GAS STATEMENT OF OPPORTUNITIES

FOR WESTERN AUSTRALIA

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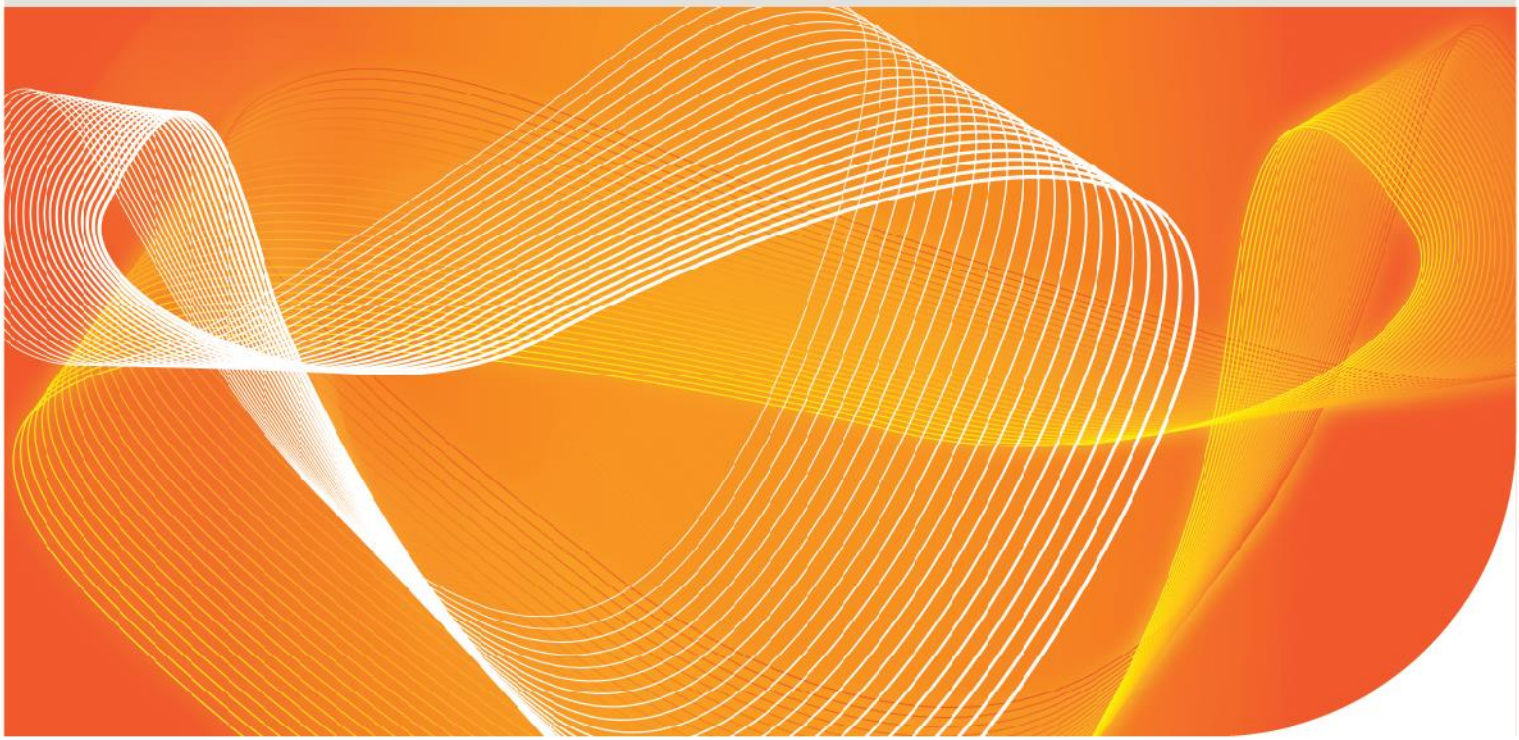

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

IMPORTANT NOTICE

Purpose

The purpose of this publication is to provide information about the natural gas industry in Western Australia.

AEMO publishes this Gas Statement of Opportunities in accordance with Rule 103 of the Gas Services Information Rules. This publication is based on information available to AEMO as at 30 August 2016, although AEMO has endeavoured to incorporate more recent information where possible.

Disclaimer

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Acknowledgements and feedback

AEMO acknowledges the support, co-operation and the contribution of gas market participants and stakeholders for providing data and information used in this publication.

Information has been received as a result of both formal and informal feedback. There will be a formal information gathering process for developing the 2017 WA GSOO that will commence early next year.

AEMO values all feedback on this report. If you have any feedback, please contact the System Capacity (WA) team directly at wa.capacity@aemo.com.au.

Version control

Version	Release date	Changes
1	08/12/2016	

EXECUTIVE SUMMARY

The 2016 Western Australian (WA) *Gas Statement of Opportunities* (GSOO) provides an independent assessment by the Australian Energy Market Operator (AEMO) of the WA domestic gas market for the outlook period 2017 to 2026.

The WA GSOO presents forecasts of WA gas demand and potential supply, including an overview of gas infrastructure and emerging issues affecting the gas industry. It is designed to assist gas market participants and other stakeholders to identify potential sources of domestic gas supply, constraints, and opportunities in the WA gas market.

Key findings

- In AEMO's Base scenario, the WA domestic gas market is expected to be well supplied, with potential gas supply expected to remain higher than forecast gas demand over the outlook period.
- There is a risk to supply after 2021 if there is no continued investment expenditure into the development of gas reserves. Several domestic production facilities may not have sufficient developed reserves to continue operating beyond 2021. From 2022, the level of supply is subject to the continued expenditure to develop gas reserves supplying the WA domestic market.[1] In addition to the Low, Base, and High scenarios for WA domestic gas demand and supply in this report, AEMO has developed another scenario – "Remaining gas reserves linked to domestic production facilities" – to account for this supply risk.
- Growth in domestic gas demand is forecast to be around 0.1% over the outlook period, as only a handful of large gas consumers are expected to enter the market over the 10-year horizon.
- There is greater potential for growth in gas demand from customers located outside of the South West interconnected system (SWIS) than in the SWIS. This is driven by potential fuel-switching from diesel to gas and prospective small new mining facilities, coupled with limited growth in electricity generation forecast for the SWIS, as discussed in the *Deferred 2015 Wholesale Electricity Market Electricity Statement of Opportunities*.[2]
- Exploration in WA's gas basins is at its lowest level since 1990. If exploration remains low, new gas projects may not be developed and existing domestic gas production facilities may cease production due to lack of gas feedstock. At the current production rates of domestic gas and liquefied natural gas (LNG), proved and probable (2P)[3] reserves can last until 2035, but a large proportion of these reserves are held by LNG export companies and joint ventures. These suppliers may only make gas available beyond their domestic market obligation quantities if the price is commercially viable.
- The reduction of 380 megawatts (MW) of Synergy's electricity generation capacity could affect gas demand from gas-powered generators (GPG) in the SWIS, depending on the type of facility that is shut down. However, in the absence of any public announcements or confirmation around which specific generators will retire, any changes in GPG as a result of emissions policy have not been accounted for in the gas demand forecasts presented in this report.

1 The WA GSOO modelling assumes that the production to reserves ratio for all production facilities remains constant over the outlook period. The "Remaining gas reserves linked to domestic production facilities" scenario shows there may be a sharp fall in gas production after 2022, associated with reserve depletion. This may happen if no new gas fields are developed to replace depleted fields as feedstock into the relevant production facilities.

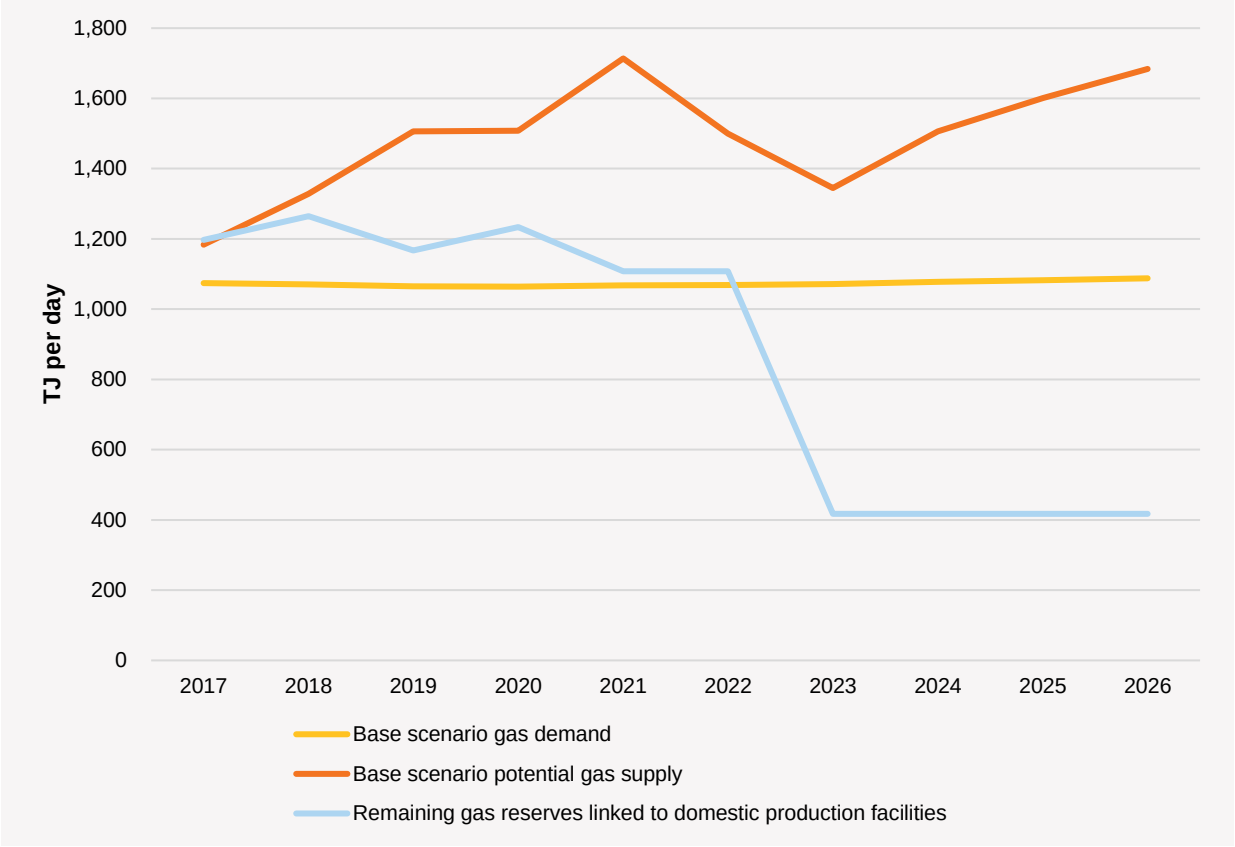
2 AEMO. *Deferred 2015 Wholesale Electricity Market Electricity Statement of Opportunities*, June 2016. Available at: http://aemo.com.au/Electricity/Wholesale-Electricity-Market-WEM/Planning-and-forecasting/WEM-Electricity-Statement-of-Opportunities.

3 A 2P resource represents a 50% probability that this quantity of gas resources are recoverable. This is a conservative estimate and the actual volume of gas extracted is likely to be higher.

Supply is expected to exceed demand over the next 10 years, but there are scenarios where this may not occur

Potential gas supply in the domestic market is expected to exceed forecast demand over the outlook period.[4] In the Base scenario, potential gas supply is forecast to exceed demand by at least 88 terajoules (TJ) per annum for the next 10 years, as shown in Figure 1, assuming that gas producers continue to develop gas reserves to supply the domestic market.

Figure 1 WA gas market balance, 2017 to 2026



Source: AEMO and NIEIR

In the Base scenario, excess supply is forecast to increase to about 640 TJ per day by 2021 with the commencement of the following domestic gas production facilities:

- Wheatstone in 2018.
- Gorgon phase two in 2020.

However, if these facilities were to be delayed beyond these projected commencement dates, short-term gas supply in 2017 or 2018 for the WA gas market may tighten when large gas supply contracts with the North West Shelf expire. From 2022, the level of supply is subject to the continued expenditure to develop gas reserves for the WA domestic market.

Given the uncertainty around available supply to the market from 2022, with multiple domestic production facilities facing reserve depletion, AEMO has developed a "Remaining gas reserves linked to domestic production facilities" scenario for this WA GSOO, in addition to the Low, Base and High scenarios. The extra scenario shows what may happen if no new gas fields were developed for the domestic market over the outlook period to replace depleted fields. In this scenario, the domestic gas

[4] Analysis on total gas demand including LNG requirements has been presented in Section 4.6 of this report.

market may be undersupplied by up to 600 TJ per day from 2023, as production facilities may not be able to supply to the market due to a lack of gas feedstock. A detailed discussion of the assumptions behind this scenario has been provided in Chapter 3.

Domestic gas demand is forecast to grow slowly

AEMO expects domestic gas demand to increase on average by less than 0.1% per annum over the 10-year outlook period, remaining almost flat, as shown in Table 1.

Table 1 Forecast WA gas demand (TJ per day), 2017 to 2026

Scenario	2017	2018	2019	2020	2021	5 year average growth pa (%)	10 year average growth pa (%)
Low	1,060	1,052	1,042	1,037	1,037	-0.5	-0.3
Base	1,074	1,070	1,065	1,064	1,068	-0.1	0.1
High	1,095	1,113	1,111	1,122	1,143	1.1	1.0

Source: NIEIR

The forecast slow decline of -0.1% until 2021 is due to an expected decrease in mining activities for some small mines, resulting from a forecast decline in commodity prices. This is projected to be partially offset by higher gas consumption from the following projects:

- Newman Power Station, which commenced supplying electricity to Roy Hill's iron ore mine in 2015.
- Goldfield's Granny Smith and Saracen Minerals' Thunderbox mines, which connected to the Goldfields Gas Pipeline system in 2016.
- The commissioning of CITIC Pacific's final two concentrators for the Sino Iron magnetite mine by the end of 2016.[5]
- South Hedland Power Station, which will supply electricity to Fortescue Metals Group's port operations in Port Hedland and Horizon Power's customers in the North West Interconnected System from 2017 and will replace the Pilbara Temporary Power Station.
- The Wheatstone joint venture (JV) commissioning its LNG facility in 2017.
- Tianqi's Lithium Australia's new lithium processing facility in Kwinana, which is due to commence operation in 2018.[6]

These projects have been included in the Low, Base, and High scenarios, as they are either operating or are considered certain to proceed based on public announcements. In addition to these projects, five prospective projects with total gas demand of around 45 TJ per day have been included in the High gas demand scenario.

From 2021, gas demand is expected to grow as commodities demand is expected to recover, resulting in an average growth of 0.1% a year over the full outlook period.

Low population growth is expected to constrain growth in demand from residential and non-residential customers connected to the distribution network.[7]

The north of WA has greater potential for gas demand growth than the South West

Forecast demand growth is greater in non-SWIS areas compared to the SWIS, as shown in Table 2.

[5] CITIC Pacific press release, "Construction Milestone at Sino Iron", 26 May 2016. Available at http://www.citicpacificmining.com/resources/attachments/20160527144601-Construction%20Milestone%20at%20Sino%20Iron.pdf.

[6] Premier of WA media release, "$400 million Kwinana lithium project underway", 12 October 2016. Available at https://www.mediastatements.wa.gov.au/Pages/Barnett/2016/10/400-million-Kwinana-lithium-project-underway.aspx.

[7] The distribution network is defined as the low-pressure gas pipelines used to supply small-use residential (less than 1 TJ per year) and non-residential customers. This includes the networks operated by ATCO in the Perth metropolitan area and regional centres of Albany, Bunbury, Geraldton, and Kalgoorlie.

Most of the gas consumed in the Metro and South West Zones is used by GPGs, alumina and nickel smelters, and other industrial customers. The SWIS currently has around 642 MW of excess electricity generation capacity[8], and electricity demand is expected to grow slowly. As a result, no new GPGs are expected to be constructed in the SWIS in the next 10 years. Therefore, gas demand growth from GPGs in the SWIS is projected to be muted.

Table 2 Forecast WA gas demand for SWIS and non-SWIS areas (TJ per day), 2017 to 2026

	Scenario	2017	2018	2019	2020	2021	5 year average growth pa (%)	10 year average growth pa (%)
SWIS	Low	695	690	682	679	678	-0.4	-0.3
	Base	704	701	696	695	696	-0.3	0.1
	High	718	727	725	727	733	0.5	0.6
Non-SWIS	Low	365	362	360	358	359	-0.6	-0.3
	Base	370	369	369	369	372	0.1	0.3
	High	377	386	387	396	410	2.4	1.8

Source: NIEIR

Three of the five prospective demand projects included in the High scenario are located in non-SWIS areas. It is likely some or all of these projects will require domestic gas supply, reinforcing the greater potential for gas demand growth in non-SWIS areas.

AEMO forecasts the domestic gas price will increase in the outlook period. Based on modelling by the National Institute of Economic and Industry Research (NIEIR), this may result in gas users reducing demand and potentially ceasing operations, although no large-scale closures are forecast in the next 10 years.

WA's potential gas supply is affected by low oil price and exchange rate forecasts over the outlook period

AEMO's potential gas supply forecasts for the outlook period, as shown in Table 3, take into account all gas reserves (LNG-linked and domestic only production facilities) available to the WA domestic gas market.

The forecasts are higher than those presented in the 2015 WA GSOO. This is largely related to exchange rate forecasts towards the end of the outlook period being more favourable than those published in the 2015 WA GSOO.

All scenarios (except for "Remaining gas reserves linked to domestic production facilities") assume reserves are developed as existing gas fields are depleted, driven by domestic gas prices.

Potential gas supply is considered from the perspective of each domestic gas supplier, supplying to the domestic market only if it is commercially viable, and managing its operations as a portfolio. It takes into account the WA Government's domestic gas reservation policy, existing and future gas supply contracts, gas production costs, and domestic gas price forecasts. However, gas producers may be unwilling to supply gas to the domestic market in excess of their current contracted positions, at least until domestic gas prices increase (or stabilise) around the middle of the outlook period (from 2020).

[8] Based on Capacity Credits assigned for the 2017–18 Capacity Year.

Table 3 Forecast WA potential supply (TJ per day), 2017 to 2026

Scenario	2017	2018	2019	2020	2021	5 year average growth pa (%)	10 year average growth pa (%)
Low	1,184	1,274	1,283	1,262	1,307	3.2	1.3
Base	1,184	1,329	1,506	1,508	1,714	10.7	4.4
High	1,184	1,557	1,648	1,690	1,761	11.3	5.9
Remaining reserves	1,197	1,265	1,167	1,234	1,108	-1.9	-11.1

AEMO expects potential gas supply to increase towards the end of the outlook period, in line with the domestic gas price forecasts. The commencement of the Gorgon and Wheatstone domestic gas production facilities is expected to increase potential gas supply between 2017 and 2020. This assumes all gas suppliers continue to develop gas reserves to allow them to supply gas to the WA domestic gas market throughout the outlook period, as domestic gas prices are forecast to remain higher than gas production costs.

In addition to gas supply from Gorgon and Wheatstone, gas may be made available from Pluto's JV participants within the outlook period. Under an agreement between the State Government and the JV partners, 15% of gas reserves must be retained and made available for the domestic market during the life of the project. Based on engagement with relevant stakeholders, it is unclear when and how domestic gas from the Pluto JV will be supplied to the market.

Moreover, given domestic gas price forecasts and Wood Mackenzie's production cost estimates[9], AEMO considers it is unlikely that Pluto will supply the domestic gas market over the outlook period.

As such, gas supply from the Pluto JV has not been included in AEMO's potential gas supply forecasts. Potential gas supply may be higher than forecast if gas becomes available from the Pluto JV participants during the outlook period.

Under the "Remaining gas reserves linked to domestic production facilities" scenario, supply would fall sharply from 2022 as production facilities are projected to cease production due to reserves depletion. This scenario may occur if no new gas fields are developed as feedstock for existing production facilities.

WA has large volumes of gas resources, but exploration has slowed

Approximately 92%, or 158,373 petajoules (PJ), of Australia's total estimated conventional gas resources are located onshore and offshore in WA. In addition, an estimated 311,428 PJ of unconventional resources (tight and shale gas) may be located in WA. Based on current production rates, WA's total gas resources may last up to 103 years beyond the outlook period.

While there is a large volume of estimated gas resources in WA, a large proportion of these resources have not been explored and discovered. Based on data for 2016 year to date, exploration in WA's gas basins is currently at the lowest levels observed since 1990, attributed to recent decreases in the international oil price. If exploration remains low, new gas projects may not be developed and some existing gas production facilities may cease production due to lack of gas feedstock. At current production rates of domestic gas and LNG, total 2P reserves held by companies can last until 2035, but a large proportion of these reserves are held by LNG export companies and joint ventures. These suppliers may only make gas available beyond their domestic market obligation quantities if the price is commercially viable.

[9] Based on cost estimates from Wood Mackenzie's upstream data service.

Emissions reduction and renewable energy policy

Australia has committed to achieving a 26% to 28% reduction in emissions by 2030 (relative to 2005 levels) as part of its obligations to keep global temperature increases to below 2°C, agreed at the 2015 Paris Climate Conference.

While Australia has ratified the Paris Agreement, detailed policy settings to achieve these commitments have not been developed.

Existing Commonwealth policies and consumer/industry preferences are favouring renewable energy, however so far there has been no firm commitment to connecting renewable energy projects to the SWIS, mainly due to excess electricity generation capacity in the SWIS and some uncertainty about Commonwealth and state emissions reduction policy.

The planned retirement of 380 MW of Synergy's generation fleet may contribute to meeting emissions targets. However, any projected impact is dependent on the fuel type of the generators chosen to be retired, which has yet not been publicly confirmed. Any potential change in GPG as a result of emissions policy has thus not been accounted for in the forecasts developed for the 2016 WA GSOO.

Policies to increase the penetration of renewable energy may displace GPGs in the SWIS. Currently, the WA State Government does not have any specific target or policy for renewable energy beyond the Commonwealth targets, and there have been no announcements about WA's contribution to meeting the federal target of 20% by 2020.

In addition, while gas is often considered to be well placed to assist in the transition to a low-emissions economy, WA already has a high proportion of GPG (approximately 60% of total SWIS generation capacity[10]). Any future expansion of electricity generation capacity is expected to come from renewable energy sources, rather than GPG.

Due to the uncertainty of WA policy and proposed retirements, AEMO has only provided a general commentary around this aspect in this report.

A detailed analysis of emissions targets in the SWIS will be an area of focus for the 2017 WA GSOO to be published in December 2017.

[10] Based on Capacity Credits assigned for the 2017–18 Capacity Year.

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CHAPTER 1. INTRODUCTION

1.1 Background and context

The Western Australian (WA) *Gas Statement of Opportunities* (GSOO) is published annually under the Gas Services Information (GSI) Rules made under the *Gas Services Information Act 2012* (GSI Act).

The primary purpose of the WA GSOO is to provide information and assessments relating to medium- to long-term gas supply and demand, including transmission infrastructure and storage capacity, in WA. The 2016 WA GSOO presents forecasts of annual gas supply and demand for WA's gas market over the 10-year outlook period 2017 to 2026.

1.2 Structure of this report

The structure of the report is as follows:

- Chapter 2 provides background information on the WA gas market, including:
  - Liquefied natural gas (LNG) exports and production facilities.
  - Gas demand, separated into large customers and retail customers.
  - Production facilities.
  - Gas pipelines.
  - Gas storage facilities.
  - Resources and reserves.
- Chapter 3 provides an explanation of the forecasting methodology and assumptions, and a discussion of factors affecting the forecasts.
- Chapter 4 presents the gas supply and demand forecasts for the 10-year outlook period from 2017 to 2026.
- Chapter 5 provides information about issues affecting the WA gas market, including the Electricity Market Review (EMR), potential changes to the WA Gas Bulletin Board (GBB), emissions targets, and renewable energy policy.
- Appendices provide supporting information, including demand and supply forecasts for all scenarios.

A data register containing the data for the figures in this report (except where data is confidential) is available on AEMO's website.[11]

[11] Available at http://aemo.com.au/Gas/National-planning-and-forecasting/WA-Gas-Statement-of-Opportunities.

CHAPTER 2. WA GAS MARKET CHARACTERISTICS

This chapter provides an overview of the key characteristics of the WA gas market, including:

- Gas used in the domestic market and processed for export as LNG.
- Large customers[12] supplied through the gas transmission network.
- Residential and non-residential customers supplied through the distribution network.[13]
- Gas production, transmission, and storage infrastructure.
- Conventional and unconventional gas resources located onshore and offshore in WA.

All data in this chapter is presented in financial years unless otherwise specified.

2.1 WA LNG exports

WA is a major LNG exporter and had its first cargo shipped from the North West Shelf (NWS)[14] to Japan in 1989. WA is geographically closer to the large gas consumers in the Asia Pacific region (including China, Japan, South Korea, and Taiwan) than the world's largest LNG exporter, Qatar.[15] Long-term contracts account for at least 86% of total processing capacity, with the majority of LNG sold from WA to the Asia Pacific region.

By the end of 2018, five LNG export facilities with total production capacity of 49.3 million tonnes per annum (mtpa) are expected to be operating in WA, accounting for around 11% of global LNG capacity.[16] When these are combined with LNG projects in Queensland and the Northern Territory (NT), Australia is expected to become the world's largest exporter of LNG from 2018, with around one-fifth of total global LNG capacity. The nameplate capacity and expected commissioning dates of existing and committed LNG projects in WA are shown in Table 4.

Table 4 WA's existing and committed LNG export facilities[a]

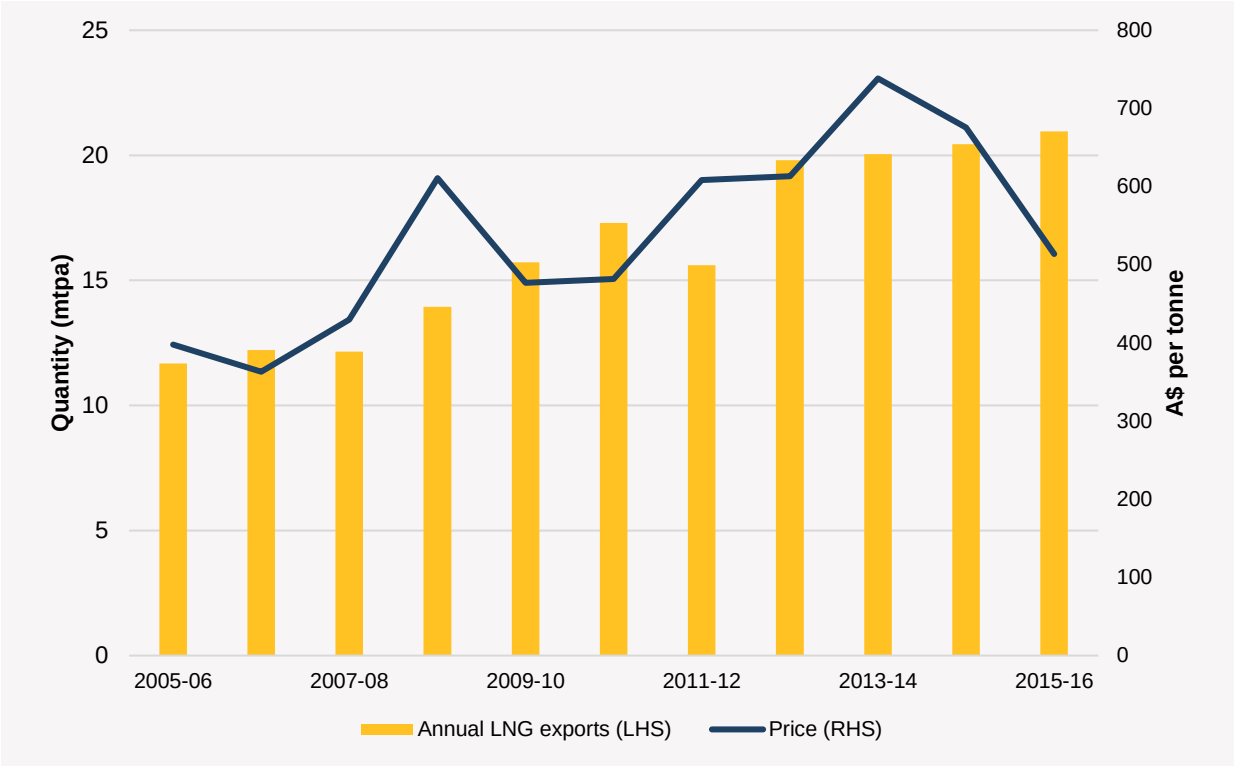
Facility	Nominal production capacity (mtpa)	Commission date or expected commission date
Gorgon	15.6	2016 to 2018
North West Shelf	16.9	1989 to 2008[b]
Pluto	4.3	2012
Prelude Floating LNG (FLNG)	3.6	2018 to 2020
Wheatstone	8.9	2017 to 2018
Total LNG export capacity (by 2018)	**49.3**	

[a] Chevron, Shell and Woodside. Full reference details are provided in Appendix F.
[b] The North West Shelf includes five LNG trains, built progressively between 1989 (train 1) and 2008 (train 5).

WA's LNG exports increased from about 12 mtpa in 2005–06 to more than 20 mtpa in 2015–16, as shown in Figure 2. The falls in LNG prices between 2013–14 and 2015–16 reflect a decrease in the international oil price, which is linked to LNG prices. LNG exports are expected to continue to increase over the next five years with the commencement of the Gorgon, Wheatstone, and Prelude LNG projects.

[12] Defined as customers using more than 10 terajoules (TJ) per day.
[13] The distribution network is defined as the networks operated by ATCO and used to supply residential and non-residential customers in the Perth metropolitan area and the regional centres of Albany, Bunbury, Geraldton, and Kalgoorlie.
[14] References to the North West Shelf relate to the Woodside-operated project throughout the document, unless otherwise specified.
[15] Department of State Development. *WA Liquefied Natural Gas Industry Profile*, June 2016. Available at: http://www.dsd.wa.gov.au/docs/default-source/default-document-library/wa-lng-profile---june-2016?sfvrsn=4. Viewed: 24 October 2016.
[16] International Gas Union. *2016 World LNG Report*. Available at: http://www.igu.org/publications/2016-world-lng-report. Viewed: 24 October 2016.

Figure 2 WA LNG export volume and prices, 2005–06 to 2015–16



Source: DMP. Full reference details are provided in Appendix F.

2.2 Domestic gas demand in WA

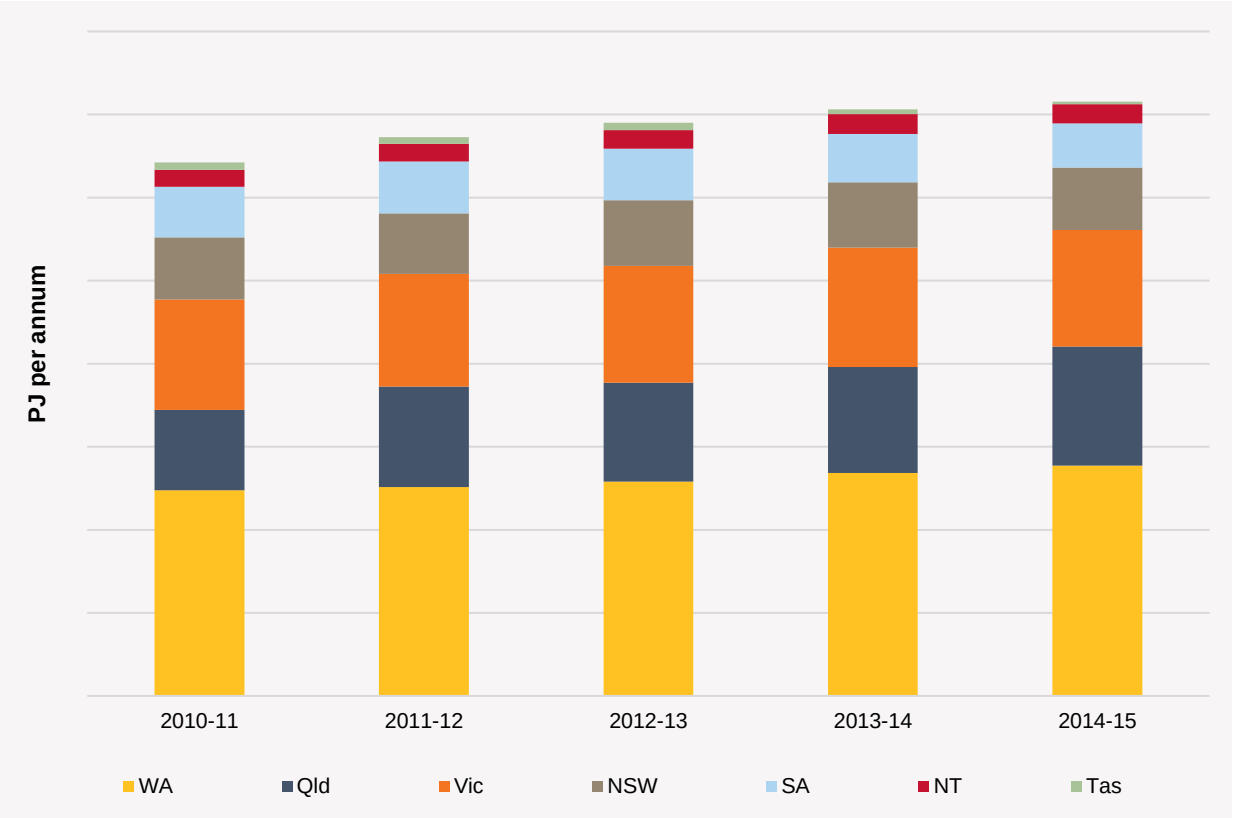
2.2.1 Overview

WA consumes more gas domestically than any other state in Australia, despite its relatively small population. In 2014–15, WA's domestic gas consumption was 554.5 petajoules (PJ)[17], accounting for almost 40% of Australia's total gas consumption, as shown in Figure 3.

In WA, gas is largely consumed by large industrial and mining users, by the minerals processing sector, and for electricity generation (gas-powered generation, or GPG). Residential consumption accounts for a small proportion of total gas use (around 2%). This is different to other Australian states, where residential customers use a greater proportion of domestic gas, particularly Victoria (where 39% of domestic gas use occurs in the residential sector). Section 2.2.2 and Section 2.2.3 provide more information about the breakdown of gas consumption in WA.

[17] Includes gas used for LNG processing.

Figure 3 Gas consumption by state, 2010–11 to 2014–15



Source: Office of the Chief Economist. Full reference details are provided in Appendix F.

2.2.2 Large customers supplied through the transmission network

Most large customers are supplied directly through the transmission network (such as the Dampier to Bunbury Natural Gas Pipeline (DBNGP) and the Goldfields Gas Pipeline (GGP)). The remaining large customers are supplied by domestic LNG facilities, which convert natural gas to LNG that is then transported by road. The large customers include:

- Mine sites such as iron ore, gold, and nickel mines.
- Mineral processing facilities such as alumina refineries and nickel smelters.
- Electricity generation from GPG, mainly located in the South West interconnected system (SWIS).
- Industrial users like brickworks, cement manufacturers, and chemicals plants.
- Production of domestic LNG, compressed natural gas (CNG), and liquefied petroleum gas (LPG).
- Petroleum processing.

Together, large customers account for two-thirds of gas used in WA, with the majority used in the minerals processing (32%), electricity generation (29%), and mining (23%) sectors.

2.2.3 Customers supplied through the distribution network

Customers supplied through the distribution network account for around 8% of total WA domestic gas consumption.

Table 5 shows the growth in the total number of customers supplied through the distribution network, and the rate at which customers switched retailers, between 2013–14 and 2015–16. WA's gas retail market connections are currently growing at about 3.1%, or 25,000 customers per year, largely as a result of new subdivision expansions and the associated construction of residential homes. The number

of customers changing retailer has increased, more than doubling from 23,184 in 2013–14 to 54,957 in 2015–16.

Until Kleenheat's entry into the retail market in 2013, the only retailer supplying residential customers was Alinta. Over the past four years, Kleenheat's share of the residential market has increased from 2% in 2012–13 to 12% in 2015–16.

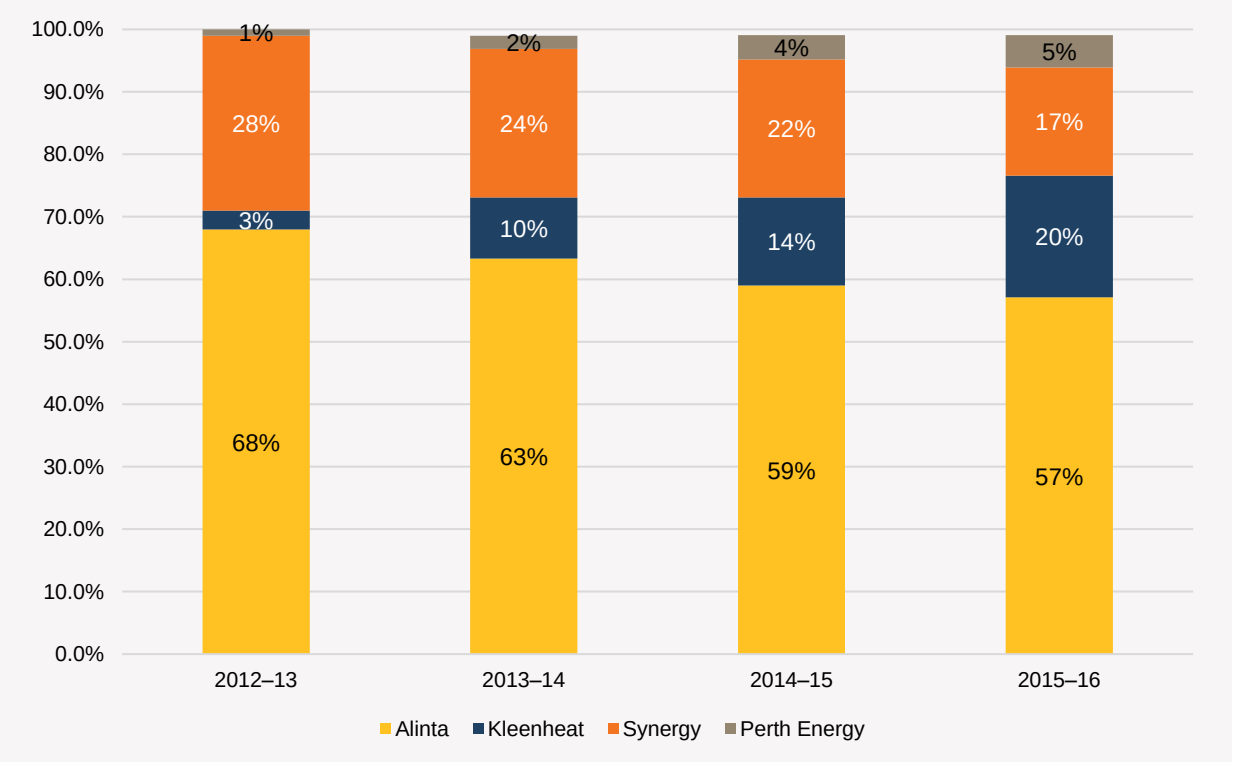
Table 5 Residential and non-residential customer numbers, 2013–14 to 2015–16

Year	Total number of customers		Existing customer transfers	
	Number	% change	Number	% churn[a]
2013–14	693,863	-	23,184	3.3%
2014–15	715,364	3.1%	36,966	5.2%
2015–16	737,679	3.1%	54,957	7.4%

[a] Calculated by dividing the number of customers changing retailer by the total number of customers for a given year.

The market shares of the retailers supplying large-scale distribution customers[18] are shown in Figure 4. There is greater competition in the non-residential market than in the residential market, with four retailers currently supplying the non-residential market. A fifth retailer (Aurora Energy) entered the non-residential market in late 2016. Alinta supplies the majority of customers (57%), with Kleenheat and Synergy accounting for most of the remainder. Over the past four years, Alinta's and Synergy's market shares have fallen, while Kleenheat's and Perth Energy's have increased.

Figure 4 Large-scale distribution customer market shares, 2012–13 to 2015–16[a]



[a] Figures are approximate. Market shares are based on customer numbers, not gas volumes.

[18] Defined as customers connected to the distribution networks and using more 1 TJ per year.

2.3 WA gas infrastructure

2.3.1 Gas production facilities

Nine gas production facilities supply the WA domestic market with a total capacity of about 1,633 terajoules (TJ) per day, as shown in Table 6. The majority (97%) of this capacity draws from gas fields located in the Carnarvon basin,[19] with four facilities (accounting for around 47 TJ per day of capacity) located in the Perth basin. The Karratha Gas Plant (KGP) remains the largest production facility at 630 TJ per day. Xyris (10 TJ per day) and Gorgon phase 1 (156 TJ per day) are the newest production facilities in the WA market. They began operating in 2016 and are located in the Perth and Carnarvon basins, respectively.

Table 6 Domestic gas production facility average production, Q3 2015 to Q2 2016

Facility	Nameplate capacity (TJ per day)	Peak production (TJ per day)	Average production (TJ per day)			
			Q3 2015	Q4 2015	Q1 2016	Q2 2016
Beharra Springs	19.6	18.4	17.9	16.4	13.7	13.1
Dongara	7	1.5	1.3	1.2	1.1	0.2
Devil Creek	220	180.5	77.0	111.5	84.6	97.6
Gorgon (phase 1)	156	Not applicable as the facility began operations in November 2016.				
Karratha Gas Plant	630	682.7	501.6	492.3	498.6	485.7
Macedon	220	220.1	179.8	174.6	208.6	217.7
Red Gully	10	9.8	7.6	8.6	9.0	7.5
Varanus Island (2 facilities)	360	269.5	138.1	81.0	112.7	113.0
Xyris	10	Not applicable as the facility began operations in August 2016.				
Total	1,633	1382.5	923.4	885.5	928.2	934.7

Two new domestic gas production facilities are expected to commence operations over the outlook period as follows:

- Gorgon (144 TJ per day) phase 2 in 2020.[20]
- Wheatstone (200 TJ per day) in 2018.[21]

Once these facilities are fully operational, WA's total domestic gas production capacity is expected to be 1,977 TJ per day by the end of 2020, an increase of around 21% from the current level of capacity.[22]

2.3.2 Gas transmission pipelines

Figure 5 shows WA's gas transmission pipelines, including the nameplate capacity of each pipeline. There are currently nine transmission pipelines in WA, all of which are privately owned and operated. The two largest pipelines are the DBNGP and the GGP. These pipelines account for almost 80% of pipeline capacity, and 90% of total domestic gas shipped throughout WA.

[19] Domestic gas production facilities that are currently connected to the Carnarvon Basin include Devil Creek, Karratha Gas Plant, Macedon, and Varanus Island.

[20] Chevron factsheet, "Gorgon project overview", 2016. Available at: https://www.chevronaustralia.com/docs/default-source/default-document-library/gorgon-project-overviewb516724323476876af0dff00008b3f1f.pdf?sfvrsn=0. Viewed: 24 October 2016.

[21] Chevron website, "Wheatstone: Downstream – Onshore Infrastructure". Available at: https://www.chevronaustralia.com/our-businesses/wheatstone/downstream. Viewed: 24 October 2016.

[22] Assuming no capacity is retired.

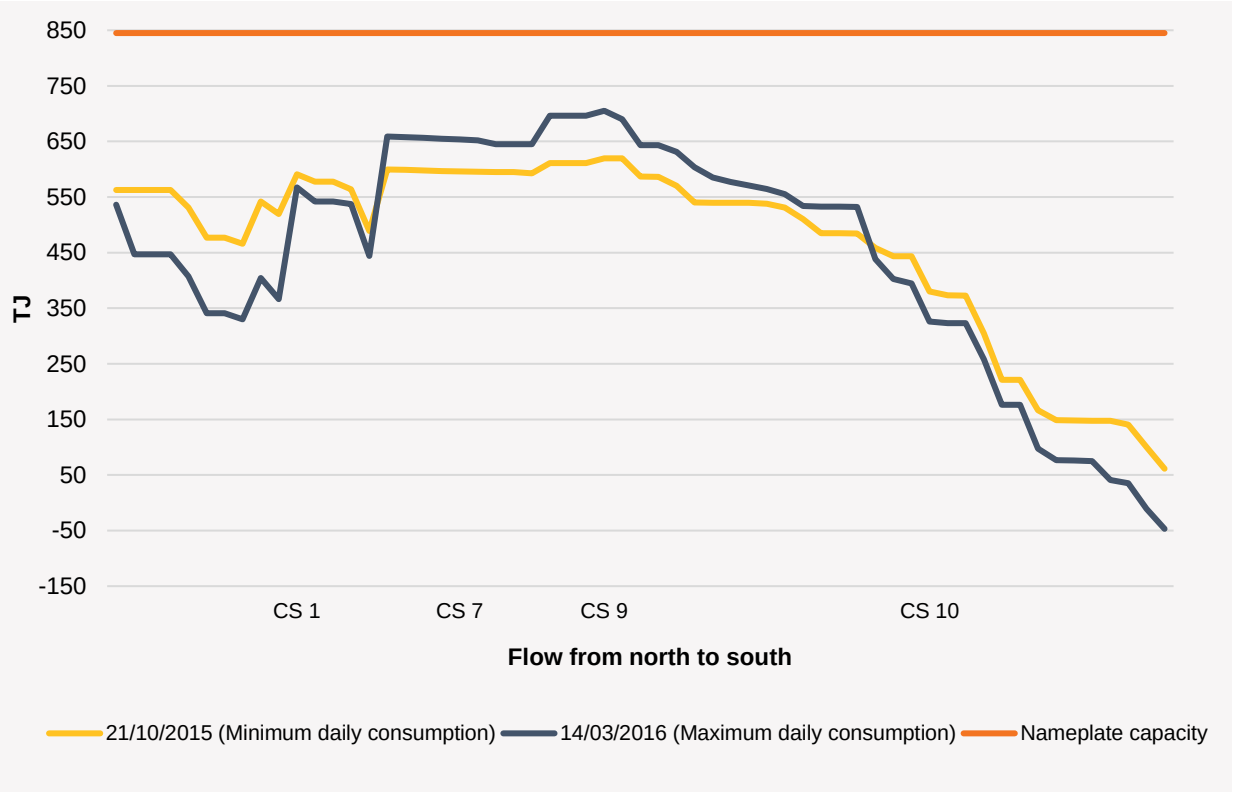
Figure 5 Gas transmission pipelines in WA

AEMO has analysed gas flows on the DBNGP and GGP by classifying all connection points as either inflow (production and storage facilities) or outflow (large customers and distribution network). This has allowed AEMO to identify potential drivers that may affect the utilisation of each pipeline. For the DBNGP, compressor stations were used as reference points to carry out this analysis. The results of the analysis are presented in the next two sub-sections.

Dampier to Bunbury Natural Gas Pipeline gas flows

The maximum and minimum gas flow days for the DBNGP in 2015–16 are shown in Figure 6. The difference between these two days indicates that there is a small variance between the maximum and minimum consumption days.

Figure 6 DBNGP gas flow on maximum and minimum consumption days, 2015–16



Gas demand is highest during summer, largely associated with higher use of GPG in the SWIS. Compressor station CS 9 has the highest utilisation of any point along the pipeline.

As at June 2016, the DBNGP is not fully contracted and has 127 TJ per day of firm full haul capacity available.[23]

The difference between maximum and minimum daily consumption is mostly related to electricity generation, which varies by location as follows:

- Increased use of GPG located outside of the SWIS (for example, Carnarvon and Exmouth) during summer results in higher gas use between compression stations CS 7 and CS 9.
- Between CS 9 and CS 10, GPGs located in the SWIS increase consumption by around 100 TJ in summer. Large customer consumption increases during summer by around 25 TJ. Partially offsetting these increases, consumption in the distribution network falls by roughly 15 TJ as households switch from heating to cooling, which uses more electricity than gas.
- South of CS 10, GPGs located in the SWIS increase consumption in summer. Partially offsetting these increases, consumption in the distribution network falls by roughly 5 TJ as households switch from heating to cooling. No obvious trend was observed for large customers.

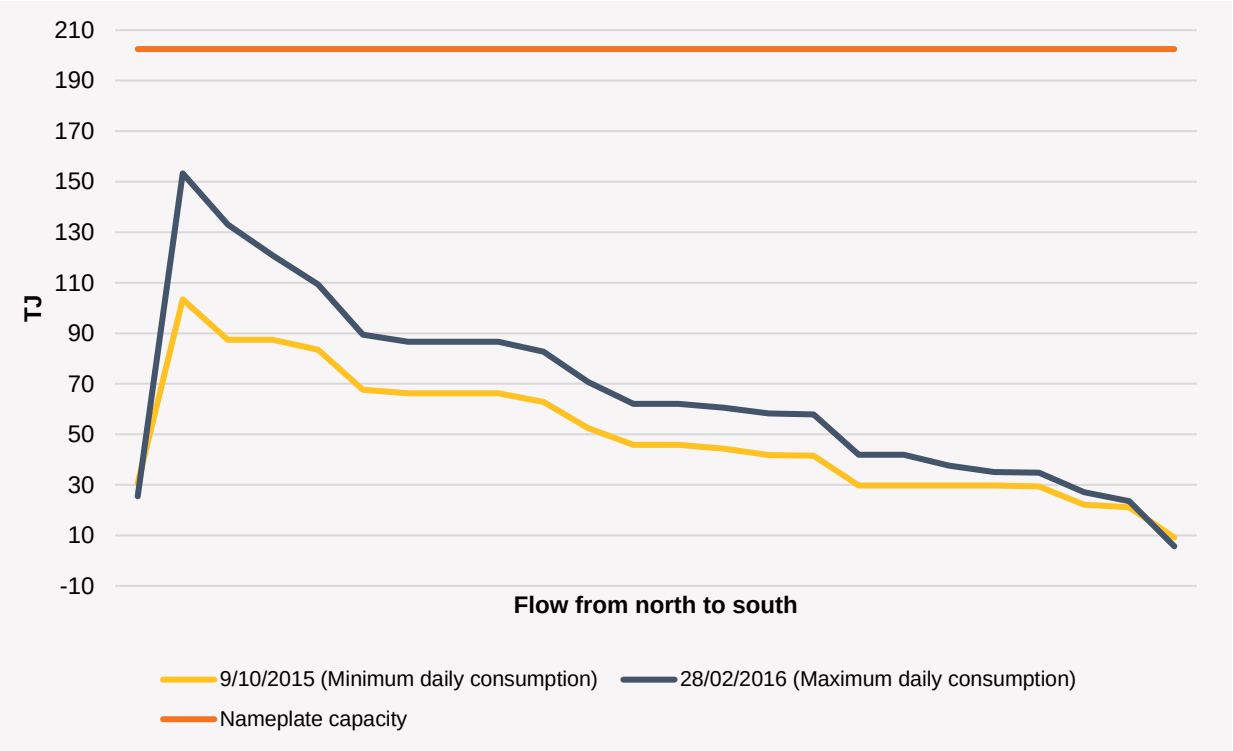
Gas consumption for SWIS electricity generation was slightly higher on 14 March 2016 (the second highest peak day) than on 8 February 2016 (peak SWIS demand day), by about 1.4%. The difference is accounted for by the total quantity of electricity generated by GPGs, at 37,662 megawatt hours (MWh) on 14 March 2016 compared to 37,216 MWh on 8 February 2016.

[23] DBP. *DBNGP Capacity Register,* current as at June 2016. Available at: http://www.dbp.net.au/wp-content/uploads/2016/06/20160617-DBNGP-Capacity-Register.pdf. Viewed: 24 October 2016.

Goldfields Gas Pipeline gas flows

The maximum and minimum gas flow days for the GGP in 2015–16 are shown in Figure 7. The maximum and minimum days vary less (in TJ) than flows on the DBNGP. An analysis of GGP gas flow by user type indicates that the difference between the maximum and minimum days is largely due to gold mining operations and expansions in the production of iron ore. As the GGP's gas consumption is largely dependent on mining-related activities, gas consumption is not seasonal and is driven by external industry factors.

Figure 7 GGP gas flow on maximum and minimum consumption days, 2015–16



2.3.3 Multi-user gas storage facilities

The Mondarra Gas Storage Facility (MGSF) is the only commercial gas storage facility in WA, located between the DBNGP and the Parmelia Gas Pipeline. This facility can store up to 15,000 TJ of gas and has injection and withdrawal capacity of 2,100 and 4,500 TJ per month respectively.[24]

There is currently sufficient capacity for existing gas market participants to use this facility to:

- Hedge against temporary high gas prices or take advantages of low spot prices.
- Add a security supply buffer during emergency conditions.
- Assist with gas rebalancing.

In late 2014, DBP Limited introduced the P2 tariff (charging shipping from MGSF to south of CS 9) to allow MGSF users to reduce shipping charges on the DBNGP.[25] This may explain the increase in utilisation of the facility from October 2015.

Another gas storage facility at the depleted Tubridgi gas field is being considered. In September 2016, DBP Development Group submitted an environmental plan to undertake activities associated with

[24] A month is considered to be a period of 30 days. More information is available at: https://www.apa.com.au/our-services/gas-transmission/gas-storage/mondarra-gas-storage-facility/.

[25] Before the introduction of the P2 tariff, MGSF users paid P1 and T1 shipping charges to ship gas stored in MGSF south of CS 9. Further information about shipping tariffs is available at: http://www.dbp.net.au/wp-content/uploads/2015/01/DBNGP-Access-Guide-as-at-February-2014.pdf.

testing the reservoir for potential gas storage. The current phase of the project evaluation involves the drilling, completion, and testing of up to four storage wells.[26]

2.4 Overview of WA's gas resources and reserves

AEMO sources information about WA's conventional gas resources and reserves from Geoscience Australia, the Australian Government agency responsible for geological mapping of Australia's mineral resources. Geoscience Australia has collected data on WA's gas resources since the mid-1990s and has assisted in promoting project development in offshore WA gas basins, particularly the Browse Basin.

Almost all (92%) of Australia's total conventional[27] gas resources are located in onshore and offshore WA.[28] Five gas basins in WA are currently active, with ongoing exploration and production activities:

- Bonaparte.
- Browse.
- Canning.
- Carnarvon.
- Perth.

Most of WA's conventional gas resources are located in the Bonaparte, Browse, and Carnarvon basins. Around half (75,681 PJ of a total 158,373 PJ) of WA's conventional gas resources are classed as 2P (proven and probable) reserves by oil and gas companies.[29] The majority of these resources are located in the Carnarvon and Browse basins.

In addition to conventional gas, WA's resources of unconventional gas (tight and shale gas) are estimated to be around 311,428 PJ, mostly located in the Canning and Perth basins.[30] Given the significant amount of conventional gas resources remaining and the relatively high cost of developing unconventional gas, there has been no commercial production of unconventional gas in WA.[31]

The current attributes of WA's active basins, including estimates of conventional and unconventional gas resources, are summarised in Table 7. In forming these estimates, AEMO has used the latest information available, noting that a number of external information sources have not been updated for several years.

[26] Department of Mines and Petroleum. *Tubridgi Gas Storage Project – Environmental Plan Public Summary,* Rev. 2, September 2016. Available at: https://ace.dmp.wa.gov.au/ACE/Public/PetroleumProposals/ViewPlanSummary?registrationId=60042. Viewed: 24 October 2016.

[27] "Conventional" and "unconventional" gas resources are defined based on the different geological locations the gas is found, and therefore the methods needed to extract the reserves. Extracting unconventional gas resources typically requires additional technology, energy, and/or capital. Unconventional resources in WA include shale gas (still within the source rock) and tight gas (in low permeability rocks).

[28] Geoscience Australia, *Australian Energy Resources Assessment Interim Report*, 2014. Available at: http://www.ga.gov.au/aera. Viewed: 21 October 2016.

[29] A 2P resource represents a 50% probability that this quantity of gas resources are recoverable. This is a conservative estimate and the actual volume of gas extracted is likely to be higher.

[30] Geoscience Australia, *Australian Energy Resources Assessment Interim Report*, 2014. Available at: http://www.ga.gov.au/aera. Viewed: 21 October 2016.

[31] 311,428 PJ is calculated from total shale resources reported by EIA and by adding one third of official tight gas reserves outlined by DSD (see Appendix F for full reference details).

Table 7 Attributes of WA's gas basins

Attribute	Bonaparte	Browse	Canning	Carnarvon	Perth
Supplies LNG export market	✓	x	x	✓	x
Supplies WA domestic market	x	x	x	✓	✓
Domestic transmission infrastructure in place	x	x	x	✓	✓
Total area offshore, km^2 (approximate)	250,000	140,000	76,000	535,000	122,500
Total area onshore, km^2 (approximate)	20,000	0	430,000	115,000	50,000
Conventional 2P gas reserves (PJ)	903	17,384	Not reported	56,926	468
Estimated remaining conventional resources (McKelvey's EDR + SDR) (PJ)	24,005	37,815	372	95,914	267
Contains unconventional gas resources	x	x	✓	✓	✓
Estimated shale resources (tcf)	NA	NA	235	NA	33
Estimated tight gas resources (tcf)[a]	NA	NA	22.2	NA	3.6

Source: DSD, EIA, EnergyQuest, and Geoscience Australia. Full reference details are provided in Appendix F.
[a] Calculated as 30% of DSD's estimates.

2.4.1 Conventional gas resources

As at September 2016, natural gas has been produced from the Bonaparte, Carnarvon, and Perth basins. The LNG export industry is supplied by the Bonaparte and Carnarvon basins, while the WA domestic gas market is supplied by the Carnarvon and Perth basins.

The Gorgon and Wheatstone LNG projects located in the Carnarvon basin are nearing completion. Gorgon's first shipment of LNG left in March 2016, while LNG exports are expected to commence from Wheatstone in mid-2017.

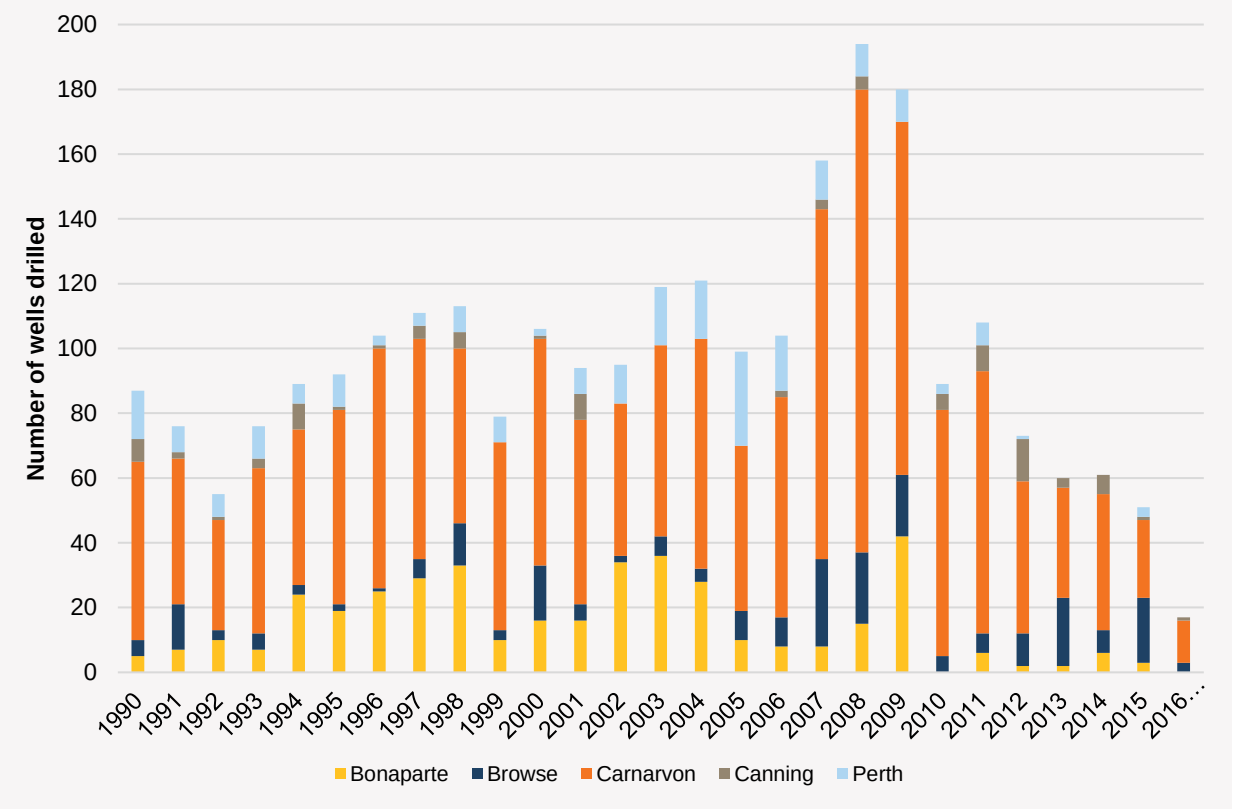
By 2020, the Browse Basin will be developed for LNG exports, with the Ichthys and Prelude projects scheduled to commence production in late 2017[32] and 2018[33] respectively. The Browse LNG project is currently on hold, with project proponents continuing to assess development options.[34]

Exploration

Between 1990 and 2016[35], a total of 2,611 hydrocarbon wells have been drilled in WA, as shown in Figure 8.

[32] INPEX web page, "Ichthys in detail/Project overview". Available at: http://www.inpex.com.au/our-projects/ichthys-lng-project/ichthys-in-detail/project-overview. Viewed: 23 September 2016.
[33] Shell. *Investors' Handbook* 2015. Available at: http://www.shell.com/investors/financial-reporting/investors-handbook.html. Viewed: 21 October 2016.
[34] Woodside web page, "Developing/Browse development. Available through links from: http://www.woodside.com.au/Our-Business/Pages/home.aspx. Viewed: 23 September 2016.
[35] Year to date to August 2016.

Figure 8 Number of exploration wells drilled, 1990 to 2016[a]



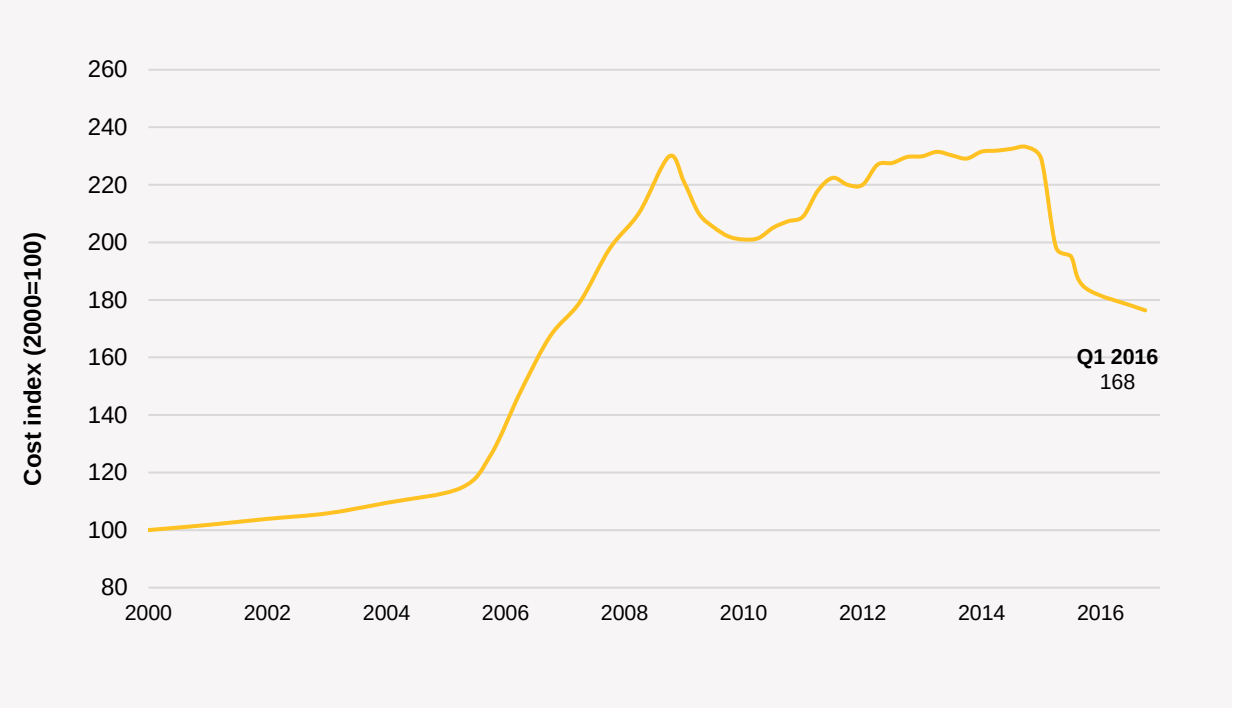
Source: Compiled using information from APPEA and National Offshore Petroleum Titles Administrator. Full reference details are provided in Appendix F.
[a] The same well may be counted twice if it is redrilled.

Around 63% of the wells drilled were located in the Carnarvon Basin, which remains a popular location for drilling due to the success of previous exploration activities and its proximity to pipeline infrastructure.

Exploration activity continues to decline since the 2008 peak, with the number of wells drilled falling to its lowest level since 1990. Only 51 wells were drilled in 2015, compared to 194 wells in 2008. Oil prices have fallen sharply resulting in less interest in exploration, despite a slight decline in international upstream capital costs, as shown in Figure 9.

The decline in petroleum exploration may have a longer lasting impact on gas supply to the WA domestic market in the next five years, as the volume of developed 2P gas reserves is depleted.

Figure 9 Upstream capital cost index, 2000 to Q1 2016



Source: IHS

2.4.2 Gas reserves by company

A review of 2P gas reserves by company for WA and the NT[36] in Table 8 shows domestic-only gas suppliers have access to a small proportion of total WA gas reserves.

Fifteen oil and gas companies have rights to around 96% of the total 2P gas reserves, 12 of which are participants in an existing, upcoming, or prospective LNG export project. Only Quadrant Energy, Tokyo EP, and Santos are not part of a WA LNG export project.

[36] EnergyQuest provides reserves data for the NT and WA together. It is estimated that the NT accounts for about 203 PJ of the reported gas reserves.

Table 8 Estimated 2P natural gas and ethane reserves (WA and NT), August 2016

Gas supplier	2P reserves (PJ)	% of total reserves
Chevron	21,096	27.9
Shell	11,125	14.7
Inpex	9,285	12.3
Woodside	7,999	10.6
ExxonMobil	6,875	9.1
TOTAL	4,070	5.4
BP	2,439	3.2
BHP Billiton	2,357	3.1
MIMI	2,029	2.7
Kufpec	1,355	1.8
Quadrant Energy	899	1.2
Eni	830	1.1
Tokyo EP	758	1.0
Tokyo Gas Co	737	1.0
Santos	690	0.9
Total	**72,544**	**96%**

Source: EnergyQuest.
EnergyQuest's data includes both natural gas and ethane, and does not provide any further breakdown.

2.4.3 Unconventional gas resources

Unconventional gas resources in WA remain largely unverified. However, several publications have suggested that WA has substantial untapped unconventional gas resources, including:

- In 2016, the WA Department of State Development (DSD)[37] estimated the Canning and Perth basins may hold up to 86 trillion cubic feet (tcf) of tight gas resources.
- In 2013, the Australian Council of Learned Academies (ACOLA)[38] estimated there is up to 475 tcf of shale gas resources mainly located in the Canning basin.
- In 2013, the Energy Information Administration (EIA)[39] of the United States estimated there is around 268 tcf of shale gas resources in WA's Canning and Perth basins.

[37] DSD. "WA Liquefied Natural Gas Industry Profile", June 2016. Available at: http://www.dsd.wa.gov.au/docs/default-source/default-document-library/wa-lng-profile--0816?sfvrsn=4. Viewed: 29 September 2016.
[38] ACOLA. *Securing Australia's Future – Engineering energy: unconventional gas production*, June 2013. Available at: http://www.acola.org.au/index.php/projects/securing-australia-s-future/project-6. Viewed: 21 October 2016.
[39] EIA, *Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States*, June 2013. Available at: https://www.eia.gov/analysis/studies/worldshalegas/archive/2013/pdf/fullreport_2013.pdf. Viewed: 21 October 2016.

CHAPTER 3. FORECAST METHODOLOGY AND ASSUMPTIONS

This chapter describes the methodology used in the 2016 WA GSOO to forecast gas demand and potential gas supply for the 10-year outlook period 2017 to 2026. It includes a summary of the input assumptions used in the forecasts, including the economic outlook and domestic gas price forecasts.

The forecasting methodology has been incrementally improved from previous GSOOs, particularly around potential gas supply forecasts, which now include an additional "Remaining gas reserves linked to domestic production facilities" scenario, as well as Low, Base, and High demand scenarios.

AEMO has consulted gas market participants through the WA Gas Consultative Forums and one-on-one meetings at different stages of developing this report.

All input assumptions have been updated to reflect the most recent information available.

3.1 Gas demand forecast methodology

AEMO presents **domestic** and **total** gas demand forecasts for WA, defined as follows:

- **Domestic gas demand forecasts** include all major industrial and commercial loads, GPG in the SWIS and non-SWIS areas, and small-use customers connected to WA's gas transmission and distribution networks.
- **Total gas demand forecasts** include domestic gas demand plus an estimate of the gas required for LNG export, reflecting an overall assessment of WA gas demand.[40]

AEMO's methodology for preparing these forecasts is described in Sections 3.1.1 and 3.1.2.

3.1.1 Domestic gas demand

AEMO engaged the National Institute of Economic and Industry Research (NIEIR) to develop domestic gas demand forecasts for the outlook period. NIEIR prepared three forecast scenarios for domestic gas demand, as shown in Table 9.

Table 9 Domestic gas demand scenarios

Scenario	Economic scenario	Projects	Prospective demand[a]
Low	Low	Projects that are certain to operate over the outlook period, including established loads and projects that have achieved a favourable final investment decision.	Not included
Base	Base		Not included
High	High		Included

[a] Prospective demand includes gas consumed by potential projects which may be developed over the outlook period, or may switch from diesel to gas over the outlook period.

Prospective gas demand included in the High scenario is discussed in more detail in Section 3.1.2.

NIEIR's domestic gas demand forecast model is shown in Figure 10. The sections below the figure describe how NIEIR applied the model to generate the forecasts.

[40] Required to be published in the WA GSOO by section 104(2) of the *Gas Services Information Regulations 2012*.

Figure 10 Domestic gas demand forecast model

SWIS electricity generation and distribution network

SWIS electricity generation

Electricity generation in the SWIS accounts for roughly one-fifth of domestic gas demand in WA, and is therefore a fairly important component of the WA domestic gas demand forecast. Around 2,995 MW of generation capable of using gas (including dual-fuelled gas/diesel) is currently installed in the SWIS, three-quarters of which is peaking and mid-merit capacity.[41] The SWIS mainly relies on GPGs to supply peaking load during the hot summer season and for the provision of frequency control ancillary services (FCAS).

Gas required to generate electricity in the SWIS was estimated using the electricity forecasts published in the latest *Electricity Statement of Opportunities* (ESOO)[42], with updated economic assumptions. NIEIR split the electricity forecasts based on generation type and applied efficiency assumptions, shown in Table 10, to determine the volume of gas required for SWIS electricity generation.

Table 10 Assumptions used to forecast gas consumption for electricity generation in the SWIS

Generation type	Efficiency
Non-gas fuelled	NA
Baseload GPG[a]	44.0%
Mid-merit GPG[b]	38.0%
Peaking GPG[c]	33.7%

Source: NIEIR
[a] Baseload capacity operates for at least 70% of the year.
[b] Mid-merit capacity operates for between 10% and 70% of the year.
[c] Peaking capacity operates for less than 10% of the year.

The forecasts were then adjusted to account for fuel substitution. Forecasts for gas consumption for the SWIS were validated against historical data published by the Energy Supply Association of Australia.

Distribution network

The distribution network includes the pipelines used to supply small-use residential and non-residential customers, and accounts for around 8% of WA's domestic gas demand.

Gas demand forecasts for the distribution network were developed as follows:

1. A regional model was used to disaggregate WA's gross state product (GSP) into sub-sectors, including mining, manufacturing, and services.
2. Residential gas demand (per customer) was forecast using a regression model which included drivers such as real household disposable income and real residential gas prices. The model adjusted the resulting forecasts to account for weather.

[41] Based on the capacity classifications published in the *Deferred 2015 Wholesale Electricity Market (WEM) Electricity Statement of Opportunities*.
[42] AEMO. *Deferred 2015 WEM Electricity Statement of Opportunities*, June 2016. Available at http://aemo.com.au/Electricity/Wholesale-Electricity-Market-WEM/Planning-and-forecasting/WEM-Electricity-Statement-of-Opportunities.

3. Non-residential demand was forecast by sub-sector using a regression model which related changes in gas consumption to changes in output and gas prices (in real terms).

Total gas distribution network demand was then estimated by aggregating the forecasts of industry gas demand and residential demand for the distribution network.

Transmission connected customers

Customers connected to the gas transmission network typically include:

- Facilities involved in mining, minerals processing, and refining.
- Industrial loads.
- GPGs located out of the SWIS.

The majority of these customers are located in the Goldfields, Metro, Mid-West, Pilbara, and South West regions of WA.

Transmission connected customers account for around 70% of WA gas demand. These large loads have been forecast using a mix of:

- Historical data drawn from the WA GBB.
- Publicly available information on existing and new projects and from pipeline operators.
- Information from major customers[43] consulted by AEMO, about each facility and the customer's corresponding forward plans.
- Economic assumptions, and assumptions about future commodity demand and international commodity prices.

Each customer's gas use was forecast individually, based on sector-specific drivers. NIEIR forecast WA's production of iron ore, gold, nickel, zinc, and ammonia nitrate based on consensus forecasts for international demand and prices. Historical gas intensity figures were then used to determine the forecast gas consumption for each customer.

Minerals processing facilities (such as alumina and lithium) have been treated differently, but still related to commodity forecasts. NIEIR used projected capacity utilisation and changes to contracted gas prices to determine gas consumption for these customers. For nickel smelters, gas consumption was calculated based on the output of the associated nickel mines and historical gas intensity.

WA's alumina refineries are among the lowest-cost facilities in the world. Therefore, AEMO assumed they will continue to operate over the entire outlook period and has not modelled any closures.

Gas price adjustments

Demand forecasts were adjusted to account for medium- to long-term average domestic gas price forecasts. Gas price adjustments, based on an assumed demand elasticity, were applied to the following:

- Electricity generation in the SWIS – the availability of substitutes (such as coal-fired generation) and exposure to the electricity spot price, which may be lower than short-run marginal costs, meaning that GPGs may reduce generation if gas prices were high. This increases the gas price adjustment factor and reduces gas demand forecasts.
- Customers connected to the distribution network – over time, households and businesses may replace gas appliances with electric ones, or install solar hot water in place of gas, if gas prices remained high. However, domestic gas tariffs have only increased by about 10% since 2010, largely due to increases in the costs of distributing gas, having a negligible effect on the adjustment factor.

[43] Including Alcoa (customer), APPEA, BP Refinery (customer), Exmouth Energy, Gas Trading, MSC Consultants (Tianqi Lithium Australia) (customer), North West Shelf, Quadrant Energy, Rio Tinto (customer), Synergy (customer), Wood Mackenzie, and Woodside Energy.

Prospective gas demand for the High gas demand scenario

Prospective gas demand are projects that may be developed and consume gas, or that are likely to switch from diesel to gas, over the outlook period. Specifically, each project shortlisted had to meet at least two of the following criteria:

- The potential demand for each project should be more than 10 TJ per day.
- The project should be located within 20 kilometres of gas transmission pipelines that are under construction, pipelines that have spare shipping capacity, or new pipelines that have attained a favourable final investment decision.
- The project proponent has a commercial arrangement with a gas pipeline or gas storage company to connect physical infrastructure to withdraw gas.
- The project may (as publicly reported) use existing domestic CNG or LNG facilities.
- The project proponent has applied to AEMO to receive Capacity Credits as an electricity generator capable of using gas.
- The expected capital cost is more than A$1 billion.
- Full project finance has been secured.
- The project proponent intends to consume gas, as publicly announced.
- The project proponent has investigated converting from diesel to gas for its operations.
- Existing pipeline operators have identified the project as a potential gas project.

The shortlisted projects were assessed further to determine the likelihood of consuming gas over the outlook period. Only those projects with a high degree of certainty to proceed were included in the list of prospective demand and the High demand forecast.

For this GSOO, five eligible projects totalling about 45 TJ per day by 2023 were included in the High scenario. The remaining shortlisted projects were excluded for one or more of the following reasons:

- The project relied on the construction of other infrastructure to transport its minerals (for example, Oakajee, Ashburton, or Esperance Ports, or the common user rail system in the Pilbara).
- The project relied on improved commodity prices in the future (for example, magnetite iron).
- The project relied on the availability of financing.
- The project was located in the SWIS, where there is significant spare capacity for electricity generation.
- The project proponent had not conducted any environmental studies.
- The project proponent did not appear to have committed to a project commencement date.

Of six projects identified as prospective gas demand in the November 2015 WA GSOO, four were included in the Base scenario for this WA GSOO. The two remaining projects remained in the prospective gas demand forecasts for the High scenario, with three new prospective projects identified. AEMO has included the intended expansion for Alcoa's Pinjarra alumina refinery[44] as one of the three new projects in the prospective demand forecast, rather than in the Base or Low gas demand scenarios.

The estimated cumulative impact of the five projects included as prospective gas demand in the High gas demand scenario in the 2016 WA GSOO is summarised in Table 11.

[44] The West Australian. "Alcoa nod for Pinjarra expansion", 6 October 2015. Available at: https://au.news.yahoo.com/thewest/wa/a/29728626/alcoa-nod-for-pinjarra-expansion/. Viewed: 20 October 2016.

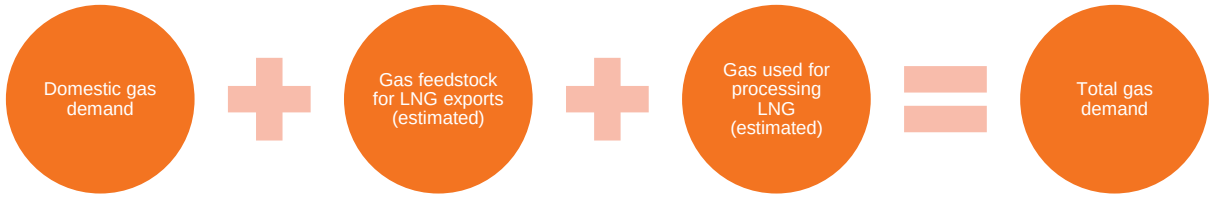
Table 11 Prospective gas demand forecasts, 2017 to 2026

	2017	2018	2019	2020	2021	2022	2023	2024 and beyond (for each year till 2026)
Prospective gas demand – SWIS (TJ per day)	0.0	5.0	7.0	9.0	12.0	12.0	12.0	12.0
Prospective gas demand – non-SWIS (TJ per day)	0.0	5.0	5.0	10.0	21.5	27.3	33.1	33.1
Number of prospective projects commencing	0	2	1	0	1	0	1	0

3.1.2 Total gas demand

To develop the total gas demand forecast, AEMO estimated the amount of gas required for WA's LNG sector and added it to NIEIR's domestic gas demand forecast, as shown in Figure 11.

Figure 11 Total gas demand forecast model



As for the domestic gas demand forecasts, AEMO developed three scenarios for total gas demand – Low, Base, and High. LNG forecasts were developed using historical data from existing LNG facilities, and publicly available information on the proposed demand and commencement date of new LNG facilities.

Unlike for domestic gas demand forecasts, the Base scenario for total gas demand was not restricted to projects that have reached a favourable final investment decision. For example, Chevron's Gorgon LNG expansion is included in the Base scenario because Chevron commenced marketing LNG for Gorgon Train 4.[45] This suggests the Gorgon LNG expansion is likely to proceed within the outlook period.

The assumptions applied in each total gas demand scenario are summarised in Table 12.

[45] Argus Media. "Gorgon expansion output on offer". Global LNG, Volume X, Issue 4, April 2014. Available at: https://www.argusmedia.com/~/media/files/pdfs/samples/argus-global-lng.pdf/?la=en. Viewed: 29 November 2016.

Table 12 Total gas demand scenarios, 2017 to 2026

Parameter	Low scenario	Base scenario	High scenario
Domestic gas demand forecasts	Low	Base	High
Gas feedstock for LNG exports	• NWS (16.9 mtpa) • Pluto LNG (4.3 mtpa) • Gorgon LNG (15.6 mtpa) • Wheatstone LNG (8.9 mtpa) • Prelude FLNG (3.6 mtpa) • Ichthys LNG (8.9 mtpa) and assumptions outlined in Table 15	• Includes facilities outlined in the Low scenario and Base scenario assumptions outlined in Table 15 • Backfill for Darwin LNG in mid-2023 • Gorgon LNG expansion (5.2 mtpa in mid-2022)	• Includes facilities in Base scenario and High scenario assumptions outlined in Table 15 (but assumes the Gorgon LNG expansion is mid- 2021) • Backfill for Darwin LNG in mid-2023 • Wheatstone LNG expansion (4.45 mtpa in 2023) • Pluto LNG expansion (2.2 mtpa in 2023)
Gas used for processing LNG[a]	8% of total LNG feedstock		

[a] Processing estimates were calculated by taking the low range of estimates outlined in Tusiani, Michael D. and Shearer, Gordon (2007). Full reference details are provided in Appendix F.

LNG feedstock requirements were adjusted by the average utilisation rate of WA LNG facilities operating between Q1 2010 and Q2 2016, as shown in Table 13.

Table 13 LNG utilisation rates (operational facilities only – percentage of nameplate), Q1 2010 to Q2 2016

Facility	2010	2011	2012	2013	2014	2015	2016 (to Q2 2016)	Average
KGP	101.4	98.4	95.5	93.5	100.8	100.9	76.3	94.5
Pluto	NA	NA	93.6	93.4	108.2	98.4	86.4	95.1

Utilisation was calculated using nameplate capacity. As AEMO does not have access to LNG facility outage data, the utilisation rates may periodically exceed 100%.

Commencement and ramp-up timing for the four upcoming LNG projects is shown in Table 14. AEMO has assumed the upcoming LNG facilities (including additional trains for the Gorgon, Ichthys and Wheatstone, and Prelude LNG projects) will start with 50% utilisation, consistent with observations from Pluto LNG and assumptions in the *2015 National Gas Forecasting Report* (NGFR).[46] Production is expected to plateau at 95% utilisation one quarter from the commencement of operations for land-based facilities. Prelude Floating LNG (FLNG) is expected to take longer, with the project assumed to reach its production plateau two quarters from the commencement of operations.

[46] Lewis Grey Advisory. *Projections of Gas and Electricity Used in LNG*, April 2015. Available at http://www.aemo.com.au/-/media/Files/PDF/Projections-of-Gas-and-Electricity-Used-in-LNG--Public-Report--Final.ashx. Viewed: 24 October 2016.

Table 14 LNG utilisation assumptions (new facilities only), start-up and ramp-up timing

LNG project			Low	Base	High
Gorgon[a]	Train 1	Start	Q1 2016	Q1 2016	Q1 2016
		Plateau	Q2 2017	Q1 2017	Q4 2016
	Train 2	Start	Q1 2017	Q4 2016[a]	Q4 2016
		Plateau	Q3 2017	Q2 2017	Q1 2017
	Train 3	Start	Q4 2017	Q3 2017[a]	Q2 2017
		Plateau	Q2 2018	Q1 2018	Q4 2017
Wheatstone[a]	Train 1	Start	Q3 2017	Q2 2017[a]	Q1 2017
		Plateau	Q1 2018	Q4 2017	Q3 2017
	Train 2	Start	Q2 2018	Q1 2018[a]	Q4 2017
		Plateau	Q4 2018	Q3 2018	Q1 2018
Prelude FLNG[b]		Start	Q3 2018	Q2 2018[b]	Q1 2018
		Plateau	Q1 2019	Q4 2018	Q3 2018
Ichthys LNG	Train 1	Start	Q1 2018	Q3 2017[c]	Q2 2017
		Plateau	Q3 2018	Q1 2018	Q4 2017
	Train 2	Start	Q4 2018	Q1 2018	Q4 2017
		Plateau	Q2 2019	Q3 2018	Q2 2018

[a] Consistent with start-up times outlined by Chevron. Full reference details are provided in Appendix F.
[b] Consistent with start-up times outlined by Shell. Full reference details are provided in Appendix F.
[c] Consistent with start-up times outlined by INPEX. Full reference details are provided in Appendix F.

3.2 Potential gas supply forecast methodology

3.2.1 Base, Low, and High scenarios

Gas supply can be measured by total domestic gas production capacity. However, this does not represent an accurate picture of the actual volume of gas available to the WA domestic market. Reasons why potential gas supply forecasts may be lower than production capacity include:

- The cost of production may exceed the domestic gas price forecasts.
- Domestic gas producers with an LNG plant may be able to achieve higher returns by selling gas into the international market instead of the domestic market.
- Producers are not obliged to supply gas beyond the quantities in the domestic gas supply agreements they have with consumers. As a result, the availability of any additional gas is determined by the price the purchaser is willing to pay and the timing of the gas demand.

These factors have been taken into account in AEMO's forecasts of gas supply.

In developing the forecasts of potential gas supply, AEMO considered the total domestic gas production capacity to be the maximum level of gas supply that is available to the market, unless it is restricted by gas reserves. This figure was then adjusted to account for expected gas production facility outages and the quantity of gas reserves over the outlook period.

AEMO estimated the volume of gas covered by pre-existing gas supply agreements, based on:

- Gas supply contract data available to AEMO.
- Analysis of GBB data.
- Discussions with gas market participants.
- Industry research and subscriptions to gas related databases (such as Wood Mackenzie's upstream data service).
- Public announcements.

The volume of additional gas that may be available to the market was calculated based on the difference between domestic gas price forecasts and estimated production costs (including a 10% profit margin) for each individual gas supplier, acquired from Wood Mackenzie's upstream data service. A linear relationship was assumed between the domestic gas price and additional supply to the market, implemented as follows:

- LNG-linked facilities – incremental capacity is made available as the domestic gas price forecast increases, with all spare capacity available if the domestic gas price forecast reaches the delivered ex-ship (DES) LNG netback price shown in Table 18.
- Domestic gas only facilities – all spare capacity is made available if the forecast domestic gas price reaches the cost of production plus a required rate of return on investment.[47]
- No additional supply is made available to the market if the forecast domestic gas price is lower than the cost of production plus the required rate of return on investment.

An additional adjustment for non-contracted demand that is the difference between the contracted and the uncontracted demand was estimated.

The forecasts for each gas supplier and the additional adjustment were then aggregated to form the WA potential gas supply forecasts.[48]

AEMO assumed that sufficient pipeline capacity is available to the WA gas market, and included all existing gas suppliers unless a relevant producer has informed AEMO of a facility's impending closure. AEMO has assumed the 2P reserves to production ratios outlined in Section 4.8 are maintained at the current level.

The potential gas supply model assumed any uncontracted gas supplied by the NWS JV would be equity marketed from 2017, with the shares of gas production capacity for each participant of the NWS JV being split evenly. Once all NWS JV contracts expire in 2020, the entire domestic gas production capacity for NWS JV for each participant was split evenly.

Table 15 summarises key model inputs and assumptions.

[47] The estimated required rate of return is 25%.

[48] A producer that owns a share of more than one production facility may supply a contracted customer with gas from any of its facilities. The model allowed for joint and equity marketing where relevant.

Table 15 Potential gas supply model assumptions and inputs

Type	Description
Model assumptions	Domestic gas producers manage their operations as a portfolio.[a] LNG-linked domestic gas producers are assumed to have a share similar to its LNG JV. No constraints on pipeline capacity. Domestic gas producers will supply in excess of their contracted volumes to the domestic market only if commercially viable (more than 10% rate of return above of production costs). Linear relationship between additional supply and the domestic gas price. Equity marketing of gas continues throughout the outlook period for non-JV gas suppliers.[b] Reserves to production ratios of gas suppliers remain constant for the entire outlook period. Uncontracted domestic gas production capacity for the NWS JV from 2017 is split into existing contracts (joint venture) and equity marketed contracts. Post 2020, gas production capacity from NWS is equity marketed.
Model input	Estimated volume of gas to be supplied under gas supply agreements. Uncontracted gas production capacity (spare capacity). Remaining gas reserves, including gas fields not yet in production. The share of gas reserves available to each gas producer. Minimum operational requirements of gas production facilities. Estimated production costs of each WA production facility.[c] Available production capacity.[d] Required rate of return on investment.[e] Opportunity costs. Current and projected exchange rates. Government regulation including the WA domestic gas reservation policy.

[a] A producer that owns a share of more than one production facility may supply a contracted customer with gas from any of its facilities. The model allowed for joint and equity marketing where relevant.
[b] Joint marketing authorisation for Gorgon and the NWS expired on 1 January 2016 and was not renewed.
[c] AEMO estimated the production cost for each facility using the latest available cost estimates from Wood Mackenzie.
[d] Annual average available capacity for each facility, calculated using WA GBB data for the period 1 September 2015 to 31 August 2016.
[e] Assumed to be a minimum of 10%, and differed for LNG and domestic-only facilities.

3.2.2 Remaining gas reserves linked to domestic production facilities scenario

Given the uncertainty around available supply to the market from 2022, with multiple domestic production facilities facing reserve depletion, AEMO has developed an additional scenario for this WA GSOO – "Remaining gas reserves linked to domestic production facilities". This shows what may happen if no new gas fields were developed for the domestic market over the outlook period to replace depleted fields. This contrasts with the potential gas supply assumption that producers will continue to explore and develop gas reserves for the domestic gas market.

To develop this scenario, AEMO collected 2P gas reserves estimates on WA gas fields from Wood Mackenzie's upstream data service, and matched it to domestic gas production facilities. Existing gas supply contracts were accounted for, to determine a minimum level of supply from each production facility. This allowed AEMO to calculate the remaining life of each domestic gas production facility based on its current production rates and future contract positions.

The estimated volume of remaining reserves by gas field at the beginning of 2017 is shown in Table 16. AEMO has assumed:

- Domestic gas production capacities remain unchanged and only the volume of gas required to be set aside for the domestic market under the WA gas reservation policy would be available from the NWS, Gorgon and Wheatstone LNG projects.
- No additional gas fields will be developed.

Pluto has not been included in this scenario because AEMO is unclear about the timing, volume, and availability of gas reserves from this project.

AEMO cannot publish a facility breakdown for this scenario, due to the confidential nature of the gas supply contract information.

The “Remaining gas reserves linked to production facilities” scenario assumes that:

- Domestic-only production facilities cease production once reserves are depleted, with the exception of Xyris.
- LNG-linked facilities continue to operate to fulfil their domestic market obligations, and will only supply their existing gas supply contract quantities.

Table 16 Estimated remaining gas reserves by gas field, 1 January 2017[a]

Gas field	Domestic gas production facility	Gas reserves (PJ)
North West Shelf JV and domestic market obligation (DMO)	Karratha Gas Plant	672
Harriet	Varanus Island	6
John Brookes	Varanus Island	544
Halyard Spar	Varanus Island	233
Reindeer	Devil Creek	318
Macedon	Macedon	758
Gorgon DMO (estimated)[b]	Gorgon	2,000[d]
Wheatstone DMO (estimated)[c]	Wheatstone	1,912
Waitsia	Xyris	361
Total		**6,804**

Source: Wood Mackenzie and AEMO estimates.
[a] Domestic market obligations of domestic gas from Pluto JV is not included as it has not commenced. The gas reserves for Beharra Springs, Dongara and Red Gully have not been included in this estimate.
[b] Gorgon’s domestic market obligation is 2,000 PJ for the whole project.
[c] Wheatstone’s domestic market obligation is 15% of remaining gas reserves of 12,024 bcf, as reported by Wood Mackenzie.
[d] Gorgon phase 1 commenced operations in November 2016. This estimate does not account for Gorgon’s production between November and December 2016.

3.3 Input assumptions

There is a direct relationship between the economic environment and gas supply and demand in the WA market. Historically, gas supply and demand have been influenced by:

- The outlook for export-based commodities in the resources sector. Strong growth in commodity prices tends to stimulate investment in new mining operations and minerals processing facilities. Such investment has historically driven demand for gas in regional and remote WA.
- The productivity of large commercial and industrial loads, whose gas demand typically increases or decreases in line with changes in the level of economic activity in the South West region of WA.
- The level of discretionary spending by small gas users.
- Increased electricity demand, which in turn drives investment in new GPGs. The influence of this factor is expected to decrease as renewable generation technology becomes an attractive alternative to gas, and demand side responses, such as energy efficiency measures, and behind the meter generation from rooftop photovoltaics (PV), take effect. In addition, while gas is often considered to be well placed to assist in the transition to a low-emissions economy, WA already has a high proportion of GPG (approximately 60% of total SWIS generation capacity[49]).
- LNG export pricing and demand, which affects the domestic gas price and WA gas producers’ willingness to supply the domestic market.

Over the past decade, WA’s growth has been driven by investment in the resources sector, which peaked at $85 billion in 2013–14. The rate of economic growth has slowed in the last two years, as international commodity markets have softened and several large resources projects have transitioned from the construction to the production phase.

[49] Based on Capacity Credits assigned for the 2017–18 Capacity Year.

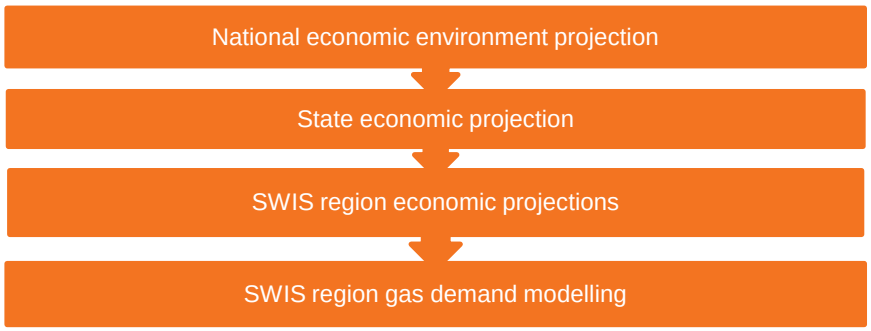
This section provides an overview of WA's forecast economic growth, AEMO's domestic price forecasts, and methodology. These economic assumptions are key inputs into the domestic potential gas supply and demand forecasts.

3.3.1 Economic outlook

Gas demand is driven largely by economic drivers and other external factors. This has been modelled by adopting the top-down econometric model summarised in Figure 12.

NIEIR's model incorporated economic indicators such as state final demand, GSP, government investment, private consumption, and population. NIEIR considered economic growth forecasts at a national, state, and regional level, which were then disaggregated into economic projections for WA and the SWIS and non-SWIS regions, as well as for the gas distribution networks.

Figure 12 NIEIR's top-down forecast methodology



NIEIR developed projections for the WA economy using data available up to September 2016. The Base economic outlook for the next five years shows a slowdown in growth (compared to recent history) for the next two years, followed by a return to a level approaching long-term average annual growth by the end of the outlook period.

Between 2016–17 and 2020–21, economic growth in WA is expected to slow in line with weaker international commodity markets. In recent years, WA's economy has been driven by construction of major resource projects. Many of these projects, including Gorgon LNG and the Roy Hill iron ore project, have commenced and are exporting commodities. Future economic growth in WA is therefore expected to be driven by increasing exports rather than construction expenditure (captured under business investment in the table below).

Commodity exports require less labour and investment than the construction of new projects, limiting projected growth in domestic labour demand for the next five years. Recent falls in commodity prices, particularly for iron ore and oil, are expected to constrain export earnings. This results in more conservative forecasts of economic growth compared to those published in the latest WA ESOO and the November 2015 WA GSOO.

NIEIR's forecasts of major economic indicators for the Base scenario for 2016–17 to 2021–22 are summarised in Table 17. Appendix A contains economic forecasts for the High and Low scenarios.

Table 17 Key economic indicator forecasts for WA, Base scenario, 2016–17 to 2021–22

	2016–17 (%)	2017–18 (%)	2018–19 (%)	2019–20 (%)	2020–21 (%)	2021–22 (%)	Average annual growth (%)
Private consumption	1.3	2.5	2.3	3.4	2.6	3.1	2.5
Private dwelling investment	-9.9	4.9	4.5	4.1	2.4	0.8	1.1
Business investment	-19.0	-8.7	-0.2	1.7	4.2	3.8	-3.0
Government consumption	3.0	2.9	2.6	2.2	2.3	2.5	2.6
Government investment	8.7	3.0	-4.0	-1.4	3.7	3.6	2.3
State final demand	-3.7	0.4	1.7	2.7	2.9	3.0	1.2
Gross state product	1.7	2.8	2.6	2.2	2.5	3.1	2.5
Population	1.2	1.1	1.4	1.5	1.5	1.5	1.4
Employment	0.5	0.9	1.4	1.2	1.0	1.1	1.0

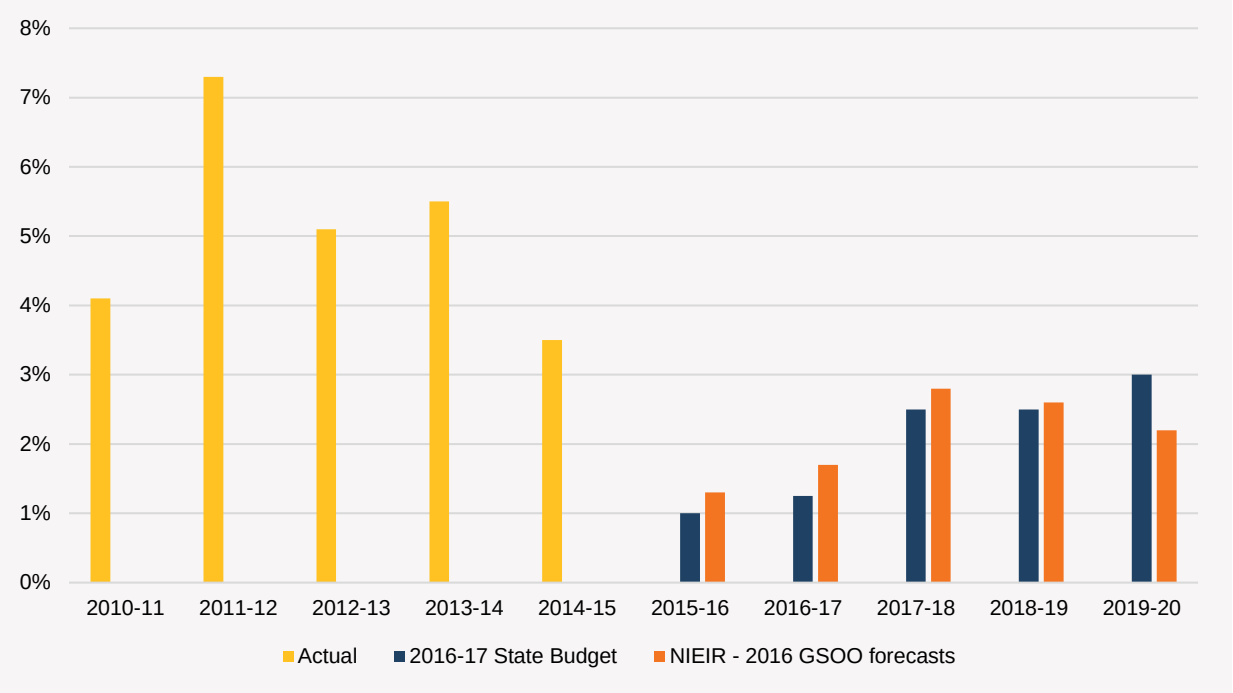
Source: NIEIR

In summary:

- Private dwelling investment is forecast to increase in 2017–18 as new housing projects commence construction.
- Business investment is projected to decline between 2016–17 and 2018–19, reflecting the completion of major iron ore and natural gas projects.
- Government investment is forecast to increase in 2016–17 and 2017–18, then to fall in 2018–19 and 2019–20 as major infrastructure projects such as the Perth Stadium ($1.4 billion) and Perth Children's Hospital ($1.2 billion) are completed.
- GSP is forecast to grow at an average annual rate of 2.5% between 2016–17 and 2021–22, supported by increasing commodity exports and private consumption expenditure.
- Population is forecast to increase in line with the long-term natural rate of population growth.

NIEIR's and the WA Treasury's GSP forecasts for 2016–17 to 2019–20 are compared in Figure 13. NIEIR's forecasts are slightly higher than Treasury's, although the difference is small (between 0.1 and 0.5 percentage points) between 2015–16 and 2018–19. The difference is larger for 2019–20, with Treasury forecasting growth of 3% compared to NIEIR's forecast of 2.2%.

Figure 13 Comparison of GSP forecasts, NIEIR and WA Treasury, 2010–11 to 2019–20



Source: ABS, NIEIR and WA Treasury. Full reference details are provided in Appendix F.

The differences between NIEIR and Treasury's forecasts are largely due to:

- Dwelling investment – NIEIR has higher projections than Treasury for new dwelling construction between 2017–18 and 2019–20.
- Government investment – Treasury expects a sharp fall from 2018–19, while NIEIR expects a more moderate decline.
- State final demand – NIEIR's forecasts are higher than Treasury's between 2016–17 and 2018–19.

3.3.2 Domestic gas price forecasts

AEMO's domestic gas price forecasts are indicative of an average WA domestic gas price. Actual negotiated prices are influenced by a range of commercial and competitive factors specific to the contracting parties. Short-term gas has not been considered in the forecasts, due to the relatively small scale and a lack of access to the data for the short-term market. The methodology below is the most practical means of estimating the average domestic gas price at this time.

Gas supply and demand forecasts are both price-sensitive, so the domestic gas price forecast is a key input. AEMO therefore produced a domestic gas price forecast to inform the supply and demand projections. As gas prices for each WA domestic gas supply contracts vary, an average domestic gas price (ex-plant)[50] for medium- to long-term contracts is forecast for each year of the outlook period. The domestic gas price forecasts exclude shipping costs.

AEMO considered the following variables when developing the domestic price forecasts for 2016 WA GSOO modelling:

- Future oil prices.
- Future DES LNG prices.
- Projected shipping and liquefaction costs.
- LNG netback prices.

[50] Ex-plant means at the point where each gas production facility meets that gas transmission pipeline.

- Projected exchange rates.
- Level of excess gas production capacity above forecast gas demand.
- Recoverable WA gas reserves.
- The WA domestic gas reservation policy.

Domestic gas price forecasts were based on projected international oil prices (Brent) and LNG DES price forecasts developed by Facts Global Energy (FGE) over the outlook period.

Oil price forecasts were converted into LNG DES prices using the following LNG pricing formula:

$$Price_{LNG} = \alpha + \beta Price_{Oil}$$

where:

- $Price_{LNG}$ is the long-term delivered contract price of LNG to the Asia Pacific market.
- α is the base price for the delivered contract price of LNG to the Asia Pacific market.
- β is typically referred to as the pricing slope, which determines the sensitivity of LNG prices to changes in the Brent oil price benchmark.
- $Price_{Oil}$ is the price of Brent oil, often measured as a lagged average of the Brent oil price. While most Asia Pacific LNG contracts contain different lags, this is assumed to fall within the same year.

The DES LNG prices are then adjusted to account for estimated shipping and liquefaction costs, exchange rates, the level of excess gas production capacity above forecast gas demand, the domestic gas reservation policy, and changes to forecast recoverable gas reserves, to estimate medium- to long-term domestic gas prices for each scenario. The prices derived for each scenario represent the likely range of average medium- to long-term[51] contract prices for each year of the outlook period.

The forecasts of the gas price parameters are shown in Table 18, and AEMO's forecast of medium-to long-term average (ex-plant) new contract gas prices for 2017 to 2026 is shown in Figure 14.

Over the outlook period, international oil prices, and consequently LNG prices, are expected to grow slowly. However, in 2020 and 2021, FGE forecasts oil prices to temporarily decrease because of increases in oil production capacity in previous years, partly offset by increasing economic activity in developed countries and a related increase in oil demand. Generally speaking, oil price variability is driven by the lag between demand growth and new supply being commissioned.

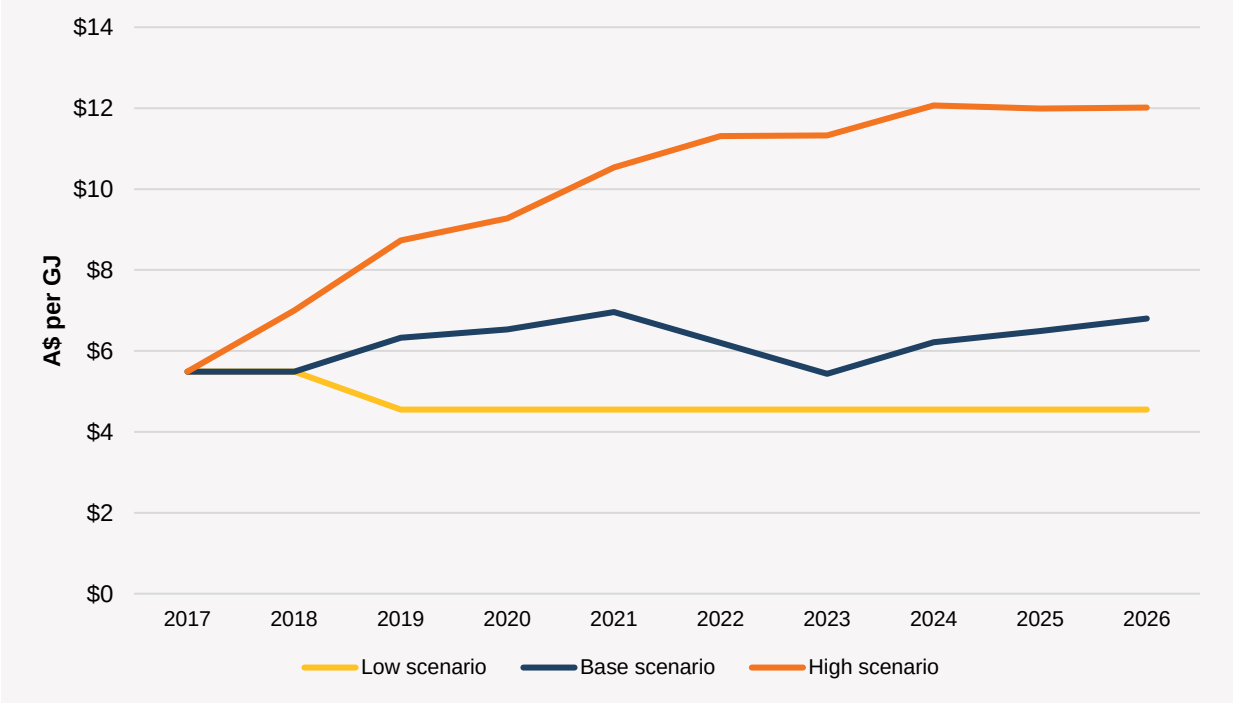
[51] A medium- to long-term gas contract is a gas supply agreement that has a term of four years or longer.

Table 18 Forecast gas price parameters, 2017 to 2026

Parameter	Scenario	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
International oil prices (Brent, US$/barrel)	Low	36.6	34.9	33.3	31.6	30.0	30.0	30.0	30.0	30.0	30.0
	Base	47.6	52.0	58.3	63.0	63.8	59.0	55.1	60.6	61.4	62.9
	High	56.9	65.2	73.4	81.7	90.0	90.0	90.0	90.0	90.0	90.0
DES LNG prices – real (US$/MMBtu)	Low	5.7	4.6	4.8	4.6	4.3	4.3	4.3	4.6	4.7	4.7
	Base	7.3	6.8	7.5	8.1	8.4	7.8	7.2	7.9	8.1	8.2
	High	8.6	8.5	9.6	10.6	11.5	11.5	11.3	11.4	11.5	11.5
Shipping and liquefaction costs (US$/MMBtu)	All	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Exchange rates (A$/US$)	All	0.73	0.68	0.64	0.65	0.66	0.67	0.69	0.70	0.71	0.71
Recoverable reserves (bcm)	Low	4,439	4,403	4,357	4,309	4,255	4,197	4,136	4,072	4,005	3,937
	Base	4,435	4,398	4,355	4,309	4,257	4,201	4,140	4,076	4,010	3,942
	High	4,429	4,392	4,352	4,308	4,258	4,203	4,142	4,079	4,012	3,944

Source: FGE, Wood Mackenzie and NIEIR

Figure 14 Forecast medium- to long-term average (ex-plant) new domestic contract gas prices (real), 2017 to 2026



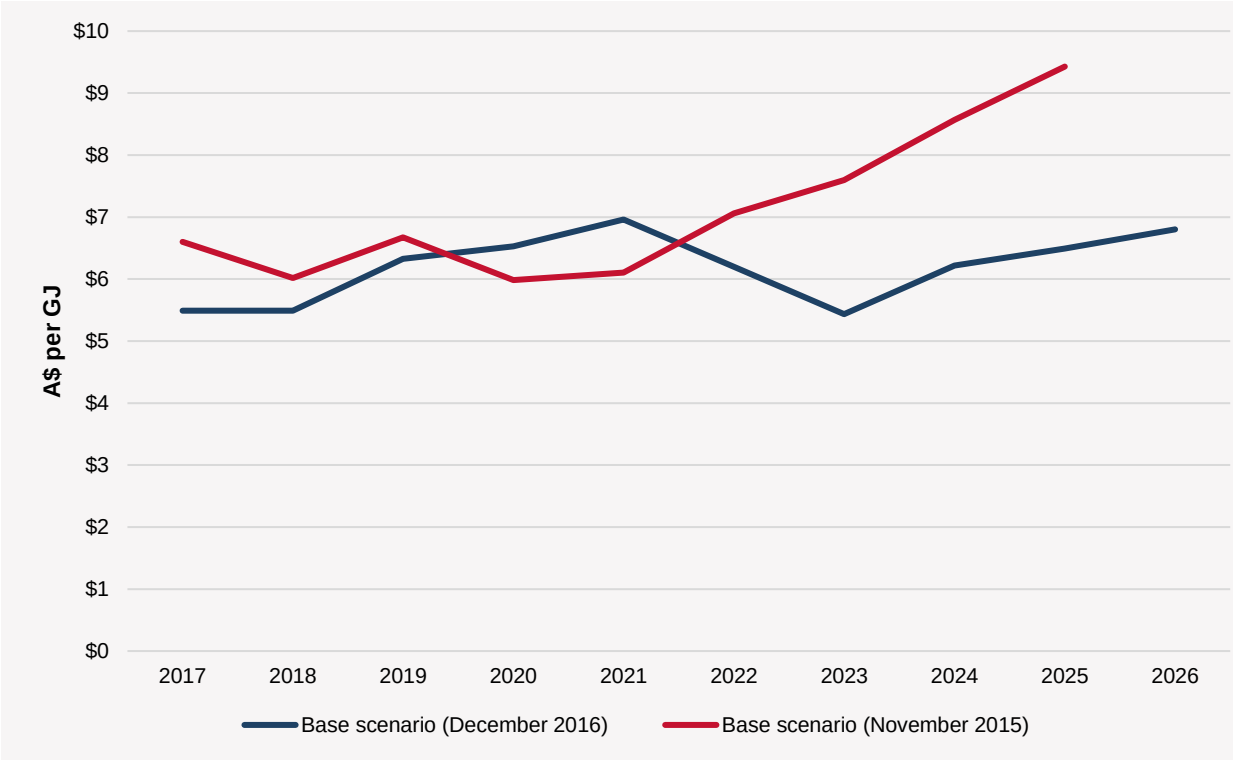
In summary, AEMO projects that, for the Base scenario:

- Domestic gas prices will remain relatively flat between 2017 and 2026, due to the slower than expected recovery of international oil prices than the November 2015 GSOO and the expected weakening of the Australian dollar.
- The US economy is expected to remain weak. There are likely to be increases in US interest rates relative to Australian interest rates, driving an appreciation of the Australian dollar, which will

increase LNG netback prices in Australian dollar terms. This is expected to drive increases to WA domestic gas price forecasts, despite continued low forecasts for Asia Pacific LNG prices.

Figure 15 shows the comparison between the average new medium- to long-term contract gas price projections developed for the Base scenario for the November 2015 WA GSOO and this report. The main driver for a sharp decrease in forecast domestic gas prices since the previous WA GSOO is that international oil prices are projected to remain weak after 2021, and excess WA domestic gas production capacity is projected to keep WA domestic gas prices in the $5 to $7 per gigajoule (GJ) range.

Figure 15 Comparison of the Base scenario medium- to long-term forecast contract prices (real), November 2015 and December 2016 GSOOs, 2017 to 2026



CHAPTER 4. FORECASTS

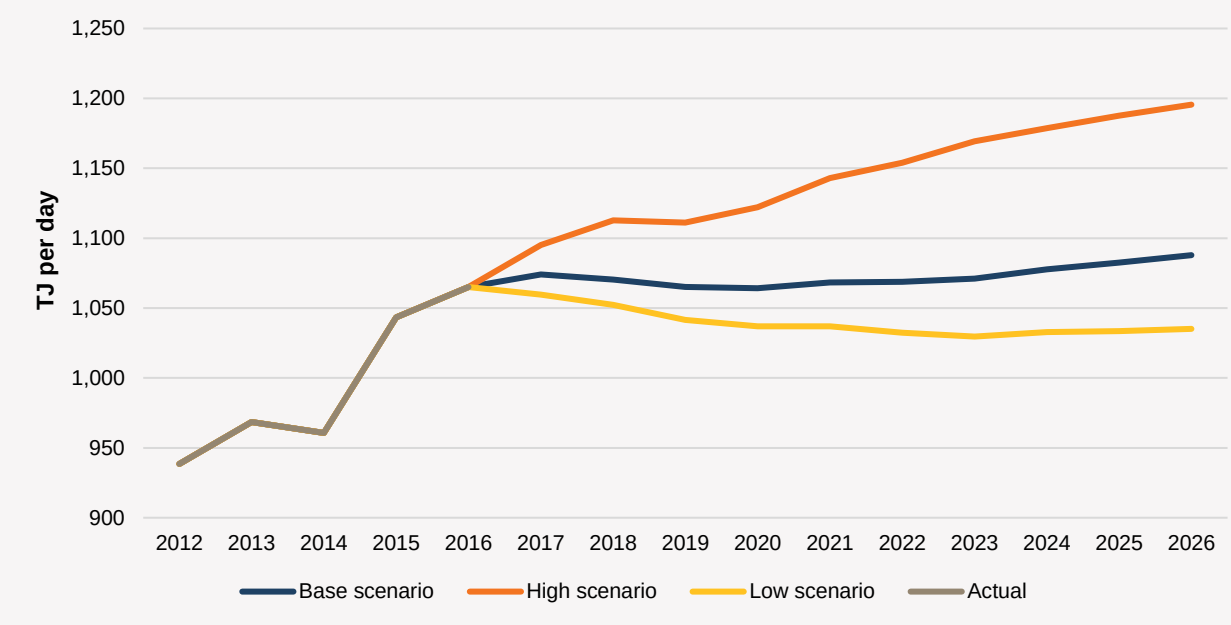
This chapter presents the following forecasts for the WA gas market over the outlook period from 2017 to 2026:

- Annual gas demand and potential gas supply.
- Peak demand forecasts for summer and winter.
- Domestic gas supply.
- Supply-demand balance.
- Total gas demand (combining domestic demand, LNG exports, and LNG processing forecasts).
- Gas reserves.

4.1 Domestic demand forecast

The Low, Base, and High domestic gas demand forecasts for the outlook period are shown in Figure 16 and Table 19.

Figure 16 Domestic gas demand forecasts, 2017 to 2026



Source: NIEIR

Table 19 Forecast gas demand (TJ per day), 2017 to 2026

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	5 year average growth pa (%)	10-year average growth pa (%)
Low	1,060	1,052	1,042	1,037	1,037	1,032	1,030	1,033	1,034	1,060	-0.5	-0.3
Base	1,074	1,070	1,065	1,064	1,068	1,069	1,071	1,078	1,083	1,088	-0.1	0.1
High	1,095	1,113	1,111	1,122	1,143	1,154	1,169	1,179	1,188	1,196	1.1	1.0

Source: NIEIR

In the Base and Low scenarios, domestic gas demand is forecast to fall over the next four years, largely due to a decline in mining activities for some small mines, associated with lower commodity prices. This is projected to be largely offset by the commencement of several projects, including:

- Newman Power Station, which commenced supplying electricity to Roy Hill's iron ore mine in 2015.
- Goldfields' Granny Smith and Saracen Minerals' Thunderbox mines being connected to the GGP in 2016.
- The commissioning of CITIC Pacific's final two concentrators for the Sino Iron magnetite mine by the end of 2016.[52]
- South Hedland Power Station, which will supply electricity to Fortescue Metals Group's port operations in Port Hedland and Horizon Power's customers in the North West Interconnected System from 2017 and will replace the Pilbara Temporary Power Station.
- The Wheatstone joint venture (JV) commissioning its LNG facility in 2017 and then becoming a gas producer in 2018.
- Tianqi Lithium Australia's new lithium processing facility in Kwinana, due to commence operation from late 2018.[53]

These projects have been included in the Low, Base, and High scenarios, because they are either operating or are considered certain to proceed based on public announcements. From 2021 until the end of the outlook period, domestic gas demand is expected to increase, driven by a forecast recovery in mining activities.

In the High scenario, domestic gas demand is expected to increase throughout the outlook period, supported by demand from five prospective projects. These projects, if they proceed, are projected to consume a total of 45 TJ per day once fully operational (see Section 3.1.1 for more information).

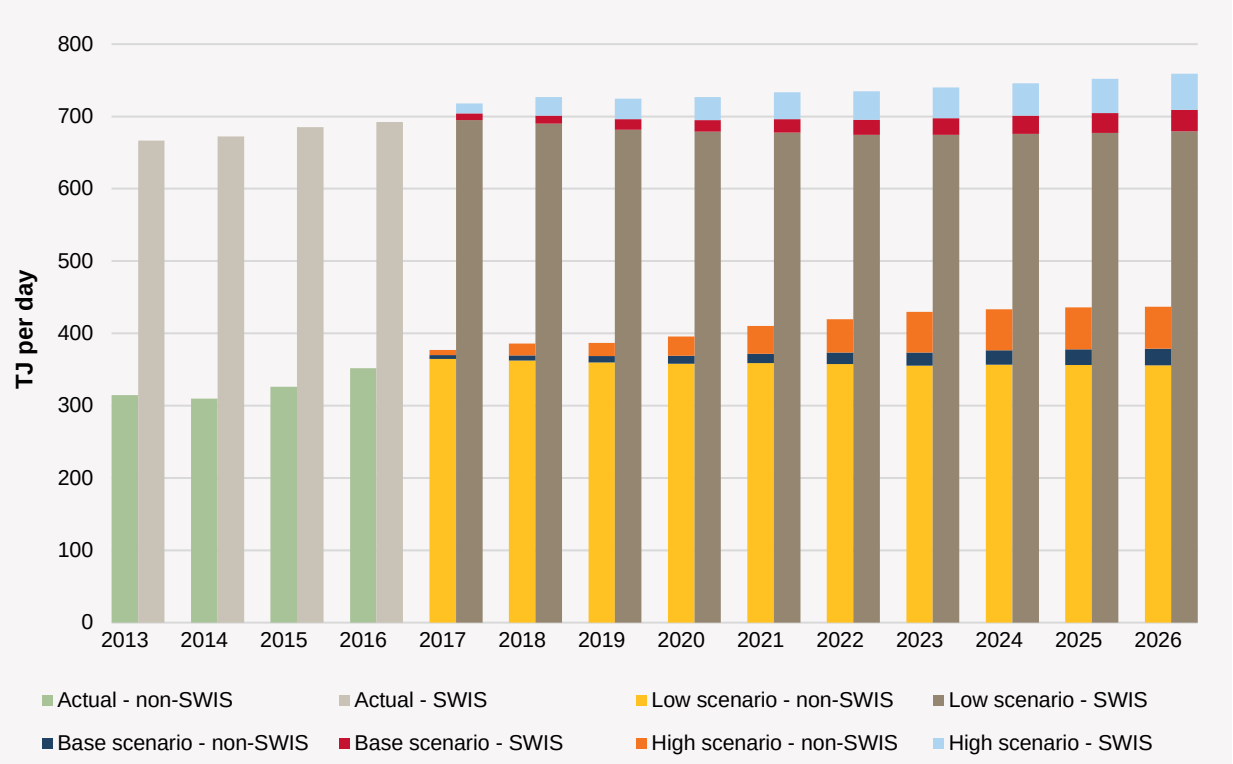
4.1.1 Gas demand by area, 2017 to 2026

Domestic gas demand growth is expected to be higher in areas outside of the SWIS than those that are connected to the SWIS. Forecasts for the Base and High scenarios for the SWIS and non-SWIS areas are shown in Figure 17 and Table 20.

[52] Citic Pacific media release, "Construction Milestone at Sino Iron", 26 May 2016. Available at: http://www.citicpacificmining.com/resources/attachments/20160527144601-Construction%20Milestone%20at%20Sino%20Iron.pdf. Viewed: 27 October 2016.

[53] Government of Western Australia media release, "$400 million Kwinana lithium project underway", 12 October 2016. Available at: https://www.mediastatements.wa.gov.au/Pages/Barnett/2016/10/400-million-Kwinana-lithium-project-underway.aspx. Viewed: 27 October 2016.

Figure 17 Actual gas demand and forecasts for SWIS and non-SWIS areas, 2013 to 2026



Source: NIEIR

Table 20 Domestic gas forecasts for SWIS and non-SWIS (TJ per day), 2017 to 2026

		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	5 year average growth pa (%)	10-year average growth pa (%)
SWIS	Low	695	690	682	679	678	675	674	676	677	679	-0.6	-0.3
	Base	704	701	696	695	696	695	698	701	705	709	-0.3	0.1
	High	718	727	725	727	733	735	740	746	752	759	0.5	0.6
Non-SWIS	Low	365	362	360	358	359	358	355	357	356	356	-0.4	-0.3
	Base	370	369	369	369	372	373	374	377	378	379	0.1	0.3
	High	377	386	387	396	410	420	430	433	436	437	2.1	1.6

Source: NIEIR

Gas demand in the SWIS is forecast to decline in the Low scenario and increase slowly in the Base and High scenarios, largely due to different assumptions about gas use for electricity generation. The forecasts assume that GPGs are displaced by continued growth in installed small-scale rooftop PV systems.

Projected growth outside of the SWIS, by contrast, is largely driven by increases to gas demand relating to improvements in the WA mining sector outlook. The Base and High gas demand scenarios considered this in the forecasts. The High gas demand scenario for the non-SWIS includes a selection of three new prospective projects (see Section 3.1.1 for more information).

Opportunities in the SWIS and non-SWIS

There are more opportunities for gas producers to supply customers located in non-SWIS areas than in the SWIS, given the gas demand forecasts shown in Table 20.

Although around two-thirds of domestic gas is used in the SWIS, the large customers in the SWIS that account for most of this demand are not expected to increase consumption in the near future. Large gas consumers in the SWIS include minerals processing (Alcoa's Kwinana, Wagerup, and Pinjarra alumina refineries and BHP's Kwinana nickel refinery) and electricity generators (such as Kwinana and Cockburn power stations). Growth in these sectors is expected to remain flat over the outlook period, with no major expansions at the refineries in the Low and Base scenarios, and slow growth in electricity demand, as forecast in the latest ESOO. In addition, the current level of excess capacity in the SWIS (about 642 MW for the 2017–18 Capacity Year) suggests that no new GPGs will be required over the outlook period.

AEMO has included two proposed industrial projects located in the SWIS in the prospective gas demand forecast. Given the level of excess electricity generation capacity, any other major projects are considered likely to connect to the SWIS rather than install an onsite GPG.

In contrast, AEMO forecasts gas demand to grow in the non-SWIS area in the Base and High scenarios. Most forecast gas demand in the non-SWIS area is from mines (such as CITIC Pacific's Sino iron project) or industrial plants (such as Yara Pilbara Fertiliser's Burrup ammonium nitrate production facility). These projects will be unable to draw on the excess electricity generation capacity in the SWIS, and must be self-sufficient for electricity generation. Currently, around 3,519 MW of GPG capacity is located outside of the SWIS, at remote mine sites and in regional centres (such as Halls Creek and Leonora).

In many instances, the choice of fuel type for onsite generation in the non-SWIS area is restricted to diesel or gas. The cost of transporting coal to remote locations is not commercially viable, while renewable generation alone is often insufficient to meet a facility's energy needs without some form of energy storage. Currently, diesel is more expensive than gas, which may encourage project proponents to choose gas, especially if their project is located near a gas transmission pipeline.

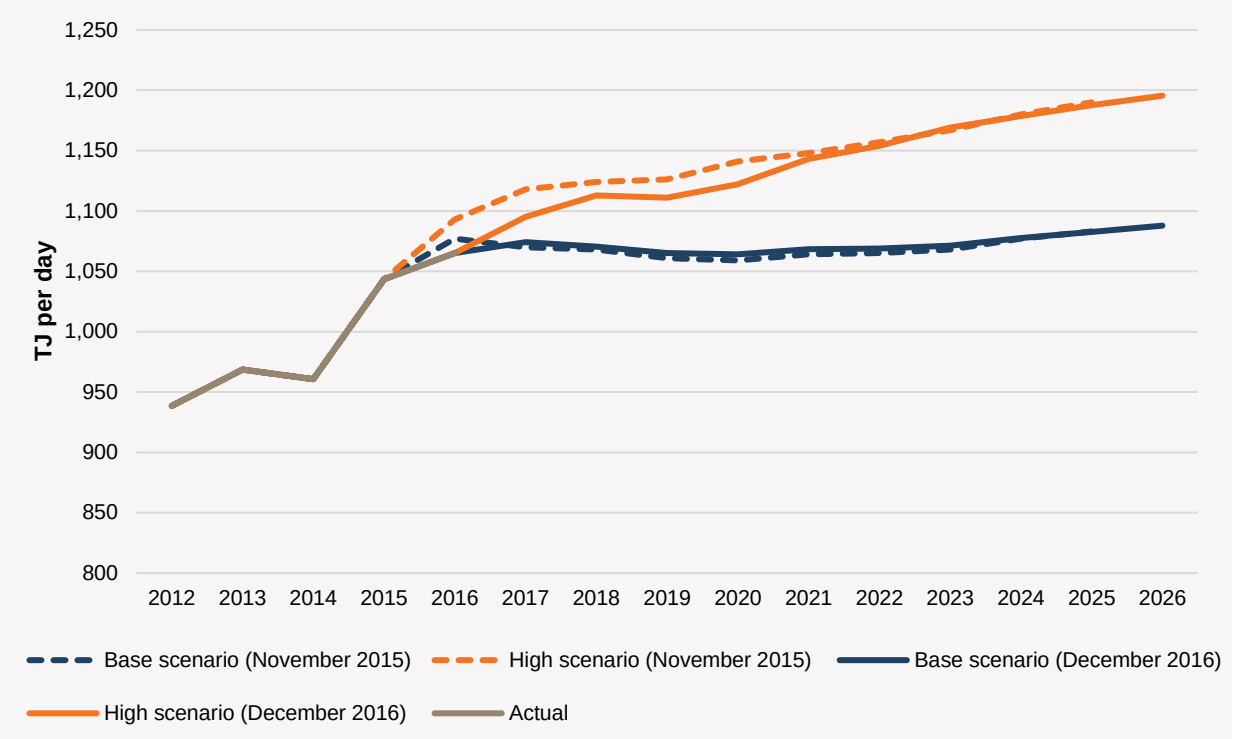
There is about 444 MW of diesel-fuelled generation capacity in the non-SWIS area. Some of this generating capacity may be converted to consume gas, particularly if diesel remains more expensive. AEMO considers that Chichester Hub operated by Fortescue Metals Group (FMG), which includes Christmas Creek and Cloudbreak mines), is likely to connect to GPG in the future. This could be done either by converting the existing 88 MW of diesel generation to a GPG, or by building a transmission line to connect Chichester to Solomon Power Station.

Further diesel to gas conversions would depend on the cost of constructing pipeline infrastructure or the availability of mobile CNG or LNG technology, as well as the cost of diesel compared to natural gas.

4.1.2 Comparison of 2015 and 2016 domestic gas demand forecasts

The Base scenario forecast presented in this report is slightly higher than the forecast published in the November 2015 WA GSOO. Lower decreases to mining activities, and an improved outlook for WA commodities, have improved the gas demand forecasts for both the Base and High scenarios over the outlook period, as shown in Figure 18.

Figure 18 Domestic gas demand forecasts, 2017 to 2026



Source: NIEIR

In the Base scenario, gas demand is now expected to:

- Decrease at an average annual rate of -0.1% over the next five years, compared to -0.2% forecast in the November 2015 WA GSOO.
- Be higher than in the November 2015 WA GSOO forecast over the entire outlook period.

In contrast, the High gas demand scenario presented in this report is:

- Slightly lower than the 2015 High gas demand scenario.
- Mainly lower as a result of changes to the prospective gas demand forecasts. Two prospective demand projects that were included in the 2015 forecast have commenced operations, but at a lower level of consumption than forecast. The five prospective gas demand projects identified in 2016 are forecast to commence operation towards the end of the outlook period (2018 to 2023).

AEMO estimates that actual gas demand for 2016 is in line with the November 2015 WA GSOO forecasts. Based on 2015–16 actual gas consumption reported by the Department of Mines and Petroleum (DMP), actual gas consumption for 2015–16 is 4 PJ (around 1%) lower than the November 2015 forecast.

4.2 Domestic peak gas demand forecast

The peak domestic gas demand forecasts are shown in Table 21 and Table 22.

Table 21 Forecast 1-in-2 (50% probability of exceedance (POE)) summer and winter peak gas demand (TJ per day), 2017 to 2026

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	5 year average growth pa (%)	10-year average growth pa (%)
Summer	1,215	1,224	1,218	1,218	1,222	1,221	1,222	1,229	1,235	1,241	0.2	0.2
Winter	1,205	1,205	1,200	1,199	1,204	1,204	1,207	1,215	1,220	1,227	0.0	0.2

Source: NIEIR

Table 22 Forecast 1-in-20 (95% POE) summer and winter peak gas demand (TJ per day), 2017 to 2026

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	5 year average growth pa (%)	10-year average growth pa (%)
Summer	1,225	1,233	1,228	1,227	1,233	1,231	1,232	1,239	1,244	1,251	0.2	0.2
Winter	1,221	1,221	1,216	1,216	1,221	1,221	1,224	1,231	1,237	1,244	0.0	0.2

Source: NIEIR

There is little difference between the summer and winter peak gas demand forecasts, with both expected to grow at around 0.2% per annum over the outlook period. The summer peak is subsequently expected to remain higher than the winter peak.

Both the summer and winter domestic demand peaks are driven by weather and associated use of appliances for heating and cooling:

- The winter peak is correlated with cold weather in the South West region, which leads to gas demand for residential heating, as well as use of reverse-cycle electric air-conditioners for heating.
- The summer peak is associated with increases in GPG consumption due to high electricity demand for cooling appliances in the SWIS.

4.3 Domestic supply forecast

4.3.1 Projected gas production capacity

The domestic gas production capacity forecasts over the outlook period are shown in Figure 19.

In summary:

- Domestic gas production capacity is estimated to increase from 1,633 TJ per day at the end of 2017 to 1,977 TJ per day by the end of 2026.[54]
- The KGP is expected to remain the largest domestic gas production facility in WA, retaining almost one-third of the total gas production capacity at the end of 2026.
- AWE Limited has indicated to the WA domestic gas market that it intends to expand Xyris gas production capacity from 10 TJ per day to between 30 and 100 TJ per day.[55] AWE Limited expects a final investment decision (FID) to be made during 2017.[56]
- No existing domestic gas production facility is expected to retire. However, due to dwindling gas reserves associated with the Beharra Springs and Dongara gas production facilities, these facilities may cease production once their existing gas supply contracts expire.[57] Any potential closures

[54] The forecast capacity only considers domestic gas production capacity that is announced. Prospective domestic gas supply from Pluto JV and Browse, Yulleroo, Warro, and other expansions are not considered in the supply forecasts for this GSOO, due to a lack of certainty on the timeframes associated with their potential contribution to domestic gas supply.

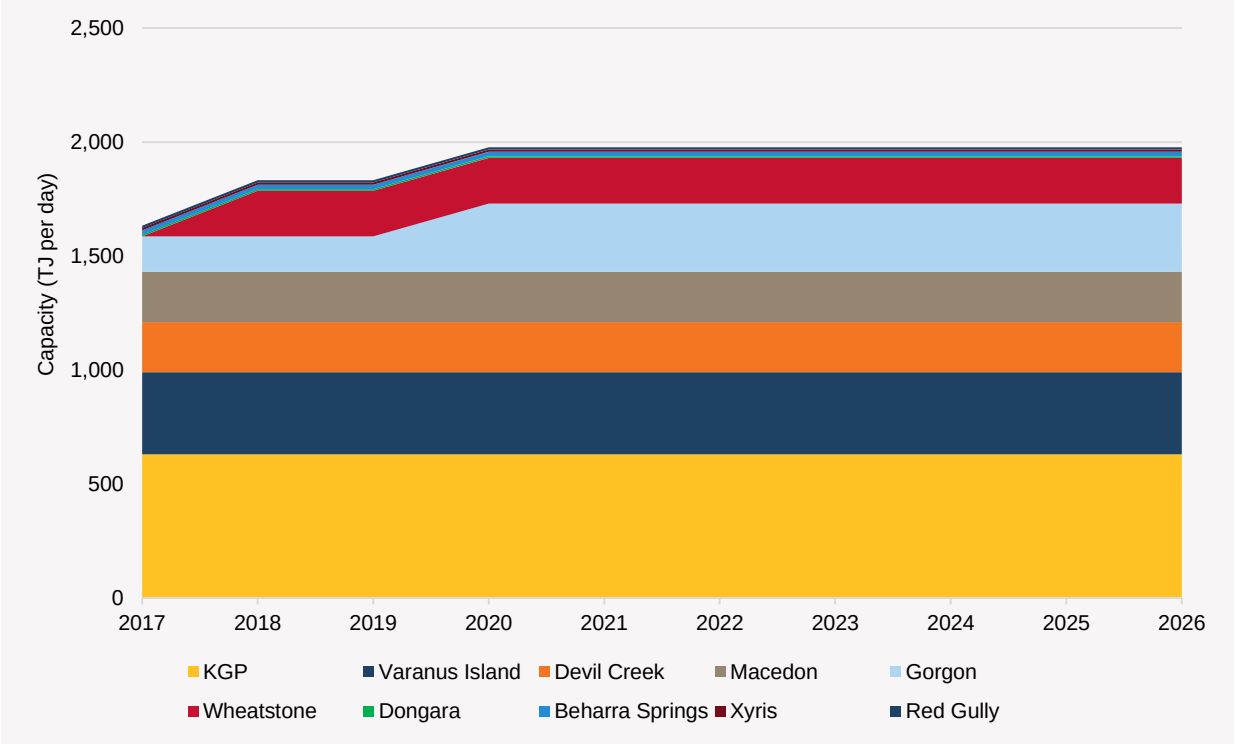
[55] The 30 TJ per day volume is an estimate of the gas production outlook outlined in AWE's presentation slides for the Good Oil Conference on 13 September 2016, while the 100 TJ per day volume is in their annual report published on 14 October 2016.

[56] Outlined on page 14 of AWE Limited's 2016 annual report. Full reference details are provided in Appendix F.

[57] According to AWE Limited's 2016 annual report, work has commenced to decommission legacy infrastructure in the Perth Basin.

have been excluded from the Low, Base, and High scenarios. Further information is available in Section 4.8.

Figure 19 Gas production capacity forecasts, 2017 to 2026[a]



Source: AEMO estimates based on GBB data and various corporate websites.
[a] Gorgon domestic phase 2 is expected to commence in 2020 and Wheatstone domestic 2018.

4.3.2 Potential gas supply forecast

The forecasts under Low, Base, and High potential supply scenarios, as well as the "Remaining gas reserves linked to domestic production facilities" scenario, are outlined in Figure 20 and Table 23.

The differences between the Low, Base, and High scenarios are due to different average gas price forecasts for medium- to long-term domestic gas contracts (see Section 3.3.2 for more information).

The "Remaining gas reserves linked to domestic production facilities" scenario assumes that no new gas fields are developed, and production facilities cease production as gas reserves are depleted.

Figure 20 Potential gas supply forecasts and remaining gas reserves linked to domestic production facilities scenario, 2017 to 2026

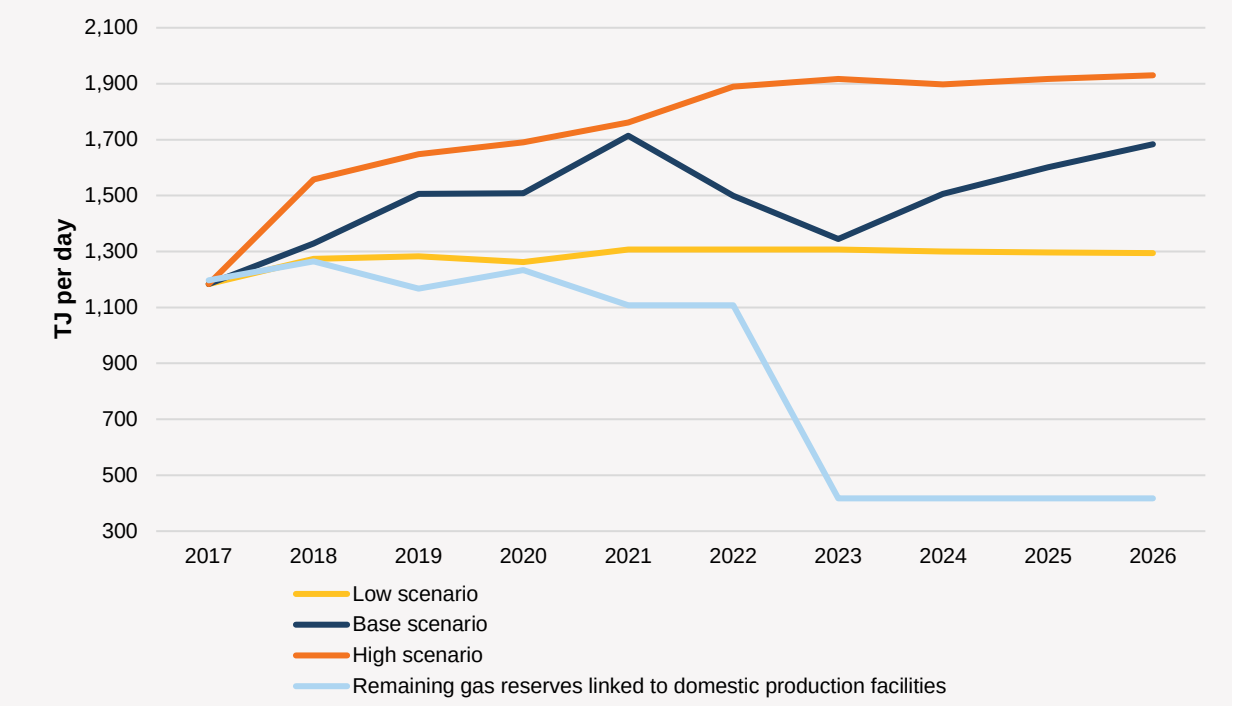


Table 23 Potential domestic supply forecasts (TJ per day), 2017 to 2026

Scenario	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	5 year average growth pa (%)	10-year average growth pa (%)
Low	1,184	1,274	1,283	1,262	1,307	1,307	1,307	1,300	1,297	1,295	2.5	1.0
Base	1,184	1,329	1,506	1,508	1,714	1,500	1,345	1,506	1,601	1,684	9.7	4.0
High	1,184	1,557	1,648	1,690	1,761	1,889	1,917	1,897	1,917	1,930	10.4	5.6
Remaining reserves	1,197	1,265	1,167	1,234	1,108	1,108	417	417	417	417	-1.9	-11.1

Potential gas supply is forecast to increase between 2017 and 2020, with the commissioning of Wheatstone and Gorgon phase 2. Between 2021 and 2023, lower potential gas supply is projected to be largely driven by lower domestic gas price forecasts. This in turn lowers the gas producers' expected willingness to supply, even though production capacity is expected to increase over that period. A lower average domestic gas price forecast means domestic gas producers may consider it uneconomic to supply to the domestic market, or may only agree to provide gas through short-term, lower priced contracts that depend on the remaining quantity of uncontracted gas reserves.

Towards the end of the outlook period, oil prices are expected to recover to about US$63 per barrel. This would drive a higher LNG net back price and, in turn, result in higher domestic gas price forecasts, which are projected to lead to higher potential gas supply.

The Low, Base, and High potential gas supply scenarios assume gas reserves are replenished throughout the outlook period as domestic gas price forecasts remain higher than estimated production costs.

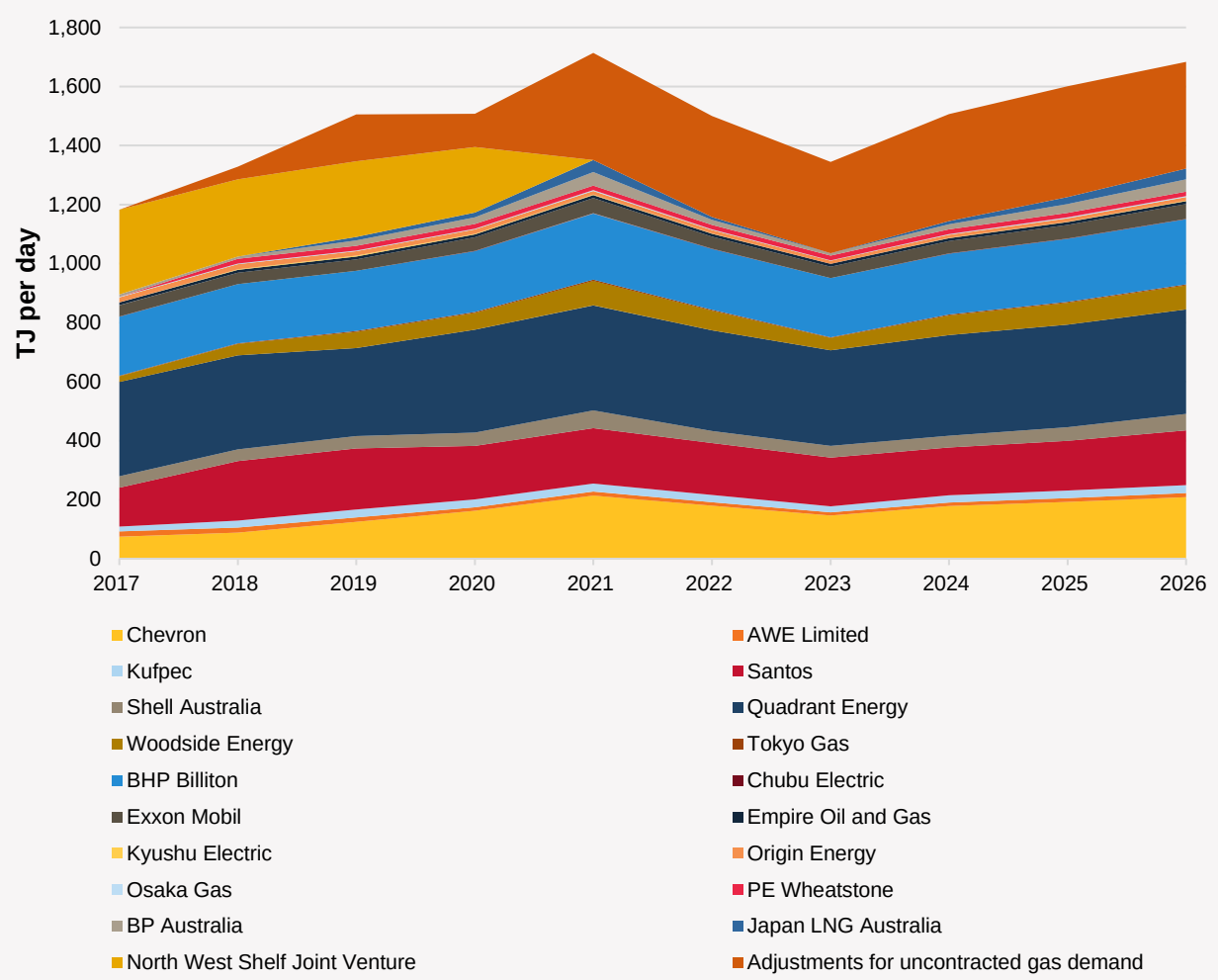
In contrast, the "Remaining gas reserves linked to domestic production facilities" scenario assumes no new gas fields are developed to replace depleted fields. Under this scenario, gas supply is projected to fall by around 690 TJ per day between 2022 and 2023, as several domestic-only production facilities

are assumed to cease production, and only Gorgon, Wheatstone, and Xyris, as well as some production from the NWS, would remain.

4.3.3 A breakdown of the Base scenario for potential gas supply

A breakdown by company for the Base scenario potential gas supply forecast is shown in Figure 21. The potential gas supply forecasts of each gas producer over the outlook period include contracted gas supply to the WA gas market and an adjustment for uncontracted gas supply.

Figure 21 A breakdown of 2016 Base scenario potential domestic gas supply forecasts

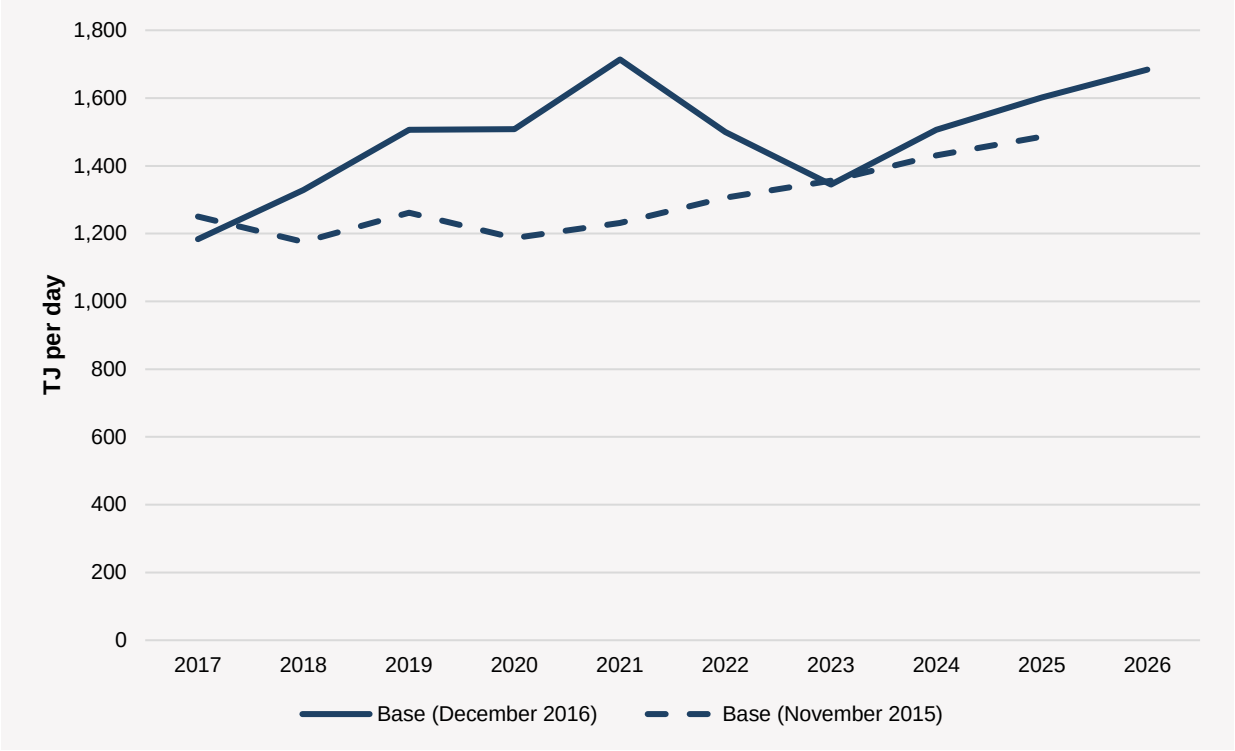


If the potential gas supply model's adjustments for uncontracted gas demand are removed, the model shows a potential supply short-fall in the domestic gas market from 2021.

4.3.4 A comparison of 2015 and 2016 potential gas supply forecasts

The potential Base scenario supply forecast for the outlook period is compared with the potential gas supply forecasts for the Base scenario developed for the 2015 November GSOO, as shown in Figure 22.

Figure 22 2015 and 2016 Base scenario potential domestic gas supply forecasts



The 2016 potential gas supply forecasts are higher than the forecasts in the November 2015 WA GSOO. This is attributed to:

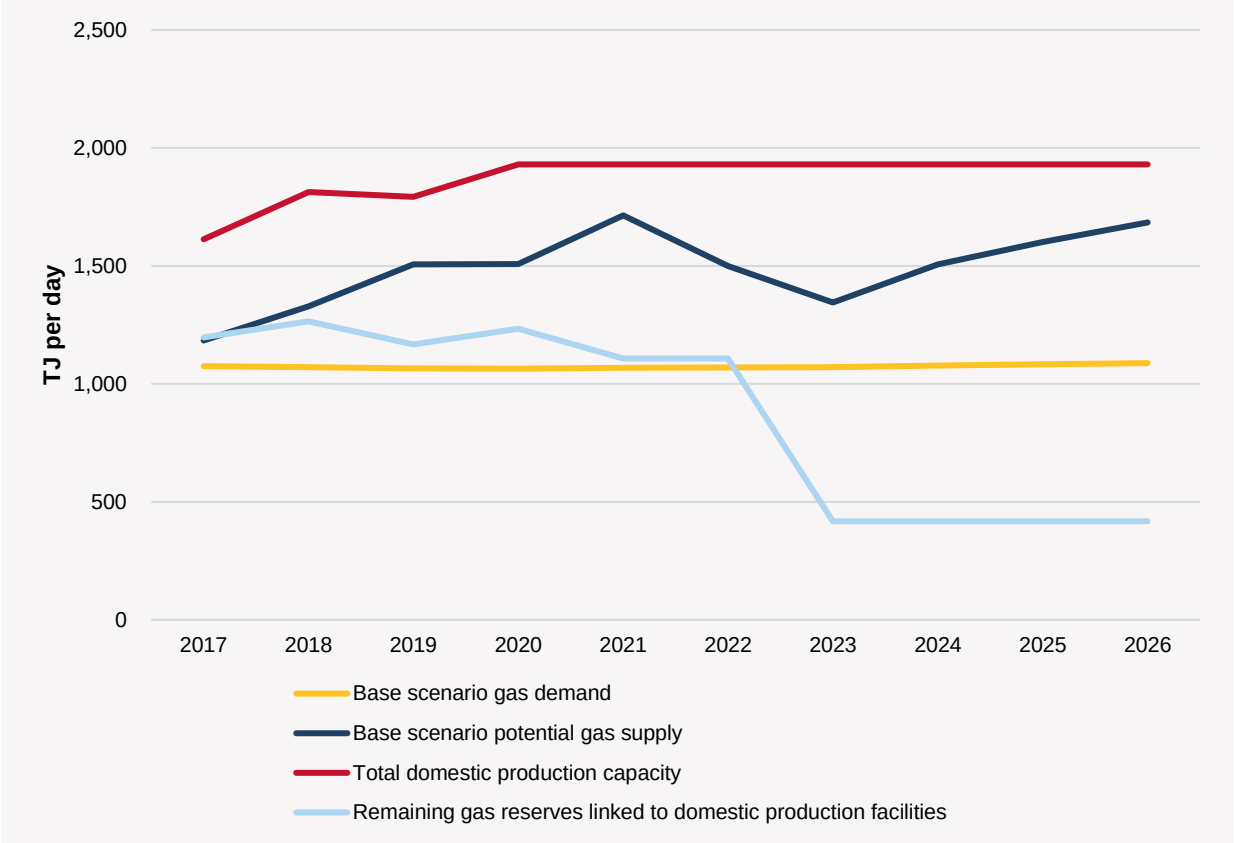
- Higher oil price forecasts.
  - The 2016 price forecasts, provided by FGE, project oil prices recovering from around US$48 a barrel in 2017 to roughly US$64 a barrel by 2021.
  - In comparison, last year's forecasts, prepared by NIEIR, forecast oil prices to remain almost unchanged at US$54 over the same period.
- Changed expected commencement dates for Gorgon phase 1. In the November 2015 GSOO, Gorgon phase 1 was expected to commence in early 2016. Gorgon phase 1 commenced operations in November 2016.
- Forecast changes to gas supply contractual agreements, exchange rate assumptions, and shipping and liquefaction costs, and a projected decline in gas production costs, over the outlook period.

Forecast domestic gas prices are slightly higher than those forecast in the November 2015 WA GSOO, largely a result of higher oil price forecasts for the 2017 to 2021 period. However, the oil price forecast from 2022 onwards is lower than was forecast in the November 2015 WA GSOO.

4.4 Domestic gas market supply-demand balance

The gas market balance for the Base supply and demand scenarios over the outlook period is shown in Figure 23.

Figure 23 Gas market balance, 2017 to 2026



Source: AEMO and NIEIR

The slight increases in gas demand forecasts are matched by an increase in the potential gas supply forecasts. As a result, AEMO expects the domestic gas market to remain oversupplied until 2021. However, from 2022, this is subject to the continued development of gas reserves to replace depleted fields.[58]

The "Remaining gas reserves linked to domestic production facilities" scenario shows what may happen if no new gas fields were developed for the domestic market over the outlook period to replace depleted fields. This scenario projects that the domestic gas market may be undersupplied by up to 600 TJ per day from 2023, as production facilities may not be able to supply to the market due to a lack of gas feedstock.

Excess gas supply projections from 2017 to 2021 depend on the commencement timing of Gorgon phase 2 and Wheatstone domestic gas production facilities. The domestic gas market may face short-term gas supply constraints in 2017 or 2018 if there are delays to the commencement of the Wheatstone domestic gas production facility.

[58] 2016 WA GSOO modelling assumed that gas reserves for all WA domestic gas production facilities remain fairly constant over the outlook period, except in the "Remaining gas reserves linked to domestic production facilities" scenario.

4.5 Other prospective WA gas supply

Although forecast production capacity is expected to exceed demand over the outlook period, domestic gas may be supplied to the market from prospective LNG projects, due to the WA Government's domestic gas reservation policy.

Prospective potential sources of new domestic gas supply are discussed below. Given the uncertainty about these projects, they have not been included in AEMO's forecasts of potential gas supply presented in this report.

Pluto LNG

Under an agreement between the State Government and the JV partners, 15% of gas reserves must be retained for the domestic market from 12 May 2017.[59] AEMO understands, based on engagement with the WA Department of State Development, that it is unclear when and how domestic gas from the Pluto JV will be supplied to the market.

Woodside must reserve 15% of the LNG production from Pluto and make it available to the domestic gas market during the project's lifetime, which, according to Wood Mackenzie, is expected to be 2035. Based on the domestic gas price forecasts in Section 3.3.2 and Wood Mackenzie's production cost estimates[60] for the Pluto project, AEMO considers it is unlikely that Pluto will supply the domestic gas market over the outlook period.

As such, gas supply from the Pluto JV has not been included in AEMO's potential gas supply forecasts, due to the lack of certainty regarding potential timeframes, availability and quantity. Potential gas supply may be higher than forecast if gas becomes available from the Pluto JV participants during the outlook period.

Other prospective gas supply

Other prospective domestic gas supplies that may be operational by the end of the outlook period are shown in Table 24.

Table 24 Other WA domestic gas suppliers that may be operational or upgraded by 2026

Potential domestic gas supplier	Gas field	Is gas production capacity contracted?
Browse JV participants	Torosa	Information is not publicly available.
Transerv Energy	Warro	Conditional gas supply agreement with Alcoa.
Buru Energy	Yulleroo/Valhalla	Information is not publicly available.

While these prospective gas supply projects appear to be well advanced, it currently appears unlikely that any of these projects will commence over the outlook period, unless commercially viable domestic gas supply agreements have been signed with these entities.

4.6 Total gas demand forecasts (domestic and LNG exports and LNG processing)

The Low, Base, and High scenarios for total gas demand for 2017 to 2026 are shown in Figure 24 and Table 25. Total gas demand is the aggregate of domestic gas demand forecasts, LNG export, and LNG processing forecasts, based on the assumptions outlined in Section 3.1.2.

[59] WA Parliament, Economics and Industry Standing Committee, *Inquiry into domestic gas prices*, Report No. 6, 2011, page 79. Available at: http://www.parliament.wa.gov.au/publications/tabledpapers.nsf/displaypaper/3813232af0e096cabecf9c8e4825785e0004c326/$file/3232.pdf. Viewed: 17 November 2016.

[60] Based on cost estimates from Wood Mackenzie's upstream data service.

Figure 24 Total gas demand forecasts, 2017 to 2026

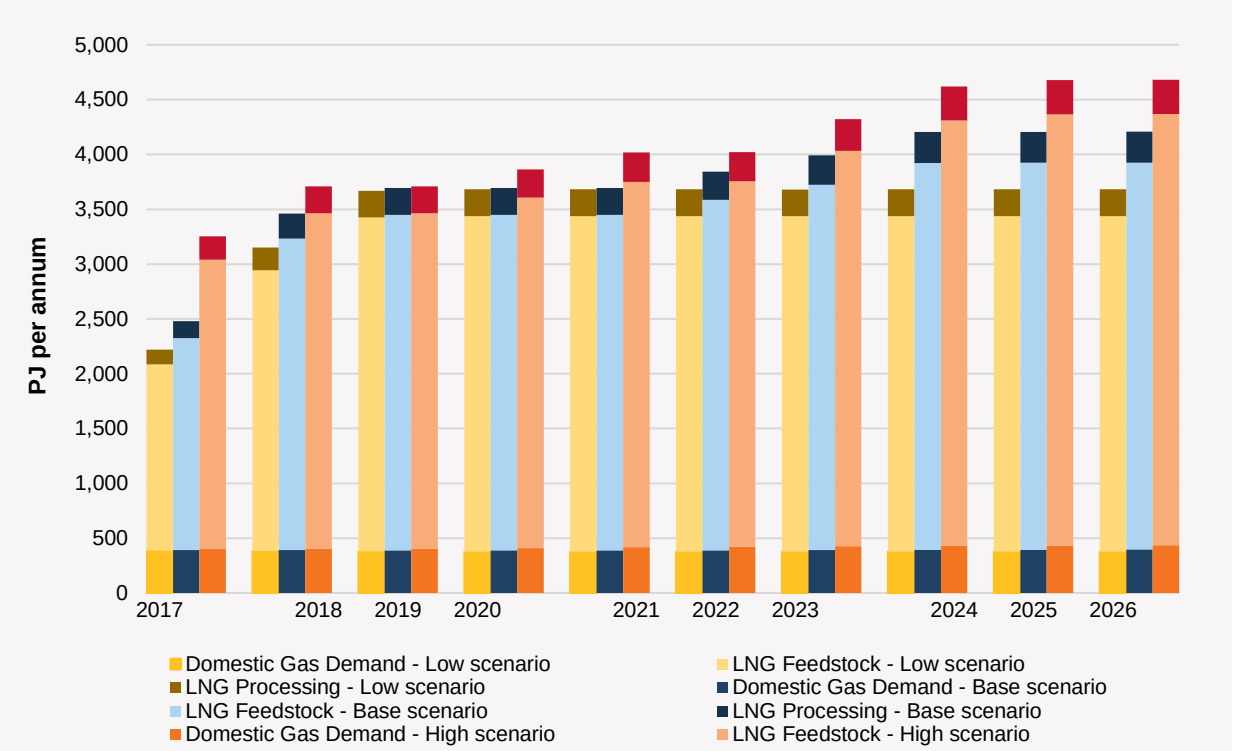


Table 25 Total gas demand forecasts (domestic demand forecasts, LNG exports and processing, PJ per annum), 2017 to 2026

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	5 year average growth pa (%)	10-year average growth pa (%)
Low	2,221	3,150	3,669	3,684	3,684	3,682	3,681	3,682	3,682	3,683	13.5	5.8
Base	2,480	3,460	3,694	3,694	3,695	3,843	3,992	4,205	4,206	4,208	10.5	6.1
High	3,252	3,709	3,709	3,863	4,018	4,022	4,322	4,620	4,680	4,683	5.4	4.1

In summary:

- Projected increases in total gas demand are largely driven by growth in LNG exports, with the Gorgon LNG, Ichthys LNG, Wheatstone LNG, and Prelude FLNG projects expected to commence production by the end of the outlook period.
  - The Low scenario focuses solely on the commencement of existing projects (Gorgon LNG, Ichthys LNG, Wheatstone LNG, and Prelude FLNG).
  - The Base scenario includes a planned expansion to the Gorgon LNG project (5.2 mtpa) from 2022.
  - The High scenario includes the Base scenario assumptions, but assumes the planned expansion of Gorgon LNG commences one year earlier, as well as expansions to the Wheatstone and Pluto LNG facilities from 2023.

The Base scenario total gas demand forecast presented in this report is slightly higher than the forecast published in the November 2015 WA GSOO:

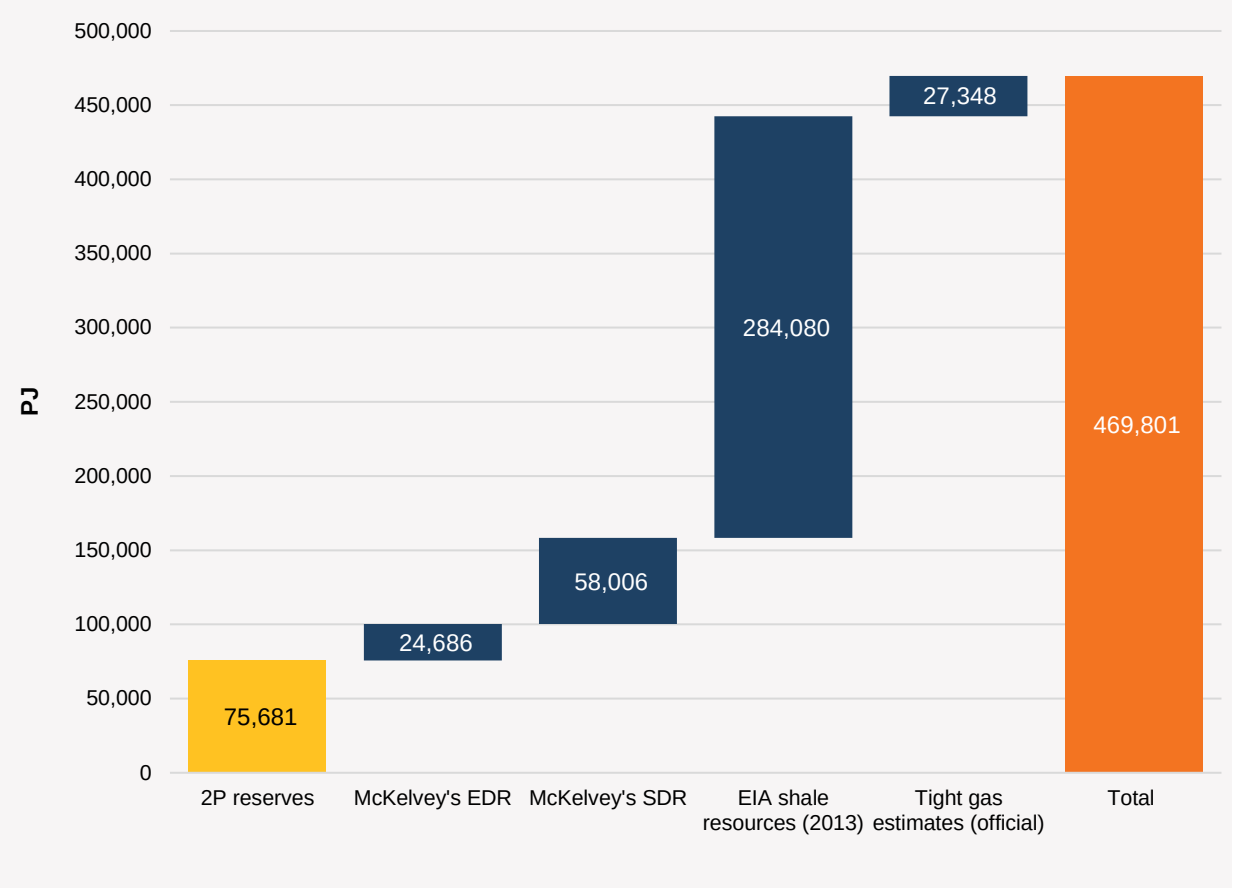
- An improved outlook for WA commodities has resulted in higher Base and High scenario forecasts for the mining sector over the outlook period.
- Some scenario assumptions have changed since the 2015 November GSOO. The Ichthys LNG and Darwin backfill projects have now been included in the Base and High scenarios. Partially offsetting these additions, the Bonaparte LNG project has been removed from the High scenario.

A breakdown of total gas demand into domestic gas demand, LNG exports, and LNG processing forecasts is outlined in Appendix D of this report.

4.7 Remaining resources and reserves

Based on the total estimates of conventional and unconventional resources, the expected life of WA's gas resources at the forecast gas production (including domestic gas and LNG) is shown in Figure 25.

Figure 25 Estimated WA resources and reserves, 2016[a]



Source: DSD, EnergyQuest and Geoscience Australia. Full reference details are provided in Appendix F.
[a] McKelvey provides two estimates of reserves – EDR and SDR.

In summary:

- While the total sum of 2P reserves is not expected to be depleted until approximately 2035, based on existing gas production, a large proportion of these gas reserves is only available to WA LNG exporting companies and joint ventures (see Section 2.4.2).
- WA's total gas resources (conventional and unconventional) are expected to last up to another 103 years beyond 2026.

4.8 Estimated reserves by domestic production facility for the WA market

The estimated volume of 2P gas reserves supplying WA's major domestic gas production facilities for the outlook period is outlined in Table 26. The estimates suggest that four (Dongara, Beharra Springs, Red Gully, and Macedon) of the nine production facilities may deplete known reserves within the next 10 years. This is in line with the "Remaining gas reserves linked to domestic production facilities" scenario.

Table 26 Estimated volume of gas reserves linked to domestic production facilities, 1 January 2017

Production facility	2P reserves (PJ)	Average production – 2016 (PJ)[a]	Years remaining (implied) based on 2016 average production[a]
Karratha Gas Plant DMO	672[b]	179.0	3.8[b]
Varanus Island	783	79.3	9.9
Devil Creek	318	33.1	9.6
Dongara and Beharra Springs	6.7[c]	5.2	1.2
Red Gully	10.9	2.9	3.8
Macedon	758	77.4	9.8[d]
Xyris	361	3.5	103.1[c]
Gorgon DMO	2,000	NA[e]	12.8
Wheatstone DMO	1,912	NA[e]	22.5

Source: Estimates based on information from AWE Limited, Empire Oil & Gas and Wood Mackenzie. Full reference details are provided in Appendix F.
[a] Estimated using WA GBB data for the period 1 January to 31 August 2016.
[b] AEMO estimates that the Karratha Gas Plant DMO is about 715 PJ and around 43 PJ of reserves are contracted.
[c] This is estimated by taking the difference between the total gas reserves for onshore WA from AWE Limited's annual report and the Waitsia reserves reported in AWE Limited's second quarter report.
[d] Macedon's reserves may be higher than in the table, as gas extracted from the Pyrenees FPSO project may be re-injected into the Macedon field for future recovery.
[e] Production figures for Gorgon and Wheatstone are unavailable because the facilities have either recently commenced or have not been completed. AEMO has estimated the remaining life based on the contracted position of each facility.

The Karratha Gas Plant is expected to prioritise LNG exports over supplying the domestic gas market. Therefore, AEMO considers that the Karratha Gas Plant will only supply to the domestic gas market up to its DMO.

The Dongara, Beharra Springs, and Red Gully gas production facilities account for a small share of total gas production capacity in WA (around 2%). BHP Billiton expects the Macedon facility to continue to process gas until at least 2033[61], but without any additional gas field developments associated with Macedon, it is unclear how gas production for the WA gas market from this facility would continue. It is unclear if Varanus Island and Devil Creek will develop any additional gas reserves.

The upcoming Gorgon and Wheatstone domestic gas production facilities have sufficient reserves to supply the WA domestic gas market for between 15 and 30 years.

[61] BHP Billiton. News release, "BHP Billiton celebrates first gas at Macedon", 20 September 2013. Available at: http://www.bhpbilliton.com/~/media/bhp/documents/investors/news/2013/130920_petroleumpotash_australiaproductionunit_macedon_bhpbillitoncelebratesfirstgasatmacedon.pdf?la=en. Viewed: 20 September 2016.

CHAPTER 5. OTHER ISSUES

This chapter summarises the other issues that are most likely to affect the WA gas market in the medium- to long-term.

5.1 WA Government Electricity Market Review

The WA Government intends to transfer gas pipeline regulation to the Australian Energy Regulator (AER) as part of Phase 2 of the EMR.[62] The objective of this reform is to achieve best practice and efficient regulation. Economies of scale are expected to improve efficiency and reduce costs, since the AER currently regulates 16 gas pipelines nationally, while the Economic Regulation Authority (ERA) is responsible for three WA gas pipelines.

Amendments to the *National Gas Access (WA) Act 2009* are required to apply aspects of the National Gas Law to WA and allow the transfer of regulatory functions from the ERA to the AER. However, relevant legislation to apply these aspects of the National Gas Law in WA was not passed by the WA Parliament before the end of November 2016. As a result, it is unclear when the transfer may occur.

These unique aspects of the WA gas market are expected to be retained:

- The WA GBB, which is not expected to be integrated with the Natural Gas Services Bulletin Board (NGSBB). More information about the WA GBB is in Section 5.2 below.
- Regulated price caps for all residential customers connected to low-pressure distribution networks.

WA does not have a short-term gas trading market that is similar to the Short Term Trading Market that operates in New South Wales, Queensland, and South Australia. There is an opportunity to investigate the introduction of a gas trading market in WA, given the expertise and systems now available to implement this.

Subject to relevant legislation being passed by Parliament following the State election in early 2017, the transfer of regulatory functions to the AER will occur in two stages:

- The initial transfer is expected to occur on 1 July 2018, when the AER will assume responsibility for administering all remaining Access Arrangements for WA gas pipelines. This transition period is expected to apply until the existing Access Arrangements expire.
- In the second stage, Future Access Arrangements are expected to be regulated by the AER, and are due to commence as follows:
  - Mid-West and South-West Gas Distribution Systems – 1 September 2018.
  - Goldfields Gas Pipeline System – 1 January 2019.
  - Dampier to Bunbury Natural Gas Pipeline – 1 January 2020.

5.2 WA Government domestic gas policy offsets

The WA Government's domestic gas policy requires exporters of LNG to make gas equivalent to 15% of their LNG exports available in the domestic market.[63] LNG exporters comply, as a condition of project approval, by committing to:

- Reserve gas for the WA market.
- Develop and obtain access to necessary domestic supply infrastructure.
- Diligently market gas to WA consumers.

[62] More information is available at https://www.finance.wa.gov.au/cms/uploadedFiles/Public_Utilities_Office/Electricity_Market_Review/Information-Paper-Network-Regualtion-Workstream.pdf.
[63] More information is available at http://www.dsd.wa.gov.au/what-we-do/advise-on-economic-policy/domestic-gas-policy.

An LNG producer can negotiate the timing and form of the commitment, for example, by proposing to offset its commitment with gas or energy from another source. The policy stipulates offset arrangements must provide a net addition to WA's energy supply.

AEMO understands, based on engagement with DSD, that there are currently no LNG producers using offsets to meet their domestic gas commitment. Any agreements on offsets between the WA Government and LNG producers will be made publicly available.

DSD advises that the WA Government will consider offset proposals on a case-by-case basis. In doing so, it will take into account whether an offset arrangement is consistent with the domestic gas policy, provides an equivalent level of energy security, and is practicable, enforceable, and consistent with broader government objectives.

5.3 Economics and Industry Standing Committee report on the WA GSOO compilation

In November 2016, the Economics and Industry Standing Committee (EISC) released a report on the compilation of the WA GSOO, in response to a request from the DomGas Alliance.[64] The report notes that the "*relatively brief review has revealed a number of important points:*

- *both AEMO and the DomGas Alliance agree that the Rules are sufficient to allow the necessary information to be obtained and included in the GSOO;*
- *AEMO recognises the need for improved consultation with stakeholders and has begun to conduct stakeholder forums;*
- *AEMO recognises the need for improved transparency about the assumptions that inform the GSOO forecasts;*
- *producers must undertake diligent and good faith marketing of domestic gas, but are not obliged to sell domestic gas at any price; that is, the domestic gas policy obligation is an obligation to market, not an obligation to supply;*
- *producers have sold gas into the domestic market at less-than-LNG netback prices;*
- *an accurate and transparent GSOO is essential for the WA economy; and*
- *an inaccurate GSOO could lead to complacency in government in relation to domestic gas supplies*."

AEMO has considered the EISC report when compiling this WA GSOO, particularly around transparency of input assumptions and stakeholder consultation.

5.4 Potential changes to WA Gas Bulletin Board

In April 2016, the Australian Competition and Consumer Commission (ACCC) completed an inquiry[65] into the east coast gas market, following industry concerns about sufficiency of gas supply and a lack of information transparency.

Following the release of the ACCC's findings, the Council of Australian Governments (COAG) Energy Council established a set of principles for Australia's future gas market. These principles included the development of a liquid wholesale gas market where there are:

- Appropriate market signals for investment and supply.
- Supportive investment and regulatory environments.
- Trades occurring in a location that best serves the needs of participants.

[64] EISC. *The Compilation of the WA Gas Statement of Opportunities*, Report 10, November 2016. Available at: http://www.parliament.wa.gov.au/parliament/commit.nsf/(Report+Lookup+by+Com+ID)/4C0D5C725939DFDE4825806600283C6C/$file/20161110+The+Compilation+of+the+WA+Gas+Statement+of+Opportunities.pdf. Viewed: 14 November 2016.

[65] ACCC, *Inquiry into the east coast gas market*, 22 April 2016. Available at: https://www.accc.gov.au/publications/inquiry-into-the-east-coast-gas-market. Viewed: 10 November 2016.

- Efficient reference prices.
- Producers, consumers, and trading markets connected to infrastructure that allows participants to trade easily between locations and take advantage of arbitrage opportunities.[66]

In July 2016, the Australian Energy Market Commission (AEMC) released a set of recommended reforms to improve efficiency and competition in the east coast gas market.[67] As part of these reforms, the AEMC recommended a number of changes to the NGSBB, including:

- Increasing reporting obligations for large gas-consuming facilities to improve transparency.
- Removing the restrictive zonal model to aggregate pipeline flow data.
- Introducing a 10 TJ per day minimum reporting threshold for all facilities.
- Requiring facility operators to provide detailed facility data so schematic diagrams similar to those featured on the WA GBB can be developed.

Some of these changes would bring the information provided through the NGSBB more in line with the WA GBB.

Other reforms recommended for the NGSBB are not current features of the WA GBB, but could be implemented in the WA GBB, since AEMO operates both markets. These changes may include:

- **Improving the timeliness of data publications** – synchronising data submissions and minimising publication lags would ensure similar publication timelines for all Australian gas market data.
- **Publication of nominated and forecast flow data by facility** – gas market participants could better anticipate changes in gas demand, develop short-term price expectations, and improve medium- and long-term planning and investment decisions across the supply chain.
- **Publication of planned expansions and asset retirements** – greater insights into the future of WA gas infrastructure would allow gas market participants to better identify opportunities.
- **Adoption of a standard for bidirectional pipelines** – this would ensure a consistent application throughout Australia gas markets.
- **Annual reporting of 2P gas field reserves** – improving transparency on 2P reserves would help WA organisations better determine the long-term supply outlook.
- **Report short- and medium-term capacity outlook and intra-day capacity changes for LNG facilities** – this would remove information gaps and align reporting requirements with the east coast gas market.
- **Publication of a biennial report on potential improvements to the WA GBB** – this would assist with the continued development of the WA gas market.

5.5 Federal government policy

5.5.1 Renewable energy policy

The Large-scale Renewable Energy Target (LRET) is a national target for renewable generation to reach 33,000 gigawatt hours (GWh), or about 23.5%[68] of Australia's forecast electricity generation, by 2020. In March 2016, the percentage of electricity generated in Australia from renewable sources was 12.75%.[69] This is a national target, and no obligations are conferred on individual states to meet a specified proportion of the target.

[66] AEMC. *Stage 2 Final Report – East Coast Wholesale Gas Markets and Pipeline Frameworks Review,* 23 May 2016. Available at: http://www.aemc.gov.au/getattachment/576299ec-c361-4a2c-a6cd-bb45fb834741/Stage-2-Final-Report.aspx. Viewed: 24 October 2016.

[67] More information is available at http://www.aemc.gov.au/getattachment/576299ec-c361-4a2c-a6cd-bb45fb834741/Stage-2-Final-Report.aspx.

[68] Australian Federal Minister for the Environment and Minister for Industry and Science media release. "Certainty and growth for renewable energy", 23 June 2015. Available at: http://www.environment.gov.au/minister/hunt/2015/pubs/mr20150623.pdf. Viewed: 24 October 2016.

[69] Australian Clean Energy Regulator (ACER). "2016 Renewable Energy Target liability obligations set", 15 March 2016. Available at: http://www.cleanenergyregulator.gov.au/RET/Pages/News%20and%20updates/NewsItem.aspx?ListId=19b4efbb-6f5d-4637-94c4-121c1f96fcfe&ItemId=229. Viewed: 24 October 2016.

In addition to the LRET, the Commonwealth Government maintains the following funds to encourage the development of renewable energy:

- Clean Energy Finance Corporation (CEFC) – the CEFC develops finance instruments for renewable energy, low-emissions technology, and energy efficiency initiatives, focusing on projects that are close to commercial development.
- Australian Renewable Energy Agency (ARENA) – ARENA was established to improve the competitiveness and increase the supply of renewable energy by 2022, and has a budget of $2.5 billion to invest in projects to achieve this aim.
- Clean Energy Innovation Fund (CEIF)[70] – this $1 billion fund to support commercialisation of emerging technologies was established in July 2016 and has funding of $100 million available each year for 10 years. It is managed jointly by ARENA and the CEFC.[71]

The Commonwealth Government policies and funding available are expected to increase penetration of renewable energy over the next 10 years. However, since these are national schemes, it is unclear how much investment in renewable energy will occur in WA.

The following factors appear likely to influence the level of interest for developing renewable energy for the SWIS:

- There is currently an oversupply of electricity generating capacity in the SWIS, as reported in the latest WA ESOO. The supply of generation capacity exceeds the Reserve Capacity Target of 4,552 MW[72] by about 651 MW or 14.3%.
- Uncertainties surrounding the WA EMR are yet to be resolved, particularly around:
  - The design of a network constrained grid for the SWIS.
  - The 380 MW reduction from Synergy's electricity generating portfolio, which may or may not be replaced by renewable facilities.
- The most recent certification process for the 2015 Reserve Capacity Cycle[73] attracted only 1.1 MW of upgraded renewable electricity generating capacity.

A limited number of Expressions of Interest for renewable energy projects have been received in the last two years, and no new large-scale renewable energy generators have been installed since 2013.[74]

AEMO will continue to monitor the effect of renewable energy policy in WA to develop scenarios for the 2017 WA GSOO.

5.5.2 Emissions reduction policy

Australia has committed to achieving a 26% to 28% reduction in emissions by 2030 (relative to 2005 levels) as part of its obligations to keep global temperature increases to below 2°C, as agreed at the 2015 Paris Climate Conference. While Australia ratified the Paris Agreement on 10 November 2016[75], the detailed policy settings to achieve this have not been developed.

[70] Prime Minister of Australia media release, "Turnbull Government taking strong new approach to clean and renewable energy innovation in Australia", 23 March 2016. Available at: https://www.pm.gov.au/media/2016-03-23/turnbull-government-taking-strong-new-approach-clean-and-renewable-energy. Viewed: 24 October 2016.

[71] ARENA media release. "ARENA welcomes new commitment to renewable innovation", 24 March 2016. Available at: http://arena.gov.au/media/arena-welcomes-new-commitment-to-renewable-innovation/. Viewed: 24 October 2016.

[72] AEMO. *Deferred 2015 WEM Electricity Statement of Opportunities for the WEM*, June 2016. Available at: http://aemo.com.au/Electricity/Wholesale-Electricity-Market-WEM/~/link.aspx?_id=C693EE6AD9C448F7A0524001E34DE77B&_z=z. Viewed: 24 October 2016.

[73] AEMO. *Summary of Certified Reserve Capacity Assigned by Facility for the 2015 Reserve Capacity Cycle for the Capacity Year from 1 October 2017 to 1 October 2018*. Available at: http://www.aemo.com.au/Electricity/Wholesale-Electricity-Market-WEM/Reserve-capacity-mechanism/Certification-of-reserve-capacity. Viewed: 24 October 2016.

[74] The most recent to start up in 2013 were Mumbida, Blair Fox Karakin, and Denmark wind farms, with a total capacity of 14.735 megawatts (MW) (based on Capacity Credits assigned for the 2017–18 Capacity Year).

[75] Minister for Foreign Affairs media release. "Ratification of the Paris Agreement on Climate Change and the Doha Amendment to the Kyoto Protocol", 10 November 2016. Available at: http://foreignminister.gov.au/releases/Pages/2016/jb_mr_161110a.aspx?w=tb1CaGpkPX%2FlS0K%2Bg9ZKEg%3D%3D. Viewed: 14 November 2016.

The reduction of 380 MW of Synergy's electricity generation capacity may contribute to meeting emissions targets. However, the quantity of reduction depends on public announcements around which facilities will be retired, and the impact based on fuel type and dispatch frequency being determined. The effect on gas demand is currently unknown, and will depend on the fuel type of the specific generators removed.

While gas is often considered to be well placed to assist in the transition to a low-emissions economy, WA already has a high proportion of GPG (approximately 60% of total SWIS generation capacity[76]). Any future expansion of electricity generation capacity is more likely to come from renewable energy sources rather than GPG.

A detailed analysis of emissions targets in the SWIS will be an area of focus for the WA GSOO to be published in December 2017.

[76] Based on Capacity Credits assigned for the 2017–18 Capacity Year.

APPENDIX A. ECONOMIC GROWTH FORECASTS

Table 27 Forecast growth in Australian gross domestic product (GDP), 2013–14 base year

Year	Actual (%)	Low (%)	Base (%)	High (%)
2006–07	3.8			
2007–08	3.7			
2008–09	1.8			
2009–10	2.0			
2010–11	2.4			
2011–12	3.6			
2012–13	2.4			
2013–14	2.5			
2014–15	2.3			
2015–16	2.9			
2016–17		1.4	2.2	3.0
2017–18		1.2	2.2	3.3
2018–19		1.5	2.5	3.5
2019–20		1.2	2.2	3.0
2020–21		0.9	2.0	2.7
2021–22		1.1	1.9	2.9
2022–23		1.6	2.8	4.0
2023–24		1.7	2.5	3.5
2024–25		1.2	2.2	3.2
2025–26		1.3	2.2	3.0
2026–27		1.9	2.7	3.5
Average growth		**1.4**	**2.3**	**3.3**

Source: NIEIR

Table 28 Forecast growth in WA gross state product (GSP), 2013–14 base year

Year	Actual (%)	Low (%)	Base (%)	High (%)
2006–07	7.0			
2007–08	5.2			
2008–09	3.4			
2009–10	4.2			
2010–11	3.8			
2011–12	9.1			
2012–13	5.5			
2013–14	5.5			
2014–15	3.5			
2015–16	1.3			
2016–17		1.1	1.7	2.5
2017–18		2.0	2.8	3.8
2018–19		1.7	2.6	3.6
2019–20		1.5	2.2	3.1
2020–21		1.4	2.5	3.3
2021–22		2.2	3.1	4.1
2022–23		2.4	3.3	4.5
2023–24		2.0	2.8	4.0
2024–25		2.4	3.3	4.3
2025–26		2.7	3.5	4.3
2026–27		2.1	2.8	3.6
Average growth		**1.9**	**2.8**	**3.7**

Source: NIEIR

APPENDIX B. FACILITIES INCLUDED IN POTENTIAL SUPPLY

Table 29 Production facilities included in the potential supply forecasts

Facility	Operator	Basin	Estimated production capacity (TJ per day)	Estimated start-up	Comments
Beharra Springs	Origin Energy	Perth	19.6	NA	
Devil Creek	Quadrant Energy	Carnarvon	220	NA	
Dongara	AWE Limited	Perth	7	NA	
Gorgon	Chevron	Carnarvon	300	2016	Phase 2 is expected to commence in 2020
Karratha Gas Plant	Woodside	Carnarvon	630	NA	
Macedon	BHP Billiton	Carnarvon	220	NA	
Red Gully	Empire Oil and Gas	Perth	10	NA	
Varanus Island – East Spar	Quadrant Energy	Carnarvon	270	NA	
Varanus Island – Harriet	Quadrant Energy	Carnarvon	90	NA	
Wheatstone	Chevron	Carnarvon	200	2018	Expected to commence in 2018
Xyris	AWE Limited	Perth	10	NA	
Total[a]			**1,976.6**		

Source: Public announcements and company websites

[a] By the end of the outlook period.

APPENDIX C. MEDIUM- TO LONG-TERM AVERAGE (EX-PLANT) NEW GAS CONTRACT PRICE FORECASTS

Table 30 Average medium- to long-term gas price forecasts (ex-plant)

Year	Low ($)	Base ($)	High ($)
2017	5.49	5.49	5.49
2018	5.49	5.49	7.00
2019	4.55	6.33	8.73
2020	4.55	6.53	9.28
2021	4.55	6.96	10.54
2022	4.55	6.20	11.31
2023	4.55	5.43	11.32
2024	4.55	6.22	12.07
2025	4.55	6.49	11.99
2026	4.55	6.80	12.02

Source: NIEIR

APPENDIX D. LNG REQUIREMENT FORECASTS

Table 31 Domestic gas demand forecasts (PJ per year)

Year	Low	Base	High
2017	386.7	392.1	399.7
2018	384.1	390.7	404.3
2019	380.2	388.8	403.7
2020	378.5	388.4	409.6
2021	378.5	389.9	417.2
2022	376.8	390.1	421.2
2023	375.8	391.0	426.8
2024	377.0	393.3	430.2
2025	377.2	395.2	433.5
2026	377.8	397.1	436.4

Table 32 LNG feedstock forecasts (PJ per year)

Year	Low	Base	High
2017	1,698.6	1,933.1	2,641.3
2018	2,561.3	2,842.1	3,060.3
2019	3,045.6	3,060.3	3,060.3
2020	3,060.3	3,060.3	3,197.2
2021	3,060.3	3,060.3	3,334.1
2022	3,060.3	3,197.2	3,334.1
2023	3,060.3	3,334.1	3,606.6
2024	3,060.3	3,528.9	3,879.1
2025	3,060.3	3,528.9	3,931.8
2026	3,060.3	3,528.9	3,931.8

Table 33 LNG processing forecasts (8% of feedstock) (PJ per year)

Year	Low	Base	High
2017	135.9	154.6	211.3
2018	204.9	227.4	244.8
2019	243.7	244.8	244.8
2020	244.8	244.8	255.8
2021	244.8	244.8	266.7
2022	244.8	255.8	266.7
2023	244.8	266.7	288.5
2024	244.8	282.3	310.3
2025	244.8	282.3	314.5
2026	244.8	282.3	314.5

Table 34 Total LNG requirement forecasts (PJ per year)

Year	Low	Base	High
2017	2,221.2	2,479.8	3,252.3
2018	3,150.4	3,460.1	3,709.4
2019	3,669.4	3,693.9	3,708.8
2020	3,683.6	3,693.9	3,862.5
2021	3,683.6	3,693.5	4,018.0
2022	3,681.9	3,843.1	4,022.1
2023	3,680.9	3,991.8	4,321.9
2024	3,682.1	4,204.6	4,619.7
2025	3,682.1	4,204.4	4,679.9
2026	3,682.9	4,208.3	4,682.7

APPENDIX E. CONVERSION TABLES

The following conversion factors have been applied in preparing figures for this WA GSOO.

Table 35 Conversion factors

	To						
Natural gas and LNG	**Billion cubic meters NG**	**Billion cubic feet NG**	**Million tonnes of oil equivalent**	**Million tonnes LNG**	**Trillion British thermal units**	**Million barrels oil equivalent**	**Petajoule**
From	**Multiply by**						
Billion cubic meters NG	1	35.3	0.9	0.74	35.7	6.6	37.45
Billion cubic feet NG	0.028	1	0.025	0.0216	1.01	0.19	1.06
Million tonnes oil equivalent	1.11	39.2	1	0.82	39.7	7.33	-
Million tonnes LNG	1.36	48	1.22	1	48.6	8.97	55.43
Trillion British thermal units	0.028	0.99	0.025	0.021	1	0.18	1.06
Million barrels oil equivalent	0.15	5.35	0.14	0.11	5.41	1	5.82
Petajoule	0.027	0.943	-	0.018	0.943	0.172	1

Note: NG is natural gas

APPENDIX F. REFERENCES

Abbreviation	Full reference	Available at	Date viewed
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ACCC, 2016	Australian Competition and Consumer Commission, *Inquiry into the east coast gas market*, 22 April 2016.	https://www.accc.gov.au/publications/inquiry-into-the-east-coast-gas-market	10 November 2016
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Abbreviation	Full reference	Available at	Date viewed
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MEASURES AND ABBREVIATIONS

Units of measure

Abbreviation	Unit of measure
A$	Australian dollar
bcm	Billion cubic metres
GJ	Gigajoule
GWh	Gigawatt hour
MMbtu	Million British thermal units
mt	Million tonnes
mtpa	Million tonnes per annum
MW	Megawatt
MWh	Megawatt hour
PJ	Petajoule
Q	Quarter
tcf	Trillion cubic feet
TJ	Terajoule
US$	US dollar

Abbreviations

Abbreviation	Expanded name
2P	Proven and probable
ABS	Australian Bureau of Statistics
ACCC	Australian Competition and Consumer Commission
ACOLA	Australian Council of Learned Academies
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
APPEA	Australian Petroleum Production and Exploration Association
CNG	Compressed natural gas
COAG	Council of Australian Governments
DBNGP	Dampier to Bunbury Natural Gas Pipeline
DES	Delivered ex-ship
DMP	Department of Mines and Petroleum
DSD	Department of State Development
EDR	Economic demonstrated resources
EIA	Energy Information Administration (US)
EISC	Economics and Industry Standing Committee
EMR	Electricity Market Review
ERA	Economic Regulation Authority
FLNG	Floating liquefied natural gas
FRGP	Fortescue River Gas Pipeline

Abbreviation	Expanded name
GBB	Gas Bulletin Board
GDP	Gross domestic product
GGP	Goldfields Gas Pipeline
GPG	Gas-powered generator
GSI	Gas Services Information
GSOO	Gas Statement of Opportunities
GSP	Gross state product
KGP	Karratha Gas Plant
JV	Joint venture
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
LRET	Large-scale Renewable Energy Target
MGSF	Mondarra Gas Storage Facility
NG	Natural gas
NIEIR	National Institute of Economic and Industry Research
NGSBB	Natural Gas Services Bulletin Board
NWS	North West Shelf
PEP	Pilbara Energy Pipeline
SDR	Sub-economic demonstrated resources
SWIS	South West interconnected system
US	United States
WA	Western Australia
WA Treasury	WA Department of Treasury
WEM	Wholesale Electricity Market

GLOSSARY

Term	Definition
2P	A measure of gas reserves that includes proven (developed and undeveloped) reserves and probable reserves.
Capacity Credit	A notional unit of Reserve Capacity provided by a Facility during a Capacity Year, where each Capacity Credit is equivalent to 1 MW of capacity.
Domestic gas demand	Includes all major industrial and commercial loads, electricity generators, and small-use customers connected to WA's gas transmission and distribution networks.
Distribution network	The distribution network is defined as the networks operated by ATCO and used to supply residential and non-residential customers in the Perth metropolitan area and regional centres of Albany, Bunbury, Geraldton and Kalgoorlie.
EDR	Reserves that can be extracted using current technology at a cost that is recoverable at prevailing market prices.
Large customers	Customers using more than 10 TJ per day.
SDR	Reserves that cannot be extracted using current technology, or that would be too expensive to develop at prevailing market prices.
Total gas demand	Domestic demand plus an estimate of the gas required for LNG export. This reflects an overall assessment of the demand for natural gas in WA.
Transmission network	The pipelines used to transport large volumes of gas from the production facilities to customers. Large customers can connect directly to the transmission network, while smaller customers are supplied through the distribution network connected to the transmission network.

LIST OF COMPANY NAMES

The following table lists the full name and Australian Business Number (ABN) of companies that may be referred to in this document.

Company	Full company name	ABN/ACN
Alinta	Alinta Pty Limited	38 102 848 055
Alcoa	Alcoa of Australia Limited	93 004 879 298
APA Group	Australian Pipeline Limited	99 091 344 704
ATCO	ATCO Gas Australia Pty Ltd	90 089 531 975
AWE	AWE Limited	70 154 832 827
BHP Billiton	BHP Billiton Limited	49 004 028 077
Chevron	Chevron Australia Pty Ltd	29 086 197 757
CITIC Pacific	CITIC Pacific Mining Management Pty Ltd	64 119 578 371
DBNGP (WA) Transmission	DBNGP (WA) Transmission Pty Limited	69 081 609 190
EnergyQuest	EnergyQuest Holdings Pty Ltd	51 110 284 270
EVOL LNG	Wesfarmers Kleenheat Gas Pty Ltd	40 008 679 543
FMG	Fortescue Metals Group Ltd	57 002 594 872
Horizon Power	Regional Power Corporation	57 955 011 697
MIMI	Japan Australia LNG (MIMI) Pty Ltd	18 006 303 180
Mobile LNG	Mobile LNG Pty Ltd	90 142 886 600
PE Wheatstone	PE Wheatstone Pty Ltd	53 158 341 612
Quadrant	Quadrant Energy Pty Ltd	58 605 014 935
Rio Tinto	Rio Tinto Limited	96 004 458 404
Santos	Santos Limited	80 007 550 923
Shell Australia	Shell Australia Pty Ltd	14 009 663 576
South32	South32 Limited	84 093 732 597
Synergy	Electricity Retail Corporation	71 743 446 839
Wesfarmers Kleenheat	Wesfarmers Kleenheat Gas Pty Ltd	40 008 679 543
Wood Mackenzie	Wood Mackenzie (Australia) Pty Ltd	85 111 634 309
Woodside	Woodside Petroleum Ltd	55 004 898 962