall. This includes understanding what alternatives to natural gas exist for residential, commercial, and industrial customers and what programs and policies, if adopted, could encourage their adoption.

The environmental rationale for investigating demand reduction measures (either fuel-switching or improved efficiency) to eliminate the forecast gas shortfall is the potential to reduce greenhouse gas emissions and reduce environmental impacts from proposed new gas fields and import facilities.

2 Understanding the forecast shortfall facing Victoria

2.1 Overview

The eastern Australian gas market has undergone significant transformation in the last five years with six gas trains built in QLD supplying LNG to an export market, and significant growth in gas production in Northern Australia (namely from coal seam gas sources in QLD). Alongside this expansion of QLD gas supply, offshore gas resources in Victoria (Otway, Bass, and Gippsland) that have supplied southern states (SA, Vic, NSW, and Tas) have begun to deplete. These changes have forced domestic gas consumers to compete with the international oil and gas market, while new gas reserves are only recoverable at higher production costs.

The 2019 Gas Statement of Opportunities (GSOO) and Victorian Gas Planning Reports (VGPR) prepared by AEMO flagged a gas supply shortfall from 2024 onwards due to:

- Falling production levels from existing southern gas fields
- Uncertainties around southern prospective resources (un-explored but estimated to exist) accessible by existing pipeline and processing infrastructure

- Moderately increasing gas demand, driven mainly by population growth driving new gas connections.

Slight differences exist between the 2019 GSOO and VGPR, but broadly they are developed on the same methodology. Table 2 summarises the 2019 demand and supply quantities for Victoria and remaining southern states (NSW, SA, Tas). Production in these remaining southern states is entirely from the Cooper Eromanga basin with gas processed at Moomba in South Australia. As noted in recent ACCC reports the actual available/deliverable volumes to southern states is difficult to confirm because:

- Most of the gas reserves are contracted to LNG producers in QLD
- A significant portion of the remaining reserves are contracted to a retailer and it is ultimately their decision into which markets they deliver this gas

Table 2 – Victorian demand and production forecasts for 2019 (taken from 2019 GSOO and VGPR and other sources as noted)

Category	Victoria	Other Southern States
Annual production	347 PJ	86[2] PJ
Daily production capacity[3]	1,275 TJ/day	435[4] TJ/day
Storage capacity	567 TJ/day	260 TJ/day
Annual demand	214.7 PJ	209 PJ
Peak summer demand (1 in 2 year)	484 TJ/day	417 TJ/day
Peak summer demand (1 in 20 year)	621 TJ/day	452 TJ/day
Peak winter demand (1 in 2 year)	1,151 TJ/day	640 TJ/day
Peak winter demand (1 in 20 year)	1,248 TJ/day	674 TJ/day

2.2 Supply overview

The maximum daily supply capacity is constrained by both the processing facility *and* the pipeline carrying capacity. The maximum daily production capacity of Victorian processing facilities is quoted as 1,528 TJ/day in the 2019 VGPR (although some discrepancies in the final number are presented in that report).

In addition natural gas can be delivered to southern states via the South Western Queensland Pipeline (SWQP), although flows have traditionally been South to North to meet demand for LNG. The net supply from Queensland to southern states was 16.7 PJ in 2018. However, the interconnection of Northern Territory into the eastern pipeline network in 2018, and upgrades to the Moomba-Sydney pipeline is slated to increase southbound pipeline capacity from the SWQP. The 2019 VGPR states that the “maximum physical capacity of gas flow from Queensland to the southern states through existing pipeline infrastructure is 145 PJ/y”.

Figure 3 shows the gas supply adequacy for southern states based on forecast demand and production from existing, committed (passed final investment decision) and anticipated projects. Anticipated projects are considered by AEMO to be those that are actively under development planning and utilise existing infrastructure and therefore do not include any onshore gas facilities in Victoria, LNG import terminals, or the proposed Narrabri gas project. This indicates a significant trend down for production resources, delivering a shortfall in supply against a moderately growing gas demand.

[2] Taken from ACCC Gas inquiry 2017–2025 December 2018 Interim Report
[3] Taking into account pipeline injection constraints
[4] Total production capacity of Moomba gas plant

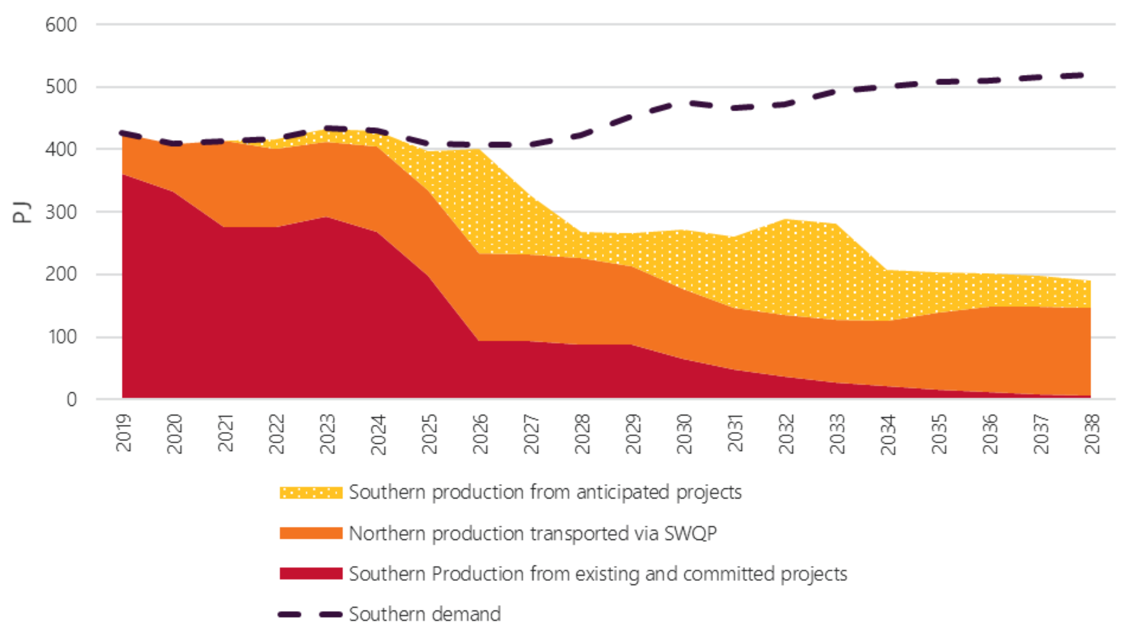


Figure 3 - Projected supply to meet southern states demand from existing, committed and anticipated projects (GSOO 2019)

It is beyond the scope of this study to investigate potential future sources of natural gas in Southern States and this has been canvassed solidly by other studies particularly the ACCC Gas Inquiry 2017-2025, CORE Energy and Resources input data to GSOO, and the 2018 Offshore South East Australia Future Gas Supply Study by the Department of Industry Innovation and Science. Table 3 presents one set of this data from the recent ACCC December 2018 Interim Report, providing 'proven', 'probable', and 'possible' reserves and 'contingent' resources for the gas basins in Australia.

Table 3 - Gas reserves and resources in Eastern Australia (ACCC, December 2018)

	Reserves			Contingent Resources	
	1P	2P	3P	1C	2C
Bowen/Surat Basins	14 376	33 848	37 875	3 685	21 927
Gippsland Basin	2 152	2 864	3 179	531	1 658
Cooper Basin	478	991	1 780	742	4 022
Otway Basin	344	517	706	21	135
Bass Basin	69	97	126	75	315
Sydney Basin	11	13	16	–	–
Clarence-Moreton Basin	–	80	408	–	588
Gunnedah Basin	–	–	–	1 182	2 060
Galilee Basin	–	–	–	355	2 750
Isa Super Basin	–	–	–	35	164
Total East Coast	**17 430**	**38 411**	**44 088**	**6 626**	**33 619**
CSG	***14 346***	***33 873***	***38 123***	***5 148***	***25 249***
Conventional natural gas	***2 894***	***4 101***	***5 153***	***862***	***3 139***
Other	***191***	***437***	***813***	***616***	***5 231***

For the purpose of AEMO GSOO and VGPR forecasts, reliable estimates for future gas production are derived from 2P (proven and probable) estimates, while longer term estimates on new gas resources likely to be recovered in the future is given by 2C (best estimate of contingent) and prospective resources (utilising existing pipeline and processing infrastructure). For Victoria these are offshore only resources, either in the Gippsland, Bass, and Otway Basins. Adding 2C reserves into the supply forecast generates the supply outlook given in Figure 4, diminishing the shortfall concerns, with supply capable of meeting demand until 2030.

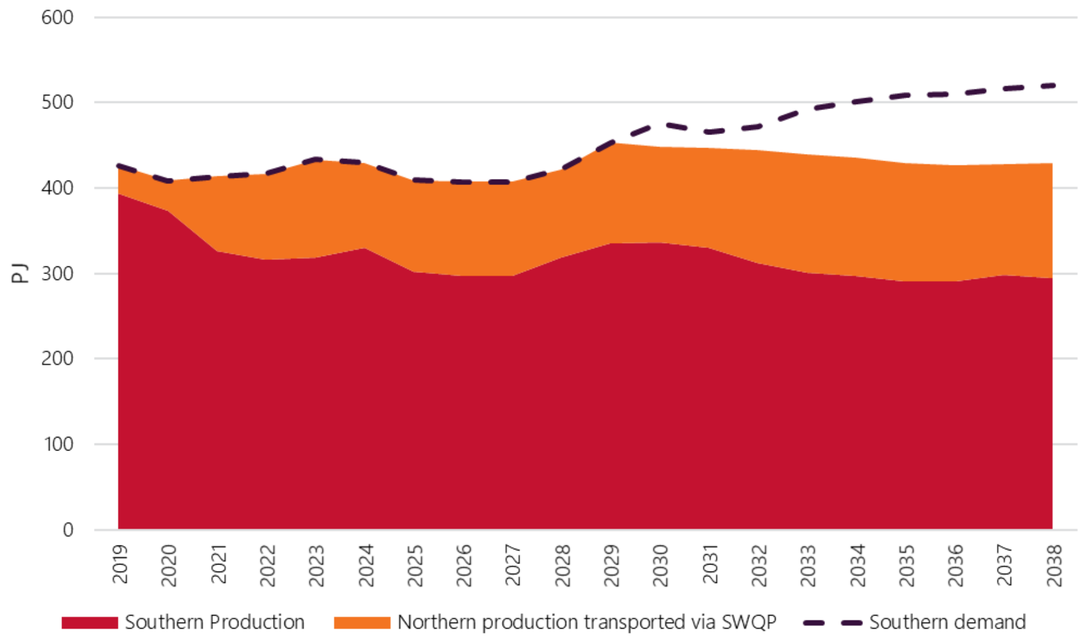


Figure 4 – AEMO's projected supply to meet southern states from all available resources, including anticipated and uncertain projects

Regardless there is consensus that Victorian offshore gas reserves are depleting as evidenced by failed exploration (e.g. the Dory gas field in Bass) and increasing impurities from Gippsland Basin. Gas production from the Gippsland Basin and Bass Straight has occurred since 1969 with lease titles dominated by Esso Australia and BHP. These oil and gas fields have been extensively explored and produced from and it isn't surprising that after 50 years they are beginning to deplete. Whilst significant attention has been on the Otway Basin in recent years, the quantity of reported resources is relatively low compared to the historical numbers from the other Victorian gas fields.

Natural gas from the Gippsland Basin has historically included higher levels of impurities, such as hydrogen sulphide, mercury, and carbon dioxide. As this basin has begun to deplete, the availability of "sweet" gas fields – those which have low impurities – have diminished and the remaining fields are "sour" requiring the gas to be processed via a gas upgrading/conditioning facility. This facility, a gas conditioning plant, is located in Longford and has a production capacity of 427 TJ/day effectively constraining production into the future from the Gippsland and Bass Basins.

2.3 Forecast gas demand without additional measures

Victorian gas demand estimates and their breakdown by use categories was downloaded from AEMO's National Electricity and Gas Forecasting portal[5] and is presented in Figure 5.

Gas demand is differentiated by tariff categories, with Tariff D representing large gas consumers billed by demand (over 10 TJ per annum) and Tariff V customers representing residential and small commercial billed by consumption (under 10 TJ per annum). Tariff D is divided into two categories – Large Industrial/ Manufacturing and 'Other business', which is generally classified as service sector (e.g. large commercial property, telecommunications, health care, education) although includes some manufacturing. In Figure 5 we have designated 'Other business' as large commercial. Tariff V is dominated in Victoria by residential consumption, with the GSOO stating 'approximately 97% of Victorian Tariff V customers are residential'.

[5] http://forecasting.aemo.com.au/Gas/AnnualConsumption/Total

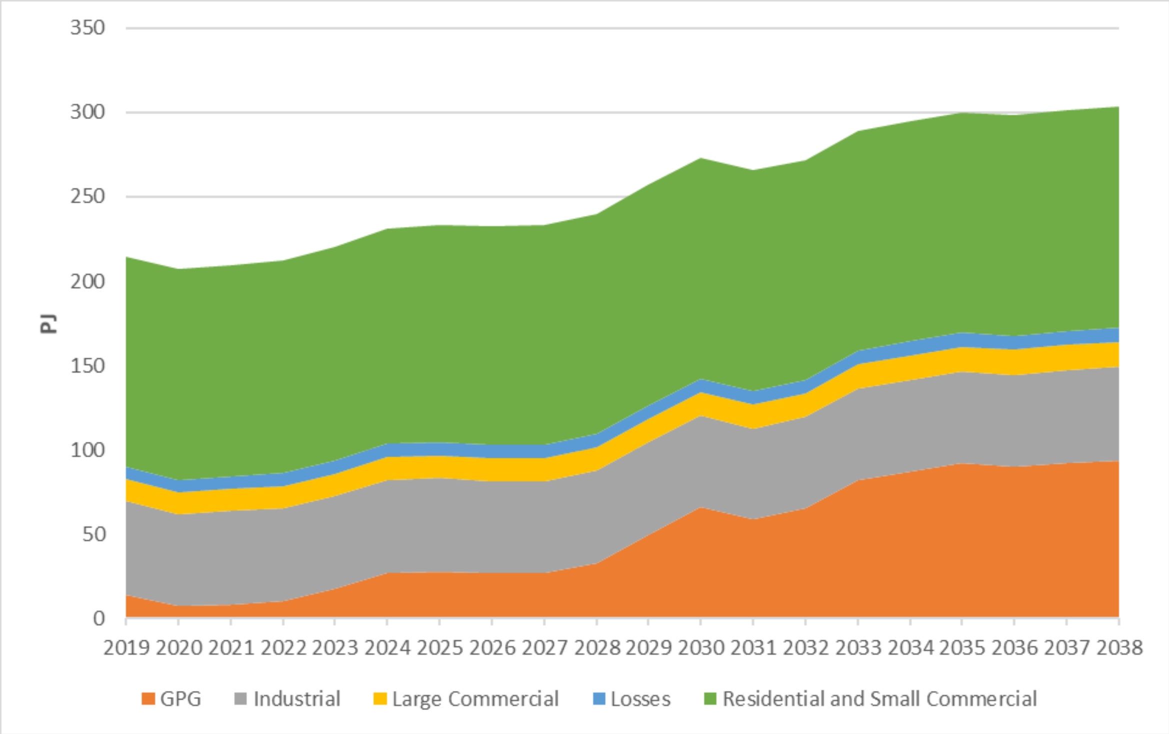


Figure 5 – AEMO forecast demand for Victoria by category (neutral scenario GSOO 2019). Note GPG is 'Gas Powered Generation'

AEMO's modelling forecasts Tariff V consumption to increase by 2% for the next five years, driven by increasing gas connections which is attributable to population growth in the state. High density developments, rising gas prices, and availability of high efficiency electric alternatives is leading to some new developments opting out of gas connection. However, this trend is offset by new housing developments in regional Victoria and outer Melbourne and incentives provided by gas pipeline operators for new connections, such as the recent $1300 connection rebate offered to homes connecting to the new gas network in Warburton. Similarly, energy efficiency provisions and minimum standards in the Building Code of Australia are agnostic towards fuel usage and thus do not provide a signal to developers to move towards all electric households.

In parallel to the rising number of gas connections, per household consumption is falling due to

- the rising gas prices reducing usage of gas space heating systems in favour of electric
- the adoption of more efficient appliances
- the impact of existing energy efficiency programs.

The major contributor to this trend is the Greenhouse and Energy Minimum Standards program (known as GEMS), which sets minimum performance standards on new equipment sold in Australia. Converse to this trend is the Victorian Energy Upgrades program, which has historically incentivised new gas hot water and space heating systems as replacement for inefficient electric systems due to high Scope 2 electricity emissions factors for Victoria.

Approximately 75% of residential gas consumption in Victoria is in space heating, 23% is in hot water heating, and the remaining ~2% is in cooking and other appliances[6]. The high level of use in space heating means Victorian gas demand is dominated by seasonal weather and winter demand is up to three times higher than summer. This imposes operational challenges on the DWGM and DTS, requiring forward planning to meet winter peaks and reliance on storage facilities. AEMO forecasting of mains gas space heating incorporates a small amount of fuel switching to electric. AEMO's modelling

[6] https://www.energyrating.gov.au/document/2015-data-tables-residential-baseline-study-australia-2000-2030

has only recently incorporated fuel switching and is based on “business as usual” uptake of residential air-conditioners, meaning the figures are not representative of the potential for fuel switching. AEMO’s modelling also accounts for climate change impacts, assuming an average 0.5°C increase over the next 20 years leading to a corresponding reduction in demand for space heating.

Table 4 - Victorian Residential Gas Demand (Source, Australian and New Zealand Residential Baseline Energy End-use Model, 2015)

Year	Appliances	Cooking	Space conditioning	Water heating	Total
2015	0.4	1.5	71.3	20.9	94.1
2016	0.4	1.5	70.6	21.2	93.7
2017	0.4	1.5	70.1	21.4	93.4
2018	0.4	1.6	69.7	21.6	93.3
2019	0.4	1.6	69.3	21.8	93.1

Bottom up estimates of residential energy consumption have been developed for the Department of Industry, Innovation, and Science by both Energy Efficiency Strategies (2008) and EnergyConsult (2015) – see Table 4. The estimated value for 2019 has been used as the best estimate of Victorian residential gas usage in order to disaggregate Tariff V into residential and small commercial.

Industrial and large commercial gas usage is forecast to reduce by 0.5% over the next five years. This is driven by the impacts of rising gas prices forcing the relocation of some manufacturing business overseas. Whilst this price impact has driven industrial users to explore measures to improve gas efficiency and to explore fuel switching to electric and bioenergy, the more risk averse nature of industry means this is still slow to translate into actual changes in gas usage. Work conducted by Strategy.Policy.Research for Department of the Environment, Land, Water and Planning in 2019 explored potential electrification opportunities in Victoria’s Industrial Sector. This included an assessment of the non-electrical energy usage for Victorian industrial facilities, shown in Figure 6. This report also noted that over 91% of non-electrical energy usage in Victorian industrial sector is natural gas.

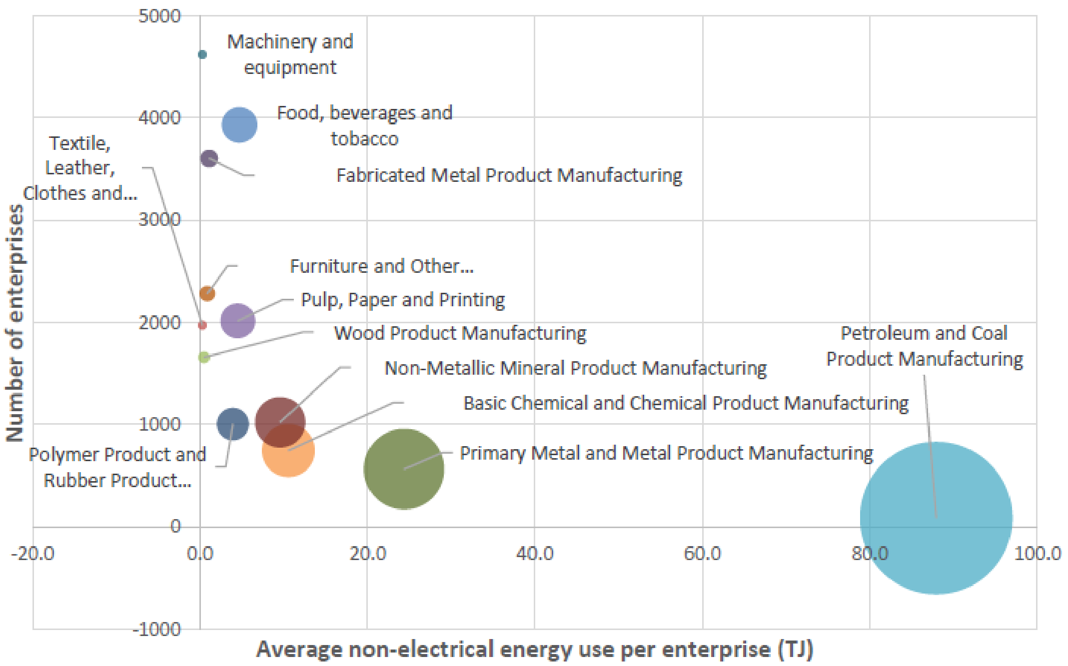


Figure 6 - Number of Industries and Average Non-electrical Energy Use for Victoria (Source, Strategy.Policy.Research, 2019)

2.3.1 Gas Powered Generation

In addition to these categories, Gas Power Generation (GPG) contributes to gas demand. The trend in recent years has been downward for GPG as a result of increasing penetrations of renewable energy in the electricity market. This trend, which has also been influenced by higher gas prices, means that new renewable energy projects can bid into the wholesale market at prices significantly lower than GPG and therefore reduce the demand for gas in GPG.

AEMO's modelling anticipates a continuation of this trend for the next 6 to 7 years with significant numbers of new renewable energy projects coming online (primarily solar and wind farms). These projects are in response to the Federal Renewable Energy Target (RET) and the Victorian Renewable Energy Target (VRET). However this trend is forecast by AEMO to reverse from 2028 onwards due to the exit of coal fired generation and the resulting reliance on gas power rotating generators to provide system stability. The 2019 GSOO states "GPG demand is forecast to rise to previously observed historical volumes, as expected coal generator retirements may re-invigorate the role of gas generators. Due to the relatively high operating cost and flexibility of gas generation to respond to changes in supply or demand, the role of GPG in the NEM is projected to shift towards providing a reliability and power system security role." The actual future level of GPG is highly contingent on a number of factors and to account for variability AEMO models three different scenarios. These are presented in Figure 7 below, highlighting significant variability in overall gas usage for GPG with two of the three scenarios not presenting a significant increase in demand until well in 2030.

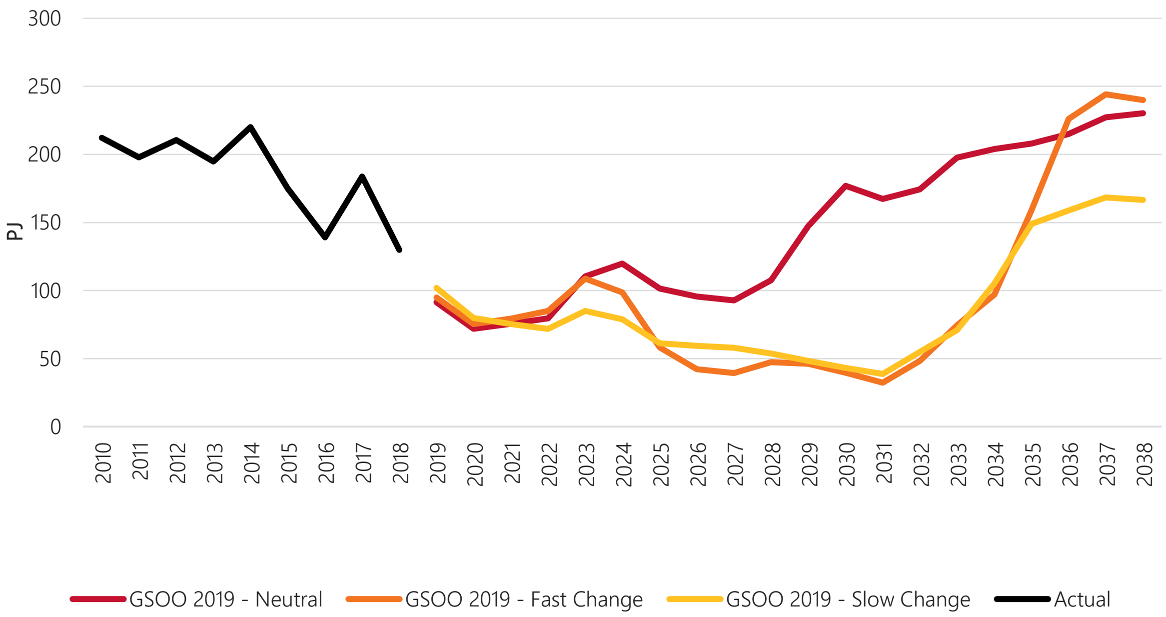


Figure 7 - Actual and forecast gas powered generation (GPG) demand across all NEM states (GSOO 2019)

Northmore Gordon is of the view that the proposed uptick in GPG usage in response to exit of coal power generators is somewhat exaggerated. Given the level of interest from state governments to transition towards high penetrations of renewable energy and the ongoing discussions about enabling system reliability at these high penetrations, we anticipate other technologies and measures to be leveraged to fulfil grid stability functions. This is even more the case for an electricity market as we move into 2030 and beyond. AEMO even references this possibility in their fast change scenario, were GPG is reduced "due to a more aggressive projected penetration of renewable generation projects, and a forecast increase in storage technologies of various sizes to support renewable generation intermittency, rather than GPG."

2.4 Modelled shortfall

2.4.1 Annual supply adequacy

The objective of the Gas Statement of Opportunities is to ensure supply adequacy and give a market signal to gas producers that more or less supply is required. However to address the uncertainty, highlighted in the previous sections, on long term forecasts of gas demand and to investigate the potential for demand side measures to mitigate supply shortfalls, we have modelled a constant gas demand between 2020 and 2030. Other reasons for modelling a constant gas demand are

- We think the uptick in GPG post 2028 is exaggerated and not reflective of the current policy setting of state governments and the broader thrust of energy market design.
- Rising residential gas consumption is entirely driven by new gas connections, and recent moves by the ACT Government to remove mandatory connection of new housing developments to the gas network reflects a general move towards reducing the carbon intensity of households and small businesses
- Other sector gas usage is consistent throughout the modelling period

This allows us to then focus on the impact of discrete targeted gas efficiency measures and fuel switching opportunities to eliminate or reduce the forecast supply shortfall. Table 5 presents the natural gas demand by sector under Business as Usual.

Table 5 - Current Victorian natural gas demand by sector

Sector	2019 Gas usage (PJ/year)
Residential	93.3
Small Commercial	31.3
Large Commercial	12.8
Industrial	55.5
GPG	14.1
Losses	7.7
Total Annual	214.7

Note that “Losses” refer to unaccounted for gas usage – generally from losses in the gas pipelines and gas usage as part of operating the gas network infrastructure, e.g. powering gas compression stations.

Given the inherent uncertainty in production from contingent and prospective resources, we have not taken these into account when considering the potential shortfall. Similarly, the uncertainties inherent in long term forecasting of demand and supply adequacy means estimates beyond 2030 have limited reliability. For example, the entire gas market has changed significantly in the last ten years with the development of unconventional gas resources in Queensland and their export to international markets as LNG. The rapidly changing nature of energy technology coupled with increasing motivations by end users to become active participants in the energy market means longer term forecasts are poor estimates of likely future scenarios. As such we have also excluded consideration of supply adequacy beyond 2030.

Using supply data from the 2019 GSOO and the Victorian gas demand figures in Table 5 we have estimated the annual surplus or shortfall in Victoria until 2030 in Figure 8. These exclude any available supply from northern regions transported via the SWQP in order to focus the investigation on whether Victoria can meet its own demand with its own production.

Our analysis found that, on an annual basis, there is enough supply capacity until 2027, however from 2027 until 2030 there is a shortfall of between 26 PJ and 85 PJ.

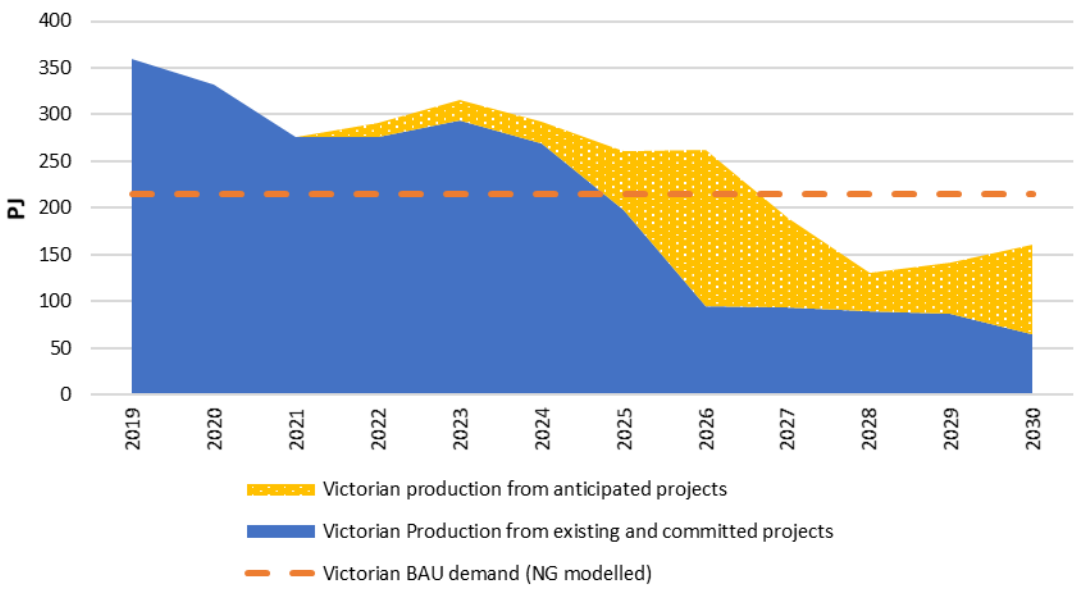


Figure 8 - Estimated Victorian gas supply surplus/shortfall until 2030

2.4.2 Peak day supply adequacy

The VGPR 2019 provides a short term (5 year) peak day supply adequacy assessment for Victoria. This assessment (shown below in Figure 9) highlighted:

- A falling maximum daily supply from Gippsland and Bass Basin reserves (from 1078 TJ/day in 2019 to 805 TJ/day in 2023)
- The maximum daily supply from Port Campbell (Otway reserves) is constrained by the capacity of the SWP pipeline, which is slated to increase from 434 TJ/day in 2019 to 449 TJ/day.
- A proportion of Gippsland production (65 TJ/day) is required to service demand in Southern NSW, Tasmania and eastern Victoria (not part of the DTS).
- The supply availability is sufficient to cover 1 in 20 year peak system demand day, however the supply adequacy is "finely balanced" with limited supply available to neighbouring states and curtailment of GPG may be necessary[7]

[7] Note that peak system demand does not include GPG

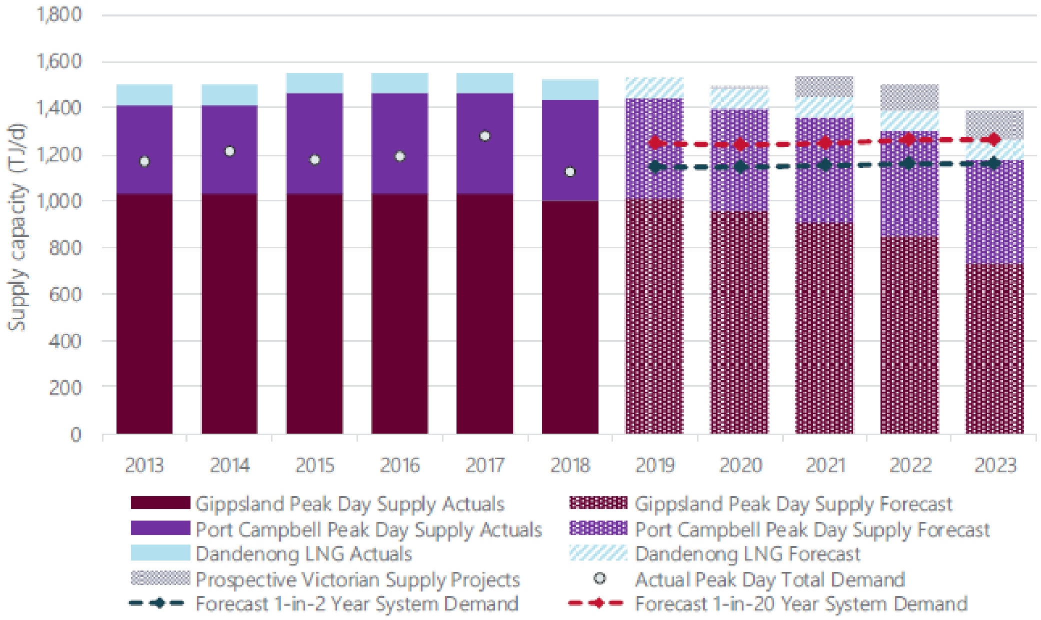


Figure 9 - Peak day supply adequacy identified in 2019 VGPR

There is limited long term modelling available on peak day supply adequacy, however the 2019 GSOO provides an assessment of seasonal demand in 2025 for southern states reproduced below as Figure 10. This reveals that the supply challenge is primarily through winter and early spring, due to high demand from residential heating needs.

This analysis, which estimates a maximum gas shortfall of 805TJ/day includes potential supply from Northern production and considers demand for all southern states (not just Victoria). This analysis indicates a faster fall in production levels from Gippsland and Otway basins than visible in the VGPR, with average 2025 production around 540 TJ/day compared with 1275 TJ/day in 2019.

Despite the 2025 scenario offering a dire warning of gas shortfalls, AEMO does note that "if all infrastructure limitations were alleviated from 2024, there is forecast to be sufficient excess northern supply to help meet all demand in both the northern and southern regions until 2027". These infrastructure limitations are primarily pipeline flow constraints and Victorian storage capacity.

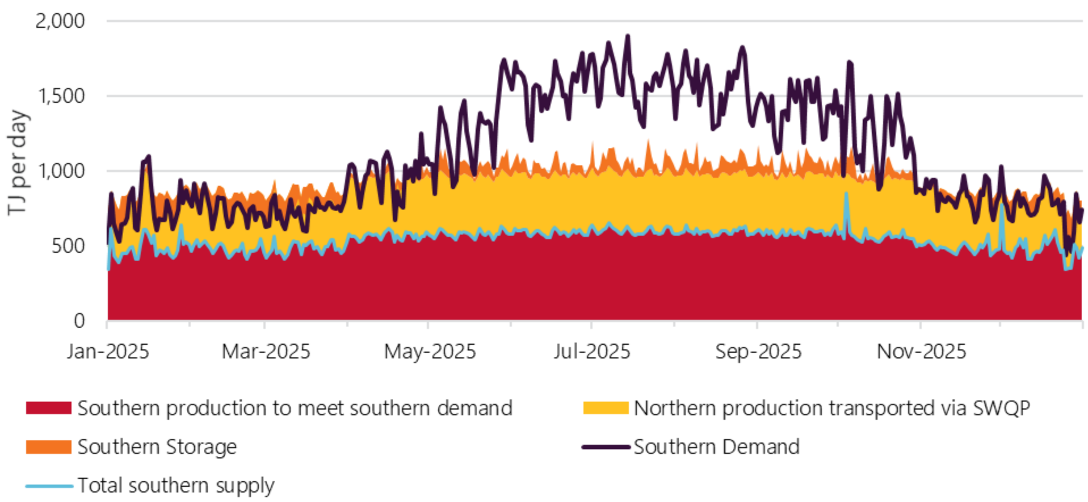


Figure 10 – AEMO forecast supply adequacy for southern states in 2025, GSOO 2019

3 Measures for reducing gas demand

Rising energy prices, declining capital costs for renewable energy infrastructure, and Australia's obligations under international greenhouse emissions agreements (e.g. the Paris Agreement) have driven a transformation in energy markets. This has revolved around:

- rapid rollout of renewable energy power stations
- rapid uptake of rooftop solar
- an anticipated transition to electric and hydrogen fuel cell vehicles
- falling carbon intensity of the electricity network
- reduced preference for natural gas heating systems and investigation into electric alternatives

Historically fuel switching away from electric sourced heating systems to natural gas fired heating systems was recommended as an effective form of carbon abatement. This was due to relatively high greenhouse emissions factors for the electricity sector. Examples of this include the Victorian Energy Upgrades program which allows households to create Victorian Energy Efficiency Certificates (VEECs) for replacement of electric heating systems with gas heating systems.

However, this approach is being abandoned as research and pilot studies highlight that electrification can deliver lower energy costs, improved performance, and lower greenhouse emissions. Examples of this include:

- 'Zero Carbon Australia Buildings Plan' which set out a plan to decarbonise Australia's building sector, including fuel switching off gas
- Reports by Alternative Technology Association (now Renew) demonstrating the superior cost performance of all electric homes
- The 2018 Beyond Zero Emissions 'Electrifying Industry Report'
- Australian Alliance for Energy Productivity (A2EP) work to support the adoption of renewable energy process heating in industry
- The recently published 'Renewable Energy Options for Industrial Process Heat' report prepared for ARENA.

Examples of technologies to electrify gas heating systems include:

- Heat pump hot water systems
- Efficient reverse cycle air-conditioning for space heating
- Electric induction heating systems, e.g. to replace gas combustion furnaces
- High temperature heat pumps for industrial process heating
- Microwave systems for direct heating, e.g. thawing frozen goods
- UV sterilisation as an alternative to steam

Similarly rising gas prices have driven gas users to investigate and implement gas efficiency projects, including:

- Installation of flue gas economisers on boilers
- Waste heat recovery from industrial processes
- Improved insulation of buildings to reduce heat loss
- Reduced losses in reticulated hot water and steam systems

This section contains initiatives that have been demonstrated to reduce natural gas demand in residential and commercial buildings, and industrial facilities. Measures were selected that are considered generally applicable and achievable in the next 5 to 10 years with current technology and targeted economic support. Anticipated gas reduction levels were estimated based on the ease of implementation, cost and applicability.

Table 6 summarises the key gas demand reduction measures investigated.

Table 6 - Summary of gas demand reduction measures

#	Technology	Sector	Ease of implementation	Cost	Applicability	Anticipated gas reduction (PJ/annum)
1	Replace ageing ducted gas heating systems	Residential	Easy	Low-Moderate	Broad	48 PJ
2	Improving building insulation[8]	Residential	Easy	Low	Broad	> 10 PJ
3	Use existing air-conditioners for space heating	Residential	Very easy	Zero cost	Some	5-15 PJ
4	Heat pump hot water	Residential	Easy	Low	Broad	10 PJ
5	Heat pump space heating	Commercial	Moderate	Moderate	Broad	7.75 PJ
6	Industrial gas efficiency	Industrial	Easy	Low	Broad	2.5 PJ to 5.5 PJ
7	Renewable process heating	Industrial	Moderate to hard	High	Some	13.6 PJ
8	High temperature heat pumps	Industrial	Moderate	Moderate	Some	1 PJ to 3.5 PJ
9	Induction cooktops	Residential	Easy	Moderate	Some	0.5 PJ
Total gas demand reduction					**98.35 PJ to 113.85 PJ**	

On an annual basis, the potential avoided gas consumption from these measures (98 to 113 PJ) is greater than the forecast shortfall facing Victoria (26 to 85 PJ), as illustrated previously in Figure 8. While this analysis does not assess consumption needs for peak day, it is worth noting that the most significant gas demand reduction measures relate to residential heating.

AEMO's demand forecasts assume only modest uptake of measures such as these, contributing to earlier and more severe projections of shortfalls. This section will assess the potential of a range of residential, commercial and industrial measures to reduce demand ideally to the point that forecast shortfalls can be avoided.

[8] Gas demand reduction is not necessarily additive with other residential measures

3.1 Residential

3.1.1 Use existing air conditioners for space heating

The 2015 Melbourne Energy Institute report 'Switching off gas - An examination of declining gas demand in Eastern Australia' identified 500,000 to 1 Million households in Australia which own reverse cycle air-conditioners but don't use them for space heating. This is further illustrated by the trend ownership levels of air-conditioning in Victoria presented in the 2015 Residential Energy Baseline Study report. By 2015 home ownership levels of air-conditioners was over 78% and the majority of these are reverse cycle. Similarly the number of households with non-ducted gas heaters is estimated to be around 350,000 in 2019.

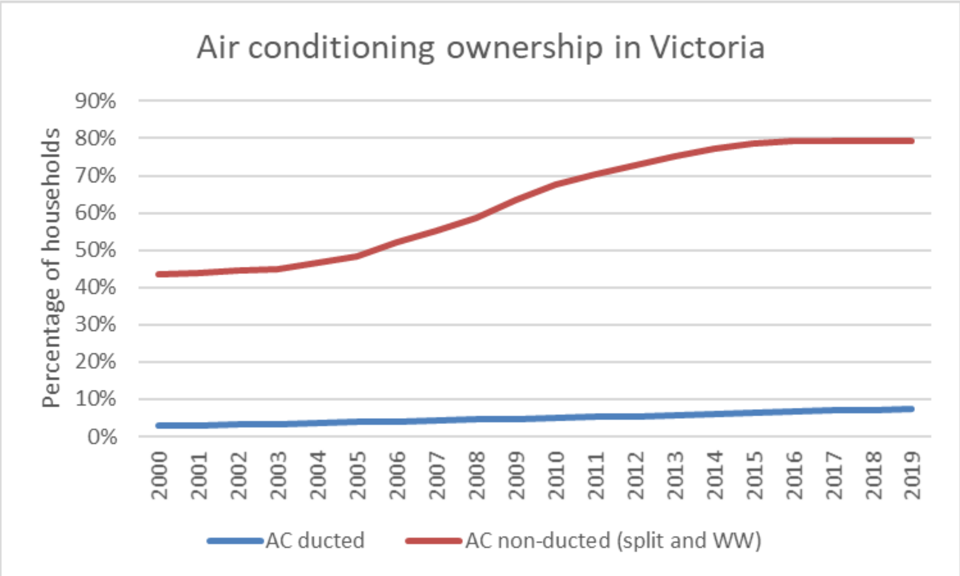


Figure 11 - Air conditioning ownership in Victoria (EnergyConsult, 2015)

Given the high penetration of air-conditioners it's likely that a number of households could simply reduce their gas usage by shifting to using their existing reverse cycle air-conditioning for space heating. Assuming 500,000 households displacing either ducted or non-ducted gas heating, this could translate to potentially 5 to 15 PJ per annum gas saving for no upfront cost. The bulk of these savings will be realised during winter months, when peak day gas demand highest.

3.1.2 Reverse cycle air-conditioning units to replace ducted gas space heating

Ducted gas space heating is the highest natural gas user in the Victorian residential sector. The Residential Energy Baseline Study report estimates a usage of 64.22PJ for ducted space heating in Victoria which is 69% of the total residential natural gas consumption in 2019. Based on the estimated ownership numbers of ducted gas systems in that study, the average consumption per household is 57,000MJ per annum.

Ducted gas space heating systems are highly inefficient, with system efficiencies in the range of 30% to 60%. An illustration of the inefficiencies of ducted gas heating systems was presented in the Zero Carbon Australia Buildings Plan, shown in Figure 12 for an older unmaintained system. Poor maintenance of duct work and low burner efficiency of 70% leads to 56% of energy being wasted and additional energy is wasted to heat unoccupied spaces. Whilst older ducted gas systems could be repaired and replaced to improve overall efficiency, it has been shown in multiple studies that the preferential use of high efficiency reverse cycle air-conditioners delivers a better economic outcome to households. Full load Coefficients of Performance (CoP)[9] for new reverse cycle air-conditioners range between 4 and 6, delivering the same heat as the ducted gas heating systems for 10 times less energy consumed.

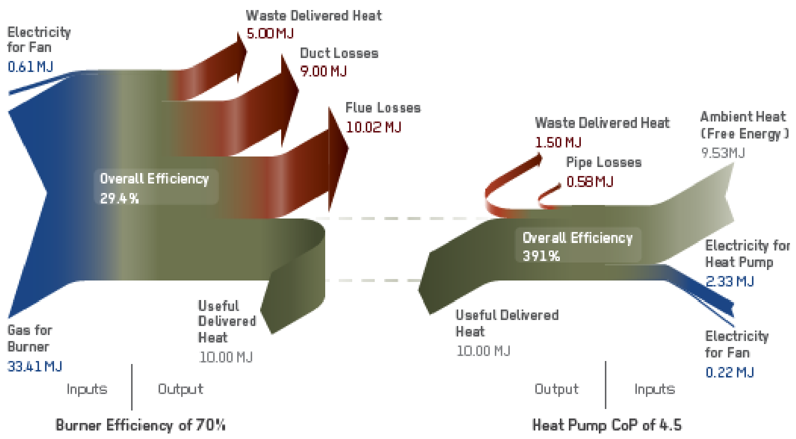


Figure 12: Ducted gas space heating (left) compared to split-system reverse cycle air-conditioning (right) (BZE, 2013)

The amount of natural gas used for ducted space heating by a household is mainly dependent on the size of the house, ambient air temperature and individual usage pattern. The 'Household fuel choice in the National Energy Market' report by Renew conducted modelling on replacing ducted gas heating systems with multiple individual split system reverse cycle air-conditioners. For Melbourne the estimated gas consumption and replacement costs for a range of households estimated by the study is given in Table 7

Table 7: Annual energy used by ducted gas space heating systems based on household type in Melbourne, Victoria (Renew, 2018)

Household type	Burner Capacity (MJ/h)	Annual natural gas usage (MJ/annum)	Cost to replace with AC
Stay at home family	80	50,196	$6,380
Large house	120	69,271	$8,270
New build	120	26,837	$6,380
Small house	50	32,326	$4,490
Working family	80	46,753	$6,380

Removal and replacement of all ducted gas heating systems in Victoria by 2030 could eliminate 75% of the estimated gas supply shortfall. We acknowledge replacement of all ducted gas systems is impractical and that a number of these units have been installed in the last 5 to 10 years. However, <u>some 600,000+ units (54% of total) are over 20 years old and could be replaced as a priority, removing 48 PJ of annual gas demand.</u>

[9] Coefficient of Performance is a measure of the amount of energy delivered divided by the input work done (electrical energy in the case of an air conditioner). It can be compared with efficiency by multiplying the CoP by 100%.

3.1.3 Heat pump hot water

Victorian residential (reticulated) natural gas usage for water heating for 2019 is estimated at 21.8PJ of which 9.88PJ is from gas storage systems.

Heat pump hot water systems apply a similar technology used in reverse cycle air conditioners. The energy used to heat water is absorbed from ambient air via a refrigeration cycle. They are highly efficient and capable of reducing hot water energy requirement by at least 50%. Historically heat pumps have performed poorly in near 0°C temperatures as moisture freezes on evaporator coils. While heat pumps are sensitive to the ambient air temperature, more recent heat pump models are better designed and perform well in cold weather conditions. This is particularly the case with the advent of CO_2 refrigerant heat pumps which are more efficient for higher temperature differentials, realising full load CoPs of 3-4 at low temperatures.

According to the Renew 'Household fuel choice in the National Energy Market' Report capex including typical installation costs for a mid-sized heat pump hot water system varies between $2,517 and $2,683 depending on STC (Small-scale Technology Certificates) rebate zones. On the other hand, Capex including installation for an instantaneous or storage gas hot water system varies between $1,360 and $1,420.

As noted later in Section 5 on Gas Efficiency Programs the Victorian Building Authority minimum energy provisions for new households has favoured gas installations. This is due to its requirement for new dwellings to meet a minimum of 6 Star energy rating and include either a new solar hot water system or a rainwater tank. Unfortunately heat pump hot water systems do not qualify under this program, and the majority of new systems are instantaneous gas boosted solar hot water systems. Regardless, focussing solely on replacing gas storage hot water systems with heat pump technology could deliver a reduction in gas demand up to a maximum 9.88 PJ.

3.1.4 Induction cooktops

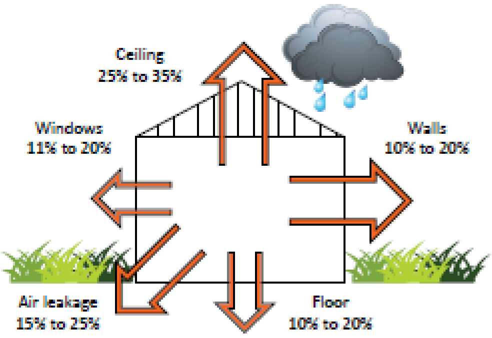
Induction cooktops have the same responsiveness as gas cooktops while using half the energy and being safer than gas.

Induction cooktops operate by inducing a magnetic field in conductive cookwear. This magnetic field then generates heat directly in the pot or pan. The heat being directly applied to the pot eliminates wastage from heat transfer and being generated by magnetic field means it avoids safety risks associated with hot plates.

Electric induction cooktops are approximately 50% more efficient at heating when compared with gas cooktops. Replacing gas cook tops with induction cooktops would halve the energy demand for cooking purposes. We have modelled a modest reduction in gas demand for cooking from preferential replacement of gas cooktops with induction electric at end of life.

3.1.5 Improving building insulation

Prior to the introduction of energy efficiency provisions in the Building Code most homes and commercial buildings had poor thermal performance.



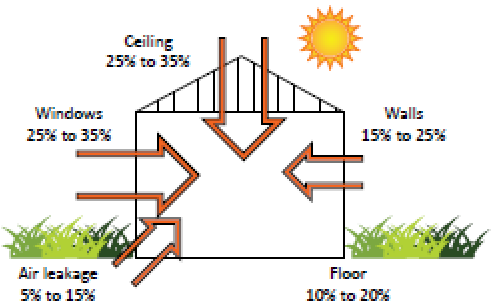


Figure 13 - Heat flows in an un-insulated cool climate house (BZE, 2013)

Adding insulation material to ceilings, walls, and floors is a key effective measure in reducing heat loss to the ambient environment in winter. R value is a measure of a materials resistance to heat flow and typical ceiling insulation levels in older homes are R2.5, while best practice insulation is R6 or higher. Ceiling insulation levels can be easily improved by adding bulk insulation, while wall and floor insulation can be achieved via application of spray foam.

Modelling conducted by Energy Efficient Strategies for the Zero Carbon Australia Buildings Plan identified a total reduction of 21.4PJ in mains gas usage by insulating all Victorian homes to best practice. These gas savings are not additive against other space conditioning measures listed and in practice only a portion of all homes could be addressed by 2030.

Location	Insulation Type and R Value	Material cost ($/m^2)	Cost ($/household, including installation)
Ceiling	High-performance ceiling batts to R6.0	5 (for top-up from R2.5 to R6)	960 (for top-up from R2.5 to R6), 2,200 (for new R6)
Wall	Bonded-bead insulation to R2.5 (90mm cavity) or R1.5 (50mm cavity)	8	1,700
Floor	Closed-cell spray foam R2	20	3,900

Figure 14: Cost associated with Insulation materials

3.2 Commercial

Limited up-to-date information is available on the level of natural gas usage in the commercial services sectors and end uses. The most recent comprehensive investigations were the 2012 Department of Climate Change and Energy Efficiency (DCCEE) report 'Baseline Energy Consumption and Greenhouse Gas Emissions - In Commercial Buildings in Australia' and the Zero Carbon Australia Buildings Plan. More recently Strategy.Policy.Research was engaged by DEWLP as part of the Victorian Energy Efficiency Target Regulatory Impact Statement to investigate the potential for electrification in the commercial sector. Drawing on the 2012 DCCEE report and other reference material Strategy.Policy.Research modelled the current and forecast gas consumption in the commercial services sectors. The total gas consumption broadly accords with our estimates for small commercial and large commercial presented in Table 5 (noting that a portion of "Large Commercial" includes some manufacturing). In Northmore Gordon's experience natural gas usage in commercial services is primarily attributed to space heating except for retail where gas usage is predominantly for domestic hot water and cooking.

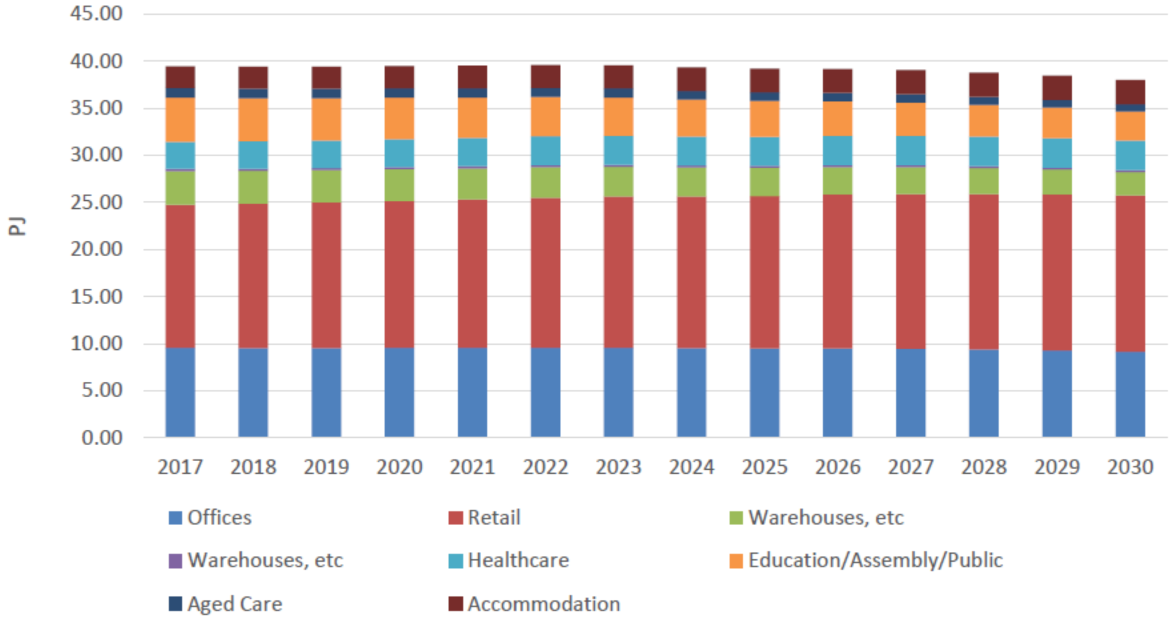


Figure 15 - Projected gas consumption in commercial services in Victoria (Strategy.Policy.Research, 2019)

3.2.1 Heat pumps and reverse cycle chillers

Space conditioning in larger commercial buildings is generally achieved via chilled and hot water coils in air handling units (or fan coil units) that deliver air at the required temperature to individual spaces. Hot water is typically supplied to these coils via boilers. In smaller commercial facilities and retail, space conditioning is generally delivered by packaged direct expansion units, which are effectively large reverse cycle air-conditioners.

As noted in the Zero Carbon Australia Buildings Plan "in Victoria, typically as much as half of a [commercial] building's total energy demand is for heating and domestic hot water requirements, as such replacing the gas boiler with a high-efficiency electric heat pump system could reduce total building energy by around 30%."

Conversion to heat pump can be achieved 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

In both cases typical CoPs of 4 can be expected to replace boilers of efficiency around 80%.

Strategy.Policy.Research investigated the potential for gas demand reduction from electrification assuming a level of support from the Victorian Energy Upgrades program delivering acceptable paybacks. This report found that for a "plausible scenario, for example, we could see annual gas savings reaching 14.5 PJ by 2030". This was from a combination of measures which included space heating, domestic hot water, cooking, and other gas appliances. The majority of the measures were space heating related and thus a conservative estimate of the potential gas demand reduction from boiler replacement with heat pump has been taken as half this figure – 7.75PJ.

3.3 Industrial

The recently released January 2020 ACCC Gas Inquiry Interim Report stated that “while C&I users continue to try to reduce their overall gas costs, most have told us they have largely exhausted all opportunities to reduce their gas use through energy efficiency improvements.” Northmore Gordon has extensive involvement with industrial gas users and this statement does not accord with our experience. Similarly, the 2018 International Energy Efficiency Scorecard published by the American Council for an Energy-Efficient Economy (ACEEE), indicated there is broad potential for improvement in industrial energy efficiency with Australia scoring 8 points below the international median score.

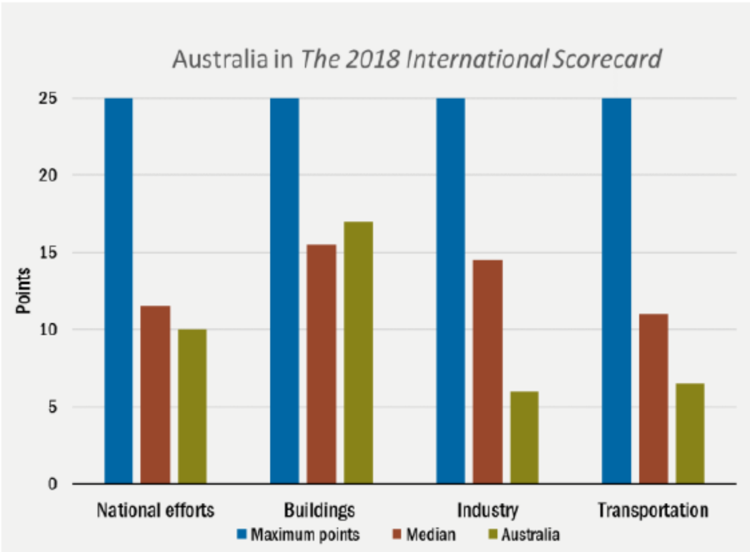


Figure 16 – Australia’s energy efficiency scorecard (ACEEE, 2018)

As noted previously out of ~214 PJ of natural gas used in Victoria 26% is consumed by the industrial sector. Key industries that consume relatively larger volumes of gas include food and beverage manufacturing, basic chemical manufacturing, primary metal manufacturing, and mining.

Process heating accounts for 51% of energy usage by the industrial sector in Australia and natural gas is the dominant fuel used. Process heating involves the application of heat in a manufacturing process for:

- Promoting a chemical reaction, such as in the production of cement
- Removing water, primarily in food and beverage applications
- Sterilisation and cleaning
- Melting and forming materials, such as in steel milling

Historically steam has been used for process heating, encouraged by low gas prices and the ease of transporting energy. Until recently, with the advent of high gas prices, there has been a lack of attention in industrial facilities on gas efficiency and optimisation of heat application. This results in steam being used for processes which don’t require high temperatures or do not need to be thermally driven. A lot of hot water at 90°C and lower is generated from heat exchangers off steam boilers, where the latent heat of vaporisation is effectively wasted.

Initiatives which optimize or replace natural gas usage in process heating activities have potential to bring about a significant reduction in natural gas usage by the industrial sector.

3.3.1 Gas efficiency measures

Significant wastage occurs in industrial process heating systems and relatively simple measures can be adopted to improve overall system efficiency. The following are examples of common efficiency measures that can be employed in industrial facilities.

3.3.1.1 Exhaust gas burner control

Low cost exhaust gas probes can be installed in the flue on boilers to measure combustion products in real time and vary the fuel air mixture in burners to achieve an optimum burn. On a typical gas boiler a $15,000 oxygen probe can deliver typical gas savings of 5%.

3.3.1.2 High efficiency burners

Older gas burners on boilers and air heaters typically had mechanical linkages between air and fuel inlets and limited turn down capacity. New burners are operated off servo motors and VSD driven fans which allow precise control of fuel air mixture, which when combined with exhaust gas probes can deliver significant improvements to overall efficiency. Retrofitting a new high efficiency burner on a 10 bar steam boiler could deliver savings of 5-10% at a cost of $50k.

3.3.1.3 Increase condensate return

Reticulated steam systems deliver their heat to a process by giving up latent heat of vaporisation and condensing to high pressure water. This “condensate” is sent back to the boiler feedwater tank, however the actual levels of condensate return vary significantly at facilities due to a range of reasons, such as:

- Failed steam traps
- Condensate pipe leaks and inadequate lagging
- Contamination in processes

Simple improvements can increase the level of condensate return leading to higher feedwater temperatures, reduced amounts of cold makeup water, reduced water treatment costs and reduced steam injection into hot water wells. A recent energy audit conducted by Northmore Gordon for a milk processing facility in Victoria identified energy and water savings amounting to $100,000 per annum from measures to increase condensate return from 76% to 90% for minimal capital cost.

3.3.1.4 Waste heat recovery

A number of processes and utilities at an industrial site generate unutilised waste heat. This includes heat recovered from:

- air-compressors (up to 70% of the energy consumed by air compressors can be recovered and transferred to generate hot water at a temperatures of 65°C)
- flue gases off boilers by using economiser heat exchangers to transfer sensible or latent heat to boiler feed water
- exhaust gases from combustion furnaces to preheat incoming air
- process integration, whereby hot and cold flows in a facility and their sources and sinks are optimised to minimise the requirements from external utilities (steam and refrigeration).

Significant amounts of economically recoverable waste heat are achievable in industrial facilities, however there have been limited incentives to investigate. Based on our experience savings of 5-10% have been achievable from waste heat recovery with short term economic paybacks

3.3.2 High temperature heat pumps

As discussed in earlier sections, heat pumps operate with a refrigerant fluid which undergoes phase changes between liquid and gaseous condition to allow heat to be removed from a source and delivered to a sink. This generally involves compression of a refrigerant via a compressor. The commercial availability of high temperature heat pumps (delivering 90°C and higher) is limited and higher temperatures are only achievable in combination with a waste heat resource that can be utilised from the site. At present, heat pumps in industrial settings are better suited to replacement of gas fired hot water boilers and hot water generated from steam boilers.

Recent energy audit and feasibility study work by Northmore Gordon has identified opportunities to replace gas boilers with heat pumps in industrial facilities. Three example cases are shown in Table 8.

The Electrification Opportunities in Victoria's Industrial Sector Report by Strategy.Policy.Research estimated 175 manufacturing businesses in the food and beverage, and textile and leather sectors with appreciable hot water usage. Assuming average gas savings between 5,000GJ and 20,000GJ, replacement of hot water boilers with heat pumps equates to savings of between 1PJ and 3.5PJ per annum.

Table 8 - Example case heat pump retrofit opportunities

Industry	Temperature		Heat pump refrigerant	Capacity	Gas savings	Capital cost
	Supply	Return				
Alcoholic beverage	50°C	40°C	Ammonia	500kW$_{th}$	4,550GJ	$500k
Abattoir	90°C	50°C	CO_2 or Ammonia	1.5MW$_{th}$	19,800GJ	$1M
Aquatic Centre	35°C	20°C	R410a	345kW$_{th}$	4,770GJ	$200k

3.3.3 Renewable process heating

3.3.3.1 Induction heating

Induction heating involves applying an oscillating electric current to a conductive metal, which induces a magnetic field generating heat in the product. Whilst induction heating is common outside of Australia and has benefits over gas combustion, historically low gas prices has led to a prevalence of gas heating in the metal manufacturing. Induction heating in steel manufacturing can have significant benefits, including eliminating scale formation from oxidation, reducing maintenance requirements associated with continuous operation of gas furnaces at high temperatures, and allowing improved batch processing. Northmore Gordon has conducted an assessment of the potential for electrification of gas fired equipment in a steel manufacturing business. This included replacement of ~1000°C reheat furnaces with induction technology, to displace ~450,000GJ of gas usage for a $20 Million investment. Whilst there is limited steel production in Victoria, there are several large secondary steel manufacturing and other non-ferrous metal manufacturing facilities in Victoria that could benefit from this technology.

3.3.3.2 Infrared heating

Another alternative to gas fired process heating is infrared heating, which involves the application of infrared electromagnetic waves generated by a radiative element. Infrared is an efficient way to heat flat thin materials, such as paper. 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. It was found that to produce one tonne of paper a conventional steam drying system required 4.5GJ of natural gas whereas the infrared system required only 811kWh of electricity (equivalent 2.9GJ).

3.3.3.3 Biomass boilers

Steam boilers are used in a wide range of industries across Australia and the majority of these boilers are fired with natural gas. Rising gas prices and the availability of low cost waste materials has led some manufacturing businesses to investigate replacing gas boilers with biomass boilers. Biomass boilers are already utilised in some industries in Australia and they are commonplace In Europe, which has not historically had a secure cheap supply of natural gas. Agricultural residues, such as straw and nut husks, and wood waste products (for example from plantation timber processing) can be readily combusted in a boiler to generate steam. The recent drought in Australia significantly diminished the availability of boiler feedstocks with appreciable nutrient content, as they were redirected to stock-feed. Biomass boilers generally make an economic return where a low price fuel can be obtained with a long term supply certainty, such as where biomass is produced as a waste product of a production process.

The 2019 ARENA Report ‘Renewable Energy Options for Industrial Process Heat’ assessed the potential for fossil fuel process heating to be converted to renewable energy via renewable powered electric, bioenergy, hydrogen, or on-site solar thermal. This evaluated the entire fossil process heat per sector and estimated the short to medium term (0 to 10 year) potential opportunity for conversion to renewable process heat as 185.3PJ nationally (out of a total fossil energy use of 628PJ). Removing Commercial Services (not industrial) and ‘short term’ opportunities in Food and Beverage (assumed to be accounted for in the previous analysis on hot water) from the estimates leads to potential fossil heat saving of 25%. Taking Victoria fossil heat demand as 80PJ and 65% of this as natural gas, leads to a total short to medium term potential of 13.6PJ.

4 Gas efficiency programs

Northmore Gordon has reviewed a number of existing and historic government support programs relating to gas usage and energy efficiency. The review investigated the efficacy of current programs in supporting households and businesses to improve energy efficiency and identifying potential pathways for supporting gas demand reduction measures.

The focus of this review was state based programs, however key current Commonwealth government programs were also included, such as the Australian Renewable Energy Agency Renewable Process Heat program.

The purpose of this review is to assess viable programs and mechanisms that policy makers can leverage to incentivise and support the measures identified in the previous section. A summary of the policy and program initiatives to help improve gas efficiency and reduce gas demand is in included in Section 5 High Level Policy Drivers.

4.1 Victorian Energy Upgrades

4.1.1 Victorian Energy Upgrades Overview

Victorian Energy Upgrades (VEU) is a program developed by the Department of Environment, Land, Water and Planning (DELWP) and administered by Essential Services Commission (ESC) in accordance with Victorian Energy Efficiency Target Act 2007 and regulations. The VEU program commenced on 1 January 2009 and is legislated to continue until 2029.

Large energy retailers are required to acquire and surrender Victorian Energy Efficiency Certificates (VEECs) to meet annual targets set in Victorian legislation. VEECs are created from calculated emissions abatement arising from approved energy saving activities. Their sale to liable entities creates a market which incentivises energy efficiency projects. Since the program started in 2009, about 9.7 million VEECs have been registered with 2 million of these relating to natural gas activities.

For the purpose of evaluating the impact of the VEU program on gas demand, we based our assessment on VEU activities not only resulting in reduced gas demand but also ones resulting in increased gas demand in both the residential and business sectors. A tabulated summary is shown at the end of this section - Table 11.

There are three main activity categories of interest for this study – 'Gas efficiency activities', 'Project-based activities' and 'Water heating, space heating and cooling activities'. An example of activities that reduce gas demand is Activity 37 'Replacement of a gas-fired steam boiler with a high efficiency gas-fired steam boiler'. 'Gas efficiency activities' are recently created for the business/industrial sectors and are yet to see much interest, having zero certificates created so far.

Activities in the water heating, and space heating and cooling categories are mainly focused on residential sector and have several existing gas fuel switching activities that result in increased gas demand. An example would be Activity 1A 'Gas/LPG storage replacing electric resistance water heater'. These activities continue to gain support from the scheme and are contributing to the overall increase in gas demand in Victoria.

Activities in the 'Project based activities' category use regression energy model or estimate of the mean under international recognised measurement and verification protocols to calculate energy savings and resulting emissions abatement. These projects typically reduce gas demand with gas efficiency measures or equipment upgrades in industrial sites. However, projects such as gas fired co-generation can still increase natural gas use for the purpose of generating electricity (if consumed on-site).

Table 9 presents analysis on the total number of certificates created since 2009 against each category, excluding lighting. Lighting activities consist of a total of 9 million certificates, representing 92.6% of the total amount of certificates created since 2009. The category of water heating, space heating and cooling activities contributed less than 5% of the total amount (4.06%).

Table 9 - All non-lighting VEECs created since 2009

Activity Categories	Number of VEECs (1 VEEC = 1 Tonne CO2 abated) registered all time since 2009
Water heating, space heating and cooling activities	396,692
Refrigerated display cabinet	177,659
Project-based activities	30,762
All other non-lighting activities	118,546

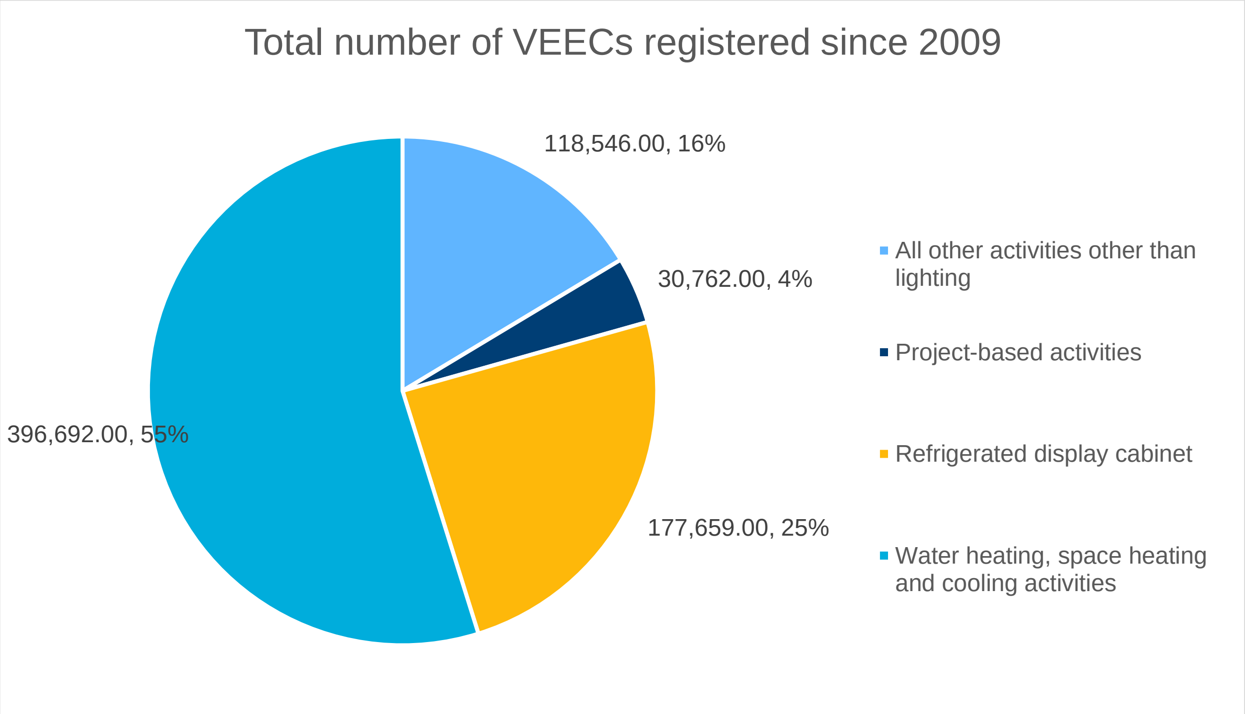


Figure 17 – All non-lighting activities registered since 2009

The quantity of carbon abatement (VEECs) delivered and number of projects implemented from gas related activities over the last three years are shown in Figure 18 and Figure 19. Though a reduction in both the number of VEECs and number of projects in the 2019 calendar year, it is likely that (at the time of conducting this analysis) not all 2019 vintage VEECs had been created. Overall, it is clear that activities that increase gas demand have been undertaken at a much larger scale than activities that reduce gas demand. The newly introduced gas efficiency activities could reverse this trend but they are yet to see much traction at this stage. Furthermore, the scheme has generally lacked support for fuel switching activities that are gas to electricity in residential/small business and industrial sectors.

Using data from the most recent 2019 calendar year, there were only 24 gas efficiency projects that reduce gas demand completed under the scheme, both residential and business combined, and contributed to 234 VEECs or an equivalent of only 234 tCO2e abatement over 10 years or less than 0.03% of carbon abatement under the scheme in 2019.

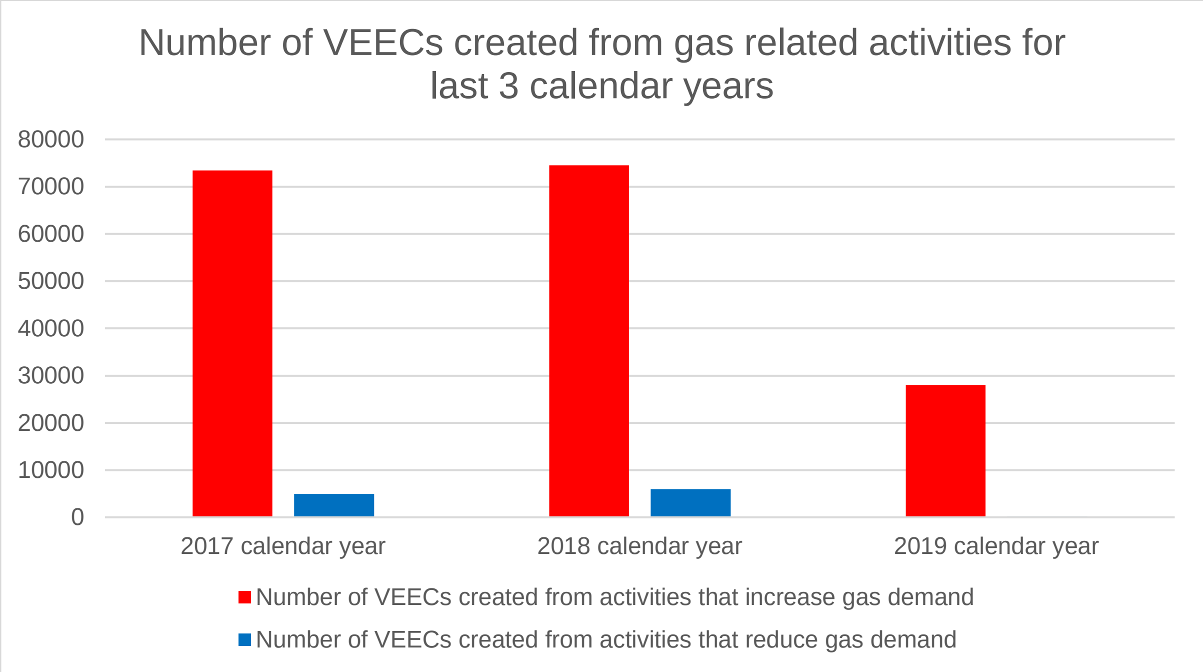


Figure 18 - Number of VEECs created from gas related activities

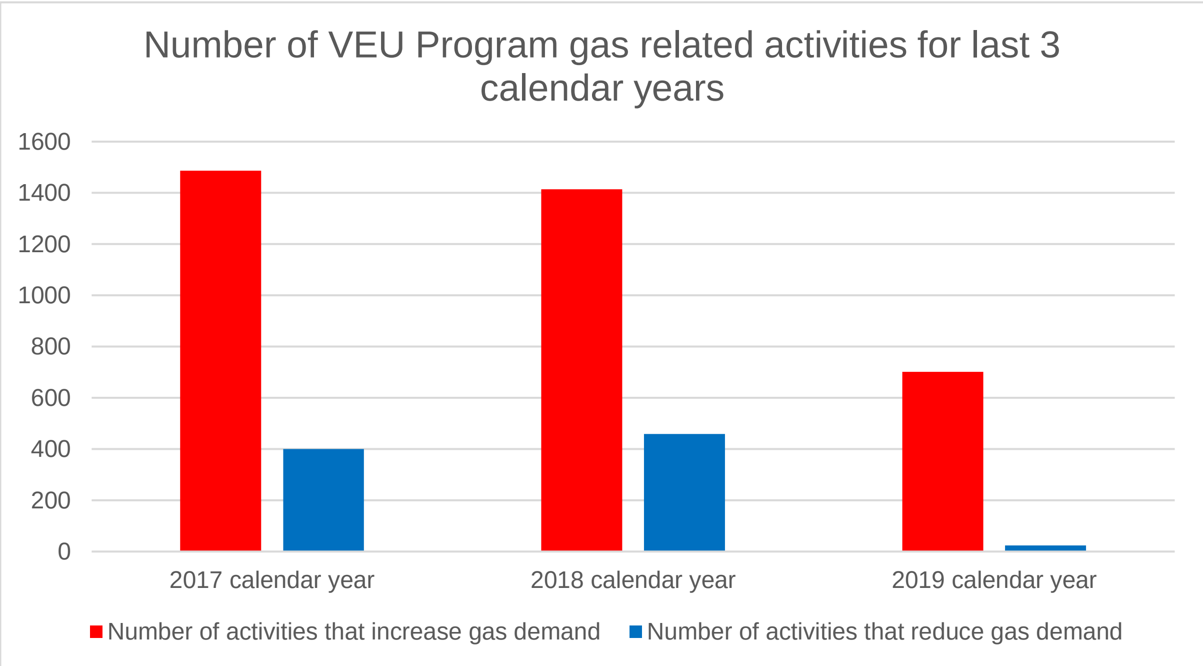


Figure 19 - Number of gas related activities created in the Victorian Energy Upgrades program

4.1.2 Regulatory Impact Statement December 2019

Since 2015 changes in the electricity sector from increased renewable energy uptake and the closure of aging coal fired power stations have significantly reduced emissions from electricity use. As part of its obligations for setting new certificate targets, DELWP released a Regulatory Impact Statement (RIS) in December 2019 which proposes a rapid fall in the electricity emission factor (see Table 10 below for details). It also proposed to set targets of 6.5 million certificates for 2021 and a gradual increase of the set target on a yearly basis to 7.3 million certificates for 2025.

The RIS states that the proposed targets will drive the VEU program to continue to achieve increasing levels of emissions reduction, providing continuity with the targets established to date and consistency with Victoria's trajectory to achieve net-zero by 2050. The RIS is currently under consultation.

Over the past ten years lighting activities have dominated the VEU program and created over 92.5% of all certificates under the scheme. As energy efficient LED lighting has become cost effective without government subsidy, the compliance hurdle has been increased and the number of certificates eligible to be created have heavily discounted. To meet the projected certificate targets to 2025 will require a significant increase in creation from non-lighting activities. Similarly, the proposed reduction in electricity emissions factors will require activities that involve gas efficiency and fuel switching from gas to electricity to do the heavy lifting. However the RIS has not proposed any new activities to facilitate this re-shuffle of the VEU program, nor illustrated the contradiction of previously encouraging uptake of gas equipment.

Moving forward the VEU program has a significant role to play in encouraging gas demand side reduction measures, via deemed gas efficiency or electrification activities and measurement and verification approaches.

Table 10 - Source: Regulatory Impact Statement Victorian Energy Efficiency Target Amendment (Prescribed Customers and Targets) Regulations 2020

The proposed average ten-year emissions factors for electricity from 2021 to 2025 will be:[1]

Current	2021*	2022	2023	2024	2025
1.095	0.8055	0.516	0.473	0.433	0.393

Table 11 - Summary of all existing and historic gas related activities under VEU program

Activity Category	Activity Description	Status	Result	Residential/Business
Gas Efficiency Activities	Activity 37 Replacement of a gas-fired steam boiler with a high efficiency gas-fired steam boiler	Existing	Reduce gas demand	Business
	Activity 38 Replacement of a gas-fired water boiler or water heater	Existing	Reduce gas demand	Business
	Activity 39 Installation of an electronic gas/air ratio control	Existing	Reduce gas demand	Business
	Activity 40 Installation of a combustion trim system	Existing	Reduce gas demand	Business
	Activity 41 Replacement of a gas-fired burner	Existing	Reduce gas demand	Business
	Activity 42 Installation of an economizer	Existing	Reduce gas demand	Business
Project-based activities	PBA measurement and verification	Existing	Reduce or increase gas demand	Business
	PBA Benchmark Rating Method	Existing	Reduce electricity and gas demand	Business
Water heating, and space heating and cooling activities	Activity 1A – Water heating – Gas/LPG storage replacing electric resistance	Existing	Increase gas demand	Residential/Business
	Activity 1B – Water heating – Gas/LPG instantaneous replacing electric resistance	Existing	Increase gas demand	Residential/Business
	Activity 1F – Water Heating – Gas/LPG boosted solar replacing electric resistance	Existing	Increase gas demand	Residential/Business
	Activity 3A – Water heating – Solar replacing gas/LPG (revoked 30/6/14)	Historic	Reduce gas demand	Residential/Business
	Activity 3B – Water heating – Gas/LPG boosted solar replacing gas/LPG	Existing	Reduce gas demand	Residential/Business
	Activity 5 – Space heating – Ducted gas replacing ducted gas (revoked 9/12/18)	Historic	Reduce gas demand	Residential/Business
	Activity 5 - Space heating - Ducted gas heater	Existing	Reduce or increase gas demand	Residential/Business
	Activity 6 - Space heating - Ducted gas replacing central electric resistance heater (revoked 9/12/18)	Historic	Increase gas demand	Residential/Business
	Activity 9 - Space heating - Gas/LPG space heater (revoked 9/12/18)	Historic	Reduce or increase gas demand	Residential/Business
	Activity 9 - Space heating - Gas/LPG room heater	Existing	Reduce or increase gas demand	Residential/Business
	Activity 20 - High efficiency ducted gas heater (revoked 9/12/18)	Historic	Increase gas demand	Residential/Business
	Activity 28 - Gas heating ductwork	Existing	Reduce gas demand	Residential/Business

4.2 NSW Energy Saving Scheme

The NSW Energy Savings Scheme (ESS) is a program that provides financial incentives in the form of Energy Savings Certificates (ESCs) to NSW businesses and households to install energy efficient equipment and appliances. Like the VEU program, the ESS was established in 2009, under the NSW Electricity Supply Act 1995 and has been running successfully since then. The ESS scheme requires businesses to apply for accreditation to be able to participate in the scheme as Accredited Certificate Provider (ACP). The ESS has a total of 43 project types under 11 calculation methods (or calculation categories). For simplicity, we have summarised these methods into 5 main categories – Installation of High Efficiency Appliances for Businesses (IHEAB); Lighting; Metered Baseline Methods (MBM); Project Impact Assessment with Measurement and Verification (PIAM&V) or Project Impact Assessment Method (PIAM); and Sale of New Appliances (SONA)[10]. Among these categories, PIAM is the only one that is retired as it has been superseded by PIAM&V, a more rigorous measurement and verification project-based method.

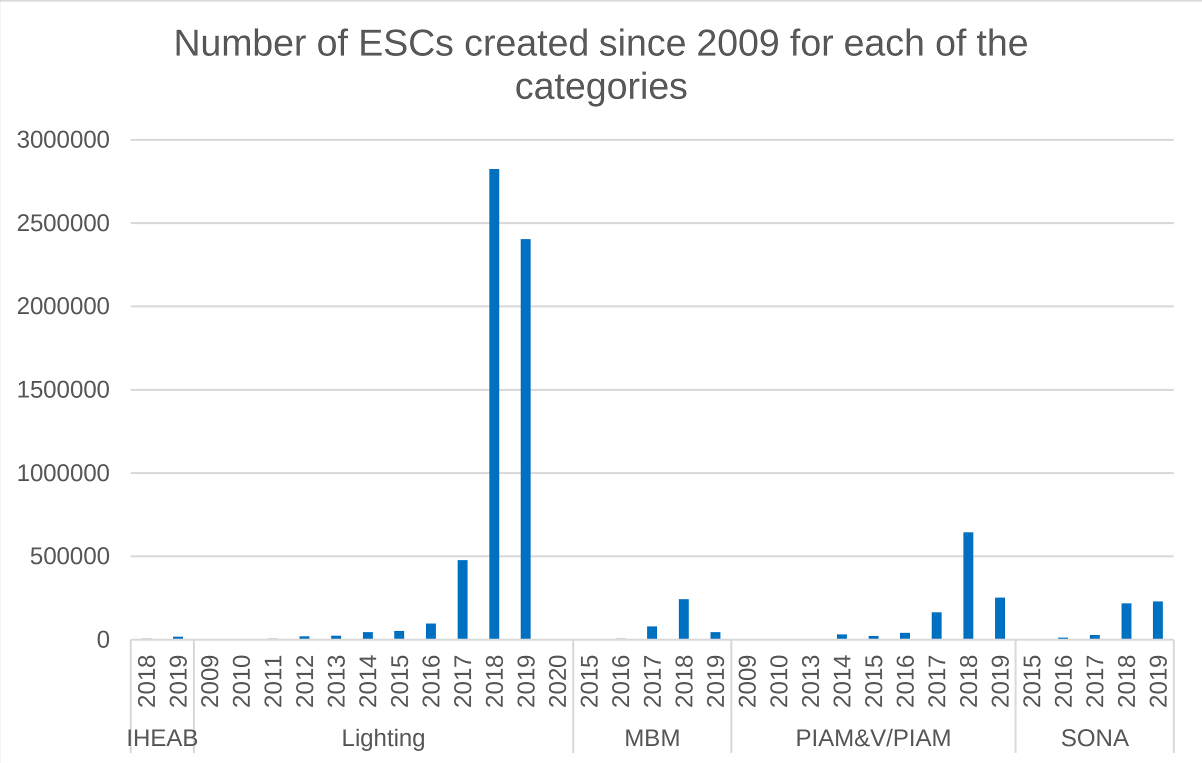


Figure 20 - ESCs created since 2009 for each main category

As we can be seen in Figure 20, almost all the categories have seen a strong rise in the number of ESCs created between 2017 and 2019 calendar year with 2018 being the peak. Lighting activities are the main contributor, amounting to 74.4% of the total. Please note 2019 vintage ESCs can still be created up until June 2020 which explains the apparent decline in certificate creation numbers in 2019.

Excluding lighting activities we can see from the pie chart below that project-based activities including PIAM&V, PIAM and MBM contribute to about 75% of the remaining certificate creations. These methods are generally used for larger energy projects undertaken by industrial and commercial energy users.

[10] Sale of New Appliances (SONA) grants certificates to retailers when selling a more energy efficient appliance compared to benchmark. It encourages retailers to put energy efficient appliances on promotions and has a positive impact on increased sale of appliances more better energy efficiency rating.

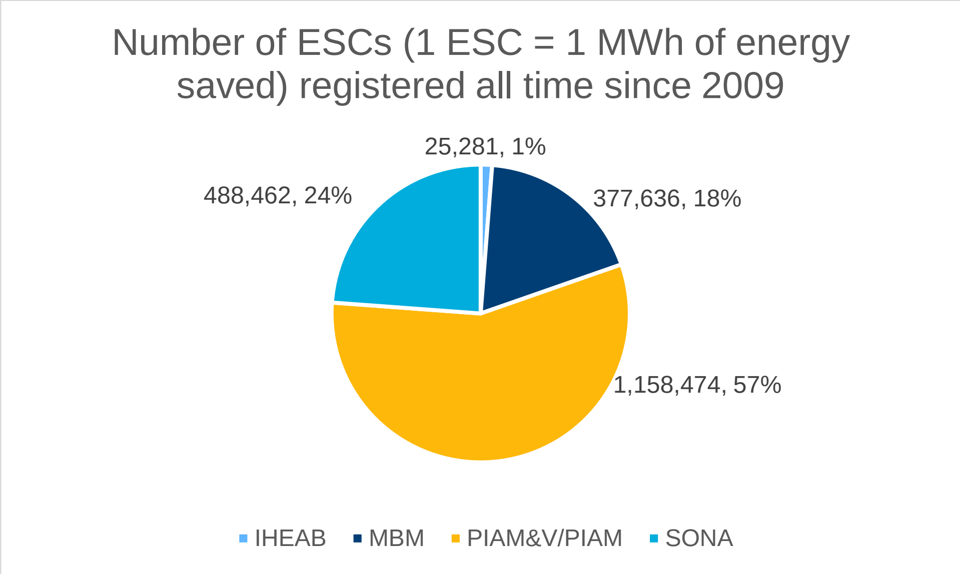


Figure 21 - Total number of ESCs registered since 2009

4.3 Victorian EPA Environment and Resource Efficiency Plans (EREP)

The EREP program was targeted at working with large users of electricity, gas and water to identify and implement efficiency measures. Over 260 facilities participated in the scheme. The EREP program made it mandatory for these businesses to implement any energy or water saving solutions that had payback periods of under three years.

The EPA's interim assessment of the program (prior to its early sunsetting due to duplication with a now-defunct federal scheme) found that the program expected to achieve savings to businesses of around $90m each year; possibly as high as $145m each year if all efficiency measures were put in place.

Most of the yearly savings ($71m) were in the manufacturing sector. Within this $71m, the food product manufacturing sector in Victoria saved $21m.

Interestingly, the EPA's assessment of the program found that even where measures were cost-effective for businesses, these were often not implemented in the absence of a program like EREP and needed EPA staff providing guidance.

4.4 Sustainability Victoria

Sustainability Victoria (SV) was established under the Sustainability Victoria Act 2005 with the statutory objective to facilitate and promote environmental sustainability. SV administers grants and funding programs to reach its statutory objective. There are no current grant programs open that directly promotes activities for gas demand reduction.

4.4.1 Gas Efficiency Grants

The Gas Efficiency Grants 2017-19 provided matched funding to 52 businesses in between 2017 and 2019 and promoted gas efficiency projects that resulted in abatement of 9,820 tCO2e p.a. or an equivalent of 117.8 TJ p.a.

The 52 businesses received matched funding between \$10,000 to up to \$50,000 and a range of gas efficiency projects were implemented. The portfolio of projects, included lagging of pipework, heat recovery systems, gas metering, and boiler upgrades.

Evaluation of the scheme demonstrated a significant reduction in gas consumption at facilities receiving grants and supported gas efficiency projects that would otherwise not have gone ahead. For example a food manufacturing site installed a heat recovery system to reuse waste heat from a refrigeration system to pre-heat boiler feedwater. This resulted in a reduction in gas consumption of between 15-20%.

The infographic in Figure 22 is a summary of the outcomes from the Gas Efficiency Grants 2017-19, published by Sustainability Victoria. The funding program resulted in an average dollar saving of \$52,770 to each participating business, aggregating to a total of over \$2.59 million or an equivalent of 9820 tCO2e abatement p.a. Furthermore, this program provided funding to a combination of businesses from various industries and in both metropolitan and regional Victoria.

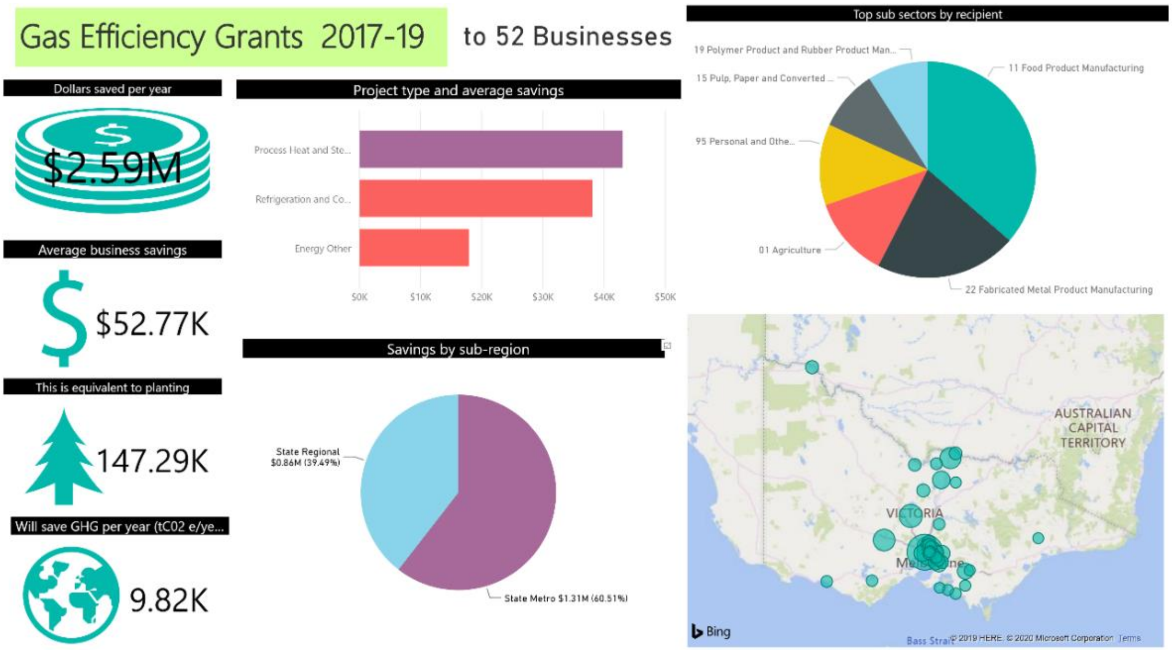


Figure 22 - High level metrics from the SV Gas Efficiency Program (Sustainability Victoria website)

4.5 NSW Energy Saver Program

Since 2009 the NSW Office of Environment and Heritage (OEH) (now Department of Industry, Planning, and Environment) has operated a highly effective Energy Saver Program supporting businesses to improve energy productivity. This program was updated following the release of the 2017 NSW Energy Efficiency Action Plan, which was a four year strategic plan to strengthen the energy efficiency market, accelerate the uptake of energy efficiency projects in targeted sectors, and educated businesses in best practice energy management. Implementation of the Action Plan was overseen by the Energy Efficient Business team within OEH and utilised a pre-qualified panel of expert consultants and service providers. Northmore Gordon has been an active member of this panel since 2009.

Nationwide the Energy Saver Program is a unique offering because it established long term relationships with large energy users, especially manufacturing, and allocated to them personnel and resources to reduce energy consumption. Between 2013 and 2017 it did this via:

- Part funded comprehensive energy audits to the Australian Standard AS3598. These extended beyond a typical audit by including the preparation of a number of dedicated business cases from identified energy saving opportunities.

- Various training programs delivered by the panel of service providers on a range of topics as well as post training support. Post training support offered one on one coaching to implement measures
- Commissioning technology guides that were subsequently published online. This included the Gas Measurement and Monitoring Guide, Industrial Refrigeration Guide, Lighting Efficiency Guide

The Energy Efficient Business team continues to operate today with a number of newly released programs including a program to support large industrial energy users to establish energy management systems, and ongoing coaching support to small and medium businesses. The Energy Management System Support program was established in recognition that a number of businesses had already received energy audits and now need to adopt a systematic approach to energy management. This program is aiming to support 110 businesses in the energy intensive target sectors of agriculture; mining; and metal, non-metallic mineral, chemical, and food and beverage manufacturing.

4.5.1 NSW Gas Efficiency Improvement Program

As part of the NSW Energy Efficiency Action Plan (EEAP) which was first published by OEH in 2013, the NSW Government committed to exploring incentives for gas efficiency activities. As a result, the Gas Efficiency Improvement Program (GEIP) was launched in 2015 to provide funding to help businesses identify and implement projects to improve their gas efficiency onsite, reducing gas demand and costs.

There were three rounds of funding. The first two rounds of funding provided up to $40,000 per site of matched funding to participating businesses with a combination of assessments including up to $15,000 for installing metering and monitoring and up to $25,000 for implementing gas efficiency projects. While the third round of funding, provided at the end of calendar year 2016, offered up to $10,000 of matched funding for smaller repair/maintenance projects.

According to Gas Efficiency Improvement Program Evaluation final report, which was prepared by Clear Horizon for OEH, the GEIP funded a total of 51 businesses and implemented 66 gas efficiency and maintenance projects. The program helped most participating businesses achieve observable gas savings, with an estimated total of 300,000GJ of gas p.a. with 123,000GJ of savings already realised, which vastly exceeded the program objective of 100,000GJ gas savings p.a.

The GEIP ran until 2017. Data from measurement and verification of the gas efficiency projects funded by the program later contributed to the development of new IHEAB methods under ESS.

4.5.2 NSW Manufacturing Efficiency Funding

The NSW government is offering over $16 million in funding to support projects in NSW that help manufacturing businesses save energy and cost. The eligible project portfolio covers a wide range of energy efficiency upgrades and equipment replacement or retrofit.

This program is ongoing.

4.6 Australian Renewable Energy Agency (ARENA)

ARENA was established by the Australian Government on 1 July 2012 to improve the competitiveness of renewable energy technologies and increase the supply of renewable energy in Australia.

Up until now, ARENA has invested $1.46B into 486 projects. The projects portfolio covers solar PV, grid integration, solar thermal, hybrid, bioenergy, storage batteries, ocean energy, geothermal, hydrogen and more.

In September 2019, ARENA announced $460,500 in funding to the Australian Alliance for Energy Productivity (A2EP) to investigate opportunities for using renewables in process heating in manufacturing. This provides fully funded pre-feasibility studies and partly funded full-feasibility studies into displacing fossil fuel heat with renewably powered alternatives. This funding is ongoing and already receiving many Expression of Interest (EOI), the number of EOIs has been reported to be more than what can be allocated. This already shows the success of the fund. One example of completed pre-feasibility study indicates the potential to replace a large natural gas fired industrial boiler with biomass boiler using renewable biomass fuel that supplies the same steam output. This has the potential to not only reduce gas consumption onsite but also disconnects gas and removes gas MIRN meter entirely.

4.7 National Construction Code Energy Efficiency Provisions

The National Construction Code (NCC) consolidated building and plumbing regulations and was first published in 2011. The latest amendment occurred in 2019. NCC 2019 consists of three volumes, with Volume 1 applying to Class 2-9 (multi-residential, commercial, industrial and public buildings); Volume 2 for Class 1 and 10 (residential and non-habitable buildings) and Volume 3 for plumbing and drainage for all building classes. Section J under Volume 1 sets specific energy efficiency requirements in areas of building fabric, glazing, building sealing, air conditioning and ventilation system, artificial lighting, heated water supply and facilities for energy monitoring.

To comply, Building Certifiers and Certifying Authorities require Energy Efficiency Performance Assessment Reports to be prepared, assessing the building against the Deemed-to-Satisfy Provisions or using energy modelling at the Construction Certificate stage. The National Construction Code Section J sets a minimum standard on both electricity and gas efficiency for Class 2-9 buildings. Part 3.12 Energy Efficiency under Volume 2 sets specific requirements for Class 1 and 10 buildings in areas such as building sealing, heating and cooling ductwork, central heating water piping, artificial lighting and water heater. This section as implemented by the Victorian government mandates a minimum 6-star energy rating as scored under the Nationwide House Energy Rating Scheme (NatHERS). It also requires new homes to have either a solar hot water system or a rainwater tank, however heat pumps are not eligible as solar hot water. As such new homes generally include gas boosted solar. This is a good example of legislation falling behind the pace of fast evolving technology. Hot water heat pump for residential houses are already a proven technology over the last few years and should be considered as an equally energy efficiency hot water system compared to solar hot water.

5 High level policy drivers to reduce gas demand

Drawing on the analysis conducted into gas demand reduction measures and the high level review of gas efficiency programs, we have prepared a recommended set of policy drivers that government and other decision makers could implement as an approach to managing the forecast gas shortfall that does not rely on increasing gas supplies and aims to reduce greenhouse gas emissions.

Northmore Gordon and its partner business Wattly are members of a number of industry associations including the Energy Efficiency Council, Australian Alliance for Energy Productivity and the Energy Savings Industry Association. We consulted representatives of these organisations as well as the sustainable energy community and advocacy organisation Renew as part of this study, to inform potential suitable policy drivers.

These policy drivers are summarised below. Note that forecast gas savings arising from these measures are not mutually inclusive and the measures proposed should be assessed independently.

Policy driver	Rationale	Measure supported	2030 gas Reduction
Amend VEU Schedule 1 activities to remove support for fuel switching from electric to gas and introduce new activities incentivising electric heat pump replacement of gas hot water systems.	Removes incentive for households to install gas hot water systems, focussing incentives to heat pump hot water systems. Introduces a new activity acknowledging the superior emissions performance of electric heat pump (with reduced electricity emissions factors)	Residential heat pump hot water systems	10 PJ
Remove VEU Schedules 5 and 9 incentivising new ducted and non-ducted gas space heaters in households	Removes incentive for new gas space heating in Victorian households in recognition of general consensus that all electric homes have superior economic and environmental performance.	Residential reverse cycle air-conditioners	3 PJ[11]
Introduce new VEU Schedules for replacement of gas ducted heating systems with reverse cycle air-conditioners	Replacement of aging ducted gas space heaters is the single most effective measure for reducing the forecast gas shortfall. A new schedule will provide a strong market signal to encourage a rapid changeover in technology.	Replacement of ducted gas space heating	48 PJ

[11] Estimated as half the GSOO forecast growth in Victorian residential gas demand between 2019 and 2030

Policy driver	Rationale	Measure supported	2030 gas Reduction
Amend the Victorian Building Authority Minimum 6 star energy provisions to include heat pumps	New homes are required to have either a solar hot water system or rainwater tank, however heat pump systems are not eligible. The VBA provisions create a barrier to new homes being all electric, by generally incentivising gas boosted solar hot water systems	Residential heat pump hot water systems	3 PJ[12]
Improve market information available to consumers about the costs and savings associated with electric versus gas equipment and services.	Typically, household appliances are only replaced when they fail and there's limited time to choose alternative systems. Improving the availability of independent market information on the economic and environmental performance of efficient electric appliances, will help consumers make informed choices.	Household and small commercial adoption of efficient electric building services Encourage households with pre-existing air-conditioners to use them preferentially for space heating	5 to 15 PJ[13]
Establish a Sustainability Victoria led training program, coupled with VEU support, to engage and educate relevant trades, developers, and building owners on all-electric homes	Research has demonstrated that it's economically and technically feasible to eliminate household gas usage. All-electric homes take advantage of increasing penetrations of grid renewables and rooftop solar and frees up natural gas supply for industrial sectors that can't easily transition away from gas. Similarly, a number of small to medium commercial buildings could readily transition away from gas usage	Household and small commercial adoption of efficient electric building services	Up to 27 PJ[14] (and potentially much greater)
Introduce a new VEU deemed activity for replacement of gas boilers in commercial buildings	A simplified activity generating VEECs for replacement of gas boilers in commercial buildings would provide upfront incentives to heat pump retailers and consumers to reduce the cost of replacing gas boilers.	Commercial building heat pump space heating	7.75 PJ
Establish a new energy efficient business program within the Victorian Department of Environment Water Land and Planning	Historically programs supporting manufacturing growth and competitiveness have been driven out of the currently named Department of Jobs Precincts and Regions,	Industrial gas efficiency and electrification	Up to 22.6 PJ

[12] Calculated from the remaining GSOO modelled forecast growth in Victorian residential gas demand between 2019 and 2030
[13] Conservatively taken as the range of savings from households which could use an existing reverse cycle air-conditioner for space heating
[14] Estimated from the range of savings possible in commercial building electrification, plus savings from residential cooktops, and remaining gas hot water

Policy driver	Rationale	Measure supported	2030 gas Reduction
(DEWLP) or the Department of Jobs Precincts and Regions (DJPR). Program to be allocated long term funding in upcoming state budget.	whereas energy programs have been driven out of DEWLP. Energy programs run out of Sustainability Victoria have traditionally only targeted small to medium enterprises (SMEs). This has created a disconnect in government support and large industrial facilities have tended to be engaged in a piecemeal fashion. A new energy efficient business program that targets industrial energy users with a long term remit can support industry to adopt best practice.		
Provide backing and joint funding to ARENA renewable process heat feasibility studies and capital funding	The adoption of electrification practices in industry requires a significant retooling of industrial processes, and while many of the technologies are commercially available few companies are willing to adopt transformative practices with sufficient proof of successful outcomes. The ARENA funded, A2EP led, feasibility study work into renewable process heating provides important funding to assess commercial and technical viability and potential capex support will reduce the risk of novel projects.	Adoption of renewable and electric industrial process heat	13.6 PJ

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6 Conclusions

To assess the ability of the proposed measures and policy drivers to eliminate the forecast shortfall, a simplified time series analysis was conducted. The proposed measures and policy drivers, and their associated anticipated gas demand reduction potential, have been chosen for their short to medium term (0 to 10 year) efficacy. In otherwords, with targeted support, the proposed gas demand reduction can be achieved by 2030. Assuming a linear adoption of proposed measures (taken from Table 6 not the table of policy drivers in Section 5) and mapping this gas demand reduction for each of the sectors (residential, commercial, and industrial) against the forecast supply adequacy presented in Figure 8, delivers the outcome shown in Figure 23.

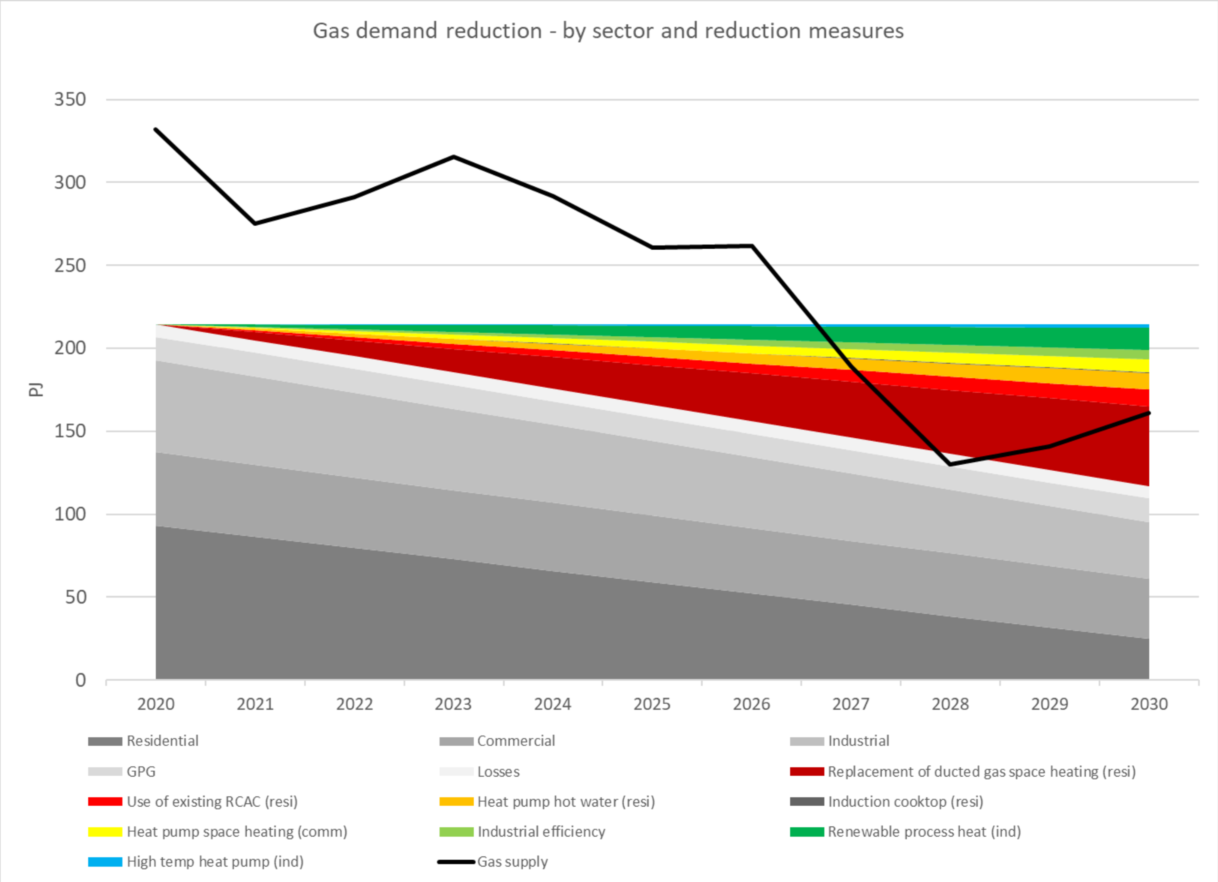

Figure 23 - Modelled gas demand reduction from proposed measures

This figure shows the actual gas demand in grey, diminishing over time by application of the proposed gas demand reduction measures in colour, against the forecast gas supply from existing, committed, and anticipated gas projects. This demonstrates that the adoption of gas demand reduction measures, such as energy efficiency and fuel switching entirely eliminates the forecast shortfall, with the exception of 2028 which has a minor 6.5PJ modelled shortfall. Furthermore, the analysis presented is conservative, because:

- It does not include any potential gas supply that could be provided by northern states via the SWQP pipeline
- Modelled savings are generally taken as the mid-point of values presented in Table 6 and does not include any gas savings from improved insulation to avoid double counting.
- Our review of gas demand reduction measures is by no means exhaustive, and additional short to medium term gas demand reduction was identified but not modelled in the analysis. An

example of this is commercial buildings, with significant potential gas reduction beyond the modelled 7.75PJ.

This study has assessed the potential 10-year Victorian gas supply shortfall, evaluated viable gas demand reduction measures, and reviewed effective policy drivers to support their implementation. A summary of recommended policy drivers to facilitate and incentivise demand side measures to eliminate the forecast shortfall is presented in Section 4. The analysis conducted in this study supports the following conclusions:

1. Victorian gas production is slated to decline in the near future, however considerable gas reserves in northern Australia provide a supply buffer.
2. AEMO modelled growth in gas demand, is almost entirely driven by new residential gas connections and forecast reliance on Gas Power Generation post exit of coal generators. Both areas of growth seem contrary to trends in government policy and the energy market.
3. Whilst shortfalls in gas supply of between 26 and 85 PJ are observable, our modelling indicates this is not experienced until 2027 and there is sufficient time for policy makers and the energy market to respond.
4. Despite not receiving attention in the public debate on the forecast gas shortfall, demand side measures can eliminate this shortfall.
5. A range of gas demand measures were identified that have wide applicability and are economically viable with targeted support. These measures will also support households, business, and industry to transition to a low carbon economy and access lower cost energy.
6. A more detailed analysis is required to confirm peak day supply adequacy, however the residential demand side measures explored lead to a 73.4% reduction in annual residential gas demand. This will have a significant impact on winter peak demand, which is almost entirely driven by residential consumption.

Importantly these conclusions draw into question the merit of any new Victorian gas supply projects and LNG import terminals. Similarly public planning in the gas market and activities of regulated bodies urgently need to include consideration of demand side measures, rather than focussing entirely on supply adequacy.

A number of key policy drivers were identified in the study, and warrant attention by key policy makers:

- Amendment of Victorian Energy Upgrades (VEU) activities to remove support for fuel switching from electric to gas
- Introduction of new VEU activities to incentivise replacement of gas hot water systems and gas space heating systems with electric heat pump and reverse cycle air-conditioners.
- Amend the Victorian Building Authority Minimum 6 star energy provisions to include heat pumps as acceptable solar hot water systems
- Establishment of a Sustainability Victoria led training program, coupled with VEU support, to engage and educate relevant trades, developers, and building owners on all-electric homes
- Establishment of a new energy efficient business program, similar to the NSW Business Energy Saver Program within the Victorian Department of Environment Water Land and Planning (DEWLP) or the Department of Jobs Precincts and Regions (DJPR).
- Provide Victorian government backing and joint funding to the ARENA renewable process heat program.

These policy changes are particularly timely in the light of proposed changes to significantly reduce the electricity emissions factor in the VEU program and the need to continue supporting industry transformation in a low carbon economy future.

7 Further reading and references

AEMO, Gas Statement of Opportunities, 2019

AEMO, Gas Demand Forecasting Methodology Information Paper Supplement to GSOO, 2019

AEMO, National Electricity and Gas Forecasting portal, http://forecasting.aemo.com.au/Gas/AnnualConsumption/Total,

AEMO, Victorian Gas Planning Report, 2019

AEMC, Gas Market Scoping Study, 2013

AEMO, Guide To Victoria's Declared Wholesale Gas Market, 2013

ACEEE, The 2018 International Energy Efficiency Scorecard, 2018

Department of Industry Innovation and Science, Offshore South East Australia Future Gas Supply Study, 2018

ACCC, Gas Inquiry 2017 to 2025 Interim Report, December 2018

MEI, Switching off gas - An examination of declining gas demand in Eastern Australia, 2015

EnergyConsult, Residential Energy Baseline Study: Australia, 2015

Renew, Household fuel choice in the National Energy Market, 2018

Beyond Zero Emissions, Zero Carbon Australia Buildings Plan, 2013

Beyond Zero Emissions, Electrifying Industry Report, 2018

DEWLP, Regulatory Impact Statement Victorian Energy Efficiency Target Amendment (Prescribed Customers and Targets), 2019

Strategy.Policy.Research, Appendix 7 RIS – Electrification Opportunities in Victoria's Commercial Sector, 2019

Strategy.Policy.Research, Appendix87 RIS – Electrification Opportunities in Victoria's Industrial Sector, 2019

ARENA, Renewable Energy Options for Industrial Process Heat, 2019

A2EP, Replacing steam with electricity technologies to boost energy productivity, 2018

Appendix – Gas market explainer

Generally, in Australia, gas is supplied from a producer to a user under long term gas supply agreements, with transportation of gas facilitated by pipeline operators that buyers must enter into contract with to access pipelines. These contracts are either of the ‘contract carriage” type or ‘market carriage’ type, defined by:

- **Contract carriage** – bilateral agreements between buyer and pipeline owner which allocates (generally firm) network capacity, with flows managed by pipeline owner. Reserved capacity is known as Maximum Daily Quantity (MDQ).
- **Market carriage** – flows and network capacity are allocated on a dynamic basis in response to supply and demand variation, via a public gas market. Participants in this market have transportation rights but cannot reserve firm capacity.

Given the contracted nature of gas supply agreements, not all pipelines are regulated under the National Gas Law. The extent to which a pipeline is ‘covered’ by regulation is implemented on a jurisdictional basis and accepted by the relevant minister. A covered pipeline can be fully regulated or subject to ‘light’ regulation. A register of all Gas Pipelines and their regulatory coverage is maintained by the Australian Energy Market Commission (AEMC)[15]. A pipeline subject to full regulation must submit an ‘access arrangement’ to the Australian Energy Regulator (AER) and obtain its approval to the terms and conditions that set out how users can access the pipeline. A pipeline operator subject to ‘light’ regulation does not need to submit a full access arrangement and can meet its obligations by publishing the terms and conditions of access on its website. The AER has power to regulate the revenues of fully regulated pipeline operators and set the maximum revenue they can earn from the assets.

While trade of gas is dominated by bilateral contracts the National Gas Laws has established a set of wholesale markets, either **gross pool markets** - through which all injections and withdrawals must be traded, or **net pool markets** - through which surplus or uncontracted capacity is traded. These gas markets are operated by the Australian Energy Market Operator (AEMO). Figure 24 provides an overview of the key distinguishing features of wholesale gas markets in Australia.

[15] https://www.aemc.gov.au/energy-system/gas/gas-pipeline-register

Network Access	**Market carriage** • Network capacity is allocated dynamically through the energy **market** (hence "market" carriage). • Limited or no firm rights to access capacity.	**Contract carriage** • Network capacity allocated on the basis of bilateral **contracts** between the network owner and the network user. • Capacity can be allocated over the long term on a firm basis, to the exclusion of other participants. • Capacity can be reallocated between network users on a secondary capacity market.
Energy trading Arrangements	**Gross pool** • All commodity that is dispatched/scheduled is traded through the market.	**Net pool** • Voluntary participation • Market participants may trade bilaterally "off market" • Market participants may choose not to trade at all – meeting their own energy requirements.

Figure 24 - Types of wholesale gas market arrangements (AEMC, 2020)

Due to the complexity of the Victorian gas market, transmission pipeline network and historical arrangements, Victorian gas pipelines and infrastructure are covered pipelines under the National Gas Law and subject to full regulation. The Victorian transmission network is called the Victorian Declared Transmission System (DTS) and is owned and maintained by the Australian Pipeline Association (APA), regulated by the AER, and operated by AEMO. The DTS is subject to Market Carriage for access arrangements.

Similarly, the Victorian gas market is a "gross pool market", meaning that all production and consumption is registered in a public market, operated by AEMO. This market is known as the Victorian Declared Wholesale Gas Market (DWGM). Victoria is unique in that it is the only jurisdiction in Australia with a gas market operated on a market carriage basis and whose major gas pipelines are fully regulated. This provides:

- Transparency of gas flows
- A competitive market framework to settle gas prices
- Obligations on AEMO to model and manage gas supply and demand
- Open access arrangements to pipeline users

However, the complexity of the Victorian gas infrastructure and market introduces challenges, namely:

- The DTS is a complex network with 7 injection points and over 120 withdrawal points
- The DTS has limited storage relative to the seasonal variations in supply and demand
- Victorian residential gas demand is the largest contributor to overall demand and is significantly affected by seasonal weather conditions.

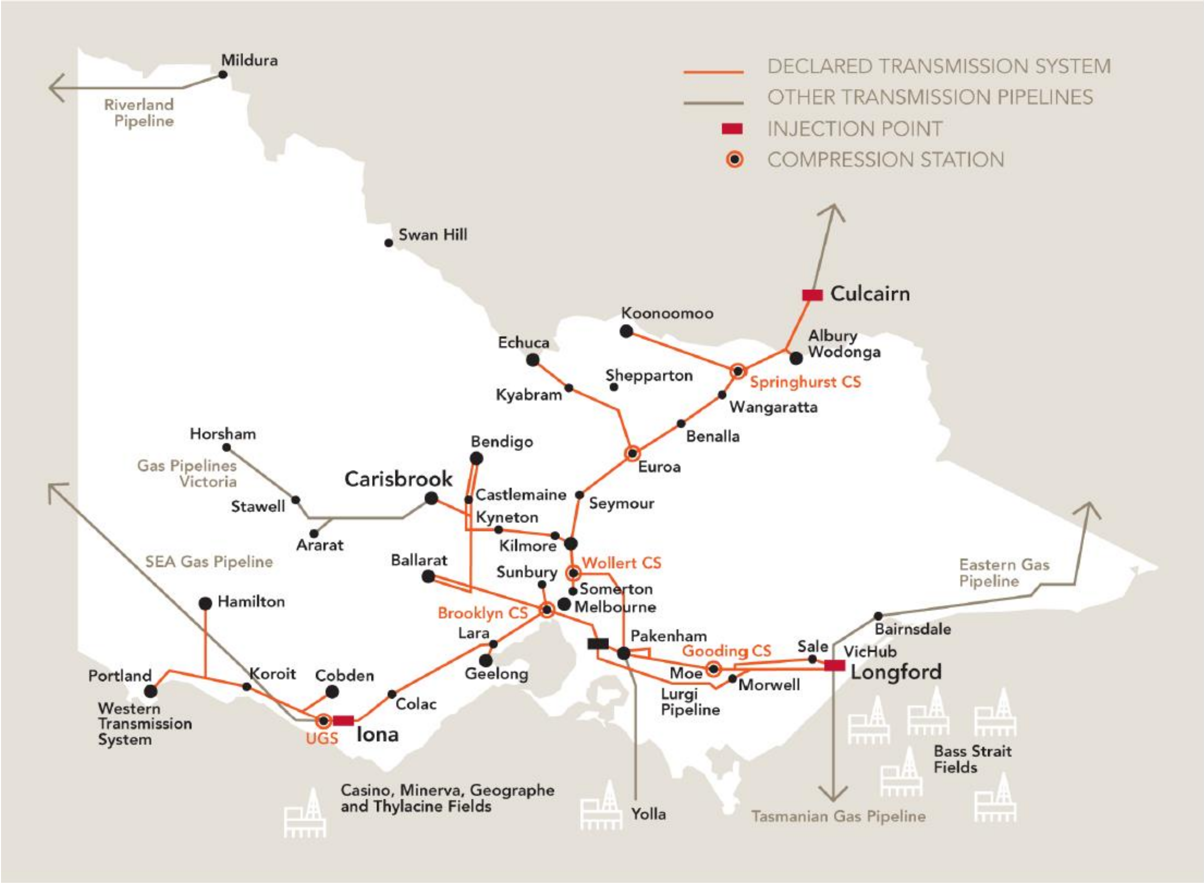

Figure 25 - Victorian Declared Transmission System (AEMO, 2013)

As part of its obligations in operating the DWGM and DTS, AEMO publishes annual the Victorian Gas Planning Report "to assess the adequacy of the Victorian declared transmission system (DTS) to supply peak day gas demand and annual consumption over a five-year outlook period."[16]

The national gas market has been subject to greater scrutiny in recent years due to concerns about the lack of transparency of bilateral agreements and pipeline access, as well as the structural impact of the eastern states Liquified Natural Gas (LNG) industry. This has involved regulatory reforms, such as the introduction of new wholesale gas trading markets (Short Term Trading Market and Gas Supply Hubs) and improved availability of market information (ACCC Gas Inquiry 2017-2025). As part of its role in managing the wholesale gas markets and providing market information, AEMO publishes the annual Gas Statement of Opportunities Report (GSOO) and the Gas Bulletin Board[17]. The GSOO is prepared to assess the adequacy over a 20 year timeframe of gas supply in eastern gas markets to meet forecast domestic gas demand and international demand of LNG.

[16] AEMO, Victorian Gas Planning Report, 2019
[17] https://www.aemo.com.au/energy-systems/gas/gas-bulletin-board-gbb

Document Control Sheet

Document information

Engagement	Victorian Gas Market – Demand Side Measures Review		
Client organisation	Environment Victoria		
Client contact	Rai Miralles, Nicholas Aberle		
Report prepared by:	Trent Hawkins, Alan Wang, and Shan Nanayakkara	Date:	19/02/2020
Reviewed by:	David Blyth	Date:	19/02/2020
Authorised by:	Trent Hawkins	Date:	20/02/2020

Revision history

Version	Status/Description	By	Chk	App	Date
1	Draft Report	TAH	DB	TAH	20/02/2020
2	Final Report	TAH		TAH	13/03/2020
3	Final Report (minor revision)	TAH		TAH	23/03/2020

Distribution history

Organisation	People	Date	Rev
EV	Rai Miralles, Nicholas Aberle	20/02/2020	1
EV	Nicholas Aberle	13/03/2020	2
EV	Nicholas Aberle	23/03/2020	3