CORE ENERGY GROUP

AEMO | Gas Price Consultancy

August 2015

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General Definitions

Acronyms

AEMO	Australian Energy Market Operator
AUD	Australian dollars
bbl	Barrel
CBJV	Cooper Basin Joint Venture
CCGT	Combined Cycle Gas Turbine
CORE	Core Energy Group
CPI	Consumer Price Index
CSG	Coal Seam Gas
EGP	Eastern Gas Pipeline
GBJV	Gippsland Basin Joint Venture
GJ	Gigajoules
GJ	Gigajoule
GPG	Gas Powered Generation
LHS	Left Hand Side
LMP	Longford Melbourne Pipeline
LNG	Liquefied Natural Gas
MAP	Moomba Adelaide Pipeline
MDQ	Maximum Daily Quantity
MSP	Moomba Sydney Pipeline
NEM	National Electricity Market
NGFR	National Gas Forecasting Report
NSW	New South Wales
NVI	NSW Victoria Interconnect
OCGT	Open Cycle Gas Turbine
QGP	Queensland Gas Pipeline
R&C	Residential and Commercial
RBP	Roma Brisbane Pipeline
RHS	Right Hand Side
SEA Gas	South East Australian Gas Pipeline
SWP	South West Pipeline
SWQP	South West Queensland Pipeline
TGP	Tasmania Gas Pipeline
TIPS	Torrens Island Power Station
USD	US dollars

Report Convention

Author	This Report has been prepared by Core Energy Group Pty Limited, henceforth referred to as 'CORE'.
Year References	All references to years that appear in the report are to fiscal years.

Frequently Used Terms

Linepack	The pressurised volume of gas stored in the pipeline system. Essential to enable gas transportation through the pipeline network throughout each day and required as a buffer for within-day supply/demand balancing.
Gas Powered Generation (GPG)	A gas market demand segment that comprises gas-fired power stations. Gas is delivered via transmission pipeline before being combusted to drive a gas turbine in order to generate electricity.
Residential & Commercial	A gas market demand segment that comprises households and businesses with connections to a gas distribution network.
Delivered Price	The price of gas at the delivery point on a transmission pipeline to a generator or gas distribution offtake point. Note that all prices are quoted in real 2015 terms.

1. Introduction

1.1. Scope of Report

The Australian Energy Market Operator ("**AEMO**") has engaged Core Energy Group ("**CORE**") to provide historical estimates and annual projections of wholesale delivered gas prices for the financial year period from 2003 to 2041 as an input into the 2016 National Gas Forecasting process. The delivered prices include:

- delivered wholesale gas price for residential and commercial ("**R&C**") demand nodes, and
- delivered wholesale gas price for gas powered generators ("**GPG**") in the National Electricity Market ("**NEM**").

1.2. Report Structure

An outline of the main body of this Report is presented below. This report should be read in conjunction with the related data book.

Executive Summary

The executive summary provides a concise overview of the assessment and methodology undertaken by CORE and highlights CORE's conclusion regarding:

- GPG delivered wholesale gas price by generator
- Retail delivered wholesale price by major R&C demand node

Methodology

This section outlines the methodology CORE adopted to arrive at estimates of historical and forecast prices.

Delivered Price | Historical and Forecast

This section summarises analysis of historical and forecast prices using CORE's proprietary pricing model.

Risks and Uncertainties

This section summarises the key uncertainties relating to the price estimates presented.

Conclusion

A concise conclusion resulting from CORE's analysis.

2. Executive Summary

2.1. Introduction

CORE has developed estimates of delivered wholesale gas prices for the major R&C demand nodes as well as GPG's connected to the NEM. Figure 2.1 presents an illustration of the eastern Australian gas market, highlighting the location of the relevant GPG and R&C demand centres, for which delivered wholesale prices are derived.

Figure 2.1 Location of GPG and R&C Demand Nodes

Source: Core Energy Group, 2015

2.2. Methodology

CORE has adopted a bottom-up approach to derive an estimate of historical and forecast delivered wholesale prices. Three major price components have been separately estimated and aggregated to derive the delivered wholesale price:

- Wholesale contract price/cost
  - The cost of gas at the inlet to the transmission line in accordance with the assumed gas sale contract price, based on a proprietary gas contract data set maintained by CORE.
- Transmission cost
  - The transmission pipeline tariffs incurred when gas is transported from the supply hub to either the GPG plant or demand node, in accordance with an assumed gas transport agreement, based on a proprietary gas transportation tariff data set maintained by CORE.
- Peak supply cost
  - The cost of peak supply service which does not form part of the wholesale contract cost/price, but incurred as an additional cost, based on a peak supply data set maintained by CORE.

For further detail on CORE's methodology and assumptions see Section 3.

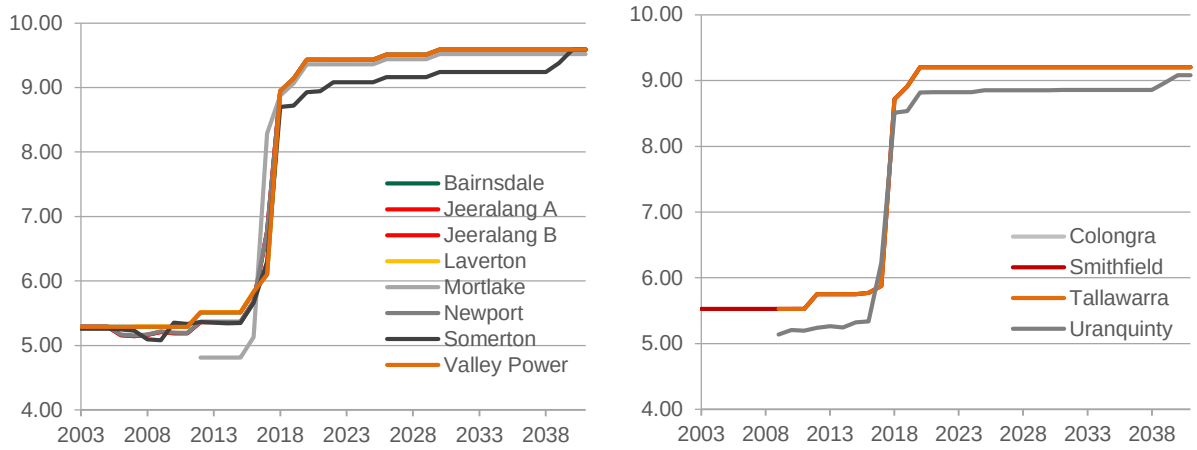
2.3. GPG Delivered Wholesale Price

CORE expects the majority of GPG delivered prices to increase from historically observed levels below AUD6/GJ to a level which is in excess of AUD8-9/GJ from 2020 onwards with some exceptions in Queensland which is discussed in Section 4 below.

- The increase is largely attributed to CORE's expectation of contract price increases between 2016 and 2018, including some oil price linkage.
- CORE assumes that the wholesale contracts for Townsville and Yarwun Power will not be reset until the end of the contract term.
- CORE assumes that prices remain relatively flat in real terms from 2018/19.

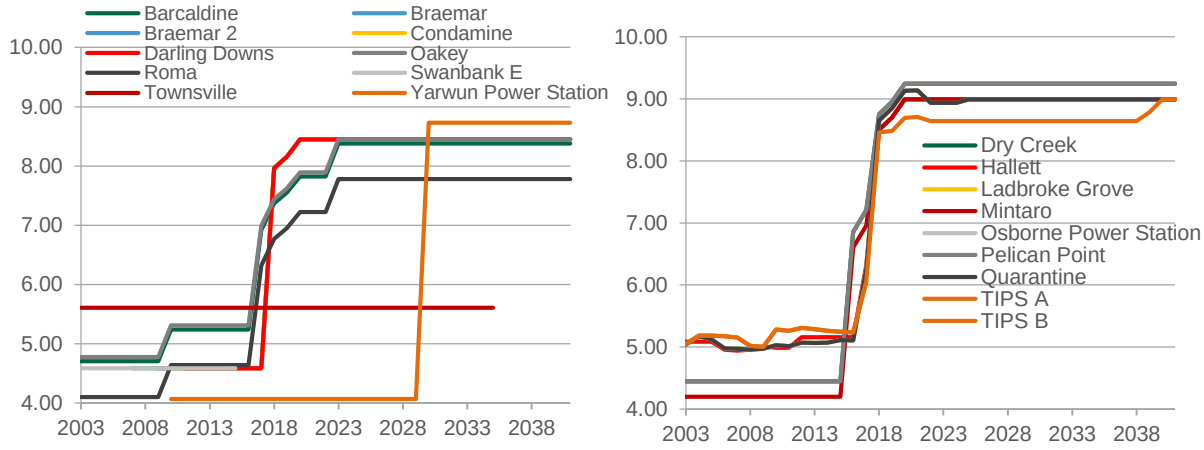
Figures 2.2 to 2.4 present the movement in GPG delivered prices for each generator by state, under the reference scenario. High and Low scenarios are presented in the body of this report.

Figure 2.2 Victoria (LHS) and New South Wales (RHS) GPG Gas Price | Reference Case | AUD/GJ real 2015



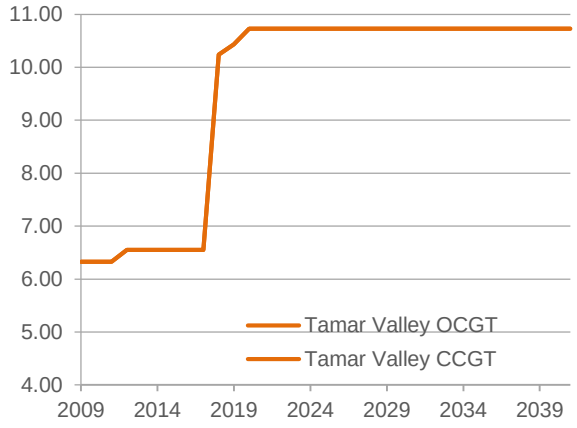
Note in Victoria, the price paths for Bairnsdale, Jeeralang A and B, Laverton, and Newport are overlaid by the Valley Power price path
Note in New South Wales, price paths for Colongra and Smithfield are overlaid by the Tallawarra price path.

Figure 2.3 Queensland (LHS) and South Australia (RHS) GPG Gas Price | Reference Case | AUD/GJ real 2015



Note that price paths for Braemar, Braemar 2, and Condamine is overlaid by Darling Downs price path.
Note the price paths for Ladbroke Grove and Osborne Power Station are overlaid by the Quarantine price path, while the Dry Creek price path is overlaid by the Pelican Point price path.

Figure 2.4 Tasmania GPG Gas Price | Reference Case | AUD/GJ real 2015



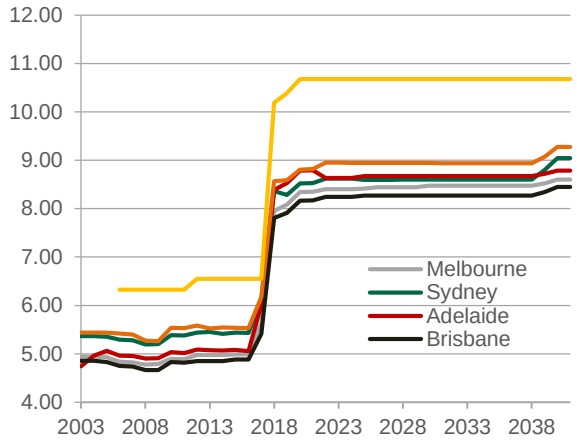
Source: Core Energy Group, 2015

2.4. R&C Delivered Wholesale Price

CORE expects that the delivered price to the majority of the R&C demand nodes will increase from below AUD5.60/GJ historically, to above AUD8/GJ from 2020 onwards. This is mainly driven by assumed price increases under wholesale contracts which was referred to in the section above. Some price increase is also expected to result from an increase in the price of peak supply service and an increase in pipeline tariffs to Tasmania.

Figure 2.5 presents the movement in retail delivered price for major R&C demand nodes under the reference scenario.

Figure 2.5 R&C Delivered Price Retail Gas Price | Reference Case | AUD/GJ



Source: Core Energy Group, 2015

3. Methodology

CORE has considered the following cost elements in the delivered price:

- Wholesale contract cost
  - The cost of gas at the inlet to the transmission line in accordance with the assumed gas sale contract price, based on a proprietary gas contract data set maintained by CORE.
- Transmission cost
  - The transmission pipeline tariffs incurred when gas is transported from the supply hub to either the GPG plant or demand node, in accordance with an assumed gas transport agreement, based on a proprietary gas transportation tariff data set maintained by CORE.
- Peak supply cost
  - The cost of peak supply service which does not form part of the wholesale contract cost/price, but incurred as an additional cost, based on a peak supply data set maintained by CORE.

It should be noted that this price represents the cost of gas to the retailer or GPG owner, not the marginal cost or opportunity cost, which may influence bidding behaviour. Costs are expressed in 2015 real terms unless stated otherwise.

The following sections provide more detail on CORE's approach to estimating the cost components.

3.1. Wholesale Contract Cost

Internally, CORE maintains a Gas Contract Database of existing eastern Australian gas sales agreements. The database includes estimated prices which have been incorporated into estimates of historical and projected wholesale gas costs. High and low case scenarios were also developed. The approach is as follows:

1. Estimate a portfolio wide gas cost for major retailers including AGL, Origin Energy and EnergyAustralia's using a contract volume-weighted method. CORE assumes historical gas costs (adjusted for CPI) prevail until a price an assumed price review or a contract renewal occurs.
2. CORE assumes that the Cooper Basin Joint Venture ("**CBJV**") and Otway basin contracts prices are linked to oil price by 2017, and remaining Gippsland Basin Joint Venture ("**GBJV**") contracts by 2018. The following are CORE's assumptions to derive oil-linked prices:

Table 3.1 Brent Oil Price forecast

Year	Brent Oil USD/bbl
2015	60
2016	65
2017	70
2018	75
2019	77
2020+	80

Source: RBA, 2015

- AUD to USD exchange rate of 0.72 to 1.
- Gas price as a percentage of oil price, see Table 3.2

Table 3.2 Gas price as a percentage of oil price

Year	Low	Reference	High
GBJV/Otway	6.5%	7.0%	8.0%
CBJV	6.0%	6.5%	7.0%

3. Estimate wholesale component of gas costs for major R&C demand nodes using a weighted approach based on retailer market share at a particular demand node.

4. Determine the wholesale component of GPG gas cost based on the weighted average portfolio cost of owner of the generator unit. For example, CORE assumes wholesale cost for AGL-owned Torrens Island Power Station ("**TIPS**") is the AGL portfolio gas cost. The exceptions to this method are as follows:

   > CORE assumes that the wholesale gas cost for Queensland generators is the price under Surat Bowen contracts.

   > The GBJV wholesale contract price is assigned to Colongra, Smithfield and EnergyAustralia-owned Tallawarra in New South Wales ("**NSW**").

3.2. Transmission Cost

CORE's Gas Infrastructure Database also contains information relating to existing transmission pipelines including estimated transmission tariffs. CORE's approach to estimating transmission cost for R&C demand nodes and GPG is as follows:

1. For R&C demand centres the transmission cost has been derived on a weighted average basis by estimating the relative utilisation of pipelines connecting each state. For example, gas is delivered to South Australia via both the South East Australian ("**SEA**") Gas Pipeline and Moomba Adelaide Pipeline ("**MAP**"), therefore transmission costs in South Australia are weighted based on the relative pipeline flows. Note that Brisbane transmission costs only come from Roma Brisbane Pipeline ("**RBP**") tariffs.

2. The transmission cost for power stations is based on the main pipeline link. For example, Bairnsdale, Jeeralang A and B and Valley Power are situated on the Longford Melbourne Pipeline ("**LMP**"), and the associated transmission cost is assumed to be just the LMP transmission tariff.

3. Transmission cost for minor pipelines is based on CORE estimates.

4. CORE has used the following indicative tariffs for major transmission lines:

Table 3.3 Indicative Transmission Tariffs | AUD/GJ

Pipeline	Indicative Tariff
SWP	0.30
LMP	0.27
MSP	0.95
EGP	1.23
MAP	0.56
SEA Gas Pipeline	0.81
RBP	0.67
QGP	0.95
MSP	0.95
EGP	1.23
TGP	2.10

Source: Core Energy Group & Company Transmission Tariffs, 2015

3.3. Peak Supply Cost

CORE's approach to estimating peak supply costs is as follows:

1. Determine the R&C and GPG peak requirements in each state.
2. Determine the utilisation of peak supply sources in each state.
3. Determine the weighted average cost of peak supply in each state.
4. CORE assumes that any variability in daily demand is met by contracted maximum daily quantity ("**MDQ**") in Queensland and Tasmania, therefore peak supply cost in both these states is negligible for R&C and GPG.
5. CORE relies on the following indicative tariffs to estimate peak supply costs

Table 3.4 Indicative Peak Supply Source Tariffs | AUD/GJ

Peak Supply Source	Low	Reference	High
Underground Storage	5.00	5.00 (2015) 5.50 (2017)	5.00 (2015) 6.00 (2017)
Contract flexibility	2.50	3.00	3.50
LNG - Dandenong	25.00	30.00	35
LNG - Newcastle	16.00	17.50	19

Source: Core Energy Group, 2015

4. Delivered Price | Historical and Forecast

4.1. Introduction

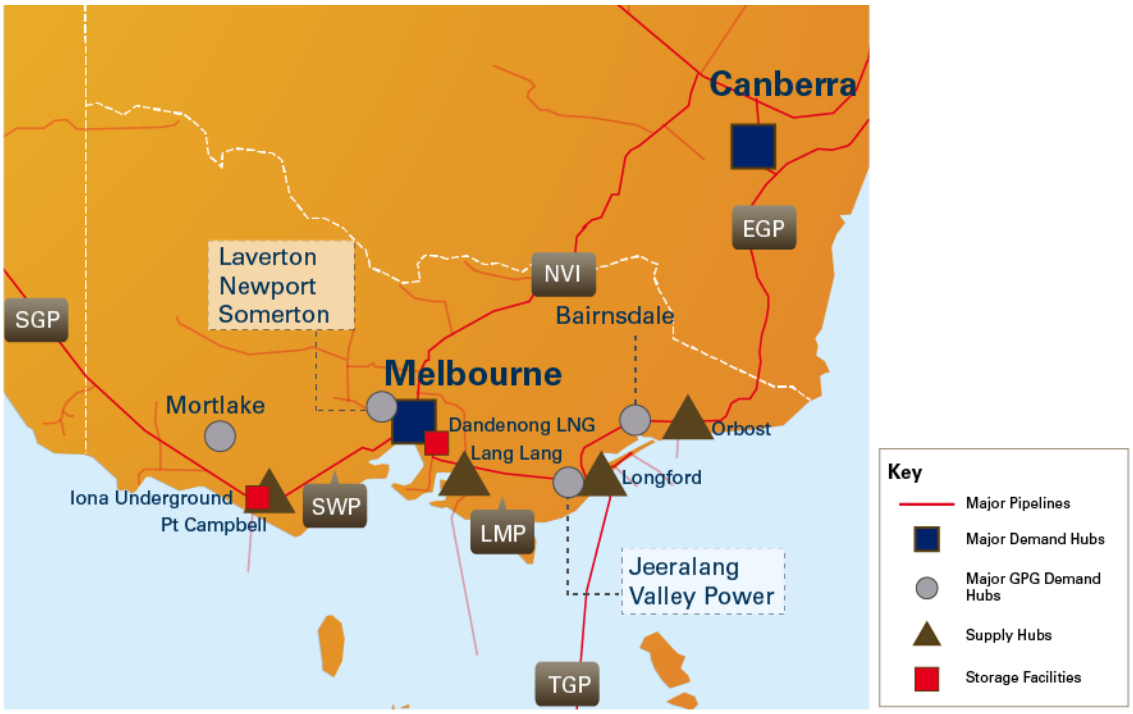
Historical and projected delivered wholesale gas price paths for each generator and demand node by State is provided in the following paragraphs.

4.2. GPG Delivered Wholesale Price

4.2.1. Victoria

The location of Victorian GPG's is presented in the map in Figure 4.1

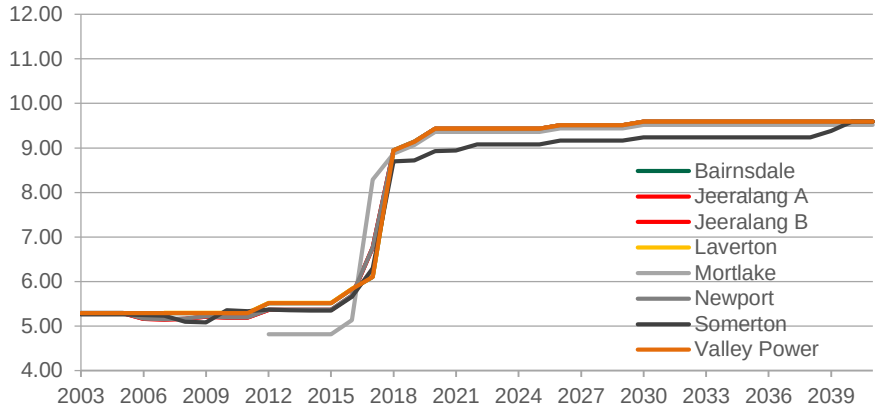
Figure 4.1 Map of Victorian GPG



Source: Core Energy Group, 2015

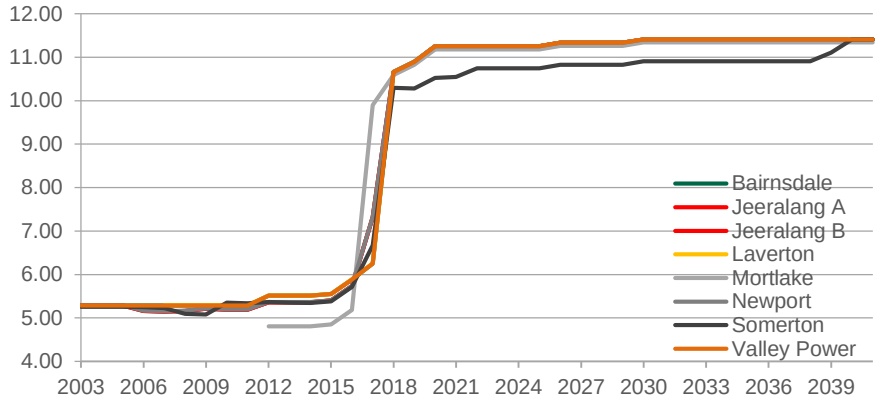
Figures 4.2 to 4.4 show historical GPG delivered prices from 2003 to 2015 as well as delivered price forecasts from 2016 to 2041. The figures show a reference, high and low case scenario for future delivered prices.

Figure 4.2 Victoria GPG Gas Price Forecasts | Reference Case | AUD/GJ real 2015



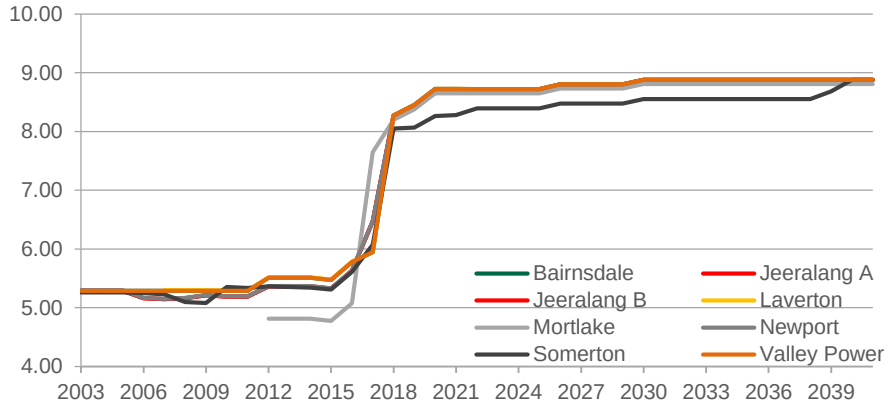
Note the price paths for Bairnsdale, Jeeralang A and B, Laverton, and Newport are overlaid by the Valley Power price path.

Figure 4.3 Victoria GPG Gas Price Forecasts | High Case | AUD/GJ real 2015



Note the price paths for Bairnsdale, Jeeralang A and B, Laverton, and Newport are overlaid by the Valley Power price path.

Figure 4.4 Victoria GPG Gas Price Forecasts | Low Case | AUD/GJ real 2015



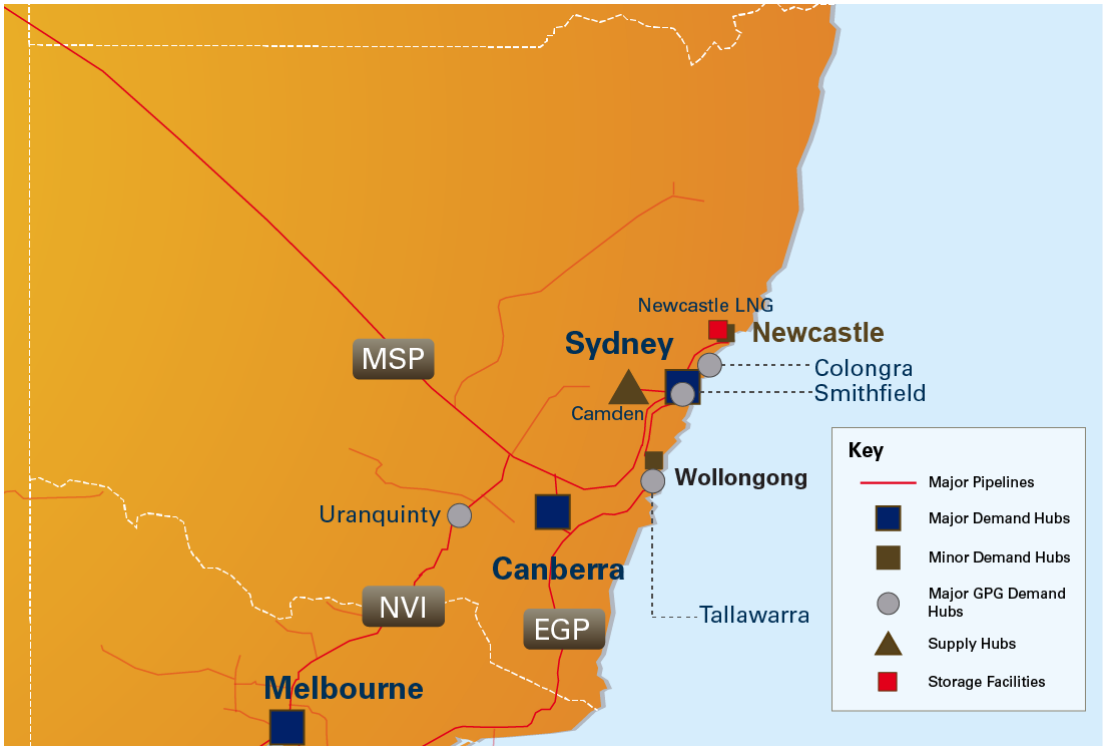
Note the price paths for Bairnsdale, Jeeralang A and B, Laverton, and Newport are overlaid by the Valley Power price path.

Source: Core Energy Group, 2015

4.2.2. New South Wales

Figure 4.5 presents the location of GPG's in New South Wales, relative to supply hubs, transmission pipelines and storage facilities.

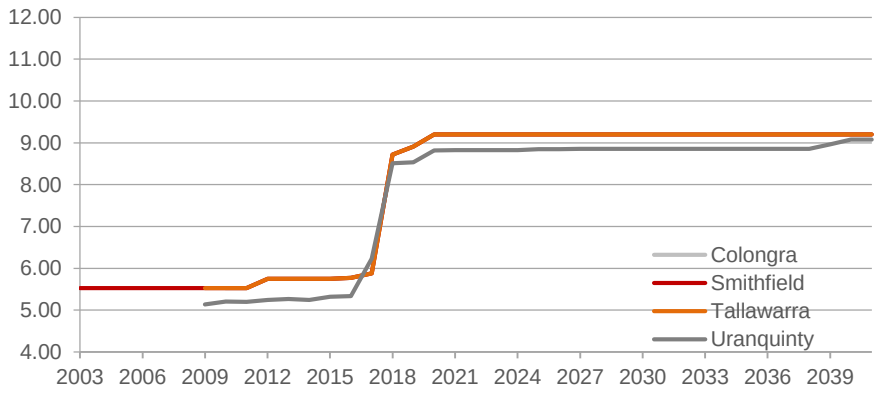
Figure 4.5 Map of New South Wales GPG



Source: Core Energy Group, 2015

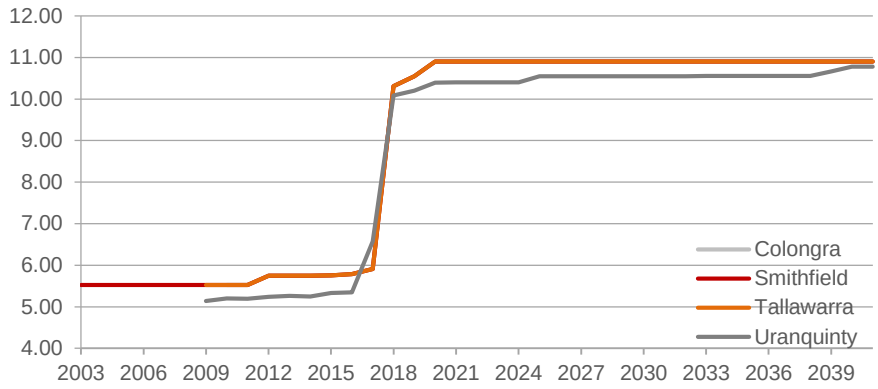
Figures 4.6 to 4.8 show historical GPG delivered prices from 2003 to 2015 as well as delivered price forecasts from 2016 to 2041.

Figure 4.6 New South Wales GPG Gas Price Forecasts | Reference Case | AUD/GJ real 2015



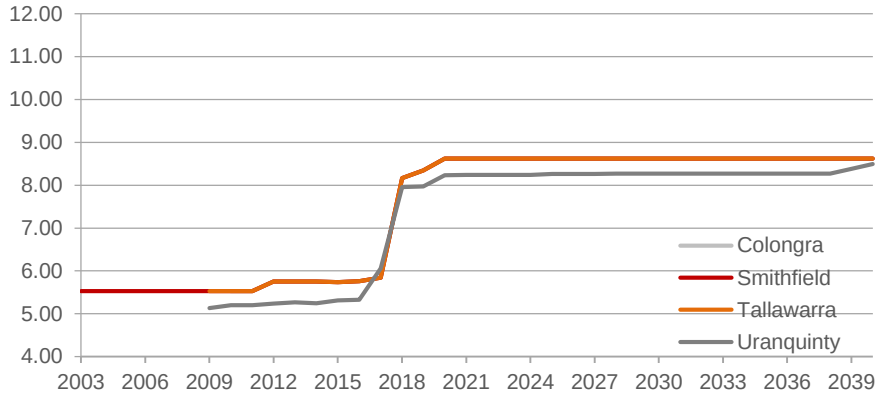
Note the price paths for Colongra and Smithfield are overlaid by the Tallawarra price path.

Figure 4.7 New South Wales GPG Gas Price Forecasts | High Case | AUD/GJ real 2015



Note the price paths for Colongra and Smithfield are overlaid by the Tallawarra price path.

Figure 4.8 New South Wales GPG Gas Price Forecasts | Low Case | AUD/GJ real 2015



Note the price paths for Colongra and Smithfield are overlaid by the Tallawarra price path.

Source: Core Energy Group, 2015

4.2.3. South Australia

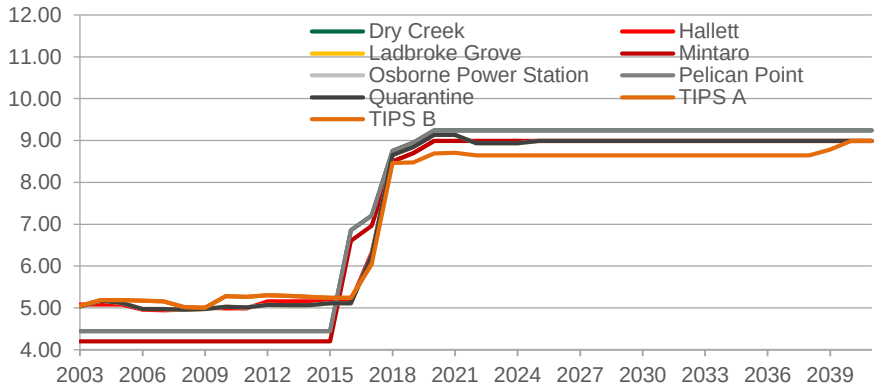
Figure 4.9 presents a summary of the location of South Australian GPG's, in relation to the major supply hubs, transmission pipelines and storage facilities.

Figure 4.9 Map of South Australian GPGs

Source: Core Energy Group, 2015

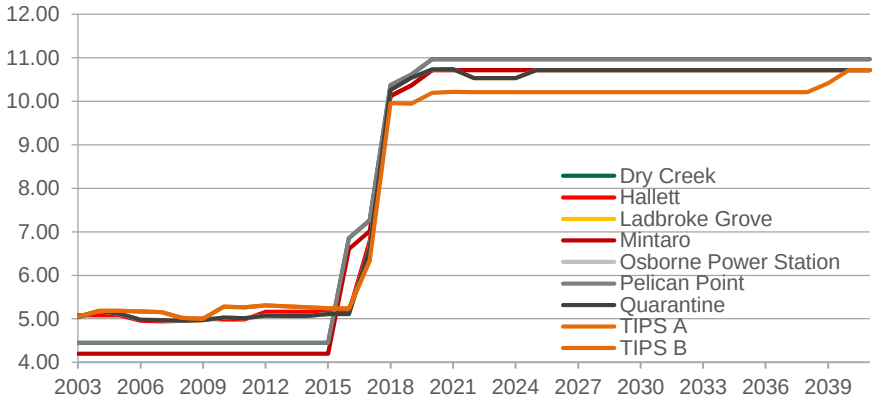
Figures 4.10 to 4.12 show historical GPG delivered prices from 2003 to 2015 as well as delivered price forecasts from 2016 to 2041.

Figure 4.10 South Australia GPG Gas Price Forecasts | Reference Case | AUD/GJ real 2015



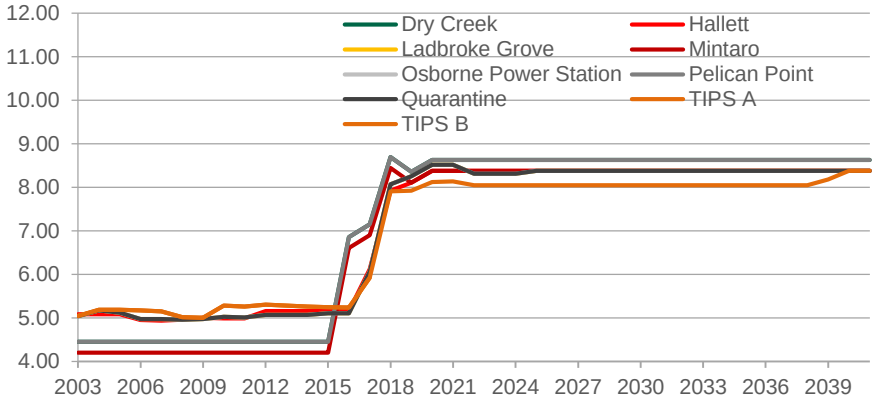
Note the price paths for Ladbroke Grove and Osborne Power Station are overlaid by the Quarantine price path, while the Dry Creek price path is overlaid by the Pelican Point price path, and Hallet price path is overlaid by Mintaro.

Figure 4.11 South Australia GPG Gas Price Forecasts | High Case | AUD/GJ real 2015



Note the price paths for Ladbroke Grove and Osborne Power Station are overlaid by the Quarantine price path, while the Dry Creek price path is overlaid by the Pelican Point price path.

Figure 4.12 South Australia GPG Gas Price Forecasts | Low Case | AUD/GJ real 2015



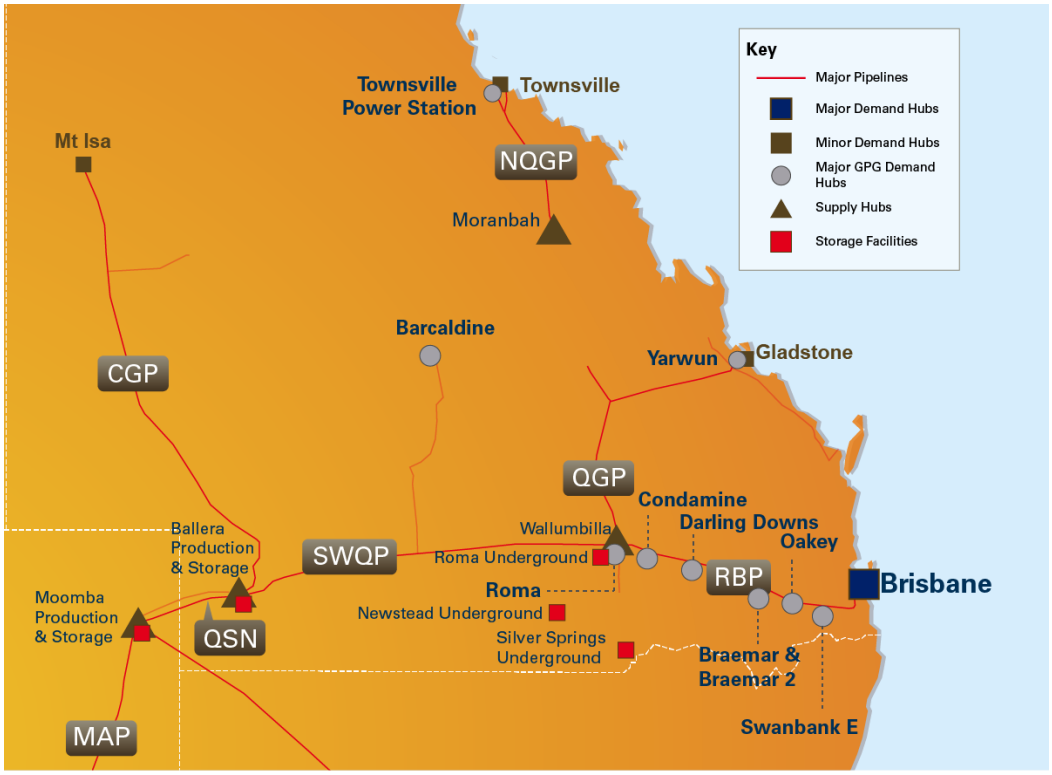
Note the price paths for Ladbroke Grove and Osborne Power Station are overlaid by the Quarantine price path, while the Dry Creek price path is overlaid by the Pelican Point price path.

Source: Core Energy Group, 2015

4.2.4. Queensland

Figure 4.13 presents the location of Queensland GPGs, relative to the supply hubs, transmission pipelines and storage facilities.

Figure 4.13 Map of Queensland GPGs

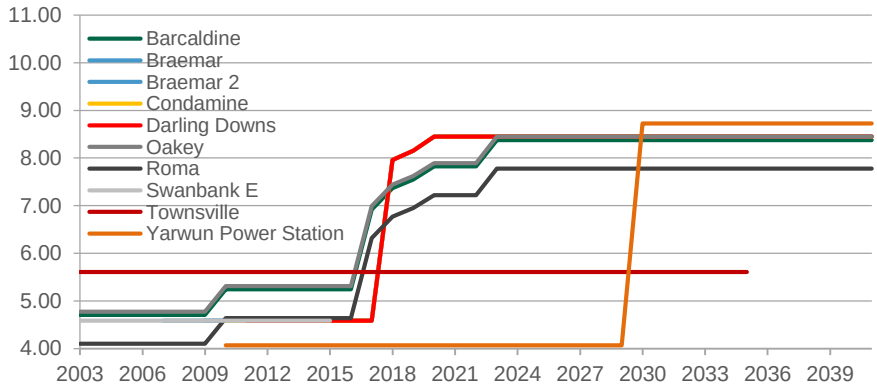


Source: Core Energy Group, 2015

Figures 4.10 to 4.12 show historical GPG delivered prices from 2003 to 2015 as well as delivered price forecasts from 2016 to 2041. The figures show a reference, high and low case scenario for future delivered prices.

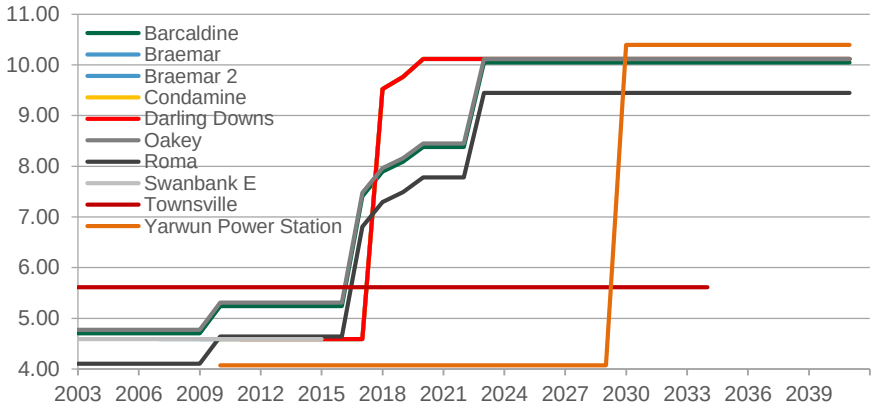
Swanbank E is assumed to close after 2015, therefore CORE has not provided a price forecast for this power station.

Figure 4.14 Queensland GPG Gas Forecasts | Reference Case | AUD/GJ real 2015



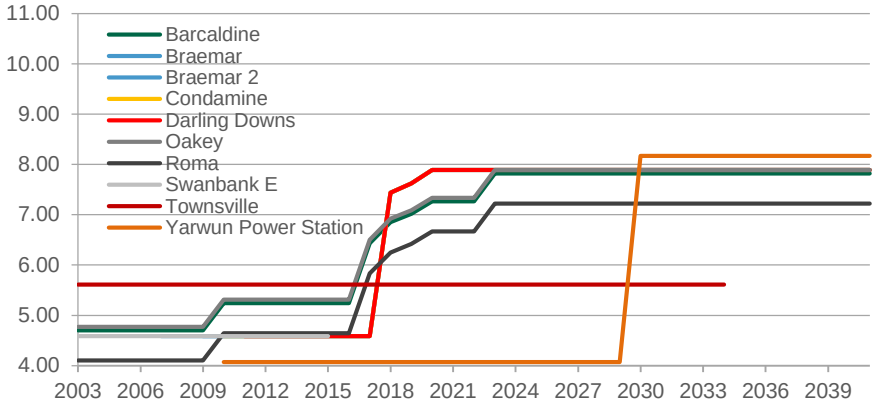
Note that price paths for Braemar, Braemar 2, and Condamine is overlaid by Darling Downs price path.

Figure 4.15 Queensland GPG Gas Price Forecasts | High Case | AUD/GJ real 2015



Note that price paths for Braemar, Braemar 2, and Condamine is overlaid by Darling Downs price path.

Figure 4.16 Queensland GPG Gas Price Forecasts | Low Case | AUD/GJ real 2015



*

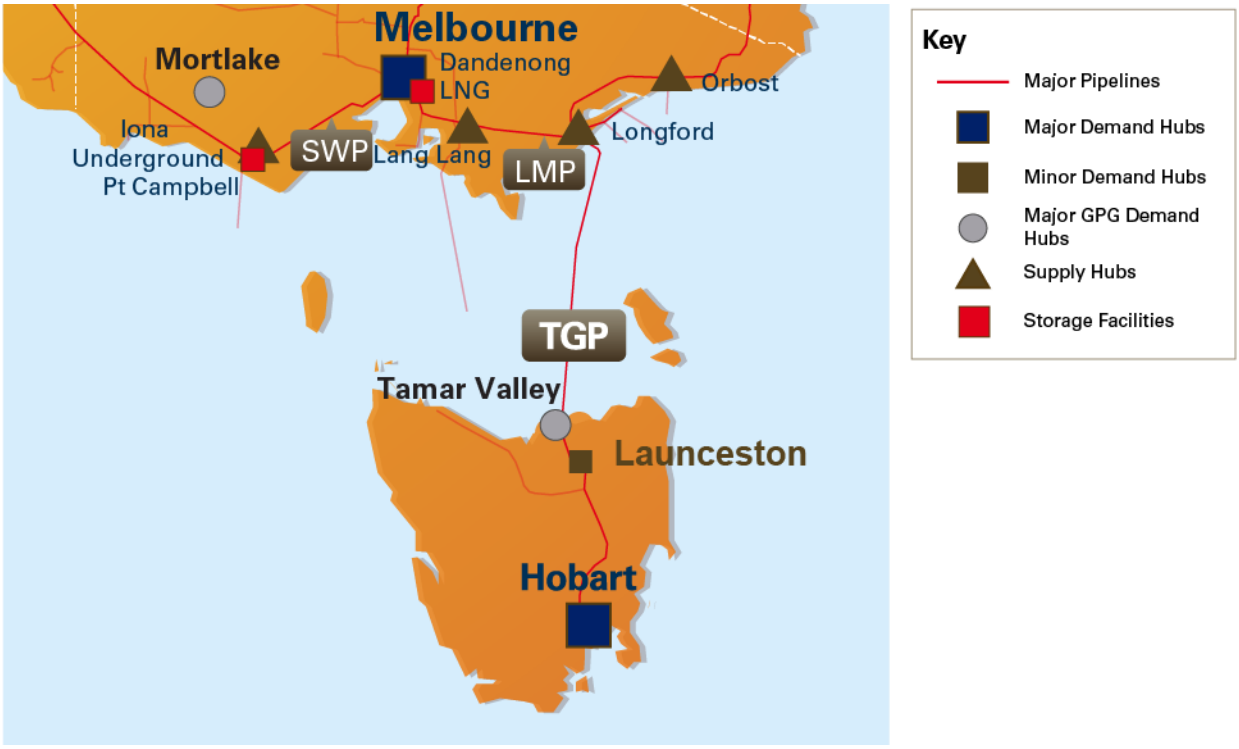
Note that price paths for Braemar, Braemar 2, and Condamine is overlaid by Darling Downs price path.

Source: Core Energy Group, 2015

4.2.5. Tasmania

The following figure presents the location of Tasmania GPGs, relative to the supply hubs, transmission pipelines and storage facilities.

Figure 4.17 Map of Tasmania GPG



Source: Core Energy Group, 2015

Figures 4.18 to 4.20 show historical GPG delivered prices from 2003 to 2015 as well as delivered price forecasts from 2016 to 2041. The figures show a reference, high and low case scenario for future delivered prices.

Figure 4.18 Tasmania GPG Gas Price Forecasts | Reference Case | AUD/GJ real 2015

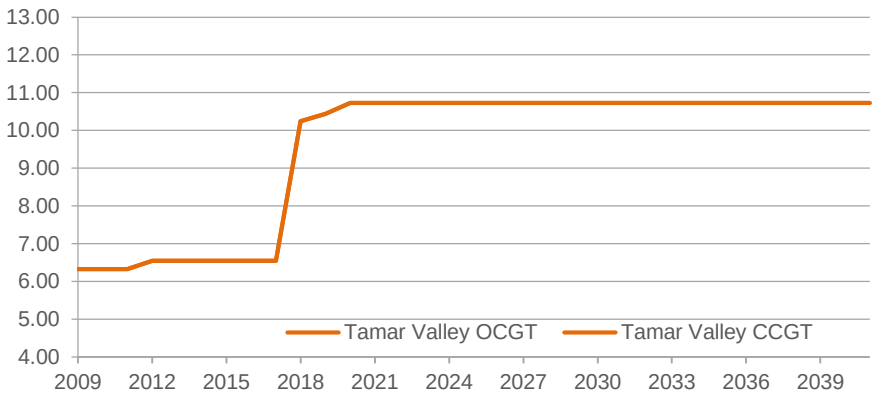


Figure 4.19 Tasmania GPG Gas Price Forecasts | High Case | AUD/GJ real 2015

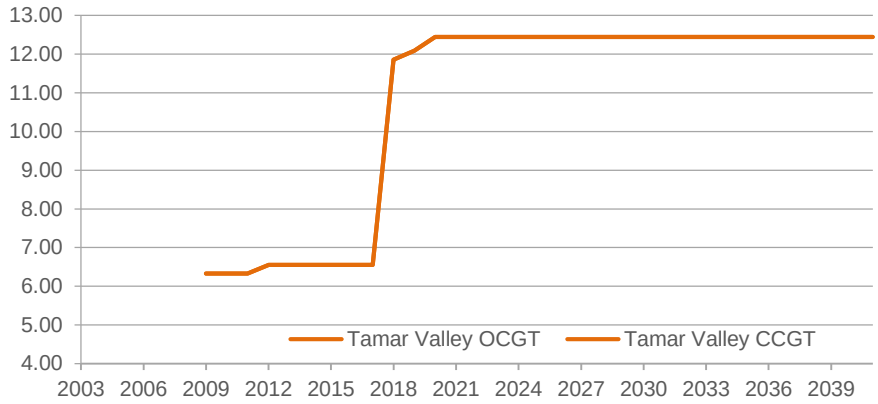
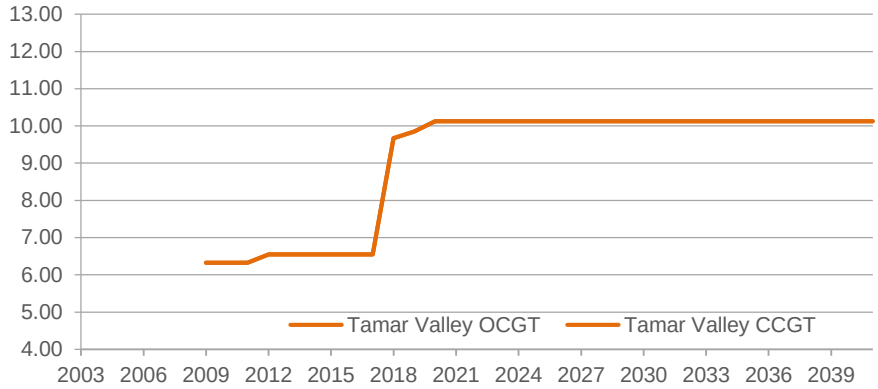


Figure 4.20 Tasmania GPG Gas Price Forecasts | Low Case | AUD/GJ real 2015



Source: Core Energy Group, 2015

4.3. Residential and Commercial Delivered Wholesale Price

Figures 4.21 to 4.23 show historical and forecast prices between 2003 and 2041 under Reference, Low and High case scenarios.

Figure 4.21 Retail Gas Price Forecast | Reference Case | AUD/GJ

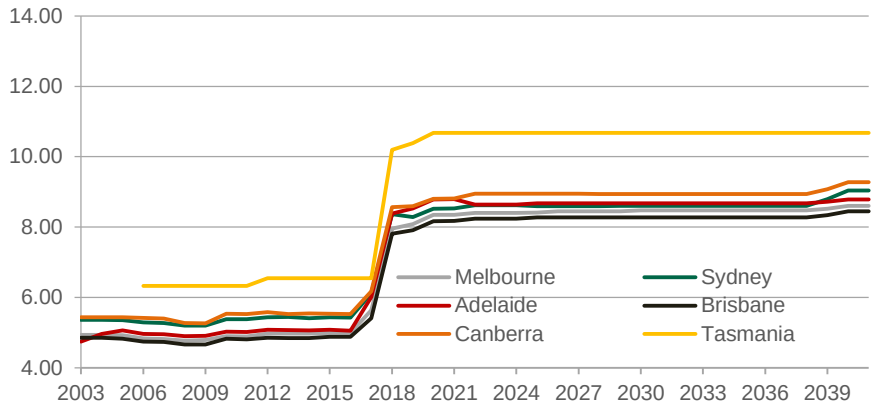


Figure 4.22 Retail Gas Price Forecast | High Case | AUD/GJ

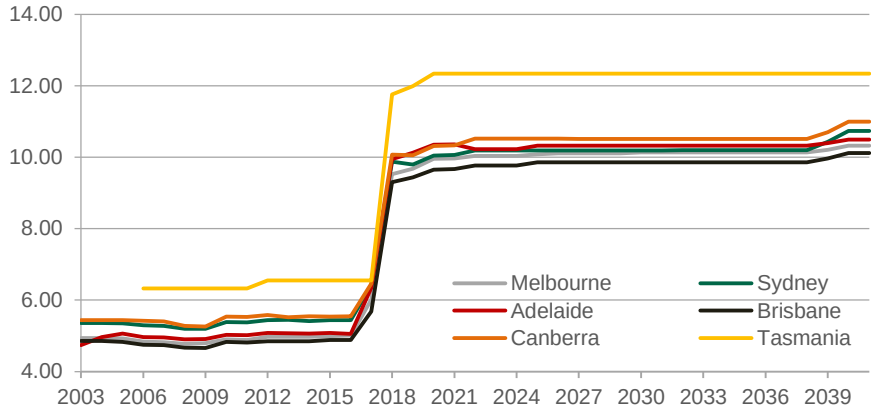
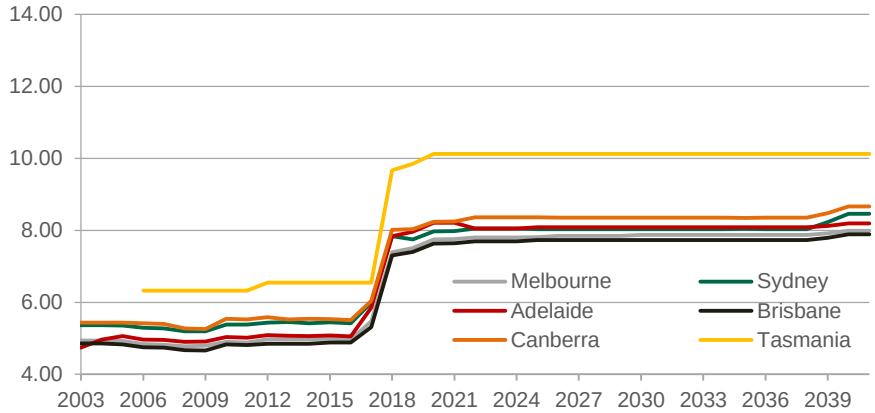


Figure 4.23 Retail Gas Price Forecast | Low Case | AUD/GJ



Source: Core Energy Group, 2015

5. Key Uncertainties

The following table provides a high level summary of the key uncertainties related to the delivered prices.

Table 5.1 Key Uncertainties

Factor	Implications on Delivered Price
Wholesale Contract Cost	
Oil Price Linkage	▪ Movement in oil price and exchange rate could materially impact future prices through contract pricing mechanisms linked to oil/JCC.
Production Cost	▪ Future cost of gas extraction, including uncertainty associated with reservoir/well performance ▪ Scope for technology advancement
Availability of Supply Source	▪ Uncertainty regarding location of future supply sources could impact cost of supply to specific centres
Transmission Cost	
Pipeline capacity reservation/ utilisation	▪ Movement in capacity contracting and utilisation impact tariffs which flow on to delivered prices
Cost of New Entrant	▪ New entrant could change competition dynamics and impact tariffs
Peak Supply Cost	
Pricing of Peak Supply Sources	▪ In an increasingly tight market with CBJV's focus on supplying the LNG market, peak supply availability in SA is likely to decline and the cost is likely to increase
Decline in Peak Demand	▪ Energy efficiency gains and penetration in renewable sources are potential downsides to peak R&C and GPG demand.
Availability of Peak Supply Sources	▪ Availability of GBJV and CBJV peak supply flexibility ▪ Availability of linepack services
Cost of New Entrant	▪ Cost of greenfield underground storage ▪ Cost of new LNG spiking facility ▪ Availability and cost of linepack service.

6. Conclusion

6.1. GPG Delivered Prices

Under a reference case, CORE expects most of GPG delivered prices to increase materially, from historically observed levels below AUD6.00/GJ to above AUD8.00/GJ from 2020 onwards, with the exception of certain Queensland generators. The increases are largely attributable to assumed gas contract price increases from 2016 to 2018, with oil price linkage.

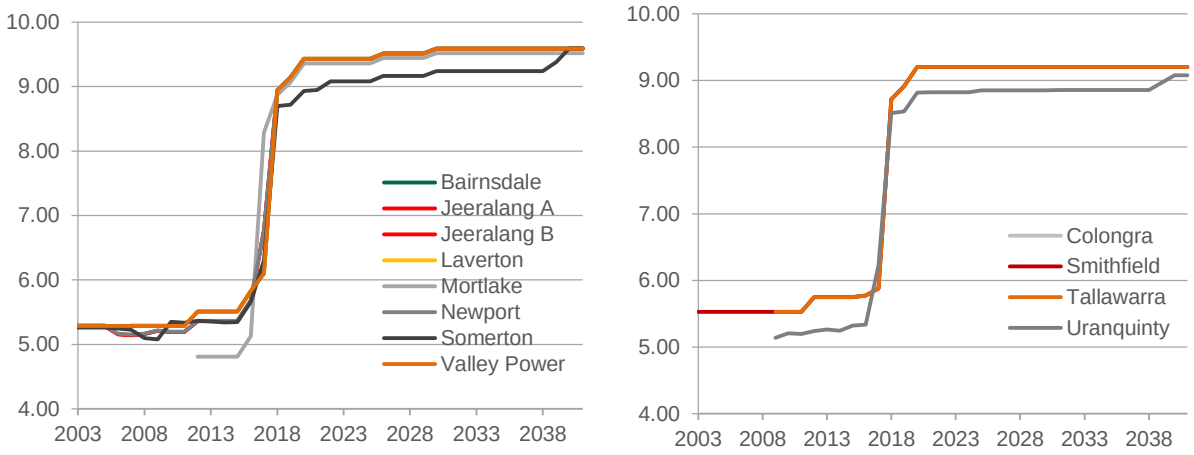
Victorian GPG gas price is expected to be above AUD9.00/GJ post 2022 under the reference scenario, driven by assumed increase in wholesale gas cost and also growing peak supply cost. In an increasingly tight peak supply market, CORE believes that cost of peak supply will increase in the future.

In Tasmania, CORE estimates the GPG gas price to increase above AUD10.00/GJ, as a result of higher wholesale gas cost and transmission cost. CORE expects the TGP transmission tariff to increase in 2018 due to lower utilisation of the pipeline.

CORE assumes that the wholesale contracts for Townsville and Yarwun Power Station do not have price reset mechanisms, other than CPI adjustment, therefore the delivered price is assumed to remain constant until the end of the contract term.

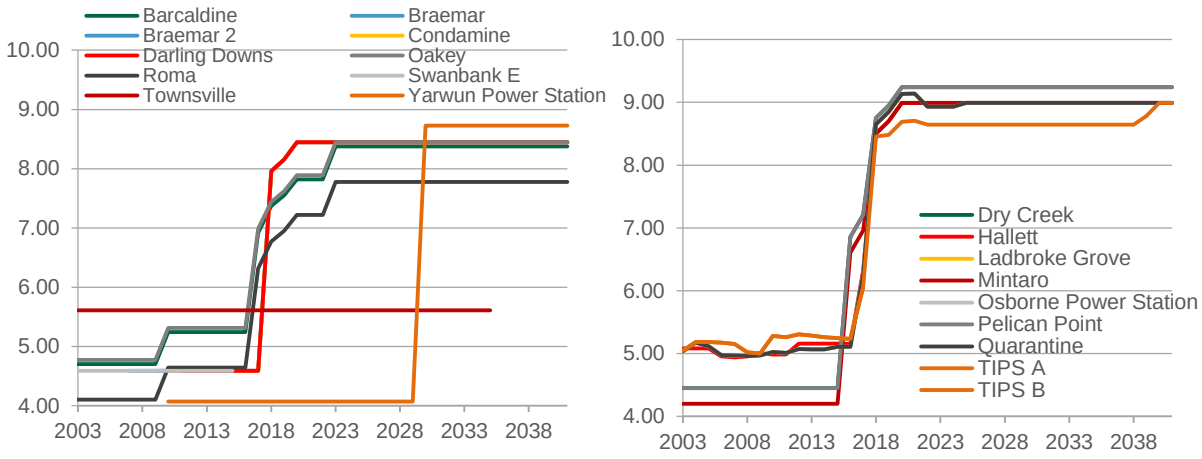
Figures 6.1 to 6.3 present the projected movement in GPG delivered prices for each generator by state, under the reference scenario.

Figure 6.1 Victoria (LHS) and New South Wales (RHS) GPG Gas Price | Reference Case | AUD/GJ real 2015



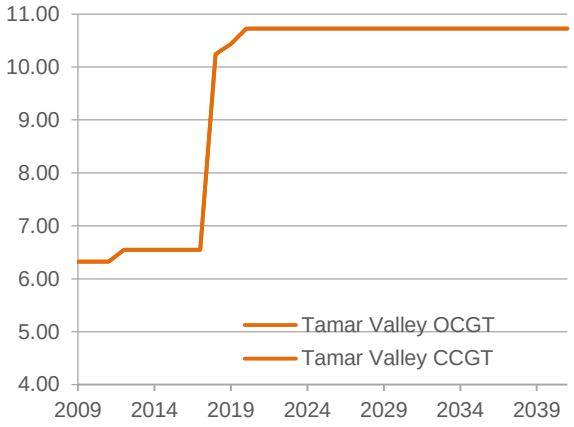
Note in Victoria, the price paths for Bairnsdale, Jeeralang A and B, Laverton, and Newport are overlaid by the Valley Power price path
Note in New South Wales, price paths for Colongra and Smithfield are overlaid by the Tallawarra price path.

Figure 6.2 Queensland (LHS) and South Australia (RHS) GPG Gas Price | Reference Case | AUD/GJ real 2015



Note that price paths for Braemar, Braemar 2, and Condamine is overlaid by Darling Downs price path.
Note the price paths for Ladbroke Grove and Osborne Power Station are overlaid by the Quarantine price path, while the Dry Creek price path is overlaid by the Pelican Point price path.

Figure 6.3 Tasmania GPG Gas Price | Reference Case | AUD/GJ real 2015



Source: Core Energy Group, 2015

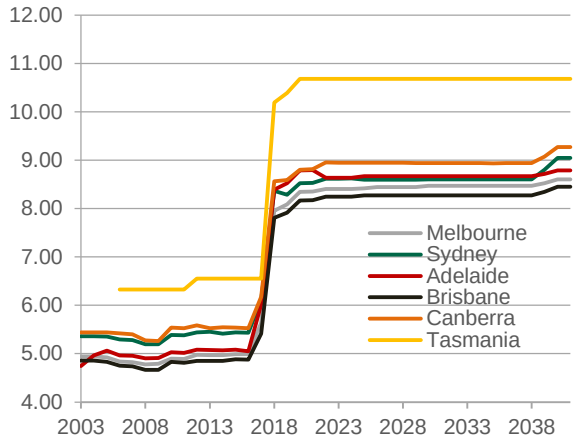
6.2. R&C Delivered Price

Consistent with the analysis summarised above CORE expects delivered wholesale costs to R&C delivery points to increase materially from 2016 due to:

- gas contract price increases between 2016 and 2018
- increases in peak supply costs
- Increases in Tasmania's gas transmission costs

Figure 6.4 presents the movement in retail delivered price for major R&C demand nodes under the reference scenario.

Figure 6.4 R&C Delivered Price Retail Gas Price | Reference Case | AUD/GJ



Source: Core Energy Group, 2015

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