Western Australia Gas Statement of Opportunities

December 2018

Important notice

PURPOSE

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

AEMO publishes this Western Australian Gas Statement of Opportunities (GSOO) in accordance with rule 103 of the Gas Services Information Rules (GSI Rules). This publication has been prepared by AEMO using information available at 14 August 2018. Information made available after this date may have been included in this publication, where practical.

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ACKNOWLEDGEMENTS AND FEEDBACK

AEMO acknowledges the support, co-operation and the contribution of Gas Market Participants and gas stakeholders for providing data and information, received via formal and informal feedback, used in this publication.

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

VERSION CONTROL

Version	Release date	Changes
1.0	13/12/2018	

Executive summary

The 2018 Western Australian (WA) Gas Statement of Opportunities (GSOO) presents AEMO's independent assessment of the WA domestic gas market for the outlook period 2019 to 2028. The WA GSOO presents forecasts of WA domestic gas demand and potential supply, including an overview of gas infrastructure and emerging issues affecting the WA gas industry to Gas Market Participants (GMPs) and stakeholders.

Key findings

- Potential gas supply[1] exceeds forecast domestic gas demand over the 10-year outlook period (2019-28), however prospective gas supply sources[2] are needed in all scenarios as early as 2022 to ensure there is sufficient supply to serve the WA domestic gas market.
  - Gas supply declines in all scenarios through 2021, in line with reserve depletion at existing production facilities.
  - As early as 2022, potential gas supply from existing and under construction supply sources is expected to be insufficient to meet low, base, or high forecast gas demand. Prospective supply sources are expected to fill this gap. Market tightness at this time may be alleviated by acceleration of production from existing processing facilities or withdrawals from gas storage facilities.
- Committed[3] and prospective supply sources have grown since 2017 and will be important to maintaining the gas demand-supply balance over the outlook period.
  - In 2019, facilities under construction will commence, adding 240 terajoules (TJ) a day in capacity.
  - Four prospective supply projects are in the planning phase, including Waitsia Stage Two, Scarborough, Equus, and Browse. The first of these is planned to commence in 2021. The maximum supply volume from these supply sources is estimated to be 485 TJ/day, if they commence by 2028.
  - To meet the base gas demand forecast in 2028, around 276 TJ/day from new gas supply sources will be required.
- A positive outlook for commodities over the 2019-28 period is expected to lift gas demand, as new gas-consuming mining and minerals processing projects commence.
  - Committed projects are estimated to add 50 TJ/day to forecast gas demand in the low, base, and high scenarios.
  - The 10-year forecasts for commodities production and prices have strengthened from the forecasts used in the 2017 WA GSOO, particularly for nickel, zinc, copper, and lithium. Due to the continued

[1] AEMO estimates the potential availability of gas supply to the WA domestic market or "potential gas supply". This is supply that could be economically offered to the domestic market, if forecast prices are greater than production costs, subject to processing capacity and gas reserves being available. The resulting forecasts are not projections of how much gas *will* be produced, but the volume of gas that *could* be produced if there was market demand for it at the forecast price. The potential gas supply forecasting model takes account of existing, under construction and prospective supply sources (as identified by AEMO).

[2] Prospective supply sources include all gas field developments which have been publicly announced that would make supply available to the WA domestic market, including liquefied natural gas (LNG) projects. In accordance with WA's domestic gas policy, LNG projects must reserve and actively market 15% of gas reserves for the domestic market. AEMO assessed 18 prospective supply sources on 10 physical and qualitative criteria, and four of these sources were included in the potential gas supply model. AEMO's model triggers commencement of these supply sources, based on a comparison of their costs of production with potential revenue in the form of forecast WA domestic gas prices or forecast Asian LNG prices, depending on their development driver.

[3] Committed supply or demand projects are existing, under construction, or have taken a positive final investment decision (FID).

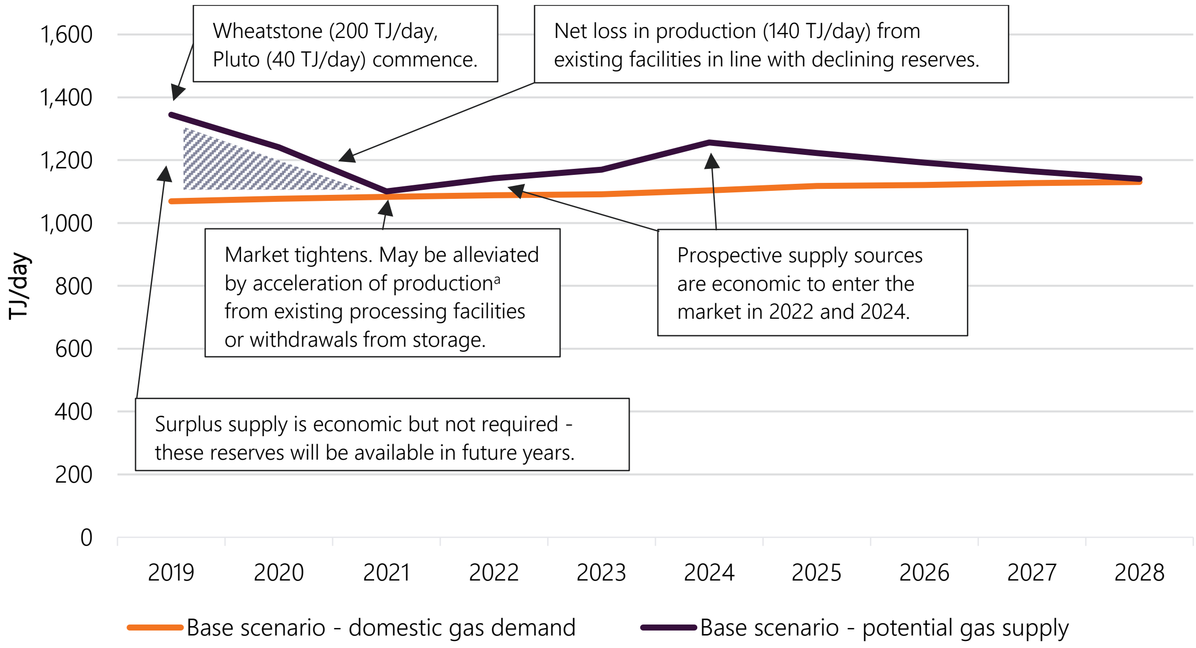
expected growth in the WA resources sector and secondary processing, a further 57 TJ/day from 13 prospective gas demand projects[4] has been added to the high demand scenario.

- Renewable energy generation entering the electricity market is expected to change the WA generation mix and influence gas demand for gas-powered generation of electricity (GPG).
  - As a result of the changing mix, some generation capacity may no longer be economic to be dispatched, under all scenarios. In the base scenario, gas demand from GPG is forecast to be higher (~17 TJ/day) in 2028 than if the existing generation mix was unchanged.
  - AEMO modelled an additional scenario for WA seeking to achieve a 26% emissions reduction (on 2005 levels) before 2030 in the South West interconnected system (SWIS)[5]. In this scenario, gas consumed by GPG in the SWIS is forecast to grow between 2021 and 2023, after some coal-fired generation is no longer dispatched from late 2021. This projected growth is then dampened between 2023 and 2025 as further renewable generation comes online. GPG gas use is forecast to return to growth from 2026, when additional coal-fired generation ceases to be dispatched under the scenario assumptions.

Potential gas supply exceeds forecast demand over the outlook period, but prospective supply is needed as early as 2022

In the base scenario forecasts, potential gas supply exceeds gas demand by at least 160 TJ/day until the end of 2020, as shown in Figure 1 and Table 1.

Figure 1 WA gas market balance (TJ/day), 2019-28



[a] Increasing the production rate from existing reserves, given the general underutilisation of existing processing capacity, thereby depleting these reserves at a faster rate than at present.
Source: AEMO and Marsden Jacob Associates (MJA).

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[4] Prospective gas demand projects may be developed over the outlook period, or may switch from diesel to gas. To be included in the high gas demand scenario, they must meet set criteria.

[5] On an accelerated trajectory, where the least economic generation is no longer dispatched earlier than in the base gas demand scenario.

Despite new supply commencing, potential gas supply is forecast to decline from 2019 to 2021, in line with reserve depletion at existing production facilities. There is a tightening in the market projected in 2021, when potential gas supply exceeds forecast gas demand by 17 TJ/day, before new supply sources are available and economically viable to enter the market in 2022. There are four prospective supply projects, currently in the planning phase, which could provide as much as 485 TJ/day in incremental supply if they commence during the outlook period[6].

Table 1 WA forecasts, base scenario potential supply and demand (TJ/day), 2019-28

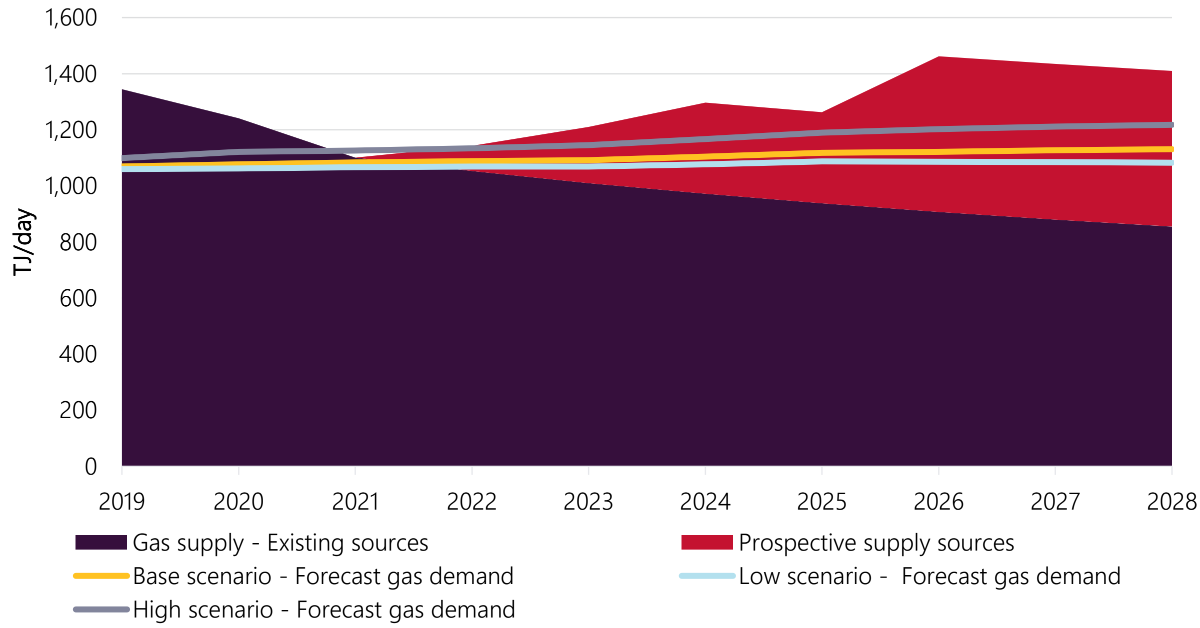
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	5-year average growth pa (%)	10-year average growth pa (%)
Potential supply	1,345	1,241	1,101	1,142	1,170	1,257	1,223	1,192	1,165	1,140	-3.4	-1.8
Demand	1,069	1,077	1,084	1,088	1,091	1,104	1,118	1,121	1,127	1,131	0.5	0.6

Source: AEMO and MJA.

Potential gas supply from committed projects is likely to be insufficient to meet the low, base, and high forecast gas demand scenarios without the development of prospective supply sources, as shown in Figure 2. If no prospective supply sources are developed, a supply shortfall[7] may emerge in 2021 for the high demand scenario or 2022 in the low and base scenarios. In this scenario, a supply deficit compared to the base demand scenario would worsen each year as demand grows, reaching around 276 TJ/day by 2028.

If all the prospective sources included in the potential gas supply model (Browse, Equus, Scarborough, and Waitsia Stage Two) are developed in line with proponents' commissioning dates, gas supply would be sufficient to meet forecast gas demand over the entire outlook period.

Figure 2 Prospective supply compared to gas demand scenarios, 2019-28



[6] In AEMO's model, new domestic gas-only projects commence if the forecast WA domestic gas prices exceed their long-run cost (LRC) of production. New LNG-linked projects are triggered to commence when forecast Asian LNG prices are higher than their LRC of production. Where appropriate, these are assumed to be backfill for existing domestic gas production facilities.

[7] Assuming that existing facilities do not increase production by accelerating reserve depletion rates or gas consumers do not make withdrawals from gas storage facilities.

Committed and prospective supply sources have grown and are important to the supply-demand balance

Between 2019 and 2022, the production costs of all available supply sources are lower than the domestic gas price forecast in the low, base, and high potential gas supply scenarios, resulting in identical potential gas supply forecasts, as shown in Table 2.

Table 2 Potential gas supply forecasts (TJ/day), 2019-28

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	5-year average growth pa (%)	10-year average growth pa (%)
Low scenario	1,345	1,241	1,101	1,142	1,170	1,132	1,098	1,067	1,040	1,015	-3.4	-3.1
Base scenario	1,345	1,241	1,101	1,142	1,170	1,257	1,223	1,192	1,165	1,140	-3.4	-1.8
High scenario	1,345	1,241	1,101	1,142	1,209	1,296	1,262	1,462	1,434	1,410	-2.6	0.5

The potential gas supply forecasts are underpinned by prospective supply projects, in addition to committed projects.

Two new gas supply sources will commence operation in 2019:

- Wheatstone production facility (200 TJ/day).
- Pluto liquefied natural gas (LNG) project, directly injecting pipeline quality gas (up to 25 TJ/day) and providing LNG for domestic consumers from a new LNG truck-loading facility (15 TJ/day).

From 2022, gas supply availability is expected to increase further if several prospective supply projects commence, including:

- Scarborough (domestic market obligation (DMO)[8] of ~120 TJ/day) and Browse (DMO of ~270 TJ/day), which are expected to use existing processing infrastructure.
- Waitsia Stage 2 field and production plant – Mitsui & Co (Australia) Ltd (Mitsui)'s acquisition of AWE Limited may give greater momentum to this proposed 100 TJ/day onshore facility, where field reserves were recently upgraded.
- Equus – a new owner and development concept for these fields is currently proposed, that is, a stand-alone LNG project, although there are options to use emerging spare capacity at existing facilities. The expected DMO volume is 40 TJ/day.

Development plans for these prospective domestic gas supply sources have solidified compared to 2017, although they are yet to reach the Final Investment Decision (FID) stage.

Despite this new prospective supply being expected to commence in 2022, gas supply is projected to decline relative to the 2019 level over the outlook period in both the base and low scenarios, due to reserve depletion at existing production facilities. In addition, in the base and low scenarios, the forecast LNG price is insufficient for some LNG-linked projects to be developed during the outlook period.

Demand lifted by new projects commencing and a positive outlook for resources sector

The domestic gas demand forecasts are underpinned by committed and prospective gas-consuming projects and non-project specific growth correlated with WA commodities production forecast over the outlook period (see Table 3):

[8] All expected DMO volumes calculated by AEMO as 15% of current proposed LNG production, in line with the WA Domestic Gas Policy. These volumes may change depending on the development path for each project prior to commencement.

- Since late 2017, expansions and new resource projects have been announced in WA. AEMO identified nine committed demand projects that are estimated to add 50 TJ/day to demand forecasts in the low, base, and high scenarios.
- The 10-year forecasts for commodities production and prices have strengthened from 2017, particularly for nickel, zinc, copper, and lithium. This non-project-specific growth has further boosted the gas demand forecasts by different levels across the low, base, and high scenarios.
- Due to the continued expected strength in the WA resources sector and secondary processing, a further 57 TJ/day from 13 prospective gas demand projects was added to the high demand scenario.

In the low, base, and high demand scenario forecasts, new mining and minerals processing projects are forecast to increase gas demand between 2018[9] and 2022. However, this is projected to be partly offset by new renewable capacity entering the market, causing a slight forecast decrease in demand from GPG in the SWIS.

Beyond 2022, in the base scenario, demand is driven by an expected return to growth in the SWIS GPG sector and continued forecast growth in mining. In addition to lower population and economic growth and domestic gas price forecasts, the low scenario forecasts are further decreased by assuming non-SWIS mining, minerals processing, and industrial facilities install solar photovoltaics (PV) to supplement their electricity requirements.

Table 3 Domestic gas demand forecasts (TJ/day), 2019-28

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	5-year average growth pa (%)	10-year average growth pa (%)
Low scenario	1,060	1,062	1,066	1,069	1,069	1,077	1,087	1,086	1,084	1,083	0.2	0.2
Base scenario	1,069	1,077	1,084	1,088	1,091	1,104	1,118	1,121	1,127	1,131	0.5	0.6
High scenario	1,099	1,121	1,126	1,134	1,145	1,166	1,190	1,202	1,212	1,218	1.0	1.1

Source: AEMO and MJA.

Gas demand in the non-SWIS areas of the state is projected to grow faster (1.2% average annual growth) than demand in the SWIS (0.2% average annual growth) over the 2019-28 period.

For the first time in the WA GSOO, AEMO has further disaggregated the gas demand forecasts[10] for the base scenario by smaller geographic area and usage category. In summary, over the 2019-28 period:

- The Metropolitan/South West area maintains the largest share of gas use, growing by 13 TJ/day over the outlook period. Due to strong growth in other regions, this results in a decrease of regional share by 2% to 60% of the total in 2028. The North area of the state is expected to show the most growth in volume (adding 28 TJ/day), followed by the East area (20 TJ/day), both driven by new projects commencing between 2019 and 2022 and strong commodities production outlooks for iron ore, gold, and nickel in the second half of the 10-year outlook[11].

[9] As 2018 is not yet complete, this year is an estimate. Growth from new projects commencing in late 2018 is included in the demand forecasts.

[10] Disaggregation of the gas demand forecasts was a key action item of the five-yearly review of the WA GSOO. See AEMO. Five-Yearly Review – Western Australian Gas Statement of Opportunities, August 2018. Available at https://www.aemo.com.au/-/media/Files/Gas/National_Planning_and_Forecasting/WA_GSOO/2018/Five-Yearly-Review-of-the-WA-GSOO.pdf.

[11] The North area includes the Gas Bulletin Board (GBB) WA zones Dampier, Karratha, Pilbara, and Telfer. The East area includes the GBB WA zones Goldfields and Kalgoorlie plus Esperance (non GBB). The Metro/South West area includes the GBB WA zones Parmelia, Mid West, South West, and Metro.

- The mining sector is expected to show the most growth, increasing 1.7% annually on average to reach a forecast 29% share of total gas consumption in 2028. The GPG sector is forecast to grow second fastest at 0.7% each year on average, although its projected share remains unchanged at 19%.

Renewable projects change electricity generation mix and influence gas demand for GPG

An increase in prospective large-scale renewable energy generation[12] projects and those under construction (totalling 762 megawatts [MW] nameplate capacity) in the SWIS between 2019 and 2024 will continue to affect WA gas consumption. These increases in renewable energy generation suggest GPG may operate for fewer hours and consume lower volumes of gas in the future compared to previous years, unless other types of existing generation capacity can no longer be economically dispatched. The low, base, and high scenarios assume some generation, notably older coal-fired generation, is no longer dispatched in the SWIS from late 2023.

An additional scenario was modelled, assuming no retirement of existing generation in the SWIS (that is, the coal- and gas-fired generators currently participating in the Wholesale Electricity Market (WEM) continue to participate over the forecast period). In this scenario, gas demand is forecast to be lower than in the base scenario by ~17 TJ/day by the end of the period.

In response to stakeholder feedback, AEMO developed an additional gas demand scenario to consider the impact of WA seeking to achieve a 26% emissions reduction (on 2005 levels) in the SWIS earlier than 2030 under an accelerated trajectory. This scenario assumes that the least economic generation is no longer dispatched at earlier dates than in the base scenario. Gas demand from SWIS GPG in this scenario is forecast to increase by 20 TJ/day between 2021 and 2023, due to some coal-fired capacity ceasing to be dispatched from late 2021. However, reductions in dispatch of coal-fired generation are also projected to incentivise over 300 MW of new renewable generation to come online, dampening forecast growth in SWIS GPG gas consumption from 2024. From 2026, growth is forecast to return when further coal-fired generation ceases to dispatch under the scenario assumptions and is replaced by a mix of renewables and GPG.

[12] Increased rooftop solar PV uptake is incorporated separately in the 2018 WEM Electricity Statement of Opportunities forecasts, which have been used as a basis for the SWIS GPG sector in the 2018 WA GSOO gas demand forecasts. An additional 1.4 GW of rooftop solar PV is forecast to be installed over the WA GSOO 10-year outlook period.

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1. Year in review

This chapter provides a snapshot of events in the Western Australia (WA) gas market in the past year, in response to stakeholder feedback received during the first five-yearly review of the WA Gas Statement of Opportunities (GSOO) (conducted in 2018)[13],[14].

1.1 Supply

- The proposed Waitsia Stage 2 onshore gas development has changed ownership after Mitsui & Co (Australia) Ltd acquired AWE Ltd and Beach Energy Ltd acquired Lattice Energy Ltd (50% each).
- Western Gas Pty Ltd (Western Gas) acquired the Equus gas fields from Hess Corporation in November 2017[15].
- Woodside Energy Pty Ltd (Woodside) bought ExxonMobil Corporation's share in the Scarborough gas fields, gaining a controlling share of 75%[16]. Woodside proposes to develop the Scarborough gas resource to produce 7-9 million tonnes per annum (mtpa) of liquefied natural gas (LNG) (including 1 mtpa of domestic gas), targeting a Final Investment Decision (FID) in 2020. Woodside will operate the proposed development.
- After technical well issues[17], the Red Gully domestic gas production plant (10 terajoules a day [TJ/day] capacity) has not produced gas since August 2017 and the wells have been placed on care and maintenance. Mineral Resources Limited acquired Empire Oil & Gas NL, operator of the Red Gully domestic gas production plant.
- In November 2018, the North West Shelf (NWS) Joint Venture signed preliminary agreements with the Browse LNG joint venture partners[18] and Chevron Australia Pty Ltd (Chevron), as the leaseholder of the Clio-Acme fields, for the processing of their respective offshore gas resources through the NWS facilities at the Karratha Gas Plant (KGP).
- The second liquefaction train at the Wheatstone LNG project commenced. The associated 200 TJ/day domestic gas production facility is expected to start in Q1 2019.
- Woodside commenced construction of a pipeline and compressor at the Pluto LNG project to allow injection of 10-25 TJ/day of gas into the Dampier Bunbury Pipeline (DBP) by the end of 2018 (subject to joint venture approvals[19] and commercial arrangements).

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[13] Stakeholders requested a "12 month look back at announcements and regulatory changes". AEMO. *Five-Yearly Review – Western Australian Gas Statement of Opportunities*, August 2018. Available at https://www.aemo.com.au/-/media/Files/Gas/National_Planning_and_Forecasting/WA_GSOO/2018/Five-Yearly-Review-of-the-WA-GSOO.pdf.

[14]References for the Year in Review chapter are provided in Appendix A1.

[15] Further details can be found in Chapter 3 – Gas supply.

[16] Further details can be found in Chapter 3 – Gas supply.

[17] The Red Gully-1 well was shut-in to conduct a planned static pressure survey. When the well was re-opened, the flow rate was insufficient to restore normal flow conditions. Empire Oil & Gas NL. "Red Gully-1 Well Update", 18 August 2017. Available at https://www.asx.com.au/asxpdf/20170818/pdf/43lhrq1ldclrqs.pdf.

[18] Joint venture partners include Woodside Browse Pty Ltd, Shell Australia Pty Ltd, BP Developments Australia Pty Ltd, Japan Australia LNG (MIMI Browse) Pty Ltd, PetroChina International Investment (Australia) Pty Ltd. Woodside Energy Pty Ltd is the operator.

[19] Joint venture partners include Kansai Electric and Tokyo Gas.

- Woodside began construction of a domestic LNG truck loading facility at the Pluto LNG project, which is scheduled to commence in 2019.
- Chevron and its joint venture partners announced the approval of the second phase of upstream development for Gorgon LNG[20], including new wells, an offshore pipeline and subsea infrastructure, to maintain long-term gas supply to its liquefaction and domestic gas plants.
- The current downstream base case for the Equus fields is a 2 mtpa LNG facility. However, Western Gas is considering multiple development plans, including domestic gas, and gas for backfill[21] or expansion for existing LNG facilities.
- Woodside awarded a front-end engineering and design contract for the proposed expansion of its Pluto LNG facility, to facilitate development of the Scarborough gas fields.
- Woodside announced a proposal to transport gas via a pipeline interconnector from Pluto LNG to the KGP. This interconnector would provide the ability to fill emerging spare capacity at the KGP. FID is planned for 2019 to commence operation in 2021.
- Santos Limited completed its acquisition of Quadrant Energy Australia Limited in November 2018.

1.2 Infrastructure

- A pre-feasibility study on the West–East Gas Pipeline was delivered to the Commonwealth Government[22].
- Chevron outlined a concept in May 2018 for the Trans Carnarvon Basin Trunkline, a multi-user offshore pipeline to gather third-party gas from undeveloped gas fields in WA's Carnarvon Basin. Shortly after, Woodside held discussions with a resource owner regarding a proposed trunkline from the Scarborough fields to the Burrup Peninsula. Woodside awarded a design contract for the Scarborough development export trunkline in June 2018.
- The Tubridgi Gas Storage Facility (42 petajoules (PJ) capacity), owned by Australian Gas Infrastructure Group (AGIG), began reporting on the WA Gas Bulletin Board (GBB) on 15 January 2018. AGIG has committed to expand its injection capacity from 50 TJ/day to 90 TJ/day and its withdrawal capacity from 50 TJ/day to 60 TJ/day.
- APA Group accepted a takeover offer from CK Infrastructure Group in August 2018. The Australian Competition and Consumer Commission (ACCC) approved the purchase subject to conditions, including the sale of all WA gas pipeline and storage assets. However, the deal was opposed by the Australian Government as being contrary to the national interest because it would result in undue concentration of foreign ownership by a single company in the gas transmission sector. APA advised that the acquisition was terminated in November 2018.

1.3 Demand

- Plans to develop battery-related minerals projects accelerated:
  - Tianqi Lithium Australia Pty Ltd's lithium hydroxide processing plant and BHP's nickel sulphate production project began construction in Kwinana.
  - Six further secondary processing plants have been proposed, or are under investigation, including:
    - Lithium hydroxide – Albemarle Lithium Pty Ltd (in Kemerton), Mineral Resources Ltd (at Wodgina), Kidman Resources/Sociedad Química y Minera de Chile (in Kwinana), Neometals Ltd/Mineral Resources Ltd (in Kalgoorlie).

[20] Joint venture partners include ExxonMobil Corporation, Royal Dutch Shell plc, Osaka Gas Co. Ltd., Tokyo Gas Co. Ltd. and JERA Co. Inc.

[21] Additional resources which support the maintenance of existing production or capacity utilisation, to counter natural production decline.

[22] Further details can be found in Chapter 6 – Implications of government and industry initiatives.

    - Nickel sulphate – Independence Group NL and Alpha Fine Chemicals (both in Kwinana).
- Iron ore expansions or backfill for existing projects have attained FID:
  - South Flank – BHP Billiton Ltd (BHP).
  - Eliwana – Fortescue Metals Group.
  - West Angelas and Robe Valley – Rio Tinto and joint venture partners.
  - Koodaideri – Rio Tinto.
- Gold production is set to grow, with a new mine, Gold Road Resources/Gold Fields Ltd's Gruyere, due to start in 2019, and committed mine expansions at AngloGold Ashanti's Tropicana and Sunrise Dam projects.
- Two large gas-consuming projects have been mooted on the Burrup Peninsula, although both are still to attain FID:
  - Perdaman Group signed a gas sale and purchase agreement with Woodside for 125 TJ/day for a term of 20 years to its proposed 2 mtpa urea production plant from the proposed Scarborough LNG project.
  - Coogee Chemicals Pty Ltd, Mitsubishi Corporation, and Wesfarmers Chemicals, Energy and Fertilisers are undertaking a joint pre-feasibility study to develop a 5,000 tonne per day petrochemical plant, which could reportedly require up to 300 TJ/day of pipeline gas.

1.4 Regulatory

The final report of the Independent Scientific Panel's Inquiry into Hydraulic Fracture Stimulation in Western Australia was delivered to the WA Government. The report found the risk to people and the environment associated with this type of drilling is low, but did not consider social or economic benefits or disadvantages. The WA Government announced that hydraulic fracture stimulation of petroleum wells will not be permitted over 98% of the state, finalising a temporary ban and moratorium based on regional location.

1.5 Retail

Simply Energy entered the market as a WA gas retailer, expanding the number of small-use customer retailers from four to five.

1.6 Five-yearly review of the WA GSOO

The WA GSOO is refined and updated every year to address existing and expected market developments in the WA gas market. Rule 105 of the GSI Rules requires AEMO to conduct a review of the WA GSOO information (Review) at least once every five years, which must be carried out in consultation with Gas Market Participants and gas industry groups. In 2018, AEMO conducted the first five-yearly review of the WA GSOO since the GSI Rules commenced in 2013. In this review, AEMO conducted desktop analysis and comprehensive consultation and engagement with stakeholders and industry groups. The 2018 WA GSOO report addresses the ten action items from the five-yearly review.

2. Gas demand

This chapter presents the following forecasts and analysis for the WA gas market over the 2019-28 outlook period:

- Historical domestic gas demand.
- Forecast domestic gas demand.
- Historical domestic peak gas day demand.
- Reconciliation of previous WA GSOO gas demand forecasts and actuals.
- Total WA gas demand (combines WA domestic demand, LNG exports, and LNG processing forecasts).

2.1 Historical domestic gas demand in WA

2.1.1 Overview and historical characteristics

The WA gas market has been shaped by conditions arising from its unique combination of geographic isolation and very large gas resources. These resources are suitable for LNG development but remote from population centres.

In the 1980s, WA Government policy promoted the development of gas fields in the North West Shelf area. The state-owned utility, the State Energy Commission of Western Australia, signed a large gas supply contract and constructed the Dampier to Bunbury Natural Gas Pipeline[23].

These conditions, along with WA's resource-based economy, resulted in a pipeline gas market that was characterised by:

- Bilateral, confidential, long-term take-or-pay gas sales contracts.
- A small number of large gas suppliers/producers and large gas consumers.
- Residential, commercial, and small industrial consumers representing only a small proportion of the market.
- A limited number of pipelines and interconnections, and little surplus transportation capacity.
- Limited gas storage capacity.
- Small volumes of short-term and spot gas sales.
- Little data to assess the state of the market, such as the availability of new supply or potential buyers[24].

[23] Later renamed Dampier Bunbury Pipeline (DBP).

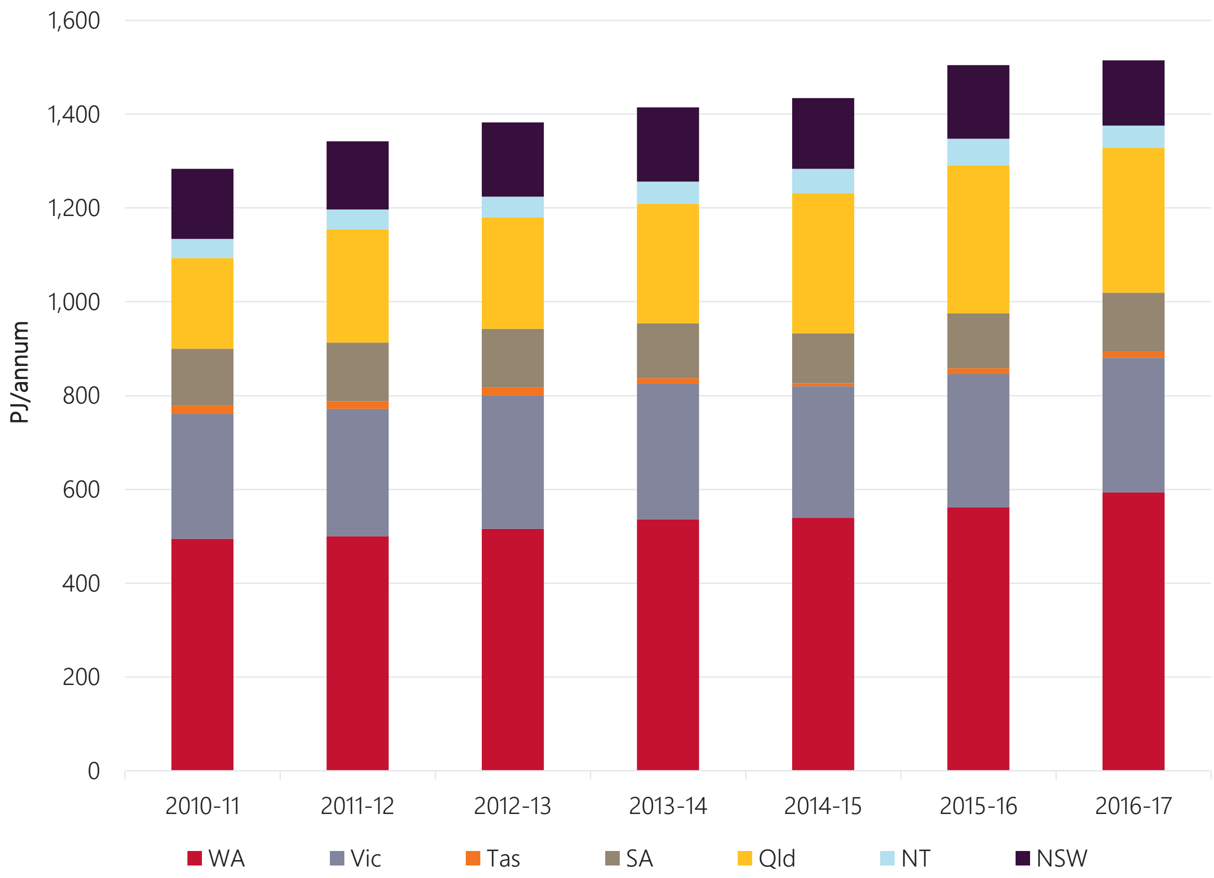
[24] Adapted from Wood Mackenzie. *Western Australia Gas Market Study*, Final Report, 26 March 2010, Attachment 1, North West Shelf Project Application to the ACCC for exclusionary provisions and associated cartel provisions: Application for Authorisation. Available at http://registers.accc.gov.au/content/index.phtml/itemId/922104/fromItemId/401858/display/application. Viewed: 8 November 2018.

In comparison, the east coast market, aside from being composed of multiple states, is generally characterised by:

- Smaller gas supply sources, the majority of which are located onshore.
- A wider range of gas consumers, and an extensive interconnected pipeline system.
- Active spot/short-term hubs allowing greater price discovery and trading flexibility.

WA consumes more natural gas than any other state in Australia, despite its relatively small population. In 2016-17, WA's total gas consumption was 593.8 PJ, around 39% of Australia's total gas consumption (see Figure 3)[25].

Figure 3 Gas consumption by state (PJ/annum), 2010-11 to 2016-17



Source: Department of Environment and Energy. *Australian Energy Update 2018 – Australian Energy Statistics*, September 2018.

As Figure 4 shows, 45% of gas in WA is consumed for electricity generation[26], 26% is consumed by the industrial and minerals processing sector, and mining makes up most of the remaining consumption (25%).

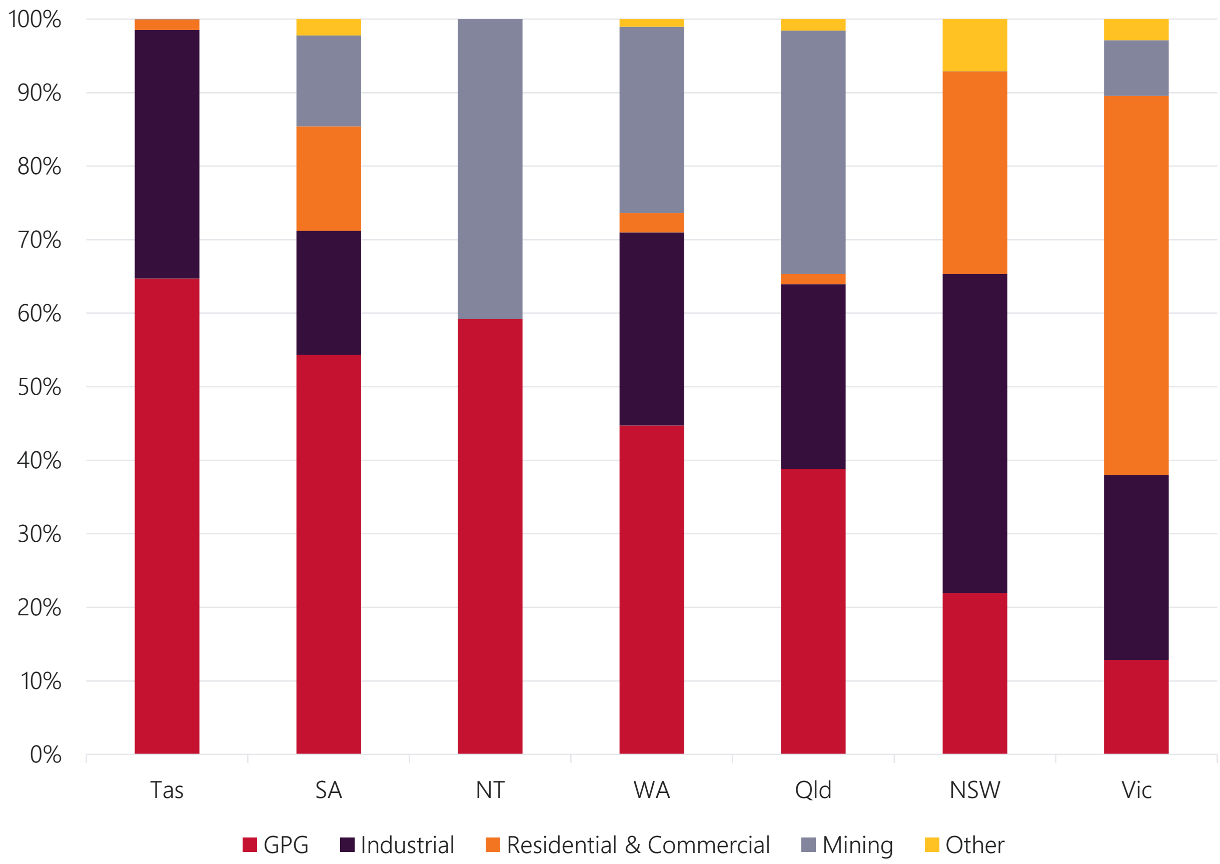
The share of WA consumption for gas-powered generation of electricity (GPG) is higher than in New South Wales and Victoria (where GPG is ~20% or less of total consumption).

[25] The data used for Figure 3 and Figure 4 is sourced from Department of the Environment and Energy. *Australian Energy Update 2018 – Australian Energy Statistics*, September 2018. Available at https://www.energy.gov.au/publications/australian-energy-update-2018. The AES data includes gas used in petroleum extraction and processing, pipeline shipping and transmission, compression, gas storage, and marine applications. These classifications differ from those used in the WA GSOO report, which only considers gas consumed from the pipeline transmission system.

[26] Including generation for mining and minerals processing.

Residential consumption in WA accounts for about 3% of total gas use. In New South Wales, South Australia, and Victoria, residential customers use an appreciably greater proportion of domestic gas[27]. Section 2.1.2 and Section 2.1.3 provide more information about the breakdown of gas consumption in WA.

Figure 4 Major category gas consumption by state (% share of total), 2016-17



Source: Department of the Environment and Energy. *Australian Energy Update 2018 – Australian Energy Statistics*, September 2018. Available at https://www.energy.gov.au/publications/australian-energy-update-2018.

2.1.2 Large customers supplied through the transmission network

Most large customers[28] are supplied directly through the transmission network (such as the DBP and the Goldfields Gas Pipeline). Remaining large customers are supplied by domestic LNG facilities, which convert natural gas to LNG that is then transported by road.

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 North West Interconnected System and the South West interconnected system (SWIS).
- Industrial users like brickworks, cement manufacturers, and chemicals plants.

[27] Residential gas consumption is estimated by the Department for Environment and Energy using econometric techniques based on factors including population, income and electricity prices. This consumption ranges as a proportion of total gas consumption ranges from 15% (South Australia) to 51% (Victoria). Department of the Environment and Energy. *Guide to the Australian Energy Statistics 2017*, August 2017, p. 23. Available at https://www.energy.gov.au/sites/g/files/net3411/f/guide-to-australian-energy-statistics-2017.pdf.

[28] Gas customers using 10 TJ/day or more.

- Production of domestic LNG, compressed natural gas (CNG), and liquefied petroleum gas (LPG).
- Petroleum processing.

Based on GBB data, in 2017-18, large customers[29] accounted for over 80% of gas used in WA, of which the majority was consumed in the minerals processing (32% of large customer use), electricity generation (25%), and mining (25%) sectors. A new analysis of historical data on WA gas consumption across both large and small users has been published in a separate paper[30].

2.1.3 Customers supplied through the distribution network

Based on WA GBB data, customers supplied through the retail distribution network account for around 7% of total WA domestic gas consumption[31].

The total number of residential and non-residential customers supplied through the WA gas retail distribution network, and the retailer churn rate, between 2013-14 and 2017-18, are shown in Table 4. The rate of growth in total customers continues to decline from 2015-16 levels, due to a slowdown in population growth and dwelling completions. Average usage per connection has fallen, attributed to increasingly efficient gas appliances, smaller household sizes, and increasing competition from alternative energy sources[32].

Prior to 2013, Alinta was the only residential and small business gas retailer. Over the past four years, Kleenheat, Origin, AGL, and Engie (as Simply Energy) entered the WA gas retail market, with AGL and Origin entering in 2017 and Engie in 2018[33]. The latest three entrants are major gas and electricity retailers in South and Eastern Australia.

Customer churn in WA has increased notably as a result, growing fivefold from 3% in 2013-14 to 15% in 2017-18. WA's current 15% churn rate is similar to that in New South Wales and South Australia (15% and 14% respectively), but lower than Victoria's 23%[34].

Table 4 Residential and non-residential retail customer numbers, 2013-14 to 2017-18

Financial year	Total number of customers		Existing customer transfers	
	Number	% change	Number	% churn[a]
2013-14	693,863	-	22,435	3
2014-15	715,364	3%	36,966	5
2015-16	737,679	3%	54,961	7
2016-17	751,342	2%	92,010	12
2017-18	761,337	1%	110,770	15

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

The annual market shares of retailers supplying non-residential distribution customers[35] are shown in Figure 5. Before AGL's entry into the WA market in July 2017, there were four retailers supplying the non-residential market: Alinta, Kleenheat, Synergy, and Perth Energy.

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[29] Excluding petroleum processing.

[30] AEMO. Western Australia Gas Bulletin board historical data analysis, November 2018. Available at www.aemo.com.au/-/media/Files/Gas/National_Planning_and_Forecasting/WA_GSOO/Western-Australia-Gas-Bulletin-Board-historical-data-analysis.pdf.

[31] Based on data from the Australian Energy Market Operator (AEMO) from the Gas Bulletin Board WA. See https://gbbwa.aemo.com.au/#home.

[32] ATCO. *2020-24 Plan: Access Arrangement Information for ATCO's Mid-West and South-West Gas Distribution System*, 31 August 2018, p. 57-8. Available at https://yourgas.com.au/wp-content/uploads/2018/09/ATCO-2020-2024-Plan-1.pdf?utm_source=plan_downloads&utm_medium=2020-24_Plan_page.

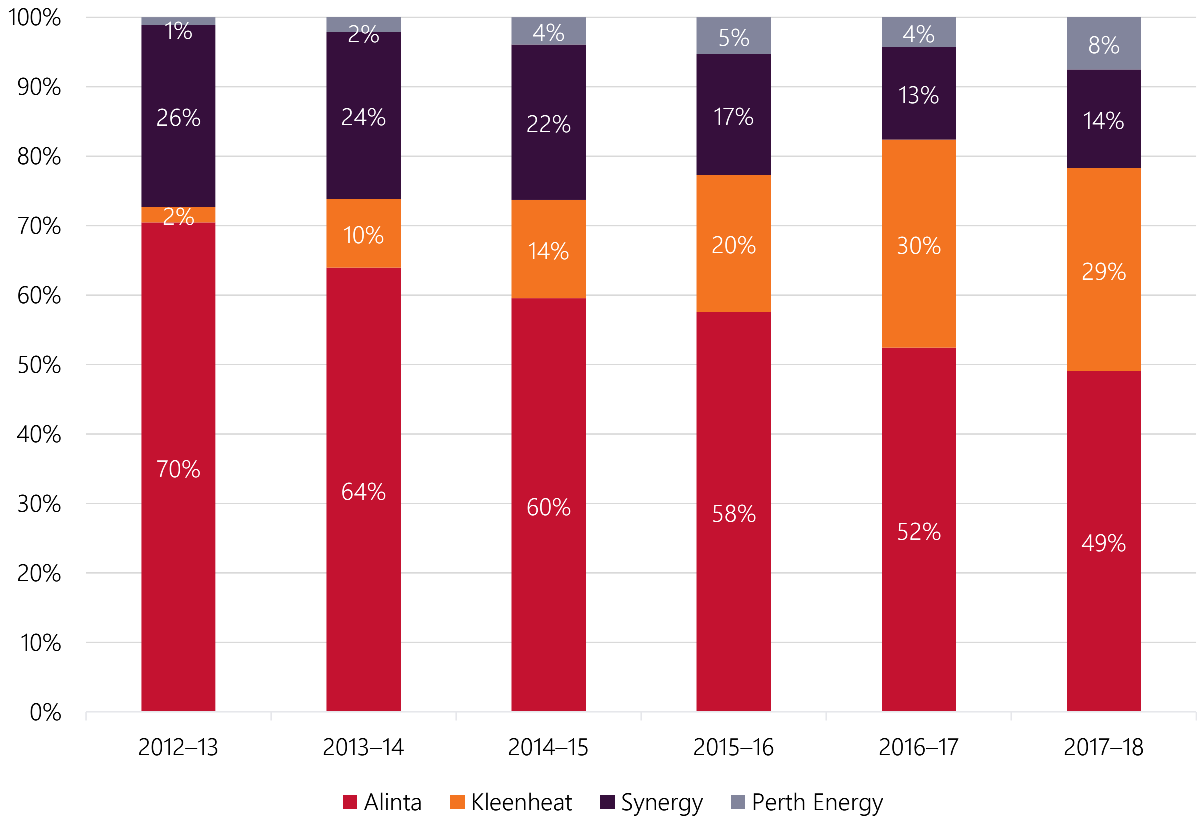
[33] Simply Energy (Engie) entered the market in the 2018-19 financial year so is not included in 2017-18 data in this chapter.

[34] Australian Energy Market Operator (AEMO). *Gas retail markets monthly statistics*, June 2018. Available at https://www.aemo.com.au/-/media/Files/Gas/Retail_Markets_and_Metering/Data/2018/Gas-Monthly-Retail-Transfer-Statistics---June-2018.pdf.

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

Alinta continues to supply most non-residential customers (49%), although its share has been decreasing consistently from 2012-13 levels (70%).

Figure 5 Non-residential distribution customer market shares (%), 2012–13 to 2017–18



Note: Figures are approximate in financial year. Market shares are based on customer numbers, not gas volumes. AGL's share of the non-residential market in WA remains at 0.1% since it entered in July 2017, and due to its small share size it is not reflected in this figure.

2.2 Domestic gas demand forecasts

2.2.1 Forecasting scenarios

The annual domestic gas demand forecasts are provided by calendar year (average TJ/day) over the outlook period and split into five scenarios, summarised in Table 5.

In addition to the low, base, and high scenarios, at the request of WA gas stakeholders, two scenarios have been designed to understand the impact on gas demand for the GPG sector:

- SWIS power generation dispatch unchanged[36].
- Accelerated SWIS emissions reduction.

[36] No retirement of existing generation fleet.

Table 5 Domestic gas demand forecast scenario assumptions, 2019-28

Scenario name	Base	Low	High	SWIS power generation dispatch unchanged	Accelerated SWIS emissions reduction
Economic growth	Base	Low	High	Base	Base
Population growth	Base	Low	High	Base	Base
Commodities production	Base	Low	High	Base	Base
Gas prices[a]	Base	High	Low	Base	Base
Non-SWIS GPG gas consumption	Base	Low demand plus new solar capacity built to support remote mining and industry.	High	Base	Base
SWIS GPG gas consumption					
Peak demand, operational consumption and PV and battery storage installation rates	Wholesale Electricity Market (WEM) Electricity Statement of Opportunities (ESOO) Expected	WEM ESOO Low	WEM ESOO High	WEM ESOO Expected	WEM ESOO Expected
New large-scale renewable energy investment and emission reduction targets	Economic renewables under existing incentives[b].	Economic renewables under existing incentives.	Economic renewables under existing incentives.	Economic renewables under existing incentives.	Paris Agreement[c] emissions reduction target achieved early in the SWIS (2027).
Existing generation plant	Some coal plus gas plant no longer dispatched as assumed to be economically rational.			No change to thermal plants being dispatched.	Some coal plus some gas plant is no longer dispatched to meet emissions targets.
New plant investment	New coal-fired generation and CCGT are assumed to be excluded. Only investment in renewables, conventional OCGT (heavy frame units), OCGT-aero, diesel generation, and battery storage is included.				

[a] Further information on WA domestic gas prices is provided in Appendix A2. Source: AEMO and MJA.
[b] Such as the Large Scale Renewable Energy Target.
[c] Under the Paris Agreement, Australia committed to a reduction in carbon dioxide equivalent emissions of between 26% and 28% relative to 2005 levels by 2030. Australia's 2030 climate change target is available at http://www.environment.gov.au/climate-change/publications/factsheet-australias-2030-climate-change-target.
Demand from gas storage and shipping is not included in the gas demand forecasts.

The high-level methodology and assumptions underpinning these scenarios are in Appendix A3, and are explained in more detail in Marsden Jacob Associate's (MJA) Methodology Report[37].

2.2.2 Gas demand forecasts by scenario, 2019-28

Low, base, and high scenario forecasts

The gas demand forecasts under the low, base, and high scenarios are presented in Figure 6 and Table 6.

The forecasts consider an expected decrease in activity at some mines, projected to be offset by both project-specific growth in demand and non-project-specific growth driven by a more optimistic commodities

[37] For details of gas demand assumptions refer to MJA. *The Development of Annual Gas Demand Forecasts for the Western Australian Gas Market*, published with the 2018 WA GSOO on AEMO's website at http://www.aemo.com.au/Gas/National-planning-and-forecasting/WA-Gas-Statement-of-Opportunities.

outlook[38]. All scenarios assume that nine major committed[39] mining and mineral processing projects commence over the outlook period, adding an anticipated 50 TJ/day of gas demand by 2028[40]:

- Development of further iron ore deposits at Robe Valley and West Angelas by joint venture partners Rio Tinto Limited, Mitsui, and Nippon Steel & Sumitomo Metal Corporation, commencing early 2019[41].
- AngloGold Ashanti Ltd's Tropicana Goldmine and Sunrise Dam Goldmine expansions, both commencing early 2019[42].
- Tianqi Lithium Australia Pty Ltd's new lithium processing facility in Kwinana. Stage 1 is due to commence operation in late 2018, with expansion (stage 2) in late 2019[43].
- Gold Road Resources and Gold Fields Ltd's Gruyere gold mine starting in 2019, to be connected to the transmission system via APA Group's new Yamarna Gas Pipeline, due for completion in late 2018[44].
- Expansion of BHP Nickel West Pty Ltd's nickel processing facility in Kwinana, scheduled to commence in 2019[45].
- Fortescue Metals Group Limited's Eliwana iron ore processing and rail project, due to commence operation in 2019[46].
- BHP Billiton Iron Ore Pty Ltd's South Flank project, due to commence operation in 2021[47].
- Rio Tinto Ltd's Koodaideri iron ore project, with first production planned for late 2021[48].

The low, base, and high scenarios vary due to assumed differences in economic outlook for the WA economy and assumptions around new demand from mining and minerals processing[49]:

- The high scenario includes 57 TJ/day of further gas demand, in addition to the 50 TJ/day noted above, based on a revised prospective gas demand project list[50].
- The low scenario considers an increasing trend, outside of the SWIS, towards hybridisation in which solar, or a combination of solar and battery, offset diesel or gas use at mines or power stations that support mining loads. The low case assumes that some of the demand[51] from projects not connected to the SWIS is offset

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[38] See Appendix A3.1.1 for further detail on the economic and commodities outlook for WA.

[39] Committed projects are existing, under construction, or have taken a positive FID.

[40] As noted in the project list, several of the committed major projects are expected to begin production in late 2018 or early 2019. This additional 27 TJ/day of demand is not yet reflected in historical GBB data, and commences on or before the first year of the outlook period, so while it is captured in the total gas demand values, it is not captured in the average percentage growth rate figures.

[41] Rio Tinto Limited. "Rio Tinto approves investment to sustain Pilbara iron ore production capacity", Media release, 1 October 2018. Available at https://www.riotinto.com/media/media-releases-237_26152.aspx. DJTSI. "Western Australia Iron Ore Profile", June 2018. Available at https://www.jtsi.wa.gov.au/docs/default-source/default-document-library/wa-iron-ore-profile---june-2018.pdf?sfvrsn=72af721c_2.

[42] AngloGold Ashanti. *Integrated Report 2017*, p. 105-106. Available at https://www.anglogoldashanti.com/investors/annual-reports/.

[43] Tianqi Lithium. "Construction commences on stage 2 lithium hydroxide processing plant", media release, 19 December 2017. Available at http://tianqilithium.com.au/wp-content/uploads/2017/12/MediaRelease-TianqiLithiumAustralia-19DEC17.pdf.

[44] APA Group. "APA to build new gas pipeline and power station in the Goldfields, WA", ASX release, 21 June 2017. Available at https://www.apa.com.au/news/asx-releases/2017/apa-to-build-new-gas-pipeline-and-power-station-in-the-goldfields-region-wa/. APA Group 2017. *Director's Report for the year ended 30 June 2017*, p. 12. Available at http://annualreport2017.apa.com.au/files/Australian%20Pipeline%20Trust/Directors'%20Report.pdf.

[45] BHP. *Nickel West – Energising our future*, presentation at Diggers & Dealers conference, 9 August 2017, p. 14. Available at https://www.bhp.com/-/media/documents/media/reports-and-presentations/2017/170809_energisingourfuture.pdf. BHP. *Nickel West: Think big – A view to the future*, presentation at the Diggers & Dealers conference, 6 August 2018. Available at https://www.bhp.com/-/media/documents/media/reports-and-presentations/2018/20180608eduard-haegeldd2018final-ppt.pdf.

[46] Fortescue Metals Group. "Eliwana Project Announcement", Announcement, 28 May 2018. Available at https://www.fmgl.com.au/docs/default-source/announcements/eliwana-project-announcement.pdf?sfvrsn=b23b5e83_6.

[47] Government of Western Australia. "Premier turns sod on BHP $4.88 billion South Flank Project", Media Statement, 25 July 2018. Available at https://www.mediastatements.wa.gov.au/Pages/McGowan/2018/07/Premier-turns-sod-on-BHP-4-point-88-billion-dollar-South-Flank-Project.aspx.

[48] Rio Tinto. "Rio Tinto approves $2.6 billion investment in Koodaideri iron ore mine", Media release, 28 November 2018. Available at http://www.riotinto.com/media/media-releases-237_26455.aspx..

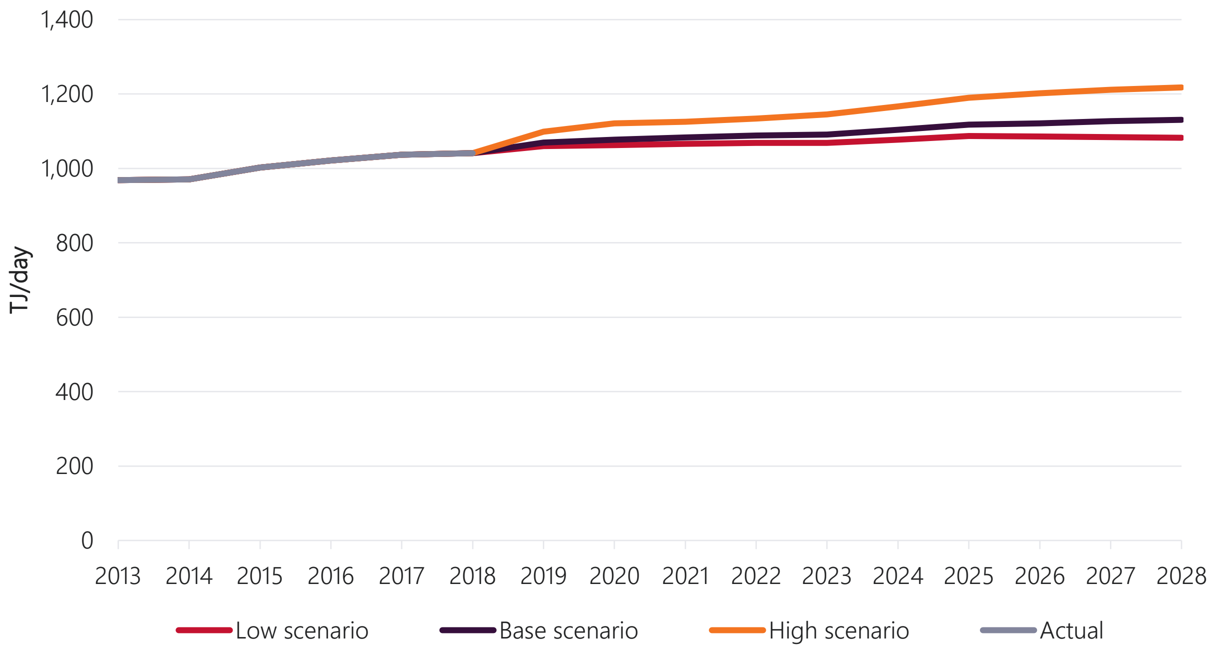
[49] Refer to Appendix A3 for further information on the WA economic and commodities outlook.

[50] Refer to Appendix A3 for further information on prospective gas demand projects.

[51] From the mining, minerals processing and industry sectors.

by solar photovoltaics (PV) providing 20% of these projects' electricity needs (in terms of megawatt hours)[52].

Figure 6 Domestic gas demand forecasts (TJ/day), low, base, and high scenarios, 2019-28



Note: Data for 2013-2016 from 2017 WA GSOO data register. Data for 2017 from MJA. Data for 2018 is an estimate based on year to date data at 14 August 2018. Source: AEMO and MJA.

Table 6 Domestic gas demand forecasts (TJ/day), low, base, and high scenarios, 2019-28

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	5-year average growth pa (%)	10-year average growth pa (%)
Low scenario	1,060	1,062	1,066	1,069	1,069	1,077	1,087	1,086	1,084	1,083	0.2	0.2
Base scenario	1,069	1,077	1,084	1,088	1,091	1,104	1,118	1,121	1,127	1,131	0.5	0.6
High scenario	1,099	1,121	1,126	1,134	1,145	1,166	1,190	1,202	1,212	1,218	1.0	1.1

Source: AEMO and MJA.

In summary:

- In the low and base demand scenario forecasts, 50 TJ/day of new mining and minerals processing project-specific demand is forecast between 2018 and 2022.
- Base scenario demand is partly offset between 2018 and 2022 by new renewable capacity entering the market, causing a slight decrease in SWIS GPG gas demand. In addition to this, in the low scenario gas demand is partly offset by assuming non-SWIS mining, minerals processing, and industrial facilities install solar PV to supplement their electricity requirements.
- In the base scenario, beyond 2022 demand is driven by a return to growth in SWIS GPG and continued growth in mining.

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[52] Examples include DeGrussa copper-gold mine, which is offsetting up to 20% of total diesel consumption annually (see https://arena.gov.au/projects/degrussa-solar-project/) and Granny Smith gold mine, with Gold Fields committing to using renewable energy for at least 20% of power requirements for new projects (see https://www.energymatters.com.au/renewable-news/solar-battery-hybrid-system-gold-mine/).

- In the high scenario, growth is stronger due to the addition of 57 TJ/day of gas demand from prospective projects between 2018 and 2022, and further non-project-specific mining and minerals processing growth based on WA commodity production forecasts.

The 2018 demand forecasts are higher than those presented in the 2017 GSOO across the base, low, and high scenarios, due to an improved economic and commodities outlook over the outlook period. Section 2.4 provides a detailed reconciliation of the WA GSOO forecasts over the last five years.

Forecasts based on additional scenarios to accommodate variation to SWIS GPG gas demand

Two additional gas demand scenarios have been explored in this report:

- The SWIS power generation dispatch unchanged.
- Accelerated SWIS emissions reduction.

These build on the base scenario but vary in the assumptions around the contribution of SWIS GPG to gas demand.

The low, base, and high scenarios assume some generation, notably older coal-fired generation, is no longer economically dispatched in the SWIS from the end of 2023, predominantly due to increased installation of new small and large-scale renewables[53]. However, the SWIS power generation dispatch unchanged scenario assumes that there is no change to the mix of existing thermal generators that are dispatched in the SWIS.

The accelerated SWIS emissions reduction scenario assumes that older coal-fired generators are not dispatched in the Wholesale Electricity Market (WEM) from the end of 2021. This further incentivises renewable plant to enter the market[54] and enables SWIS electricity generation to meet its share of Australia's commitment to reduce its greenhouse gas emissions (GHG) by 26% to 28% relative to 2005 levels[55] by 2027.

The gas demand forecasts under these scenarios are presented below in Figure 7 and Table 7, alongside the base scenario for comparison.

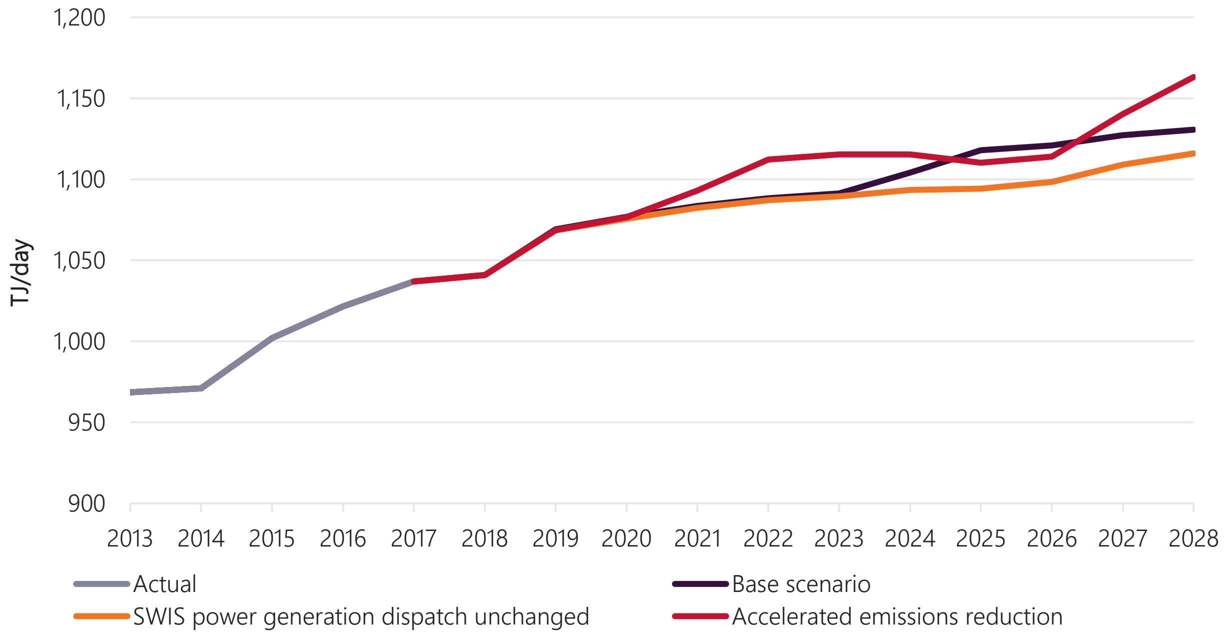
These additional scenarios indicate that a reduction in dispatch of coal-fired generation in the SWIS does have some projected impact on gas demand, due to GPG replacing coal-fired generation. However, the impact is forecast to be partly offset as new large-scale renewable generation replaces a proportion of the coal-fired generation. These scenarios are analysed further by comparing their impact on gas demand from SWIS GPG against the base scenario, in Section 2.2.5.

[53] Decisions to no longer dispatch generation capacity are based on a number of considerations, not all of which can be captured in market modelling. The condition of assets, portfolio optimisation and financial position, rehabilitation costs, and company policies will all influence any commercial decision to withdraw generation. Therefore, the timing and amount of generation withdrawn, could vary from what has been assumed here.

[54] Based on WEM modelling conducted by MJA. *The Development of Annual Gas Demand Forecasts for the Western Australian Gas Market*, published with the 2018 WA GSOO on AEMO's website at http://www.aemo.com.au/Gas/National-planning-and-forecasting/WA-Gas-Statement-of-Opportunities.

[55] Under the Paris Agreement, Australia committed to a reduction in carbon dioxide equivalent emissions of between 26% and 28% relative to 2005 levels by 2030. Australia's 2030 climate change target is available at http://www.environment.gov.au/climate-change/publications/factsheet-australias-2030-climate-change-target.

Figure 7 Domestic gas demand forecasts (TJ/day), SWIS power generation dispatch unchanged and accelerated SWIS emissions reduction scenarios, 2019-28



Note: Y-axis not based at 0. Note: Data for 2013-2016 from 2017 WA GSOO data register. Data for 2017 from MJA. Data for 2018 is an estimate based on year to date at 14 August 2018. Source: AEMO and MJA.

Table 7 Forecast annual gas demand (TJ/day), SWIS power generation dispatch unchanged and accelerated SWIS emissions reduction scenarios, 2019-28

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	5-year average growth pa (%)	10-year average growth pa (%)
SWIS power generation dispatch unchanged scenario	1,069	1,076	1,082	1,087	1,089	1,093	1,094	1,098	1,109	1,116	0.5	0.5
Accelerated SWIS emissions reduction scenario	1,069	1,077	1,093	1,112	1,115	1,115	1,110	1,114	1,140	1,163	1.1	0.9

2.2.3 Gas demand forecasts by area, 2019-28

In line with previous WA GSOO reports, gas demand has been disaggregated into two areas, SWIS and non-SWIS, as shown in Table 8.

The expected growth in gas demand outside the SWIS continues to exceed the expected growth rate within the SWIS. Non-SWIS growth is projected to be stronger than that forecast in the 2017 WA GSOO, predominantly due to stronger projected mining growth, which tends to be located outside of the SWIS.

Demand growth in the SWIS is forecast to be more subdued. While an increase in demand from minerals processing is expected as new lithium hydroxide and nickel sulphate facilities start production, this is offset by a forecast fall in SWIS GPG demand. This reduction is due to an influx of renewable generation projects, which are anticipated to put downward pressure on SWIS GPG generation. The effects of this are most apparent over the first half of the outlook period, leading to a negative five-year average annual growth rate. Over the second half of the outlook period, it is assumed that this influx of new generation will contribute to some coal-fired generation ceasing to be dispatched, allowing SWIS gas demand to return to growth as GPG generation increases to replace some coal-fired generation.

Table 8 Forecast annual gas demand by area (TJ/day), base scenario, 2019-28

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	5-year average growth pa (%)	10-year average growth pa (%)
Non-SWIS	383	394	406	409	411	413	415	418	425	427	1.7	1.2
SWIS	686	683	678	680	681	691	703	703	703	703	-0.2	0.3

Source: AEMO and MJA.

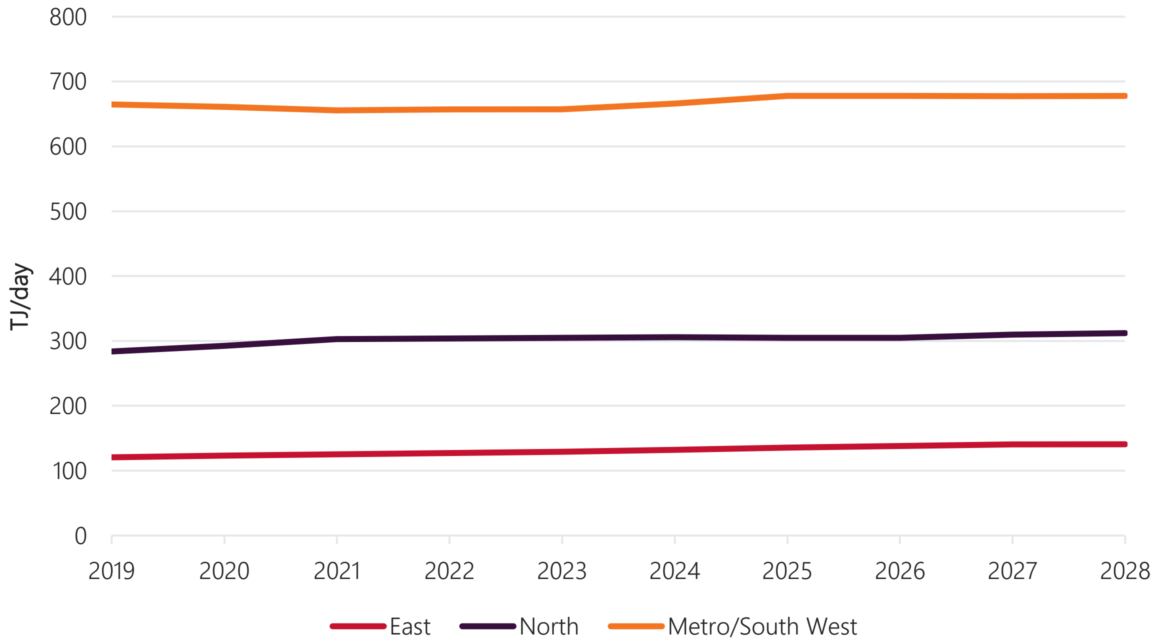
2.2.4 Gas demand forecasts by region, 2019-28

One of the outcomes from the five-yearly review of the WA GSOO[56] was to further disaggregate gas demand forecasts. Consequently, the WA domestic gas demand forecast has been split into three regions for the 2018 WA GSOO:

- East (includes the GBB zones Goldfields, Kalgoorlie, and Esperance).
- North (includes the GBB zones Karratha, Dampier, Pilbara, and Telfer).
- Metro/South West (includes the GBB zones Mid-West, Parmelia, Metro, and South West)[57].

Figure 8 and Table 9 present the expected domestic gas demand forecasts by region for the base scenario.

Figure 8 Domestic gas demand forecasts by region (TJ/day), base scenario, 2019-28



Source: AEMO and MJA.

[56] See AEMO. *Five-Yearly Review – Western Australian Gas Statement of Opportunities*, August 2018. Available at https://www.aemo.com.au/-/media/Files/Gas/National_Planning_and_Forecasting/WA_GSOO/2018/Five-Yearly-Review-of-the-WA-GSOO.pdf.

[57] Note that this is not identical to the SWIS Area presented above for SWIS/non-SWIS demand forecasts.

Table 9 Forecast annual gas demand by region (TJ/day), base scenario, 2019-28

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	5-year average growth pa (%)	10-year average growth pa (%)
East	121	123	125	127	129	132	135	138	140	141	1.7	1.7
North	284	292	303	304	305	306	305	305	310	312	1.8	1.1
Metro/ South West	665	661	656	657	657	666	678	678	677	678	-0.3	0.2

Source: AEMO and MJA.

When the annual demand forecasts are disaggregated into the regions, the relative areas of growth become apparent. All regions experience some growth in demand over the 10-year forecast, however, in volumetric terms (TJ/day), growth in the North is expected to be stronger than in the East or the Metro/South West.

East and North gas demand forecast growth is driven by a stronger commodities outlook. In the East, this adds 20 TJ/day of gas demand from mining over the outlook period. In the North, of the 28 TJ/day forecast growth in the base scenario, mining demand accounts for 26 TJ/day.

The Metro/South West region sees a contraction over the first five years of the outlook period, predominantly due to a forecast softening in SWIS GPG demand caused by a number[58] of renewable energy projects forecast to come online. This is projected to offset the forecast 12 TJ/day increase in gas demand in the region from minerals processing, driven predominantly by anticipated growth in lithium hydroxide and nickel sulphate production, in the base scenario.

The projected return to slow growth in the Metro/South West in the second half of the outlook period is driven by forecast increased demand from GPG. Section 2.2.5 discusses this in further detail.

2.2.5 Gas demand forecasts by usage category, 2019-28

In addition to disaggregating gas demand by region, the 2018 GSOO demand forecasts disaggregate demand by the following usage categories[59]:

- GPG (SWIS and non-SWIS).
- Mining[60].
- Mineral processing[61].
- Industry (major users such as ammonia, fertiliser, LPG production, and domestic gas used in LNG production).
- Distribution.

This breakdown is shown for the base scenario in Figure 9 and Table 10.

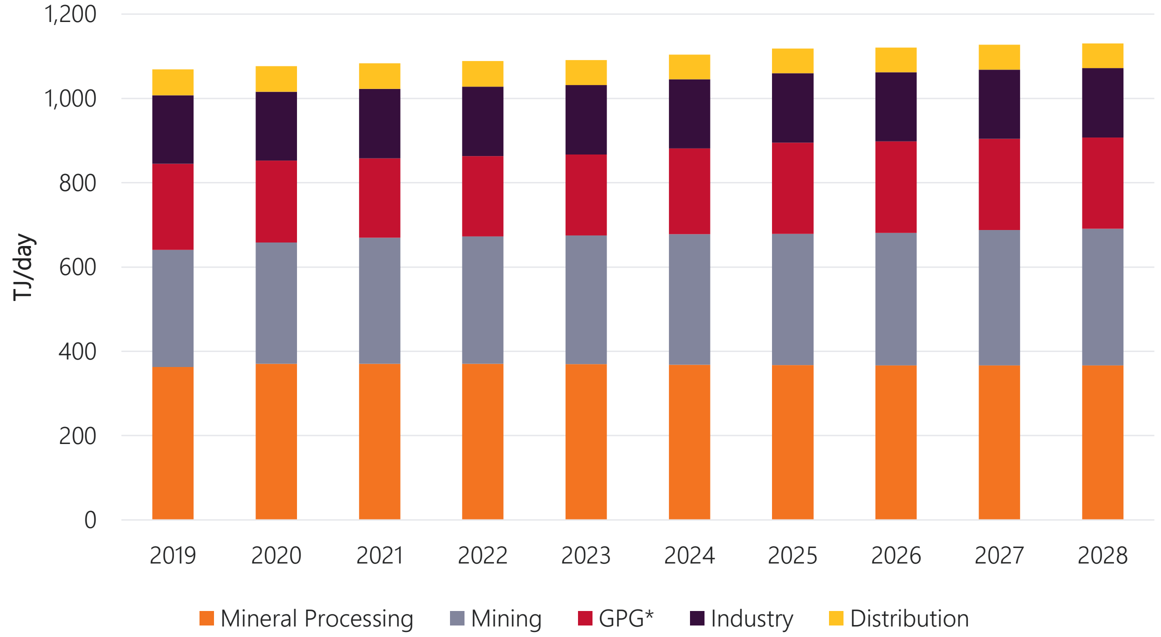
[58] Refer to Appendix A3.2.1 for details.

[59] The usage categories were defined in this way for the purposes of forecasting as each category is affected by different sets of external and internal influences.

[60] Includes any gas consumed for electricity generated at remote mine and mineral processing sites.

[61] See footnote 59.

Figure 9 Domestic gas demand forecasts by sector (TJ/day), base scenario, 2019-28



Source: AEMO and MJA.
* GPG sector gas demand excludes gas used to fuel GPG associated primarily with mining activities, and gas used in CCGTs to generate steam for mineral processing activities.

Table 10 Forecast annual gas demand by sector (TJ/day), base scenario, 2019-28

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	5-year average growth pa (%)	10-year average growth pa (%)
Mineral processing	363	370	371	370	369	368	367	367	367	367	0.5	0.1
Mining	278	288	299	302	305	309	311	314	321	324	2.4	1.7
GPG*	204	194	188	191	193	204	217	217	216	216	-1.4	0.7
Industry	162	163	164	164	164	164	164	164	164	164	0.3	0.1
Distribution	62	61	61	61	59	58	58	59	59	59	-1.0	-0.5

Source: AEMO and MJA.
* GPG sector gas demand excludes gas used to fuel GPG associated primarily with mining activities, and gas used in CCGTs to generate steam for mineral processing activities.

Mining sees the strongest growth over the outlook period. This is driven by project-specific growth, particularly in the iron ore, gold, and nickel sectors, through to 2022, and non-project-specific growth based on the commodities production forecasts[62].

Mineral processing sees some projected growth in gas demand, driven primarily by new lithium hydroxide and nickel sulphate facilities that are forecast to begin operation over the next few years.

Demand from GPG is forecast to grow over the outlook period, but not before weakening in the next five years as more renewable generation comes online in the SWIS. A projected return to growth in GPG gas demand beyond 2023 is driven by some older coal-fired generation ceasing to be dispatched in the SWIS, as it becomes less economic with more renewable facilities coming online.

[62] Refer to Appendix A3.

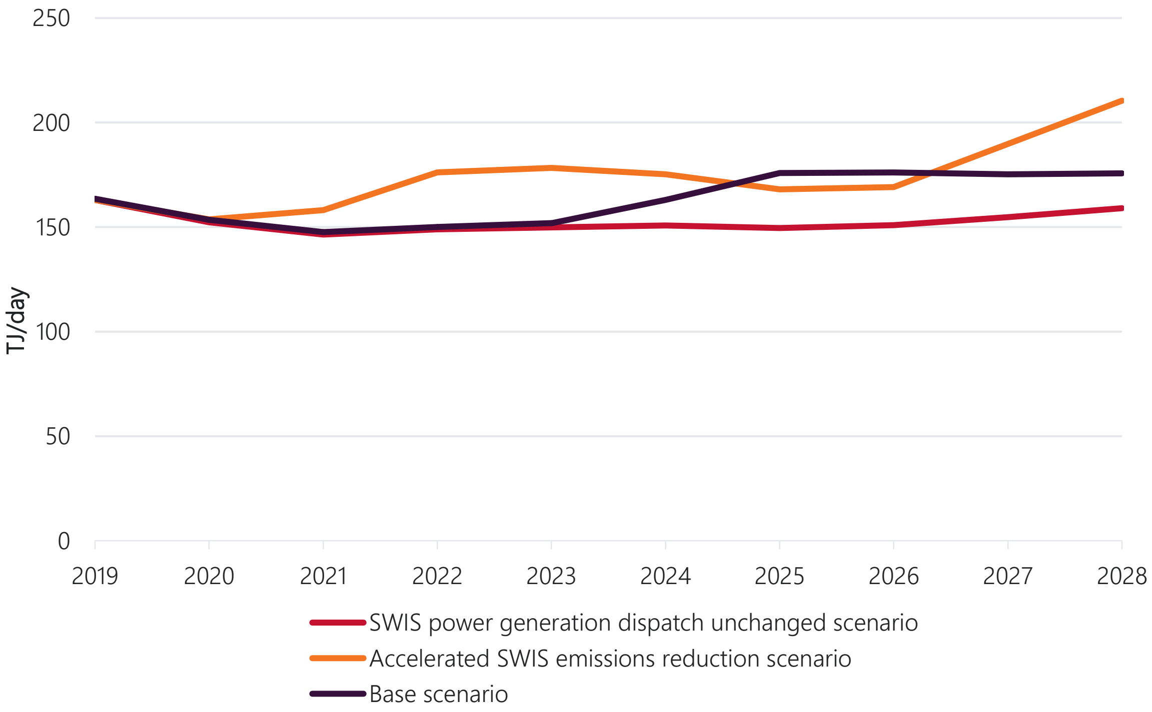
In the base scenario, gas demand from industry has remained stable since 2013 and is forecast to be relatively static over the outlook period. Large industrial gas users are primarily made up of a few large customers with stable production, apart from regular maintenance shut downs[63].

Distribution demand is forecast to decline over the outlook period. Gas connections continue to grow, but at a slower rate than previously. At the same time, the average demand per connection is falling due to gas appliances becoming more efficient, changes to building regulations that make it more difficult to install gas appliances in new homes, and higher rooftop solar PV penetration[64].

SWIS GPG gas demand under the alternate scenarios

To understand the effect that the SWIS power generation dispatch unchanged and accelerated SWIS emissions reduction scenarios could have on forecast gas demand for GPG, these scenarios are compared to the base scenario in Figure 10 and Table 11 below.

Figure 10 Domestic gas demand forecasts for SWIS GPG sector* (TJ/day), base, SWIS power generation dispatch unchanged and accelerated SWIS emissions reduction scenarios, 2019-28



Source: AEMO and MJA.
* GPG sector gas demand excludes gas used to fuel GPG associated primarily with mining activities, and gs used in combined-cycle gas turbines (CCGTs) to generate steam for mineral processing activities.

[63] Existing industrial facilities generally operate at a steady capacity factor, with limited scope to increase production without an expansion project. There is some potential for large proposed industrial projects, however, these projects do not currently meet AEMO's criteria (outlined in Appendix A3) to be included in the high scenario, so have been excluded from the demand forecasts.

[64] Increased penetration of rooftop PV makes it more likely that electric rather than gas appliances will be installed in homes.

Table 11 Domestic gas demand forecasts for SWIS GPG sector* (TJ/day), base, SWIS power generation dispatch unchanged, and accelerated SWIS emissions reduction scenarios, 2019-28

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	5-year average growth pa (%)	10-year average growth pa (%)
Base scenario	164	153	148	150	152	163	176	176	175	176	-1.9	0.8
SWIS power generation dispatch unchanged scenario	163	152	146	149	150	151	150	151	155	159	-2.1	-0.3
Accelerated SWIS emissions reduction scenario	163	154	158	176	178	175	168	169	190	210	2.2	2.9

Source: AEMO and MJA.
* GPG sector gas demand excludes gas used to fuel GPG associated primarily with mining activities, and gas used in CCGTs to generate steam for mineral processing activities.

All three scenarios forecast some reduction in gas demand from SWIS GPG over the first few years as new renewable generation is commissioned. The base scenario assumes that some older coal-fired generation in the SWIS is no longer dispatched from the end of 2023. This leads to an increase in forecast demand from SWIS GPG between 2023 and 2025. This gas demand levels out beyond 2025 as further renewables come online from 2026.

The SWIS power generation dispatch unchanged scenario initially follows the same trajectory as the base scenario. Both scenarios see new renewable energy projects reducing gas demand from SWIS GPG through to the end of 2023.

Beyond 2023, as all coal-fired facilities continue to be dispatched, there is less scope for SWIS GPG to increase its share of generation than in the base scenario, and therefore gas demand from SWIS GPG is forecast to remain relatively flat for the remainder of the outlook period.

The accelerated SWIS emissions reduction scenario assumed that a proportion of older coal-fired generation is no longer dispatched earlier than in the base case, starting from the end of 2021. A further proportion of older coal-fired generation is assumed to no longer be dispatched beyond 2026, with roughly half of current SWIS coal-fired generation no longer being dispatched in this scenario beyond 2026.

This sees forecast gas demand from SWIS GPG increase between 2021 and 2023. However, the reduction in coal-fired dispatch incentivises new renewable generation to come online, which dampens forecast growth in SWIS GPG gas consumption beyond 2023. Growth in SWIS GPG gas consumption is projected to return from 2026, when an additional proportion of SWIS coal-fired generation ceases to be dispatched.

2.3 Historical peak WA domestic gas demand days

MJA analysed historical WA gas demand using GBB data for the period 1 August 2013 through 14 August 2018. The largest gas usage day[65] was 11 June 2018 with consumption of 1,190.2 TJ/day.

[65] Excluding gas demand used in gas shipping and compression but including injections to storage facilities.

The 20 largest gas usage days for each year since the GBB commenced, and the seasons in which they were recorded, are shown in Table 12. High consumption days have been more likely to be associated with cooler days, mostly falling in the winter season. The exceptions were:

- 2016, which was an unusually warm summer, leading to periods of higher electricity demand and GPG consumption.
- 2013, for which data collection on the GBB commenced in August (the end of winter), missing the summer and autumn seasons entirely.

Table 12 20 largest gas usage days (total WA), number of days each year falling in each season, 2013-18

Number of peak gas usage days in:	2013 (1 August to year end)	2014	2015	2016	2017	2018 (Year start to 14 August)
Winter	1	19	15	4	15	18
Spring	14	1	-	5	3	-
Summer	5	-	5	4	-	-
Autumn	-	-	-	7	2	2

Source: MJA.

Table 13 shows the 20 largest gas usage days over the same period by region.

Table 13 20 largest gas usage days by geographic region, number of days each year falling in each season, 2013-18

Number of peak gas usage days in:	Metro/South West	North	East
Winter	19	3	5
Spring	1	3	11
Summer	-	7	-
Autumn	-	7	4

Source: MJA.

MJA conducted econometric analysis of the historical GBB data, identifying major drivers of high demand days, including:

- Weather-related factors, such as heating and cooling days.
- Other daily factors, like the day of the week, public holidays and school holidays.
- Economic activity (represented by State Final Demand (SFD)[66]) and population.
- Outages of non-gas electricity generation facilities.

This analysis showed that:

- Variations in consumption are most marked in the Metro/South West, with 110 TJ difference between the highest gas use day and the twentieth highest, driven predominantly by changes to consumption from GPG and minerals processing. In contrast, there is much less variation in the North region (10 TJ) and less again in the East (3 TJ).
- There is a strong day of the week effect in the Metro/South West region, with Mondays seeing the strongest positive effect on gas demand and public holidays seeing a negative effect.

[66] State Final Demand is a broad measure for goods and services in the economy which excludes the effects of net exports and inventories.

- The effect of non-gas-fired power plants being on outage was small, at around 0.03 TJ/day for each megawatt on outage for the day. However, this effect may be non-linear (that is, it may increase with increasing non-gas-fired outages).
- Most high usage days in the Metro/South West occur in winter. In the North of the state, these days occurred mostly in summer and autumn, while in the East they are most likely to be in the spring.

2.4 Reconciliation of previous WA GSOO domestic gas demand forecasts vs actuals

MJA carried out a reconciliation of previous WA GSOO domestic gas demand forecasts against actual data from the GBB. The deviation between the forecast and unadjusted actual values is shown in Table 14.

Table 14 Reconciliation of previous WA GSOO domestic gas demand forecasts (% deviance of forecast from actual), 2013-18

	2013 actual	2014 actual	2015 actual	2016 actual	2017 actual	2018 actual*	Average over the forecast series (absolute terms)
July 2013 GSOO forecast deviance (%)	+2.2	+0.8	+0.2	-1.9	-3.8	-2.9	1.9
January 2014 GSOO forecast deviance (%)		+1.8	+1.6	-2.3	-4.4	-4.1	2.8
December 2014 GSOO forecast deviance (%)			+3.7	+5.8	+5.6	+4.7	5.0
November 2015 GSOO forecast deviance (%)				+6.1	+3.2	+2.6	4.0
December 2016 GSOO forecast deviance (%)					+3.6	+2.8	3.2
December 2017 GSOO forecast deviance (%)						+1.0	1.0

* Based on average daily gas use to 14 August 2018. Source: MJA.

When comparing the demand forecast against GBB data, two issues should be considered:

- The GBB only commenced in August 2013. Historical gas transmission data was provided by pipeline operators to the Independent Market Operator for the early WA GSOO forecasts. It is reasonable to assume that the improvement of gas use data (quality and longitude) sourced from the GBB contributed to improving accuracy of the forecasts over time.
- It is useful to normalise GBB consumption data for weather, days of the week, public holidays, and one-off events. Gas is generally used for heating and cooling. As 2016 had an unusually warm summer, this may partly explain the higher deviance of the 2016 actual value to previous forecasts.

Based on this reconciliation of actuals and previous WA GSOO domestic gas demand forecasts, MJA concluded that:

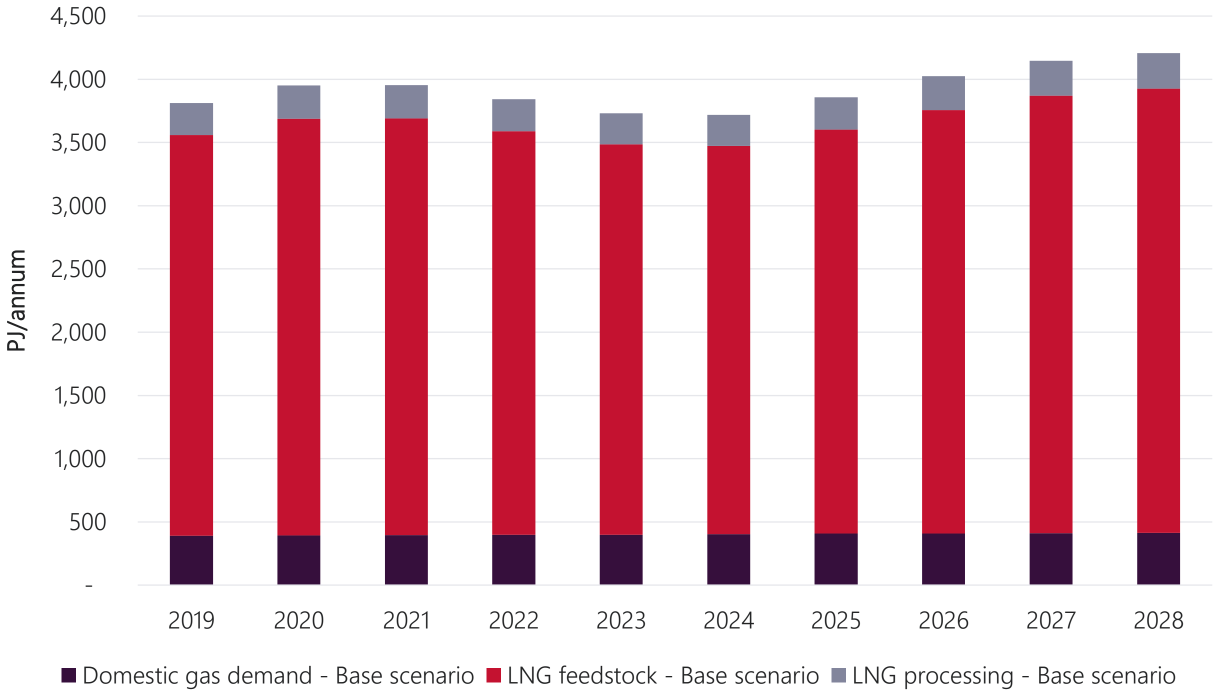
- There is generally little deviance when comparing the first two or three years of forecasts with actuals.
- A bottom-up forecasting approach for WA domestic demand is more reliable than a top-down method, with the major projects identified accounting for most of the growth in gas use. Gas use in WA is driven by major users, who invest based on long-term global demand and relative cost.
- The instability of economic conditions contributes to the difficulty of forecasting gas demand. The largest discrepancies of the forecasts to actuals are associated with the domestic recession, particularly 2015-16.

2.5 Total gas demand forecasts (domestic and LNG exports/processing)

Total gas demand is the aggregate of domestic gas demand forecasts, LNG export, and LNG processing forecasts, based on the assumptions outlined in Appendix A3.

The base scenario forecast for total gas demand for 2019-28 is shown in Figure 11. A breakdown of total gas demand forecasts for the low, base, and high scenarios for 2019-28 is outlined in Appendix A4.

Figure 11 Total gas demand forecasts (PJ/annum), base scenario, 2019-28



Projected increases in total gas demand are driven by:

- Continued growth in LNG exports from projects under construction, with the Ichthys LNG and Prelude floating LNG (FLNG) projects expected to commence.
- Potential backfill for the NWS project.
- A new prospective project (Equus).
- Expansions of existing projects (primarily in the high scenario).

The low total gas demand scenario assumed backfill for Darwin LNG to continue production at the same rate, with potential delays to the commencement of existing projects under construction (Prelude FLNG and second train at Ichthys LNG).

The base scenario included similar parameters to the low scenario, except that backfill for the NWS was assumed to come from the Scarborough and Browse gas fields in 2024 and 2026, respectively. Prelude FLNG and Ichthys Train 2 were assumed to commence earlier, and Equus was assumed to start in 2023.

The high scenario included all the base scenario assumptions but assumed the Pluto LNG project is expanded to process Scarborough gas due to capacity constraints at NWS as Browse production ramps up (see Section 3.4 for further details). Expansions to the Gorgon, Wheatstone, and Ichthys LNG facilities were also included.

The base scenario forecast illustrates the decline in production for the NWS project between 2021 and 2024, in line with the proponents' forecast increase in spare processing capacity due to reserves depletion[67] (see Section 3.2 for further details). New supply sources are introduced as backfill for the NWS while a new project enters (Equus) (see Section 3.4 for further details). The average annual growth rate for LNG feedstock over the outlook period is 1.1%. Domestic gas demand is estimated to compose 10.2% of total gas demand in 2019, falling slightly to 9.8% in 2028.

The total gas demand forecast for the base scenario presented in this report differs to that published in the 2017 WA GSOO. The 2018 forecast is slightly higher in the years 2019 to 2021, and lower from 2022 onward, due to:

- An improved outlook for WA commodities, which has resulted in rising forecast WA domestic gas consumption in the near term.
- Some scenario assumptions have changed since the 2017 WA GSOO. The 2018 forecasts incorporate the emergence of spare capacity at the NWS, and the firming of development plans for Scarborough and Browse gas and the Equus project (see Appendix A3).
- Given the allocation of gas resources to LNG production in the mid-term, expansions of existing LNG projects have been shifted to the high scenario.

[67] See Section 3.2 for details.

3. Gas supply

This chapter presents the following forecasts and analysis for the WA gas market over the 2019-28 outlook period:

- Historical profile of gas reserves and resources, exploration, and gas production facilities.
- Potential gas supply forecast assumptions.
- Profile of prospective gas supply sources included in the potential gas supply forecasts.
- Potential gas supply forecasts.
- Comparison of the 2018 WA GSOO and the 2017 WA GSOO base scenario potential gas supply forecasts.

3.1 Profile of upstream and gas production

3.1.1 Reserves and resources

Gas resources and reserves are categorised according to the level of technical and commercial uncertainty associated with recoverability[68]:

- Reserves are quantities of gas that are anticipated to be commercially recovered from known accumulations. Proved and probable reserves (2P) are considered the best estimate of commercially recoverable reserves[69].
- Contingent resources are considered less commercially viable than reserves. These resources are equivalent to 2P, except for one or more contingencies or uncertainties currently impacting the likelihood of development. 2C resources are considered the best estimate of sub-commercial resources[70].

Third-party estimates of WA total conventional and unconventional gas resources are summarised in Table 15[71]. Compared to the same period in 2017, conventional 2C gas resources in 2018 have increased over 8%, while conventional 2P gas reserves have fallen by 2%.

In addition to conventional gas, WA's resources of unconventional gas (shale and tight gas) are estimated to be substantial, mostly located in the Canning and Perth basins. However, the estimates have remained

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[68] AEMO. *WA GSOO*, December 2017, p. 22. Available at https://www.aemo.com.au/-/media/Files/Gas/National_Planning_and_Forecasting/WA_GSOO/2017/2017-WA-GSOO.pdf. These uncertainties could include securing finance, obtaining government approvals, negotiating contracts, or overcoming geological challenges. The terms resources and reserves are not interchangeable: reserves constitute a subset of resources.

[69] 2P reserves categorisation indicates that there is a reasonable probability that 50% or more of the gas is recoverable and economically profitable. Proved reserves (1P) indicate that this probability is higher than 90%. Gas producers generally sign gas supply sales contracts based on 1P reserves.

[70] The resources are estimated to exist in prospective areas but have not been proven by drilling.

[71] DJTSI. *WA LNG Industry Profile*, Sept/Oct 2017, p. 5. Available at http://www.jtsi.wa.gov.au/docs/default-source/default-document-library/wa-lng-profile-0917.pdf?sfvrsn=6, and DJTSI, 2018. *WA LNG Industry Profile*, Sept, p. 5. Available at https://www.jtsi.wa.gov.au/docs/default-source/default-document-library/wa-lng-profile-0918.pdf?sfvrsn=ea0d721c_6.

relatively static from 2017. Given the 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. A new policy on the use of hydraulic fracture stimulation techniques[72] in WA means future unconventional gas production will be limited.

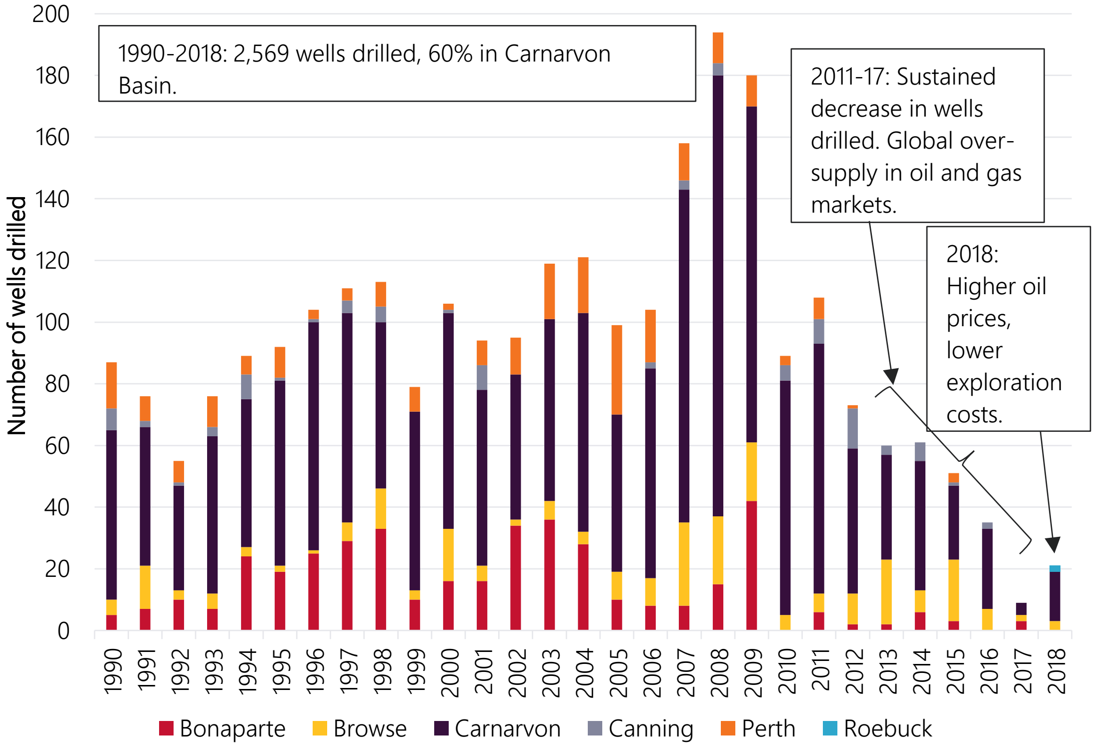
Table 15 WA conventional and unconventional gas resources and reserves (PJ)[a], September 2018

Attribute	Total 2017	Total 2018
Conventional 2P gas reserves (PJ)	73,913	72,186
Conventional 2C gas resources (PJ)	74,231	80,454
Unconventional: Estimated shale gas resources, range low to high (PJ)[b]	96,501-204,666	96,460-204,580
Unconventional: Estimated tight gas resources[c]	91,198	91,160

[a] Sum of resources and reserves provided by basin, with the figures for the Bonaparte Basin giving the net entitlement to Australia. Converted from trillion cubic feet (Tcf) to PJ. 2C resources reported are over and above the 2P reserves reported.
[b] Based on WA Dept. of Mines, Industry Regulation and Safety's current, best estimates of risked, recoverable resources.
[c] GIIP: Gas-initially-in-place, referring to the total amount of gas contained in each basin, including volumes that are deemed sub-economic, and which may never be recovered.

Exploration

Figure 12 Exploration and development wells drilled (number), 1990-2018 (year to date)



Source: Compiled using information from Australian Petroleum Production & Exploration Association (APPEA), and from National Offshore Petroleum Titles Administrator (NOPTA), *National Offshore Petroleum Information Management System (NOPIMS)*. Available: https://nopims.dmp.wa.gov.au/Nopims/Search/Wells. Viewed: 20 September 2018.

Gas supply to the domestic market is largely dependent on the sustained development of gas reserves. Reserves associated with domestic gas production exhibit a natural decline. This year to date, 21 exploration

[72] For details, see Chapter 1 and Chapter 6.

and development wells have been drilled, up from nine last year, although still the second lowest figure since 1990 (see Figure 12)[73].

Of the wells drilled this year, 17 are in locations that could theoretically connect to the WA transmission pipeline network. Two of these wells were in the Roebuck Basin[74], one of the least explored regions of the North West Shelf[75].

Production by facility

There are nine gas production facilities that supply the WA domestic market, with a total capacity of about 1,628 TJ/day (shown in Table 16). The Red Gully and Dongara Facilities have not operated since Q3 2017[76]. The KGP maintains the largest capacity at 630 TJ/day.

Over the year to Q2 2018, there has been some reduction in average gas production from the Devil Creek and KGP facilities, a general increase in production from Macedon and Varanus Island, and a mostly stable level of production from Gorgon, Beharra Springs, and Xyris.

Table 16 Domestic gas production facility average production (TJ/day) and utilisation (%), Q3 2017 to Q2 2018

Facility	Nameplate capacity (TJ/day)	Average production (TJ/day)				Average capacity utilisation[a] FY 2017-18 (%)
		Q3 2017	Q4 2017	Q1 2018	Q2 2018	
Beharra Springs	19.6	14	13	13	13	68
Devil Creek	220	117	136	97	99	51
Gorgon (Phase 1)	182	142	151	141	155	81
Karratha Gas Plant	630	392	408	386	357	61
Macedon	220	197	158	172	180	80
Varanus Island	345	227	204	235	259	67
Xyris	11.5	9	6	9	9	72
Total	1,628.1	1,098	1,076	1,053	1,072	69

[a] Utilisation was calculated using nameplate capacity and average production over the preceding four quarters. Source: WA GBB and EnergyQuest.

As reported in the 2017 GSOO, two new domestic gas production facilities are expected to commence operations over the outlook period: Wheatstone (200 TJ/day) in Q1 2019[77] and Gorgon (118 TJ/day) tranche two in 2021[78].

Once these facilities are producing, WA's total domestic gas production capacity is expected to increase by 20% from the current level to reach 1,946 TJ/day[79].

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[73] Year to date to September 2018.

[74] Previously known as the Offshore Canning Basin.

[75] Geoscience Australia. *Roebuck Basin Regional Geology*. Available at https://2017-petroleumacreage.industry.slicedtech.com.au/2017/geology/roebuck-basin/roebuck-basin-regional-geology. Viewed: 22 October 2018.

[76] For more information on the status of the Red Gully facility, see Chapter 1. The Dongara Production Facility is being prepared for partial care and maintenance, as the Dongara gas field ceased production in 2017. Mitsui. *What we do*. Available at https://mitsuiepmidwest.com.au/what-we-do/. Viewed: 22 October 2018.

[77] Woodside Energy. *Third quarter report for period ended 30 September 2018*, 18 October 2018, p. 4. Available at https://woodsideannouncements.app.woodside/18.10.2018+Third+Quarter+2018+Report.pdf.

[78] DJTSI. *Western Australian LNG Project Domestic Gas Agreements*. Available at https://www.jtsi.wa.gov.au/docs/default-source/default-document-library/western-australian-lng-project-domestic-gas-agreements60eb0fa57ba2628e86e4ff0000981137.pdf?sfvrsn=de496d1c_6. Viewed: 26 October 2018.

[79] Assuming no capacity is retired.

Further information about WA gas infrastructure, including details of multi-user gas storage facilities, gas transmission pipelines, spot and short-term gas trading mechanisms and LNG export production facilities, can be found in Appendix A5.

3.2 Potential gas supply forecast assumptions

AEMO does not forecast WA domestic gas supply. AEMO estimates the potential *availability* of gas supply to the WA domestic market by evaluating gas producers' willingness to supply 'at the right price' on an annual basis. Potential gas supply is domestic gas supply that could be economically offered given forecast prices and production costs, subject to the availability of domestic gas supply capacity and gas reserves. The resulting forecasts are therefore not projections of how much gas *will* be produced, but how much gas *could* be produced if there was market demand for it at the forecast price. This approach assesses gas supply adequacy and identifies potential supply shortfalls, where expected domestic gas demand is greater than expected supply availability

The model nets out already-contracted domestic sales, treating them as 'locked in' at pre-determined prices. It focusses on determining how much non-contracted (or 'spare') gas supply capacity would be made available for sales to the domestic market at expected prices. For further information about the methodology and input data underpinning these forecasts, see Appendix A3.1.4.

The fundamental assumptions for the 2018 low, base, and high potential gas supply scenarios are summarised in Table 17.

Table 17 Potential gas supply forecast scenario assumptions

Inputs	Low scenario	Base scenario	High scenario
Domestic gas demand	Low	Expected	High
Costs of production[a] by supply source/production facility: • Short-run for existing • Long-run for prospective	Expected	Expected	Expected
Reserves and gas sales: • Gas reserves connected or expected to be connected to domestic gas production facility • Maximum contracted quantity, by facility	Expected[b]	Expected[b]	Expected[b]
For domestic gas-only projects to supply uncontracted gas: • Domestic gas price[c]	Low	Expected	High
For LNG-linked projects to be triggered: • Oil price (US$/barrel)d • LNG price (% index to oil price)[d] • Exchange rate (A$/US$)[e]	Low	Expected	High
For LNG-linked projects: • Domestic market obligation (15% of gas resources)	Expected	Expected	Expected

[a] AEMO estimates based on EnergyQuest Pty Ltd, Wood Mackenzie, and public information. Note that the changes to the Petroleum Resource Rent Tax announced in November 2018 have not been incorporated. See Chapter 6 for details.
[b] Sourced from 2018 Formal Information Request data (conducted by AEMO for the purposes of the WA GSOO – See Chapter 5 for details) for existing facilities, public domain for others.
[c] Forecasts sourced from Wood Mackenzie.
[d] Forecasts for the base scenario sourced from FGE (FACTS Global Energy), AEMO forecasts for low and high scenarios.
[e] AEMO forecasts.

In addition, for the purposes of the potential gas supply modelling, AEMO has assumed:

- All domestic market obligation (DMO) quantities[80] become available to the domestic gas market as infrastructure and gas reserves are developed over the outlook period. WA has a Domestic Gas Policy that aims to secure the state's long-term energy needs by ensuring that LNG export project developers make gas available to the WA domestic gas market[81]. The policy seeks to make gas equivalent to 15% of LNG exports available for WA consumers.
- Beharra Springs, Devil Creek, Gorgon (tranche one), Macedon, Varanus Island, and Xyris are existing facilities[82].
- Most existing domestic production facilities decrease output linearly over time as reserves decline.
- Wheatstone will make its full 200 TJ/day production capacity available from 2019[83].
- Gorgon tranche two will be available from 2021[84].
- 40 TJ/day will be available from Pluto from 2019 through the LNG trucking and domestic gas facilities currently under construction[85]. Currently, there is insufficient infrastructure at Pluto to process the full 110 TJ/day DMO, so AEMO assumes that an additional 70 TJ/day ("second tranche") will be made available from 2023[86].
- The KGP will produce at either its contracted rate or the DMO volume of 90 TJ/day[87], whichever is greater, until the end of the outlook period.

In addition to existing and committed production capacity, AEMO included four prospective supply sources in the model, as shown in Table 18. Detailed information on these sources can be found in Section 3.4.

Table 18 Prospective supply sources included in the potential gas supply model

Source	Available from[a]	Incremental volume available to the domestic gas market (TJ/day)[b]
Waitsia Stage 2	2022 [c]	90
Equus	2023	40
Scarborough	2024	125
Browse	2026	230

[a] AEMO's assumptions are based on information from the project proponent and expected availability of reserves and infrastructure.
[b] AEMO sourced DMO volumes from the WA Department of Jobs, Tourism, Science and Innovation (DJTSI) where available. For new supply sources, where figures from DJTSI were unavailable, AEMO calculated approximate DMO volumes as 15% of the gas resources and assumed a 20-year project life. For Waitsia, AEMO assumed a 90 TJ/day increase to the Xyris production facility (~10 TJ/day) to bring the total capacity to 100 TJ/day. For Equus, AEMO calculated a DMO given the downstream base case of a 2 mtpa LNG facility, as proposed in a September 2018 presentation by Western Gas. See Section 3.4.2.
[c] Beach Energy expects FID in 2019. AEMO has assumed a two-year construction period (2021) and availability to the market from the start of the following year.

[80] The greater of the aggregate domestic gas contract volume or the full DMO is available for supply.

[81] DJTSI. *WA Domestic Gas Policy*. Available at https://www.jtsi.wa.gov.au/economic-development/economy/domestic-gas-policy. Viewed: 20 November 2018.

[82] Red Gully was excluded from the modelling (see Chapter 1).

[83] Woodside Energy. *Third quarter report for period ended 30 September 2018*, 18 October 2018, p. 4. Available at https://woodsideannouncements.app.woodside/18.10.2018+Third+Quarter+2018+Report.pdf.

[84] DJTSI. *Western Australian LNG Project Domestic Gas Agreements*. Available at https://www.jtsi.wa.gov.au/docs/default-source/default-document-library/western-australian-lng-project-domestic-gas-agreements60eb0fa57ba2628e86e4ff0000981137.pdf?sfvrsn=de496d1c_6. Viewed: 20 November 2018.

[85] Woodside Energy. *Corporate Brochure*. Available at http://www.woodside.com.au/Investors-Media/media-library/Documents/Woodside%202018%20Corporate%20Brochure.pdf. Viewed: 20 November 2018.

[86] DJTSI. *Western Australian LNG Project Domestic Gas Agreements*. Available at https://www.jtsi.wa.gov.au/docs/default-source/default-document-library/western-australian-lng-project-domestic-gas-agreements60eb0fa57ba2628e86e4ff0000981137.pdf?sfvrsn=de496d1c_6. Viewed: 20 November 2018.

[87] ibid.

Spare capacity at the Karratha Gas Plant

Assumptions about the future of the KGP, the largest WA domestic gas production facility in operation, are critical to the potential gas supply forecasts. To extend the aging plant's life, refurbishment of its LNG and domestic gas processing infrastructure was carried out between 2016 and 2018[88]. However, the facility's spare capacity will increase as reserves from the current fields decline. Additional fields must be connected to the existing processing infrastructure and substantial further investment will be needed to extend the plant's life[89].

A proposal to use existing onshore and some offshore infrastructure to enable long-term processing of third-party gas at the KGP was referred by the NWS Joint Venture to the WA Environmental Protection Authority and the Commonwealth Department of Environment and Energy on 14 November 2018[90].

Woodside (the operator) expects substantial spare capacity to become available at the KGP gas production trains (both LNG and domestic gas) starting from the early 2020s[91]. Despite the connection of the Greater Western Flank Phase two fields (Keast, Dockrell, Sculptor, Rankin, Lady Nora, and Pemberton) in October 2018[92], there is a continued overall resource decline in the producing fields.

AEMO has identified three potential sources of backfill for the KGP:

- Equus (see Section 3.4.2 for further information)[93].
- Scarborough (see Section 3.4.3 for further information)[94].
- Browse (see Section 3.4.4 for further information).

Woodside is actively progressing Browse as backfill for the KGP, signing a non-binding preliminary agreement with the NWS joint venture partners in November 2018 detailing terms and pricing for using the facility to process gas[95]. However, joint venture partners do not plan for Browse to commence operation until around 2026[96] and, once developed, it may not fill the total available LNG processing capacity. Either Equus or Scarborough (or possibly both) could be used to fill the KGP's remaining capacity.

To access the Scarborough development, Woodside is targeting FID in 2019 on construction of a roughly five-kilometre-long interconnector pipeline to transport gas from Pluto LNG to the KGP[97]. This is intended to allow flexibility to fill spare capacity at the KGP with gas from Pluto, Scarborough and potentially other supply sources[98].

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[88] Monadelphous. "MGJV secures Karratha Gas Plant services contract", ASX Announcement, 9 December 2015. Available at https://www.monadelphous.com.au/media/4539601/151209_mnd_asx_announcement_kle.pdf.

[89] Woodside Energy. *Woodside's North West Shelf Project Extension*, November 2018. Available at https://woodsideannouncements.app.woodside/NWS+Project+Extension+Fact+Sheet.pdf.

[90] Ibid.

[91] Woodside Energy. *Investor briefing day,* 23 May 2017, p. 57. Available at http://www.woodside.com.au/Investors-Media/announcements/Documents/23.05.2017%20Investor%20Briefing%20Day%202017.pdf.

[92] Woodside Energy. "Greater Western Flank Phase 2 commences production", Media release, 25 October 2018. Available at https://woodsideannouncements.app.woodside/25.10.2018+Media+Release+-+Greater+Western+Flank+Phase+2+commences+production.pdf.

[93] One development option for Equus is to tie-back to the KGP. However, Western Gas's current downstream base case is to develop Equus as a stand-alone 2 mtpa LNG project.

[94] Scarborough is expected to primarily be developed to support an additional LNG production train at Pluto. However, domestic gas could be produced at the KGP using Scarborough gas via the proposed interconnector.

[95] The agreement also includes processing of the Chevron's Clio-Acme fields. Woodside. "North West Shelf Venture signs preliminary agreements to process third-party gas", Australian Stock Exchange (ASX) announcement, 7 November 2018. Available at https://woodsideannouncements.app.woodside/7.11.2018+Media+Release+-+North+West+Shelf+Venture+signs+preliminary+agreements+to+process+third-party+gas.pdf.

[96] Woodside Energy. *Half-year report 2018*, 30 June 2018. Available at https://woodsideannouncements.app.woodside/15.08.2018+Half-Year+Report+2018.pdf.

[97] ibid.

[98] Woodside Energy. *Half-year report 2017*, 30 June 2017. Available at http://www.woodside.com.au/Investors-Media/announcements/Documents/16.08.2017%20Half-Year%20Report%202017.pdf. Woodside. *Investor briefing day*, 23 May 2017. Available at http://www.woodside.com.au/Investors-Media/announcements/Documents/23.05.2017%20Investor%20Briefing%20Day%202017.pdf.

Browse and Scarborough have been modelled separately as prospective supply sources, but are assumed to use existing infrastructure for processing for the purposes of estimating production costs (for further information about these projects see Section 3.4).

3.3 Criteria for assessing prospective supply

AEMO's assessment of prospective supply sources reflects information from external consultants[99] and in the public domain. AEMO used both physical and qualitative characteristics when assessing supply sources, as shown in Table 19.

Table 19 Criteria for assessing prospective gas supply sources

Physical characteristics	Qualitative characteristics
• Reserves volume. • Water depth. • Reservoir characteristics (for example, dry, technically challenging, presence of contaminants like carbon dioxide). • Likely development path (for example, tie-back to an existing facility or new production capacity). • Estimated development cost, based on the likely development path, and including long-run (capital) and short-run (operating) costs. • Domestic market obligation for sources that are primarily being developed to supply the global LNG market.	• Ownership structure (for example, joint venture, sole owner). • Proponent or operator experience. • Primary development driver (for example, global LNG market, domestic gas market). • Commercial arrangements (for example, any tolling arrangements that may be required).

AEMO assessed 18 prospective supply sources, and 14 were excluded for at least one of the following reasons:

- Insufficient testing of the field had been completed to evaluate the size and characteristics of the resource.
- The development time frame was likely to extend beyond the end of the outlook period (2028).
- Developing the resource was uneconomic under current and expected near-term LNG and domestic market conditions.

AEMO will continue to monitor these developments as potential future prospective supply sources.

The remaining four prospective supply sources were included in the potential gas supply model to determine whether they were likely to be developed over the outlook period. Based on AEMO's economic and price assumptions (see Appendix A3 for further information), all the prospective supply sources could be economically supplied during the outlook period in the high scenario.

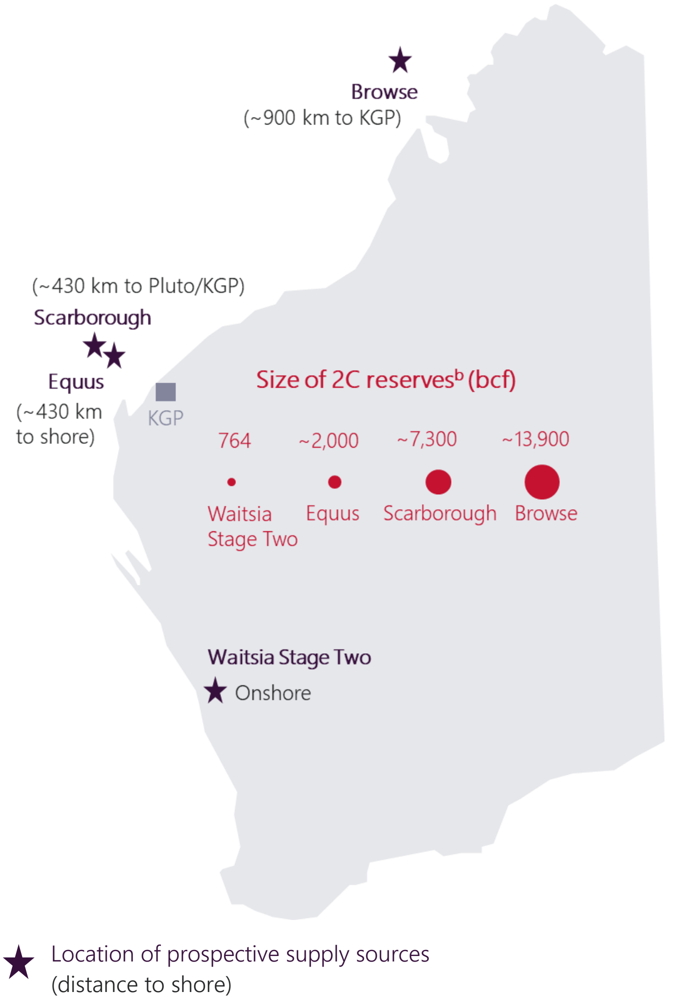
AEMO has used the project operator's expected commencement dates (see Table 20 in Section 3.4), sourced from publicly available information, in the potential gas supply modelling (see Section 3.2).

3.4 Prospective supply sources

There are substantial undeveloped gas reserves located in WA that could provide domestic gas in the future, either through new or existing processing facilities. AEMO identified four major prospective sources, as summarised in Figure 13 and Table 20.

[99] AEMO engaged EnergyQuest Pty Ltd and Wood Mackenzie Ltd to provide independent advice on prospective supply sources.

Figure 13 Prospective gas supply sources[a] infographic



Note: Map is indicative, not to scale.

[a] Based on publicly available information sourced from company websites.

[b] Waitsia reserves are 2P and were sourced from Wood Mackenzie.

Table 20 Prospective gas supply sources, operators and proponent commencement dates

Field/source name	Operator	Proponent commencement date
Waitsia Stage 2	Mitsui E&P Australia	2021[a]
Equus	Western Gas	2023[b]
Scarborough	Woodside Energy	2023[c]
Browse	Woodside Energy	2026 and 2027[d]

[a] Beach Energy expects FID in 2019. AEMO has assumed a two-year construction period. See Beach Energy. *2018 Investor briefing,* 27 September 2018, p. 64. Available at https://www.beachenergy.com.au/asx/.

[b] Western Gas expects first gas in 2023 under the current development concept. See Western Gas. *Equus gas project fact sheet*. Available at http://www.westerngas.com.au/sites/default/files/Equus%20Gas%20Project%20Fact%20Sheet%20-%20May%202018%20-%20r2.pdf. Viewed: 20 November 2018.

[c] Year of ready for start-up (RFSU)(when the plant or facility is mechanically completed, fully commissioned and read to introduce the gas feedstock) for the upstream development. See Woodside Energy. *Scarborough development technical fact sheet*. Available at http://www.woodside.com.au/Investors-Media/media-library/Documents/Woodside-Scarborough-%20Technical-Fact-Sheet.pdf. Viewed: 20 November 2018.

[d] Ready for start-up for the Calliance and Brecknock fields is expected in 2026, and for the Torosa field in 2027. See Woodside Energy. *Half-year report 2018,* 30 June 2018. Available at https://woodsideannouncements.app.woodside/15.08.2018+Half-Year+Report+2018.pdf.

3.4.1 Waitsia Stage Two

The Waitsia field is located onshore in the Perth basin. The project has been split into two stages:

- Stage 1 – development through the existing 9.6 TJ/day Xyris facility, which commenced production in 2016.
- Stage 2 – construction of a new production facility to expand the project to 100 TJ/day.

The project is owned by Mitsui (operator) and Beach Energy.

According to Beach Energy[100], several development options are currently being considered, including domestic gas and export of LNG, with FID expected by mid-2019. AEMO assumes that the project will be developed for the domestic gas market (as per the development plans prior to ownership changes in 2018[101]) and expects full operation at 100 TJ/day by 2022.

3.4.2 Equus

The Equus project consists of multiple fields, including Glencoe, Glenloth, Nimblefoot, and Mentorc, located offshore in the North Carnarvon basin. Western Gas is the sole owner of the fields.

A tender for full-field development services was released in May 2018 towards the appointment of an engineering partner in late 2018[102]. FID is planned for late 2019, and delivery of first gas from 2023.

The Equus development plan includes an initial stage comprising three production wells linked to a floating production storage and offloading facility. After removing condensate, natural gas will be piped to shore via a pipeline directly to the DBP.

Currently, the Equus "downstream base case" is a 2 mtpa LNG facility[103]. However, onshore gas processing will depend on the outcome of marketing arrangements, with options including domestic gas, a new LNG production facility, or provision of gas as backfill or expansion of existing LNG facilities.

3.4.3 Scarborough

The Scarborough gas field is in the North Carnarvon Basin, approximately 430 kilometres from the Pluto LNG facility. The field is owned by Woodside (operator) and BHP.

Woodside's preferred development option for Scarborough is to support a second 4-5 mtpa LNG train at Pluto at a development cost of around US$11 billion[104]. The original environmental approval for the Pluto project included a second LNG train. Woodside expects to take FID on the project in 2020[105].

Another development option for Scarborough gas is via the interconnector between Pluto and the KGP. This would take advantage of the spare production capacity expected to emerge at the KGP from the early 2020s. For further information about this development option, see Section 3.2.

3.4.4 Browse

The Browse project consists of the Brecknock, Calliance, and Torosa gas fields and is in the Browse basin approximately 425 kilometres north of Broome. The project is owned by a joint venture consisting of Woodside (operator), Shell, BP, MIMI Browse Pty Ltd, and BHP.

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[100] Beach Energy. *2018 Investor briefing*, 27 September 2018, p. 64. Available at https://www.beachenergy.com.au/asx/.

[101] See Chapter 1 for details of ownership changes for Waitsia Stage 2.

[102] Western Gas. "Equus Gas Project enters next phase of development", Media release, 10 May 2018. Available at http://www.westerngas.com.au/sites/default/files/2018-05-11-Equus-Gas-Enters-New-Phase-of-Development-r4.pdf.

[103] Western Gas. *Western Gas: Accelerating development of Western Australia's discovered gas resources*, presentation at the South East Asia Australia Offshore & Onshore Conference, 6 September 2018, p. 6.

[104] Woodside Energy. *Investor briefing day 2018*, 23 May 2018. Available at https://woodsideannouncements.app.woodside/23.05.2018+2018+Investor+Briefing+Day.pdf.

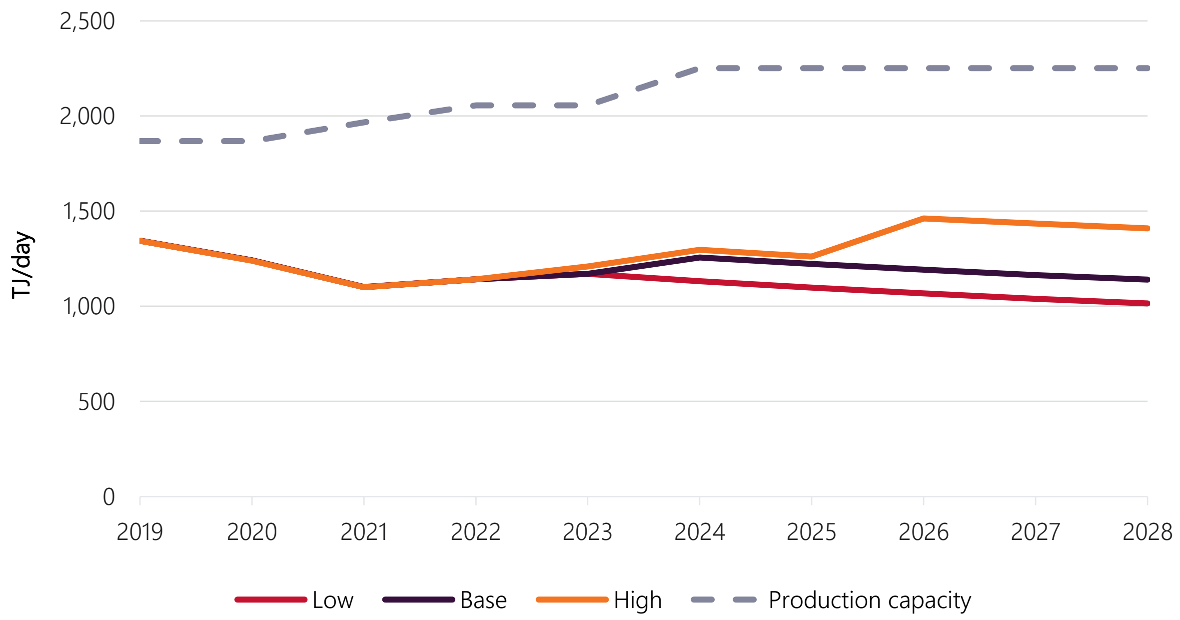
[105] Ibid.

The Browse joint venture is currently considering developing Browse to supply around 10 mtpa of LNG via a roughly 900-kilometre-long subsea pipeline to the KGP, underpinned by a preliminary tolling agreement with the NWS joint venture partners[106]. Key terms and pricing have been agreed between the Browse and NWS joint ventures, with an indicative expected toll of around $2/Million British thermal units (MMBtu)[107]. Development costs (at ready for start-up [RFSU]) are estimated to be around US$15 billion[108].

3.5 Potential gas supply forecasts

AEMO's potential gas supply forecasts for the low, base, and high scenarios are shown in Figure 14 and Table 21.

Figure 14 Potential gas supply forecasts, 2019-28



Note: Production capacity assumes prospective supply sources enter the market as per the base scenario for the potential gas supply forecasts.

Table 21 Potential gas supply forecasts (TJ/day), 2019-28

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	5-year average growth pa (%)	10-year average growth pa (%)
Low scenario	1,345	1,241	1,101	1,142	1,170	1,132	1,098	1,067	1,040	1,015	-3.4	-3.1
Base scenario	1,345	1,241	1,101	1,142	1,170	1,257	1,223	1,192	1,165	1,140	-3.4	-1.8
High scenario	1,345	1,241	1,101	1,142	1,209	1,296	1,262	1,462	1,434	1,410	-2.6	0.5

[106] Woodside Energy. "North West Shelf Venture signs preliminary agreements to process third-party gas", Media release, 7 November 2018. Available at https://woodsideannouncements.app.woodside/7.11.2018+Media+Release+-+North+West+Shelf+Venture+signs+preliminary+agreements+to+process+third-party+gas.pdf.

[107] ibid.

[108] Woodside Energy. *Investor briefing day 2018*.

In all scenarios, all existing domestic gas supply sources are included in the model, as well as the four identified prospective supply sources.

Depending on the various input assumptions[109] for the low, base, and high scenarios, new supply sources are triggered to commence if:

- Forecast WA domestic gas prices exceed the long-run costs of production (LRC), for domestic gas-only projects.
- Forecast LNG prices exceed their LRC, for LNG-linked projects. If the source commences, it is assumed that an associated 15% DMO will be offered to the domestic gas market.

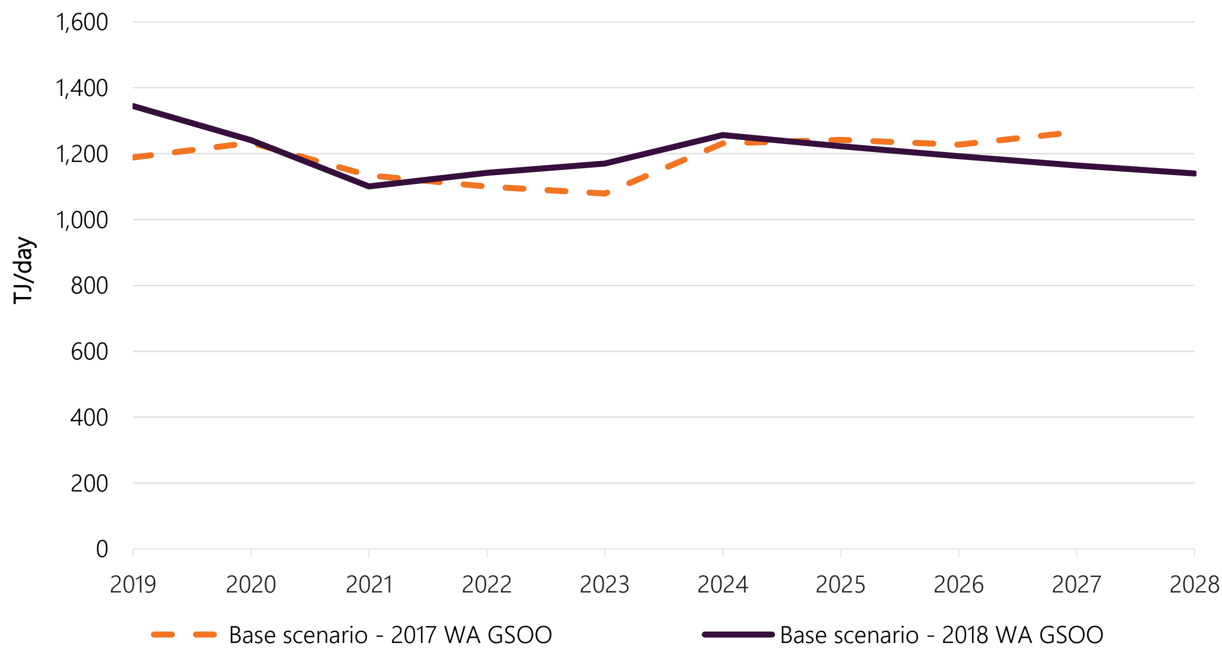
Nameplate production capacity is expected to exceed potential gas supply in all three scenarios over the outlook period. In summary:

- Between 2019 and 2022, the production costs of all available supply sources are lower than the domestic gas price forecast in all three scenarios, resulting in identical potential gas supply forecasts.
- Despite new prospective supply commencing in 2022, gas supply is forecast to decline relative to the 2019 level over the outlook period in both the base (-1.6% average annual growth) and low (-2.8% average annual growth) scenarios due to reserve depletion at existing production facilities.
- In the high scenario, potential gas supply is expected to increase slightly (0.5% average annual growth) over the outlook period as further new supply sources commence.
- In the base and low scenarios, the forecast LNG price is insufficient for some LNG-linked projects to be developed during the outlook period.

3.5.1 Comparison of 2018 WA GSOO and 2017 WA GSOO

The base scenario potential gas supply forecast for the outlook period is compared with the potential gas supply forecasts for the base scenario developed for the 2017 WA GSOO (forecasting the period 2018 to 2027) in Figure 15.

Figure 15 2017 and 2018 base scenario potential gas supply forecasts, 2019-28



[109] See Appendix A3 for further details of the potential gas supply modelling methodology.

The key differences between the base scenario forecasts in the 2017 WA GSOO and the 2018 WA GSOO are:

- Revisions to the potential gas supply model, which this year took account of reserve decline in existing production facilities, resulting in the 2018 base scenario potential gas supply falling from 2024 until 2028. In comparison, the 2017 WA GSOO potential gas supply model forecasts assumed that reserves were replaced as gas fields were depleted.
- Updates to production cost information in the model, which this year used short-run costs for existing facilities rather than long-run costs.
- The 2018 WA GSOO potential gas supply forecasts incorporate prospective supply sources. This change increases the base scenario potential gas supply between 2021 and 2024 relative to the 2017 WA GSOO forecasts, which excluded prospective supply sources (see Section 3.4 for further information).
- The higher forecasts for 2019 are partly due to additional gas supply from Pluto (40 TJ/day), assumed in the 2018 WA GSOO model.

For further information about the changes to the potential gas supply model, see Appendix A3.

4. Domestic gas market supply-demand balance

This chapter briefly summarises key points in relation to the WA domestic gas demand and potential gas supply forecasts, before considering the supply-demand balance.

4.1 Summary of gas demand and potential gas supply forecasts

In summary, a positive outlook for commodities over the 2019-28 period is expected to lift gas demand, as new gas-consuming mining and minerals processing projects commence:

- With publicly announced new resource projects and expansions, committed projects are estimated to add 50 TJ/day to forecast gas demand in the low, base, and high scenarios.
- The 10-year forecasts for commodities production and prices have strengthened from the forecasts used in the 2017 WA GSOO, particularly for nickel, zinc, copper, and lithium. Due to the continued expected strength in the WA resources sector and secondary processing, a further 57 TJ/day from 13 prospective gas demand projects is added under the high demand scenario.

Gas demand in the SWIS GPG sector is expected to see increased variability, facing downward pressure as new renewable generation is anticipated to enter between 2019 and 2024. Following this, growth returns as some existing generation capacity is assumed to no longer be economically dispatched. In the base scenario, gas demand is forecast to be around 17 TJ/day higher in 2028 than if the existing generation mix was unchanged.

The potential gas supply forecasts are underpinned by prospective supply projects and those under construction. In 2019, facilities under construction will commence, adding 240 TJ/day in supply capacity, including:

- Wheatstone production facility.
- Pluto LNG project directly injecting pipeline quality gas and providing LNG for domestic consumers from a new LNG truck-loading facility.

From 2022, gas supply availability is expected to increase further if several prospective supply projects commence. The upper bound of supply from these sources is 485 TJ/day by 2028, including:

- Development progress for the large offshore Scarborough and Browse fields, which are expected to use existing processing infrastructure.
- Mitsui's acquisition of AWE Limited, which may give greater momentum to the proposed onshore Waitsia Stage 2 field and production plant, where reserves were recently upgraded.
- A new owner and development concept for the Equus fields. This is currently proposed to be developed as a stand-alone LNG project, although there are options to use emerging spare capacity at existing facilities.

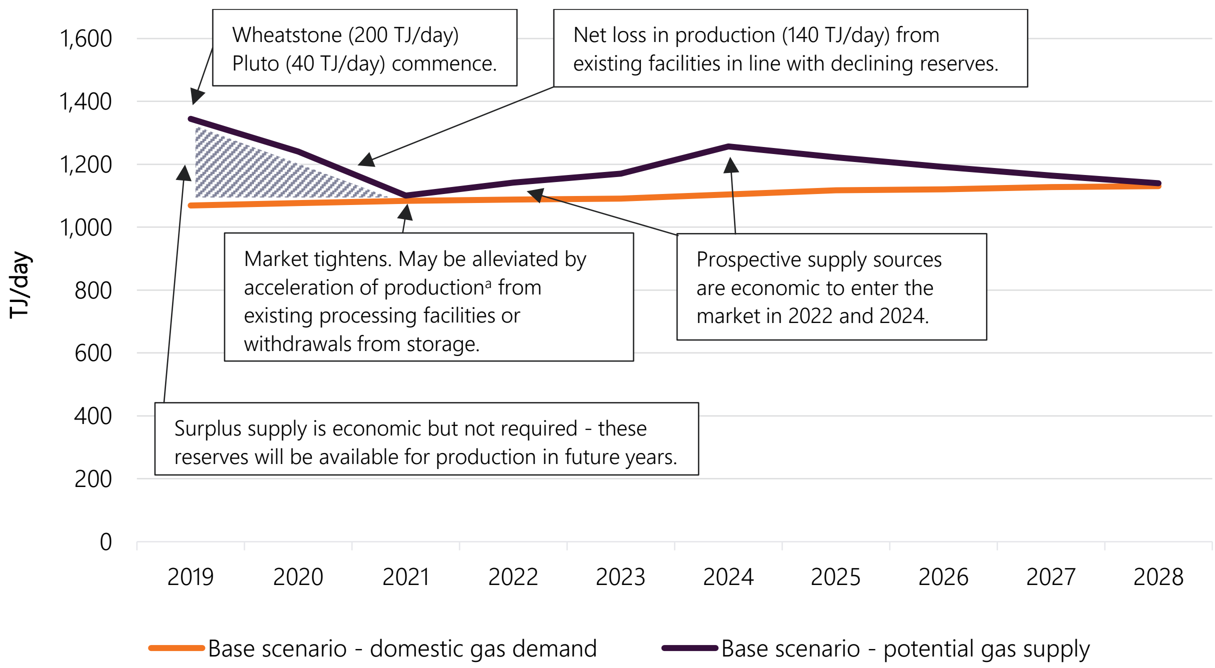
Development plans for these prospective domestic gas supply sources have solidified compared to 2017, although they are yet to reach FID.

Potential gas supply declines relative to the 2019 level over the outlook period in both the base and low scenario forecasts due to reserve depletion at existing production facilities, despite new prospective supply commencing in 2022. In the base and low scenarios, the forecast LNG price is insufficient for some LNG-linked projects to be developed during the outlook period. In the high scenario forecast, potential gas supply is expected to increase slightly as further new supply sources commence.

4.2 Supply-demand balance

In the base scenario forecasts, potential gas supply exceeds gas demand by at least 160 TJ/day until the year ending 2020, as shown in Figure 16 and Table 22. Despite new supply commencing, potential gas supply declines from 2019 to 2021, in line with reserve depletion at existing production facilities. There is a tightening in the market projected in 2021, when potential gas supply only exceeds forecast gas demand by 17 TJ/day. This tightness may be alleviated by acceleration of production from existing processing facilities or withdrawals from gas storage facilities. New supply sources are available and economically viable to enter the market in 2022.

Figure 16 WA gas market balance (TJ/day), 2019-28



[a] Increasing the production rate from existing reserves, given the general underutilisation of existing processing capacity, thereby depleting these reserves at a faster rate than at present.
Source: AEMO and MJA.

Table 22 WA forecasts, base scenario potential gas supply and demand (TJ/day), 2019-2028

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	5-year average growth pa (%)	10-year average growth pa (%)
Potential supply	1,345	1,241	1,101	1,142	1,170	1,257	1,223	1,192	1,165	1,140	-3.4	-1.8
Demand	1,069	1,077	1,084	1,088	1,091	1,104	1,118	1,121	1,127	1,131	0.5	0.6

Source: AEMO and MJA.

4.2.1 Additional supply representations

AEMO has developed additional gas supply scenarios to reflect possible market outcomes under different assumptions.

Scenario 1: New supply sources are delayed by two years

To better understand the impact of delays to the proponents' announced start dates for prospective supply sources, AEMO modelled an additional scenario with a two-year delay in availability from these dates[110].

This results in forecasts of potential gas supply falling between 2019 and 2023, then increasing slightly as new supply comes online in 2024 and 2025.

In this case, AEMO projects insufficient supply to meet demand in the period 2022 to 2026. While this could be alleviated by increasing output from existing facilities, ramping up production may require rapid rates of reserve depletion that may be operationally challenging.

Scenario 2: No prospective supply projects commence

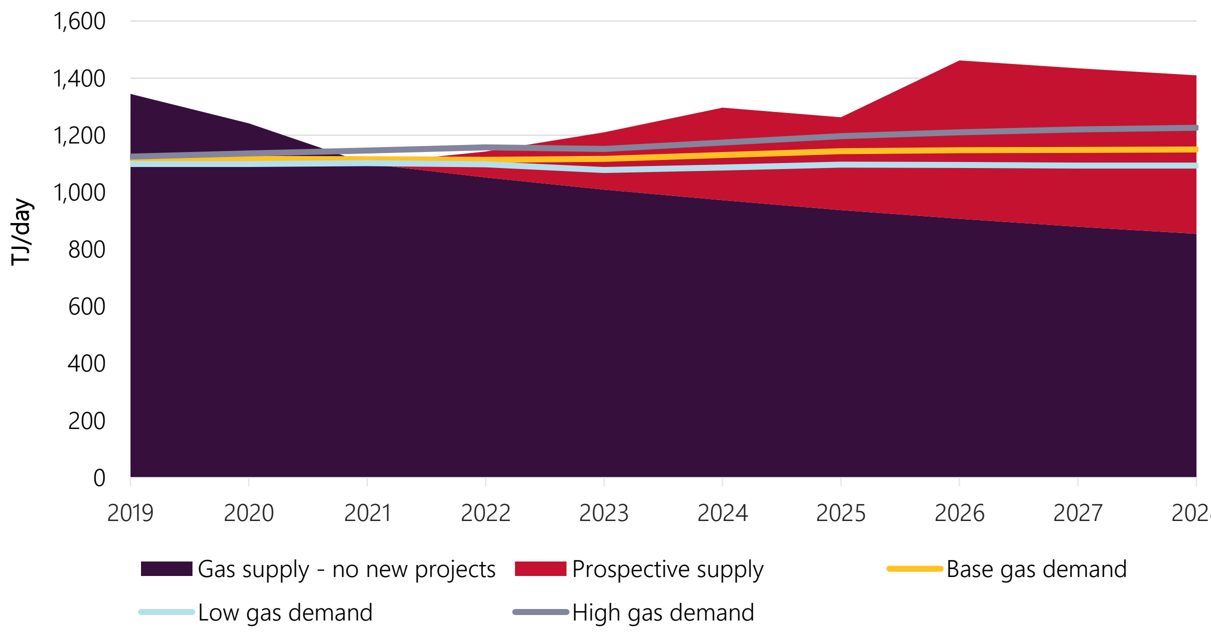
Potential gas supply from existing and under-construction projects is likely to be insufficient to meet the low, base, and high forecast gas demand scenarios without the development of prospective supply sources, as shown in Figure 17.

In forecasts under this scenario, which assumes no prospective supply sources are developed:

- A supply shortfall may emerge from 2022 (assuming existing facilities do not increase production by accelerating reserve depletion rates and gas consumers do not make withdrawals from gas storage facilities).
- The supply deficit compared to the base demand scenario would worsen each year as demand grows, reaching nearly 276 TJ/day by 2028.

Existing domestic-only facilities tend to be constrained by their existing reserves, while LNG-linked projects (excluding the NWS), despite having sufficient reserves, are constrained by their available processing capacity.

Figure 17 Prospective supply compared to gas demand scenarios, 2019-28



Source: AEMO and MJA.

110 Otherwise using the base scenario assumptions.

Based on this scenario, AEMO considers that prospective supply sources are required to be developed to meet forecast gas demand. If all the prospective sources considered by AEMO (Browse, Equus, Scarborough, and Waitsia) are developed, gas supply would be sufficient to meet forecast gas demand over the entire outlook period. However, there is still uncertainty about the development path of these supply sources, whether they will reach FID or meet announced commencement dates, and the quantities of gas that may be made available to the domestic gas market.

Additional prospective supply sources or backfill gas fields could be developed during the outlook period (Greater Gorgon fields, Roc/Phoenix, or others) if there is a shortfall of gas in either the domestic or LNG markets. While AEMO has not included these supply sources in its assessment for various reasons (see Sections 3.3 and 3.4 for further information), changing market conditions over the next 10 years may accelerate development plans.

AEMO will continue to monitor developments that may change this assessment, particularly any changes in the price outlook for LNG or domestic gas, and will report on these changes in future WA GSOO reports.

5. 2018 Formal information request process data analysis

5.1 Introduction

This chapter presents (in aggregate form, to respect confidentiality) information submitted by GMPs and non-GSI participants through the 2018 FIR process conducted in March 2018[111], covering either the 10-year outlook period 2019 to 2028 or as at March 2018. For demand, this data covers roughly 70% of the average daily gas consumption for WA in 2017, while the maximum contracted demand covers all GMPs[112]. Where possible, AEMO has used the FIR data as inputs to develop the gas demand and potential supply forecasts for the 2018 WA GSOO report.

AEMO conducts a confidential formal information request (FIR) process annually, which collects data and information from Gas Market Participants (GMPs)[113] for the purposes of the WA GSOO. The process was first conducted in 2017[114], in line with the provisions set out in the Gas Services Information (GSI) Rules[115]. All GMPs responded to AEMO's request and some non-GSI participants provided information voluntarily.

The data presented in this chapter as part of the 2018 formal information request process includes:

- Gas demand and supply estimates.
- Contracted volumes.
- Gas resources and reserves.
- Domestic gas prices that would encourage expansion or cause closure of gas-consuming facilities.
- Key market events that GMPs identified, which may impact the WA domestic gas market balance.

[111] All 2018 FIR data is provided to AEMO is the latest available as at March 2018.

[112] The 2018 FIR expected demand data excludes gas-powered electricity generation (GPG) and facilities that are not required to be registered as GMPs (such as small commercial gas users). AEMO has not included estimates of the remaining 30% of gas consumption in this report. Most GPGs were exempted from this request, because it is not feasible for mid-merit or peaking generation facilities to assess daily expected demand over a 10-year outlook period, due to the irregular dispatch of these facilities. GPGs were, however, required to submit their maximum contracted gas demand over the period.

[113] Under GSI Rule 21, GMPs include Registered Facility Operators and Registered Shippers, although some exemptions are available. For example, some facilities that consume gas are not responsible for the shipping of this gas and are thus not required to be registered. The GSI Register for GMPs and Facilities is maintained and updated regularly by AEMO. Both are available at https://www.aemo.com.au/Gas/WA-Gas-Services-Information/GSI-participant-information/GSI-register.

[114] In November 2016, the Economics and Industry Standing Committee (EISC) of the WA Legislative Assembly reported on the compilation of the WA GSOO, and recommended AEMO develop a more formal annual process for gathering information. The first FIR was conducted in 2017 in response to this recommendation. Source: 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.

[115] Under GSI Rule 106, AEMO may require GMPs to provide information for the WA GSOO. This does not cover all participants in the WA domestic gas market.

Other information[116] submitted in the FIR process has not been presented to preserve confidentiality for individual respondents.

AEMO has taken due care to reconcile the information received but accepts no liability for any errors it may contain. The data reported is from the 2018 FIR, unless otherwise specified. It should be considered indicative only and does not represent AEMO forecasts.

5.2 Gas demand and supply data

For the 10-year outlook period 2019 to 2028, AEMO requested GMPs[117] to provide:

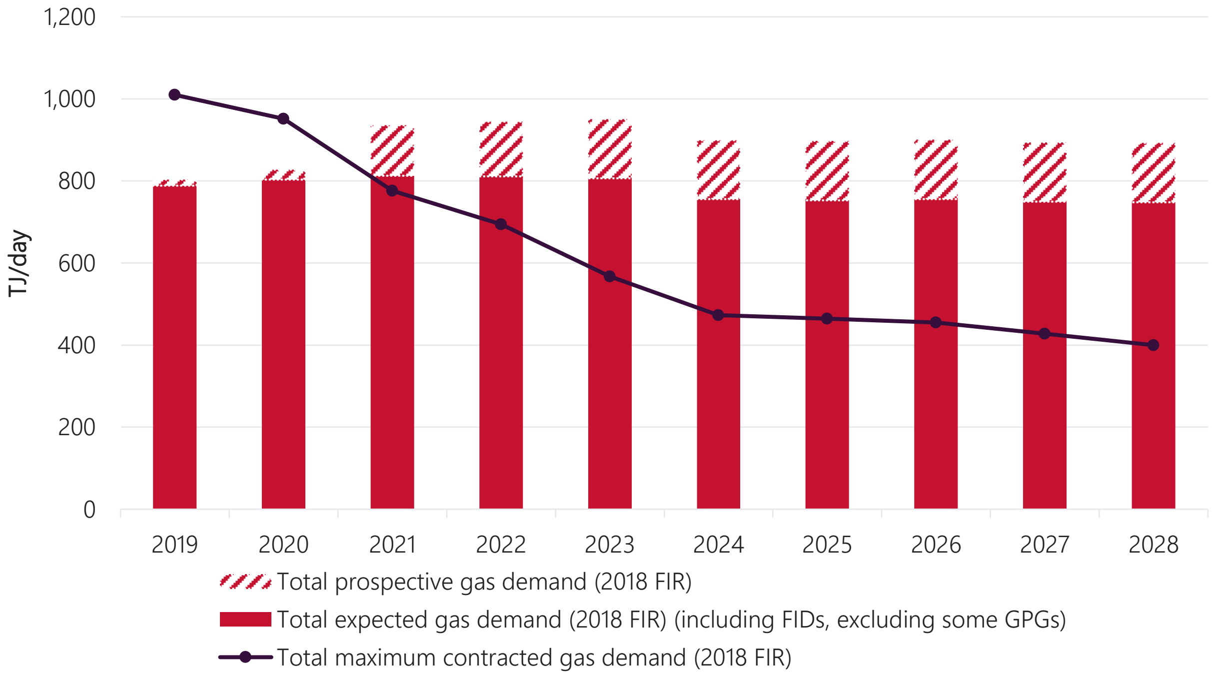
- For gas consumers – total expected and maximum contracted gas demand estimates by facility.
- For gas production facility operators and their joint venture partners – total firm supply capacity and maximum contracted gas supply estimates by facility.

The sections below provide comparisons between these measures to give indicative insights on the WA gas market over the next 10 years.

5.2.1 Total expected and maximum contracted gas demand

Figure 18 presents the expected[118], prospective, and contracted gas demand submitted by gas consumers through the 2018 FIR (covering around 70% of total WA gas consumption).

Figure 18 Total expected, prospective, and maximum contracted gas demand submitted by GMPs, with estimated gas demand (TJ/day), 2019-28



Source: GMPs, as at March 2018.

[116] Other information collected through the 2018 FIR, but not reported, includes future and prospective supply or gas-consuming facility names, their capacities and development status, and consumption by pipelines and storage facilities.

[117] Altogether, 36 GMPs and six non-GSI market participants responded to the 2018 FIR, providing responses related to 45 gas-consuming facilities, nine gas production facilities, eight pipelines, two storage facilities, and the main distribution network. All non-GSI submissions were from gas suppliers. The FIR excluded multiple entities which report for the same facility, facilities no longer operating but not de-registered, and retailers (to avoid double-counting).

[118] Total expected gas demand includes projects that have taken a Final Investment Decision (FID) and are expected to commence in 2018 or after, but excludes some GPGs, as detailed in footnote 119.

Based on this data, gas demand is expected to grow at a slow annual rate of 0.6% between 2019 and 2023, then fall more than 6% between 2023 and 2024. This is likely related to the end of production life for some mines. Post 2024, expected demand stays relatively stable to 2028.

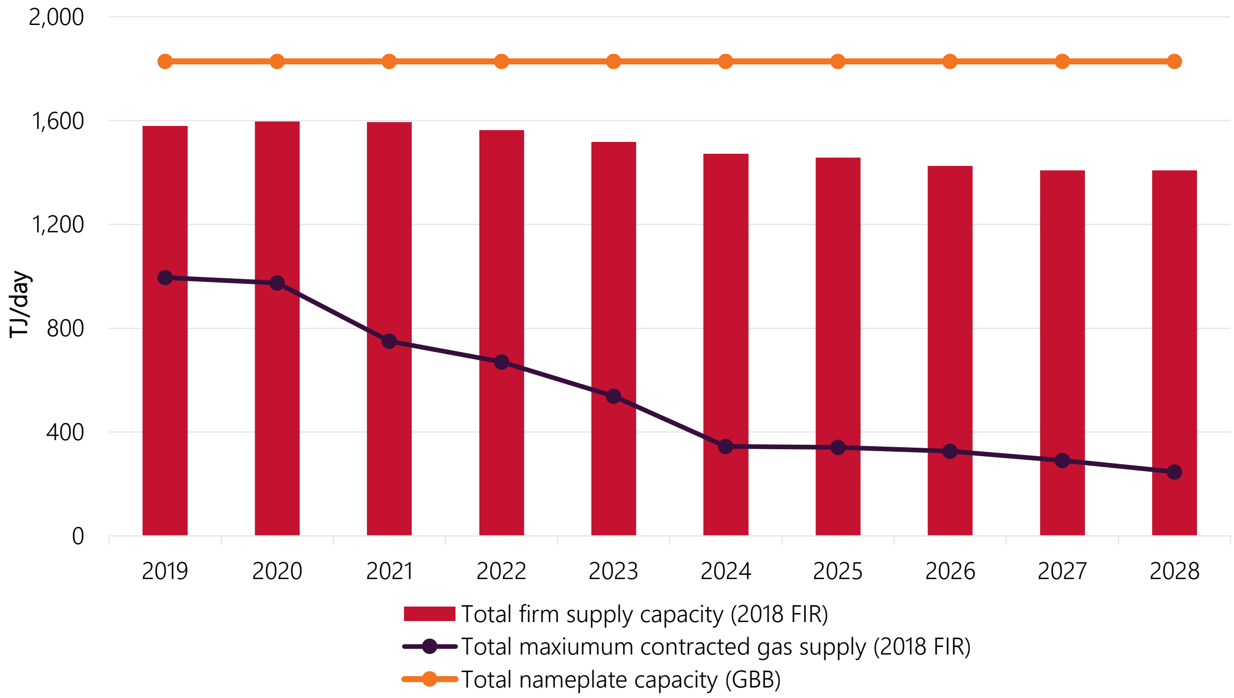
In addition to expected demand, GMPs provided estimates of incremental prospective demand, which included new or expanded gas-consuming facilities[119]. While it is unlikely that all these projects will be developed, the data gives a more speculative indication of future WA gas demand compared to the 2017 FIR data. Prospective demand may add up to 125 TJ/day above expected gas demand by the end of the outlook period.

Total maximum contracted gas demand exceeds expected gas demand (which excludes GPG) reported in the 2018 FIR between 2019 and 2020, but falls rapidly between 2021 and 2024, to reach 55% of expected demand by 2028. Maximum contracted demand does not necessarily match expected gas demand, as the latter figure excludes GPGs and gas consumers are often not required to take the maximum quantity.

5.2.2 Total firm gas supply capacity and maximum contracted gas supply

Domestic gas production facility operators and joint venture partners submitted estimates of total firm gas supply and maximum contracted gas supply[120] for their facilities and individual corporate entities, as shown in Figure 19, with a comparison to total nameplate capacity[121].

Figure 19 Total firm and maximum contracted gas supply estimates submitted by market participants compared to total nameplate capacity (TJ/day), 2019-28



Source: GMPs and some non-GSI participants, as at March 2018.

The total firm gas supply capacity represents the supply capacity of domestic gas production facilities that respondents expect to make available to the WA market, given current gas reserves[122].

[119] Projects were classified according to development stage – FID, environmental approval, internal approval, or speculative.

[120] This does not represent the total contracted supply in the whole WA domestic gas market, because supply contracts that are held by non-GSI market participants were not captured in the information request. Data was collected for the Wheatstone domestic gas production facility, although it has yet to commence operations.

[121] The total nameplate capacity of the domestic gas production facilities was based on GBB data. Available at https://gbbwa.aemo.com.au/#capacities.

[122] Some submissions for firm supply capacity did not appear to reflect reserves decline, where these are depleted annually in line with current production levels for the facility over the outlook period. Respondents may have assumed that reserves would be developed to support backfill of their domestic gas production facilities.

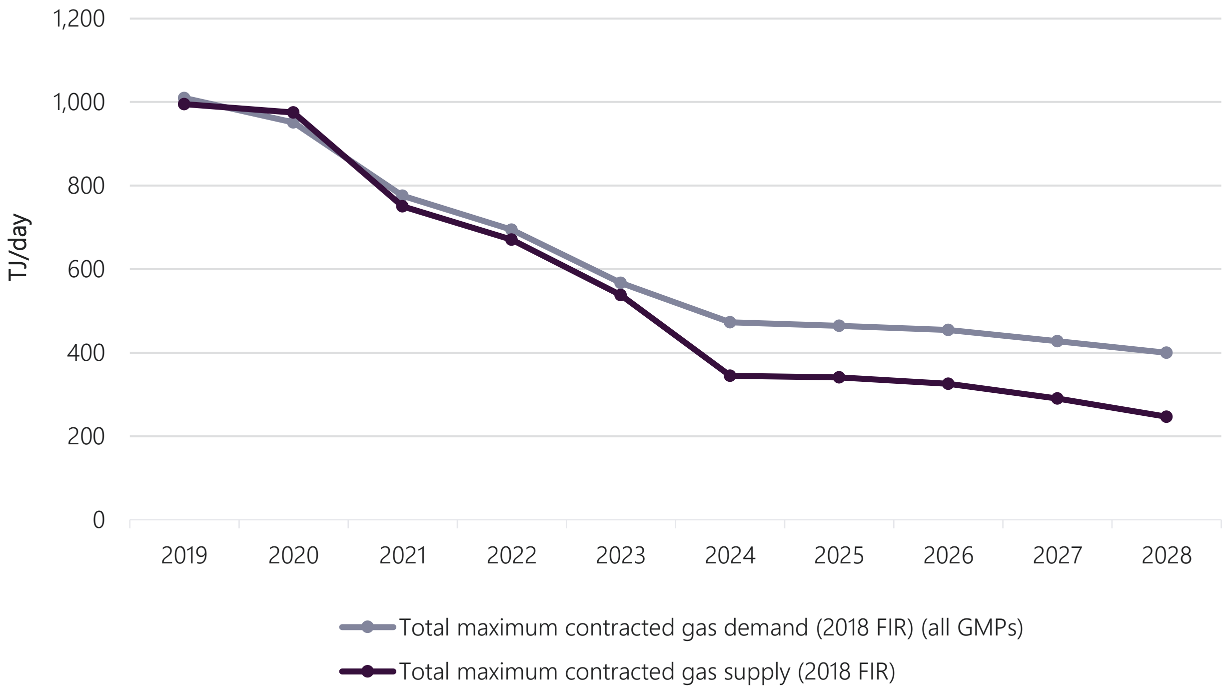
Submissions by participants show that they expect total firm gas supply capacity to be lower than the total nameplate capacity of the associated domestic gas production facilities over the outlook period. In 2019, the estimated total firm supply capacity is 1,579 TJ/day, accounting for 86% of the total nameplate capacity. After growing to 1,596 TJ/day in 2020, firm supply capacity is expected to decrease gradually over the rest of the outlook period. By 2028, estimated total firm supply capacity is expected to be 11% lower than in 2019.

Participants expect the total maximum contracted supply to be well below the total firm gas supply capacity. In 2019, the total maximum contracted gas supply is estimated to account for 63% of the total firm gas supply capacity. This proportion is expected to fall every year over the outlook period, reaching 23% in 2024 and 18% in 2028. The contracted gas volume is expected to decrease rapidly between 2020 and 2024, reflecting the expiration of long-term contracts, with few new contracts yet finalised to replace them.

5.2.3 Total maximum contracted gas supply and demand

The total maximum contracted gas supply and demand submitted by participants are roughly equal[123] between 2019 and 2023, as shown in Figure 20.

Figure 20 Total maximum contracted gas supply and demand estimates submitted by market participants (TJ/day), 2019-28



Source: GMPs and some non-GSI participants, as at March 2018.

In 2024, participants expect total contracted gas supply to fall more sharply, compared with contracted gas demand, resulting in a difference of 128 TJ/day. Some gas consumers may have assumed the renewal of gas demand contracts after long-term contracts expire, while suppliers may assume that they will have the opportunity to negotiate new gas sales agreements. Both contracted demand and supply are expected to fall more gradually over the period from 2024 to 2028. In 2028, contracted gas supply is estimated to be 153 TJ/day below contracted gas demand.

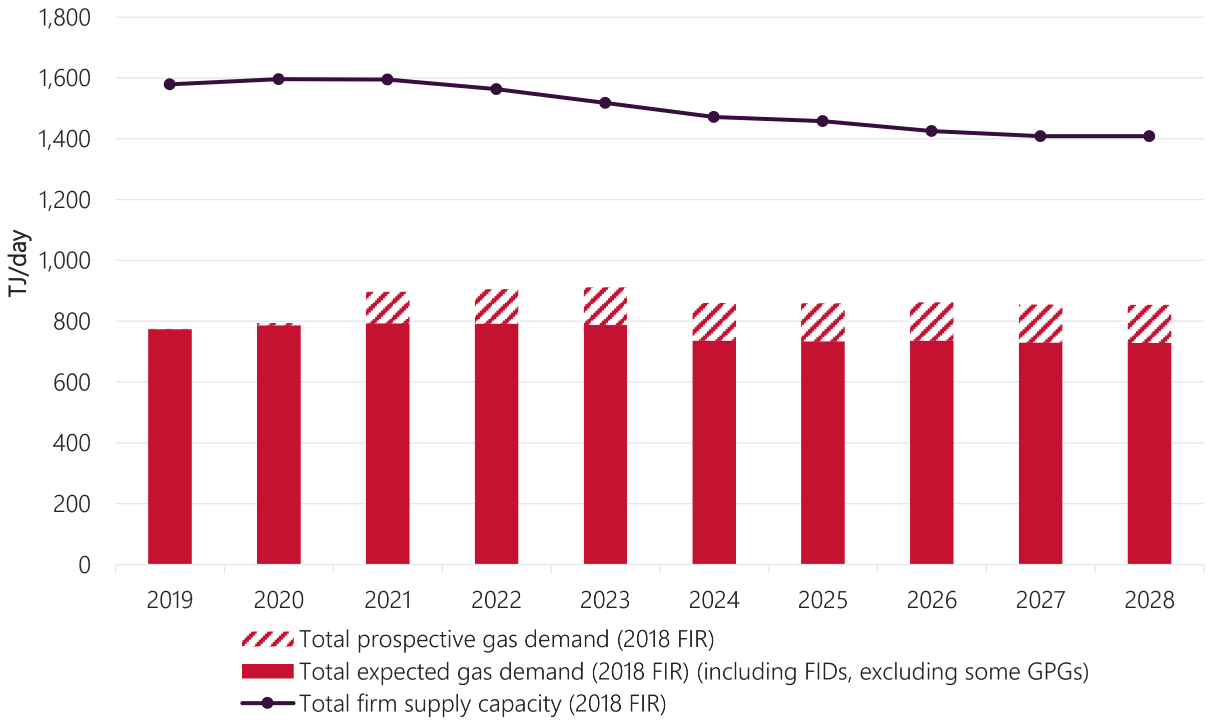
[123] AEMO clarified the wording of the 2018 FIR to ensure that maximum contract quantity was provided by both consumers and producers, leading to better alignment between the two data sets this year (see Chapter 2 of the 2017 WA GSOO. Available at https://www.aemo.com.au/-/media/Files/Gas/National_Planning_and_Forecasting/WA_GSOO/2017/2017-WA-GSOO.pdf).

5.2.4 Gas supply/demand balance

Participants' estimates of total firm supply capacity exceed the expected gas demand[124] over the outlook period (bearing in mind the exclusion of GPGs in demand), with the surplus ranging from 805 TJ/day in 2019 to 680 TJ/day in 2028, as shown in Figure 21. The surplus level reduces to 607 TJ/day after 2023 if prospective demand is considered in addition to the expected gas demand.

In 2019, the sum of the expected and prospective demand is 775 TJ/day, accounting for 49% of the total firm supply capacity. By the end of the outlook period, this high case demand reaches 61% of the total firm supply capacity.

Figure 21 Total firm gas supply capacity and gas demand estimates submitted by market participants (TJ/day), 2019-28



Source: GMPs and some non-GSI participants, as at March 2018.

5.3 Resources and reserves

Domestic gas production facility operators and joint venture partners reported the volumes of 2C gas resources and 2P gas reserves associated with all their WA petroleum production licences, as well as 2P gas reserves that are physically connected to each existing domestic gas production facility[125]. This resources and reserves data is an input into AEMO's potential gas supply model.

The aggregate 2C gas resources and 2P gas reserves connected to domestic gas production facilities is compared with the figures collected under the 2017 FIR in Table 23. Connected reserves have increased 36% from the volume reported in the 2017 FIR.

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[124] Note that this represents roughly 70% of the 2017 average daily gas consumption.

[125] Contingent resources are considered less commercially viable than reserves, and 2C resources are considered the best estimate of sub-commercial resources. Prospective resources are estimated volumes associated with undiscovered accumulations of gas. Reserves are quantities of gas that are anticipated to be commercially recovered from known accumulations. Proved and probable reserves (2P) are considered the best estimate of commercially recoverable reserves.

The 2018 FIR figure for total 2C resources for all WA petroleum production licences is 21% lower than the 2017 FIR figure. In 2017, AEMO estimated the resources held by non-GSI market participants but did not repeat this process in 2018 to avoid inaccuracy[126].

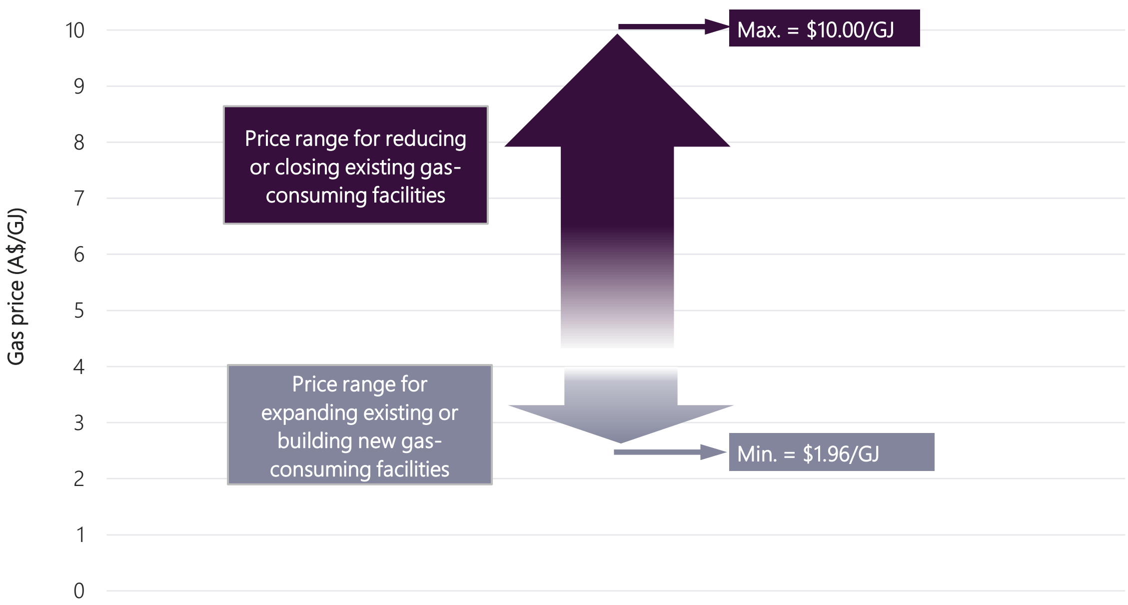
Table 23 Total 2C gas resources and 2P gas reserves submitted by market participants (PJ), 2017 and 2018

Gas reserves and resources	2017 (PJ)	2018 (PJ)
Total 2P reserves connected to domestic gas production facilities	35,159[a]	47,886
Total 2C resources	74,073[b]	58,526

[a] Collected under the 2017 FIR, but not reported in the 2017 WA GSOO.
[b] Reported in the 2017 WA GSOO.
Source: GMPs and some non-GSI participants, as at March 2018.

5.4 Gas prices that would influence gas consumption changes

Figure 22 Gas price estimates on considering changes of gas consumption submitted by market participants (A$/GJ), 2018



Source: GMPs, as at March 2018.

Six gas consumers provided WA domestic gas price levels[127] over the outlook period that would:

- Encourage expansion of their gas demand (either through existing or new facilities).
- Prompt reduction of their gas demand (through closure or curtailment).

Two more consumers provided comments on gas prices and other factors that would affect their operations.

In total, these eight gas consumers represent around 25% of gas consumption in WA (2017), based on their historical gas use.

[126] Some large gas resources and reserves holders are not GMPs.

[127] The gas prices were provided in 2018 A$/GJ.

The prices which would encourage expansion of gas-consuming operations are relatively low ($1.96/gigajoules [GJ] minimum, $2.75/GJ median, and $3.05/GJ maximum) compared to recent historical gas prices, which averaged $4.97/GJ in 2017 (Figure 22)[128].

The range of prices which would cause contraction or closure of existing gas-consuming facilities is quite wide ($3.69/GJ minimum, is $7.37/GJ median, $10/GJ maximum).

In addition to gas prices, some other factors, such as international commodity prices, construction and labour costs, were also mentioned as triggers for gas consumers to consider changing their current operation scales.

5.5 Market events which may impact the WA domestic gas market supply-demand balance

In total, 16 gas consumers and producers/suppliers identified specific prospective events that they believe may impact the WA domestic gas market balance over the 10-year outlook period. AEMO used this information to ensure that these key events are represented in the gas demand and potential supply forecast scenarios developed for the 2018 WA GSOO. AEMO categorised the events into four major issue types, shown in Table 24.

Table 24 Prospective market events which may impact the WA domestic market balance, submitted by market participants (number), 2018

Category	Number of respondents
Domestic gas price changes	21
Prospective supply (new production projects)	19
Continuing supply (existing production projects)	8
Significant demand change (increase - prospective lithium/battery related minerals; decrease – price change)	2

Source: GMPs and some non-GSI participants, as at March 2018.

Events that would result in WA domestic gas price changes were foremost in the minds of FIR respondents. These events included:

- The effect of the expiration of legacy long-term gas sales contracts on domestic gas prices.
- Commencement of new supply sources.
- Effect on delivered gas prices from potential pipeline expansions, such as the West-East Pipeline being studied by the Australian Government.

Almost equally important to respondents was the likelihood of, or uncertainty around, the entry of new domestic gas-only or LNG-linked prospective supply sources, including the timing of delivery of Domestic Market Obligation volumes into the WA market over the outlook period.

The decline of reserves at existing domestic gas production facilities and uncertainty around their continued sales volumes was mentioned less frequently. The potential for demand destruction or rapid demand growth was of limited concern for respondents.

[128] WA Department of Mines, Industry Regulation and Safety. *Latest Statistics Release – Major Commodities Resources File*. Available at http://www.dmp.wa.gov.au/About-Us-Careers/Latest-Statistics-Release-4081.aspx. Viewed: 6 September 2018.

6. Implications of government and industry initiatives

This chapter examines events and initiatives that have implications for the WA domestic gas market.

6.1 Initiatives affecting gas supply

Initiatives in this section have the potential to increase or decrease current or future gas supply to the WA domestic gas market.

6.1.1 WA fracking inquiry

In September 2017, the WA State Government[129]:

- Banned hydraulic fracture stimulation ("fracking") drilling techniques for exploration or production in existing and future petroleum titles in the South-West, Peel, and Perth metropolitan regions, with a temporary moratorium on the remainder of the State.
- Announced that the outcome of an independent scientific panel inquiry into the effects of fracking on the WA environment will inform future policy decisions and determine whether the temporary moratorium outside the South-West, Peel, and Perth metropolitan regions becomes a permanent ban.

The inquiry's terms of reference included[130], among others:

- Using scientific and historical evidence to assess the level of the health and other risks associated with identified impacts.
- Recommending a scientific approach to regulating fracking that could acceptably mitigate or minimise risks if the moratorium were to be lifted.

The panel sought information and submissions from industry, scientific experts, and the wider community[131]. Its final report was delivered on 12 September 2018[132]. In November 2018, the WA Government announced that hydraulic fracture stimulation of petroleum wells will not be permitted over 98% of the state, finalising a

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[129] Statement by the Minister for Mines and Petroleum in the WA Legislative Assembly. *Hydraulic fracturing – South West ban and statewide moratorium – Inquiry establishment, 5 September 2017*. Available at www.parliament.wa.gov.au/Hansard/hansard.nsf/0/0ca40786ca865931482581950023 0d67/$FILE/A40%20S1%2020170905%20p3300b-3300b.pdf.

[130] Hydraulic Fracture Stimulation Inquiry Panel. *Scientific Inquiry into Hydraulic Fracture Stimulation in Western Australia*, 3 November 2017, pg. 1. Available at https://frackinginquiry.wa.gov.au/sites/default/files/Scientific%20Inquiry%20into%20Hydraulic%20Fracture%20Stimulation%20in%20WA%20-%20Background%20Paper%20-%203%20November%202017.pdf.

[131] Independent Scientific Panel Inquiry into Hydraulic Fracture Stimulation in Western Australia. *Submissions Library*. Available at https://frackinginquiry.wa.gov.au/submission-library.

[132] Independent Scientific Panel Inquiry into Hydraulic Fracture Stimulation in Western Australia. *Final Report*. Available at https://frackinginquiry.wa.gov.au/.

temporary ban and moratorium based on regional location. This will constrain the development of onshore gas supply.

6.1.2 Petroleum licensing reviews

NOPTA review of NWS retention leases

In 2017-18, the National Offshore Petroleum Titles Administrator (NOPTA) launched a re-evaluation of the commercial viability of 10 offshore petroleum retention leases[133] in the Browse and Carnarvon basins, and provided an initial report on its review[134] to the Joint Authority of Western Australia, which has authority to grant, refuse and cancel petroleum titles[135]. The leases were selected to be analysed for their development potential and ability to be processed through the KGP. The results of this review could impact future supply of gas through the KGP.

Council of Australian Governments (COAG) Energy Council Review of Petroleum Licensing Regulations

The COAG Energy Council began conducting a Review of Petroleum Licensing Regulations across Australia (all states and territories except Tasmania) in 2017, considering the whole retention lease framework. Three of the four review phases have been completed to date. The review addresses concerns from large domestic gas users that retention lease provisions give established companies a mechanism to withhold gas from the domestic market by planning production for a later time (termed "warehousing").

The key findings of the draft report, published in August 2018, were:

- In general, the retention lease regimes supported exploration and development, providing flexibility to address resource commercialisation challenges.
- There was no evidence of producers withholding (or "warehousing") gas.

The draft report proposed five broad reform options, aiming to enhance clarity and improve frameworks and processes associated with retention lease regimes[136]. The COAG Energy Council will consider the report recommendations in 2019. Changes to petroleum licensing regulations could alter the development plans of existing licence holders, if retention leases were relinquished.

6.1.3 Petroleum Resource Rent Tax (PRRT)[137] review

The Commonwealth Treasury initiated a review of the tax regime for oil and gas projects in November 2016. This review, conducted by an independent expert, recommended improvements to the PRRT, including decreasing the "uplift rate" for new and proposed projects, which would reduce allowable tax deductions[138].

In November 2018, the Commonwealth Government released its final response to the PRRT review. The changes to the PRRT, to be introduced from 1 July 2019, include:

- Lower uplift rates – the general expenditure uplift rate will be limited to the Long Term Bond Rate (LTBR) plus 5 percentage points (instead of the previous rate of LTBR+15%) for projects that apply for a production

[133] Retention Leases are awarded for an initial period of five years for petroleum discoveries that are not currently commercially viable, but likely to become commercial within the next 15 years. When the discovery is deemed commercial, the lease must be converted to a Production Licence.

[134] NOPTA. *NOPTA Annual Report of Activities 2017-18*, pgs. 4 and 13. Available at http://www.nopta.gov.au/_documents/NOPTA-Annual-Report-of-Activities-2017-18.pdf.

[135] The Joint Authority comprises the Commonwealth Minister for Resources and Northern Australia and the relevant WA Minister.

[136] Noetic Group. *Review of Petroleum Retention Lease Arrangements in Australian Jurisdictions*, Report for the Department of Industry, Innovation and Science, July 2018. Available at http://www.coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/Noetic%20Group%20report_Review%20of%20Petroleum%20Licencing%20Regulations.pdf.

[137] The PRRT is a tax on profits generated from the sale of marketable petroleum commodities, including natural gas. PRRT has applied to most offshore petroleum projects since 1987. PRRT is levied when a project has recovered all eligible project expenditures, including a threshold rate of return.

[138] Australian Government Treasury. "Release of the Petroleum Resource Rent Tax Review", Media release, 28 April 2017. Available at http://sjm.ministers.treasury.gov.au/media-release/038-2017/.

licence after 1 July 2019. Exploration expenditure incurred from 1 July 2019 will be subject to the decreased uplift rate[139].

- Onshore projects will be removed from the PRRT regime.
- The Commonwealth Treasury will commence a review into regulations that determine the price of gas in integrated LNG projects for PRRT purposes.

Changes to the tax regime could affect the business case for several offshore projects that have been proposed but have yet to attain FID.

6.1.4 West-East Gas Pipeline (WEGP) pre-feasibility study

The 2017 Federal Budget allocated funds for a study into a west-east gas transmission pipeline from WA to South Australia[140]. Consultants GHD Group and ACIL Allen Consulting were awarded the study contract to deliver the pre-feasibility report in March 2018[141]. No further information from the study has been released as at October 2018. If the WEGP was to be developed, it would open a new demand market for WA gas suppliers.

6.1.5 Australian Domestic Gas Security Mechanism (ADGSM)

The ADGSM was initiated by the Australian Government in 2017 to address projected gas supply shortfalls in the east coast markets. Under the ADGSM, the Federal Minister for Resources and Northern Australia can determine whether export restrictions should be imposed to avoid any potential shortfall in meeting domestic demand for gas in eastern and south-eastern Australia. The three east coast LNG exporters signed Heads of Agreement in October 2017, and again in September 2018, formally committing to provide a secure supply of gas to the east coast domestic market until 2020[142]. While the ADGSM does not apply in WA, it has put greater focus nationwide on consideration of gas supply security.

6.2 Initiatives affecting gas demand

Initiatives in this section have the potential to increase or decrease current or future gas demand in WA.

6.2.1 Gas in processing lithium and other energy metal resources

Secondary processing of lithium is energy-intensive and could be a considerable driver of gas demand in future.

WA could be a crucial supplier to the growing energy metals market of lithium, which is required for the manufacture of rechargeable lithium-ion batteries used for energy storage. The Reserve Bank of Australia projects an increase in export volumes for non-ferrous metals, with copper and lithium driving growth, and lithium exports expected to triple[143]. The Commonwealth Government, WA State Government, and industry have all expressed a common interest in the growing lithium industry and WA's substantial lithium deposits.

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[139] Commonwealth Treasury. *Government response to the Petroleum Resource Rent Tax Review*, 2 November 2018. Available at https://treasury.gov.au/publication/p2015-t339508/.

[140] The Hon. Mathias Cormann, Australian Minister for Finance. "West-East Gas Pipeline pre-feasibility study", 30 October 2017. Available at http://www.environment.gov.au/minister/frydenberg/media-releases/mr20171030.html.

[141] Australian Government Department of the Environment and Energy. *West-east gas pipeline pre-feasibility study*, 30 October 2017. Available at https://www.energy.gov.au/news-media/news/west-east-gas-pipeline-pre-feasibility-study.

[142] Minister for Resources and Northern Australia. "New Heads of Agreement to secure gas supply", 30 September 2018. Available at https://www.minister.industry.gov.au/ministers/canavan/media-releases/new-heads-agreement-secure-gas-supply.

[143] Reserve Bank of Australia. *Statement on Monetary Policy,* "Box C Outlook for non-ferrous metal exports", August 2018. Available at https://www.rba.gov.au/publications/smp/2018/aug/box-c-outlook-for-non-ferrous-metal-exports.html.

The WA State Government established a taskforce on lithium and other energy materials in May 2018, which is due to present recommendations to the WA State Government by November 2018[144]. The taskforce held the first industry consortium on its Lithium and Energy Materials Strategy in July 2018[145].

Resources and Energy Quarterly (REQ) lithium forecasts

The REQ summarises the forecasts of the Commonwealth Government's Office of the Chief Economist's key resources and energy commodity exports.

Its September 2018 issue contains a special focus on lithium, highlighting that[146]:

- WA is rich in hard rock (spodumene ore) deposits, which can be converted to lithium hydroxide using a relatively simple process. This gives WA producers a processing cost advantage compared to other large lithium producers (Chile, Argentina and Bolivia), where lithium is contained in brine that is first pumped from underground and then harvested as evaporation occurs from surface ponds.
- Lithium is crucial to electric vehicle (EV) batteries, and EVs are poised to dominate the auto market in the future, so steeply rising demand for lithium is projected and investment conditions are strong.
- WA is a strong candidate for lithium refining, because it has ready access to the raw materials required to build EV batteries and other energy storage devices, as well as world-class port facilities (including a proposed new port in Kwinana), relatively low energy costs, and reliable gas supplies.
- WA has already seen large investment in new lithium mines, coupled with larger investments in secondary processing. Earnings for spodumene ore from WA increased by 166% in 2017 to A$780 million, and five large processing plants are proposed or under construction in WA.

The REQ forecasts Australia could become a noteworthy refiner by the early 2020s, with greater earnings in lithium hydroxide (the output of secondary processing) than spodumene ore.

Regional Development Australia (RDA) case for WA as "Lithium Valley" hub

RDA published a report in July 2018 building a case for WA becoming a hub for battery mineral mining and processing, battery manufacture, and recycling referred to as "Lithium Valley". The RDA report recommendations relevant to gas demand in WA included[147]:

- A Specialised Industrial Park in Kwinana as a base for Lithium Valley, in conjunction with the WA and Federal Governments.
- WA State Government incentives to assist priority industries that use energy metals, and policy to regulate and incentivise EV uptake, which could have flow-on effects for electricity demand, including gas demand for GPG.
- WA and Federal Government bilateral approval processes for key sites in WA (such as Kwinana) to accelerate planning approvals for strategic Lithium Valley projects.

Bid for Future Battery Industry Cooperative Research Centre (FBICRC)

In May 2018, the WA Government Budget committed $5.5 million to the Minerals Research Institute of WA (MRIWA)'s bid for the FBICRC, if the bid is successful.

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[144] Government of Western Australia. "New strategy to capitalise on once-in-a-lifetime lithium opportunity", 24 May 2018. Available at https://www.mediastatements.wa.gov.au/Pages/McGowan/2018/05/New-strategy-to-capitalise-on-once-in-a-lifetime-lithium-opportunity.aspx; Chamber of Commerce and Industry Western Australia. "Industry-govt join for lithium strategy", 19 July 2018. Available at https://cciwa.com/about-us/news-and-media-statements/industry-govt-join-for-lithium-strategy.

[145] Government of Western Australia. "Lithium taskforce announces first industry consortium", 28 June 2018. Available at https://www.mediastatements.wa.gov.au/Pages/McGowan/2018/06/Lithium-taskforce-announces-first-industry-consortium.aspx.

[146] Department of Industry, Innovation and Science. *Resources and Energy Quarterly – September 2018*. Available at https://www.industry.gov.au/data-and-publications/resources-and-energy-quarterly-september-2018.

[147] Regional Development Australia. *Lithium Valley*, 13 July 2018. Available: https://www.rdaperth.org/rda-projects/lithium-valley/.

MRIWA's bid aims to leverage WA's new energy material resources and research capability, with 42 partners committing cash and in-kind contributions in Stage 1[148]. The FBICRC is to be headquartered in Perth, with initial proponents including Pilbara Minerals and Tianqi Lithium[149]. In October 2018, the FBICRC was announced as one of six shortlisted applicants[150], and the winner will be announced in Q1 2019[151].

Association of Mining and Exploration Companies (AMEC) report on lithium industry

AMEC commissioned a report on the lithium industry in Australia and how to incentivise downstream processes that develop Australia's capability across higher value refining and processing of lithium. The report found value-add opportunities throughout the lithium production process and suggested that a large battery chemical plant in Australia would be globally cost-effective, due to the dependable and available supply of raw materials[152].

6.2.2 Gas as marine fuel

International Maritime Organisation (IMO) emissions regulations

In October 2016, the IMO announced it had decided to implement stricter regulations on sulphur oxide and particulate matter emissions from the international shipping sector from 1 January 2020[153]. The IMO notes that more ships are already using gas as a shipping fuel, due to its lower pollution impact compared with traditional marine bunker fuels[154]. If the use of gas as a marine fuel continues to grow, there is potential for greater gas demand from the international shipping sector.

The IMO[155] has further adopted a strategy to reduce GHG emissions from shipping and to identify investment opportunities for LNG bunkering, in which LNG is used as a shipping fuel[156].

"Green Corridor" project for LNG-fuelled shipping

Concurrently, the "Green Corridor" Joint Industry Project has been set up to design a LNG-fuelled bulk carrier for the Australia-China iron ore and coal trade route. The WA partners, including Woodside, Rio Tinto, BHP, Shell, and others, have conducted a feasibility study on a LNG-fuelled very large ore carrier, with its concept design currently undergoing confirmation and approval[157]. Woodside is already using a LNG-powered support vessel for its assets in the Exmouth and Pilbara areas, and is investigating converting its entire fleet of marine support vessels to LNG over the next five years[158].

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148 Minerals Research Institute of Western Australia (MRIWA). "Future Battery Industry CRC Bid submitted", 3 July 2018. Available: https://www.mriwa.wa.gov.au/news/fbi/.

149 MRIWA. *Future Battery Industries Cooperative Research Centre - Prospectus*, May 2018. Available at https://www.mriwa.wa.gov.au/wp-content/uploads/2018/06/03-FBI-CRC-Prospectus.pdf.

150 Minister for Industry, Science and Technology. "Applicants shortlisted to deliver new industry-focused research", Media release, 6 October 2018. Available at https://www.minister.industry.gov.au/ministers/karenandrews/media-releases/applicants-shortlisted-deliver-new-industry-focused-research. .

151 Government of Western Australia. "McGowan Government backs WA bid for battery research centre", Media statement, 18 July 2018. Available at https://www.mediastatements.wa.gov.au/Pages/McGowan/2018/07/McGowan-Government-backs-WA-bid-for-battery-research-centre.aspx.

152 AMEC. *A lithium industry in Australia,* 30 January 2018. Available at https://www.amec.org.au/Public/Advocacy/AMEC_Submissions/A_lithium_Industry_in_Australia.aspx.

153 International Maritime Organisation (IMO). *Sulphur oxides (Sox) and particular matter (PM) – Regulation 14.* Available at http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Sulphur-oxides-(SOx)-%E2%80%93-Regulation-14.aspx. Viewed: 20 November 2018. IMO. *Marine Environment Protection Committee (MEPEC), 70th session, 24-28 October 2016*, 28 October 2016. Available at http://www.imo.org/en/mediacentre/meetingsummaries/mepc/pages/mepc-70th-session.aspx.

154 IMO. *Frequently Asked Questions - IMO regulations to reduce air pollution from ships and the review of fuel oil availability,* 20 September 2016. Available at http://www.imo.org/en/MediaCentre/HotTopics/GHG/Documents/sulphur%20limits%20FAQ_20-09-2016.pdf. .

155 With the European Bank of Reconstruction and Development.

156 IMO. *Greenhouse gas emissions*. Available at http://www.imo.org/en/OurWork/environment/pollutionprevention/airpollution/pages/ghg-emissions.aspx. Viewed: 22 November 2018.

157 DNV GL. *Green corridor JIP takes LNG propulsion to the next level*, 2 June 2018. Available at https://www.dnvgl.com/expert-story/maritime-impact/Green-Corridor-JIP-takes-LNG-propulsion-to-the-next-level.html. Viewed: 22 November 2018.

158 Woodside Energy. *Corporate Brochure,* July 2018. Available at http://www.woodside.com.au/Investors-Media/media-library/Documents/Woodside%20Corporate%20Brochure%20-%20July%202018.pdf. .

LNG producers across the world and in Australia are marketing LNG fuel for marine customers, which could signal a preparation for a switch to LNG as a shipping fuel.

In WA, Fremantle Ports granted the first LNG bunkering licence in Australia in July 2017[159]. Greater LNG demand for ships travelling to and from Australia could incentivise increased development of WA gas resources for LNG.

6.3 Initiatives with market-wide impact

This section discusses key initiatives that could potentially have a wider impact on the WA domestic gas market, including federal policies that may have direct or flow-on effects for WA.

6.3.1 Australian Energy Market Commission (AEMC) review: economic regulation applied to covered pipelines

COAG asked the AEMC to review pipeline regulation in response to the increased impact of the gas export industry on domestic markets, as well as a 2016 ACCC inquiry, which found monopoly pricing of transmission pipeline services[160].

The AEMC review, initiated in May 2017, examined the economic regulation framework for pipelines regulated by the Australian Energy Regulator and the Economic Regulation Authority of Western Australia (ERAWA), particularly regarding concerns that fully regulated pipelines were still able to exercise market power over the long-term interests of consumers.

The final AEMC report published in July 2018 prepared 32 recommendations to amend the National Gas Law and National Gas Rules (NGR)[161]. Among these was a requirement for stronger information reporting obligations on full and light regulation pipeline service providers to address information asymmetry between pipelines and their shippers.

The COAG Energy Council progressed most of the AEMC's recommendations in August 2018 and expects to implement rule changes through the AEMC's expedited rule change process[162]. A further review is recommended in 2019.

The ERAWA now administers a new regulatory framework for non-scheme pipelines, contained in Part 23 of the NGR and adopted in December 2017. Non-scheme pipelines must now comply with the framework, which includes information provision requirements, access negotiations and dispute arbitration[163].

These reforms allow for greater transparency in gas pipeline pricing and access, which can benefit gas shippers.

6.3.2 Policy initiatives

The following initiatives could have flow-on effects on gas market dynamics in WA:

- WA State Government's electricity industry reform program – these reforms consider power system security, such as implementation of constrained network access, which may have implications for GPG due

[159] Fremantle Ports. *2017 Annual Report – Full report*. Available at http://www.fremantleports.com.au/news/publications/annualreport/reports%202017/2017%20annual%20report%20-%20full%20report%20-%20interactive%20pdf.pdf.

[160] Australian Energy Market Commission (AEMC). *Information sheet: Review into the scope of economic regulation applied to covered pipelines*, July 2018. Available at https://www.aemc.gov.au/sites/default/files/2018-07/Information%20sheet.pdf.

[161] AEMC. *Final report: Review into the scope of economic regulation applied to covered pipelines,* 3 July 2018, pg. iii-v. Available at https://www.aemc.gov.au/sites/default/files/2018-07/Final%20Report.PDF.

[162] COAG Energy Council. *Gas Market Reform Bulletin No. 3*, 16 August 2018. Available at http://coagenergycouncil.gov.au/publications/gas-market-reform-bulletin-no3.

[163] ERAWA. *Non-scheme pipelines*. Available at https://www.erawa.com.au/gas/gas-access/non-scheme-pipelines. Viewed: 22 November 2018; Australian Energy Market Commission (AEMC). *Regulatory classification of gas pipelines*. Available: https://www.aemc.gov.au/regulation/energy-rules/national-gas-rules/regulatory-classification-gas-pipelines. Viewed: 22 November 2018.

to this type of plant's flexibility and ability to ramp up and meet demand when needed. These attributes make GPG suited to participate in the reformed market, particularly relating to shorter gate closure timeframes, shorter dispatch cycles, and competitive co-optimised ancillary service markets[164].

- Security of Critical Infrastructure Act – this Commonwealth Act came into force in July 2018 and addresses national security risks regarding foreign ownership and operation of critical infrastructure. The Act may add additional steps and processes to the transfer of ownership and operation of critical gas assets, which it defines as major gas processing, gas storage facilities, and gas transmission pipelines and networks[165].

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164 Public Utilities Office (PUO). *Wholesale Electricity Market Reform Program Industry Forum,* 20 September 2018. Available at http://www.treasury.wa.gov.au/uploadedFiles/Site-content/Public_Utilities_Office/Industry_reform/WEM-Reform-Program-Industry-Forum-September-2018.pdf.

165 Parliament of Australia. *Security of Critical Infrastructure Act*, No. 29, Assented to 11 April 2018. Available at https://www.legislation.gov.au/Details/C2018A00029.

A1. References – year in review

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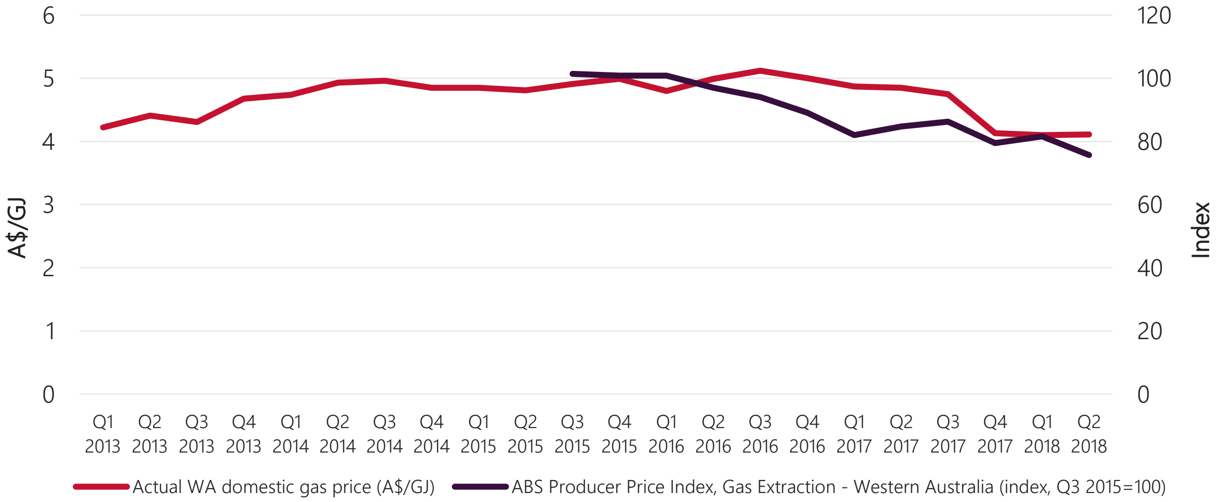
A2. Historical domestic gas prices and forward reference prices

This appendix provides information on historical WA domestic gas prices and a forward-looking reference price series which may guide the formation of WA domestic gas contract prices over the outlook period.

A2.1 Historical domestic gas prices

The quarterly historical domestic gas contract price[166] is compared with the Australian Bureau of Statistics' (ABS) producer price index (PPI)[167] for gas extraction in Figure 23.

Figure 23 Historical domestic gas contract prices (A$/GJ, nominal) and ABS PPI – Western Australia (gas extraction, index), Q1 2013-Q2 2018



Source: ABS and DMIRS.

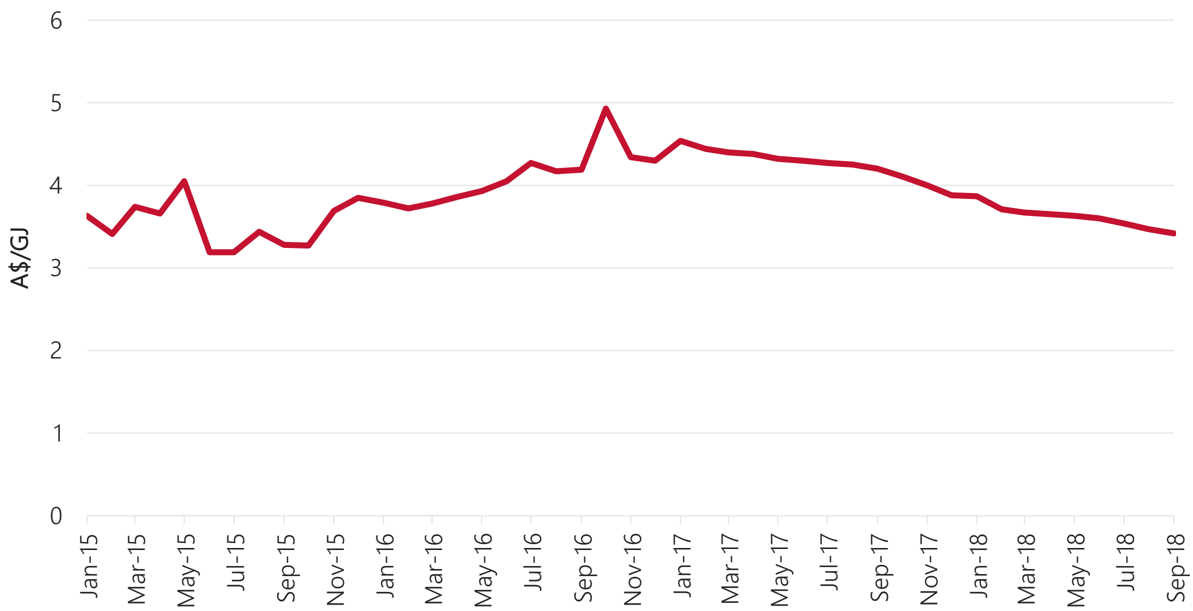
[166] WA Department of Mines, Industry Regulation and Safety (DMIRS). *Latest Statistics Release – 2017-18 Major Commodities Resources File*, http://www.dmp.wa.gov.au/About-Us-Careers/Latest-Statistics-Release-4081.aspx.

[167] The base for the index is FY 2015-16. ABS 2018. *Producer Price Indexes, Australia, Jun 2018*, Table 36 – Output of the Mining industries, index numbers. Available at http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6427.0Jun%202018?OpenDocument.

Prices fell between the end of 2016 until the second quarter of 2018, from A$5/GJ to A$4.11/GJ. The ABS PPI (gas extraction) has shown a similar trend, although it fell more sharply in this period.

Figure 24 shows monthly nominal spot prices since early 2015 (before the expiry of NWS and Gorgon joint marketing authorisation from the ACCC at the end of 2015[168]) published by gasTrading. Spot prices for gas traded via gasTrading increased from A$3.63/GJ in January 2015 to peak at A$4.93/GJ in November 2016, before declining by around 25% from $4.54/GJ in January 2017 to A$3.42/GJ in September 2018.

Figure 24 WA spot gas prices from gasTrading (A$/GJ, nominal), January 2015-September 2018



Source: gasTrading.

The falling domestic gas price is largely a result of excess supply in the market, as well as:

- Increased competition among suppliers following the expiry of joint marketing arrangements[169] at the end of 2015.
- Limited growth in gas demand.

A2.2 Reference prices for the WA domestic gas market

The first five-yearly review of the WA GSOO was conducted in 2018[170], including the collection of wide-ranging stakeholder feedback. An action item was that AEMO discontinue domestic gas price forecasts in the form presented in the 2017 WA GSOO. Instead, AEMO was to develop a reference price series over the 10-year outlook period for presentation in the 2018 WA GSOO.

Reference prices are designed to provide a confidence band depicting the lower and upper bounds which may guide the formation of WA domestic gas contract prices[171]. These include weighted average production

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[168] ACCC. *The North West Shelf Project – Authorisations*, A91220-A91223, 31 March 2010. Available at https://www.accc.gov.au/public-registers/authorisations-and-notifications-registers/authorisations-register/the-north-west-shelf-project-authorisations-a91220-a91223.

[169] As authorised by the Australian Competition and Consumer Commission (ACCC).

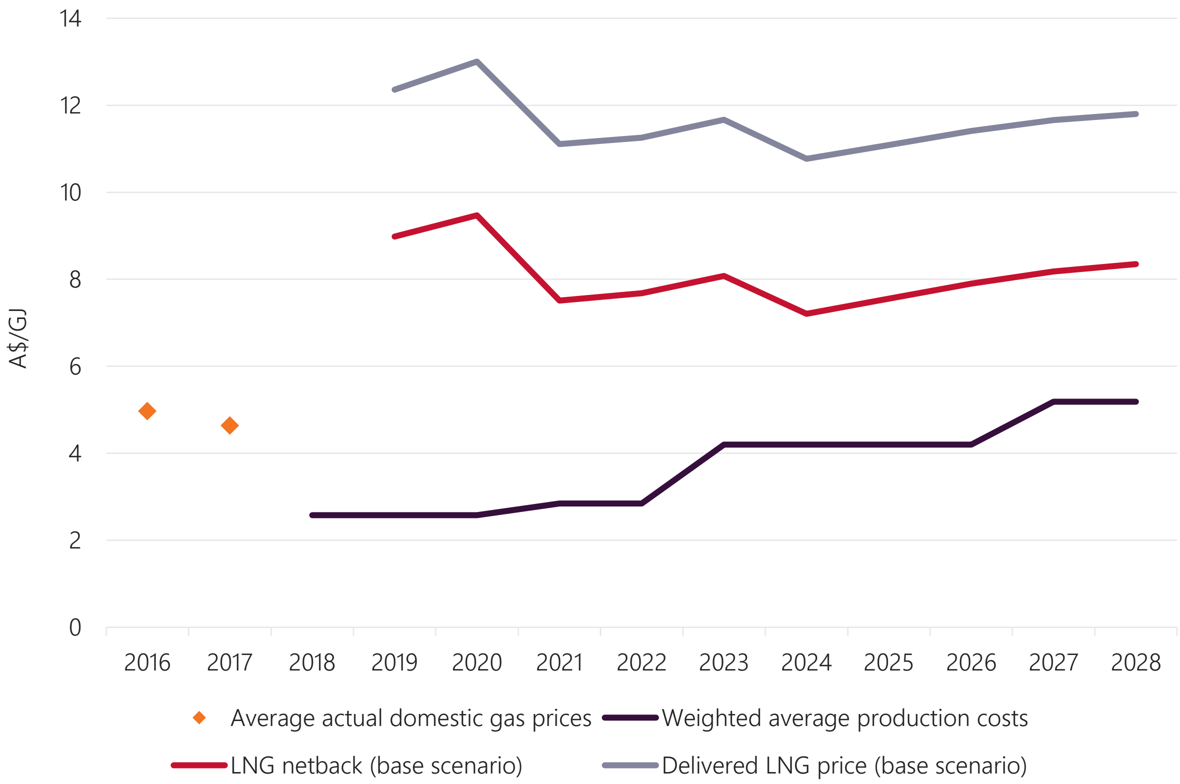
[170] AEMO. *Five-Yearly Review – Western Australian Gas Statement of Opportunities*, August 2018. Available at https://www.aemo.com.au/-/media/Files/Gas/National_Planning_and_Forecasting/WA_GSOO/2018/Five-Yearly-Review-of-the-WA-GSOO.pdf.

[171] AEMO has sourced forecast weighted average WA domestic gas price forecasts from Wood Mackenzie to use as inputs to the WA potential gas supply model. These figures are proprietary and cannot be provided in the public domain.

costs, LNG netback[172], and delivered LNG prices. Since diesel is a substitute for natural gas, for comparison purposes AEMO calculated the current wholesale diesel price as A$26/GJ[173].

The reference prices for the WA domestic gas market, with three years' historical data for context, are shown in Figure 25. Based on forecast oil and LNG prices, LNG netback is expected to remain higher than the weighted average production cost for the entire outlook period. As a result, the LNG netback price may set an upper limit on domestic gas contract prices over the outlook period. However, the estimated cost of supply of the most expensive prospective supply project assessed by AEMO exceeds this upper limit.

Figure 25 Reference prices for the WA domestic gas market (A$/GJ), 2015-2028



Note: Weighted average production costs include prospective supply sources. Source: AEMO calculations based on data sourced from EnergyQuest and FGE forecasts (converted from US$/MMBtu to A$/GJ). Actual domestic gas prices were sourced from DMIRS.

AEMO used the following assumptions to calculate weighted average production costs[174]:

- Short-run (operating) costs were used for existing facilities.
- Long-run (capital) costs plus short-run (operating) costs were used for new developments.
- For projects being developed as backfill to existing domestic gas production facilities, tolling costs were assumed to be between A$0.5/GJ and A$0.75/GJ.

[172] The LNG netback price represents the price a gas supplier would expect to receive from a domestic gas buyer at which the supplier would be indifferent between selling the gas domestically or exporting it as LNG. LNG netback is calculated by taking the delivered price (from Australia to Japan) paid for LNG and subtracting or 'netting back' costs incurred by the supplier to convert the gas to LNG and ship it to the destination port. For the reference price series, AEMO subtracted the cost of liquefaction (US$2/MMBtu) and shipping (US$0.60/MMBtu) from delivered LNG price forecasts obtained from an external consultant (FGE) over the outlook period.

[173] Based on an average wholesale diesel price of 152.9 cents/L for the week ending 14 October 2018, as published by the Australian Institute of Petroleum (see https://aip.com.au/sites/default/files/download-files/2018-10/Weekly%20Diesel%20Prices%20Report%20-%2014%20October%202018.pdf). The price has been adjusted to account for the tax rebate of 41.2 cents/litre for the period 1 July 2018 to 31 January 2019 (see https://www.ato.gov.au/Business/Fuel-schemes/Fuel-tax-credits---business/Rates---business/From-1-July-2018/).

[174] AEMO consulted EnergyQuest and Wood Mackenzie, as well as making its own estimates, to develop these figures.

- New projects were introduced to the market according to the timeframes publicly announced by the project operator (see Sections 3.2 and 3.4 for further information about these dates).
- A 10% internal rate of return was included.
- Costs were weighted by the nameplate capacity of the production facility for both existing facilities and prospective supply sources[175].

As new supply sources enter the market, AEMO expects domestic gas prices to increase, due to the higher production costs for these projects. Step changes in production costs over the outlook period occur when new supply sources are assumed to enter the market in the forecasts, particularly when the projects are large and are more expensive than existing production facilities[176]. For example, the assumed entry of new supply in 2023 causes the weighted average production cost to increase by almost 50% (A$1.40/GJ). If all prospective supply sources commence supply to the WA domestic gas market, AEMO estimates that the weighted average cost of production could more than double from the 2018 level to reach A$5.19/GJ.

Based on externally generated forecasts (see Section A3.1.2), the WA weighted average domestic gas contract price could rise by 9.4% from the 2018 level by 2028.

[175] AEMO tested using actual production rates from 2017 to calculate the weighted average costs but found the difference between the two methods negligible at A$0.01/GJ. For existing facilities, AEMO has used the nameplate production capacity. For prospective supply sources, the DMO quantity or the expected production capacity has been used as applicable. See Chapter 3 – Gas supply for further details of production capacity.

[176] This is partly because long-run costs are used for new projects, which are typically higher than the short-run costs used for existing production facilities.

A3. Input assumptions and methodologies

This appendix provides details of input assumptions and methodologies used for forecasting:

- Domestic gas.
- Total gas demand.
- Potential gas supply forecasts.

A3.1 Input assumptions – economics and domestic gas prices

There is a direct relationship between the economic environment and gas demand and potential supply 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, which has historically driven gas demand in regional and remote WA.
- The productivity of commercial and industrial users on the distribution networks, whose gas demand may increase or decrease in line with changes in the level of economic activity in the South West region of WA.
- Increased electricity demand, which is positively influenced by economic growth, and may drive higher gas consumption by GPG. However, growth in electricity demand is being dampened by energy efficiency improvements and behind-the-meter generation from rooftop PV and increasing large scale renewable generation, which could offset some GPG gas consumption.
- LNG export pricing and demand, which affects the establishment of new WA LNG projects. These can be subject to the WA Domestic Gas Policy requiring 15% of LNG production to be made available to supply the domestic market.

Over the past decade, WA's economic growth has been driven by investment in the resources sector, which peaked in 2013-14. The economic growth rate has since slowed, as international commodity markets have softened, and large resources projects have transitioned from the construction to the production phase.

This section provides an overview of WA's forecast economic growth and details the WA domestic gas price assumptions that were inputs into AEMO's gas demand and potential gas supply modelling processes for developing this WA GSOO report.

A3.1.1 Economic outlook

AEMO engaged the National Institute of Economic and Industry Research (NIEIR) to provide economic and commodity forecasts as inputs to the development of the WA domestic gas demand forecasts.

NIEIR used a top-down econometric model to forecast key indicators for the WA economy, including SFD, gross state product (GSP), government investment, private consumption, and population. NIEIR considered economic growth forecasts at an international, national, and state level. In addition, NIEIR developed a price and production outlook for individual commodities produced in WA[177].

After a period of rapid economic growth between 2009-10 and 2014-15, WA experienced relatively low growth in 2015-16 (1%) and a recession in 2016-17 (-2.7%). This slowdown was related to sharp falls in business investment and weak commodity prices which affected government revenue and mining industry employment. As a result, in 2015-16 and 2016-17 population growth slowed to around 0.7% per year as employment fell and overall consumer and business confidence declined.

In the base scenario, WA's GSP is forecast to grow modestly over the 10-year outlook period, largely because of an improved outlook for commodities. The forecasts for commodities production and prices have strengthened from 2017, particularly for nickel, zinc, copper, and lithium. This has led to stronger metals and minerals exploration expenditure which is expected to lead to expansions and new operations over the medium term.

In summary, for the period 2018-19 to 2027-28:

- GSP is forecast to increase at an average annual rate of 2.6%, supported by rising commodity exports and stronger employment growth which lead to gradual increases in population growth, household expenditure and dwelling construction activity.
- Population growth is forecast to recover from relatively low levels over the past three years, averaging 1.6% a year.
- Business investment is projected to strengthen, although from a low base, to grow at 5.2% on average annually, reflecting incremental iron ore expansions and continued investment in gold and other metals like lithium.
- WA public sector expenditure growth (from Commonwealth, state, and local governments) is expected to be relatively modest (2.3% annually) as slower revenue growth constrains spending. Separately, WA public capital expenditure is forecast to grow by 3.4% per year, assisted by additional infrastructure funding, particularly for METRONET public transport projects.

Table 25 presents the WA economic growth forecasts used as inputs into the low, base, and high gas demand scenarios.

[177] Economic growth and commodities forecasts are based on data available up to August 2018.

Table 25 WA gross state product (%), actual 2013-14 to 2017-18 and forecasts 2018-19 to 2027-28

Financial year	Actual	Low	Base	High
2013-14	5.9			
2014-15	2.7			
2015-16	1.0			
2016-17	-2.7			
2017-18	2.9			
2018-19		2.3	3.3	4.3
2019-20		2.7	3.5	4.5
2020-21		1.7	2.7	3.5
2021-22		1.3	2.2	3.1
2022-23		1.3	2.2	3.2
2023-24		1.5	2.3	3.3
2024-25		1.7	2.6	3.8
2025-26		1.5	2.3	3.0
2026-27		1.4	2.6	3.6
2027-28		1.9	2.7	3.7
Compound average annual change (%), 2018-19 to 2027-28		1.7	2.6	3.6

Source: NIEIR.

A3.1.2 Domestic gas price assumptions

AEMO sourced domestic gas price forecasts (in A$/GJ) for the period 2018 to 2035 from Wood Mackenzie[178] and used these forecasts as inputs into the modelling processes for the potential gas supply and domestic gas demand forecasts. The domestic gas price forecasts are proprietary and cannot be published.

In summary, AEMO used the following Wood Mackenzie price forecasts in the model for the period 2019 to 2028:

- For the base potential gas supply scenario, weighted average contract prices[179].
- For the low potential gas supply scenario, the low forecast domestic gas price.
- For the high potential gas supply scenario, the high forecast domestic gas price.

To provide gas stakeholders with information about pricing in the WA domestic gas market, AEMO has developed a series of reference prices over the outlook period, as detailed in Appendix A2.

A3.2 Gas demand forecast methodology

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

- Domestic gas demand forecasts – all major mining and minerals processing, industrial, and commercial demand, GPG demand in the SWIS and non-SWIS areas, and small-use customers connected to WA's gas transmission and distribution networks.

[178] Wood Mackenzie. *WA Domestic Gas Market*, commercial in confidence report, March 2018.

[179] The Wood Mackenzie weighted average contract price forecasts are projected through 2025. AEMO has used the series trend to extrapolate prices for 2026 to 2028.

- Total gas demand forecasts – domestic gas demand plus an estimate of the total quantity of gas required for LNG exports, reflecting an overall assessment of WA gas demand.

The methodology for preparing these forecasts is described in Sections A3.2.1 and A3.2.2.

A3.2.1 Domestic gas demand

AEMO engaged MJA to develop domestic gas demand forecasts for the outlook period. This section provides an overview of the methodology MJA adopted in developing its domestic gas demand forecasts[180].

In conjunction with AEMO, MJA prepared five scenarios for forecasting domestic gas demand, which are detailed in Table 5 in Section 2.2.1.

The underlying economic assumptions outlined in Table 25 above for the domestic gas demand scenarios are outlined in Section A3.2.

Unlike the 2017 WA GSOO demand forecasts, the low, base, and high scenarios now include an assumption that some existing SWIS power plants (most notably, older coal fired generation) are no longer dispatched from the end of 2023 based on plant age and economics[181].

Due to continued interest in new renewable electricity generation, all scenarios developed for the 2018 WA GSOO assume that committed and likely[182] large-scale renewable energy projects proceed in the SWIS (nine projects totalling 762 megawatts [MW]). In addition to this, further non-project specific large-scale wind and solar generation capacity is included in the second half of the outlook period, where modelling indicates that further renewable investment is economic[183].

In addition to the base, low, and high scenarios, two alternative scenarios have been included to estimate the potential impact of the SWIS generation mix on WA gas demand:

- Accelerated SWIS emissions reduction – to facilitate SWIS power generation meeting their estimated share of the Paris Agreement emissions reduction target by 2027, this scenario assumed older coal-fired generators are not dispatched in the WEM from the end of 2021 and assumed increased renewable power generation in the SWIS.
- SWIS power generation dispatch unchanged – this scenario assumed no change to the current mix of existing generators that are dispatched in the SWIS (that is, the coal- and gas-fired generators currently participating in the WEM continue to participate over the forecast period).

These used the base scenario gas demand assumptions as a starting point, as outlined in Table 5 in Section 2.2.1.

The accelerated emissions reduction scenario added 325 MW of renewable generation capacity over and above the renewable energy projects already included in the base scenario, to reach a total of 1,891 MW of large-scale renewable generation capacity in the SWIS by 2028[184]. To facilitate this, some generation capacity was assumed to retire earlier than in the base scenario.

MJA's domestic gas demand forecast model is illustrated in Figure 26.

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[180] This methodology is described in greater detail in MJA's methodology report, *The Development of Annual Gas Demand Forecasts for the Western Australian Gas Market*, published with the 2018 WA GSOO on AEMO's website at http://www.aemo.com.au/Gas/National-planning-and-forecasting/WA-Gas-Statement-of-Opportunities.

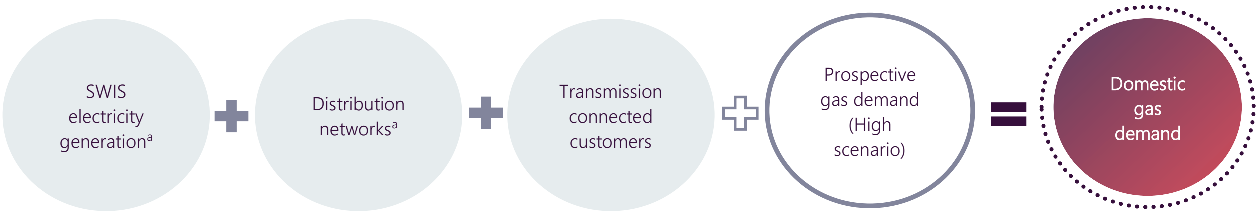
[181] Decisions to no longer dispatch generation capacity are based on a number of considerations, not all of which can be captured in market modelling. The condition of assets, portfolio optimisation and financial position, rehabilitation costs, and company policies will all influence any commercial decision to withdraw generation. Therefore, the timing and amount of generation withdrawn, could vary from what has been assumed here.

[182] AEMO operates the WA Reserve Capacity Mechanism. This provides awareness of committed renewable projects for the following two Reserve Capacity cycles. The likely renewable projects are estimated from a selection of public sources.

[183] Based on energy market simulation modelling using MJA's WEM model (PROPHET Market Simulation).

[184] While a total renewable plant nameplate capacity of 1,566 MW for the base scenario and 1,891 MW for the accelerated emissions reduction scenario by 2028 may appear high, it should be noted that capacity factors for renewable plant are relatively low (between 25% and 50%), so total electrical energy generated per year by 1 MW of renewables will be considerably lower than total energy generated by 1 MW of coal-fired generation.

Figure 26 Domestic gas demand forecast model



[a] Accounting for the gas price elasticity of demand.
Demand from gas storage and shipping is not included in the gas demand forecasts.

The sections below describe the components of the gas demand model, providing a brief overview of the methodology that MJA applied to generate the gas demand forecasts.

SWIS electricity generation

Electricity generation by GPG in the SWIS accounts for roughly one-fifth of domestic gas demand in WA and is therefore an important component of the WA domestic gas demand forecast. Around 2,955 MW[185] of SWIS generation can use gas (including dual-fuel gas/diesel). Two-thirds of this total capacity is peaking or mid-merit[186]. Typically, the SWIS relies on GPG to supply peak load over the summer season and for the provision of Load Following Ancillary Services (LFAS).

SWIS GPG has exposure to fuel substitutes (such as coal-fired generation) and to the electricity spot price. Where the electricity spot price is lower than short-run costs (due to a low spot price or high gas price), GPG may reduce generation.

Future demand from SWIS GPG was forecast using MJA's energy market simulation model (PROPHET) to forecast the future generation mix in the SWIS, and power station specific heat rates[187].

Gas demand forecasts for SWIS electricity generation were adjusted to account for medium- to long-term average domestic gas price forecasts based on an assumed demand elasticity as GPG has exposure to fuel substitutes (such as coal-fired generation) and to the electricity spot price. Where the electricity spot price is lower than short-run costs (due to a low spot price or high gas price), GPG may reduce generation.

Distribution network

The distribution network includes the low-pressure pipelines used to supply small-use residential and non-residential retail customers, and this accounts for around 7% of WA's domestic gas demand.

Growth in gas demand in the distribution network was forecast using regression analysis, which considered drivers of growth including population growth, gas prices, and SFD. Other factors, such as improving energy efficiency standards and increased penetration of reverse-cycle air-conditioning, were also considered[188].

Gas demand forecasts for customers connected to the distribution network were adjusted to account for medium- to long-term average domestic gas price forecasts based on an assumed demand elasticity. If gas prices remain high over time, households and businesses may replace gas appliances with electric appliances or install solar hot water in place of gas. However, domestic gas tariffs have grown at or below the inflation rate since 2014-15.

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[185] Based on Capacity Credits assigned to gas and dual-fuel facilities in the 2018-19 Capacity Year.

[186] Based on the capacity classifications published in the *2018 WEM Electricity Statement of Opportunities*. Available at https://www.aemo.com.au/-/media/Files/Electricity/WEM/Planning_and_Forecasting/ESOO/2018/2018-WEM-ESOO-Report.pdf.

[187] This methodology is described in greater detail in MJA's methodology report, *The Development of Annual Gas Demand Forecasts for the Western Australian Gas Market*, published with the 2018 WA GSOO on AEMO's website at http://www.aemo.com.au/Gas/National-planning-and-forecasting/WA-Gas-Statement-of-Opportunities.

[188] ibid.

Transmission-connected customers

Other than SWIS GPG, customers connected to the gas transmission network typically include:[189]

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

These transmission-connected customers account for around 75% of WA gas demand, and have been forecast using a mix of:

- Historical gas flow data from the WA GBB.
- Publicly available information on existing and new projects and from pipeline operators.
- Information provided by gas consumers, gas suppliers, pipeline operators, and non-GSI participants consulted by AEMO, about each facility and the customer's corresponding forward plans.
- Committed[190] major new mining and mineral processing projects that have achieved, or are highly likely to achieve, FID (nine projects in total). A list of these projects is presented in Section 2.2.1.
- Economic assumptions, and assumptions about future commodity demand and international commodity prices.

Prospective gas demand for the high gas demand scenario

The high gas demand scenario included projects that may be developed and consume gas, and projects that are likely to switch fuels from diesel to gas over the outlook period.

To be included in prospective demand, each project initially shortlisted had to meet at least two of the criteria outlined below:

- The potential demand for each project should be more than 10 TJ/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.
- 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 them consuming gas over the outlook period. The final list includes projects submitted by GSI and some non-GSI market participants in the 2018 FIR process[191] as well as information from the public domain.

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[189] The gas demand forecasts do not consider withdrawals or injections from either the Mondarra or Tubridgi gas storage facilities, as they have a net neutral impact on annual gas demand over the long term. However, GBB data indicates considerably higher injections into the Tubridgi facility than withdrawals over the last year. Refer to "Domestic gas storage and shipping" in Section 2.2.5 for further information.

[190] Committed projects are under construction, or have taken a positive FID.

[191] No confidential information was supplied to the external consultant responsible for generating the WA gas demand forecasts.

A total of 13 projects were identified as prospective gas demand for the high gas demand scenario in the 2018 WA GSOO. Five of these projects are located in the SWIS, while eight are located outside of the SWIS.

The remaining shortlisted projects may have been excluded for one or more of the following reasons:

- The project relied on the construction of other infrastructure to transport its minerals (for example, a port or the common user rail system).
- The project relied on improved commodity prices in the future.
- The project relied on the availability of financing.
- The project is located in the SWIS, where there is spare capacity for electricity generation.
- The project proponent had not conducted any environmental or front-end engineering and design studies.
- The project proponent did not appear to have committed to a project commencement date.

Compared to the projects in the 2017 WA GSOO, for the 2018 WA GSOO:

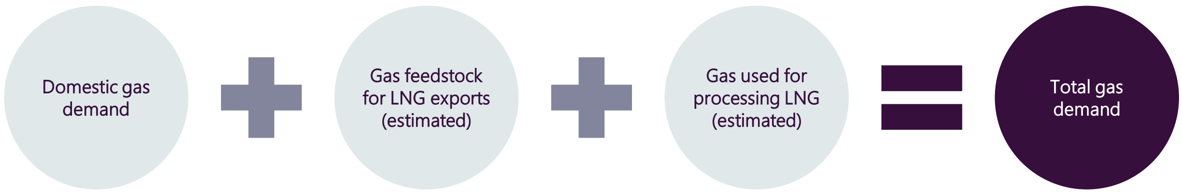
- Two projects identified last year have been included in the base gas demand scenario forecast.
- One project has been retained as prospective gas demand for the high gas demand scenario.
- There were 10 new prospective projects identified.

The estimated cumulative impact of these projects reaches a maximum of 57 TJ/day of gas consumption over the outlook period.

A3.2.2 Total gas demand

To develop WA total gas demand forecasts, AEMO estimated the amount of gas required for WA's LNG sector and added it to MJA's domestic gas demand forecast, as shown in Figure 27.

Figure 27 Total gas demand forecast model



AEMO developed three scenarios of total gas demand – low, base, and high. LNG forecasts were developed using historical production utilisation data for existing LNG facilities and publicly available information on the proposed production capacity and commencement date of new LNG facilities.

Unlike domestic gas demand forecasts, the LNG feedstock forecast scenarios were not restricted to committed gas-consuming projects. AEMO's LNG forecasts together with MJA's domestic gas demand forecasts formed three scenarios of total gas demand. The assumptions applied in the estimation of each total gas demand scenario are summarised in Table 26.

LNG feedstock requirements were adjusted by the average utilisation rate of WA LNG facilities operating between Q1 2010 and Q2 2018, while for new LNG facilities this was assumed to be 95% once a facility reaches a steady state after LNG commissioning.

Table 26 Total gas demand forecast scenarios, 2019-28

Parameter	Low scenario	Base scenario	High scenario
Domestic gas demand forecasts	Low	Base	High
Gas feedstock for LNG exports	NWS (16.9 mtpa, supported by commencement of Greater Western Flank 2 in 2018, and backfill from Scarborough gas 4 mtpa, commencing in June 2025 [b]) • Pluto LNG (4.9 mtpa) • Gorgon LNG (15.6 mtpa) • Wheatstone LNG (8.9 mtpa) • Prelude FLNG (3.6 mtpa, commences in June 2019) • Ichthys LNG (8.9 mtpa, of which 4.45 mtpa commences in October 2018 and the remainder in June 2019) • Equus (2 mtpa commences in March 2026) • Backfill for Darwin LNG in 2021	Includes facilities outlined in the Low scenario assumptions except: • NWS production maintained via backfill from Scarborough (commences in June 2024) and Browse fields (10 mtpa, commences in 2026) • Prelude FLNG (commences in November 2018) • Ichthys LNG (of which 4.45 mtpa commences in October 2018 and the remainder April 2019) • Equus (commences in June 2023)	Includes facilities outlined in the Base scenario assumptions except: • Pluto expansion from Scarborough gas (4 mtpa, commences 2025) • Gorgon LNG expansion (5.2 mtpa in June 2027) • Wheatstone expansion (4.45 mtpa in June 2026) • Ichthys expansion (4.45 mtpa in June 2028)
Gas used for processing LNG [a]		8%	

[a] Processing estimates were calculated by taking the low range of estimates from Lewis Grey Advisory 2016. *Projections of gas and electricity used in LNG*, Public report prepared for AEMO, 18 November, p. vi, http://www.aemo.com.au/-/media/Files/Gas/National_Planning_and_Forecasting/NGFR/2016/Projections-of-Gas-and-Electricity-Used-in-LNG-Public-Report-November-2016.pdf.
[b] Woodside Energy. "Delivering value growth – 2017 Investor Briefing Day", ASX Announcement, 23 May 2017, p. 57. Available at http://www.woodside.com.au/Investors-Media/announcements/Pages/announcements-previousYear.aspx#.W72-H9MzY-U.

A3.3 Potential gas supply forecast methodology

AEMO forecasts the volume of gas that could be economically offered to the domestic market given forecast prices and production costs, subject to the availability of domestic gas supply production capacity and gas reserves ('potential gas supply'). The resulting forecasts are not projections of how much gas *will* be produced, but how much gas *could* be produced if there was market demand for it at the forecast price. This approach is useful in addressing questions of supply adequacy, or for identifying potential supply shortfalls where expected domestic gas demand may exceed expected supply availability.

AEMO's potential gas supply model has been designed to address the following key questions, under alternative future scenarios:

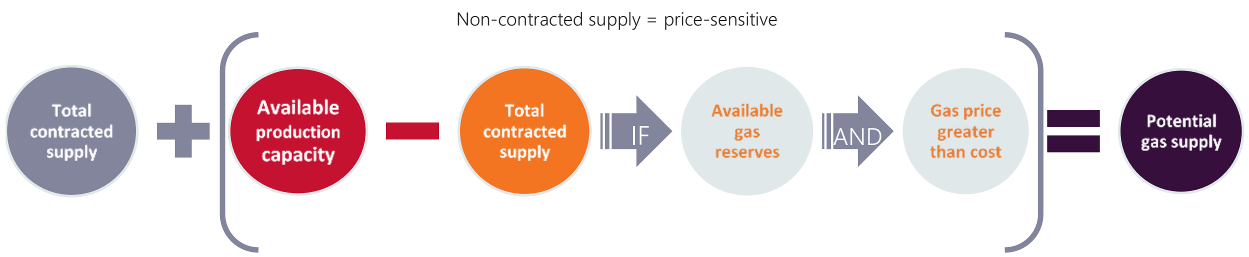
- Is the level of WA domestic gas supply likely to be adequate to meet the needs of domestic customers over the forecast time horizon?
- If the model identifies a potential domestic gas supply shortfall, when is that shortfall likely to arise and how severe is it likely to be?

The model nets out already-contracted domestic sales, treating them as 'locked in' at pre-determined prices. It focuses on determining how much non-contracted (or 'spare') gas supply capacity would be made available for sales to the domestic market at expected prices. The operation of the potential gas supply model is outlined in Figure 28.

In 2018, ACIL Allen Consulting redeveloped AEMO's potential gas supply model in response to feedback received as part of the five-yearly review of the WA GSOO[192]. To ensure AEMO's model aligned with best practice, ACIL Allen conducted a literature review of documentation for three reputable gas supply models developed by Australian and international expert organisations[193].

ACIL Allen's model review aimed to ensure that all relevant supply drivers and mechanisms were considered while recognising that the WA domestic gas market has unique characteristics. It found that AEMO's approach was sound, given its purpose and data availability, and was being broadly aligned with the three models assessed through the literature review. Some enhancements and improvements were incorporated in the redeveloped model, including addressing the unique mechanism of WA's domestic gas policy[194].

Figure 28 Potential gas supply forecast model



The new model features in 2018 are summarised as follows:

- Potential gas supply was modelled this year at a production facility level instead of a 'producer equity portfolio' level. Each domestic production facility was assumed to operate efficiently to meet existing domestic gas supply contracts and domestic market obligations (if applicable).
- Reserves decline annually in line with production volumes. Production in a given year was limited to the lesser of either of a facility's production capacity or 10% of the remaining gas reserves. The model tracked the gas reserves available to each domestic production facility by incorporating assumptions about initial gas reserves, modelled annual gas sales (contracted and uncontracted), fuel gas requirements, and incremental reserves additions. The model determined potential production profiles by considering the effects of reserves depletion on gas deliverability.
- The model distinguished between LRC and short run costs of production (SRC)[195] as drivers for, respectively, initial investment decisions in new domestic gas supply capacity and discretionary sales of gas from existing uncontracted capacity. New domestic gas-only projects commence if the forecast WA domestic gas prices exceed the LRC. New LNG-linked projects were triggered to commence when forecast Asian LNG prices are higher than their LRC. Where appropriate, these were assumed to be backfill for existing domestic gas production facilities.
- The model did not generate projections of domestic gas prices. Instead, it incorporated externally-derived projections of price as inputs to the supply model[196] (for further information on the price forecasts, see Appendix A2 and Appendix A3.1.2).
- The model operated on an annual settlement basis for gas reserves and gas in storage.

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[192] For further information, see Section 4 of the five-yearly review of the WA GSOO report. Available at http://aemo.com.au/-/media/Files/Gas/National_Planning_and_Forecasting/WA_GSOO/2018/Five-Yearly-Review-of-the-WA-GSOO.pdf.

[193] These included: Australian Government, Productivity Commission. *Examining barriers to more efficient gas markets*, 2015; the U.S. Energy Information Administration. *Oil and gas supply module of the National Energy Modelling System*; Model documentation, 2017; and the International Energy Agency. *World Energy Model Documentation*, 2017.

[194] New gas supply capacity may enter the market as part of a domestic market obligation, rather than in response to efficient market signals.

[195] All production costs incorporate a 10% rate of return.

[196] The domestic gas price forecasts utilised were in line with the prices used as inputs to the domestic gas demand forecasts.

- Transmission pipeline capacity constraints were not considered in the model.

A settlement module took the model inputs and used them to determine the potential domestic gas supply available from each facility. Potential supply was then allocated, where economic, from the year the supply was assumed to be available.

As inputs, the model used data submitted by GMPs and non-GMPs under the annual FIR process. This information included gas reserves and contracted supply volumes connected to each existing domestic gas production facility, and firm gas supply capacity for each production facility, provided by suppliers. Where this data was not available, AEMO made assumptions based on public domain information.

The fundamental assumptions for the 2018 low, base, and high potential gas supply scenarios are detailed in Section 3.2, Table 17.

A4. Total gas forecasts

Table 27 Domestic gas demand forecasts (PJ/annum), 2019-28

Year	Low	Base	High
2019	386.9	390.2	401.2
2020	387.8	393.0	409.3
2021	389.1	395.5	410.9
2022	390.1	397.2	413.9
2023	390.0	398.3	417.9
2024	393.1	403.0	425.7
2025	396.8	408.1	434.3
2026	396.4	409.1	438.7
2027	395.8	411.4	442.2
2028	395.2	412.7	444.4

Source: AEMO and MJA.

Table 28 LNG feedstock forecasts (PJ/annum), 2019-28

Year	Low	Base	High
2019	2,847.3	3,168.4	3,168.4
2020	3,281.9	3,295.5	3,295.5
2021	3,295.5	3,295.5	3,295.5
2022	3,191.2	3,191.2	3,191.2
2023	3,087.0	3,087.0	3,087.0
2024	2,982.8	3,070.6	3,176.0
2025	3,070.6	3,193.4	3,298.8
2026	3,159.5	3,348.2	3,348.2
2027	3,090.3	3,458.9	3,807.4
2028	2,986.1	3,512.7	4,118.6

Source: AEMO.

Table 29 LNG processing forecasts (8% of feedstock) (PJ/annum), 2019-28

Year	Low	Base	High
2019	227.8	253.5	253.5
2020	262.5	263.6	263.6
2021	263.6	263.6	263.6
2022	255.3	255.3	255.3
2023	247.0	247.0	247.0
2024	238.6	245.7	254.1
2025	245.7	255.5	263.9
2026	252.8	267.9	267.9
2027	247.2	276.7	304.6
2028	238.9	281.0	329.5

Source: AEMO.

Table 30 Total gas demand forecasts (PJ/annum), 2019-28

Year	Low	Base	High
2019	3,461.9	3,812.1	3,823.1
2020	3,932.2	3,952.1	3,968.4
2021	3,948.2	3,954.6	3,970.0
2022	3,836.6	3,843.8	3,860.5
2023	3,724.0	3,732.3	3,751.9
2024	3,614.5	3,719.3	3,855.7
2025	3,713.1	3,857.0	3,996.9
2026	3,808.6	4,025.2	4,054.8
2027	3,733.3	4,147.1	4,554.3
2028	3,620.1	4,206.4	4,892.5

Source: AEMO.

A5. WA gas infrastructure

WA gas infrastructure includes multi-user gas storage facilities, gas transmission pipelines, spot and short-term gas trading mechanisms, and LNG export production facilities. Information on domestic gas production facilities is provided in Chapter 3 – Gas supply.

A5.1 Multi-user gas storage facilities

There are two multi-user gas storage facilities in operation in WA (Table 31).

Table 31 WA multi-user gas storage facilities, 2018

	Gas storage capacity (Total, PJ)	2018 injection/withdrawal capacity (TJ/day)
Mondarra Gas Storage Facility (APA Group)	18	150/70
Tubridgi Gas Storage Facility (Australian Gas Infrastructure Group)	42	50/50
Total	60	200/120

The Tubridgi Gas Storage Facility (TGSF) has committed to expanding its injection and withdrawal capabilities to 90 TJ/day and 60 TJ/day, respectively[197].

See Year in Review (Chapter 1) for details of mergers and acquisitions activity in this sector.

A5.2 Gas transmission pipelines

The WA gas transmission system provides 1,380 TJ/day capacity (Figure 29).

The new 198-kilometre Yamarna gas pipeline (8 TJ/day), connected to the Murrin Murrin lateral, is expected to be commissioned in late 2018[198].

When the Wheatstone domestic gas production facility commences (planned for Q1 2019), the 22.8-kilometre (337 TJ/day) Wheatstone Ashburton West Pipeline will deliver gas from it into the gas transmission system[199].

See Year in Review (Chapter 1) for details of mergers and acquisitions activity in this sector.

[197] Energy News Bulletin. "AGIG expands WA's largest gas storage facility", 22 March 2018. Available at https://www.energynewsbulletin.net/pipelines/news/1334579/agig-expands-wa%E2%80%99s-largest-gas-storage-facility.

[198] APA Group. "APA to build new gas pipeline and power station in the Goldfields region, WA", 21 June 2017. Available at https://www.apa.com.au/news/asx-releases/2017/apa-to-build-new-gas-pipeline-and-power-station-in-the-goldfields-region-wa/.

[199] AEMC. *WA: Wheatstone Ashburton West Pipeline*. Available at https://www.aemc.gov.au/energy-rules/national-gas-rules/gas-scheme-register/wa-wheatstone-ashburton-west-pipeline. Viewed: 23 October 2018.

Figure 29 Gas transmission pipelines in WA

A5.3 Spot and short-term trading

AEMO does not operate any gas trading hubs or a Short Term Trading Market in WA, as it does in east coast gas market jurisdictions.

Most short-term volumes in WA are traded bilaterally between parties via confidential agreements. The two entities that have an independent and non-aligned process to facilitate the spot sale of gas to third parties are:

- gasTrading Australia Pty Ltd – runs an open monthly bidding round setting prices based on indicative volumes. Volumes are spot until confirmed a day ahead. Monthly data on prices and volumes are posted on the gasTrading website. Updates are made after each monthly bid process and actual trade data is published at the completion of each month.
- Energy Access Services Pty Ltd – real-time short-term trading for members via an online platform (prices, quantities and delivery points), with monthly pricing posted on its website.

Information in the public domain regarding the quantity or associated prices of spot or short-term gas traded is provided by gasTrading Australia Pty Ltd[200] and Energy Access Services Pty Ltd[201].

[200] See http://www.gastrading.com.au/.

[201] See https://www.energyaccessservices.com.au/.

AEMO estimates that the volume traded on a short-term basis is around 3-5% of total domestic gas consumption in Western Australia.

The growth in multi-user storage capacity (Appendix A5.1) could provide support for a greater volume of spot and short-term trading in the WA gas market.

A5.4 LNG export production facilities

As at October 2018, there are four LNG production facilities exporting from WA, totalling 46.1 mtpa nameplate capacity:

- NWS (KGP).
- Pluto.
- Gorgon.
- Wheatstone.

The second liquefaction train at the 8.9 mtpa Wheatstone LNG plant began operation in June 2018.

A5.4.1 Offshore WA fields not connected to WA gas pipeline system

The associated gas fields for two LNG projects are sourced from WA waters, however neither will be connected to WA's pipeline gas transmission system:

- The first liquefaction train of the 8.9 mtpa Inpex Corporation-operated Ichthys LNG project commenced, shipping its first LNG export cargo in October 2018[202]. Ichthys gas will be piped to its onshore liquefaction plant located in Darwin, Northern Territory. Its production is therefore not included in the total WA LNG production capacity.
- The 3.6 mtpa Royal Dutch Shell plc-operated Prelude floating LNG facility first took gas on board in June 2018 in preparation for commissioning[203]. Prelude LNG will be directly exported from the offshore vessel. When operational, its LNG production capacity will be included in the total for WA.

[202] INPEX Corporation. "INPEX confirms first LNG cargo from Ichthys LNG Project", 23 October 2018. Available at http://www.inpex.com.au/news-media/news/inpex-confirms-first-lng-cargo-from-ichthys-lng-project/.

[203] Reuters. "Shell feeds gas to Australia's new Prelude floating unit", 13 June 2018. Available at https://www.reuters.com/article/us-australia-gas-shell/shell-feeds-gas-to-australias-new-prelude-floating-unit-idUSKBN1J908D.

Conversion tables

The following conversion factors have been applied in preparing figures for the 2018 WA GSOO.

Table 32 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.

Units of measure

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

Abbreviations

Abbreviation	Expanded name
1P	Proved reserves
2C	Contingent resources
2P	Proved and probable reserves
ABS	Australian Bureau of Statistics
ACCC	Australian Competition and Consumer Commission
ADGSM	Australian Domestic Gas Security Mechanism
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AGIG	Australian Gas Infrastructure Group
AMEC	Association of Mining and Exploration Companies
CNG	Compressed natural gas
COAG	Council of Australian Governments
DBP	Dampier Bunbury Pipeline
DJTSI	WA Department of Jobs, Science, Tourism and Innovation
DMO	Domestic market obligation
EISC	Economics and Industry Standing Committee
ERAWA	Economic Regulation Authority of Western Australia
ESOO	Electricity Statement of Opportunities
EV	Electric vehicle
FBICRC	Future Battery Industry Cooperative Research Centre
FGE	FACTS Global Energy
FID	Final investment decision
FIR	Formal information request
FLNG	Floating liquefied natural gas
GBB	Gas Bulletin Board
GHG	Greenhouse gases
GMP	Gas Market Participant
GPG	Gas powered generation
GSI	Gas Services Information
GSOO	Gas Statement of Opportunities
GSP	Gross State Product
IMO	International Maritime Organisation

Abbreviation	Expanded name
KGP	Karratha Gas Plant
JV	Joint venture
LFAS	Load Following Ancillary Services
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
LRC	Long run cost
LTBR	Long Term Bond Rate
MJA	Marsden Jacob Associates
MRIWA	Minerals Research Institute of WA
NGR	National Gas Rules
NIEIR	National Institute of Economic and Industry Research
NOPTA	National Offshore Petroleum Titles Administrator
NWS	North West Shelf
PPI	Producer price index
PRRT	Petroleum Resource Rent Tax
PV	Photovoltaics
RDA	Regional Development Australia
REQ	Resources and Energy Quarterly
RFSU	Ready for start up
SFD	State final demand
SRC	Short run cost
SWIS	South West interconnected system
TGSF	Tubridgi Gas Storage Facility
WA	Western Australia
WEGP	West-East Gas Pipeline
WEM	Wholesale Electricity Market

Glossary

This document uses terms that have meanings defined in the Gas Services Information (GSI) Rules. The GSI meanings are adopted unless otherwise specified.

Term	Definition
1P	A measure of gas reserves that includes proven (developed and undeveloped) reserves.
2C	A measure of gas resources that are considered less commercially viable than reserves. 2C resources are considered the best estimate of sub-commercial reserves.
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.
Committed projects	Gas supply or demand projects that are existing, under construction or have taken a positive final investment decision.
Distribution network	The distribution network is defined as the low-pressure networks operated by ATCO and used to supply residential and non-residential customers in the Perth metropolitan area, regional centres of Albany, Bunbury, Geraldton and Kalgoorlie.
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.
Large customers	Gas customers using 10 TJ/day or more. On the GBB WA these are called large users.
Potential gas supply	AEMO estimates the potential availability of gas supply to the WA domestic market by evaluating gas producers' willingness to supply 'at the right price' on an annual basis. "Potential gas supply" is domestic gas supply that could be economically offered to the domestic market, given forecast prices and production costs, subject to the availability of domestic gas supply production capacity and gas reserves. Hence, the resulting forecasts are not projections of how much gas will be produced, but the volume of gas that could be produced if there was market demand for it at the forecast price. The potential gas supply forecasting model takes account of existing, under construction and prospective supply sources (as identified by AEMO).
Prospective projects	Prospective gas supply sources include all gas field developments which have been publicly announced that would make supply available to the WA domestic market, including liquefied natural gas (LNG) projects. Selected prospective supply sources have been included in the potential gas supply forecast model. Prospective gas demand projects may be developed over the outlook period, or may switch from diesel to gas. To be included in the high gas demand forecast scenario, they must meet set criteria described in Section A3.2.1.
Total gas demand	Domestic gas demand plus an estimate of the gas required to produce LNG for export. This reflects an overall assessment of the demand for natural gas in WA.
Transmission network	The high-pressure 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.