GSOO METHODOLOGY

METHODOLOGY FOR THE GAS STATEMENT OF OPPORTUNITIES

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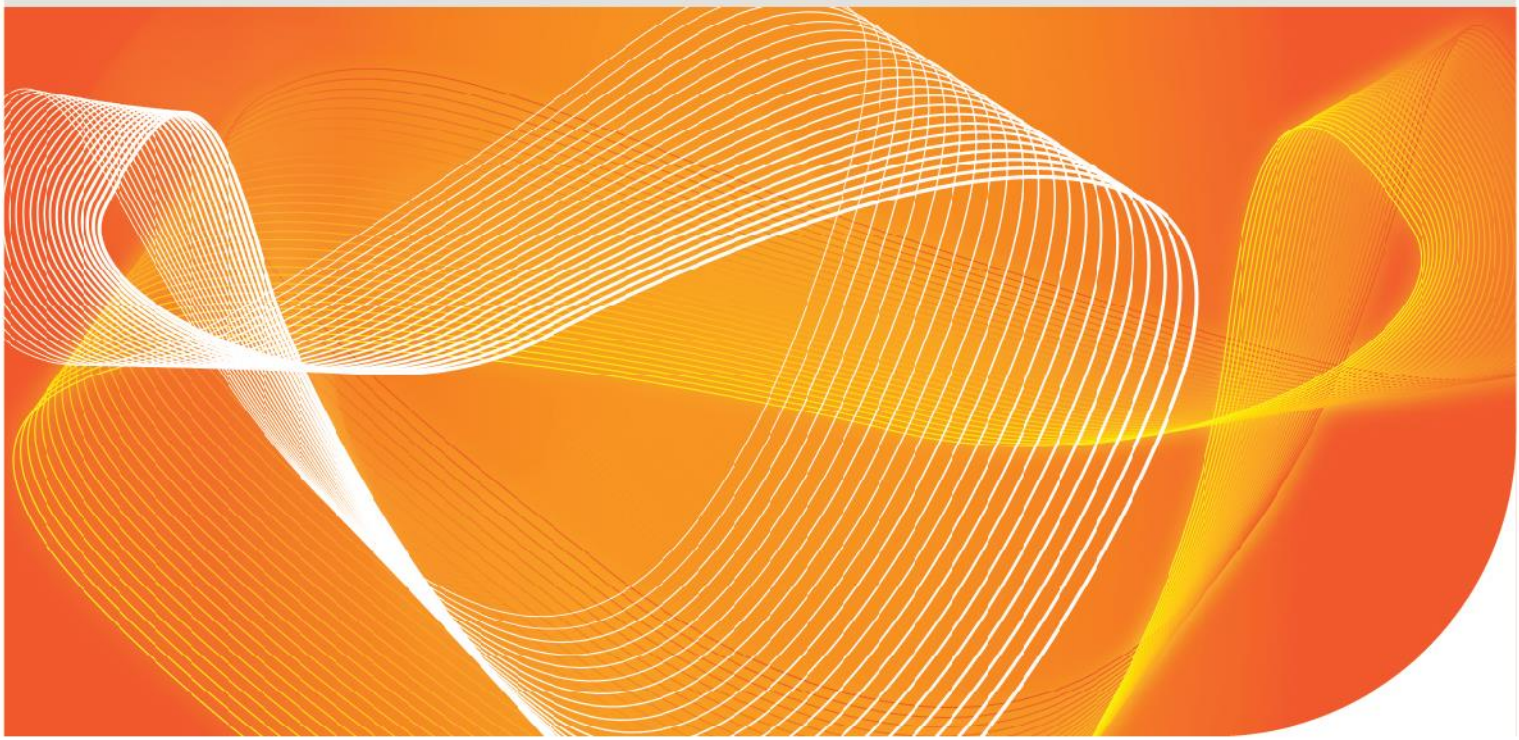

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

IMPORTANT NOTICE

Purpose

AEMO has prepared this document to provide information about the methodology and assumptions used by AEMO to develop its 2016 Gas Statement of Opportunities under the National Gas Law and Part 15D of the National Gas Rules.

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Version control

Version	Release date	Changes
1	10/3/2016	

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CHAPTER 1. INTRODUCTION

This document describes the methodology and assumptions used to develop the *2016 Gas Statement of Opportunities* (GSOO).[1]

The GSOO assesses the adequacy of gas supply and demand in eastern and south-eastern Australia over a 20-year outlook period. The adequacy assessment is performed using a model of supply and demand (gas model) that includes representations of:

- Reserves and resources.
- Gas supply contracts.
- Existing, committed, and proposed new and expanded gas processing facilities.
- Existing, committed, and proposed new and expanded gas transmission pipelines.
- Existing, committed, and proposed new and expanded gas storage facilities.
- Gas consumption forecasts for residential, commercial and industrial customers, gas-powered generation (GPG), and liquefied natural gas (LNG) export, as forecast in AEMO's *National Gas Forecasting Report* (NGFR).[2]

The gas model attempts to balance supply and demand on a daily basis at lowest cost, taking account of contract commitments, gas reserves and resource availability, pipeline and processing infrastructure constraints.

Key outputs of the gas model include daily pipeline flows, gas production, and potential shortfalls.

The analysis is repeated for a range of scenarios and sensitivities, as outlined in the 2016 GSOO, to determine the robustness of outcomes to changes in modelled assumptions.

1.1 Shared assumptions with other AEMO modelling

The GSOO is part of a comprehensive suite of AEMO's planning publications, an overview of which is shown in Figure 1.

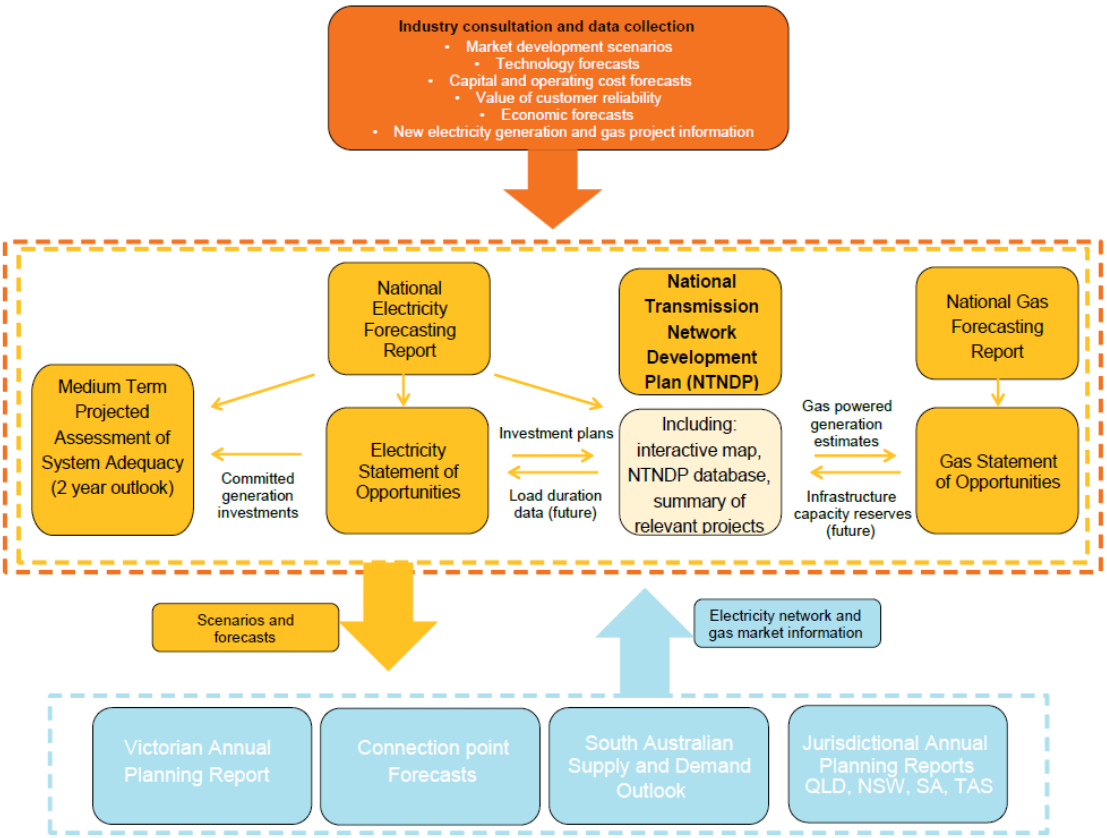
The GSOO process begins with the annual *National Electricity Forecasting Report* (NEFR), which produces electricity demand forecasts. AEMO's electricity model determines how to meet this forecast demand for the *National Transmission Network Development Plan* (NTNDP). The GPG gas demand which is forecast through this process to help meet the projected electricity demand is fed into the NGFR, and the total demand forecasts from the NGFR create the demand input data for the GSOO.

It is very important that AEMO bases its whole suite of forecasting and analysis on the same set of assumptions and inputs, so there is a consistent basis for all its models and projections.

AEMO publishes methodology documents to support all major forecasting and planning publications. These are available on AEMO's website and provide additional relevant background to GSOO data and modelling assumptions.

[1] AEMO. *2016 Gas Statement of Opportunities*. Available: http://www.aemo.com.au/Gas/Planning/Gas-Statement-of-Opportunities.
[2] AEMO. *2015 National Gas Forecasting Report v2.0*. Available: http://www.aemo.com.au/Gas/Planning/Forecasting/National-Gas-Forecasting-Report.

Figure 1 AEMO's planning and forecasting publications



1.2 Supporting material

A suite of resources has been published on the AEMO website to support the content in this Methodology Document and the 2016 GSOO report.

Table 1 Links to other supporting information

Source	Website address
2016 GSOO inputs and stakeholder survey information (for updated processing capacity of each facility used in the GSOO)	http://aemo.com.au/Gas/Planning/Gas-Statement-of-Opportunities/2016-GSOO-Supporting-Information
2016 GSOO Supply-Demand modelling output files	http://aemo.com.au/Gas/Planning/Gas-Statement-of-Opportunities/2016-GSOO-Supply-Demand-Modelling-Output-Files
2015 National Gas Forecasting Report	http://www.aemo.com.au/Gas/Planning/Forecasting/National-Gas-Forecasting-Report
Archive of previous GSOO reports	http://www.aemo.com.au/Gas/Planning/Gas-Statement-of-Opportunities/Previous-GSOO-reports

CHAPTER 2. GAS MODEL

2.1 Data sources

Table 2 shows key sources for the gas model inputs.

Table 2 Key sources for gas model input data

Input	Source
Demand	AEMO 2015 NGFR
Contracts	Core Energy Group
Reserves and resources	Core Energy Group and gas industry participants
Production costs	AEMO analysis, derived from Core Energy Group data
Transmission costs	Gas industry participants. Any gaps (where data was not provided and/or was considered confidential), AEMO used data supplied by Core Energy Group.
Pipeline, processing, storage facility capabilities and daily rates	Gas industry participants. Any gaps (where data was not provided and/or was considered confidential), AEMO used data supplied by Core Energy Group.
Annual field production limits	Gas Bulletin Board and gas industry participants.

2.1.1 Gas industry participants survey

AEMO surveyed gas industry participants to obtain detailed gas information including:

- Processing facility capacities, and potential or committed future expansions.
- Pipeline capacities, and potential or committed future expansions.
- LNG facility capacities, and potential or committed future expansions.
- Gas project developments (including reserves).
- Storage facility capacities and potential or committed future developments.

This information is up to date as of 10 December 2015, although AEMO has endeavoured to incorporate more recent information where practical.

Collated results from the survey of gas industry participants are available on AEMO's website.[3]

2.2 Assessing adequacy

2.2.1 Minimising the cost to supply forecast demand

The GSOO gas model is formulated as a transportation problem (a type of linear program focused on optimising transportation and resource allocation), that simulates gas market supply and demand conditions over the 20-year outlook period, from 2016 to 2035. It calculates optimum production and flow by minimising the cost to supply forecast daily demand, subject to:

- The capability of the transmission system (gas pipelines) to deliver gas to demand centres.
- The capacity of gas processing facilities to supply sufficient gas into the transmission system.
- The availability of reserves to maintain gas processing facility throughput.
- Contract commitments for gas producers.

[3] AEMO. *2016 Gas Processing, Transmission, and Storage Facilities*. Available: http://www.aemo.com.au/Gas/Planning/Gas-Statement-of-Opportunities/2016-GSOO-Supporting-Information.

2.2.2 Reserves and resources

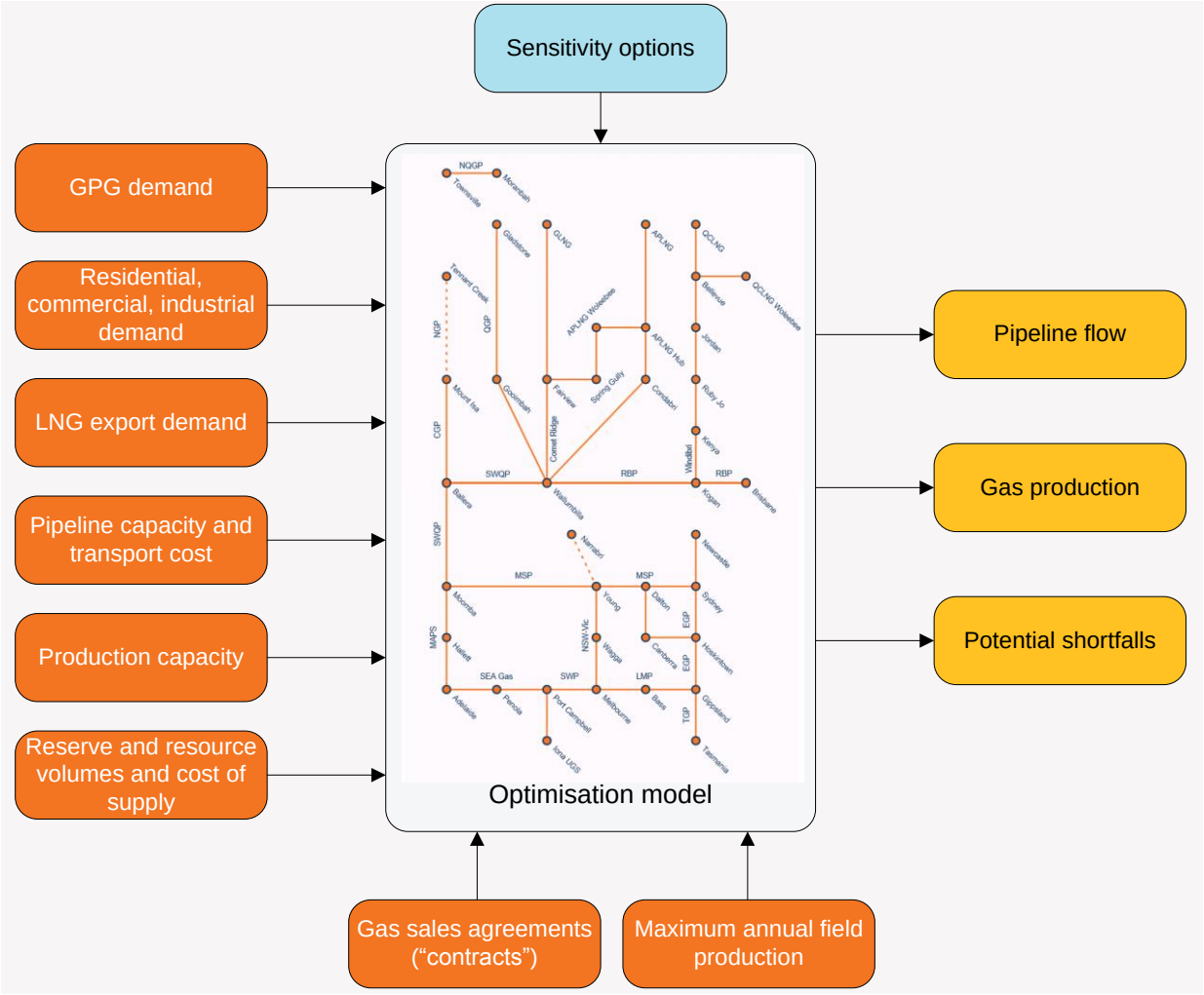
In the gas model, reserves and resources are consumed over the 20-year outlook period based on estimates of supply availability, assuming 100% conversion to production is possible if required. In determining the rate of depletion, the model considers both contract commitments and the cost of production. Further detail about reserves quantities used in the 2016 GSOO is available on AEMO's website.[4]

2.2.3 Total gas network capacity

Capacities from existing transmission and processing infrastructure and publicly-announced infrastructure augmentations are used to determine total gas network capacity to facilitate supply.

A representation of the gas model with its inputs and outputs is shown in Figure 2.

Figure 2 Model inputs and outputs



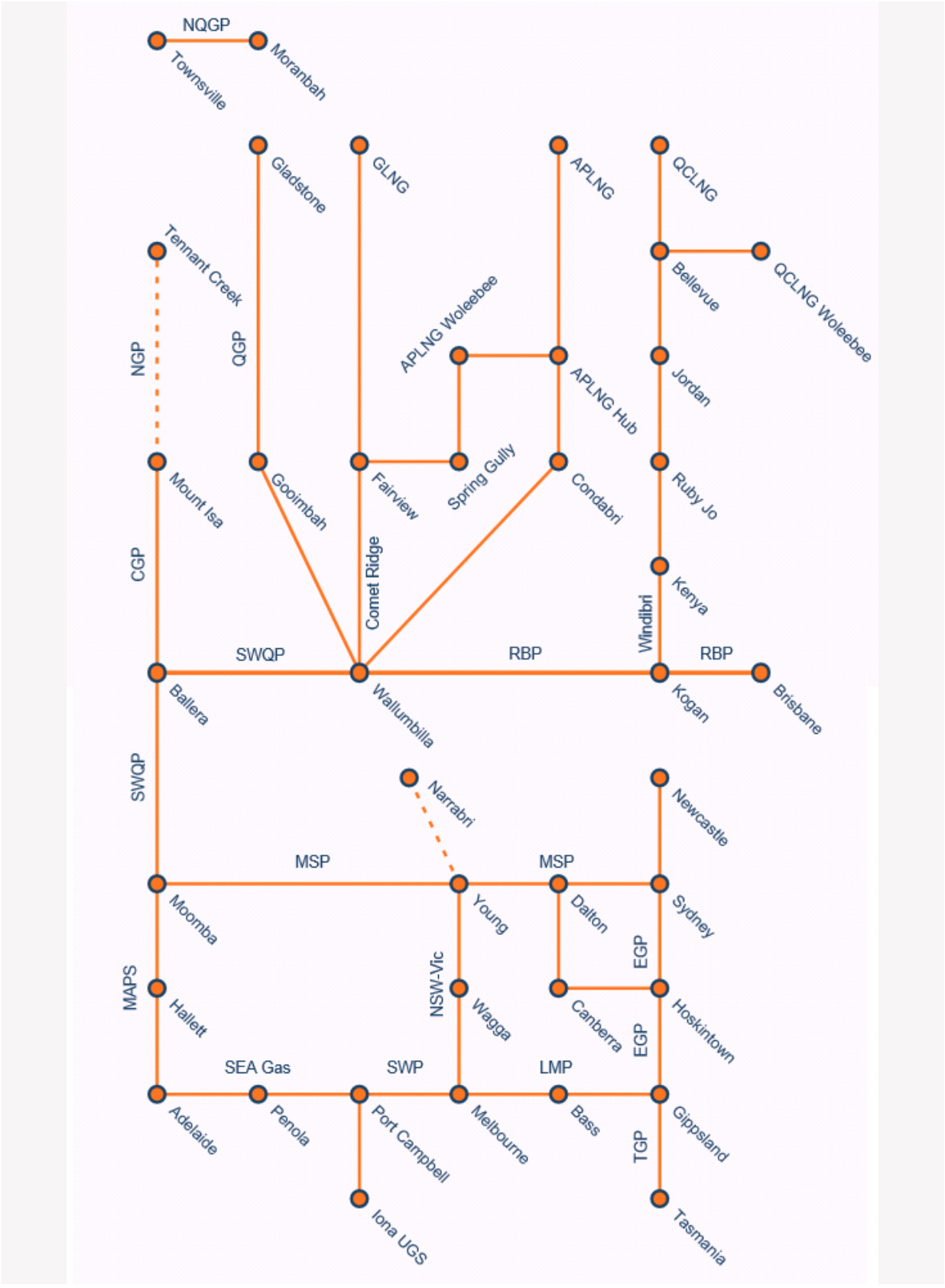
The eastern and south-eastern gas network is represented by a series of connected nodes. At each node, gas may be injected into or withdrawn from the network, or flow may be redirected.

[4] http://aemo.com.au/Gas/Planning/Gas-Statement-of-Opportunities/2016-GSOO-Supporting-Information.

Connections between nodes define paths over which gas can flow. Together, nodes and their connections define a topology. The topology used for modelling in the 2016 GSOO, shown in Figure 3, is designed to capture key features of the physical gas network.

In many cases, a connection (or series of connections) represents an actual pipeline. Pipeline transmission costs are considered in the gas model optimisation.

Figure 3 Gas model topology for 2016 GSOO



2.3 Supply contracts and annual field production limits

AEMO has improved its modelling methodology for the 2016 GSOO by including publicly-announced Gas Sales Agreements (wholesale gas 'contracts'). Contract volumes drive field deliverability in the gas model to better represent actual production.

The gas model allocates uncontracted gas based on least cost, considering gas processing costs and transmission costs.

AEMO has also used Gas Bulletin Board (GBB)[5] data to assess maximum field deliverability on an annual basis to ensure that projected annual production levels align with historical information. Where insufficient historical production information was available, AEMO has assumed that fields are capable of operating continuously at the stated maximum capacities of their processing facilities. If these fields do not deliver to rated capacities, GSOO results will vary accordingly.

2.4 Gas processing facilities

Gas production at processing facilities is determined by the gas model at a daily resolution. At each daily step, a modelled processing facility may supply gas up to its processing capacity.

Each reserve and resource has a separate production cost. This cost is applied for every unit of gas produced by the associated processing facility.

The Ballera processing facility (included in the 2015 GSOO) has not been included in the 2016 GSOO. Any gas processed at Ballera must enter the gas network via the Moomba processing facility, so including both facilities in the GSOO model would result in duplication of capacity.

Each processing facility may be associated with one or more fields. In the gas model, a field is any defined accumulation of gas with a specific uniform extraction cost. A modelled field may correspond to:

- A real-world field (for example, Minerva or Longtom).
- An aggregation of fields (for example, the Casino, Henry and Netherby fields are represented by a single field in the gas model).

2.5 Storage

The gas model optimises gas storage operation on the assumption that there is a unit cost for both injection into and withdrawal from a storage facility. The injection and withdrawal behaviour of each storage facility is optimised to meet local peak demand fluctuations at least cost.

The gas model also aims to replenish annual storage inventory to ensure that storage levels at the beginning of each year are the same.

[5] The GBB (www.gbb.aemo.com.au) provides information on major interconnected gas processing facilities, gas transmission pipelines, gas storage facilities, and demand centres in eastern and south-eastern Australia.

2.6 Demand

2.6.1 Demand prioritisation

Three classes of gas demand (as forecast in the NGFR) are defined in the gas model, each assigned a value of customer reliability (VCR). The VCR determines which class of demand is supplied first.[6]

In the 2016 GSOO, gas demand was supplied in the following order:

1. LNG export demand.
2. Residential, commercial and industrial demand.
3. GPG demand.

Due to this ordering, GPG was the first class of demand to be displaced by a potential shortfall.

For more information about the development of each class of demand and the key assumptions used, refer to the *2015 NGFR Forecasting Methodology Information Paper*.[7]

2.6.2 Daily demand profile development

AEMO developed a daily demand profile for each residential, commercial and industrial demand area, each gas-powered generator, and each LNG export project.

Residential, commercial and industrial demand

AEMO developed a daily reference profile, using historical data from either the Gas Bulletin Board, Victorian Declared Transmission System data (for Victorian demand only), or flow data provided by pipeline operators (where available). The reference data was based on flows observed in 2010, selected as a typical year from analysis of historical flows over the range of available data, and consistent with AEMO's 2015 electricity planning modelling.

The daily reference profile was then applied to annual consumption and maximum demand forecasts for the 20-year outlook period. This produced 20 years of daily demand for each residential, commercial and industrial demand area.

GPG demand

AEMO used electricity model simulations to produce hourly GPG generation data for the 20-year outlook period. AEMO combined this hourly generation data with estimates of the GPG heat rates, to develop gas consumption values for each GPG in each hour of the outlook period.

LNG export demand

AEMO divided the (monthly or six-monthly) data, sourced via the 2015 NGFR, into daily equivalents to determine average daily demand profiles.

2.6.3 Transmission losses

The GSOO also considered gas losses along the transmission network in addition to NGFR demand. This accounted for up to 17 PJ each year.

[6] Unlike VCR values in AEMO's electricity modelling, the gas model's VCR values are not determined by consultation with stakeholders, because the VCR is not used to provide a valuation of augmentation proposals. Instead, the gas model VCR values are merely large numbers that ensure demand is supplied to the capacity of the system before a potential shortfall is reported, and ordered to allow prioritisation of some classes of demand over others.

[7] AEMO. *2015 National Gas Forecasting Report – Forecasting Methodology Information Paper*. December 2015. Available: http://aemo.com.au/Gas/Planning/Forecasting/~/media/Files/Gas/Planning/Reports/NGFR/2015/2015%20National%20Gas%20Forecasting%20Report%20Methodology%20Information%20Paper.ashx.

CHAPTER 3. INFRASTRUCTURE CHANGES FROM 2015

The 2016 GSOO reflects three notable pipeline capacity increases since the 2015 GSOO, shown in Table 3.

Table 3 Pipeline upgrade summary – 2016 GSOO compared to 2015 GSOO

Pipeline	New capacity (TJ/d)	Increase (TJ/d)
Eastern Gas Pipeline	358 (winter capacity) 351 (rest of year)	60
VIC–NSW Interconnect	148 (northern flow)	30
Wallumbilla to Gladstone Pipeline (previously QCLNG pipeline)	1,530	120

Similarly, processing facility capacity has been reassessed since the 2015 GSOO. Table 4 shows facilities where new capacity has been installed, capacity has been upgraded, or existing capacity has been removed or downgraded.

Table 4 Changes to processing facility capacity – 2016 GSOO compared to 2015 GSOO

Processing facility	New capacity (TJ/d)	Increase/decrease (TJ/d)
Berwyndale South	140	-4
Fairview	580	+28
Iona	550	+50
Ironbark	50	+50
Jordan	450	+150
Longford	1175	+30
Minerva	65	-16
Moomba	375	-15
Orana	195	+25
Roma Hub	282	+137
Woleebee Creek	450	+150
Net increase		**+585**

MEASURES AND ABBREVIATIONS

Units of measure

Abbreviation	Unit of measure
PJ	Petajoule
TJ	Terajoule

Abbreviations

Abbreviation	Expanded name
AEMO	Australian Energy Market Operator
APLNG	Australia Pacific LNG
CGP	Carpentaria Gas Pipeline
EGP	Eastern Gas Pipeline
GBB	Gas Bulletin Board
GLNG	Gladstone LNG
GPG	Gas-powered generation
GSOO	Gas Statement of Opportunities
LMP	Longford to Melbourne Pipeline
LNG	Liquefied Natural Gas
MAPS	Moomba–Adelaide Pipeline System
MSP	Moomba–Sydney Pipeline
NGP	Northern Gas Pipeline
NQGP	North Queensland Gas Pipeline
QCLNG	Queensland Curtis LNG
QGP	Queensland Gas Pipeline
RBP	Roma–Brisbane Pipeline
SEA Gas	South East Australia Gas Pipeline
SWP	South West Pipeline
SWQP	South West Queensland Pipeline
TGP	Tasmanian Gas Pipeline

GLOSSARY

These terms are used in the *2016 GSOO Methodology Document*.

Term	Definition
annual consumption	Gas consumption reported for a given year.
contingent resources	Gas discoveries that are not yet commercially viable.
demand	Capacity or gas flow on an hourly or daily basis.
Gas Bulletin Board (GBB)	A website **(**www.gbb.aemo.com.au**)** managed by AEMO that provides information on major interconnected gas processing facilities, gas transmission pipelines, gas storage facilities, and demand centres in eastern and south-eastern Australia. Also known as the Natural Gas Services Bulletin Board or the Bulletin Board.
gas powered generation (GPG)	Where electricity is generated from gas turbines (combined cycle gas turbine (CCGT) or open cycle gas turbine (OCGT)).
liquefied natural gas (LNG)	Natural gas that has been converted into liquid form for ease of storage or transport.
maximum demand	The highest daily demand occurring during the year. This can include residential and commercial demand, industrial demand, GPG demand, or distribution losses. Unless otherwise specified, maximum demand includes transmission losses.
production	In the context of defining gas reserves, gas that has already been recovered and produced.
prospective resources	Potentially recoverable gas from highly uncertain, undiscovered accumulations.
reserves	Gas resources that are considered to be commercially recoverable and have been approved or justified for commercial development.
resources	See contingent resources and prospective resources.