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Economics of SWP Expansion for the Access Arrangement Proposal (period 2018-2022)

Prepared for the Consortium of Gas market Participants

Marsden Jacob Associates
Financial & Economic Consultants

ABN 66 663 324 657
ACN 072 233 204

Internet: http://www.marsdenjacob.com.au
E-mail: economists@marsdenjacob.com.au

Melbourne office:
Postal address: Level 4, 683 Burke Road, Camberwell
Victoria 3124 AUSTRALIA
Telephone: 03 9882 1600
Facsimile: 03 9882 1300

Perth office:
Level 1, 220 St Georges Terrace, Perth
Western Australia, 6000 AUSTRALIA
Telephone: 08 9324 1785
Facsimile: 08 9322 7936

Sydney office:
Rod Carr 0418 765 393
Ken Harper0412 318 324

Authors: Andrew Campbell
Andrew Brown
Hana Ramli

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GLOSSARY

ACQ	Annual Contract Quantity
AEMO	Australian Energy Market Operator
BLP	Brooklyn Lara Pipeline
CBJV	Cooper Basin JV
CSG	Coal Seam Gas
DTS	Declared Transmission System
DWGM	Declared Wholesale Gas Market
EGP	Eastern Gas Pipeline
GBB	Gas Bulletin Board
GBJV	Gippsland Basin Joint Venture
GJ	Gigajoule
GPG	Gas Powered Generation
GSA	Gas Sales Agreement
GSOO	Gas Statement of Opportunities
GWh	Gigawatt hour
LMP	Longford Melbourne Pipeline
LNG	Liquefied Natural Gas
MAP	Moomba Adelaide Pipeline
MDQ	Maximum Daily Quantity
MHQ	Maximum Hourly Quantity
NSW	New South Wales
minDQ	Minimum Daily Quantity
MSP	Moomba Sydney Pipeline
Mtpa	Million Tonnes per Annum
NGFR	National Gas Forecasting Report
NVI	NSW-Victoria Interconnect
PJ	Petajoule
R&C	Residential & Commercial
SA	South Australia
SEA Gas	SEA Gas Pipeline
SWQP	South West Queensland Pipeline
SWP	South West Pipeline
TGP	Tasmania Gas Pipeline
TJ/day	Terajoules per day
ToP	Take or Pay
UGS	Underground Gas Storage
VTS	Victorian Transmission System
WORM	Western Outer Ring Main

Executive Summary

Study Findings

- Filling Iona UGS over summer prior to the winter period is becoming increasingly critical for gas supply security and cost. At the same time the availability of gas to refill Iona UGS is under pressure due to:
  - the projected decline is local sources of gas to refill Iona UGS (Casino, Minerva and Otway)
  - reduced gas availability ex Moomba (and increased cost) putting pressure on the remaining available gas supply from Otway and Gippsland; and
  - possible uncertainty in Gippsland availability as production from existing sources declines as it transitions to the new gas fields.
- These changes are transforming the need and role SWP will play in the market.
- Based on the most likely market outlook (of reduced Otway and Gippsland production):
  - ***to fill Iona will require SWP capacity be increased for flows to Iona to over 220 TJ/day*** (from its current level of 102 TJ/day). Not doing so would result in significant pipeline limitations that have Iona UGS only partially filled by Gippsland gas prior to the winter months.
  - to provide the sustained and firm capacity required physically and contractually during the winter months in the face of growing supply uncertainty, both Iona UGS and ***SWP need to be expanded for flow to Melbourne (****to over 500 TJ/day* from SWP's current level of approx. 430 TJ/day in the medium to longer term). Not doing so would have the market short firm (and contract) capacity as a result of the production reductions outlook at Port Campbell, Gippsland and from Moomba.

  Ignoring the above would introduce significant gas supply security and cost implications.

  Given the immediacy of the issues and the lead time in addressing them, it is imperative that the recommendations below are considered with some urgency.

Recommendations

- Consider development that provides for increased flow to Iona in the shortest time possible. This would involve combinations of:
  - reconfiguration of BCS to allow direct compression of units 11 and 12 into the Brooklyn-Lara Pipeline, and
  - operation of BCS Unit 10.
- To address the increasing flows projected on the SWP (and Iona), additional compression should be considered. Options here would include making the Winchelsea compressor bi-directional, and a new compressor at Lara or Stonehaven.
- The longer term needs require the capacity provided by options that include the WORM. The importance of this to gas supply security suggests that action on this issue be brought forward commensurate with the changing nature of the gas production arrangements.

This report presents the independent findings of a study undertaken by Marsden Jacob into the need and economics of upgrading the South West Pipeline (SWP) in Victoria. The study was co-ordinated by Lochard Energy for a large group of gas market participants[1] that accounts for most of the gas retailed in the gas market.

All of the members of the participant group confidentially surveyed considered that upgrading the SWP for flows to Iona especially, was a matter of urgency, and that upgrading SWP for flow to Melbourne was also required as a matter of priority. The results of this independent survey matched with Lochard Energy's Iona UGS future storage customer/market demand assessments, that is the basis of their planned storage expansions as announced to AEMO.

Role of the SWP

The SWP plays a most important role in the cost and security of the Victoria and South Australia gas markets. This role has been as follows:

- To transport gas from Otway production and Iona UGS to Victoria during high gas demand days (nominally winter days). The 430 TJ/day of capacity provided by SWP to Melbourne is critical to Victorian gas supply security;
- To transport Gippsland gas to Iona UGS during the non-winter period in order that UGS can be filled for use during the winter period.

  The importance of filling UGS prior to the winter period is that Iona UGS gas is needed on a peaking and a ***sustained*** (day by day) basis during the winter period. UGS gas cannot be replaced by 'needle' peaking gas sources such as Dandenong LNG.

  Failure to fill UGS prior to the winter period would either leave Victoria short of gas or require the purchase of potentially very high cost gas from Moomba or Queensland, the latter which cannot be assured for gas security purposes as described further below;
- To transport Gippsland gas to SA on the increasing number of days when Otway gas is not sufficient.

The SWP's importance for supply to Melbourne has increase with the reduced availability of Moomba gas.

Gas Market Changes and Implication to the role of SWP

The changes in the East Australia and Victoria gas market over the past two years and that will continue to occur are transforming the role that SWP will be required to undertake in the gas market. These changes and associated consequences are as follows.

Decline of Gas Production at Port Campbell

Until 2015 the level of gas production from Port Campbell (consisting of Casino, Minerva, and Otway gas processing) totalled about 250 TJ/day. This gas was used to augment Moomba to supply SA and to inject into UGS. The result was that flow on the SWP to Iona was not critical to filling UGS prior to the winter period.

The level of gas production at Port Campbell has declined and will continue to decline. Minerva production is projected to cease operation over the next year, Casino may continue at reduced output (subject to well work), and Otway gas production, which may increase over the

[1] The participants included AGL, EnergyAustralia, Alinta Energy, gasTrading Australia, O-I Asia Pacific, M2 Group, and Origin Energy.

next few years due to development of Halladale, is projected to decrease below 100 TJ/day by 2021.

This will mean that all Otway gas will be insufficient to supply SA, and that SA will need additional gas from Gippsland.

SWP will be required to transport practically all of the gas that will be required to fill storage at Iona prior to the winter period and to transport Gippsland gas to SA.

Gas Powered Generation

An increase in Gas Powered Generation (GPG) that may be required in the NEM would add both to increase gas volume and increase daily gas delivery, which can potential coincide with high gas demand days. Operation of Laverton Power Station reduces SWP daily flow capacity by the amount of gas Laverton uses. The retirement of Hazelwood adds to the uncertainty around gas demand, especially during peak periods.

Decline of Gas Production at Gippsland

While gas production at Gippsland is projected to be ongoing for many decades, the outlook for gas production levels is that this will less in the future. Reasons for this include the decline of the current fields and nature of the new Gippsland gas fields.

Additionally, Gippsland production is increasingly expected to supply more gas to NSW as Moomba gas is no longer under contract to supply Sydney via MSP.

While not announced by ESSO/BHP, these factors are likely to mean a reduction in the maximum daily production level for Victoria. The recent announcement of the potential development of Sole gas (estimated at 70 TJ/day) should assist in reducing the loss of production from Gippsland. This will mean that increased daily gas supply capacity will be required by either Iona UGS, Moomba or from Queensland. This will require an increase in SWP capacity to Melbourne.

Adelaide based consultancy ENERGYQUEST are of this view, and in a recent report[i] they state:

> *"Gippsland Basin Joint Venture (GBJV) production is assumed to increase over the next four years (Kipper is expected to be commissioned in the second half of 2016), but then goes into a steep decline, from a peak of 289 PJ in 2017 to 164 PJ in 2025. Production from the CO2 prone fields will be limited by the capacity of the CO2 removal plant while the legacy fields that do not require CO2 removal (Marlin, Barracouta and Snapper) are assumed to decline at 20% pa"*

The decline in Gippsland gas production presents a significant issue to gas supply security, as it compounds the decline in gas from Otway and Moomba.

Decline of Moomba Production and Availability of Moomba and Queensland Gas

The gas demanded by the Gladstone LNG trains has not been matched by Queensland CSG development resulting in a gas shortage in Queensland. LNG demand has been supplemented through supply from Moomba and also from Gippsland.

The issues that will impact this in the future are having all six trains operating at full production, the matching development of CSG in Queensland, and the decline in gas production at Moomba.

It was outside of the scope of this study to assess the firmness and arrangements that would be required to treat gas from Queensland as being suitable to replace gas supply within Victoria.

Suitable market arrangements usually require contractual arrangements between parties be established. The participant group stated that there are limited opportunities for this to occur.

It is clear that the availability of Moomba gas is uncertain, and this has implications for both the ability to refill Iona and for peak supply to Melbourne.

SWP Upgrade Options

Previous gas market analysis by AEMO has indicated that the current limitation of the SWP for flows to Iona presents a significant and urgent issue to gas supply security, and there is a vital need for this to be increased from the current level of 102 TJ/day. To this end, AEMO have formulated a number of options that increases the flow capacity on the SWP for flows to Iona and for flows to Melbourne. The options comprise a combination of identified work that provide for increased flow on SWP. These works include:

- Reconfiguration of BCS to allow direct compression of units 11 and 12 into the Brooklyn-Lara Pipeline;
- Operation of BCS Unit 10 (compressor works required);
- Making the Winchelsea compressor bi-directional;
- New bidirectional compressor(s) at Lara, Stonehaven or Wollert;
- Development of the WORM.

The options developed by AEMO to date can broadly be divided into three categories:

- Those that can be implemented in the short term – these options include the reconfiguration of BCS, making Winchelsea compressor bi-directional and the operation of Unit 10 compressor.
- More substantial expansion of the SWP in the medium term. This would include a new compressor station and the WORM.

  These options can provide increased flow to Iona of up to 300 TJ/day and flow to Melbourne of up to 472 TJ/day. The WORM was seen as essential in the future development strategy for the SWP.
- Longer term developments of an SWP expansion may include installation of additional compressors and duplication. The WORM alone is not sufficient as while it provide for increased flow to Iona of up to about 300 TJ/day it only provided a modest increase for flow from Iona to Melbourne.

  This report identifies a need for greater expansion of SWP to Melbourne than the modest level of expansion under the options in the previous AEMO report and that this is a matter of priority within this 5 year period. The WORM should not delay the development of the shorter term developments that are required as a matter of urgency.

SWP Upgrade Economic Criteria

The requirement to expand the SWP was assessed using the criteria for the expenditure of new capital given by Rule 79 of the National Gas Rules. Three parts of this were relevant and used in this study:

- Use of expanded SWP capacity;
- Gas Supply Security (supply consequences if Iona UGS does not have sufficient gas prior to the winter period);

- Economic Cost (cost of using Queensland gas in place of Gippsland gas, both during the refill process and when gas is required to supply demand). The additional cost of using Queensland gas compared to Gippsland gas was $3.5/GJ ($2.5/GJ being transport).

SWP Upgrade for Flows to Iona - Economics

To assess the value of upgrading the SWP capacity for flow to Iona, gas market modelling was undertaken. This involved the use of a time sequential model and the "Goal Search Gas Model". The former provided for the weekly dynamics and value of upgrading the SWP to be observed, while the later provided for the minimum SWP capacity required to fill Iona UGS under a set of assumptions to be determined.

A number of scenarios were modelled to capture the potential range of Gippsland (includes Longford, Lang Lang, and potentially Sole) and Otway gas production levels, and the potential profile of daily Victorian gas demands. The range was:

- Gippsland (Longford, Yolla and Sole if operating) gas production capacity varying from 1064 TJ/day to 920 TJ/day;
- Otway gas production capacity varying from 160 TJ/day to 60 TJ/day;
- Two patterns of daily Victorian gas demands.

Based on Iona UGS not being expanded the modelling found the following (see Table 12 and Table 13 in the main report):

- Reducing Gippsland production reduced the days available that UGS could be filled:
  - Assuming Otway production at 160 TJ/day, this required SWP expanded for flow to Iona to about 150 TJ/day. Not doing so would have Iona UGS at only 25% full prior to winter.
  - Even with this expansion, higher Victorian gas demands could result in UGS not be filled with the potential for gas supply shortfalls.
- Reducing Otway production reduced the amount UGS could be filled using Otway gas, requiring UGS to be filled using Gippsland gas via the SWP:
  - a reduction of Otway to 100 TJ/day would require SWP expanded for flow to Iona to over 220 TJ/day. Not doing so would have Iona UGS at less than 10% full prior to winter.
  - This was regardless of the level of Gippsland production.

In relation to the Established Criteria:

Gas supply security: the consequences of not filling Iona UGS prior to winter would have serious issues for gas supply security as Victoria would potentially be short gas and capacity for many days over the winter period.

Economics: at a cost differential of $3.5 between Gippsland gas and Queensland gas, the annual cost of replacing Gippsland gas was in the range $30M to $70M per year. This is a very substantial annual cost that would be passed on to gas consumers.

The results show that based on the most likely market outlook SWP is required to be expanded for flow to Iona of over 220 TJ/day.

SWP Upgrade for Flows to Melbourne – Economics

The study quantified that Iona UGS plays a critical role is suppling gas during the winter period above that provided by Gippsland and Otway gas (not used to supply SA). This role has Iona UGS providing both gas volume (utilising lower cost gas stored) and gas capacity. Gas capacity provides for Iona to supply high gas demand days and (storage) volume to undertake this on a sustainable basis.

The study identified that the reduction in gas capacity from Port Campbell and Gippsland will require additional capacity to be available from Iona to Melbourne. Based on Victorian gas forecasts, capacity requirements in addition to that provided by the current SWP and Gippsland gas, for days that can occur on a regulator basis (and thus not suitable for 'needle' peaking gas which is reserved for extreme gas demand days) can be expected to be over 100 to 150 TJ/day for about 15 days each winter (and likely to become greater over time as Gippsland gas supply declines).

With Iona UGS and the SWP (Iona to Melbourne) expanded, this increased capacity can be contracted by market participants and used to manage wholesale gas supply on very high demand days. The participant group stated clearly that the arrangements required are not possible using Queensland gas, and that the risks of capacity shortages are increasing due to increased demand volatility and aging production assets.

To address this capacity need requires both Iona UGS and SWP be expanded for flows to Melbourne. The requirements of the market show that this should be a priority within this 5 year review period. Iona can upgrade to 570 TJ/day and the participant group has stated that this is required as a matter of priority. This would require a commensurate capacity on the SWP to Melbourne.

In relation to the Established Criteria:

Asset Use: The survey (undertaken confidentially by Marsden Jacob) of the participant group showed a demand for Iona/SWP capacity to Melbourne of over 470 TJ/day by 2019, over 500 TJ/day by 2020 and over 600 TJ/day by 2021.

Gas supply security: Shortage of gas capacity, both physically and contracted, presents significant gas supply security issues. Increased capacity is required at Iona UGS and this cannot be supplied to the market without commensurate transport.

Economics: The increased service value to the gas market involved both volume and capacity and the two are interlinked. Without SWP increased in both directions the economic costs will be associated with significant gas purchase costs, gas capacity costs and potential gas shortfall costs. The incremental (Capex) costs to the upgrades required to expand SWP Melbourne to Iona flow capacity to over 200TJ/d is low and not expected to be material.

1. Introduction

This report presents the finding of an independent study undertaken by Marsden Jacob Associates (Marsden Jacob) for a consortium of gas market participants[2] on the economics of expanding the South West Pipeline (SWP).

1.1 Background

The 2016 winter period saw high gas demands and gas retailers having difficulty managing wholesale gas purchase and associated risks. In particular a number of gas retailers were short of gas during days when gas was needed. This was a result of issues that included reductions in Longford production due to development/maintenance works, high gas demand in Tasmania due to the outage of Basslink[3], and the decline of gas availability from Moomba to supply NSW and South Australia.

The outlook for the gas market is an increasing tighter demand/supply balance, and for gas market participants:

- Increasing risk of having insufficient gas in storage at Iona UGS to supply winter gas demand;
- Increasing risk of being short MDQ to supply gas during very high gas demand days;
- Increasing difficulty in obtaining gas supply contracts that address price risk at times of high gas demand.

For supply to the Victorian, South Australian (SA) and New South Wales (NSW) gas markets, increasing the capacity of the SWP in both directions is seen by many gas market retailers as most important to future gas supply security and risk management.

Submissions on the Assess Arrangements of the Victorian Transmission System (VTS) for the period between 2018 to 2022 are being accepted by the Australian Energy Regulator (AER) and this report addresses the economics of upgrading the SWP in that context.

1.2 Study Scope of Work

The scope of work provided to Marsden Jacob by Lochard Energy, acting as a secretariat for the consortium group, was presented as follows:

2.1 Conduct a forward looking quantification of SWP expansion (firm bi-directional) required by the market – taking into account of system security for peak winter demand and to support gas powered generation demand (particularly in South Australia via SEA Gas) and partial supply outages. This should include interviewing Market Participants on their future requirements and aggregating the results for the study.

2.2 Conduct a Market Benefit Test for the SWP expansion options. This should be aligned with the AER's criteria for approving expansion proposals.

[2] Lochard Energy acted as the secretariat for this consortium.

[3] The outage of Basslink required the operation of the gas powered generator Tamar Valley Power Station. This significantly increased gas demand that was supplied by Gippsland gas.

2.3 Review the prospect of changing the tariff structure across the market to absorb the investment on the SWP expansion. The basis is that the SWP expansion provides benefits across the market.

2.4 Provide comment on the need for mechanisms to have effective control measures to ensure approved capital is used for the specific expansion activities.

This work is to include capturing information from the retailer group on their capacity needs and from the Australian Energy Market Operator (AEMO) in relation to the options available to upgrade the SWP.

1.3 Notes to this report

1.3.1 Members of the Consortium Group

The consortium Group of gas market participants consisted of the following:

- AGL;
- Alinta Energy;
- EnergyAustralia;
- gasTrading Australia;
- Owen Illinois O-I Asia Pacific;
- M2 Group;
- Origin Energy.

1.3.2 Abbreviations

Unless otherwise specified:

- "gas market" refers to the gas market in the States of South Australia (SA), Victoria, New South Wales (NSW) and Tasmania;
- "winter period" refers to the period May, June, July and August.

1.3.3 Dollars

Unless otherwise specified, all dollars are real 1 January 2017 Australian dollars.

2. Gas Supply Operation

This chapter describes the operation of how gas is supplied to the individual states of SA, Victorian and NSW in the gas market. An overview of the gas market in SA, Victoria, NSW and Tasmania is presented in Appendix 1.

In the discussion presented and for the purposes of this report:

- Tasmanian gas demand is considered part of Victoria[4] unless otherwise specifies;
- ACT gas demand is considered to be part of NSW.

2.1 Victoria

Victorian gas demand is supplied from the Gippsland producers via the Longford to Melbourne Pipeline (LMP), from Iona / Otway producers via the South West Pipeline (SWP) and from Moomba via the New South Wales Victoria Interconnector (NVI)[5]. .

To illustrate the profile of gas supply to Victoria, the historical outcomes over the period 2014 to 2016 are shown in Figure 1 and Figure 2 below.

Figure 1 shows actual Victorian daily demand and daily flows on the LMP, SWP and NVI over the period 2009 to 2016, ordered from highest to lowest Victorian demand days[6]. As Victorian demand increases (moving to the left) the gap between supply via the LMP and demand increases[7]. Flow on the SWP increases to the current limit of 430 TJ/day at the time of Victorian maximum demand of about 1250 TJ/day. At times of high gas demand Victoria can receive gas from the NVI. However, there has been very little flow into Victoria via the VNI in recent years.

The capacity of the SWP in both directions is reduced by 1TJ/day for every 1 TJ/day used by the Laverton Power Station (which takes gas off the SWP). This can result in a daily reduction in SWP capacity in the order of 70 TJ/day.

In the absence of peaking gas supply (from LNG or parked gas) the required usage of the SWP would be increased to the extent gas to Victoria is not available from Moomba or Queensland via the NVI. Importantly Iona would normally be used ahead of LNG as LNG is reserved for linepack to avoid system security issues.

To illustrate SWP and Iona operation, Figure 2 shows the serial profile of daily Victorian demand, flow on SWP, and Iona storage withdrawal over the period 2014 to 2016. The figure shows the strong seasonal correlation of gas flows.

[4] Tasmania is connected to Victoria by the Tasmanian Gas Pipeline (TGP), and with the gas power station Tamar Valley being placed into long-term standby has a small annual gas demand of less than 10 PJ/year. It is noted that due to drought conditions in Tasmania compounded by an outage of Basslink that Tasmanian gas powered generation output in the 2015/16 financial year was higher than expected/normal. There are no gas production facilities in Tasmania.

[5] Also known as Culcairn.

[6] Referred to as a load duration curve.

[7] The greatest flow on the LMP since 2009 is 905/TJ/day.

Prior to 2016 SWP flows to Iona on the SWP were low, the reason being is that the Iona UGS was primarily filled using gas from Port Campbell (primarily Casino). In 2016 the SWP had substantial flows to Iona at the flow limit (of 102 TJ/day) .

With gas production at Port Campbell decreasing a substantial increase in flows from Melbourne to SWP will be required to fill the Iona UGS.

Figure 1 Actual Victorian Demand and LMP, SWP and NVI Flows

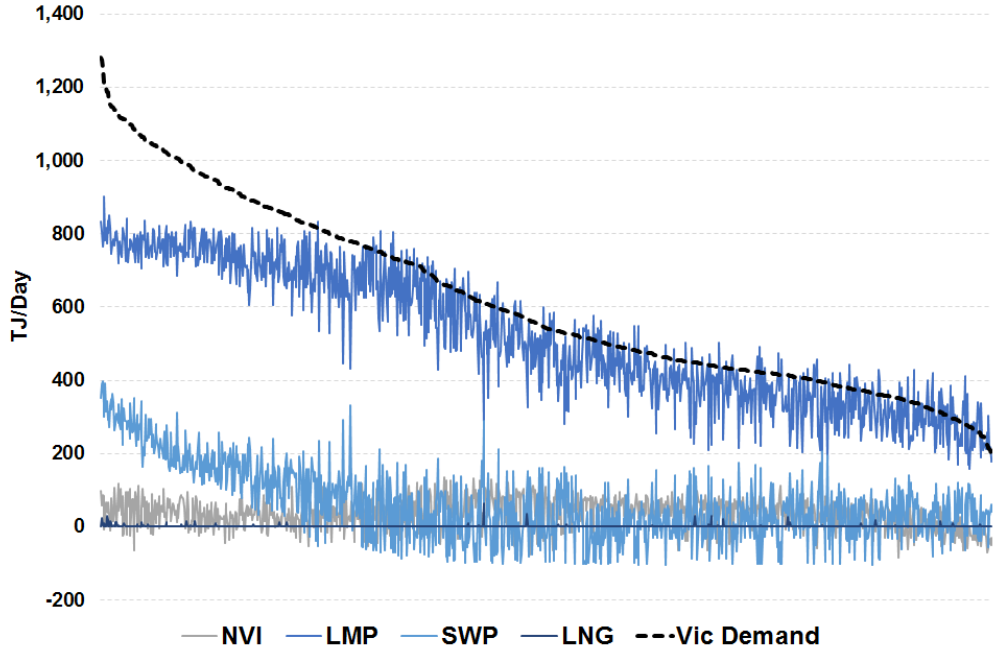
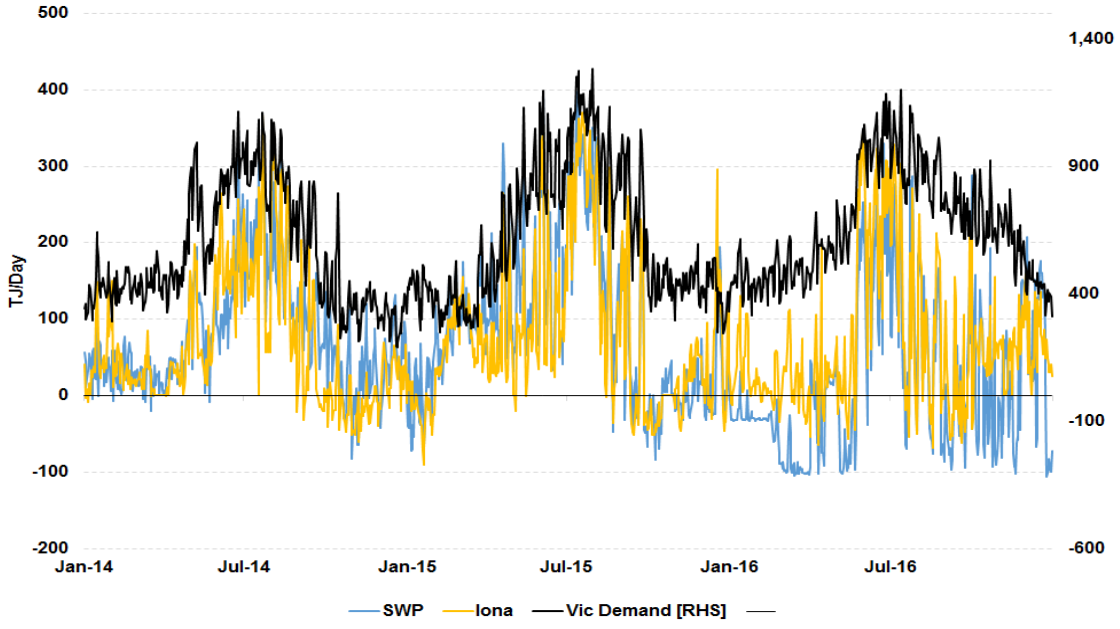


Figure 2 Victorian Daily Gas Demand, SWP flow, and Gas from Iona. TJ/day



There are other sources of peak supply gas that can be used in Victoria to support gas demand on very high demand winter days, these being:

- Dandenong LNG storage (Storage has 650 TJ and maximum daily production is 158 TJ/day);
- Gas "parked" on pipelines outside of Victoria – MSP, EGP, and TGP (referred to as linepack)[8]. The Victorian gas arrangements (market carriage) do not provide for gas to be parked on pipelines that are part of the Declared Transmission System (DTS).

However these sources are not sustainable on a day on day basis.

In addition to identifying potential gas sources available, the logistics of arranging gas to be supplied by Moomba or Queensland and/or requiring the use of pipelines outside of the VTS needs to be undertaken under the arrangements of the contract carriage model. This can mean supply opportunities may be difficult to capture and the resulting costs of supply can be high.

The decrease in Moomba and possibly Queensland gas availability means that Victoria may be MDQ short if additional gas cannot be transported from Iona to Melbourne.

2.2 South Australia

The South Australian demand has traditionally been met with supply from Otway via the South East Australian Gas Pipeline (SEA Gas) and from Moomba via the Moomba to Adelaide Pipeline System (MAPS).

Future sources of gas to supply SA will be from:

- Otway gas while this is available. Developments at Otway may have this available in the medium term but in the long term gas from Otway is expected to be substantially reduced;
- Gippsland gas via the SWP and SEAGas pipeline. This would require the SWP to provide gas to Iona UGS and to SA (via Iona UGS). This would significantly increase the required capacity of SWP to Iona;
- Moomba gas associated with gas developments at Moomba and / or Queensland that are economic to supply the domestic market[9]. In the absence of sufficient Otway and /or Gippsland gas, gas from Moomba and /or Queensland will be necessary.

This suggests that SWP may have an increasing role in supporting gas supply to SA. .

2.3 New South Wales

New South Wales does not have any significant internally produced gas and as a consequence relies on gas supplied from:

- Moomba or Queensland via the Moomba to Sydney Pipeline (MSP); and
- Gippsland producers via the EGP.

There are Coal Seam Gas reserves in NSW but there is a moratorium on their development.

[8] ,LNG storage and parked gas are only available for a few days each winter and therefore cannot provide the service undertaken by Iona via the SWP. These services are usually reserved for days of very high demand when Iona is not sufficient or days where fast response is required due to issues such as demand forecast error

[9] The cost of this gas would place a floor on gas price.

While supply from Moomba and Gippsland may be sufficient, Iona may have a role in supporting high gas demand days in NSW (given that extreme gas demand days are not coincident in Victoria and NSW). This support would be via injection from Iona into the Victorian market via the SWP or via the WORM when this is available.

3. Future Maximum Demand Outlook

AEMO develop and publish gas demand forecasts as part of the National Gas Forecasting Report (NGFR). The latest NGFR was published in December 2016 and is the basis for the AEMO projections used in this report (with some modifications described below).

With the operation of Iona UGS dependent on both the cumulative flows associated with filling and emptying storage, and the provision of MDQ for extreme demand days, both average daily gas demand and extreme daily gas demand by State determine the operation of Iona UGS and the pipeline needs to and from Iona UGS. Average and extreme daily gas demands are presented in turn below.

To support the demand outlook this chapter, Appendix 2 presented the historical average and historical maximum daily demands for Victoria, SA and NSW.

3.1 Average Demand

Table 1 presents the historical average daily demand levels over the period 2009 to 2016 for SA, Victoria and NSW and the projected average daily demand level. This is also provided by winter and non-winter days for historical demands (this is not provided in the forecast demands). The projected average daily demands are discussed below.

Table 1 Average Daily Demand Outlook and Historical Average Demands

	NGFR		Historical (2009 to 2016)		
	Total PJ	Annual Average TJ/day	Annual Average TJ/day	Winter Average TJ/Day	Non-Winter Average TJ/Day
NSW	120	329	413	499	370
SA	70	192	273	305	257
TAS	6.3	17	40	37	41
VIC	190	521	607	866	478

3.1.1 Forecast of Average Demands

With the demand outlook projected to have little or no growth, only small changes in annual gas demands are projected for each State over the next 10 years and beyond. The level of GPG is an uncertainty that could result in gas demands being higher than current projected by AEMO.

Table 1show for each State the projected annual (which only varies slightly each year) and the average historical demands. All States show a significant decrease in average daily gas demands compared to historical.

3.2 Maximum Daily Demands

3.2.1 AEMO Maximum Demand Outlook

The 10 year projections of maximum daily demand for the individual states of Victoria, SA, and NSW are shown in **Error! Reference source not found.**Table 2 below. AEMO do not provide a combined east coast or Victoria/ SA/NSW maximum daily demand forecasts.

Figure 3 overleaf presents graphical display of the 1 in 20 demand forecasts and the level of GPG contained in these projections.

Observation in relation to AEMO gas demand projections are as follows:

- The AEMO outlook has GPG at 121 TJ/day for the combined non-coincident maximum demand days for SA, Victoria and NSW. This is considered low compared to the combined GPG generation on the combined SA/Victoria/NSW maximum demand day which has been in the order of 400 TJ/day;
- The projected 1 in 20 SA daily demands in the AEMO forecast is in the order of 240 TJ/day. This is well below historical SA maximum gas demands of over 450 TJ/day. Even allowing for the upgrade of the interconnector and additional renewable generation, this is not considered consistent with a 1 in 20 demand level.

The conclusion is that the GPG generation level and SA maximum daily demand as contained in the NGFR 2016 are not supported and are low.

Table 2 NGFR 2016 Maximum Daily Demand Projections (includes GPG) TJ/day

Incl GPG

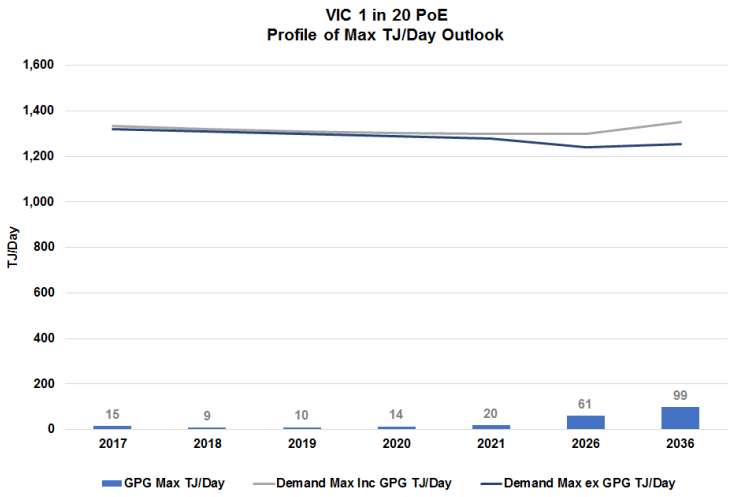
Type	PoE	Region	2016	2017	2018	2019	2020	2021	2026	2036
Region	1 in 2	NSW	517	515	506	510	516	516	518	571
Region	1 in 2	QLD	436	457	412	407	415	413	449	513
Region	1 in 2	SA	234	265	242	226	221	224	232	255
Region	1 in 2	TAS	56	34	34	33	33	34	34	41
Region	1 in 2	VIC	1218	1223	1209	1200	1193	1190	1193	1245

Type	PoE	Region	2016	2017	2018	2019	2020	2021	2026	2036
Region	1 in 20	NSW	555	553	544	548	554	554	556	609
Region	1 in 20	QLD	440	462	417	411	419	417	453	516
Region	1 in 20	SA	242	273	251	235	230	232	240	263
Region	1 in 20	TAS	57	35	35	34	34	36	36	43
Region	1 in 20	VIC	1329	1334	1319	1311	1303	1300	1300	1353

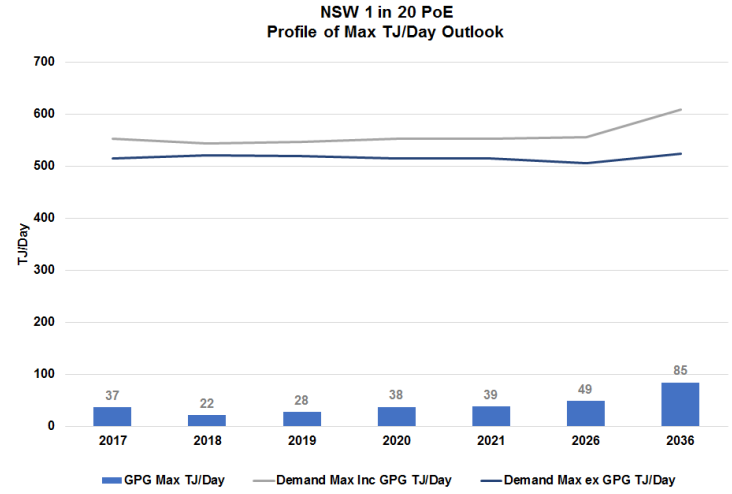
Source AEMO NGFR 2016

Figure 3 AEMO NGFR 2016 Victorian Demand Projection

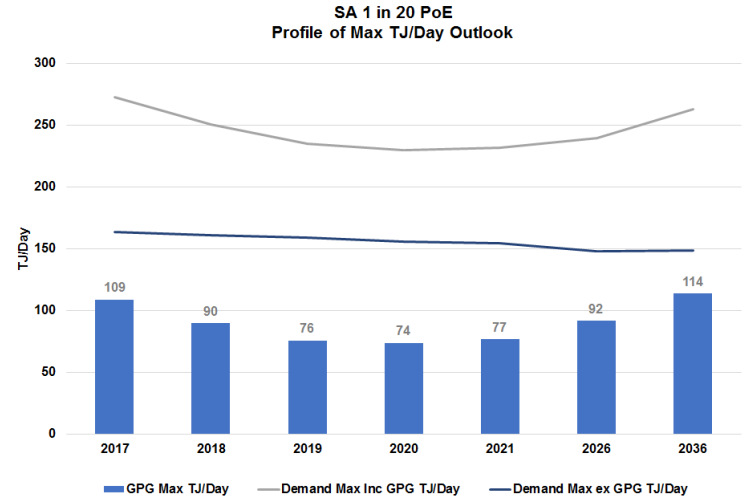
Victoria



NSW



SA



3.3 Gas Projections used in this Report

There are three aspects to future gas demand;

- Individual State and total gas market annual gas use (PJ);[10]
- Individual State daily maximum gas demand (TJ/day);
- Combined gas market (SA/Victoria/NSW/Tasmania) daily maximum gas demand (TJ/day).[11]

Marsden Jacob considered the AEMO projection of annual gas quantities (PJ) for all sectors, including GPG, is consistent with trend. Consequently these forecasts were used in this report.

The contribution of GPG to extreme gas demand days (1 in 2 and 1 in 20) were considered problematic, particularly for South Australia. As a result SA maximum daily demand was increased from that contained in the 2016 NGFR.

The Victorian 1 in 20 demand was high even with the small contribution from GPG and the maximum daily demand in Victoria contained in the NGFR was used.

[10] Annual gas use is the summation of individual state gas use.

[11] The non-coincident nature of State maximum daily demands means that this is not the summation of the individual State daily maximum gas demand.

4. Retailer SWP MDQ Requirements

Fundamental to pipeline economics is the demand by wholesale gas retailers for wholesale gas transport (i.e. pipeline capacity).

To ascertain the demand for SWP capacity requirements, the consortium of gas market participants completed a questionnaire regarding their intended contracting on the SWP:

- This was confined to their intended contracting on the SWP to support the supply of customer demand in Victoria; and
- Their views of the need for and reasons for an increase in the capacity of the SWP in both directions, and the developments that are and will impact the gas market moving forward.

In additional to this the participant group provided input to issues identified through the study. The findings of this process are presented below.

4.1 Intended Contracting

While the survey was not completed by all participants, those that responded represented the vast majority of customers to be supplied. The key issue for the participants (and key line item) was the required MDQ required on the SWP for flows to Melbourne, and the aggregated MDQ of the responses are shown in the table below.

Of particular note is the increase from the current level to 603 by 2021. We note that the 603 TJ/day was for only those participants that provide input.

Table 3 Total of Responses form the Retailer Group

	2017	2018	2019	2020	2021
SWP to Vic TJ/day	374.0	428.0	468.0	528.0	603.0

4.2 Basis for Retailer SWP MDQ Needs

Three questions were asked to the participant group. The questions are responses are shown in the tables below. Each cell of table below represents a response from an individual participant.

A summary of the issues and basis for the MDQ requirement of the SWP is as follows:

- Small tier two participants require storage and this is not available. This is reducing their competitive position. SWP capacity is limiting this;
- Storage will become more valuable as gas supply options decrease (including Gippsland reserves), swing from suppliers reduces, and outages of aging gas production plant increases;
- Market demand will become peakier due to GPG requirements, degradation of the flat industrial load;
- There is no contingency in the system and outages of plant such as Longford can have very significant impacts.

Question 1

Do you believe the SWP should be expanded to flow to Iona?

Yes, given current limited Storage Capabilities on the East Coast this facility is critical for smaller tier two participants to be able to manage positions. The current limitations of availability is a limiting factor.
Yes As the number of sources of gas supply for East Coast reduce, Iona storage becomes increasingly important To use storage effectively, it needs to be refilled Refill is constrained by SWP Increasing SWP capacity will reduce constraint
Yes – We require increased flows in both directions on the SWP from 2018 as per the table in the Template.
Yes, as the market demand becomes peakier due to: ▪ more GFG requirement due to closure of Hazelwood and renewable intermittency ▪ degradation of the flat industrial load ▪ reduction in producer swing ▪ decline in gas available at the Otway region to fill Iona, hence gas has to flow from Longford/MSP ▪ SA power demand (increasing) requiring more gas to flow from VIC if there is no gas from Moomba.

Question 2

Do you believe the SWP should be expanded to flow to Melbourne?

Yes, again the infrastructure is critical for managing flex in Melbourne and current limits are restricting Tier 2 capability of being competitive.
Yes Call as per above, call on capacity from Iona will increase Reduced reliability and availability of Longford
Yes -We require increased flows in both directions on the SWP from 2018 as per the table in the Template.
Yes. Similar reasons to above. Increased peakiness in demand & loss of base coal will put increased pressure and requirement on GPG which has been underestimated. Battery Storage technology will need to improve markedly but until it does the reliance on GPG will increase reliance on storage. Declining Longford Reserves and MDQ Capacity.

We note that gas from North may be able to help reduce reliance. And TGP may provide limited capacity relieve for a very short period of time. Security of Supply : There is no contingency in the system. Longford is an old plant and the outage on the 1st of October 2016 on one of the lowest demand days of the year showed the systems' vulnerability when Longford is on forced outage. If this occurred in winter a WUGS withdrawal volume increase may not solve the issue but it could help ease the problem.

Question 3

Do you see any developments recent or forecast that will significantly impact the demand / supply balance in Victoria. (eg. Increase demand for GPG, reduced Longford production, increased peak demand, increased in LNG demand, higher oil price).

Yes, All of the above.
Reduced Longford reliability, requires more capacity to be provided by Iona storage Hazelwood decomm will increase call on power gen – this affects SWP ability to refill storage
Demand in SA for GPG have increased since the closure of Northern. The expectation is the same will happen in VIC with the Hazelwood closure. This puts stress on the gas markets in either direction on the SWP pending where the generation is needed on a given day.
Demand degradation in C&I space due to increased gas price based on supply/demand of gas with LNG and higher GPG. Ability of LNG projects to replace committed cargoes and divert gas back south may change the requirements to send gas into and out of storage depending on where it is built. Either in VIC or SA. Further loss of coal fired generation will place further strain on gas requirements for GPG. The location of AGL's planned LNG import terminal is probably really important to the utilisation of SWP. If it sits to the left of SWP, then the flows into Melbourne need to be higher to reflect this. However if it sits to the right of SWP and it can be flexed easily to adapt to the winter shape, then flow from SWP to Melbourne may be reduced, but flows from SWP to Iona will certainly increase to facilitate the LNG import schedules

4.3 Additional Input from the Participant Group

In the course of the study the participant group provide input to a number of issues. Key among these was the availability of gas at Queensland to support gas supply in Victoria. The participant group were of the view that it is most difficult to get gas from Queensland and that this situation was not likely to change in at least the medium term.

5. Future SWP and Iona Upgrade Options

AEMO has the role of developing the Victorian Gas Planning Report (VGPR) each year. This report utilises the projections of future gas demand developed through the National Gas Forecasting Report (available at the time) and develops transport options (such as pipeline upgrades or changed operation) to ensure that the Victorian gas market operate such that all Victorian customer demands can be met at the lowest cost in the future.

This chapter presents expansion options developed by AEMO to address the future needs of the Victorian gas market. The options presented in this chapter utilised the most recent publication of the VGPR published in February 2016 by AEMO and informal discussions with AEMO on these options and possible amendments to these options which will be discussed in AEMO VGPR to be published in March 2017.

5.1 Summary of Options to Expand the SWP

Gas market analysis by AEMO has indicated that:

- The current limitation of the SWP to Iona presents a significant and urgent issue to gas supply security, and there is a vital need for this to be increased from the current level of 102TJ/day.
- Show constraints on SWP to Iona over the last 6 months to demonstrate the need for immediate expansion.

AEMO has developed a number of options that provide for increased flow on the SWP in both directions. The options contain combinations of works, with the individual work items being:

- Reconfiguration of BCS to allow direct compression of units 11 and 12 into the Brooklyn-Lara Pipeline;
- Operation of BCS Unit 10 (compressor works required);
- Making the Winchelsea compressor bi-directional;
- New bidirectional compressor at Lara or Stonehaven;
- Development of the WORM, which includes a new bi-directional compressor at Wollert .

A summary of the options developed (and understood being developed) by AEMO is presented in Table 4. The naming is intended to be consistent with the option names being used by AEMO. The table presents for each option:

- Option name;
- Brief description;
- Capacity on the SWP for flows to Iona and flow to Melbourne;
- Estimated cost. The estimated cost has been undertaken by Marsden Jacob including informal discussion with AEMO. The costs presented do not present the formal views of AEMO (who have not produced any public material on option costs).

The following section provides more detail on the SWP expansion options presented, firstly for flow to Iona and then for flow to Melbourne. Appendix 3 presents additional details of the development options.

Table 4 SWP Capacity Options

No	VGPR 2016	Description	SWP Capacity at Iona TJ/day (1)		
			Injection (2)	Withdrawal (3)	Cost $M
1	Current	No change	430	102	0
2	Option 2	Reconfiguration of BCS to allow direct compression of units 11 and 12 into the Brooklyn-Lara Pipeline.	430	147	2.5
3	Option 3	Operation of BCS Unit 10 (compressor works required) with units 11 and 12	430	135	2
4	Option 4	Options 2 and 3	430	170	4.5
5	Option 4a (3)	Option 2 Lara bidirectional Compressor	450	200 +	44
6	Option 5	WORM with compressors at Wollert	450	300	100
7	Option 5a	Worm and Lara CS	472	300	144

Notes: (1) capacities estimated through information contained in the VGPR 2016 and discussions with AEMO. AEMO has not provided any numbers other than that contained in the published VGPR 2016.
(2) Injection to UGS is associated with flow from Melbourne to Iona.
(3) Withdrawal from UGS is associated with flow from Iona to Melbourne..

5.2 Options for increased Flow to Iona

The options for increasing flow on the SWP to Iona are described below.

5.2.1 Option 2

Background

There are two key pipelines for increasing flow on the SWP to Iona:

- The Brooklyn to Corio Pipeline (BCP) – Corio being the supply point into Geelong. This is a small 300mm lower pressure (6,800 kPa) pipeline that was built to supply Geelong before Iona was developed (after the Longford fire in 1998);
- Brooklyn to Lara Pipeline (BLP) – which at Lara becomes the South West Pipeline (SWP). This is a 500mm higher pressure (10,200 kPa) pipeline. Flow to Port Campbell along the BLP/SWP connects off the BCP;

  The SWP was built in 1999 (prior to winter) to supply gas from Port Campbell to Melbourne via a connection into the BCP. The BLP was commissioned prior to winter 2008 to increase the pipeline capacity from Port Campbell to Melbourne.

These pipelines can be seen in Figure 4 below as the pipelines from Brooklyn to Lara and from Brooklyn to Geelong.

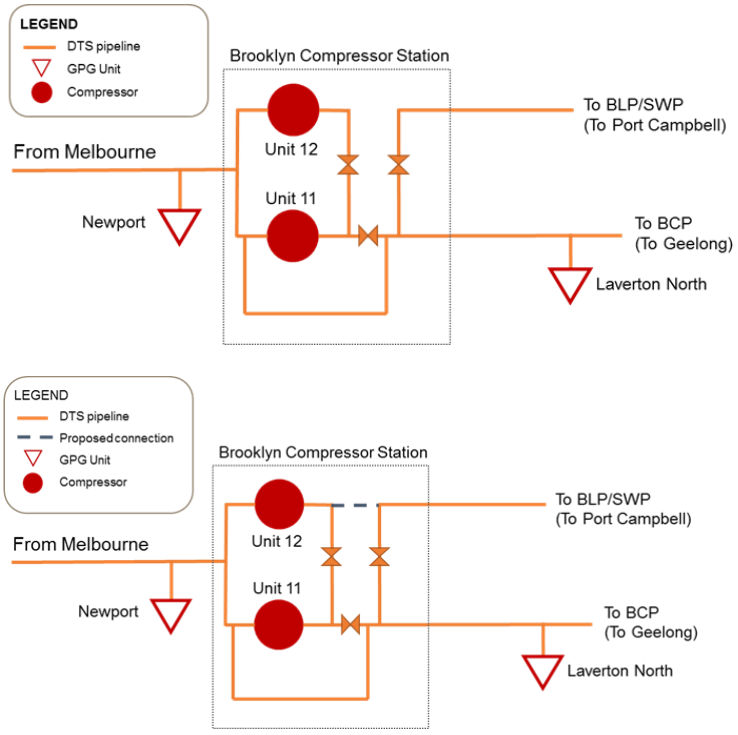
Figure 4 Pipelines from Brooklyn to Port Campbell

Source: AEMO

At Brooklyn there are three compressors that are used to flow gas on these two pipelines. Currently compressor units 11 and 12 can operate in parallel with these compressors discharging into the Brooklyn to Corio Pipeline (BCP). The Brooklyn compressors do not connect directly to the BLP. This is seen in the top diagram of Figure 5.

Flow to Port Campbell along the BLP/SWP (which connects off the BCP) is inefficient because the supply to Geelong is being unnecessarily compressed. During summer Geelong can be supplied without compression via a bypass around the compressors into the BCP, but this bypass cannot be used if gas needs to be sent to Port Campbell where the BLP connects into the BCP.

Figure 5 Configuration at Brooklyn – Current and that Proposed for Option 2



Current Configuration

Option 2

Involves piping work to directly connect the compressor (12 and 11) to the BLP/SWP

Source: AEMO

Solution – Option 2

AEMO has proposed an option to place a direct connection from compressor units 11 and 12 to the BLP. This would allow:

- These compressors to only supply the BLP/SWP (which sends gas to Port Campbell);
- Supply to Geelong to bypass compressor units 11 and 12 providing for to "free flow" along the BCP without compression.

To further improve flow capability the compressor at Winchelsea would be made bidirectional.

The result is as follows:

- The BLP/SWP capacity to Port Campbell would increase from 102 TJ/d to 132 TJ/d on a 300 TJ system demand day. This increase in capacity is roughly the supply to Geelong that no longer has to be compressed;
- Operating the Laverton North Power Station (LNPS) would reduce this increase. LNPS operation requires gas to be compressed to meet its inlet pressure requirements, requiring one or both compressor units 11 and 12 be needed to supply LNPS. This would directly reduce gas flow to Port Campbell.

5.2.2 Option 3

An improvement to the current arrangement can be achieved through operating compressor unit 10 at Brooklyn. Currently this compressor is not utilised by AEMO. Compressor unit 10 could be operated in parallel with units 11 and 12 providing for additional flow capacity to Port Campbell (given any technical issues can be addressed).

Option 3 involves the operation of all three compressors (10, 11 and 12) without the piping modification to connect directly into the BLP as per Option 2. It is understood that capital expenditure required and this is estimated at $2M although this could be lower. This would mean that some compression output is still "wasted" by unnecessarily compressing the supply to Geelong.

5.2.3 Option 4

This option combines Option 2 and Option 3:

- Piping modification (so no wasted flow to Geelong);
- Operation of all three compressors (10, 11 and12);
- Winchelsea compressor is made bidirectional.

5.2.4 Option 4a

Additional flow to and from Port Campbell can be achieved through a new compressor at Lara. A compressor at Lara would provide:

- Additional compression towards Port Campbell;
- Increased pipeline flow towards Melbourne;
- A back-up for the single (no spare) compressor at Winchelsea. If the Winchelsea compressor was not available Lara would provide more capacity than just the incremental increase on top of the Winchelsea capacity.

Option 4a is Option 2 plus a new bi-directional compressor at Lara.

5.2.5 Option 5

This option recognises that transporting gas from Longford to Port Campbell is very inefficient. The reason for this inefficiency is that during the summer months (when Iona is being filled) pressure needs to be reduced at the Dandenong City Gate and increasing from Brooklyn[12].

The Western Outer Ring Main (WORM)[13] would provide for gas to flow from Longford to Wollert via the existing (Eastern) Outer Ring Main. At Wollert the pressure would be approximately 6,000 kPa. A new compressor(s) would boost this pressure up to 10,200 kPa to provide for flow around the 500mm diameter WORM, where it would connect into the BLP, then flow to Port Campbell via the SWP. Compression at Lara would assist this flow along with making the Winchelsea compressor bi-directional.

The result of this option is as follows:

- With one new Centaur compressor the capacity of flow to Port Campbell would be 165 TJ/day.
- With two Centaur compressors at Wollert into the WORM the transportation capacity towards Port Campbell could increase to about 300 TJ/d (noting that AEMO have not yet undertaken modelling on this).

5.3 Options for increased Flow to Melbourne

The options for increasing capacity from Port Campbell to Melbourne are limited[14].

Without duplicating sections of SWP pipeline (which would be expensive) the identified options to increase in flow to Melbourne are as follows;

- The WORM on its own;
- A compressor station near Geelong. Lara or Stonehaven may be suitable locations;
- The WORM, Winchelsea and Lara compressors. This would increase the flow to Melbourne to 472 TJ/day. This report has labelled that option 'Option 5a".

Flow to Melbourne could be increased slightly through additional investment that include one or more of:

- Another compressor between Lara and Wollert;
- Making the WORM a 600mm pipeline.

[12] During the summer months the pressure on the LMP to the Dandenong City Gate is approx.6,000 kPa from Dandenong to Brooklyn 2,760 kPa, and from Brooklyn to Port Campbell 6,000 to 7,000 kPa.

[13] See page 23 and pages 27-29 of the 2016 VGPR Update for more details

[14] For flow from Port Campbell to Melbourne, look at pages 27-29 of the 2016 VGPR Update again – particularly Figure 15 on page 29.

5.4 Iona Upgrade Plan

Lochard Energy has announced their intention to increase the capacity of the Iona UGS. The effectiveness of any increase in storage capacity is potentially contingent on the SWP being upgraded in both directions.

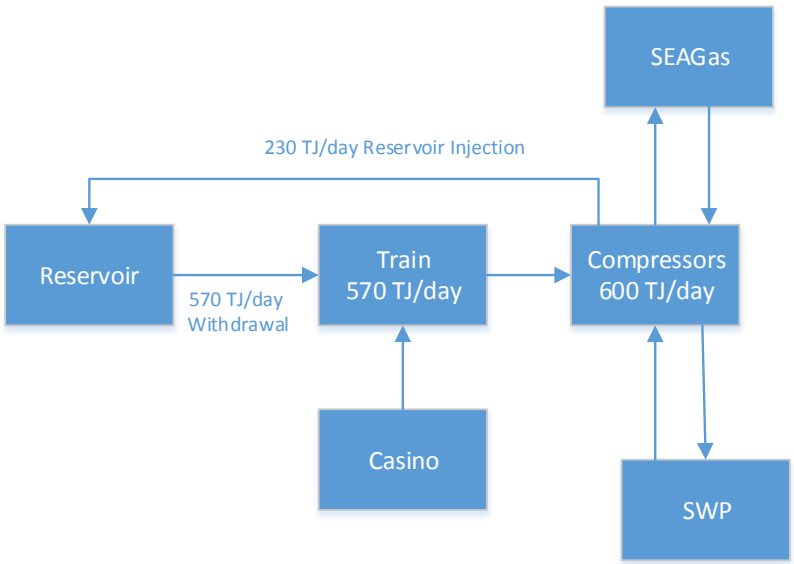
There are three issues associated with Iona moving forward:

- The increase in UGS injection (to storage) and withdrawal (from storage);
- The volume of storage;
- The compression available at Iona to provide for combined gas injections to SWP and SEAGas.

As background to this discussion, Figure 6 presents a simplified diagram of the arrangements at Iona showing the connections of Casino Gas, UGS, SEAGas pipeline and the SWP. The physical arrangements are:

- The SWP and SEA Gas Pipeline connect through Iona;
- Casino gas can be injected into Iona storage (noting Casino is projected to potentially cease production in 2018);
- Gas from the Otway Project gas fields (Geographe and Thylacine) is processed then connected to one or more of the SWP, SEA Gas Pipeline, the Mortlake Power Station, or Iona storage; and
- Iona has up to about 600 TJ/day of compression[15] that is used to transfer gas between pipelines and between storage and pipelines. An overview of the compression and flow capacities are shown in the diagram below.

Figure 6 Arrangements at Iona – UGS, Casino gas, SEAGas and SWP



[15] Information from Lochard Energy.

5.4.1 UGS upgrade

The Iona UGS upgrade level and timing that has been provided to AEMO by Lochard Energy is shown in Table 5 below.

Table 5 Iona Upgrade Plan

	Max. injection rate into DTS TJ/day	Max. withdrawal rate from DTS TJ/day
2017	435	153
2018	440	173
2019 onwards	570	230

5.4.2 Total capacity of Injections from Iona

The capacity of Iona plus Otway gas production that can be provided on any day is constrained by the total flow capacities of SEAGas and SWP combined. These are respectively 314 TJ/day and 430 TJ/day which totals to 744 TJ/day.

To obtain this amount of flow sufficient compression is required. Compression is provided by Otway plant, SEAGas and Iona.

SEAGas requires twice the compression as SWP meaning that the estimated 600 TJ/day of compression at Iona (assuming no supply from Otway) can provide 420 to SWP and 135 TJ/day on SEAGas, for a total of 555 TJ/day.

Compression at Iona can vary depending on the level of gas in storage at UGS and Otway production. When the storage level is low the effective compressor capability reduces and may reduce to about 600 TJ/day at Iona[16]. If only Iona compression is available then the 1:2 requirement of SEAGas limits what can be sent to the market.

This means upgrading Iona UGS capacity without a comparable upgrade to SWP capacity for flow to Melbourne would have the risk of the market not being able to utilise Iona's full expansion capacity.

[16] Information provided by Lochard energy.

6. Economics of System Augmentation

Capital expenditure for new or upgrading pipelines is assessed under the National Gas Rules, and the economics undertaken in this report was required to be consistent with the criteria contained in the National Gas Rules.

This chapter presents:

- An overview of the planning and development process used in Victoria for identifying options that require new capital investment;
- The economic criteria used by the AER to approve capital investments in gas market access arrangements;
- The approach used in this report for assessing the economics of SWP expansion options (consistent with the AER criterion).

6.1 Process of Pipeline Development

The process of developing and implementing development options in the Victorian gas market is as follows:

- AEMO undertaking a planning process:
  - Forecasts of gas demand (volume and maximum daily demand) and the capability of gas sources (reserves, daily production capacity);
  - Assessment of supply adequacy including extreme gas demand days;
  - Identification of options that address any shortfalls in gas supply capacity and that form the basis of a long term gas supply strategy;
- Asset owners adopting option(s) from the planning studies or otherwise and including these in their five yearly access arrangement;
- The AER reviewing the proposed capital expenditure against the economic criteria presented in Rule 79 of the National Gas Rules.

6.2 AER Economics Test

The criterion for the expenditure of new capital is given by Rule 79 of the National Gas Rules. This rule is reproduced in full in Appendix 5.

The key criteria contained in this rule are as follows:

- Efficiently – achieving the lowest sustainable cost of providing services;
- Expenditure provides positive economic value or the capital expenditure is necessary for issues that include safety of services / integrity / a regulatory obligation;
- The present value of the expected incremental revenue to be generated exceeds the present value of the capital expenditure;
- To maintain demand being met at the time the capital expenditure is incurred.

The rule also states that the basis of any economic and revenue assessment is to be as follows:

- Economic value is limited to that directly accruing to the service provider, gas producers, users and end users;
- Changes in revenues are based on prevailing reference tariffs;
- Discount rate equal to the rate of return implicit in the reference tariff.

Interpretation

Expressed more simply and consistent with informal discussion with the AER, the AER economic criterion has that a capital expenditure is justified if:

- The asset attracts sufficient volumes of use such that the revenues generated exceed the asset costs;
- The saving in costs to customers exceed the assets cost.

In relation to costs and benefits:

- Are measured over a suitable time frame and expressed as a NPV using a discount rate implicit in the reference tariff;
- The costs are the economic costs associated with the service provision and not the prices which they may be traded at.

6.3 Economics of Iona UGS and SWP Expansion

Iona UGS is used to supply Victorian and South Australian demand on many days of the year. With the projected decline in Gippsland, Otway and Moomba gas and possible issues with obtaining Queensland gas, the role and importance of Iona UGS will increase in the future.

Iona UGS provides for lower cost gas to be stored during the non-winter months and used in place of high cost gas that would need to be purchased in the winter period. It also provides capacity to be used on very high gas demand days.

Consistent with the above there are two dimensions to the service that can be provided by Iona UGS, these being:

- The maximum daily withdrawal from storage and the pipeline capacity to deliver this to demand (particularly Victoria). The capacity of SWP to Melbourne is a key factor;
- The quantity of gas in storage to provide for Iona UGS to operate throughout a winter period. The capacity of SWP to Iona a key factor to the amount of gas that can be stored prior to the winter period;

  It is noted that gas withdrawn from Iona outside of winter (for GPG demand or producer outages and system maintenance) will need to be replaced ahead of winter. This would require additional SWP capacity to Iona on top of the volume required for winter demand.

These are discussed in turn below followed by the approach to the economic assessment.

6.3.1 Factors to SWP Capacity Value

Capacity of Iona UGS to provide gas

The need for increased flow to Melbourne on the SWP relates to the following:

- The capability of gas supply sources at Port Campbell to utilise any increase in SWP capacity to Melbourne with a projection that has Minerva and Casino ceasing operation and Otway gas on the decline.
- Gippsland and Moomba gas production projected to decline;
- Potential logistical difficulties of obtaining Queensland gas[17];
- Potential increase in Victorian daily demand with the closure of coal power stations and potential increase in GPG in winter;
- Provide economic supply of gas to market. Gas sourced from Moomba and Qld costs more and is more expensive to ship.

Capacity to Fill Iona UGS

The need for increased flow from Melbourne to Iona on the SWP relates to the following:

- During the months Iona is filled, flow on the SWP to Iona will be increasingly be used to supply SA demand from Gippsland and well as transporting Gippsland gas to storage. This is very different than historically where most of the gas in storage was provided by Casino gas and Otway gas was sufficient for supply to Adelaide (via SEAGas).
- The amount of gas in storage will have a higher value as the ongoing requirement for supply from Iona UGS will increase over the winter period;
- The quantity of Gippsland gas that is available to fill Iona UGS outside of the winter period.

6.4 Approach to Economic Assessment

The approach to the application of the AER test presented in this report consisted of identifying the criteria to be used and the assessment/ modelling approach to undertake. These are described in turn below.

6.4.1 Assessment Criteria

Consistent with the AER test, the economic assessment consisted of three aspects:

SWP Increased Capacity Use

This was assessed through the modelling and participants aggregate intentions.

Gas Supply Security

This is based on the consequences if Iona UGS does not have sufficient gas prior to the winter period.

This involved assessing the minimum SWP capacity (in both directions) that will be required for gas supply security (i.e. that without the identified upgrade would results in a high probability that gas demand would need to be curtailed);

Economic Cost

This is the economic cost of using Queensland gas in place of Gippsland gas, both during the refill process and when gas is required to supply demand. The distinction is made between economic costs and the prices (which may be very much higher than economic costs).

[17] This observation was made those of the participant group involved in such processes.

The economics of these two issues as described above are shown in the table below.

Table 6 Cost changes associated with increasing the capacity of UGA and the SWP

Factor	Value
Change in gas production – Moomba to Gippsland	$3.5/GJ Based on $1 commodity and $2.5/GJ transport.
Change in shortfall gas	Measured in TJ not supplied The value of load not supplied in Victoria is $800/GJ ($800,000/TJ).

6.4.2 Modelling Undertaken

The analysis and modelling consisted of the following:

- Sequential gas market modelling to investigate the dynamics of filling SWP on an annual basis accounting for the profile of State daily gas demands through a year;
- The use of a "Goal Seek Gas Model" that determined the minimum capacity of SWP to enable Iona UGS to be filled prior to the winter period. The results of this model were checked for consistency with the time sequential model;
- Analysis of gas supply to Victoria during the winter period. This is associated with providing sustainable supply in additional to gas from the Victorian production plants at Otway and Gippsland; and
- Analysis of extreme high day events that utilise peaking gas plant. Such peaking gas plant is not available on a sustained basis.

The following chapter present the modelling and analysis described above.

7. Refill UGS - Sequential Modelling

This chapter presents the time sequential modelling undertaken to quantify the security and economic consequences of not increasing the capacity of SWP for flow to Iona. Time sequential modelling provides for the pattern of Iona UGS storage and pattern of Iona UGS operation to be viewed across time.

Presented are the following:

- The modelling approach and scenarios modelled;
- Brief description of the model used;
- The modelling results.

7.1 Approach

The approach undertaken for the time sequential modelling was as follows:

- Market scenario assumptions for the period 2017 -2026 were developed (these are as described in the scenarios);
- An annual model of the SA/Vic/NSW/Tasmania gas market for the years 2018, 2022 and 2026 were developed;
- For each market scenario the model was run for each year (2018, 2022, 2026) based on the current Iona UGS and SWP flow capacities;
- The following were recorded from the model runs :
  - gas use by source (Longford, Otway, Moomba)
  - gas swing from source (average versus maximum)
  - unserved gas demand (if any);
- The assumption regarding Iona UGS and SWP flow capacities were changed;
- The model was rerun and the factors listed above recorded;
- The change in factors recorded was determined.

The gas model used was the MJA PROPHET Gas Model. This model operates on a daily basis and clears the market based on demands (at demand nodes), pipeline limits and gas supply offer prices. A brief description of the model is presented in Appendix6.

7.2 Model Runs

As described above, the factors that determine the level of refill that can be achieved and the cost of refill can be categorised as:

- Market scenarios;
- Iona upgrade scenarios;
- SWP upgrade scenarios.

The model runs undertaken in terms of market scenarios and Iona and SWP capacities are presented below.

7.2.1 Scenarios

The market scenarios:

- Used the gas demand projections described in Section 4.4 in all the model runs;
- Had two market scenarios based on different levels of Gippsland and Otway gas production in each of the three years modelled. These scenarios are shown in Table 7 below. The range of scenarios accounted for:
  - Gippsland: projection of Longford and Yolla gas and the possible developments such as Sole
  - Otway: the decline and limited option for new gas developments;
- These scenarios were intended to cover the possible production levels and gas availability over the period 2018 to 2026.
- Moomba / Queensland gas was schedules only to supply gas demand that would not have been supplied otherwise.

Table 7 Market Scenarios Modelled Production Capacities TJ/day

		2018	2022	2026
Scenario 1	**Longford**	1024	1024	1024
	Otway	160	100	60
Scenario 2	**Longford**	1024	880	880
	Otway	160	100	60

7.2.2 Iona and SWP Capacities

The assumed upgrades for Iona UGS and SWP these were as follows:

- Iona upgrade as Table 5;
- SWP upgrade as per Option 5a.

7.3 Time Sequential Model Outcomes

Figure 7 and Figure 8 respectively show the modelling results for Scenario 1 and Scenario 2, with the top graph showing the outcomes under no upgrade of UGS or SWP and the bottom graph showing the outcomes with the upgrades included. Each of the graphs shows the weekly outcomes of storage level and gas injected and withdrawn from UGS:

- The weekly storage level (green line);
- The weekly volume of gas injected to storage (blue shading);
- The weekly volume of gas withdrawn from storage (red shading).

Figure 7 Scenario 1: 2018, 2022, 2016 Iona Level, withdrawal and injection

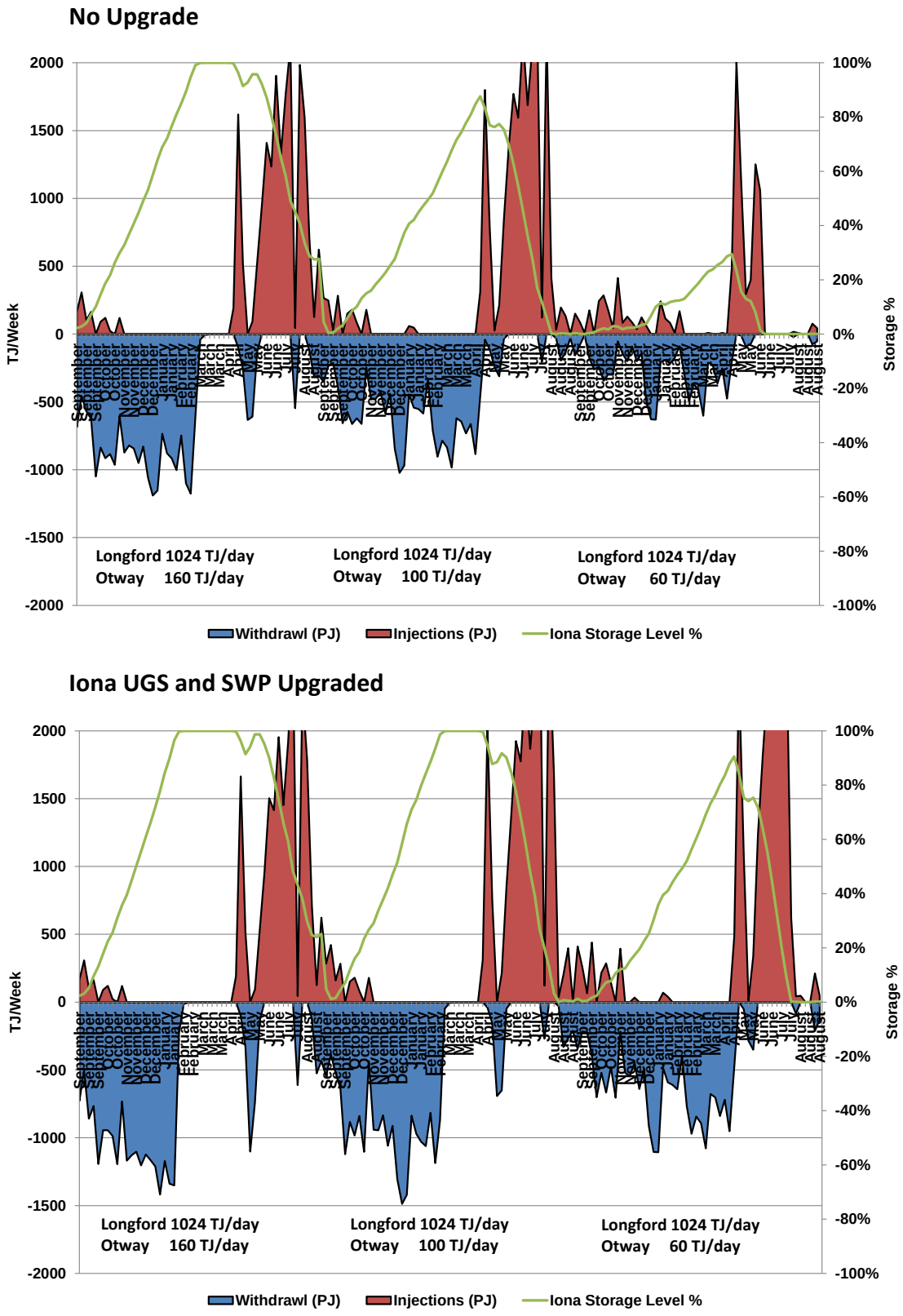
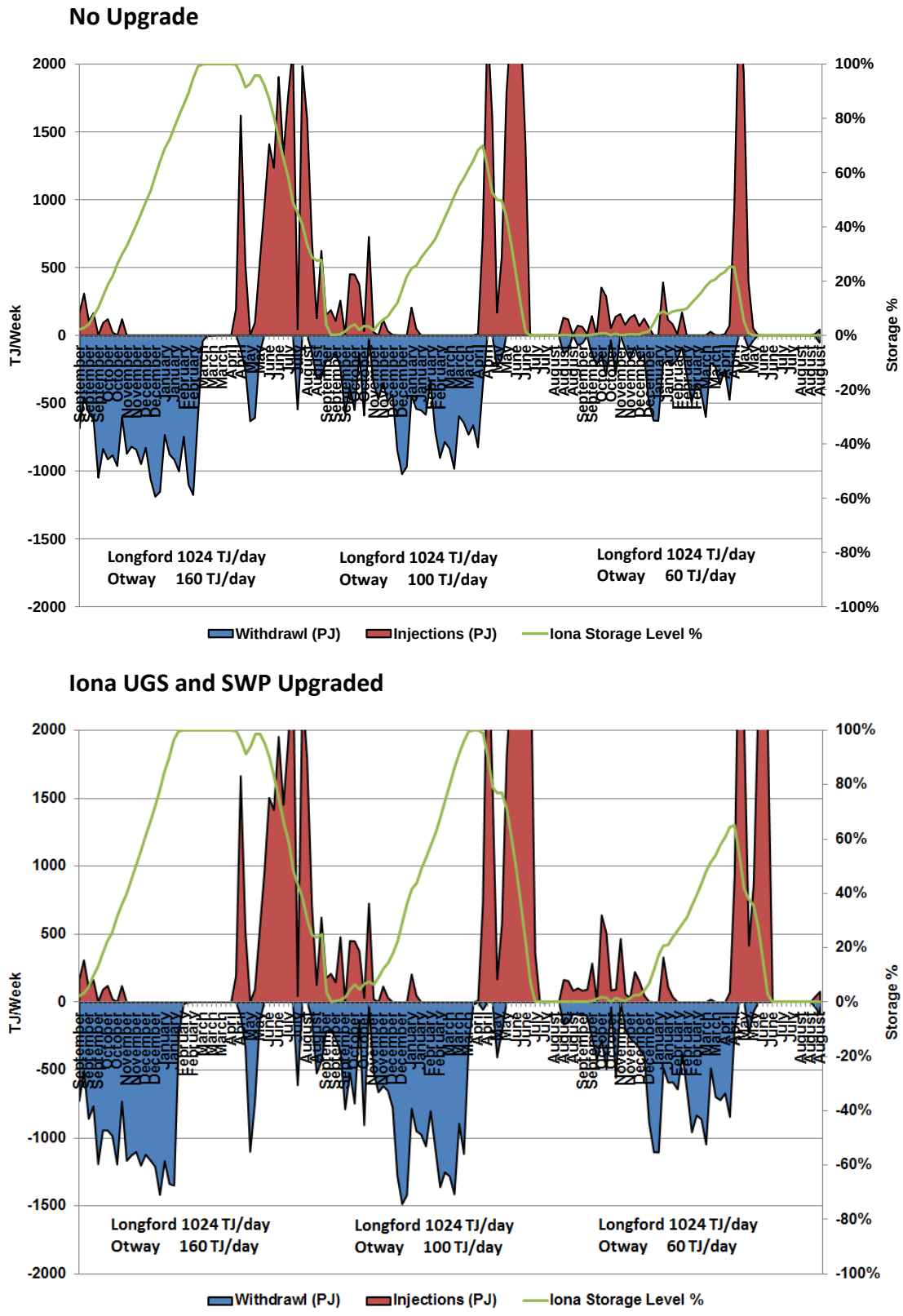


Figure 8 Scenario 2: 2018, 2022, 2016 Iona Level, withdrawal and injection



7.4 Summary of Modelling Results

The results of the modelling are summarised in Table 8 and Table 9. These tables present the key outcomes of the modelling based on:

- No upgrade to Iona UGS or SWP (Table 8); and
- The assumed Iona UGS and SWP upgrades being included (Table 9).

In relation to the outcomes shown:

- Max UGS – this is the level of Iona UGS storage achieved prior to the winter period;
- Gippsland Gas – this is the total Gippsland gas production in PJ (gas used to both fill UGS and also to supply gas demand)
- Moomba - this is the level of Moomba or Queensland gas used to supply SA, Victoria and NSW demand in PJ

Table 8 Results – Current System (No Iona UGS or SWP Upgrade) PJ

		2018	2022	2026
Scenario 1	**Max UGS (% Full)**	100%	84%	27%
	Gippsland Gas (PJ)	329.4	339.3	340.2
	Moomba (PJ)	1.9	6.9	27.7
Scenario 2	**Max UGS (% Full)**	100%	66%	24%
	Gippsland Gas (PJ)	329.4	316.9	318.2
	Moomba (PJ)	1.9	29.2	49.7

Table 9 Results – SWP and Iona UGS assumed Upgraded PJ

		2018	2022	2026
Scenario 1	**Max UGS (% Full)**	100%	100%	85%
	Gippsland Gas (PJ)	331.3	343.9	355.8
	Moomba (PJ)	0.2	2.7	12.3
Scenario 2	**Max UGS (% Full)**	100%	99%	61%
	Gippsland Gas (PJ)	331.3	323.8	328.6
	Moomba (PJ)	0.2	22.4	39.4

Table 10 presents the changes between the expansion and no expansion cases, and Table 11 presents the associated change in storage level in J and costs based on the values presented in Table 6.

Table 10 Results – Change due to Iona UGS and SWP Upgrade

		2018	2022	2026
Scenario 1	**Max UGS (% Full)**	0%	16%	58%
	Gippsland Gas (PJ)	1.86318	4.59591	15.57903
	Moomba (PJ)	-1.65383	-4.17263	-15.4168
Scenario 2	**Max UGS (% Full)**	0%	33%	37%
	Gippsland Gas (PJ)	1.9	6.9	10.4
	Moomba (PJ)	-1.7	-6.8	-10.3

Table 11 Results – Reduction in Gas Short and Annual Costs due to Iona UGS and SWP Upgrade

		2018	2022	2026
Scenario 1	**Gas in Storage PJ**	0.0	3.8	13.3
	Cost $M	$0	$13	$46
Scenario 2	**Gas in Storage PJ**	0	7.6	8.5
	Cost $M	$0	$27	$30

The results show the following:

- With Longford at 1024 TJ/day and Otway at 160 TJ//day (continuously) there is sufficient gas to fill the UGS storage;
- With reductions in both Longford gas and Otway gas the ability to fill will be greatly reduced;
- With any reduction from this assumed level of Gippsland and Otway production level or increase in gas demand, it is not possible to fill the UGS storage. Increasing both Iona UGS and SWP as per the assumption provides for Iona UGS fill to be substantially increased. However under conditions of Otway gas at only 60 TJ/day there is insufficient gas to fully fill Iona UGS.
- Replacement gas will be required from either Moomba and/or Queensland. The cost of the replacement gas would be in the order of $13M to $46M depending on the assumptions of Longford and Otway production capacity.

While not shown above the modelling also showed the following:

- The level of SA demand is a critical issue as it influences the amount of gas flowing on SEAGas (to Adelaide) and not flowing into storage;
- The level and profile of Victorian daily demand highly influences the level and number of days gas is available for filling Iona UGS (this is examined in the next chapter).

8. Refill Iona - Minimum SWP Capacity

The previous chapter presented the results of gas market modelling to illustrate the profile of Iona UGS operation without and with SWP (and Iona) upgrades and to quantify the future difficulty Iona UGS will have in refilling storage each year and the economic cost of this.

This chapter builds on that by undertaking modelling designed to determine the minimum size of the SWP to provide for Iona UGS to be filled on the basis that Iona UGS is not upgraded. The modelling also considers the sensitivity of the profile of daily gas demands to the required flow capacity of SWP.

8.1 Goal Search Gas Model

A goal search gas market model of SA/Victoria/NSW was utilised to investigate the minimum size of the SWP capacity to Iona required to enable the Iona UGS storage to be filled, assuming that Iona UGS is not upgraded. The model provides for Moomba or Queensland gas to be used after all gas sources in Victoria are used.

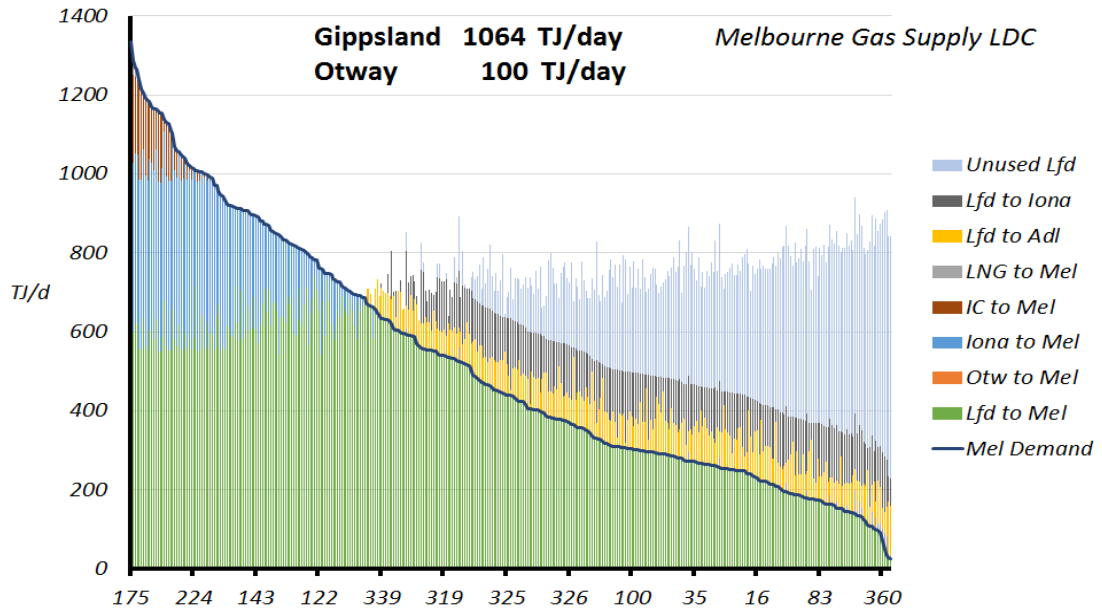
This model operates on a daily basis over a year and schedules gas production to satisfy the Victorian demand and to fill Iona UGS. The rules implemented for this application mirrored the priorities in the market and were as follows:

- Gippsland gas to Sydney;
- Gippsland gas (remaining) to Melbourne;
- Otway gas to Adelaide;
- Otway gas (remaining) to Melbourne;
- Iona gas to Melbourne (if required);
- NVI gas (assumed to be from Moomba/Queensland) to Melbourne (if required);
- Dandenong LNG to Melbourne (if required);
- Iona to Adelaide (if required);
- Otway gas (remaining) to Iona UGS;
- Gippsland gas (remaining) to Iona UGS.

A diagrammatic output of the model is shown Figure 9. The legend to the graph describes the results shown. Of particular note are the following:

- The Victorian demand is presented as a demand duration curve (i.e. ordered from high demand to lowest demand;
- The brown lines at the top is the gas required from Moomba or Queensland;
- The yellow along the Victorian demand curve is the Gippsland gas to storage and the grey lines above the yellow is the Gippsland gas to UGS. In the case shown the SWP has been upgraded allowing the yellow plus grey capacity to be higher than 102 TJ/day.
- The light below (above the grey line) is the unused Gippsland gas.

Figure 9 Diagrammatic Output of the Goal Search Gas Model



8.2 Assumption Used and Results

In additional to assumptions on Gippsland and Otway gas production, the assumptions used in this model included the profile of daily Victorian gas demand through the year. The profile of daily gas demand is important as it influences the profile of available Gippsland gas (once demand has been met) that can be used to fill Iona UGS and the profile of total production capacity required to supply winter demand.

Two assumptions were used in respect of the Victorian daily demand profile:

- The Victoria daily demand profile observed in 2013 and called to the annual energy projected in the NGFR 2016 for 2017;
- The Victoria daily demand profile that has the same annual energy and MDQ as projected in the NGFR 2016 for 2017.

8.2.1 No SWP Upgrade – Outlook for Level of Iona Fill

Before the Goal Search Gas Model was used to determine the minimum size of SWP capacity required to fill Iona UGS (under various assumptions), the Goal Search Model was used to support the modelling undertaken in the previous chapter by determining the amount Iona UGS can be filled under similar assumptions.

The results of this modelling are shown in Table 12 overleaf. This table shows for the assumptions of Gippsland and Otway capacity and Victorian demand profile, and based on the SWP and Iona UGS not being upgraded, the amount of gas that can be put to storage prior to the winter period. Also shown is the assessed cost of replacing this gas with Queensland gas.

Diagrammatic model outputs for all cases based on the 2013 daily demand profile are shown in Appendix 7. This illustrates the changing nature of market operations under the different assumptions.

The results indicate the future issues and high cost of failure to have SWP capacity to fill Iona UGS.

Table 12 Results: Level of Iona UGS Fill under the Assumptions Shown

Victorian Gas Production TJ/Day		Results – Level UGS is filled PJ		Results – Cost
Gippsland Production Capacity	Otway Production Capacity	NGFR 2016 Victoria Demand Profile	2013 Victoria Demand Profile	$M per year
1064	160	19.8	17.9	$21
1064	100	6.2	5.6	$60
1064	60	.7	.7	$76
920	160	17.4	12.6	$33
920	100	5.4	3.8	$64
920	60	0.6	0.5	$76

8.2.2 Minimum SWP Capacity to Fill Iona UGS

The Goal Search Gas Model was used to determine the minimum size of SWP for flow to Iona in order that Iona UGS can be filled using Gippsland Gas. The assumptions used and results are shown in Table 13.

The results shown that with any reduction in either Gippsland or Otway capacity that SWP would need to be upgraded by more than the capacity provided to Option 5a.

Not doing so would risk both high cost and gas supply security.

Table 13 Goal Search Gas Model – Assumptions and Results

Victorian Gas Production		Results – Minimum SWP Capacity to Iona	
Gippsland Production Capacity	Otway Production Capacity	NGFR 2016 Victoria Demand Profile	2013 Victoria Demand Profile
1064	160	128	142
1064	100	194	223
1064	60	239	Cannot be filled
920	160	146	191
920	100	222	Cannot be filled
920	60	280	Cannot be filled

9. MDQ Sufficiency

The purpose of this chapter is to assess the role and required future capacity level of SWP (for flows to Melbourne) in the future.

MDQ sufficiency refers to having sufficient gas production capacity, including stored gas, to supply gas on days on high gas demand. This requires the gas system to provide:

- Sufficient available and firm capacity supported by gas (production or storage) that can be use on an ***ongoing basis*** to supply high demands through the winter period. This report refers to this as "sustainable capacity". This includes all gas production facilities in Victoria and NSW, and Iona UGS. It excludes LNG and parked gas on pipelines.
- Moomba and/or Queensland gas is treated separately. The reason for this is the question in relation to its availability and sustainability over a winter period. The advice from the participant group is that both the logistic and gas availability result in obtaining gas from Moomba or Queensland very difficult if at all possible.
- Peaking capacity that may only be available for 3 or 4 days over the winter period. This peaking capacity is reserved for days of extreme demand and/or when supply may be curtailed. This includes LNG and parked gas on pipelines.

These issues are considered in turn below and their implication to SWP capacity needs for flow to Melbourne.

9.1 Victoria - Sustainable Capacity Needs

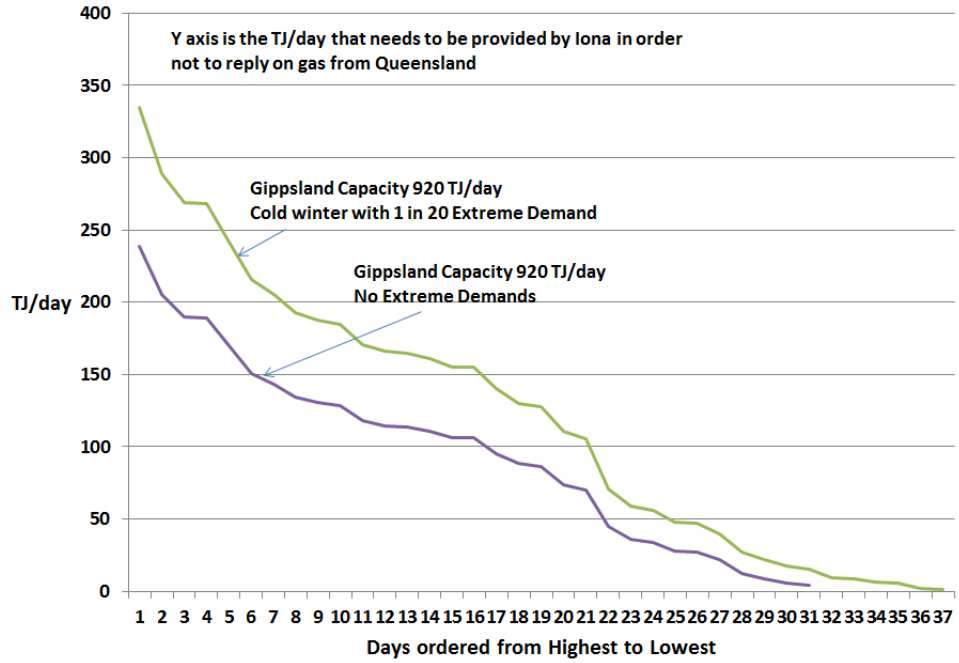
The sustainable (i.e. day on day) gas capacity required to supply Victorian winter gas demand above that provided by Gippsland (via the LMP) and Iona UGS/Otway (via the SWP) can readily be determined. This is the daily Victorian demand less committed Gippsland gas to Sydney (via the EGP) and less the current capacity of SWP. The profile of Victorian daily gas demand is relevant as higher average winter demands would increase this need.

This has been developed for the top 40 days of Victorian gas demand over the winter period on the assumption the sustainable capacity from Gippsland is 920 TJ/day and under two profiles of Victorian daily gas demand. To two profiles represent a year with extreme gas demands and a year that does not have extreme gas demands. This is shown in Figure **10** below.

To be clear, the graph shows the amount the Victorian demand (ordered from highest to lowest) is above the capacity of Victorian production facilities based on Gippsland at 920 TJ/day and the SWP at 430 TJ/day (being supplied by Iona and Otway gas). The additional capacity shown would be required to come from gas from Moomba or Queensland. The firmness of this gas directly relates to the firmness that gas can be sourced from Moomba and/or Queensland.

Chapter 2 of this report noted the commitment of Moomba and Queensland gas to LNG supply and the potential issues in obtaining this gas that can be relied upon for day to day provision.

Figure 10 Victoria – Sustainable Capacity Requirements additional to South State Sources, including SWP Capacity at 430 TJ/day



To the extent that Moomba or Queensland cannot be considered **firm** then additional gas production would be required. Supply to Sydney/NSW on the EGP is committed and is not available to Victoria. This means the only option is additional gas supply capacity from SWP being supplied by an upgraded Iona UGS.

It was outside of the scope of this report to assess the firmness and arrangements that would be required for gas from Queensland to be treated as available and firm. However the following are noted:

- Firm gas does require contractual arrangements between parties. As available spot gas does not qualify as firm;
- The participant group stated that obtaining Queensland gas is not readily done and is unlikely to be available on short notice.

On the basis that Moomba or Queensland gas is not considered firm, the analysis above shows that SWP will be needed to be expanded to 570 TJ/day and that additional capacity in additional to this is likely to be required.

9.2 Extreme Day Gas Supply

The supply of gas on very high demand gas days is different than supplying day to day winter demands. This can require all production facilities including the use of LNG (at Dandenong and Newcastle) and parked gas on pipelines (e.g. EGP, MSP, TGP). LNG and parked gas services are used sparingly as these can be exhausted in a few days after which it may take many months to refill and only when there is spare gas available to do so.

To review the projected position of the market on such days two assessments are presented below:

- A "static" analysis that assumes that all peaking gas sources are available. This is a best outlook assessment;

- A dynamics analysis that considers how peaking gas sources may be used and rationed over a week of cold weather and very high gas demands.

9.2.1 Static MDQ Assessment Table

Static MDQ adequacy tables were developed on the assumption that all storages are full (parked gas, LNG), available, and are used with perfect foresight (the daily demand is not known until the day is complete).

MDQ analysis needs to consider both the total SA/Victoria/NSW/Tasmanian gas market demand and also Victoria demand alone. The analysis presented in Table 14 below is undertaken under two cases, the first assumes the current production levels at Longford and Otway and the second reduced production levels at Longford and Otway.

With gas demand levels projected to remain fairly unchanged for many years the balance is indicative of the gas market moving forward. The adequacy of all gas sources to supply daily maximum demand at the 1 in 20 and 1 in 20 level are shown and expressed as a surplus of daily gas production. For the purpose of this table Moomba gas is assumed available to the market at the levels shown (which is 300 TJ/day to the market and 132 TJ/day to Victoria via the NVI).

Table 14 MDQ Analysis – SA/Victoria/NSW/Tasmania TJ/Day

	SA/Vic/NSW		Victoria	
	Current production	Reduced Production	Current production	Reduced Production
Longford	1024	880	1024	880
Yolla	50	50	50	50
Otway (to SA)	160	100		
Iona UGS	430	430	430	430
Moomba	300	300	132	132
Camden	15	15		
LNG Vic	158	158	158	158
LNG NSW	100	100		
Parked gas (TGP)	100	100	100	100
Parked gas (NSW SA)	100	100		
From Vic - EGP/TGP			-360	-360
From Vic - SEAGas			-160	-100
Max Demand 1in 20	2200	2200	1319	1300
Max Demand 1in 2	2000	2000	1209	1190
Surplus MDQ 1in 20	237	33	55	-10
Surplus MDQ 1 in 2	437	233	165	100

The balance shows that that even with all peaking sources used, the balance is tight for a 1 in 20 gas demand day. Gas from Moomba or Queensland is required if demand is to be met.

9.2.2 Dynamic MDQ Sufficiency

A dynamic analysis considers how gas would be supplied over a number of days, thus providing for recognition of how peaking gas sources may need to be rationed over this time.

An analysis, which is for four consecutive days resulting in a 1 in 20 maximum daily demand on the third day, is shown in Table 16. This is shown firstly for Longford and Otway and their current levels and secondly at reduced levels.

The Victorian supply is taken as Gippsland gas less flow on the EGP, maximum flow on the SWP to Melbourne, peaking gas supply such as LNG, and gas from Queensland.

The analysis indicates that Moomba gas is required and that the level could be over 400 TJ/day on the 1 in 20 demand day.

We note that information from the participant group emphasised the difficulty to consistently source gas from Moomba and Queensland to supply southern states.

Table 15 MDQ Analysis – Gas Supply to SA/Victoria/NSW/Tasmania over four High Demand Days and two scenario of Victorian Supply Capacity

	Current LongFord and Otway Levels				Reduced LongFord and Otway Levels			
Day No	1	2	3	4	1	2	3	4
Demand Vic/Tas	1200	1270	1330	1100	1200	1270	1330	1100
Demand SA	300	350	350	350	300	350	350	350
Demand NSW	400	480	570	350	400	480	570	350
Longford	1020	1020	1020	1020	880	880	880	880
Yolla	40	50	50	40	40	50	50	40
Otway	160	160	160	100	160	160	160	100
Moomba	39	165	306	195	99	265	437	314
Camden	15	15	15	15	15	15	15	15
LNG Vic	50	60	158	0	50	50	158	21
LNG NSW	35	50	100	0	35	50	120	0
Parked gas for Vic	11	50	11	0	91	100	0	0
Parked gas for NSW/SA	100	100	0	0	100	100	0	0
Iona UGS	430	430	430	430	430	430	430	430
EGP/Tas	-351	-351	-351	-351	-351	-351	-320	-351
NVI (to Melb)	0	11	12	11	60	111	132	130
SEAGas to SA	-160	-160	-160	-150	-160	-160	-160	-150
MAPS (to Adl)	140	190	190	200	140	190	190	200
MSP1 (to Syd)	-101	-25	116	-5	-41	75	247	114
MSP2 (to Syd)	-101	-36	104	-16	-101	-36	115	-16
SWP Flow	430	430	430	380	430	430	430	380

9.3 MDQ Development Options and role of the SWP

This chapter has identified the daily gas supply capacity required to be provided on an ongoing basis during winter and also under extreme and infrequent high gas demand days.

The capacity requirement has been on the basis that Moomba and Queensland gas may not be available. This report has also note that while there is gas in Queensland to supply Victoria, the participant group has provided their experiences that indicates that such gas may not be available and should not be considered as firm.

10. Impact to TUOS Charges

In the Victorian gas market use of the transmission system is paid through Transmission Use of System (TUoS) tariffs. (The TUoS charges for 2017 are presented in Appendix 5.)

These tariffs are understood to be based on[18]:

- Injection to the VTS reflecting the cost of capacity. This has the injection tariff based on payment only during the 10 highest demand days;
- Withdrawal from the VTS reflecting the customer paying for the costs of the pipeline. This has the withdrawal (i.e. delivery) tariff based on payment for withdrawals from the VTS on all days.

TUoS tariffs are revised each calendar year to reflect investments that may have been made to the VTS. When TUoS charges are revised, AEMO and the AER undertake reviews to ensure that that cost recovery matches projected expenditures (operations and capital) based on the expected demand outlook and expected gas injections from the gas supply sources.

APA provides the basis for and explanation of the development of the TUoS tariffs in their access arrangement (titled "victorian transmission system, access arrangement submission", APA, dated 3 January 2017). Chapter 10 "Revenue allocation and tariffs" deals with TUoS charges. Three selected pieces from that chapter are as follows:

> "As the DWGM allocates pipeline capacity by the operation of the bidding process for gas, tariffs are necessarily flow based, as market participants cannot reserve capacity under contract for their exclusive use;"
>
> "Investment in system augmentation - transmission prices should signal efficient new investment in the pipeline system;"
>
> "South West Pipeline
>
> A separate regime applies to the SWP. The cost allocation for the SWP was approved by the ACCC for the second access arrangement period. The ACCC acknowledged that the SWP provided both direct benefits of connecting a new gas source (both the Lochard Underground storage facility and new production) to the VTS and system wide benefits of inter basin competition in the wholesale gas market and enhanced system security in the event of supply disruption. The ACCC approved a cost allocation for the SWP consisting of a 50 per cent allocation directly to the injection pipeline and 50 per cent to be allocated to the VTS as a whole on a postage stamp basis.
>
> The AER's final decision for the current access arrangement period approved a change to this allocation to take account of investment and throughput on the SWP. APA VTS had proposed a higher allocation to the SWP (75 per cent), but the AER rejected this allocation and instead decided that the Port Campbell injection tariff be set in relation to the Longford injection tariff, with the allocation of rolled out costs not to exceed 50 per cent.178 In applying these considerations to final tariffs, the final allocation of rolled out costs to the SWP in the current period was 41.5 per cent. APA VTS has applied the same considerations to setting the SWP tariff in the forecast period. To achieve an injection tariff that is commensurate with the Longford injection tariff, the proposed allocation of rolled out costs is 21.5 per cent."

[18] This is the understanding of Marsden Jacob noting that there is no known literature on this.

From the structure of TUoS and information provide in the APA submission we make the following observations.

Increased SWP capacity to Iona

In relation to SWP capacity to Iona:

- The works associated with this capacity do not provide other benefits to the VTS which means that the costs would be directed to withdrawals at Iona;
- It would be expected that an increase in this capacity would result in increased flows to Iona (i.e. the increased capacity would be used).

This would indicate that:

- TUoS rates would be moderate;
- The upgrade would satisfy Rule 79 of the National Gas Rules.

Increased SWP capacity to Melbourne

- In relation to SWP capacity to Melbourne the injections charges would reflect at least 50% of the cost of an SWP upgrade;
- The usage of SWP capacity for flows to Melbourne would be unlikely to exceed the current limit of 430 TJ/day very often;
- Payments for this would be on the basis of injections being paid on the 10 highest demand days (by the parties injecting on those 10 highest demand days).
- The works associated with increasing SWP flow to Melbourne such as the WORM provide other benefits and thus would be socialised across the market.

11. Capital Expenditure

As part of the Victorian assess arrangements the AER review and allow or disallow capital expenditures. The AER allow capital expenditures subject to Rule 79 of the National Gas Rules. The criteria contained in that rule have been discussed. Importantly capital expenditure is associated with specific projects.

Once the capital expenditure has been allocated there is no rule in the National Gas Rules that specifically require how the capital expenditure will be spent. This is a short coming of the National Gas Rules. It effectively forces stakeholders to review projects – assessing and commenting on their appropriateness – with no capacity or capability to ensure that those capital works are completed once approved. Also importantly some capital expenditures may be critical to gas supply security.

It is understood that the reasoning for this approach is twofold:

- Firstly that the AER does not have" line of sight" of a regulated entities capital works program (and should not have responsibility for directing it); and
- Secondly it creates an incentive on the part of the regulated entity to not invest in the capital works if it determines they are no longer required.

A good example of this is the Brooklyn Compressor station upgrade which was first identified by APA in 2007 and subsequently approved by the ACCC in 2008-12 access determination. Marsden Jacob understand in discussion with AEMO that subsequently to completing capital works at Brooklyn, APA directed to spend less money on addressing pressure and safety issues and not increasing capacity to transport gas to Iona for underground storage refilling.

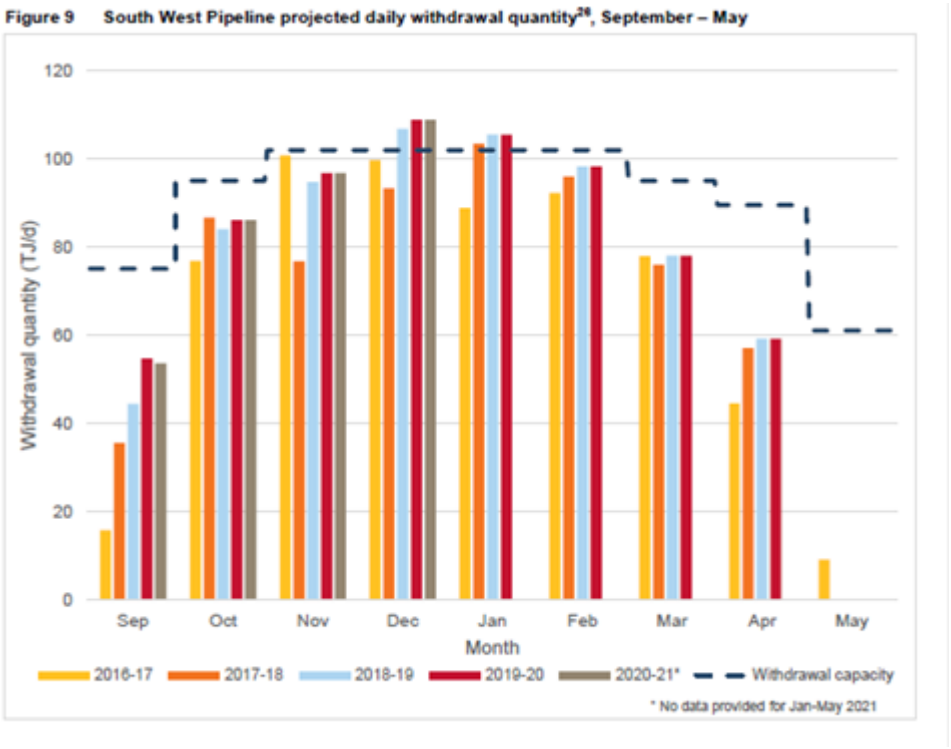
The following figure, prepared by AEMO, underscores the need for this investment to still occur (AEMO, Victorian Gas Planning Report pg. 19 - http://www.aemo.com.au/Gas/National-planning-and-forecasting/-/media/DE3789E9F970422A985EB2DE2E060B87.ashx). The proportion of the bar sitting above the dashed line is AEMO's forecast of the shortfall in the withdrawal quantity against the withdrawal capacity.

Accordingly, Marsden Jacob would recommended that the AER be asked to comment on whether the existing regulatory settings should be amended in order to provide stakeholders with sufficient confidence that a regulated entities capital works program, once approved, actually takes place ,particularly when such worms are identified as being required (for specific purposes).

We understand that there is still merit in the Brooklyn investment being completed as it would improve outcomes for both gas and electricity markets. Specifically, the capital investment would:

- Assist the reduce congestion on the South West Pipeline;
- Promote further competition in the gas market by unlocking capacity on pipelines; and
- Diversify the gas supply mix for South Australia electricity supply , which is moving towards increased reliance on gas fired generation to manage the transition to greater reliance on intermittent renewable energy generation capacity.

Figure 11 Figure from AEMO 2016 VGPR[19]



In relation to capital expenditures on identified works on the SWP, inclusion of such capital expenditures in the access arrangements would be understood by all parties paying for access that the precise development works would be undertaken. Failure to undertake the precise works may have significant consequences for gas supply adequacy and retail risk management for reasons only fully appreciated by these parties. This is critical in a gas system that is becoming very tight.

The critical nature of the upgrades needed on the SWP should mandate that the works (and capital expenditures) that were the basis of approved capital expenditure are actually undertaken. This would require expenditures to be paired with specific works and that such expenditure would not be available for other uses.

It is recommended the Gas Market Rules be modified to ensure that capital works contained within an access undertaking be undertaken, and that the AER review the relationship between capital spent and the capital work the access was based.

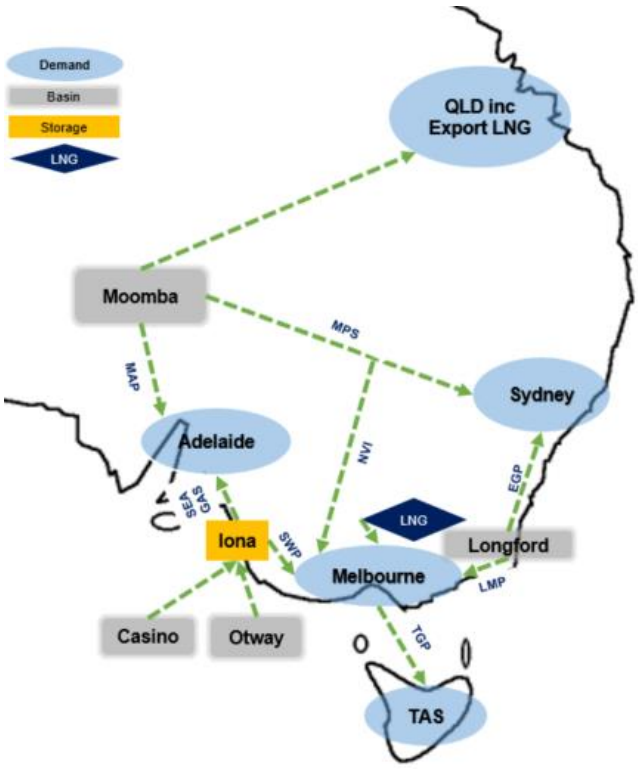
[19] AEMO, Victorian Gas Planning Report pg. 19 - http://www.aemo.com.au/Gas/National-planning-and-forecasting/-/media/DE3789E9F970422A985EB2DE2E060B87.ashx

12. Appendix 1 The SA, Victoria and NSW Gas Market

This chapter describes the supply, transport and demand profile of the SA, Victoria, NSW and Tasmania gas market. .

Figure 12 presents a diagram of the gas supply sources and pipeline network in Victoria, SA, NSW and Tasmania. Queensland is shown as a supply source / demand.

Figure 12 Gas Supply in SA / Victoria / NSW



Source: Marsden Jacob Associates

12.1 Market Separation - Queensland and SA/Victoria/NSW

The East Australia gas market can be considered to be divided into two main areas, these being (1) Queensland and (2) the States of SA, Victoria, NSW and Tasmania. These two areas are connected through Moomba by the South West Queensland Pipeline (SWQP). This pipeline has a daily flow limit of 404 TJ/day.

The operation of the Queensland market is dominated by the gas demand of the Liquefied Natural Gas (LNG) trains and the development of Coal Seam Gas (CSG) to supply these trains. This balance largely determines the flow on the SWQP and the price for gas purchases and sales at Moomba.

South of Moomba (i.e. NSW, Victoria, SA and Tasmania) the demand and supply of gas is determined by:

- Gas demand in SA/Victoria/NSW/Tasmania;
- Gas supply sources in Victoria and South Australia (Moomba); and
- The amount of gas that can be obtained from Moomba and/or Queensland to supply non-Queensland gas demand. Looking forward this will be influenced by CSG developments in Queensland, the rate of Moomba gas decline, and the timing when all six trains are operating at full capacity[20].

12.2 Gas Supply Sources

The gas supply sources by gas field, production plants and estimated production costs in SA/Victoria/NSW are shown in Table 17 below.

The estimated gas production costs were developed by Core and published by AEMO in the Gas Statement of Opportunity (GSOO) report. These are discussed in Section 2.2.5 below.

Table 17 Gas Production Facilities in SA/Victoria/NSW

Gas Field	Production Plant	State	Description	Gas Cost $/GJ
Bass Straight	Longford Gas Plant	Vic	Existing	$4.50
Kipper Tuna Turrum	Gas Conditioning Plant and Longford Gas Plant	Vic	Gas Conditioning Plant capacity is 800 TJ/day	NA
Yolla	Lang Lang	Vic	BassGas Project	NA
Otway	Otway Gas Plant capacity is 205 TJ/day	Vic	In decline	$3.70
Otway	Iona Gas plant	Vic	Due to finish in 2018	-
Otway	Minerva gas Plant	Vic	Due to finish in 2017	-
Copper Basin	Moomba Gas Plant	SA		$5.30
Camden	Camden gas Plant	NSW	Small supply near Sydney	
None	Iona Gas Plant	Vic	Iona underground Gas Storage	$3.70
None	Dandenong LNG	Vic	LNG storage	High
None	Newcastle LNG	NSW	LNG Storage	High

Source: Core data, Marsden Jacob

To illustrate the gas production profile of the main gas production sources,

Table 18 presents the winter and non-winter period maximum and average production from Longford, Otway and Moomba gas. This is followed by a discussion of these gas production sources.

While not shown in the table above, gas from Queensland can be supplied to SA/Victoria/NSW, although such gas may not be considered firm. We note that Origin and Santos control significant quantities of CSG production in Queensland.

[20] Currently GLNG is operating two trains at about 50% capacity.

Table 18 Gas Production 2016: Average TJ/day, Maximum TJ/day, and Swing (%)

	Longford	Otway	Moomba
Winter: Max Production	1059	184	562
Winter: Average	1005	83	342
Non winter: Max Production	1030	184	326
Non Winter: Average	775	103	182
Winter: Swing	5%	121% (1)	64%
Non-Winter: Swing	33%	77%	79%

Note (1) The New Halladale & Speculant gas fields came in winter 2016 resulting in a higher potential daily rate understood to be 184TJ/day. Otway usually operates without much swing.

12.2.1 Gippsland fields and Plants

The Gippsland gas fields consist of:

- Bass Straight gas fields and Longford Gas Processing Plant.
- Kipper Tuna Turrum (KTT) project (Esso). This field will augment the existing Bass Straight fields which are in decline. It is understood that the required treatment of gas from the Kipper field[21] and blending with non-Kipper gas will reduce the maximum daily production of Longford to about 880 TJ/day[22].

  This issue is discussed in the report by ENERGYQUEST titled East Coast Gas Market Scenario and Implications for South Australia" and dated 1 July 2016, which states:

  > Gippsland Basin Joint Venture (GBJV) production is assumed to increase over the next four years (Kipper is expected to be commissioned in the second half of 2016), but then goes into a steep decline, from a peak of 289 PJ in 2017 to 164 PJ in 2025. Production from the CO2 prone fields will be limited by the capacity of the CO2 removal plant while the legacy fields that do not require CO2 removal (Marlin, Barracouta and Snapper) are assumed to decline at 20% pa.

  The potential reduction in Longford capacity is a key issue for gas supply security in Victoria, SA and NSW and Tasmania.
- Yolla gas fields and Lang Lang Processing Plant (BassGas project).[23] This is a relatively small facility that has an annual production of about 18 PJ/year.

Gippsland gas is the main gas supply to Victoria (via the LMP), to Tasmania (via the TGP) and to NSW (via the EGP). From the low level of gas swing that is being provided by Longford (compared to the other gas production facilities) we observe that Longford production can be considered as a "base load" gas supplier, particularly during the winter period. During this period daily gas demand variation is being supplied through Iona UGS, Moomba/Queensland and Otway.

[21] The treatment plant has a capacity of 800 TJ/day.

[22] There is no public announcement by Esso/BHP that Longford production capacity will decrease.

[23] Origin

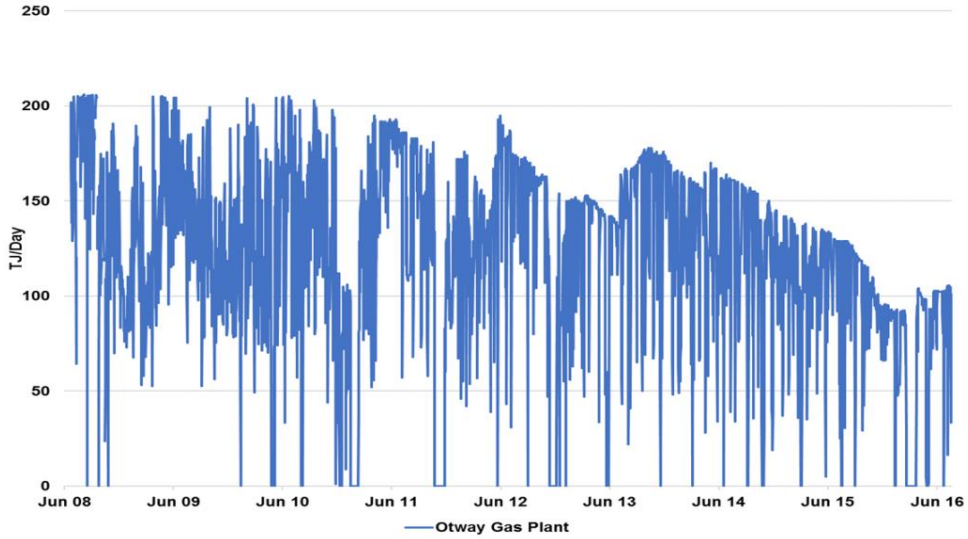
12.2.2 Otway fields and Plants

The Otway gas fields consist of the following:

- The Otway Gas Project which consists of two offshore gas fields, Geographe and Thylacine, and the onshore gas processing facility Otway Gas Processing Plant (near Port Campbell)[24].

  This gas field is in decline as evidenced by the maximum daily output over 2016 of less than 110 TJ/day (Gas Processing Plant has a capacity of 205 TJ/day). Developments are expected to lift production to about 160 TJ/day over the next 2 to 3 years after which it will decline. Figure 13shows the daily production level from the Otway Gas Plant over the July 2008 to June 2016. The decline is clearly evident.

Figure 13 Production from the Otway Gas Plant 2008 to 2016 TJ/Day



This facility is owned and operated by Origin Energy. .

- Casino gas field and processing plant. This gas field is in decline with daily production now about 45 TJ/day (down from about 120 TJ/day in the past). This gas was traditionally used to fill the Iona Underground Gas Storage (UGS). Cooper are the new operator of the Casino fields and have made a public statement that it intends to continue to produce from the fields at 40TJ/day.
- Minerva[25] field and processing plant. This field is in decline and production is understood to finish in 2017. This gas field was the main gas supply to the Pelican Point gas generator.

12.2.3 Cooper/Eromanga fields and Plants

Gas supply from the Cooper basin consists of conventional gas fields, the Moomba processing facility[26] and Moomba Gas Storage. This is operated by Santos.

Prior to the development of the LNG facilities at Gladstone, Moomba gas was the main gas supply source to SA and NSW. Since that time the following has occurred:

[24] There is a wellhead platform on the Thylacine reservoir, a subsea manifold on the Geographe reservoir and a subsea pipeline from the wellhead platform to the onshore gas plant.

[25] Santos

[26] Santos

- The demand for gas by the LNG plants and the shortage of CSG to supply these plants, particularly the Santos GLNG project, has resulted in Moomba gas being sold to supply these plants.

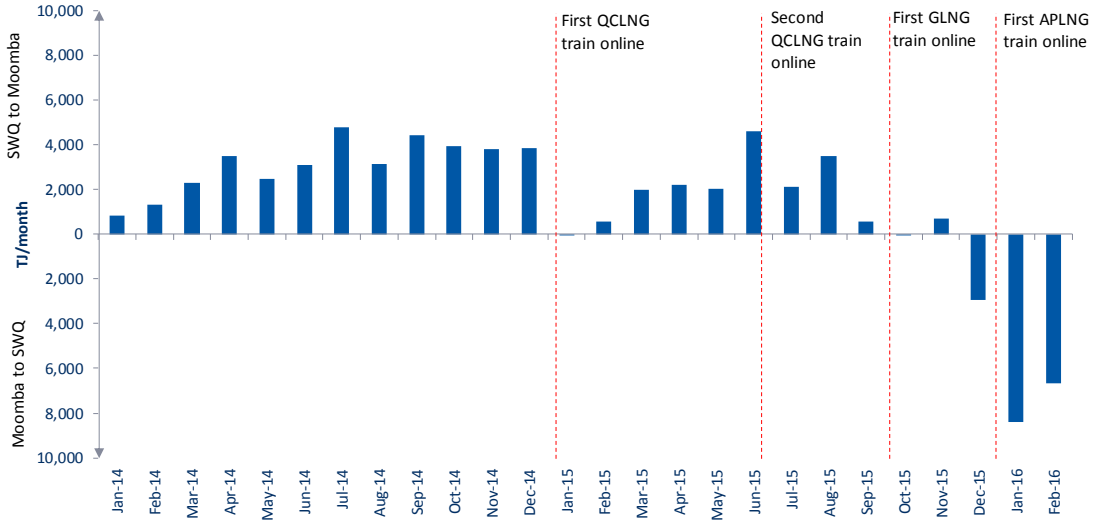
  From the start of 2016 gas flows on the South West Queensland Pipeline (SWQP) commenced flowing at near its full capacity to Queensland. This is shown in Figure 14.

- Gas from Moomba is in decline. The need for Moomba gas production to support the LNG demand, having more gas taken than would be normal practice, may result in the future decline being faster than would normally be the case.

- As of 1 January 2017 all Moomba gas is contracted for flows to Queensland, meaning there is currently no Moomba gas available for use in SA/Victoria/NSW.

Gas from either Moomba or Queensland will be required to satisfy gas demand in SA/Victoria/NSW/Tasmania. What is known is that the current arrangements are meaning that it is difficult to move gas from the LNG plants to the southern States, and this is an important issues to be considered in the volume and capacity needs of SA/Victorian and NSW.

Figure 14 Monthly Gas Flows on the SWQP: 2014 to 2016



The issue of Moomba gas availability is discussed in the report by ENERGYQUEST titled East Coast Gas Market Scenario and Implications for South Australia" and dated 1 July 2016, which states:

> The Cooper Basin is assumed only to produce sufficient gas to meet existing contracts, including the Horizon contract with GLNG. This reflects the significant fall in Cooper Basin drilling activity. The implications of this are that no Cooper Basin gas is assumed to flow to Adelaide after 2016. The Cooper Basin may produce less than the amount assumed if, for example, Santos finds it is cheaper to supply gas from elsewhere. On the other hand, if the oil price recovers to around US$70-80/bbl for a sustained period and drilling costs are reduced, Cooper Basin development would become more viable.

The firm availability of gas from either Moomba or Queensland is a most important issue to security of gas supply to SA/Victoria/NSW/Tasmania. It is also relevant to the need for increase capacity at Iona.

12.2.4 Gas Storage

With the reduction in gas production capacity available to SA/Victoria/NSW/Tasmania, the role of gas storage in the gas market will increase.

The main gas storage facilities are the Iona UGS and the LNG plants (Dandenong and Newcastle). LNG use is restricted to about 5 days each year due to its long refill time (in the order of months).

It is also noted that the TGP was augmented in late 2016 to also provide a gas storage service into Victoria[27]. This storage is for peaking gas only as it is available for one or two days.

Gas production capability in addition to that provided by the gas fields and processing plants in Victoria and NSW is required on most days over the winter period.

This means that the capability to refill Iona UGS and the capacity of this plant to deliver gas to market will be essential to Victorian as well as SA, NSW and Tasmania gas supply security in the future.

12.2.5 Gas Supply Costs

The cost of gas production, and any changes in the costs incurred due to a capital investments are essential to the economics of such investment.

Gas costs are fundamental to the economics of wholesale gas supply and to the economics criteria specified in the National Gas Rules.

Table 17 presented the costs of production from the gas production facilities listed. We note that gas production cost is not the same as the gas price. Cost reflects the resources required to produce the gas while price reflects the monetary value obtained. .

In relation to these costs the following are noted:

- The cost of conventional gas is essentially the cost of exploration, appraisal and development of the wells and processing facilities necessary to produce the gas, divided by the quantity of gas in the reservoir. Offshore gas, tight reservoirs and poor gas quality increase the cost of the facilities and therefore the gas cost.
- Gas that is obtained in associated with liquids (oil, condensate, LPG etc) usually has a lower cost than gas produced without liquids (i.e. dry gas) because of the high value of the liquids.
- The economics for unconventional production is different. The wells are much cheaper, but many more of them are needed and they are less productive than conventional wells. The cost of unconventional gas comes mostly down to the permeability and gas content of the coal. CSG is economic if the average well production rate is above a certain threshold.

[27] It is understood that that the TGP storage service is as follows:

- Up to 150 TJ per day firm;
- Refill rate of up to 100 TJ per day, comprising 40 TJ per day firm and an additional 60 TJ per day as-available; and
- Injection Rate of up to 120 TJ per day firm, and up to 5 TJ per hour MHQ.

12.3 Pipelines

Figure 12 shows the main pipelines in SA, Victorian and NSW. The arrows show the expected direction of gas flow when demands are high. Table 17 presents the pipelines in SA, Victoria, NSW and Tasmania in terms of their name and daily gas flow limits.

The role of each of the pipelines is as follows:

- Longford to Melbourne Pipeline (LMP):
  - supplies Melbourne from Longford and Lang Lang gas processing plants
  - with the EGP directing Longford gas to NSW the LMP has not been constrained for many years;
- NSW Victoria Interconnector (NVI):
  - supplies Melbourne from the MSP using gas from Moomba or Queensland. As previously discussed, gas from Moomba or Queensland is generally not available
  - supplies Qld or NSW using gas from Longford or Otway/Iona;
- Eastern Gas Pipeline (EGP):
  - supplied totally from Longford
  - this is the main gas supply route for NSW / Sydney gas
  - the EGP is contracted near its full capacity of 351 TJ/day;
- Moomba to Sydney Pipeline (MSP):
  - historically the main gas supply to Sydney when Moomba was the main source of gas to Sydney
  - with Moomba gas now being totally contracted to supply in Queensland, future gas supply to NSW or Victoria using this pipeline is dependent on gas developments in Queensland. MSP is expected to provide a small amount of gas to Sydney when needed
  - used to ship gas north to Moomba for supply to Queensland;
- South West Pipeline (SWP):
  - supplies Melbourne using gas from Otway or UGS
  - supplies UGS using gas from Gippsland
  - supplies SA using gas from Gippsland;
- Moomba to Adelaide Pipeline System (MAPS)
  - traditionally supplied SA gas from Moomba;
- South East Australia Gas Pipeline (SEAGas):
  - supplies gas to SA using gas from Otway, UGS or Gippsland;
- Tasmanian Gas Pipeline (TGP):
  - supplies gas to Tasmania
  - recent augmentations to allow bidirectional flow and provide storage service.

Table 19 Pipelines in SA, Victoria, NSW and Tasmania

Pipeline	Abbreviation	From	To	Capacity TJ/d	Reverse TJ/d
Eastern Gas	EGP	Longford	Sydney	351	NA
NSW-Vic Interconnect	NVI	Melbourne	Young	137	132
Longford - Melbourne	LMP	Longford	Melbourne	1,030	NA
Moomba - Adelaide	MAPS	Moomba	Adelaide	209	85
Moomba - Sydney	MSP	Moomba	Sydney)	439	381
SEAGas	SEAGas	Port Campbell	Adelaide	314	NA
Southwest	SWP	Port Campbell	Melbourne	429	102
Southwest Queensland Pipeline	SWQP	Wallumbilla	Moomba	340	404
Tasmanian Gas Pipeline	TGP	Longford	Tasmania	129	NA

The cost of transport is important when comparing the costs supply from various supply sources to demand centres.

In this study the competing supply source to Gippsland and Otway is gas from Queensland. The additional transport costs for Queensland to Melbourne are in the order of $2.5/GJ (or more).

12.4 Demand

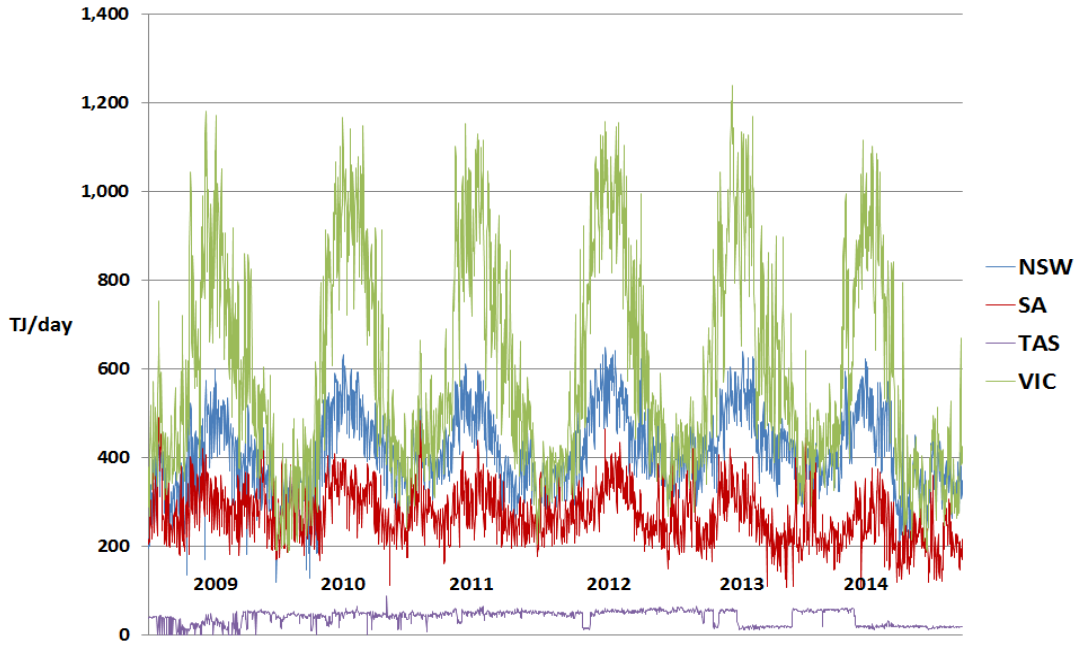
Gas demands are the drivers of pipeline flows from the production facilities. In relation to pipeline usage when cumulated volumes are critical (such as filling Iona UGS) it is average daily demands that are important. For supplying extreme days it is the level of demand on these days that is relevant.

Figure 15 shows a graph of daily gas demands for SA, Victoria, NSW and Tasmania over the period 2009 to 2016 calendar years. The average and maximum daily gas demands have been as shown in Table 20 below.

Table 20 State Gas Demand – Average and extreme Daily Maximum Gas Demand

	Average TJ/day	Extreme TJ/day
New South Wales	330	620
South Australia	200	460
Victoria	522	1250
Tasmania	16	34

Figure 15 Daily Gas Demand in SA, Victoria and NSW: 2009 to 2016 TJ/day [to be updated]



The historical demands show significant daily and seasonal variations, similar and positively correlated seasonal patterns across the States.

12.5 Longer term changes

Currently all the six Gladstone LNG trains are in operation with the of production being equivalent to five fully operating trains. The level of CSG production at this stage is not sufficient to fully supply the operating trains and gas is being supplied from Moomba and Victoria to make up the shortfall.

Moving forward, CSG development and production should continue to increase until demand for LNG production is satisfied (i.e. six trains at full operation) and ultimately the pressure on Moomba production is relaxed, freeing up some additional supply for the southern states. On the assumption that there are no further gas developments in Victoria, SA or NSW, this must occur otherwise the market will be short of gas.

How the demand and supply balance will change over time in the future is uncertain. The determining factors are

- Gas developments in Queensland to support full LNG operation;
- New gas discovery in the south or demand collapse;
- The decline already apparent in Otway and Moomba conventional supply;
- The decline in Gippsland gas.

The most likely supply to fill the emerging gap will be additional Queensland CSG. Producers in Queensland have already demonstrated the ability to grow production, and there are sufficient reserves to supply incremental demand above the LNG requirement. The [northern Bowen basin] around Moranbah is also prospective, though developing this resources would require a new pipeline to Gladstone. The issue would be if all of the extra reserves required were of low quality and hence too expensive.

Additional gas could also come from the Northern Territory. The Northern Territory is prospective for gas and underexplored (due to the absence of a market for any discovery). However, a link (the Northern Gas Pipeline (NGP)) between the Northern Territory and Mt Isa has already been announced with first gas expected to flow during 2018. The NGP could be expanded and extended to supply gas to the East Australian gas market should resources be discovered at a price more competitive than incremental Queensland CSG.

New supply from unconventional sources in the southern states (e.g. Narrabri) would make a bigger impact but exploration and development is currently blocked by regulation in Victoria and NSW. The Cooper basin may hold significant unconventional gas, but exploration to date has not shown anything conclusively commercial.

13. Appendix 2 Historical gas Demand

This appendix presents a review of average and maximum daily gas demands by State and by total SA/Victoria/NSW/Tasmania. The profile of these demands is an important issue to the value of upgrading the SWP.

13.1 Historical Average Demands

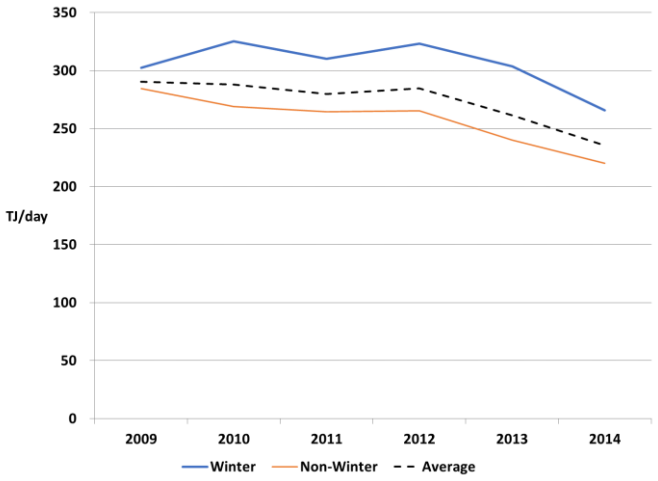
Error! Reference source not found. Figure 16 presents the historical average daily gas demands for the years 2009 to 2016 for SA, Victoria and NSW. Average daily demands are shown on an annual, winter period (May to August) and non-winter period basis.

The historical demands show that the ratio of average winter to average non-winter has been fairly constant:

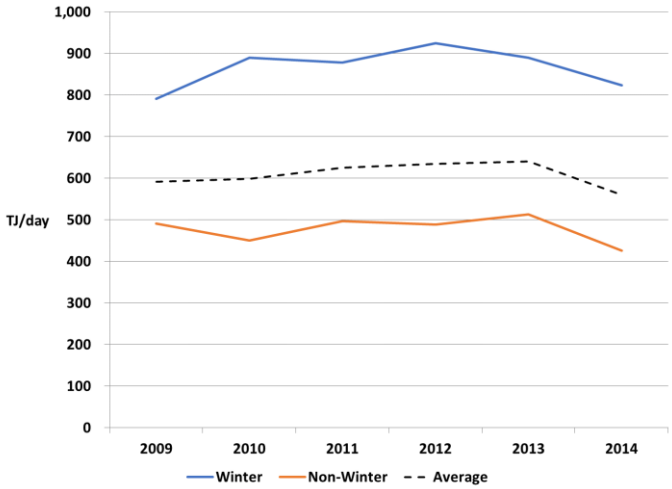
- SA has the narrowest band reflecting the high competent of GPG in the total demand and that GPG in used in both winter and non-winter;
- Victoria has the highest spread, with winter almost averaging twice non-winter gas demand.

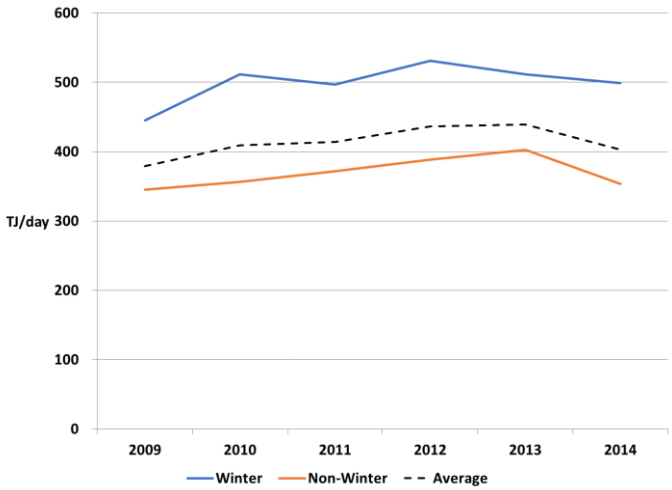
Figure 16 Historical Average Winter Period and Non-Winter Period Demands TJ/day

South Australia



Victoria





New South Wales

The average non-winter gas demand in SA has been over 250 TJ/day. With Minerva and Casino production projected to cease, this is 90 TJ/day more than the projected daily gas production at level Port Campbell, meaning that the SWP flow will need to cater for both flows to SA and flow to Iona storage. This is a very different flow pattern than in past years.

For a given annual SA demand projection, the profile of daily demand and the winter / non-winter spread is critical to the required flows on SWP.

13.2 Historical Maximum Day Demands

Figure 18 overleaf present a graphical display of the maximum daily gas demands for SA, Victoria and NSW over the period 2009 to 2016. Also shown is the level of gas used by GPG on these days. Table 21 presents the day the maximum daily gas demand occurred in these states.

Table 21 Historical Dates of Historical Maximum Demands 2009 to 2016

Max TJ/Day Date	All ex QLD	VIC	NSW	SA
2009	10/06/2009	10/06/2009	6/07/2009	29/01/2009
2010	28/06/2010	28/06/2010	30/06/2010	10/02/2010
2011	8/06/2011	8/06/2011	8/06/2011	31/01/2011
2012	2/07/2012	2/07/2012	4/07/2012	2/07/2012
2013	20/08/2013	24/06/2013	24/07/2013	7/03/2013
2014	21/07/2014	14/07/2011	2/07/2014	15/01/2014
2015	#N/A	30/07/2015	17/07/2015	27/07/2015
2016	#N/A	13/07/2016	5/07/2016	7/07/2016

Of particular note are the following:

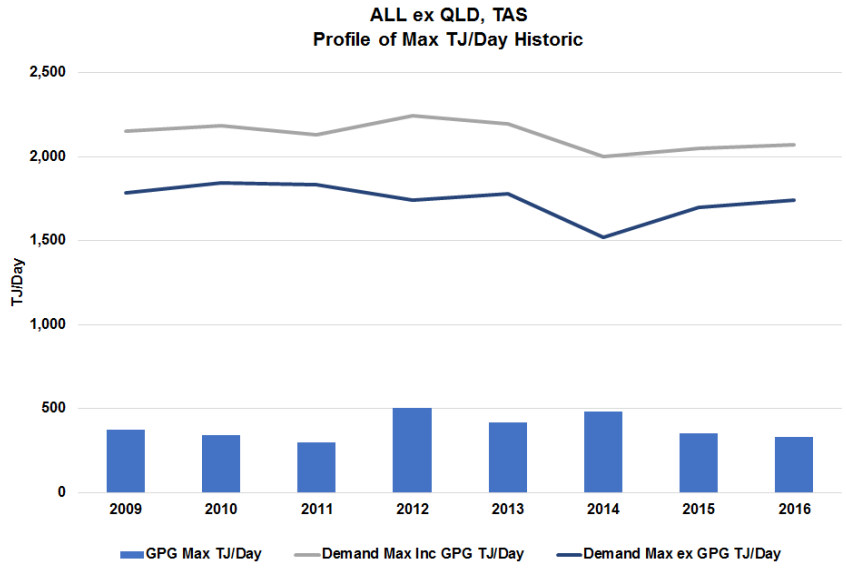
- There have days where Victoria and NSW both had their maximum demand (8 June 2011)

- The maximum gas demands in SA, Victoria and NSW all occurred in July over the past two years. This indicates the probability of coincident cold and high gas demand days may be increasing;
- Victoria had very low GPG on its maximum gas demand days in 2015 and 2016 while SA and NSW had high GPG.

On a total gas market basis it is the maximum gas demand day for the combined SA/Victoria/NSW/Tasmania that is important. This is also important to Victoria as NSW has no gas production apart from Camden (15 TJ/day) and Moomba gas (in SA) is committed to Queensland. The combined SA/Victoria/NSW/Tasmania market needs to be supplied from production facilities in Victoria and Queensland.

Figure 17 presents the combined maximum daily gas demand in SA/Victoria/NSW/Tasmania.

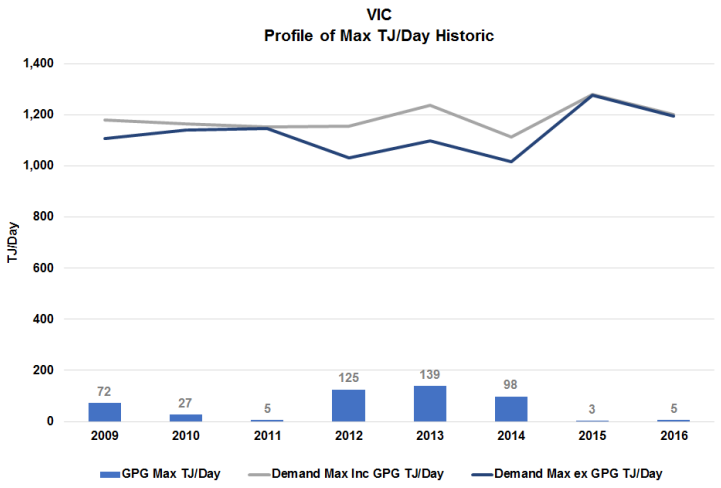
Figure 17 SA/Vic/NSW/Tas - Historical Annual Maximum Daily Demand and Associated GPG TJ/day



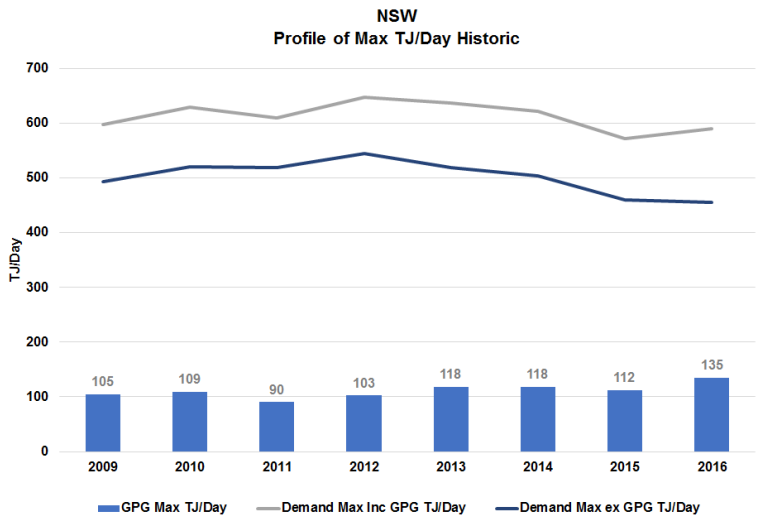
Based on the maximum gas demand trends for the individual States and that these all occurred in July of each year, it is assessed that the maximum combined demand SA/Victoria/NSW would be in the order of 2250 TJ/day.

Figure 18 Victoria - Historical Annual Maximum Daily Demand and Associated GPG TJ/day

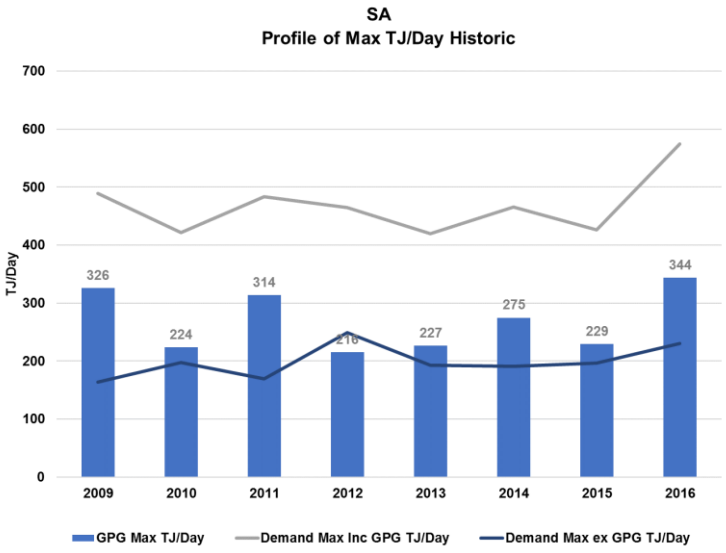
Victoria



NSW



SA



14. Appendix 3 SWP Capability and Development Options

The AEMO 2016 GSOO update (dated February 2016) presented a number of options for upgrading the SWP in each direction. These options were presented in terms of the works that would be required and the impact they would have on SWP daily flow capacity. The report did not contain any information on costs associated with each option.

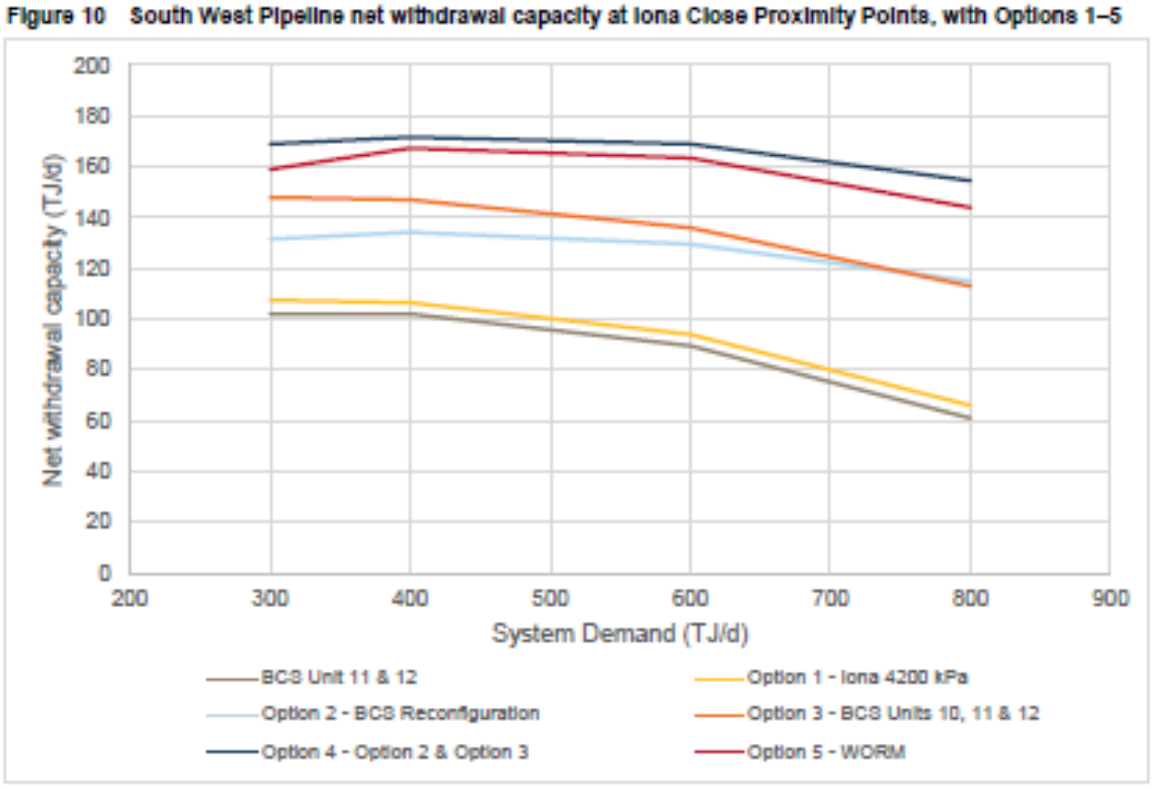
These options and flow capacity graphs presented in the above mentioned report are presented below.

14.1.1 SWP Flow from Melbourne to Iona

The options presented and SWP capacity for flow to Iona are shown below.

- Option 1 – Reduction of Iona minimum withdrawal pressure from 4,500 kPa to 4,200 kPa.
- Option 2 – Reconfiguration of BCS to allow direct compression of units 11 and 12 into the Brooklyn–Lara Pipeline (BLP).
- Option 3 – Operation with BCS Units 10, 11 and 12.
- Option 4 – Combination of Options 2 and 3.
- Option 5 – Construction of the Western Outer Ring Main (WORM).

Figure 19 Capacity Profile of SWP flow to Iona



Source AEMO 2016 GSOO

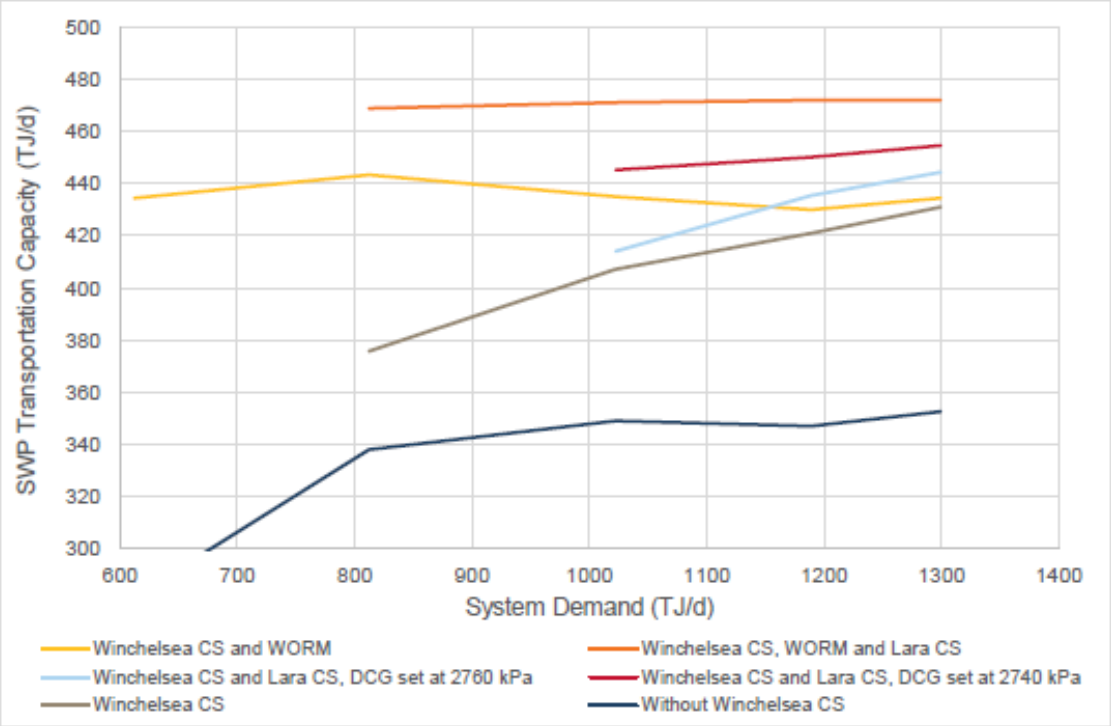
14.1.2 SWP Flow from Iona to Melbourne

The options presented and SWP capacity for flow to Melbourne are shown below.

- Option 1 – Dandenong City Gate pressure reduction
- Option 2 – Additional South West Pipeline compression
- Option 3 – Western Outer Ring Main

Figure 20 Capacity Profile of SWP flow to Melbourne

Figure 15 South West Pipeline capacity to Melbourne with Western Outer Ring Main and Lara Compressor Station



Source AEMO 2016 GSOO

15. Appendix 4 Historical Gas Production

This appendix presents the historical production of Longford, Otway, and the level of gas production from Moomba / Queensland flowing on the MAPS and MSP pipelines. The figures that follow show the daily gas production from these gas sources.

Table 22 Historical Gas Production – Longford, Otway, MAPS+MSP PJ

Longford

	2012	2013	2014	2015	2016
Winter: Max Production	1111	1026	997	1043	1059
Winter: Average	966.3089	909.252	840.2927	933.6911	1004.886
Non winter: Max Production	1027	906	977	1007	1030
Non Winter: Average	610.6049	595.5413	523.0083	583.9752	774.5309

MAPS + MSP from Moomba

	2012	2013	2014	2015	2016
Winter: Max Production	538.9	459.2	475.8	469.2	561.6
Winter: Average	389.3846	319.1358	361.6528	339.5854	342.0203
Non winter: Max Production	381	359.5	440.1	353.4	325.6
Non Winter: Average	236.0156	233.6616	272.9926	227.1017	182.3816

Otway Gas Plant

	2012	2013	2014	2015	2016
Winter: Max Production	195	178	170	142	183.5
Winter: Average	153.9268	125.4309	133.1951	109.6455	82.85041
Non winter: Max Production	176	178	166	142	183.5
Non Winter: Average	120.177	141.8636	122.6653	99.68595	103.4258

Figure 21 Otway Daily Production 2008 to 2016

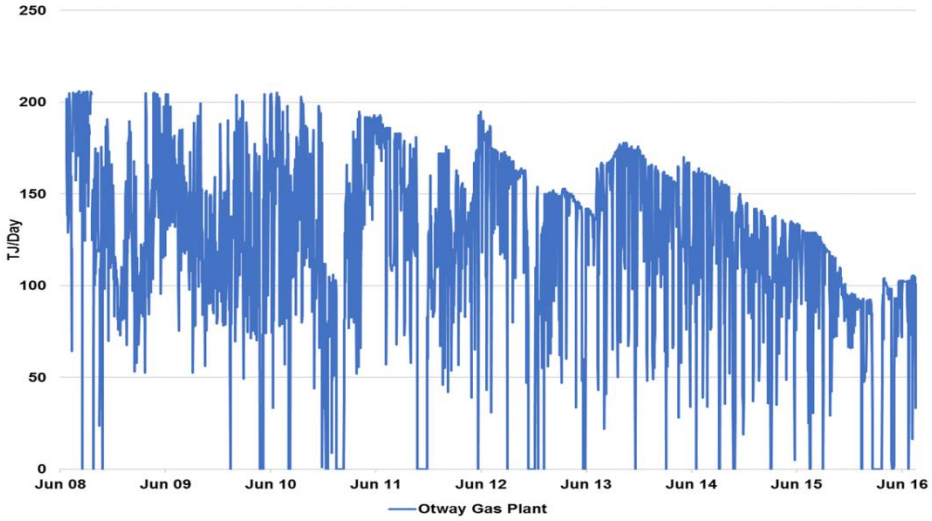


Figure 22 Longford Daily Production 2012 t0 2016

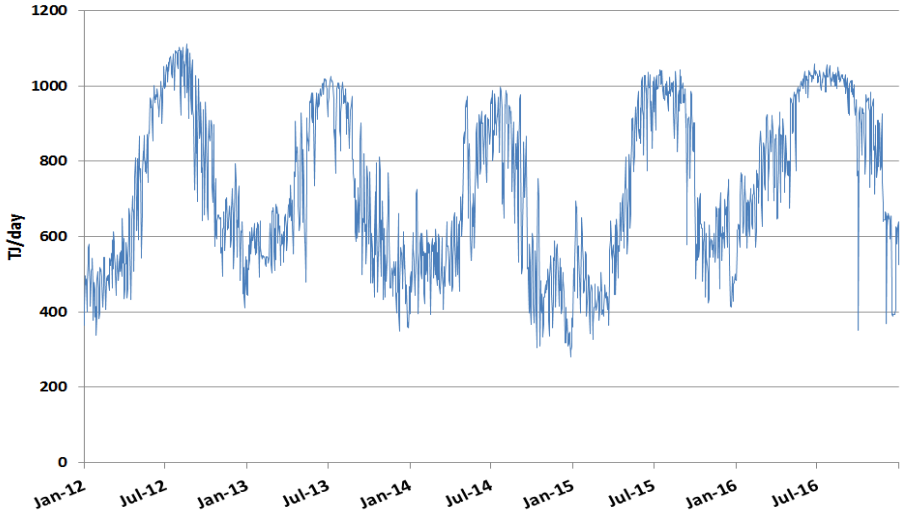
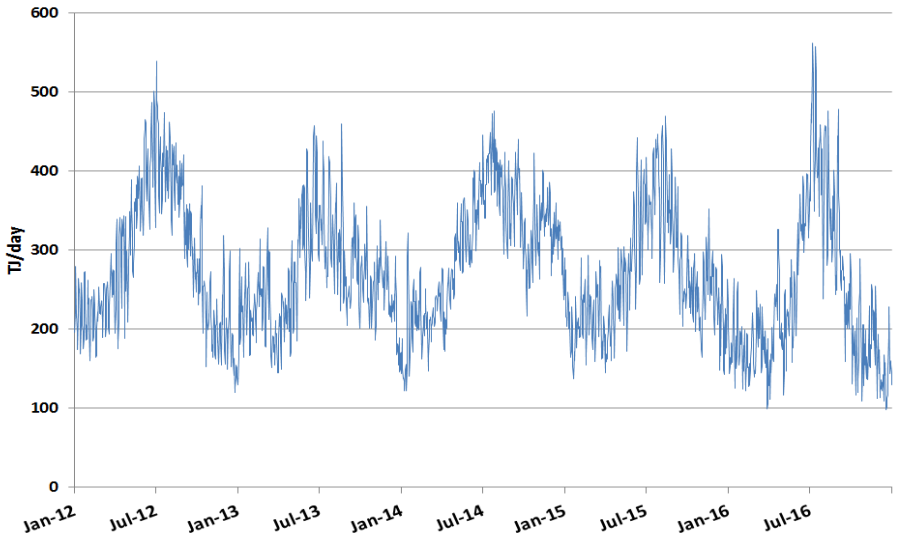


Figure 23 MAPS + MSP Flow South of Moomba 2012 to 2016



16. Appendix 5 Rule 79 of the National Gas Rules

Rule 79 of the National Gas Rules Version 32 relates to the criteria for new capital expenditure. This rule is reproduced below.

79 New capital expenditure criteria

(1) Conforming capital expenditure is capital expenditure that conforms with the following criteria:

(a) the capital expenditure must be such as would be incurred by a prudent service provider acting efficiently, in accordance with accepted good industry practice, to achieve the lowest sustainable cost of providing services;

(b) the capital expenditure must be justifiable on a ground stated in subrule (2)

(2) Capital expenditure is justifiable if:

(a) the overall economic value of the expenditure is positive; or

(b) the present value of the expected incremental revenue to be generated as a result of the expenditure exceeds the present value of the capital expenditure; or

(c) the capital expenditure is necessary:

(i) to maintain and improve the safety of services; or

(ii) to maintain the integrity of services; or

(iii) to comply with a regulatory obligation or requirement; or

(iv) to maintain the service provider's capacity to meet levels of demand for services existing at the time the capital expenditure is incurred (as distinct from projected demand that is dependent on an expansion of pipeline capacity); or

(d) the capital expenditure is an aggregate amount divisible into 2 parts, one referable to incremental services and the other referable to a purpose referred to in paragraph (c), and the former is justifiable under paragraph (b) and the latter under paragraph (c).

(3) In deciding whether the overall economic value of capital expenditure is positive, consideration is to be given only to economic value directly accruing to the service provider, gas producers, users and end users.

(4) In determining the present value of expected incremental revenue:

(a) a tariff will be assumed for incremental services based on (or extrapolated from) prevailing reference tariffs or an estimate of the reference tariffs that would have been set for comparable services if those services had been reference services; and

(b) incremental revenue will be taken to be the gross revenue to be derived from the incremental services less incremental operating expenditure for the incremental services; and

(c) a discount rate is to be used equal to the rate of return implicit in the reference tariff.

(5) If capital expenditure made during an access arrangement period conforms, in part, with the criteria laid down in this rule, the capital expenditure is, to that extent, to be regarded as conforming capital expenditure.

(6) The AER's discretion under this rule is limited.

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Note:

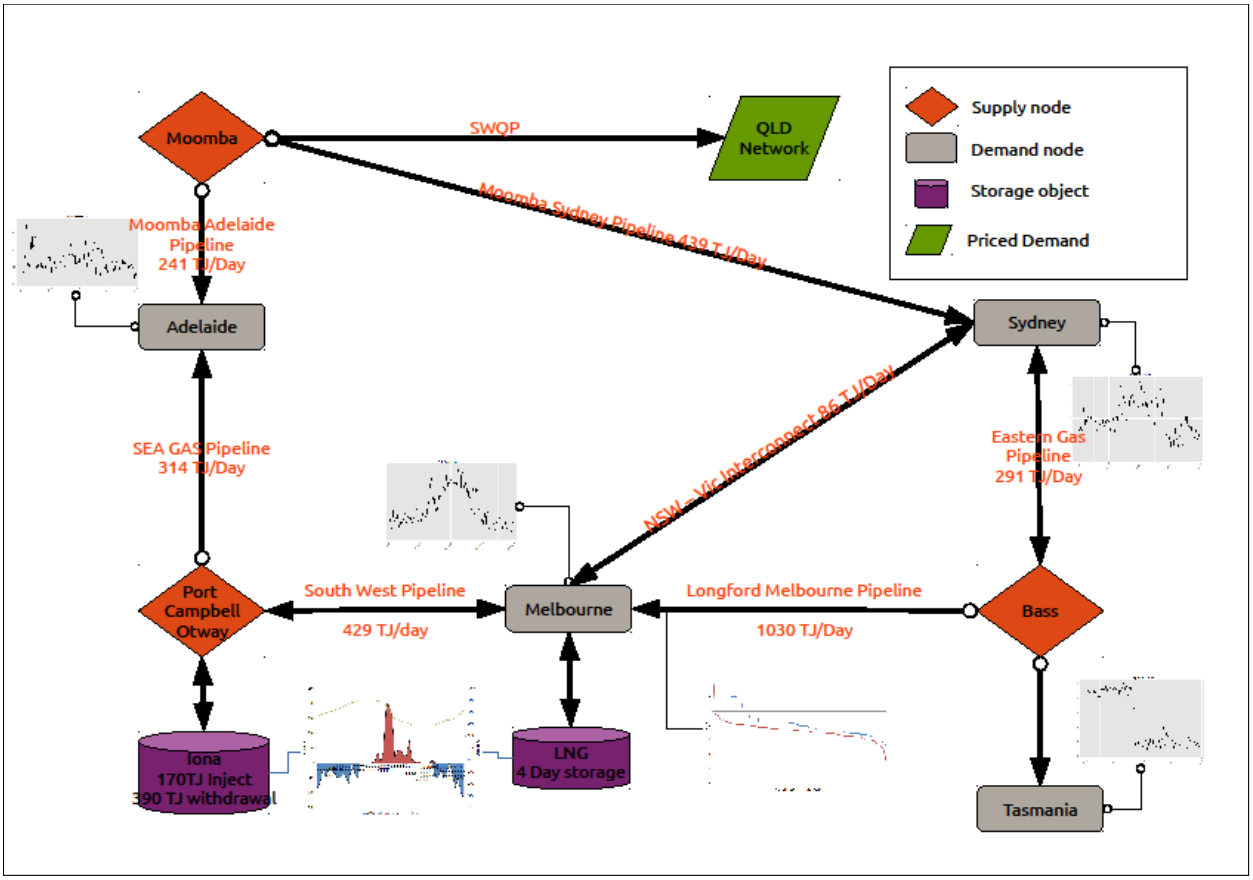
See rule 40(2).

17. Appendix 6 PROPHET Gas Model

The MJA PROPHET Gas market model operates through clearing the market each day based on demand at demand nodes, gas supply costs (or offer prices), transport costs, and the constraints of gas production sources, storage facilities, and pipelines.

The model set-up for the modelling presented in this report is shown in the figure below. The model represented SA, Victoria and NSW in detail, with Queensland being represented as a gas supply source after all gas production had been used in SA, Victoria and NSW.

Figure 24 Diagram of the SA/Victoria/NSW/Tas Model Structure



18. Appendix 7 Diagrammatic Results of the Goal Search Gas Model

Figure 25, Figure 26, Figure 27 and Figure 28 overleaf present the diagrammatic outputs of the Goal Search Gas Model for the gases shown in Table 23. All of the cases shown in this appendix used the Victorian daily demand profile recorded in 2013 scaled to the NGFR Victorian demand for 2017.

Table 23 Goal Search Gas Model Results Shown

Figure	SWP Capacity to Iona	Victorian Gas Production	
		Gippsland Production Capacity	Otway Production Capacity
Figure 25	102 TJ/day	1064	160
"	"	1064	100
"	"	1064	60
Figure 26	170 TJ/day	1064	160
"	"	1064	100
"	"	1064	60
Figure 26	102 TJ/day	920	160
	"	920	100
	"	920	60
Figure 28	170 TJ/day	920	160
	"	920	100
	"	920	60

Figure 25 Model Results: No SWP Upgrade, Current Gippsland Production

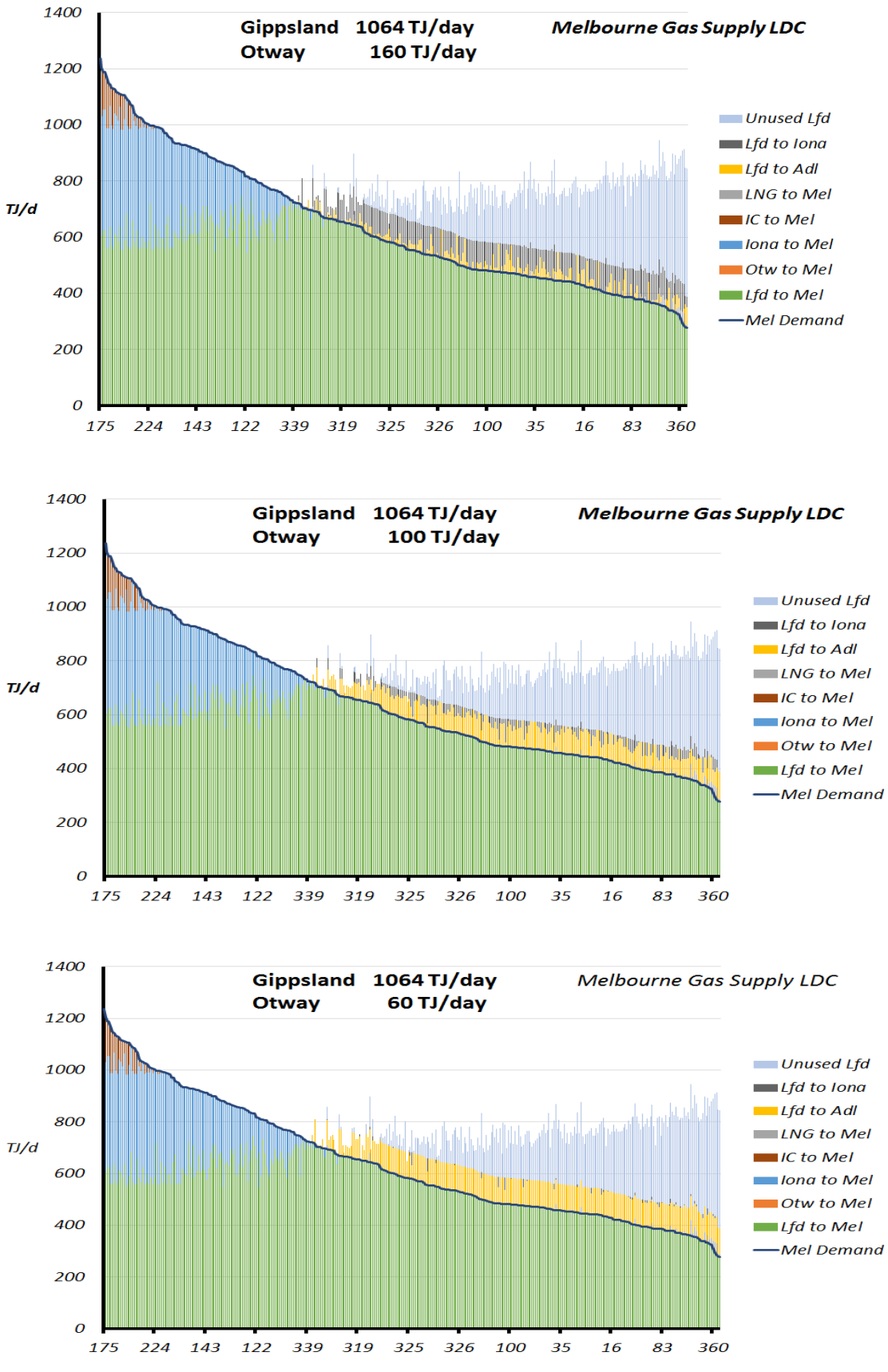


Figure 26 SWP Upgraded: tp 170 TJ/day to Iona, Current Gippsland Poduction

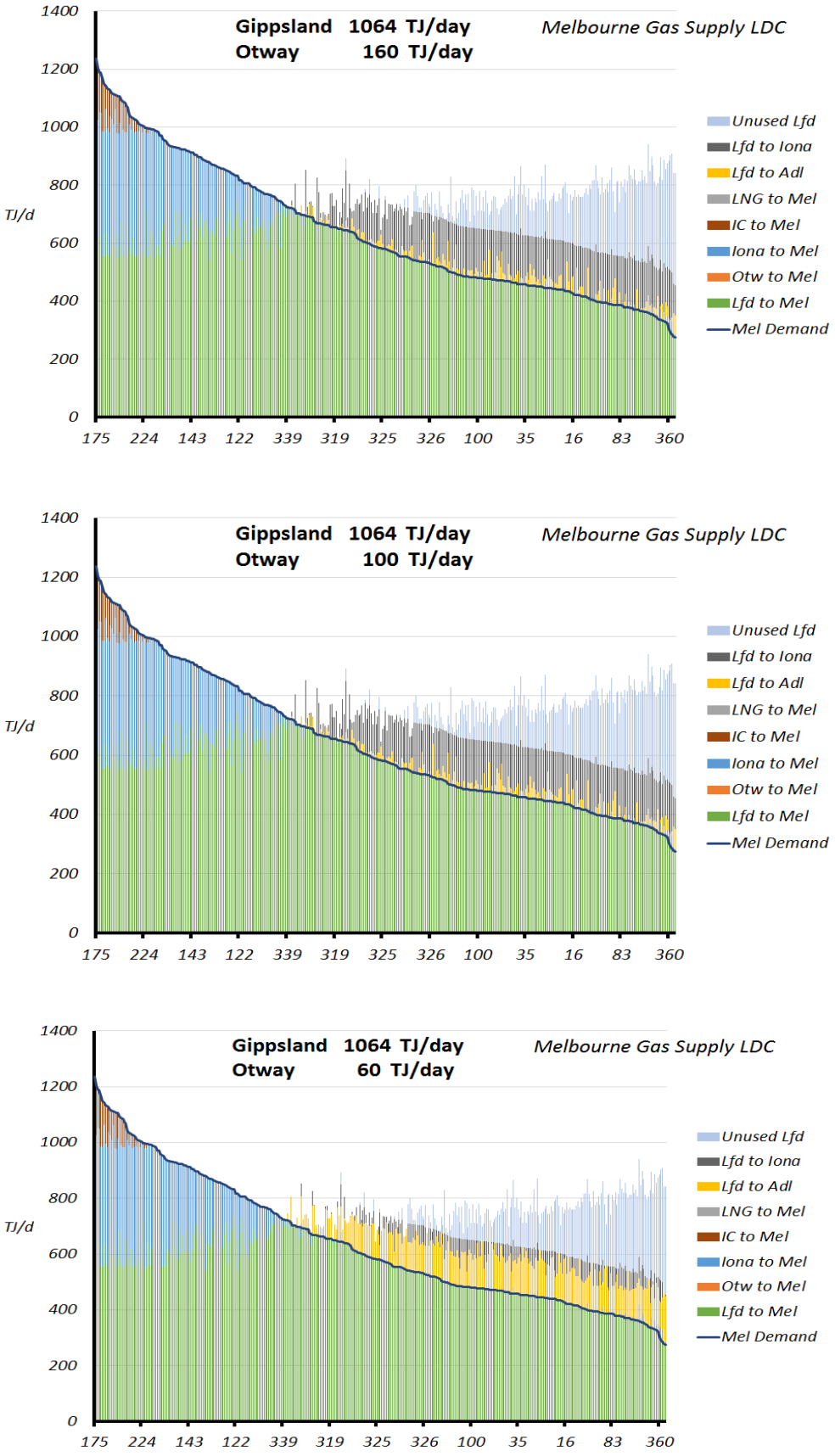
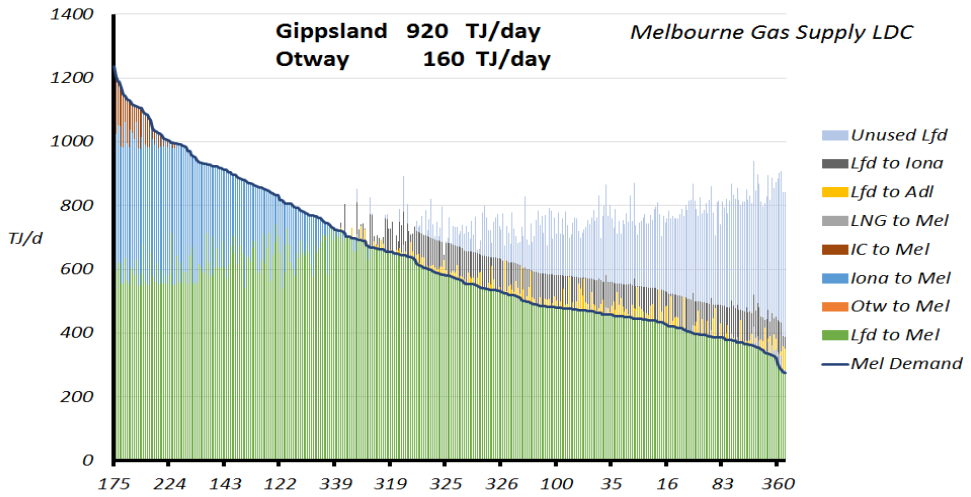
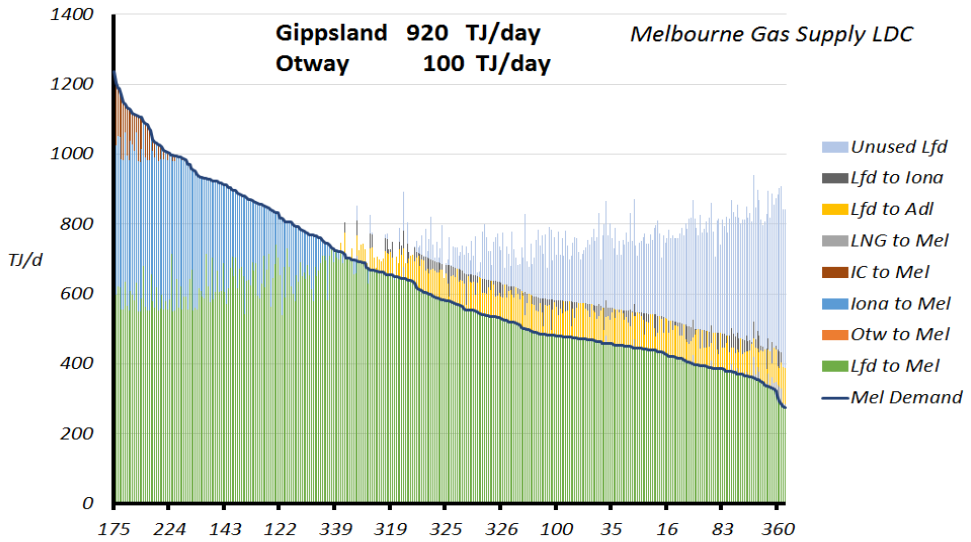


Figure 27 No SWP Upgrade and Reduced Gippsland Production





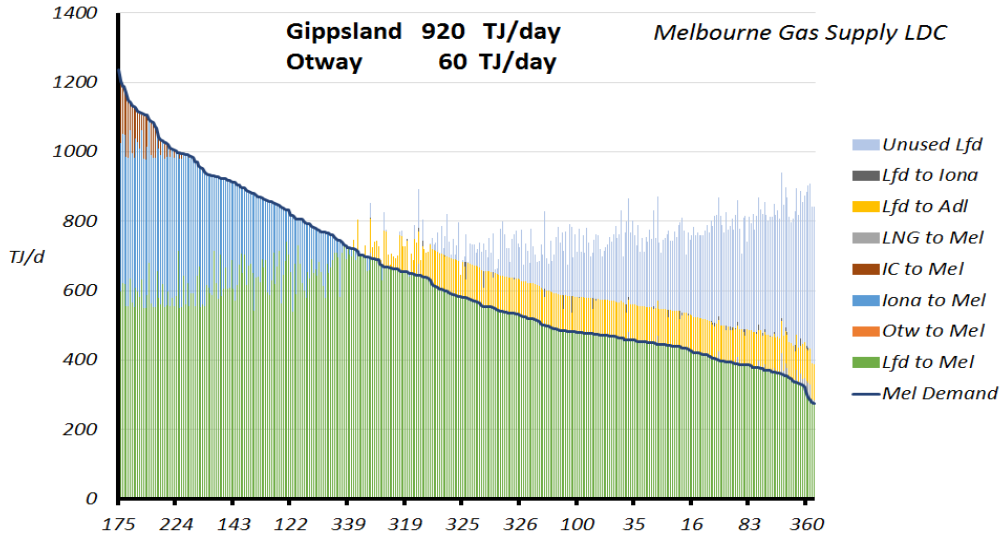
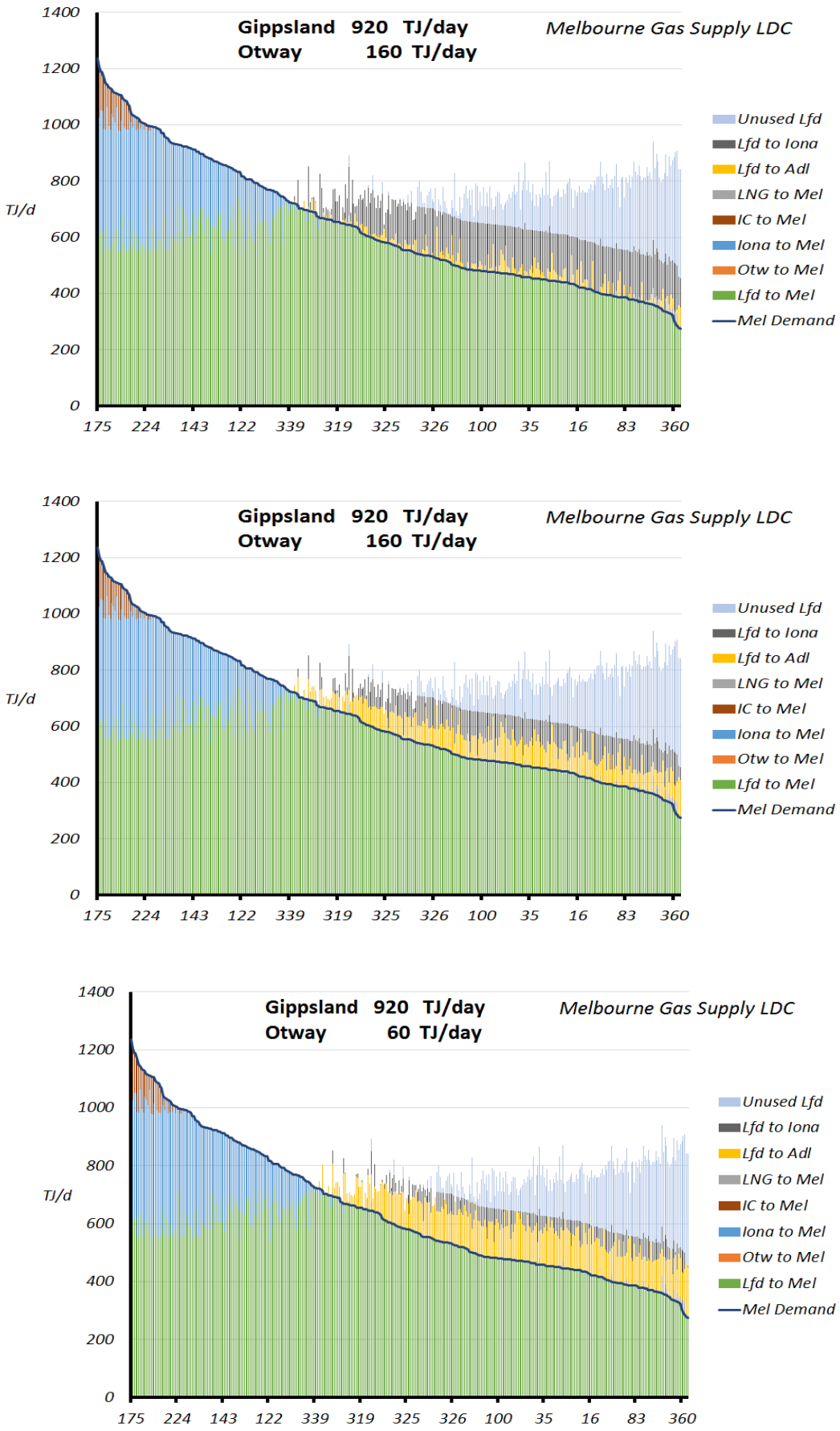


Figure 28 Model Results: SWP Upgrade to 170TJ/day, Reduction Gippsland Production



19. Appendix 8 Victorian TUoS Reference Tariffs

This appendix presents the APA Transmission Use of System (TUoS) reference tariffs applicable for the 2017 calendar year. This is shown in the figure below.

Figure 29 APA VTS TUOS Charges

APA VTS TUoS Reference Tariffs: Applicable from 1/1/2017 to 31/12/2017
Tariffs are GST exclusive & do not include AEMO charges.

		Delivery Charges		Matched Delivery Charges			Injection Charges (top-10 winter MDQ at source)						
		Annual Volume			Annual Volume		101	103	105	109	107	108	110
		Tariff-D	Tariff-V	Injected at	Tariff-D	Tariff-V	Longford	Culcairn	Iona	Pakenham	VicHub	SEAGas	OtwayGas
Transmission Supply Point Tariff :		$/GJ	$/GJ		$/GJ	$/GJ	$/GJ	$/GJ	$/GJ	$/GJ	$/GJ	$/GJ	$/GJ
1	LaTrobe	0.1363	0.1364				0.3300	1.5110	1.4621	0.3006	0.3300	1.4621	1.4621
2	West Gippsland	0.1629	0.1796				1.1172	1.5110	1.4621	0.3006	1.1172	1.4621	1.4621
3	Lurgi	0.1895	0.2229				0.4706	1.5110	1.4621	0.3006	0.4706	1.4621	1.4621
4	Metro North West	0.3012	0.2834				1.8619	1.5110	1.4621	0.3006	1.8619	1.4621	1.4621
5	Calder	0.6385	0.7920				1.8619	1.5110	1.4621	0.3006	1.8619	1.4621	1.4621
6	South Hume	0.3862	0.3906				1.8619	1.5110	1.4621	0.3006	1.8619	1.4621	1.4621
7	Echuca	0.7460	1.1064				1.8619	1.5110	1.4621	0.3006	1.8619	1.4621	1.4621
8	North Hume	0.7598	0.9804	Culcairn	0.2772	0.3201	1.8619	1.5110	1.4621	0.3006	1.8619	1.4621	1.4621
9	Western	0.5878	0.8279				1.8619	1.5110	0.0000	0.3006	1.8619	0.0000	0.0000
10	Murray Valley	1.2079	1.6751				1.8619	1.5110	1.4621	0.3006	1.8619	1.4621	1.4621
11	Interconnect	0.8687	1.3993	Culcairn	0.1363	n/a	1.8619	0.3736	1.4621	0.3006	1.8619	1.4621	1.4621
13	South West	0.1361	0.1363				1.8619	1.5110	0.5144	0.3006	1.8619	0.5144	0.5144
17	Wodonga	0.6753	1.3993	Culcairn	0.1522	0.1774	1.8619	1.5110	1.4621	0.3006	1.8619	1.4621	1.4621
18	Tyers	0.1678	0.1814				0.4706	1.5110	1.4621	0.3006	0.4706	1.4621	1.4621
19	NSW Export	0.8000	n/a				1.8619	1.5110	1.4621	0.3006	1.8619	1.4621	1.4621
20	Metro South East	0.3012	0.2834	Pakenham	0.1330	0.1494	1.8619	1.5110	1.4621	0.3006	1.8619	1.4621	1.4621
21	Warrnambool	0.0948	0.1590				1.8619	1.5110	0.0000	0.3006	1.8619	0.0000	0.0000
22	Koroit	0.1999	0.5312				1.8619	1.5110	0.0000	0.3006	1.8619	0.0000	0.0000
23	Refill LNG	0.0539	n/a				1.8619	1.5110	1.4621	0.3006	1.8619	1.4621	1.4621
24	Geelong	0.1630	0.1918				1.8619	1.5110	1.4621	0.3006	1.8619	1.4621	1.4621
25	Maryvale	0.0540	n/a				0.3300	1.5110	1.4621	0.3006	0.3300	1.4621	1.4621
31	VicHub	0.0000	n/a	Longford	0.0000	n/a	0.3300	1.5110	1.4621	0.3006	0.3300	1.4621	1.4621
32	Refill WUGS	0.0539	n/a				1.8619	1.5110	1.4621	0.3006	1.8619	1.4621	1.4621
33	SEAGas	0.0178	n/a	Iona	0.0000	n/a	1.8619	1.5110	0.0000	0.3006	1.8619	0.0000	0.0000
34	Otway Gas	0.0178	n/a	Iona	0.0000	n/a	1.8619	1.5110	0.0000	0.3006	1.8619	0.0000	0.0000
Cross System (incremental) :		0.1651	0.1471										

AMDQ Credit Certificate (Port Campbell, Culcairn & Pakenham Injection Zones) 0.0125
(Injection Tariff, $/GJ, for the 10 Day Injection Volume)

Victorian gas TUoS charges work as follows:

- Injections are charged the rate shown in the table for flows on the 10 highest demand days:
  - Longford injection are charged at $1.8619/GJ
  - Iona injections are changed at $1.5110/GJ
- Delivery charges apply for all withdrawals:
  - South West is $0.1361/GJ.

[i] *East Coast Gas Market Scenario and Implications for South Australia" 1 July 2016*