MARSDEN JACOB ASSOCIATES

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Future Requirements of the SWP Phase 1 Study Report

A report by Marsden Jacob Associates

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A Marsden Jacob Report

Prepared for Lochard Energy

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Acronyms and abbreviations

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

1. Executive summary

This report presents the finding of the Phase 1 study by Marsden Jacob on the future peak day capacity requirements of the southern gas market and the APA Victorian Transmission System (VTS) South West Pipeline (SWP). The main conclusions of the study are first presented followed by a summary of the report contents.

Key Findings of the Phase 1 Study

The key findings of the study were as follows:

- Participant feedback indicated a need for an expansion of the SWP. Reasons provided for this included:
  - there is a high level of demand for capacity on the SWP
  - intended contracting capacity traditionally from Longford is being transferred to the SWP.
- The review of the Oakleigh Greenwood report by Marsden Jacob concluded the following:
  - while the Oakley Greenwood report presents a reasonable view on possible changes to the demand outlook, the assumptions on which the analysis was based were not considered suitable for supply adequacy assessment
  - the analysis did not demonstrate (either for security or economics) that upgrading VNI is a superior option to upgrading SWP.
- Pending any other sources of peak day capacity, there is an apparent need to increase the capacity of the SWP.
- Phase 2 modelling is required to confirm this need and to quantify the relative benefits of the various supply options. The Phase 2 modelling will:
  - review the scenarios and assumptions, and
  - additionally encompass:
    - modelling of storage inventories and storage inventory constraints
    - season supply capacity and storage refill economics to manage seasonal demand
    - the gas required to support future Gas Powered Generation
    - security of supply for high stress days in the southern market.

Introduction

This Phase 1 study was limited to peak day supply adequacy in the southern gas market and the potential need to augment the APA SWP. This study is a forerunner to a more comprehensive and detailed (Phase 2) study that will be based on more sophisticated supply and demand modelling.

This Phase 1 study involves three elements of work, these being:

- A survey of gas users on their future capacity requirements including that on the SWP;
- A review of the APA provided draft Oakley Greenwood report (dated 13 September) titled "Issues Affecting Demand and Supply for Gas on the Victorian Transmission System". This also required Marsden Jacob to undertake a review of the recent AEMO 2021 VGPR[1] and AEMO 2021 GSOO[2] reports on the gas market; and
- Marsden Jacob's initial and independent modelling of the peak day capacity requirements of the southern gas market.

The key findings from each of the work components are presented below.

Survey of gas users

The survey of gas market participants consisted of two elements:

- Data supplied on intended contracted capacity to support gas supply in SA, Victoria and NSW; and
- Replies to four questions.

Intended Contracting Capacity

A key finding of the survey was the indicated level of intended contacting (Port Campbell to Melbourne) on the SWP. Table ES1 below presents the future aggregate planned level of capacity required on the SWP for flow to Melbourne (for the future years 2023 to 2030).

Table ES1 Aggregate of Intended Contracts on the SWP to Melbourne TJ/day

	2023	2024	2025	2026	2027	2028	2029	2030
SWP TJ/day	572	568	569	570	571	569	564	515

Source: Responders replies and Marsden Jacob analysis and presentation

The intended contracting shows that there is a high level of demand for peak day capacity on the SWP, and that this is greater than the current name plate capacity of the SWP. These insights may indicate a reduction in structured contracting positions from Gippsland due to declining basin reserves.

Lochard Energy requested from consortium members their forecast capacity requirements for the purposes of this report. Some users of the APA Victorian Transmission system did not provide representative forecast data for the purpose of this report. Lochard Energy provided data on a best endeavours basis of their forecast use of the SWP for this group.

[1] Victorian Gas Planning Report
[2] Gas Statement of Opportunities

Question Responses – Views on Future gas Market Outlook and Needs

Table ES2 below presents the percentage of responders that provided either, Yes, No, or another answer (as shown) to each of the questions relating to future SWP capacity and future gas market security.

Table ES2 Percentage of Question Replies to Yes or No Response

Question	Yes	Qualified Yes (1)	No	No Answer
Do you believe the SWP should be expanded to flow to Melbourne	100%			
Do you believe the SWP should be expanded to flow to Iona	50%	50%		
Do you see any developments recent or forecast that will significantly impact the demand / supply balance in Victoria	50%	25%	25%	
Do you consider that there is a significant security of supply risk over the forecast period	50%	25%		25%

Note (1) "Qualified Yes" refers to agreement subject comments that are reflected in the reply to the questions asked.
Source: Responders replies and Marsden Jacob analysis and presentation

The comments that accompanied the Yes/No/Other responses (shown in the table above) supported the answers shown in Table ES2 above. The key messages from the comments provided were as follows:

- General concern regarding the forecast decline in Longford production and the uncertainties and risks associated with new supply developments (such as Sole and Golden Beach).
- A general theme that supply adequacy is seen as an increasing issue.
- That the role of Iona is expected to increase in the future and that that refilling capacity may become an issue.
- General agreement on the increasing reliance that will be placed on the SWP as Gippsland declines.

Oakley Greenwood Report Review

Our review of the Oakley Greenwood report concluded that while it did identify issues and factors to be considered in supply planning, it did not (in the opinion of Marsden Jacob) allow conclusions to be drawn on the future capacity needs of the gas market or the most suitable supply options. Our reasons for this were as follows:

- No evidence was provided on the key assumption of electrification of gas heating, meaning that great care and qualification would be required in using this assumption in a central case of capacity adequacy

assessment. Marsden Jacob did not support the treatment of this assumption in the Oakley Greenwood report.

- The resulting outlook developed in the report reduced the potential need for new capacity, which in turn reflected on considerations of future capacity and general gas system needs.
- There was no assessment or consideration of the economics (cost benefit) of the potential supply options.

This meant that in the opinion of Marden Jacob, the report did not demonstrate the opinion provided (in the Oakley Greenwood report) that northern gas, by upgrading VNI, is a superior option to upgrading SWP.

Marsden Jacob Initial Modelling

Marsden Jacob undertook initial modelling using Marsden Jacob's in house Gas Model. This model operates on a daily basis, where for each day it determines the regional gas demands to be supplied, and then allocates supply to these demands from gas supply sources via pipelines that account for the various system production and transport constraints. The allocation is essentially based on supply costs (gas and transport).[3]

For the Phase 1 modelling the following was assumed:

- There was no analysis of annual quantities, no accumulation analysis (storage volume constraints or refill considerations) or future economics considered. The modelling dispatched gas in a simplified order of sources based on Marsden Jacob's view of the likely average costs [4].
- The supply available assumed the current supply and capacities[5], with the following exceptions:
  - AEMO's forecast decline in Gippsland gas supply[6] is reflected and modelled as a decline in Longford Gas Plant capacity
  - the Port Kembla Gas Terminal (PKGT) is available as forecast from winter 2023
  - commissioning of the Western Outer Ring Main (WORM) in "late 2022".

These assumptions are essentially the same as those used by AEMO. Marsden Jacob note that none of these assumptions are certain as they pertain to events in the future. In particular, the first two assumptions above are highly significant in this forecast. Any change in the forecast of Gippsland decline, positive or negative, will significantly impact this forecast, as would the delay or non-completion of the PKGT. A full review of forecast assumptions and key sensitivities will be contained in the Phase 2 study.[7]

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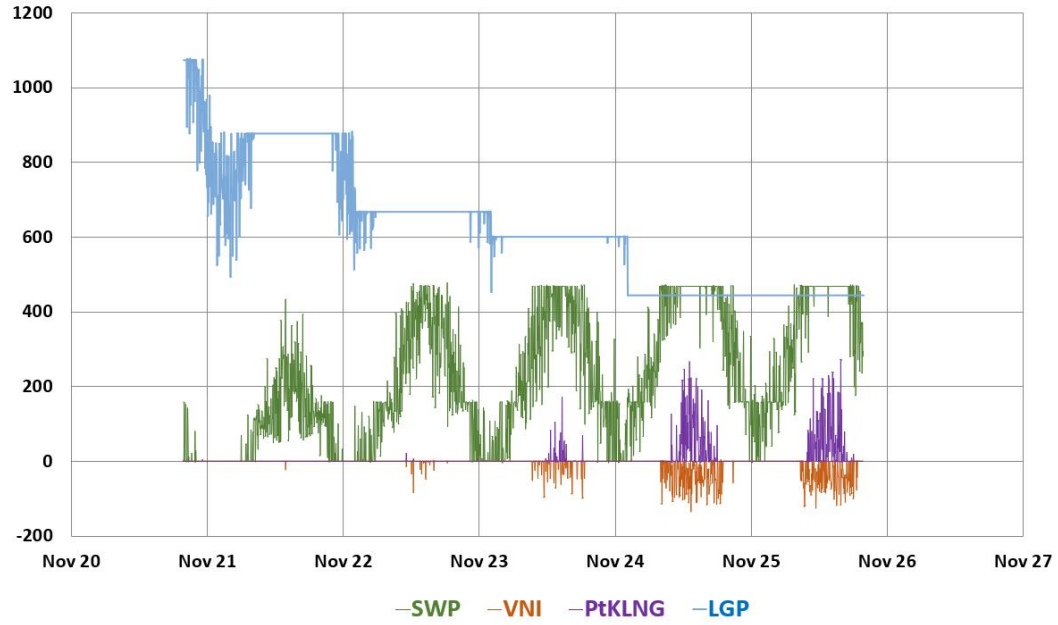
[3] With a few minor exceptions for perceived operational and regulatory constraints not represented in the path costs.
[4] The modelling included the allocation of gas to supply demand in order of assessed cost. No cost of supply was reported. Phase 2 modelling will include economics.
[5] As presented in the nameplate report on the Gas Bulletin Board, except as noted
[6] AEMO 2021 VGFR p7, and AEMO 2021 GSOO fig 22 etc.
[7] Again based on AEMO 2021 VGPR and GSOO

A key output of the modelling was the daily flows on the SWP (modelled to 2026). This is shown in Figure ES1 below which shows the stochastic results of the forecast production decline from Gippsland, and the early flows from the PKGT, and the flows to Melbourne on the SWP.

The results of the modelling show the SWP flows become increasingly capped at its maximum flow capacity each year as production at Longford reduces. The PKGT is then required to make up the shortfall due to the SWP constraint[8]. While this modelling is preliminary (and will be improved upon in the Phase 2 study) it clearly reflects the impact of the decline of Gippsland and signals the potentially significant role the SWP will play in the meeting peak day gas demand.

Figure ES1 Forecast flows: Longford Gas Plant, SWP and PKGT (TJ/day)



Source: Marsden Jacob preliminary modelling

[8] That the SWP is dispatched before PKGT reflects Marsden Jacobs (preliminary) view on the relative price of gas from those two sources

2. Introduction

This report presents the findings of an independent study by Marsden Jacob Associates (Marsden Jacob) on the peak demand day capacity requirements of the southern gas market, and particularly for the South West Pipeline (SWP).

2.1 Background

APA Group are preparing a proposal to the AER on the Victorian Transmission System Access Arrangement (AA) for the 2023 – 2027 period.

Important to that submission is a fully considered assessment of the changing nature of the southern gas market[9] and the implication this has for the future adequacy of supply and the role of the SWP for security of supply services.

Marsden Jacob have been commissioned to undertake an independent assessment of the future supply requirements in the southern gas market and the implications this has to the SWP.

The demand/supply outlook in the southern gas market is significant in both the medium term (to say 2027) and longer term (post 2027). This outlook is being driven by the expected decline of the Victorian gas fields which will substantially reduce both commodity (annual supply volumes) and capacity (peak supply rates) available to the market.

This supply outlook[10] has by 2025 a reduction in Gippsland supply of 163 PJ/year and a peak day capacity decrease of over 600 TJ/day. Port Campbell has no apparent significant decrease in peak day supply over the period[11].

The major committed[12] new supply is the LNG import terminal at Port Kembla (Port Kembla Gas Terminal or PKGT) with capacity of 500 TJ/day, and the associated modification to the EGP to allow reverse flow from Port Kembla to Victoria. The only other new peak day supply included in the AEMO forecast is the extra 19 TJ/d available on the SWP from Q2 2023 due to the commissioning of the new Western Outer Ring Main (WORM) project.

Since the AEMO forecasts from the GSOO and VGPR were produced (March 2021), Origin Energy have announced[13] a new gas contract with APLNG and APA Group have announced[14] an associated increase in pipeline capacity from Queensland to the Sydney STTM. This new supply has not been included in our modelling in order to enable comparisons with the AEMO forecasts[15]. New northern

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[9] New South Wales, Victoria, South Australia, Tasmania. See "Appendix 1. The Southern Gas Market" below.
[10] As published in the 2021 AEMO GSOO and VGPR
[11] Presuming decline in Thylacine and Geographe will be offset by the current development drilling campaign, and the limited gas production from the Casino Henry and Netherby fields will be maintained by the lower inlet pressure of the new Athena (revamped Minerva) Gas Plant.
[12] In the view of AEMO, and hence part of their planning basis VGPR p35 para 1
[13] Origin Energy media release 5 May '21
[14] APA Group ASX Release 5 May '21
[15] But will examine the impact of this augmentation in the Phase 2 study

supply could be used either to supply southern peak day demand directly, or be shaped using southern storage for subsequent peak day supply. There are also other potential sources of supply, most of these are listed in "Appendix 6 – Anticipated and Potential Developments".

While the current gas demand forecast by AEMO are for peak supply to be a marginal post 2025, the demand outlook is uncertain. Influencing issues include economics, impact of reducing emissions policy and increasingly economic renewable energy, timing of the assumed new supply, the decline of existing gas reserves, and the future role of Gas Powered Generators (GPG) in the NEM where coal plants are closing earlier than planned – all of which are themselves uncertain.

This high level of uncertainty (above) means there may be a justification for increased peak day supply even if the supply demand margin is in surplus, given that the margin is tight. The PKGT and potentially an expansion of pipeline capacity from the north are factors in this analysis, but the other potential sources of peak supply should be considered, especially those available in the short term.

This study is interested in the implications this situation has for the SWP. AEMO modelling[16] suggests that the SWP capacity will constrain the ability of gas from Port Campbell (primarily the Otway Gas Plant and Iona Gas Storage) from supporting peak day demand in Melbourne[17]. A need for increased SWP services was forecast in the AEMO 2021 Gas Statement of Opportunities (GSOO)[18] but it is not yet clear whether this will be reflected in capital works program being proposed by APA for the next Access Arrangement period.

This report (Phase 1) is an initial report that is limited to identifying the factors impacting peak day supply adequacy in the southern gas market and identifying the potential need for a capacity augmentation of the SWP. It is a forerunner to a more complete (Phase 2) report that will include modelling of the seasonal capacity requirements in the DWGM.

2.2 Scope of Work

The Phase 1 scope of work provided to Marsden Jacob by Lochard Energy, acting as a secretariat for the consortium group, is presented below:

- Undertake a survey of gas market participants on their respective requirements from the SWP and their ability to source gas commodity and capacity over the period 2023 to 2030.
- Review the report from Oakley Greenwood on the future capacity requirements of the SWP and compare and contrast this with the analysis described above.
- Undertake a quantitative assessment of the peak day capacity outlook in the Southern gas States (SA, Victoria, NSW) in terms of capacity demand and capacity sources, and the resulting capacity requirements of the SWP. Determine what this means for the need to increase the eastward flow capacity of the SWP.
- Present the work described above in a concise report for publication.

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[16] See AEMO 2021 VGPR Table 15 and 16
[17] Preliminary modelling from Marsden Jacob supports this conclusion
[18] Page 63 under the title "Expanding Existing Assets"

2.3 Structure of this report

The structure of this report reflects the three components of work undertaken, and from these components, drawing conclusion regarding the future capacity requirements of the SWP.

A review of the survey responses from gas market participants (Chapters 3 and 4) on their planning needs and perspectives on the future southern gas market is first presented.

Chapter 5 the presents the review by Marsden Jacob of the Oakley Green report titled "Issues Affecting Demand and Supply for Gas on the Victorian Transmission System". The review here was to ascertain matters identified in that report that need to be accounted for.

The independent modelling of the capacity needs of the southern market is lastly presented (Chapter 6).

The final chapter (Chapter 7) presents our key findings.

Appendix 1 is presented as reference material only and the other appendices provide additional supporting information.

2.4 Notes to this report

Members of the Consortium Group

The consortium group consisted of the following:

- AGL;
- Alinta Energy;
- Cooper Energy;
- EnergyAustralia;
- GloBird Energy;
- Lochard Energy;
- M2 Energy;
- Venice Energy.

Dollars

Unless otherwise stated all dollars are nominal dollars.

Reports referenced

- AEMO 2021 Victorian Gas Planning Report, March 2021;
- AEMO 2021 Gas Statement of Opportunities, 29 March 2021;
- Victorian Transmission System 2023-27 access arrangement stakeholder reference group, Issues Paper on the capital program;
- Oakley Greenwood draft report (dated 13 September 2021) titled "Issues Affecting Demand and Supply for Gas on the Victorian Transmission System.

Abbreviations

Unless otherwise specified the "gas market" refers to the "east coast gas market"

The southern gas market refers to the gas market in Victoria, South Australia, New South Wales, and Tasmania.

3. Participant Responses: Questions

The study included a survey of the capacity supply needs of gas market participants operating in the southern gas market. The parties surveyed volunteered to participate in the survey.

This chapter presents the results of the responses received to the questions in the survey.

3.1 Description of the Survey

The survey consisted of two elements:

- Four questions to be briefly answered; and
- Data to be supplied on intended contracted capacity to support gas supply in SA, Victoria and NSW. The template that was supplied to be completed is shown in Appendix 2.

The basis of parties participating in the survey was that all data and information provided would be treated by Marsden Jacob as strictly confidential. This meant that:

- The results of the intended level of contracting survey could only be presented as the aggregate of all parties participating in the survey; and
- Question responses can only be presented in a manner that does not identify the parties that made the comments.

3.2 Questions

The question asked were as follows.

Question 1: Do you believe the SWP should be expanded for flow to Melbourne (Y/N). Reasons for answer.

Question 2: Do you believe the SWP should be expanded for flow to Iona (Y/N). Reasons for answer.

Question 3: Do you see any developments recent or forecast that will significantly impact the demand / supply balance in Victoria (Y/N)
(e.g. increased demand for GPG, reduced Longford production, increased peak demand, increased in LNG demand, higher oil price). If so, please note the changes.

Question 4: Do you consider that there is a significant security of supply risk over the forecast period (Y/N). Reason for answer.

The responses to these questions are presented below as follows:

- Section 5.3 presents a summary of the affirmative and negative responses to the propositions posed by the four questions; and
- Section 5.4 presents a review of the comments provided to the to the questions.

3.3 Summary of Views to the Question Propositions

Table 1 below presents the percentage of responders that provided either, Yes, No, or another answer (as shown) to each of the questions.

Table 1 Percentage of Question Replies to Yes or No Response

Question	Yes	Qualified Yes (1)	No	No Answer
Do you believe the SWP should be expanded to flow to Melbourne	100%			
Do you believe the SWP should be expanded to flow to Iona	50%	50%		
Do you see any developments recent or forecast that will significantly impact the demand / supply balance in Victoria	50%	25%	25%	
Do you consider that there is a significant security of supply risk over the forecast period	50%	25%		25%

Note (1) "Qualified Yes" refers to agreement subject comments that are reflected in the reply to the questions asked.
Source: Responders replies and Marsden Jacob analysis and presentation

These responses illustrate the following:

- There was universal belief that the SWP should be expanded for flow to Melbourne.
- There was a strong belief that the SWP should be expanded for flow to Iona, although 50% of the responders considered flow to Melbourne more important.
- There was a high level of consensus that supply security is an increasing issue and that there are changes occurring that will both have positive and negative impacts on supply security.

3.4 Review of Comments Provided

The replies to the questions provided many comments. While these were directed at the specific question being asked, the replies often addressed broader issues that applied across the questions.

A review of the replies showed that they could be conveniently grouped under the following headings while maintaining the meaning of the reply:

- Demand;

- GPG Demand;
- Declining gas fields;
- New gas supply;
- Port Kembla Gas Terminal;
- Iona Underground Gas Storage;
- SWP;
- Gas Supply Adequacy.

The comments provided are summarised and presented below.

The comments present the full range of answers received (noting that some rewording has been undertaken).

Demand

There was one comment that electrification may see a reduction in the longer term but in the interim peak demand requirements are likely to remain largely unchanged until about 2030.

GPG Demand

There were a number of comments on GPG gas demand which supported an expectation of increasing GPG use.

These comments had the following message:

- The outlook is for sustained gas power generation due to higher penetration of intermittent renewables, ageing coal power station, and capacity limits in obtaining gas supply from Queensland in winter.
- In the NEM there is an increasing reliance on GPG for capacity for both system security and for energy supply. This is due to ageing coal plant that is creating supply issues and the need for renewable firming.

Declining Gas Fields

There were a number of comments and concerns expressed on the declining gas fields. The strong theme of the comments was as follows:

- There is generally a lack of certainty in relation to the speed of decline of the existing legacy fields; and
- There is an increasing risk of N-1 events occurring due aging fields and infrastructure.

Longford

There was great concern expressed about the decline in Longford and what this is meaning for gas supply adequacy. Noted comments expressed the following:

- Longford is in decline and there is no committed replacement.

- Longford decline can be considered in terms of both capacity and plant integrity.
- Short-term, unforced outages of Longford have been increasing as this winter has demonstrated.
- Supply failures at Longford can result in extreme prices.
- There is increasing uncertainty in relation to Longford production and its ability to provide winter shaped supply and reliable supply.

New supply

There were concerns expressed about the uncertainties and risks associated with new supply developments. These included the following messages:

- Plant issues at Sole.
- Golden Beach entry uncertainty.
- Golden beach is untested and unproven.
- There is uncertainty around potential new and existing field production. This includes BassGas decline, Sole processing concerns, reliance on additional drilling in the Otway.
- There is red tape on new projects that hinders development.
- There is increasing risk of well replacement rates in Queensland not achieving expectations, which would result in a limited ability for Queensland CSG fields to support southern gas market demand.
- There are timing/investment risks with the required expansions of SWQP/MSP/Culcairn by APA.
- A potential import terminal on the western side of the VTS is likely to create a further bottleneck in transportation and influence system constraints.
- Adding an import terminal at Geelong would add to the complexities associated with the changing utilisation of the Qld/SWQP and Culcairn across the year.

Port Kembla Gas Terminal (PKGT)

The PKGT was seen as critical to supply. While most were highly confident the PKGT would enter, there was uncertainty expressed about its entry, its ability to obtain cargos, and its ability to replace Longford.

Comments reflected the following:

- The AEMO GSOO and EnergyQuest have factored in the AIE Import Terminal as a certainty.
- Port Kembla is far from certain.
- While AEMO doesn't predict a large capacity deficit within the next 2 to 3 years, this is solely reliant on Port Kembla being commissioned (with associated transport upgrades), and cargoes being committed to the project (at a time of increasingly tight international markets), as well as no other plant or production problems.

- If Port Kembla does proceed, we do not believe it will be sufficient to replace the decline at Longford, though the expansion in Queensland supply plus Golden Beach could delay the requirement of an expansion into the market from the SWP.

Iona

There was general commentary that the role of Iona is expected to increase in the future, and that this meant that refilling capacity may become an issue.

Comments made reflected the following:

- Filling UGS at maximum capacity rates is a lesser issue than having the ability to send gas to the DWGM at maximum capacity.
- Consistent year on year high utilisation of Iona may require additional refilling capacity.
- This winter had Iona increasingly used as a mid-merit "supply" or "deep storage" source as opposed to purely peak shaving.
- The slow refill rate of Iona UGS limits recovery of the storage volume if it has been emptied rapidly.
- If there is insufficient market demand and excess supply in the proximity of UGS, then an expansion is necessary.
- The Iona expansion volume should reflect the anticipated increase in capacity. With the Lochard expansion the expectation is that the facility will be capable of taking 250 TJ/day into the facility. Currently this is capped at 155 TJ/day on SWP and will be 200 TJ/day with Worm expansion. This still leaves 50 TJ/day.

SWP

There was general agreement on the increasing reliance that will be placed on the SWP as Longford declines.

Comments reflected the following:

- The SWP should be expanded.
- At the moment there exists constrained capacity at SWP (supporting Iona/ Otway/Casino/Henry) with a relatively low cost of expansion.
- Significant capacity increase in the SWP is needed to cope with Iona expansion, additional Victorian West Coast Supply, and a new import terminal supply.
- An expansion of the SWP would reduce systemic risk.
- An increase in SWP capacity could help provide certainty of access to the market for further field expansion in the Otway region.
- Market participants will have difficulty committing to buying additional capacity at Iona or additional supply from Otway if there is no surety of scheduling and dispatch to DWGM.

- Potential new supply at Otway may compromise/congest UGS capacity.
- Should there be demand for UGS filling exceed available capacity then SWP should be expanded to flow to Iona.
- Keen for the South West pipeline in Victoria to have the necessary expansion to transport gas to demand centres as needed whilst catering for Iona's gas storage and reinjection needs.

Gas Supply Adequacy

Supply adequacy was seen as an increasing issue.

Comments reflected the following:

- AEMO modelling is indicating an increasing need for peak day capacity and/or shortfalls by the end of the access arrangement period.
- Increased reliance on Iona / northern gas for capacity at peak in absence of alternative large sources.
- Ageing gas fields and plant infrastructure with accompanying lack of capital investment is affecting both gas supply and demand.
- Forecasts are likely based on "expected" outcomes or base-case scenarios. However, low probability, high consequence risks need also to be considered.
- If demand (southern markets in particular) cannot be met using the sum of UGS and SWQP and Gas Plant MDQ's, then there is a real threat to system security and supply, particularly on unproven assumptions and uncommitted resources/facilities.
- There is risk.
- While AEMO are not forecasting any capacity constraints in the most recent GSOO on a 1 in 20 day, this assumes that all other plants are operating as expected. This winter has shown that the NEM and East Coast Gas markets are increasingly becoming less resilient to extreme market events and or multiple credible contingencies.
- The outcomes of the 2021 winter have shown how balanced the East Coast gas market is, particularly when credible contingency events occur simultaneously in both the gas and electricity markets.
- From a system security and gas power generation requirement, additional capacity is required in the market, particularly as Gippsland declines.
- Keen for the South West pipeline in Victoria to have the necessary expansion to transport gas to demand centres as needed whilst catering for Iona's gas storage and reinjection needs.

4. Participant Responses: Intended Contracted Capacity

This chapter presents the results of the consolidated gas supply capacity requirements of the parties that participated in the survey.

This chapter is structured as follows:

- The quantitative component of the survey undertaken is explained;
- The quantitative results of the survey, presented as the consolidated (i.e. summed) total of all responses, is presented; and
- From this an interpretation (by Marsden Jacob) of the results is provided.

4.1 Explanation of the Survey

The consortium members were asked to complete a survey containing the table shown in Appendix 2. This table was developed to show the level of demand the parties are planning on supplying and the associated level of gas supply required.

In relation to the survey responses:

- Not all of the consortium members (see Section 2.4) responded to the survey.
- Lochard responded to the survey by providing the total level of intended contracting from Iona for parties (consortium members and non-consortium members) that did not respond to the survey.
- The omission of responses from some SWP users indicates that the total level of intended contracting capacity for SWP may be higher than reported in this report i.e. to transport gas directly from the SEAGas Pipeline to SWP.

The table consists of the following:

- Gas demand excluding GPG (TJ/day) in Adelaide, Melbourne and Sydney.
- Gas demand for GPG (TJ/day) in Adelaide, Melbourne and Sydney.
- Surveyed intended capacity contracting (MDQ TJ/day) in SA on the SEAGas pipeline and other.
- Surveyed intended supply contracting (MDQ TJ/day) in Vic / NSW on the SWP.
- Surveyed intended supply contracting (MDQ TJ/day) in Vic / NSW from sources other than the SWP (referred to as other).

The interpretation of the table needs to recognise that the results do not represent the whole market, and that the proportion of the market represented in the “intended contracting on the SWP” is higher than for the other figures.

Because of the above, Marsden Jacob's interpretation of the table is that the capacities shown represent minimum demand.

4.2 Results of the Survey

The results of the survey (from 2023 onwards) are presented in Table 2 below. Only the aggregate MDQ required capacity (TJ/day) is shown.

Table 2 Consolidated Responses of Gas Supply Capacity Requirements (TJ/day) [1]

Quantity TJ/day	Planned							
	2023	2024	2025	2026	2027	2028	2029	2030
Demand (ex GPG)								
Adelaide	33	34	34	34	35	35	36	36
Melbourne	587	582	587	590	593	597	600	604
Sydney	201	204	206	207	209	211	212	214
Demand - GPG								
Adelaide	125	15	15	15	15	15	15	15
Melbourne	175	175	175	175	175	175	175	175
Sydney	60	80	80	80	80	80	80	80
Intended Contracting								
SA								
SEAGas	10	10	-	-	-	-	-	-
Other	19	19	5	5	5	5	5	5
Total SA	**29**	**29**	**5**	**5**	**5**	**5**	**5**	**5**
Vic / NSW								
SWP	572	568	569	570	571	569	564	515
Other	272	268	274	277	282	284	287	290
Total Vic / NSW	**844**	**836**	**843**	**847**	**853**	**853**	**851**	**805**

Note (1): The figures do not include the required capacities from all market participants (meaning that the capacities cannot be totalled to give the total market needs). Marsden Jacob's interpretation of the table is that the capacities shown represent minimum demand.

Source: Responders replies and Marsden Jacob analysis and presentation

The key results are the following:

- The total level of demand in Victoria, Sydney, and Adelaide (by those that participated in the survey) is less than the AEMO 1 in 2 year peak day demand projection. The reason for this is that parties surveyed did not represent the whole market.
- MDQ required for GPG demand in Victoria is in the order indicated by the GPG projections (see appendix 5 of this report). This indicates that the GPG outlook may be higher than AEMO are projecting.
- The planned contracting capacity on the SWP is around 570 TJ/day apart from 2030 where this is less. While this outlook represented a larger portion of the market than the other supply sources, it is likely to be less than the total intended contracting on this pipeline.

- The planned contracting capacity from other (not SWP) sources only increases by 18 TJ/day over the period.

4.3 Key Conclusions from the Survey

The main conclusions of the survey are as follows:

- There is a high level of demand for capacity on the SWP.
- The intended peak day utilisation on the SWP, forecast at 570 TJ/day, is above the SWP nameplate capacity limit. This is a traditional market signal for expansion.

5. Review of Oakey Greenwood Report

APA have engaged Oakley Greenwood to study supply adequacy of the Victorian gas market for the next Access Arrangement (AA) period and immediately beyond. This chapter presents a review of the draft report by Oakley Greenwood dated September 2021 and titled "Issues Affecting Demand and Supply for Gas on the Victorian Transmission System"[19].

The review of the Oakley Greenwood report presented here considers only the information and analysis in that report, and is prepared in advance of the detailed supply and demand modelling planned by Marsden Jacob in Phase 2 of this engagement.

Structure of this Review

This review is structured as follows:

- An overview of the Oakley Greenwood report;
- A description of the changes to peak day demand and supply proposed by Oakley Greenwood from that in the AEMO gas outlook reports;
- A discussion of the impact of these changes to the adequacy of Victoria peak day supply;
- Issues relevant to peak day supply and demand not addressed in the Oakley Greenwood report;
- An evaluation of the Oakley Greenwood conclusions on future gas supply options.

AEMO Reports

This review and the Oakley Greenwood report both refer to the gas market outlook reports developed by AEMO. The two reports (which are referred to as the AEMO gas outlook reports) are:

- AEMO 2021 Victorian Gas Planning Report (VGPR); and the
- AEMO 2021 Gas Statement of Opportunities (GSOO).

Summaries of the findings of these reports that Marsden Jacob consider relevant to the discussion in this chapter are presented in appendices 2, 3 and 4.

[19] The disclaimer of that report states "This report was commissioned by APA understand the factors that are likely to affect the supply / demand balance in the Victorian gas market over the period of their next Access Arrangement period, and more specifically, the impact that those factors could have on the Victorian Gas Transmission System (including peak demands, and required augmentations)."

5.1 Caveats

Oakley Greenwood noted a number of caveats that are worth repeating here to provide context to their report.

On the objective:

> "APA commissioned [Oakley Greenwood] to understand the factors that are likely to affect the supply / demand balance in the Victorian gas market over the period of their next AA period, and more specifically, the broad impact that those factors could have on the Victorian Gas Transmission System (including peak demands, and required augmentations)."[20]

Caveats:

> "In order to complete this task, we considered, and in many cases relied on, publicly available information. We have taken much of this information on face value, and to the extent it is incorrect, the conclusions drawn from that information may also be incorrect.
>
> For the avoidance of doubt, we did not seek any information directly from any party other than APA, nor did we seek information that directly related to any supply proponent, from any third party.
>
> Given the complexity of the east coast gas supply/demand dynamic, the paucity of publicly available information in some cases (particularly in relation to the costs of undertaking certain upgrades, which we note, we were not asked to model in detail), and the long-term nature of the forecasts that we have been asked to develop, it has been necessary to make a number of assumptions and to draw conclusions from a number of different information sources.
>
> The forecasts and conclusions contained in this report need to be considered in this light."[21]

5.2 Overview of the Oakley Greenwood Report

The Oakley Greenwood report is structured to first review the peak day supply /demand outlook presented by AEMO (in the southern gas markets[22] with a focus on Victoria), present factors that in their opinion have changed since that outlook, and from this draw conclusions about the adequacy of peak day supply and demand outlook.

The Oakley Greenwood report then reviews and compares possible future peak day supply expansion options to address any shortfalls that may occur in the outlook period.

The outlook period considered in the Oakley Greenwood report is not limited to the 2023 to 2027 Access Arrangement AA period. Quantitative analysis is presented for some years up to 2030, and qualitative comments are provided for the post 2030 period.

The references used by Oakley Greenwood are:

- The 2021 AEMO 2021 Gas Statement of Opportunities (GSOO);

—

[20] Issues Affecting Demand and Supply for Gas on the Victorian Transmission System, Final Draft Oakley Greenwood 13 September 2021 p7

[21] Ibid. p13

[22] New South Wales, Victoria, South Australia, and Tasmania.

- The 2021 Victorian Gas Planning Report (VSPR);
- The AEMO Inputs, Assumptions and Scenario Report (IASR) prepared for the AEMO 2021 Integrated System Plan (ISP);
- Referenced announcements.

For the start of the AA period (year 2023) the Oakley Greenwood report notes that without an import terminal at Port Kembla or other anticipated projects, AEMO is forecasting a supply gap of up to ~100TJ/day, for 3 days a year in 2023. With an import terminal at Port Kembla, and no other change, AEMO's modelling is indicating that there would be no supply gap in 2023. This reflects the finding of the AEMO forecast.

5.3 Changes from the AEMO Forecast

The Oakley Greenwood[23] report proposes changes in the gas demand and supply assumptions from those used in the VGPR and the GSOO, and that as a result, change the gas supply adequacy outlook.

The section presents these changes, and a view on the appropriateness of including these changes in the supply planning basis.

5.3.1 Reduced Industrial Demand

Oakley Greenwood report presents the impact of the announced shutdown of the Altona Refinery and a Qenos steam cracking plant (announced since the VGPR), and concludes that this will reduce peak day demand by 7.3 TJ/d.

This announcement was not included in the VGPR forecast (it was announced since the VGPR was published) and Marsden Jacob agree Oakley Greenwood are reasonable to adjust demand for this shutdown.

5.3.2 Reduced Gas Heating not in the AEMO Outlooks

Oakley Greenwood present the view that the Victorian environmental policy of net zero emissions by 2050 will result in a transition of domestic gas heating load to electricity heating load, and that this should be included as an assumption (to a greater or lesser extent) in all scenarios used.

To support this position, Oakley Greenwood reference the Zero Emissions scenario[24] in the IASR, and a statement made in the IASR in regard to the outlook of gas heating in that scenario. This statement is as follows (Zero Emissions Scenario description, Page 13):

> "Stronger economy-wide decarbonisation, particularly industry electrification, occurs in later years as the 2050 deadline approaches. Consumers are initially continue [sic] to heat their homes in the same manner they do today, but by the mid-2030s nearly half the current gas heating has been electrified, and in the final years of the horizon nearly all residential heating is electrified."

[23] Taken from Section 2.3 (page 23) and Table 7. Not all statements are included.
[24] This scenario is base don new zero emissions by 2050.

Oakley Greenwood then use the indication expressed in the IASR (noted above) to develop three scenarios of gas heating conversion to electricity heating and the resulting impact this would have on peak day gas demand. The three scenarios have a transition of domestic gas customers to electricity by 2035 as follows: 10% (Low), 25% (Medium) and 50% (High). The assessed impact on peak gas demand from these scenarios is then assessed as between 7 TJ/day and 33 TJ/day on a peak day in 2025, and between 33 TJ/day and 167 TJ/day in 2030.

The Oakley Greenwood report notes the following from the 2021 GSOO:

> "…while not considered in the scenario collection for this year's GSOO, a scenario with greater electrification of residential heating (or other heating alternatives to gas) would drive down Victoria's maximum daily demand for gas much faster than currently forecast. This possibility will be explored in more detail in future GSOOs, and AEMO's 2022 Integrated System Plan"

Marsden Jacob Comments

It is first noted that it is possible that such a policy could be announced in the future, and on that basis, the VGPR should consider the impact of such policy. In Marsden Jacob's view, the uncertainty of the nature and extent of any climate change policy means that, before any such announcement, it is not a prudent basis for an evaluation of gas peak day supply adequacy.

This view is supported by the following.

Firstly, reference to reduced gas heating is contained in only one scenario of the AEMO 2021 IASR, and in that scenario, the assessment of reduced gas heating reads as an "unsupported" assumption of what the conversion might be in the mid 2030's. The AEMO IASR has five scenarios and only one mentions 50% of gas heating being electrified by the mid 2030's (this is the Zero Emission Scenario), and this scenario provides no indication of path.

References to electrification in the IASR scenarios are presented in Box 1 below.

Secondly, the Oakley Greenwood report does not present any modelling behind the rate of churn from gas to electricity assumed, or a thorough determination of the impact of the assumed churn on the reduction in peak day gas demand (and so the quanta cannot be reviewed).

Thirdly, the assumption does not consider the impact of the resulting increase in peak electrical load on peaking gas powered generation. This could significantly offset the reduction in peak gas demand.

For the above reasons, Marsden Jacob questions the assumed reduction in peak day gas demand for electrification of heating load, both in the shorter term, where Marsden Jacob are of the view that there is no solid basis to include any gas heating electrification in the demand outlook, and post 2027 as the reasons for such switching are complex.

In general, it is relevant to note that gas demand forecasts prepared by AEMO are used by AEMO to identify potential supply reliability issues and by the industry for supply planning, and as such it is important it is realistic and conservative in its assumptions.

Box 1: References to Electrification in the AEMO Input Assumption and Scenario Report, July 2021

Slow Change Scenario description (page 13)

Marsden Jacob note that is no mention of gas heating being electrified in this scenario.

Steady Progress Scenario, Section 2.1.2 (page 15)

"Uptake of DER, energy efficiency measures, and the electrification of the transport sector proceed in line with AEMO's current best estimates to 2030, reflecting continued strong trends in distributed investments as consumers benefit from reducing investment costs and relatively short payback periods."

Step Change Scenario description (page 13)

"By 2050, most consumers rely on electricity to heat their homes and businesses."

Zero Emissions Scenario description, Page 13

"Stronger economy-wide decarbonisation, particularly industry electrification, occurs in later years as the 2050 deadline approaches. Consumers are initially continue to heat their homes in the same manner they do today, but by the mid-2030s nearly half the current gas heating has been electrified, and in the final years of the horizon nearly all residential heating is electrified."

Hydrogen Superpower Scenario description (page 14)

"New household connections tend to rely on electricity for heating and cooking, but those households with existing gas connections progressively switch to using hydrogen – first through blending, and ultimately through appliance upgrades to use 100% hydrogen."

5.3.3 Additional gas supply from (mainly) hydrogen

Oakley Greenwood propose to include additional gas supply from (mainly) hydrogen. They assume an additional 9.15 TJ/day in 2025, and 24.42 TJ/day in 2030, based on an assumption of 10% of the volume ("3% of the energy") in 2035.

Marsden Jacob note that to our knowledge, (green) hydrogen has not yet been proven commercial for conventional domestic gas supply (i.e. in competition with electricity) . Biomethane is probably competitive, but quantities are limited.

For these reasons and in our view, the renewable gas scenario is speculative and consequently not a suitable basis for capacity planning.

5.3.4 Augmentation of the SWQP and MSP not in the VGPR

Oakley Greenwood include 100 TJ/d of additional peak day supply based on the augmentation of the South West Queensland Pipeline and Moomba Sydney Pipeline by the APA Group, and the accompanying gas supply agreement between Origin Energy and APLNG for 91 PJ of Queensland gas over four years from 2022.[25]

[25] https://www.reuters.com/article/australia-gas-origin-energy-apa-idUSL4N2MS1FR

Marsden Jacob agree that the announced supply arrangements would increase peak day supply as suggested. What is not clear is whether they are "committed" in the context of AEMO's supply adequacy forecasting (noting that the APA/Origin announcement was after the VGPR was published).

Marsden Jacob are of the view that clarification of the above is required.

The next section discusses how Oakley Greenwood factor their proposed changes to supply and demand assumptions (discussed above) are factored into their supply adequacy outlook.

5.4 Impact of Changes to Victoria

Oakley Greenwood use the four changes described above (i.e. lower industrial demand due to the Altona shutdowns, low gas heating due to electrification of gas heating load, additional gas from hydrogen, and the proposed upgrading the SWQP and MSP) to modify the AEMO outlook of gas supply capacity (TJ/day).

The resultant gas supply capacity outlook is presented in the Oakley Greenwood report in Table 4 (and Table 7[26]). Table 4 is introduced as "the potential impact that the above factors could have on AEMO's forecast of peak demand (TJ/day) to 2030". This shows a surplus in 2025 of 406 to 423 TJ/day, and in 2030 a shortfall of 9 to 93 TJ/day. Figure 1 below presents Table 7 from the Oakley Greenwood report (which is also identical to Table 4 in that report)[27].

Oakley Greenwood state after Table 7 (page 38):

> "Our analysis indicates that as a result of the Victorian Government's legislated commitment to Net Zero by 2050, and reflecting AEMO's IASR that under a Net Zero scenario, nearly half the current gas heating could be electrified by the mid-2030s (which broadly aligns with the Victorian Government's pathways analysis), there may only be a very small supply shortfall (-9.24TJ) on peak demand days in 2030. If electrification were to lag AEMO's assumption, with only 25% of customers having their heating loads electrified by 2035, the supply shortfall is larger, but still not insurmountable (at -92.79TJ) in 2030. Options for covering this supply shortfall are discussed in the next section."

[26] These table are identical.

[27] For Tables 4 and 7 of the Oakley Greenwood report it is not stated where the figures for the row titled "original GSOO Peak Day Supply Adequacy with PKGT" for the years 2025 or 2030 come from. It is assumed appears that they are from the graphs and accompanying tables contained in the GSOO (Figures, 22, 28,30).

Figure 1 Table 7 from the Oakley Greenwood report

3.5. Summary of impact on AEMO's GSOO forecasts

The following table summarises the potential impact that the above factors could have on AEMO's forecast of peak demand (TJ/day) to 2030.

Table 7: Impact on Peak Demand

Key Issue	Impact in 2025 (TJ/Day)	Impact in 2030 (TJ/Day)
Est. AEMO peak demand starting base	1250	1250
Increased Supply		
Increased supply resulting from expansion of the SWQP/MSP	100	100
Increased supply from Renewable Gases	9.15	24.42
Reduced Demand		
Reduced consumption from Altona Refinery and Qenos	(7.24)	(7.24)
Reduced peak day consumption due to electrification		
High (50%)	(33.42)	(167.11)
Medium (25%)	(16.71)	(83.55)
Low (10%)	(6.68)	(33.42)
Net Change in Supply Adequacy		
TOTAL Change - Medium Elec	133.1	215.21
TOTAL Change - High Elec	149.81	298.76
Supply Adequacy		
Original GSOO Peak Day Supply Adequacy with PKGT (Southern Mkts)	+273	-308
Peak Day Supply Adequacy after adjustments (Southern Mkts)	+406.1 to +422.81	-92.79 to -9.24

NOTES: OGW analysis

Source: Oakley Greenwood report.

Marsden Jacob comments

For comparison to the capacity demand and supply outlook presented in Tables 4 and 7 of the Oakley Greenwood report (shown above), Marden Jacob note that the supply capacity adequacy for the years 2023 and 2025 are provided in the VGPR. Table 3 below presents a table of the Victorian demand / supply balance constructed (by Marsden Jacob) from data contained in the VGPR. The sources within that report are referenced (ALL means multiple locations in the VGPR).

Table 3 Victoria Demand / Supply Balance using AEMO 2021 Data

		TJ/day		Table 15		Table 16
Source	Factor	2021	2022	2023	2024	2025
Ex sum	Existing	1585				983
Exec sum	Gippsland existing	1030		561		443
Exec sum	Gippsland with anticpated developments			686		489
Table 14	Gippsland existing	1012	822	561	530	428
	Gippsland with anticpated developments	1012	822	686	695	489
ALL	Port Campbell	468	468	468	468	468
	Dandenong LNG	87	87	87	87	87
	DTS excluding Gippsland anticipated developments	1567	1377	1116	1085	983
	DTS including Gippsland anticipated developments	1567	1377	1241	1250	1044
ALL	Port Kembla total into Victoria			395	395	395
	EGP			200	200	200
	VNI			195	195	195
	Total excluding Gippsland anticipated developments	1567	1377	1511	1480	1378
	Total including Gippsland anticipated developments	1567	1377	1636	1645	1439
	DTS 1 in 20			1228		1210
Table 23	DTS 1 in 20	1262.8	1250.2	1228.5	1217.9	1209.8
	Surplus excluding Gippsland anticipated developments	304.2	126.8	283	262.1	168
	Surplus including Gippsland anticipated developments	304.2	126.8	408	427.1	229

Source: AEMO 2021 Victorian Planning Report

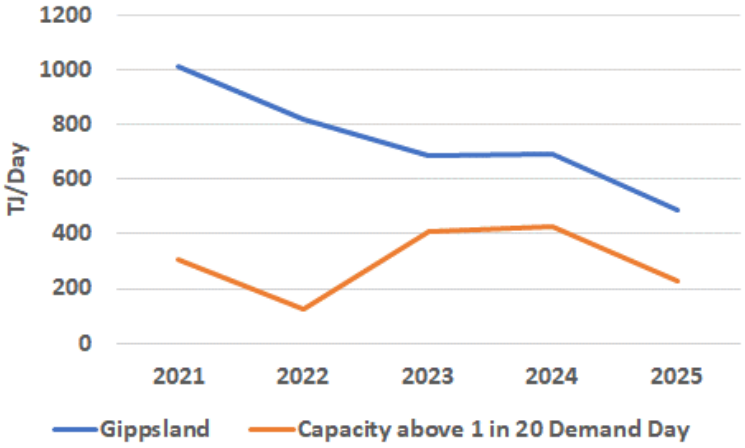
In relation to the projections in the VGPR presented in Table 3 above the following are noted:

- MSP capacity is increased to 450 TJ/day for the winter of 2021 (past). The MSP/SWQP development is not included in this AEMO forecast and would add 100 TJ/day to peak day supply if it were (as noted by Oakley Greenwood).
- The PKGT is developed and provides 395 TJ/day into Victoria (200 TJ/day via the EGP and 195 TJ/day via VNI). This is also included in the Oakley Greenwood report as such.
- AEMO gas demand projections. These projections include energy efficiency but do not specifically consider additional gas heating electrification. As discussed above, by 2025 Oakley Greenwood assume a range of High (50%) 33.42 TJ/day, Medium (25%) 16.71 TJ/day, Low (10%) 6.68 TJ/day.

The Victorian DTS outlook in 2025 presented in Table 3 shows a small capacity surplus over the 1 in 20 day peak demand, and the need for the PKGT.

What is evident is that any change to gas capacity from Gippsland could have a significant impact on the gas capacity adequacy outlook. This is illustrated in Figure 2 below, which shows the size of AEMO's forecast decline in Gippsland capacity compared to supply capacity available above a 1 in 20 day peak demand (i.e. the expected 1:20 peak day surplus). This large uncertainty reinforces the need for gas supply resilience noted in the 2021 GSOO, and for a prudent and conservative approach to the supply and demand assumptions.

Figure 2 Victorian DTS Outlook – Gippsland Supply Capacity and DTS Capacity Surplus



Gippsland is the total supply available from Gippsland. This shows the decline in capacity

The capacity above a 1 in 20 demand day is total available supply capacity less the 1 in 20 year peak day demand level of that year.

Source: AEMO VGPR and Marsden Jacob analysis

5.5 Issues not addressed in the Oakley Greenwood Report

While Oakley Greenwood present a reasonable view on possible changes to the demand outlook, in drawing conclusions about the adequacy of supply, in the opinion of Marsden Jacob, the Oakley Greenwood report does give appropriate recognition to other significant factors that are relevant to the consideration of supply adequacy and the supply options necessary for secure supply.

Factors not explicitly addressed in the Oakley Greenwood report include:

- The future level of Gas Powered Generation (GPG) and how this might be different to that projected by AEMO; and
- The potential reduction in VNI import capacity to Victoria due to operation of the Uranquinty gas generator.

Factors which should have more recognition (in the opinion of Marsden Jacob) are as follows:

- The impact of the uncertainty in the decline of peak day supply capacity from Gippsland and the availability of anticipated gas (assumed in the GSOO); and
- The future need for gas supply resilience.

These are addressed in turn below.

5.5.1 Gas Powered Generation

Future GPG is a significant issue for both the NEM and the gas market. The NEM is entering a new phase of development where greater reliance will be place on "firming" assets such as GPG to ensure supply reliability. Factors that will potentially and significantly increase GPG in winter days include:

- 5 minute energy market settlement (requiring GPS plant to be operating in preparedness for high prices).
- The potential earlier closing of coal plant than is assumed in the current AEMO Integrated System Plan.
- Increasing levels of solar generation (small scale and large scale) that will likely result in reduced coal plant operation and increased reliance on gas plant.
- Battery operation more "stretched" in the winter period, increasing the reliance on gas plant.
- Transition of gas consumers to electricity (such as residential heating if and when this occurs[28]).
- Climate change policy initiatives, or even the uncertainty around them.

Evaluation of the GPG peak demand for gas is complex and necessarily includes a consideration of the electricity market, and the impact of the GPG gas demand could be significant in the quantum of surplus or shortfall in gas peak day supply.

Marden Jacob expects the quantity and profile of gas demanded by GPG will be increasingly intermittent and with an increasing trend to having many gas generators potentially starting at the same time. This will require highly flexible gas supply.

5.5.2 VNI Capacity and Uranquinty Generation

The VNI import capacity (to Victoria) is reduced when Uranquinty Power station is operating, or if there is high system demand off the Young to Culcairn lateral. This is understood to be substantial and relevant given the tightening demand /supply outlook for the southern gas market.

This is a complex issue and should be addressed in any consideration of capacity supply and demand (including in the context of the electricity system), and especially when capacity is being assumed available via the VNI to the DTS.

5.5.3 Gas supply

The Oakley Greenwood report does note the issue of the AEMO assumption that anticipated gas supply will be available.

Oakley Greenwood note the following (page 23):

> "As shown in Figure 8, AEMO is forecasting a supply shortfall from 2029 even with the assumptions that committed, and anticipated projects are developed, and all associated reserves and resources are commercially recoverable. The gas supply shortfall rises steeply from 2029 to 2040."

[28] Noting this is the reverse of the gas heading assumption

Oakley Greenwood note the following (page 39):

> "Even after incorporating the factors that we have discussed in this section of the report, there is still a supply shortfall in 2030 of 55.4PJ under the medium case, and 48.08 under our high case, assuming as given AEMO's other GSOO assumptions e.g., declining Longford supplies; LNG receipts; north / south transmission constraints for a substantial amount of the year. Whilst this shortfall is material, AEMO is forecasting no shortfall until 2029, beyond the AA period, and moreover, this figure is likely to be subject to significant uncertainty (e.g., the quantum of the reduction in Longford, noting the nature of any gas reservoir engineering analysis supporting this, and the inherent uncertainties that this entails)."

While this is a complex issue and uncertain, Marsden Jacob are of the opinion that the risks of 2C gas not being available need to be recognised in assessments and scenarios of gas demand and supply outlooks and reflected in the assumptions used for supply planning. If such gas is not made available (due to economics or other), then this could have implications for the economics of a second LNG import terminal in Victoria, increased storage, and the need for an expanded SWP.

5.5.4 Supply Resilience

The 2021 GSOO emphasises the need to include consideration of the future operating challenges of the gas system and the need to include a consideration of resilience in potential new gas supply options.

Oakley Greenwood note:

> "There [sic] future conditions affecting the domestic gas market are inherently uncertain – more so now than possibly at any time in its history. This uncertainty increases the value of flexible supply and infrastructure options to meet projected seasonal supply gaps, or put another way, it increases the risk associated with making long-term, large scale investments, in the face of this uncertainty."[29]

Marsden Jacob support the opinion expressed in the 2021 GSOO that the changing (and tightening) nature of the gas market is reducing market resilience and threatening supply security. In addition, it could be argued that high market uncertainty means that it is prudent to require larger margins of surplus, and greater optionality of supply sources.

While the Oakley Greenwood report did not focus on supply resilience, this is an important factor in supply planning and to future supply options. Future supply options are discussed in the next section.

5.6 Future Options

This section reviews and provides Marsden Jacob comments on Chapter 4 of the Oakley Greenwood report.

The Oakley Greenwood says that there is a "shortfall to be managed from 2030" given their demand/supply outlook to 2030. This suggests that upgrading capacity of infrastructure may not be needed post 2030. The Oakley Greenwood report also recognises that there are uncertainties that

[29] p13

could result in additional capacity being required. This is expressed in the Oakley Greenwood report at the end of Chapter 3 (Page 38):

> "Our analysis indicates that as a result of the Victorian Government's legislated commitment to Net Zero by 2050, and reflecting AEMO's IASR that under a Net Zero scenario, nearly half the current gas heating could be electrified by the mid-2030s (which broadly aligns with the Victorian Government's pathways analysis), there may only be a very small supply shortfall (-9.24TJ) on peak demand days in 2030. If electrification were to lag AEMO's assumption, with only 25% of customers having their heating loads electrified by 2035, the supply shortfall is larger, but still not insurmountable (at -92.79TJ) in 2030. Options for covering this supply shortfall are discussed in the next section."

Noting the above, Chapter 4 of the Oakley Greenwood report states that the objective of this section (i.e. Chapter 4) is to:

> "Outline the feasible options for alleviating any forecast supply / demand imbalance towards the end of APA's AA period, including:
>
> - Augmenting the South West Pipeline; and
> - Augmenting the Young-Culcairn link (Interconnect);
>
> Other more marginal options:
>
> - Augmenting the Dandenong LNG facility; and
> - Relying on price induced demand response of a formal, centralised, demand response mechanism."

Additionally, Oakley Greenwood commented:

> "Whilst we have not undertaken a detailed real options analysis for the purposes of this project, we are of the opinion that unless the Iona injection capacity into the SWP is fully contracted long-term, increased compression on the VN Interconnect is likely to be a more appropriate solution to rely on given the current uncertainty affecting the gas market at present"[30].

And

> "Clearly, adding additional compression to support existing Iona withdrawal capacity has the advantage of leveraging an already completed investment. Although for the avoidance of doubt, the true test is whether the market has valued that existing withdrawal capacity enough to actually contract for it, subject to increased SWP capacity being made available. We are not in a position to assess whether or not this is the case, however it is a critical issue."[31]

Marsden Jacob Comments

The Oakley Greenwood report provides a substantial amount of commentary on the above mentioned options and provides opinion on which may be preferred. The details of this are not provided here.

In the opinion of Marsden Jacob, the limited analysis and discussion presented in the Oakley Greenwood report means that the views expressed by Oakley Greenwood need to be considered in the context that

[30] Page 14
[31] Page 45

recognises the limitations of that report, and that these limitations mean that an assessment of what might be a preferred option needs to be viewed in this context. In providing this opinion we are not suggesting that Oakley Greenwood may not have the same perspectives given the contents of their report.

In relation to this, Marsden Jacob summarise below our perspectives of the limitations of the Oakley Greenwood report in respect to their assessment of preferred supply options in the second part of that report.

Limitations of the Oakley Greenwood Report

Four observations are made in relation to the limitations of the Oakley Greenwood report.

Firstly, the assumptions used in the capacity adequacy report are not supported (by Marsden Jacob) for application in a centralised capacity adequacy assessment, because of the high level of reliability required of the gas system and how this impacted by the assumptions used (particularly in a central outlook).

Secondly, the resulting outlook shortfall is described as "manageable", which has the effect of limiting the quantification in the report of future capacity needs and the options that may or will be required. In the opinion of Marsden Jacob, this tends to limit the recognition of the risk issues (noted in the previous section) such as the need for resilience.

Thirdly, Marsden Jacob acknowledges that the Oakley Greenwood report has not claimed to do, or presented, any assessment or considering the economics of the available options. We also note that no economic analysis has been undertaken in this (Marsden Jacob) report. This is not a criticism, but an observation that limits the conclusions that can be drawn in relation to any comparison of supply options.

Fourthly, the suggested evidence presented in the discussion of potential supply options that the SWP has been underutilised may be misleading. The observation by Oakley Greenwood[32] that:

> "… Iona's maximum net injection into the VTS has, in recent years, been 390TJ/day; less than the capacity of the SWP."

does not state that Iona's production is only one component of SWP flow, the other component being supply from Port Campbell.

Without an economic analysis (costs, benefits), an evaluation of the comparative value of the SWP or any other peak day supply options can only identify issues for consideration, but not what the result of any such consideration might be. In particular, this means that any implied or asserted potential issues need to be treated as questions to be resolved. For example, the implication that there is insufficient gas available in Port Campbell to fill the SWP, or that the expansion of the VNI is preferable to expansion of the SWP.

[32] Page 41, third paragraph.

Preferred Option

The discussion above means that the opinion provided in the Oakley Greenwood report that northern gas, by upgrading VNI, is a superior option than upgrading SWP, is not supported by Marsden Jacob, pending the necessary analysis. While noting the issues raised for consideration, Marsden Jacob believe that "picking a winner" is premature prior to the essential quantitative analysis.

6. Peak Day Capacity Modelling

This chapter presents the Marsden Jacob Gas Model and initial modelling undertaken on the peak day capacity requirements in the southern gas market.

The Phase 1 modelling is a precursor to the Phase 2 modelling which will seek to quantify the value of expanding the SWP given the highly uncertain and dynamic nature of peak demand capacity forecasting.

The structure of this chapter reflects the approach to the Phase 1 modelling. This is as follows:

- The stochastic gas model developed and used in this report is presented including the assumptions of the modelling.
- The developed peak day gas demands are reviewed.
- The gas market supply and pipeline flows from the model are shown for selected peak demand days.
- The stochastics modelled flows on the SWP over the study period are presented.

6.1 Marsden Jacob Gas Model

The Marsden Jacob Gas Model is a stochastic model of the East Australian gas market. For this study (Phase 1 and Phase 2 modelling) the model has been structured for the southern gas market.

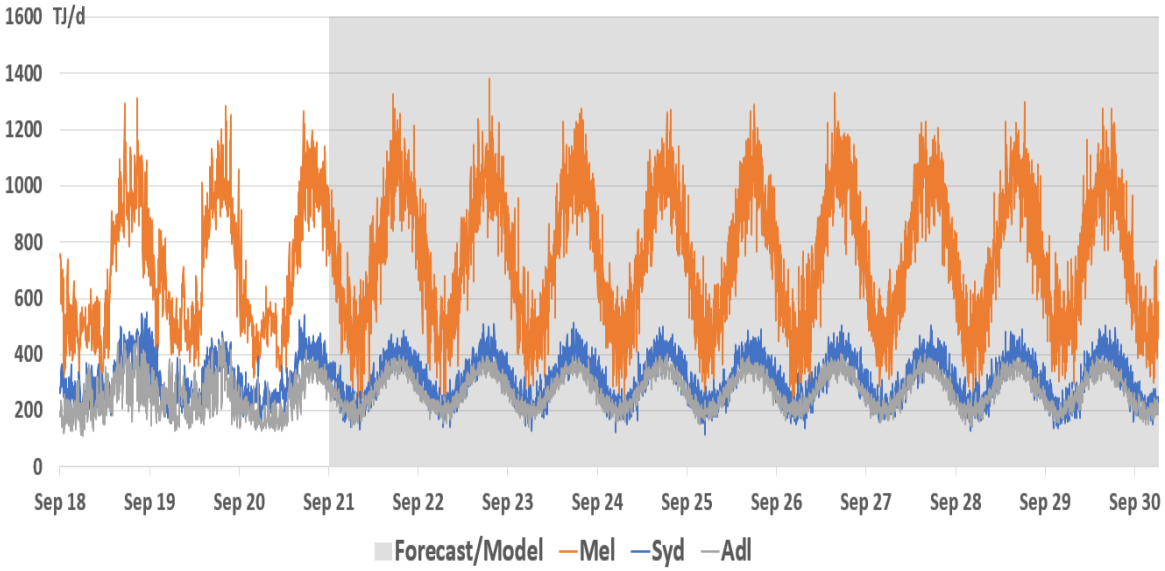
The model determines the regional gas demand for each day in the forecast period using a stochastic demand model based on historical daily demand and volatility[33].

The figures below present the following

- Figure 3 shows for daily demand, a comparison of historical and forecast; and
- Figure 4 shows for annual maximum demands, a comparison of the model and the AEMO peak day forecasts.

[33] The Marsden Jacob forecast for each demand centre is based on a stochastic, cosine "day of year" demand model, with minimum load, temperature sensitivity, cosine phase and volatility all based on historical values (September 2018 to September 2021). The demand model currently extends out to 2030.

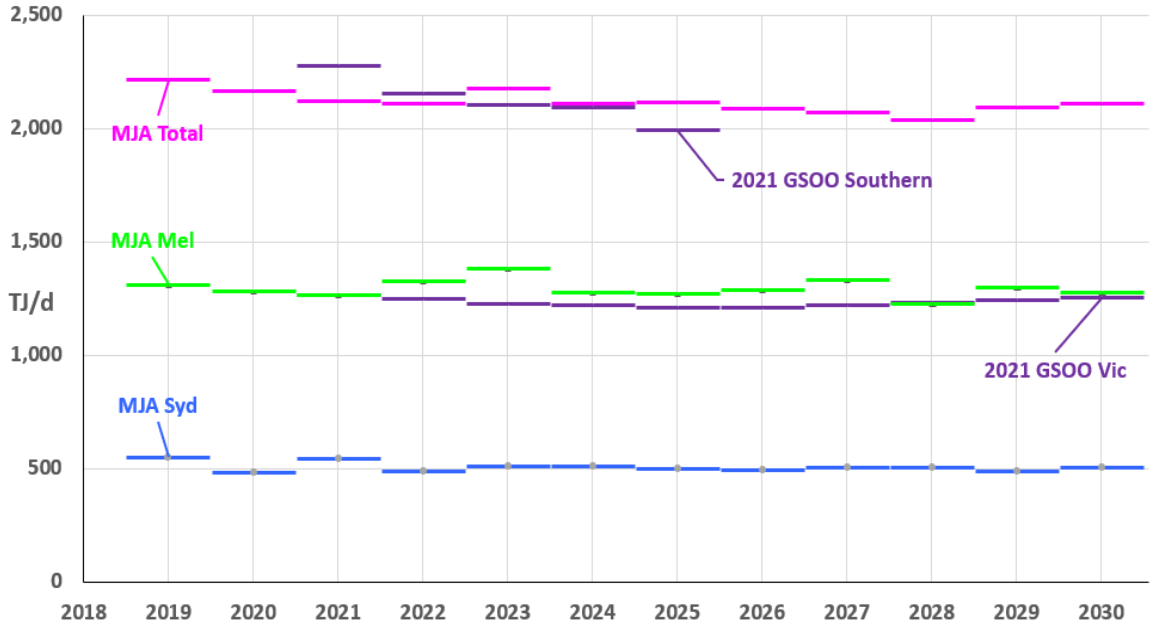
Figure 3 Demand Actual and Forecast



Notes (1) Actual demand presented up to Sep 2021
(2) Shaded area is forecast demand data ex Marsden Jacob Southern Gas Market Model

Source: AEMO 2021 GSOO, Marsden Jacob Modelling, Gas Bulletin Board

Figure 4 1:20 Peak Day Demand – Forecast and Actual



Notes (1) MJA Forecast ex Marsden Jacob Southern Gas Market Model (actual values for 2019, 2020, and 2021 ex GBB)
(2) AEMO Southern and Vic Forecasts ex GSOO 2021 (from 2026 a 1:2 forecast has been used and corrected by Marsden Jacob.

Source: AEMO 2021 GSOO, Marsden Jacob Modelling, Gas Bulleting Board

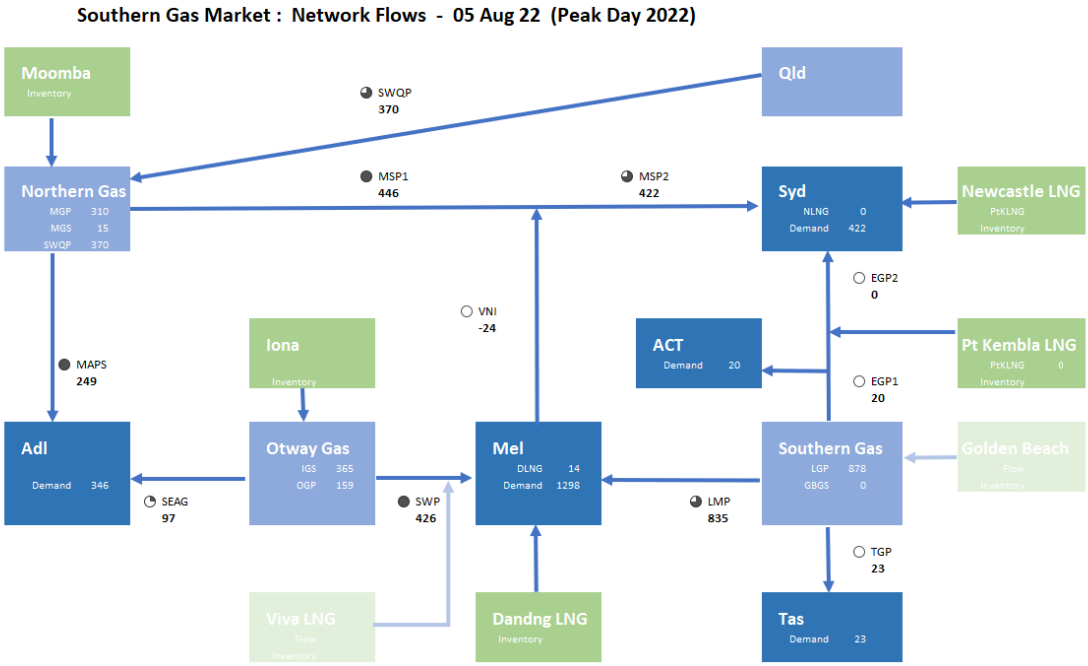
The gas network is represented as a network of facilities connected by pipelines. The forecast daily demands are met by the sequential dispatch of gas from production and storage facilities to regional

demand centres. Supply is dispatched in sequence determined (mainly[34]) by gas cost, until either the demands are met, or capacity is exhausted.

In this Phase 1 study the focus is on peak day analysis. The model was operated to consider how daily demands were met by available supply capacity (TJ/day). There is no consideration of annual quantities, no accumulation analysis (storage volume constraints or refill considerations), and no economics considered. These will be addressed in the Phase 2 modelling.

The structure of the southern gas market (facilities and pipelines) as represented in the model is shown schematically in Figure 5 below. Also shown are the gas sources (TJ for that day) and flows (TJ for that day) for the example day shown.

Figure 5 Southern Gas Market – Network Schematic



Source: Marsden Jacob preliminary modelling

6.2 Model Assumptions

In dispatching supply to meet demand, the model observes facility capacity constraints.

By changing these capacity constraints, different scenarios can be modelled, each based on a list of defined constraint assumptions.

The modelling assumptions for the Phase 1 modelling consisted of peak day demand assumptions (including daily volatility assumptions), maximum gas production assumptions, and maximum pipeline flow assumptions. These are addressed in turn below.

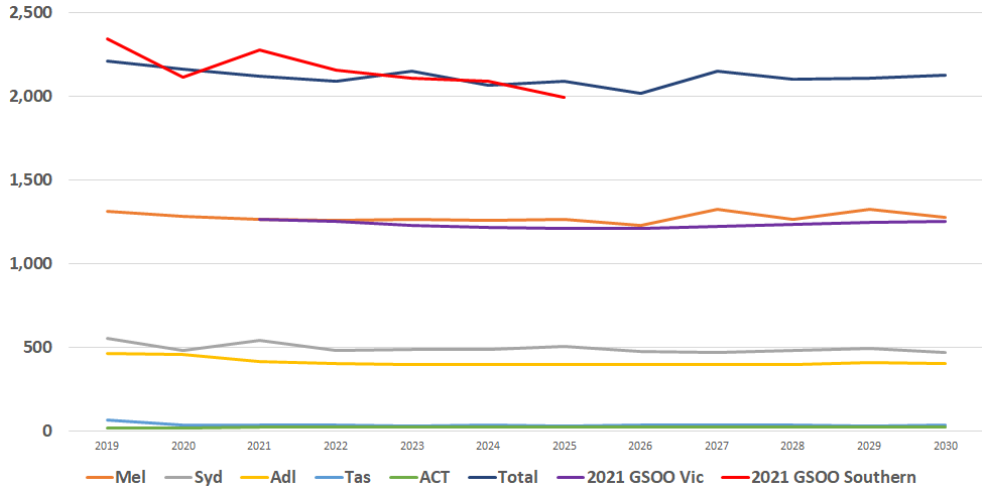
[34] A small number of flows are determined manually to reflect operational or regulatory constraints not recognised by the model

6.2.1 Peak Day Demand

The Phase 1 modelling is focussed on maximum demands[35]. This is the required daily demand level with which to compare the capacity of the gas network in the southern gas market. The Marsden Jacob model was required to develop realistic future stochastic daily demands. (The stochastic nature of peak days in the southern states is that that these are unlikely to occur on the same day. The modelling accounts for the diversity of peak days in the southern states.)

Figure 6 below presents the maximum daily gas demand for the demand centres in the southern gas market - Melbourne, Sydney, Adelaide, ACT, and Total (total southern gas market) for the period 2019 to 2030. The model peak days from 2019 to 2021 are actual values from historical data. Also shown in the figure are the available AEMO forecasts – 2021 GSOO daily maximum gas demands for the southern gas market (to 2025)[36] and for Victoria (to 2030).

Figure 6 1:20 Peak Day Demand: AEMO and Marsden Jacob for the Southern Gas Market



Source: AEMO 2021 GSOO; Marsden Jacob modelling and presentation

The figure shows that the independent Marsden Jacob forecast of peak day demands is in good agreement with the AEMO peak day forecast for the forecast period (2022 onwards). Noting the above and the similarity in the distribution of forecast and actual daily flows (see Figure 3), the Marden Jacob demand model presents a reasonable basis for the peak day analysis in this Phase 1 study.

Consistent with a prudent (conservative) approach to demand forecasting for supply adequacy assessment (and consistent with the AEMO approach) we have not adjusted the demand forecast for:

- Particular customer actions;
- Potential climate policy or changing generation mix; or
- Forecast gas powered generation (GPG) changes.

[35] Only 1:20 (P.O.E. 5%) Peak Days are considered, as this is the (conservative) basis for supply planning (the focus of this analysis)

[36] 2019, 2020 and 2021 values for the GSOO peak day were from previous GSOO forecasts and reflected a more bullish demand forecast.

Note that the AEMO peak day forecast beyond 2025 is based on a 1:2 (50%) POE[37,38] projection, and this has been adjusted by Marsden Jacob to correct this.

While these assumptions are considered reasonable in the opinion of Marsden Jacob, the demand model assumptions will be subject to review and extension in the Phase 2 modelling.

6.2.2 Peak Day Supply

The supply available to meet peak day demand over the study period is limited by the production capacity of production plants (gas supply sources) and the transport capacity of the southern market pipelines. These constraints are set in the model by using the current facility nameplate capacities as presented by the Gas Bulletin Board[39], with the following adjustments to represent known market developments over the study period. There are three adjustments:

1. AEMO's forecast decline[40] in native southern gas supply is modelled as a decline in Longford Gas Plant capacity[41]). (This decline is shown in Figure 13 below.)
2. The PKGT is assumed to be available as forecast from winter 2023 at 500 TJ/d, and the EGP south of the Port Kembla lateral is assumed to be modified for 200 TJ/d reverse flow to Longford at the same time.
3. Commissioning of the Western Outer Ring Main is assumed to occur in time for winter 2023, resulting in an increase in South West Pipeline capacity of 23 TJ/d (to 468 TJ/d).

The assumptions are all in line with the AEMO assumptions for the period, and consistent with the AEMO planning basis, no other expansion of supply is assumed for the study period to 2030.

(These and other assumptions will be reviewed in the Phase 2 modelling.)

6.2.3 Pipeline Capacity

Pipelines capacities were as per the Gas Bulletin Board and subject to the adjustments above. These will also be reviewed in the Phase 2 modelling.

6.2.4 Modelling Supply Operation and Adequacy

There are some subtleties in modelling peak day flows for demand centres using a stochastic model:

- Firstly, the supply available to each region is impacted by the demand in each of the other regions. A high demand in Sydney during a peak day in Melbourne, for example, reduces the gas available to Melbourne via the VNI, and the surplus PKGT gas available to Melbourne via the EGP.
- Secondly in a stochastic model the demands themselves are volatile – this is how the model represents

[37] This is all that has been published by AEMO as far as Marsden Jacob is aware.
[38] 1:2 or 50% P.O.E (Probability of Exceedence) means that the value that should be exceeded 50% of the time - the most likely value (normally distributed values assumed). 1:20 or 5% P.O.E means that the value will only be exceeded 5% of the years – on average once every 20 years.
[39] "Namplate Rating" report, downloaded 10 Oct 2021
[40] AEMO 2021 GSOO figure 22
[41] The AEMO 2021 VGPR represents the decline as a decline in "Gippsland " capacity. This is consistent with Marsden Jacob's best estimate of forecast Port Campbell gas supply.

the demand uncertainty (1:20 peak for example).

- Finally changes in these two factors can impact the flow paths that are used on any day to meet the required demand, which in turn can change which constraints are limiting supply.

It is these characteristics that make the stochastic model so useful in accurately modelling uncertainty in markets (see Figure 13 for an example of the benefits of stochastic modelling).

For this Phase 1 work, which has a focus on peak demand days, a representative demand and allocation of gas production and pipeline flows to meet demand is used, along with a comparison of the AEMO Peak Day limits. For this reason, the Phase 1 model only identifies whether supply is adequate on each Peak Day, and how the demand is met. That is, it identifies any shortfall, but not the remaining capacity. These will not be limitations in the Phase 2 modelling.

6.3 Gas Demand and Supply – Example Peak Day Outcomes

The gas model was used to model the operation of the gas market on peak demand days and to identify the supply sources used, the pipeline flows, and the active constraints on supply.

The results of individual peak demand days are presented in the following four figures:

Figure 7 and Figure 8 respectively show the following for peak gas days in 2023 and 2025 (for Sydney and Melbourne respectively):

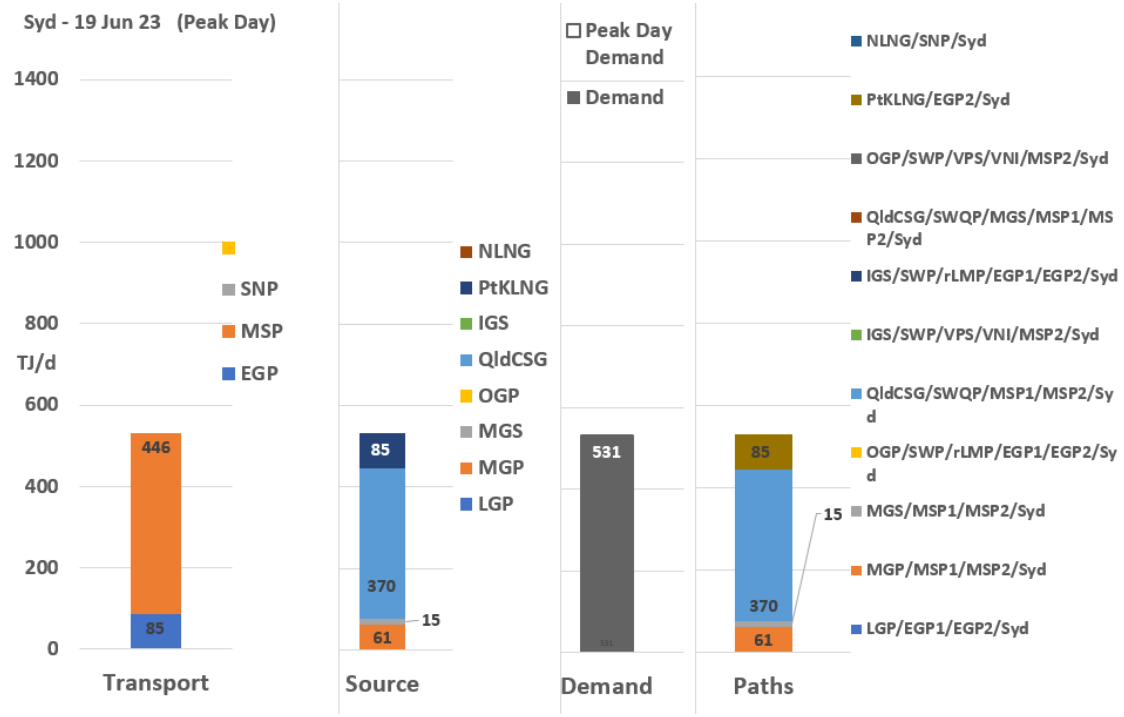
- Peak day demand;
- How that demand is met by source, transport and flow path.

Figure 9 and Figure 10 respectively show the following for the peak gas days in 2023 and 2025:

- Location demands;
- Gas being supplied from each supply source;
- The flows on each pipeline.

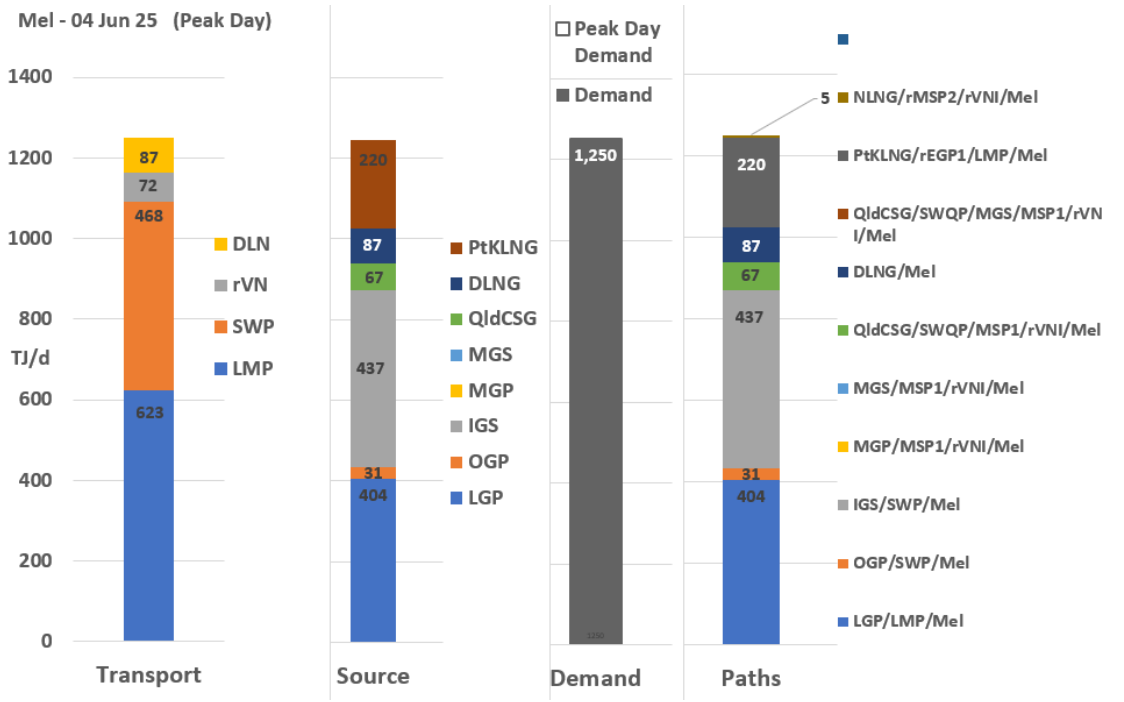
These are shown to illustrate the operation of the model and to show forecast supply and pipeline flows under the assumptions stated for peak day demands in the year 2023 and 2025.

Figure 7 Forecast Dispatch: Sydney - Winter 2023



Source: Marsden Jacob preliminary modelling

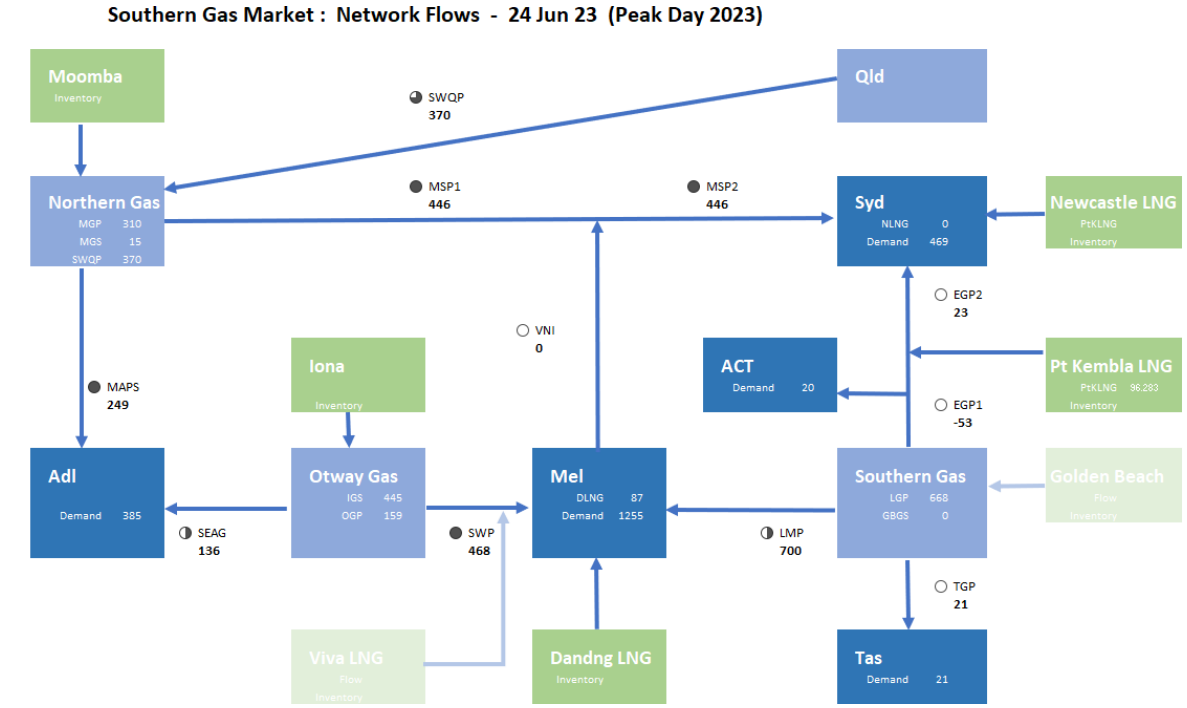
Figure 8 Forecast Dispatch: Melbourne - Winter 2025



Source: Marsden Jacob preliminary modelling

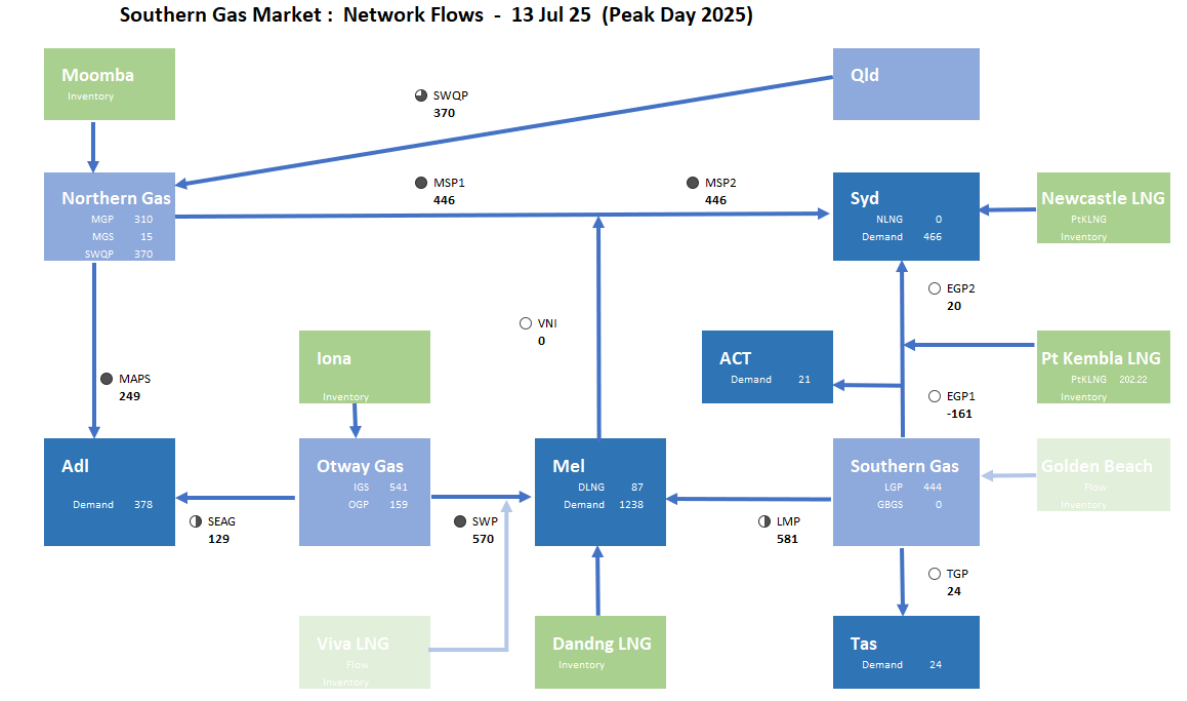
GLOSSARY – and rVN? IGS, OGPLGP

Figure 9 Forecast Dispatch: Winter 2023[42]



Source: Marsden Jacob preliminary modelling

Figure 10 Forecast Dispatch: Winter 2025



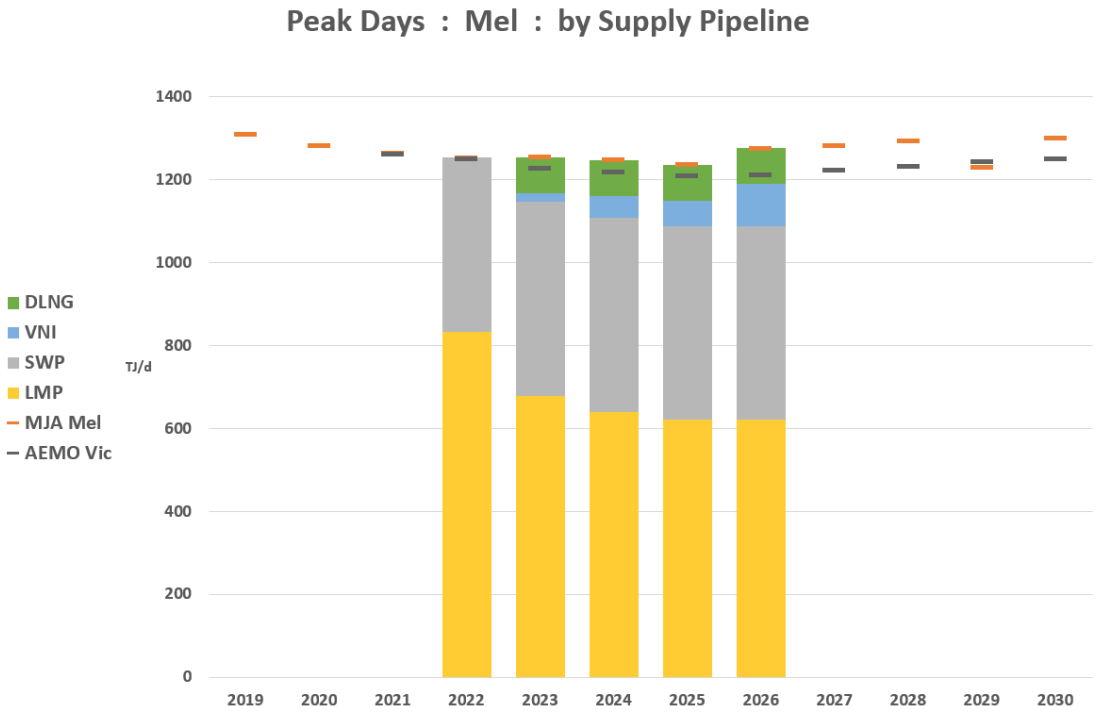
Source: Marsden Jacob preliminary modelling

[42] For the peak day in winter 2023 see Figure 3 above.

6.4 Outcomes Over the Study Period

Subject to the limitations described in section 6.2.4, and based on the assumptions in sections 6.2.1 and 0, the following figures describe a preliminary view of gas supply adequacy in Melbourne and in the southern gas market overall for the study period.

Figure 11 Melbourne 1:20 Peak Day Supply



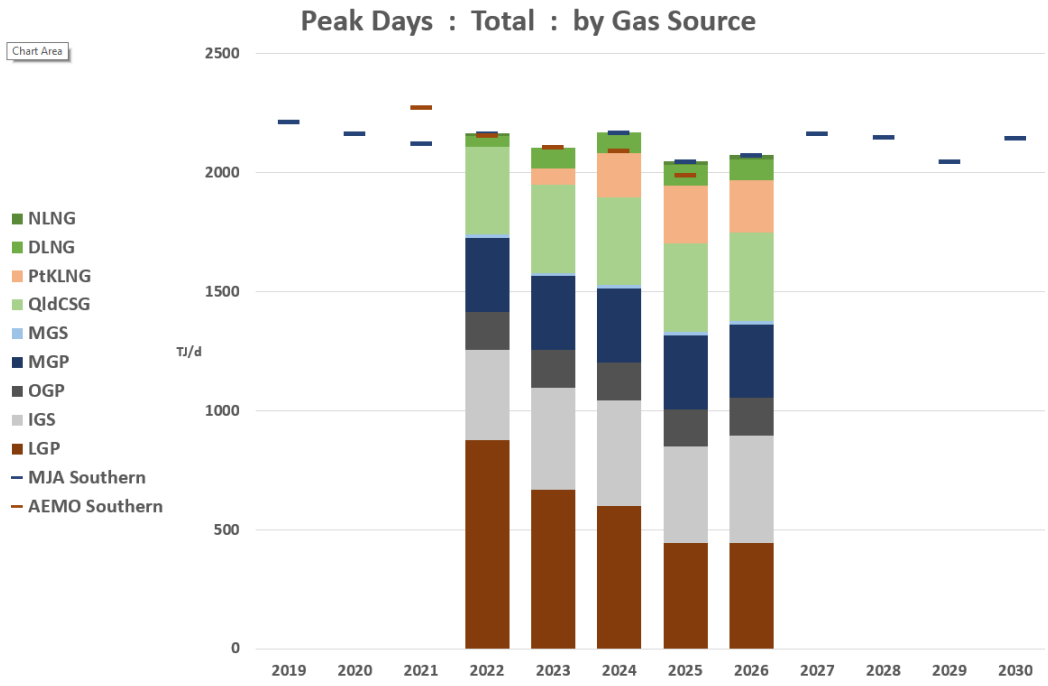
Source: Marsden Jacob preliminary modelling

The figure above shows that supply is adequate to meet the 1:20 Peak Day demand (AEMO and forecast MJA peak demand) in each year in the study period. The declining contribution via the LMP reflects the forecast drop in Gippsland supply capacity, but this is made up by increased supply via the VNI and from Dandenong LNG. SWP is essentially at capacity from 2023 onwards on Peak Days.

There is no shortfall in this forecast.

Figure 12 below shows the Peak Days for the whole southern gas market. In this case the supply is shown by source, because selecting pipeline flows would be somewhat arbitrary. Again, supply is adequate (meets the MJA maximum demand and the AEMO Peak Day demand) in all years.

Figure 12 Southern Gas Market 1:20 Peak Day Supply



Source: Marsden Jacob preliminary modelling

6.5 Model Insights

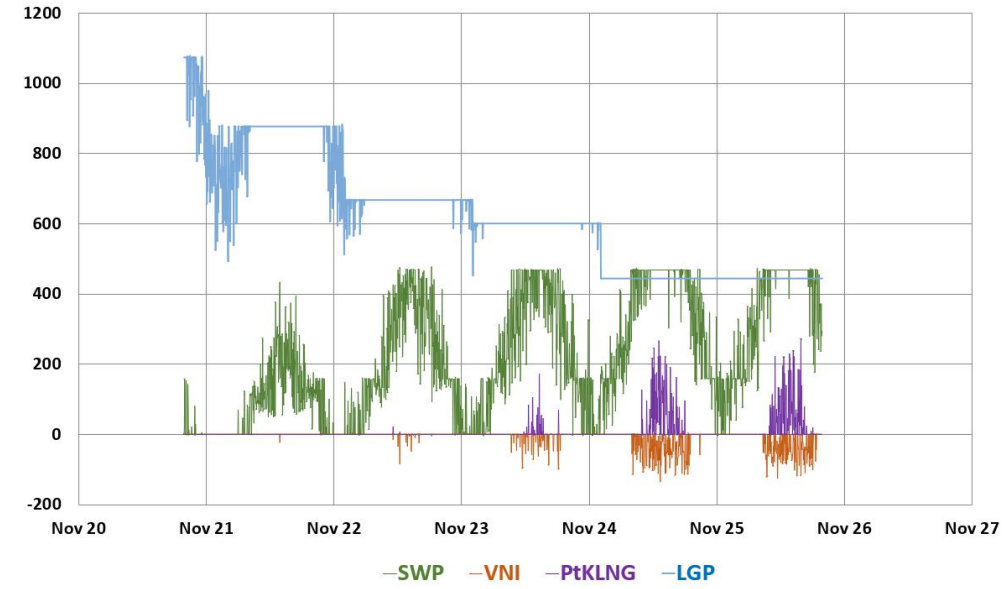
Finally, the following series of charts (Figure 13 to Figure 15) is descriptive of Melbourne supply over the period 2021 to 2025[43].

The low flow from PKGT reflects that this plant was assumed to be dispatched last based on a preliminary cost dispatch order. As the modelling did not include a commodity balance (i.e. accumulations) the gas volumes (such as from PKGT) did not include supply associated with storages or other limitations. The Phase 2 modelling will include the commodity balance and will provide the expected volumes of gas supplied from the various sources.

Figure 13 shows the decline in Gippsland production as an annual stepwise drop (blue – modelled as Longford Gas Plant capacity) and the resulting increased utilisation of the SWP (green) as the demand for Port Campbell gas increases. The SWP becomes more frequently constrained, even though its capacity has been increased by the commissioning of the WORM prior to winter 2023. In this model PKGT (purple) and the VNI (brown – shown here are a reverse flow) comes in last to meet demand that the Iona and Otway Gas Plant can't meet due to the SWP max flow limit.

[43] And is representative of the expected output from the Phase 2 study

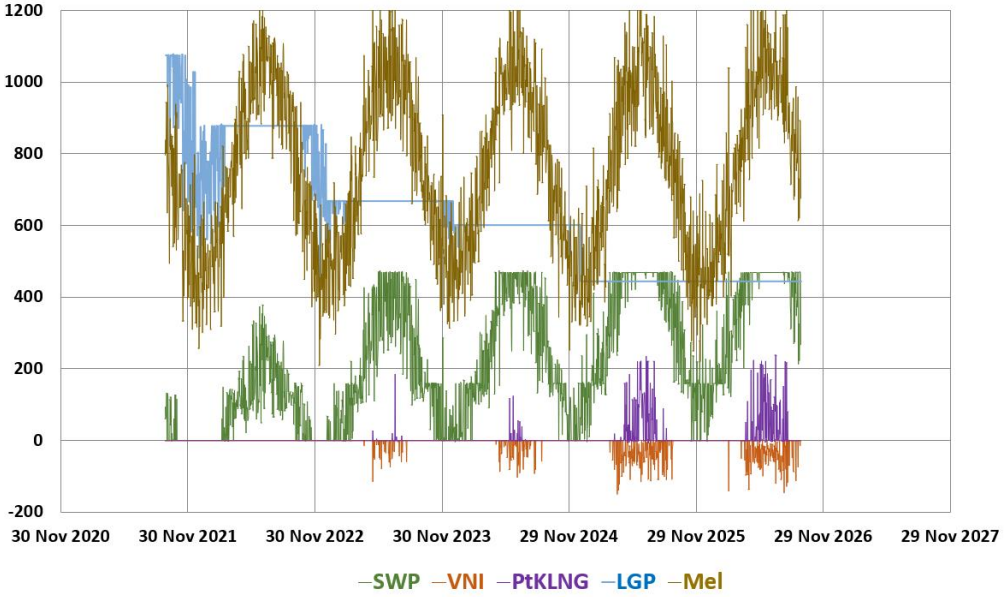
Figure 13 Forecast flows: Longford Gas Plant, SWP and PKGT - TJ/day



Source: Marsden Jacob preliminary modelling

Figure 14 includes the Melbourne demand so it can be seen how stacking Longford, SWP, PKGT and VNI south would closely match the Melbourne demand. It is also interesting to note that based on the assumption in this modelling, Longford goes from a supplier of swing to a flat base load supply, and the swing is increasingly taken by the SWP (presumably Iona) and PKGT. Longford also goes from supplying gas in excess of Melbourne demand to having no surplus gas for Sydney.

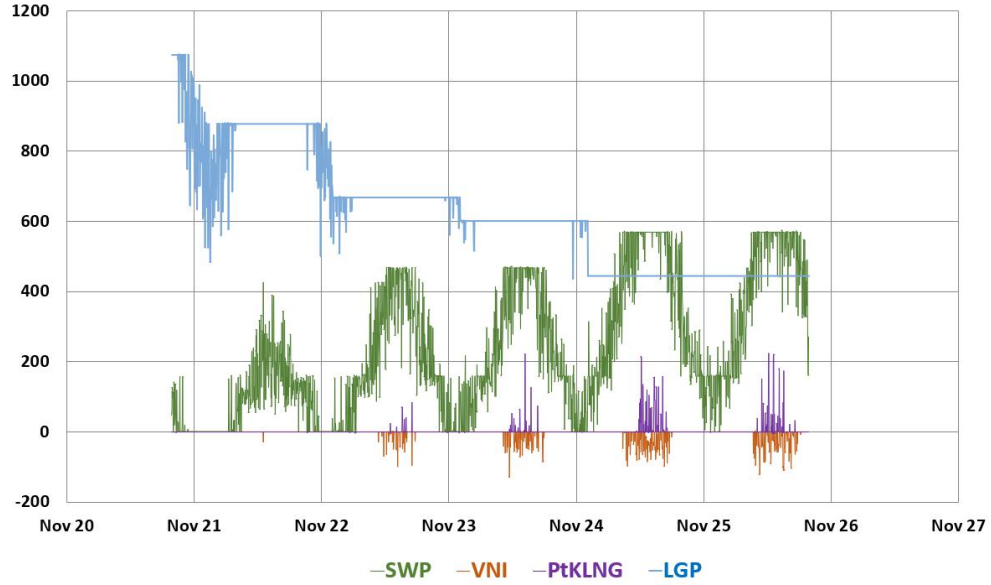
Figure 14 Forecast flows: Melbourne Demand, Longford Gas Plant, SWP and PKGT - TJ/day



Source: Marsden Jacob preliminary modelling

Finally, Figure 15 below shows the impact of an expansion of the SWP to 570 TJ/d prior to winter 2025. Reliance on PKGT and imported LNG is reduced.

Figure 15 Forecast flows: Longford Gas Plant, SWP and PKGT - TJ/day



Source: Marsden Jacob preliminary modelling

Importantly, none of this takes into account the cumulative annual quantities supplied by these facilities, and any inventory or annual production constraints. This again will be modelled in the Phase 2 study and means that the results above must be treated as preliminary.

Conclusions and Note on Phase 2 Modelling

The Phase 1 modelling has demonstrated the significant impact of the decline of Gippsland supply, and highlights the potential role the SWP may have to play in the future supply of gas in the southern gas market.

This modelling clearly signals the need for detailed modelling of the southern gas market to ascertain the future requirements of the SWP under potential future scenarios of demand and supply developments.

The Phase 2 modelling will be designed to undertake this modelling by building on the preliminary work of the Phase 1 modelling. This will include:

- Review of scenarios and assumptions;
- Modelling of storage inventories and storage inventory constraints;
- A full supply and demand breakdown daily for each facility and demand centre;
- Annual and cumulative production tracking and facility utilisation;
- Potential to explore the impact of varying constraints and timing of system changes;
- Automatic tracking of the depletion of production reserves;
- Actual gas network flows for comparison from 2019 onwards (to match the actual demand data).

7. Key Study Findings

This chapter brings together the three elements of work undertaken in this report, and from this draws our conclusions in relation to the future needs of the gas market and the SWP in particular.

In presenting the key findings Marsden Jacob note that this Phase 1 report was scoped as an initial review of the need to upgrade the capacity of the SWP pending a more compressive assessment in the Phase 2 work.

The key findings of the Phase 1 study were that:

The potential need to increase the capacity of the SWP was established.

The Phase 2 modelling planned is required to confirm this need.

The key findings of the study:

- Were supported by the two components of assessment undertaken by Marsden Jacob (peak day capacity modelling and the participant survey); and
- Was not (in the opinion of Marsden Jacob) shown not to be the case in the report undertaken by Oakley Greenwood.

Appendix 1. The Southern Gas Market

This chapter presents a brief summary of the southern gas market that consists of the states Victoria, South Australia (SA), New South Wales (NSW), and Tasmania. This is provided for reference only.

Figure 16 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 16 Gas Supply in SA / Victoria / NSW

Source: Marsden Jacob Associates

A1.1. 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 southern gas market which is composed of the states of SA, Victoria, NSW and Tasmania. These two areas are connected through Moomba by the South West Queensland Pipeline (SWQP).

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, gas developments in the Northern Territory, and the rate of Moomba gas decline.

A1.2. Gas Production Facilities

The gas supply sources by gas field and production plants in SA/Victoria/NSW are shown in Table 4 below.

Table 4 Gas Production Facilities in SA/Victoria/NSW

Production Plant	Associated Gas Fields	State	Description
Longford Gas Plant	Various including recently Zipper, Tuna, Turrum	Vic	Primary source of gas and capacity to Victoria and NSW. Capacity thought to be increasingly limited by declining reserves
Lang Lang	Yolla	Vic	BassGas Project. Production limited by field
Otway Gas Plant capacity is 205 TJ/day	Thylacine, Geographe (Prospective: Enterprise)	Vic	Currently undertaking a round of development drilling. Capacity 205 TJ/d but production limited by field to about 160 TJ/d
Iona Gas plant	Casino, Henry, Netherby	Vic	Storage and (currently minimal <20 TJ/d) gas production. Current gas supply going to the new Athena plant when commissioned
Minerva gas Plant	None, but soon Casino, Henry, Netherby (Prospect: Annie)	Vic	Currently offline but being refurbished by Cooper energy (to be called Athena Gas Plant). 150 TJ/d capacity, but will be limited by field production
Moomba Gas Plant	Various	SA	Has associated storage
Camden Gas Plant	Camden CSG	NSW	Small supply near (in) Sydney
Orbost Gas Plant	Sole (Prospect: Manta)	Vic	Limited by field producibility. Sulphur removal required

Source: Marsden Jacob

A1.3. Gas Storage Facilities

The gas storage facilities in SA/Victoria/NSW are shown in Table 4 below.

Table 5 Gas Storage Facilities in SA/Victoria/NSW

Production Plant	Type	State	Description
Iona Gas Storage	Reservoirs (3)	Vic	530 TJ/d deliverability, 23 PJ storage
Dandenong LNG	Cryogenic tank	Vic	Needle Peak and intraday linepack management for Melbourne
Newcastle LNG	Cryogenic tank	Vic	Needle peak for Sydney
Pt Kembla Gas Terminal (LNG) (Committed)	Maritime import terminal	NSW	LNG import terminal with storage. 500 TJ/d deliverability (200 TJ/d EGP flow reversal to accompany PKGT)
Golden Beach (Prospective)	Reservoir	Vic	Initially to produce native gas at ~100TJ/d (18 months) then storage at ~250 TJ/d?

Source: Marsden Jacob

A1.4. Pipelines

Figure 16 shows the main pipelines in SA, Victorian and NSW. The arrows show the expected direction of gas flow when demands are high. Table 6 below 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 gas processing plant
  - 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
  - supplies Qld or NSW using gas from Longford or Otway/Iona;
- Eastern Gas Pipeline (EGP):
  - supplied from Longford
  - this is the main gas supply route for NSW / Sydney gas;
- Moomba to Sydney Pipeline (MSP):
  - historically the main gas supply to Sydney
  - historically also used to ship gas north to Moomba for supply to Queensland (reverse flow);
- South West Pipeline (SWP):
  - supplies Melbourne using gas from Otway or Iona

- supplies Iona or SA using gas from Gippsland;

- Moomba to Adelaide Pipeline System (MAPS):
  - traditionally supplied SA gas from Moomba
  - can reverse flow;
- 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
  - can provide limited storage service from linepack.

Table 6 Pipelines in SA, Victoria, NSW and Tasmania (1)

Pipeline	Abbreviation	From	To	Capacity TJ/d	Reverse TJ/d
Eastern Gas	EGP	Longford	Sydney	350	NA
NSW-Vic Interconnect	VNI	Melbourne	Young	223	226
Longford - Melbourne	LMP	Longford	Melbourne	1,030	NA
Moomba - Adelaide	MAPS	Moomba	Adelaide	249	85
Moomba - Sydney	MSP	Moomba	Sydney	489	193
SEAGas	SEAGas	Port Campbell	Adelaide	314	NA
Southwest	SWP	Port Campbell	Melbourne	426	147
Southwest Queensland Pipeline	SWQP	Wallumbilla	Moomba	384	340
Tasmanian Gas Pipeline	TGP	Longford	Tasmania	129	NA

Source: Gas Bulletin Board Data, Marsden Jacob Analysis (Current Capacities)

A1.5. 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.

The average and maximum daily gas demands are shown in Table 7 below.

Table 7 State Gas Demand – Average and extreme Daily Maximum Gas Demand (1)

Actual Data 2019-2021	Average TJ/day	Peak TJ/day
New South Wales	320	551
South Australia	257	465
Victoria	716	1310
Tasmania	23	66
ACT	20	23

Source: Gas Bulletin Board Data, Marsden Jacob Analysis

Appendix 2. Survey Questionnaire

This appendix presents the survey questionnaire sent to the parties that agreed to participate in the questionnaire.

The spreadsheet format that parties providing data were asked to complete is shown below.

		Actual	Planned							
		2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Demand (exclude GPG)											
Adelaide											
Average volume	TJ/day										
MDQ	TJ/day										
Melbourne											
Average volume	TJ/day										
MDQ	TJ/day										
Sydney											
Average volume	TJ/day										
MDQ	TJ/day										
Demand - GPG (if applicable)											
Adelaide											
Average volume	TJ/day										
MDQ	TJ/day										
Melbourne											
Average volume	TJ/day										
MDQ	TJ/day										
Sydney											
Average volume	TJ/day										
MDQ	TJ/day										
MDQ Requirement (intended contracting)											
SA											
SEAGas	TJ/day										
Other	TJ/day										
Total SA	TJ/day	0	0	0	0	0	0	0	0	0	0
Vic / NSW											
SWP	TJ/day										
Other	TJ/day										
Total	TJ/day	0	0	0	0	0	0	0	0	0	0

Appendix 3. Review of the Victorian Gas Planning Report

This appendix presents a summary of the AEMO 2021 Victorian Gas Planning Report (VGPR) relevant to the consideration of this report.

The VGPR consider the outlook of the Victorian gas market to the period 2021 to 2025.

The VGPR outlook is expressed in terms of both commodity (PJ) and capacity (TJ/day).

A summary of the AEMO capacity outlook for the Victorian Declared Transmission System (DTS) presented in the VGPR is as follows:

- AEMO is forecasting a supply gap in Victoria of up around ~100TJ/day for 3 days in 2023 without surplus NSW supply. With surplus NSW supply (including the proposed LNG import terminal at Port Kembla), and no other change, AEMO's modelling is indicating that there would be no supply gap in 2023[44] .
- AEMO consider the Pt Kembla LNG import terminal (referred to as the Port Kembla Gas Terminal or PKGT) to be committed from summer 2023.[45] The PKGT would provide surplus gas supply in NSW in up to and including 2025.
- Similarly in 2025, AEMO is forecasting a peak day supply surplus of 168 TJ/d, again based on NSW imports.[46]
- NSW imports comprise the PKGT plus supply from Orbost (via the EGP) and Queensland (via Moomba). Transport is assumed to be via VicHub and the North Victorian Interconnector. Total available NSW imports are assumed to be 395 TJ/d (though only 227 TJ/d are used in 2025 for example).
- Victorian supply comprises supply from Longford and Lang Lang as limited by forecast reserves depletion, and supply from Port Campbell gas production and Iona Gas Storage as limited by SWP capacity.

Appendix 4 presents a review of the key findings of the 2021 AEMO Gas Statement of Opportunities (GSOO). This shows a gas capacity (TJ/day) supply shortfall starting and increasing from 2029.

[44] AEMO 2021 VGPR table 15
[45] AEMO 2021 VGPR paragraph 1, p 35
[46] AEMO 2021 VGPR table 16

Appendix 4. Review of the AEMO 2021 GSOO

This appendix presents a summary of the AEMO 2021 Gas Statement of Opportunities (GSOO) relevant to the consideration of this report. This report considers the over the period 2021 to 2040

The GSOO does not present additional capacity data to 2025 to that presented in the 2021 Victorian Gas Planning Report. The GSOO supports the substantial reduction in supply capacity over the next 4 years to 2025.

The GSOO outlook is expressed in terms of demand consumption (PJ) and gas reserves (PJ).

Key observations from the 2021 GSOO post 2025 relevant to the discussion in this report include the following:

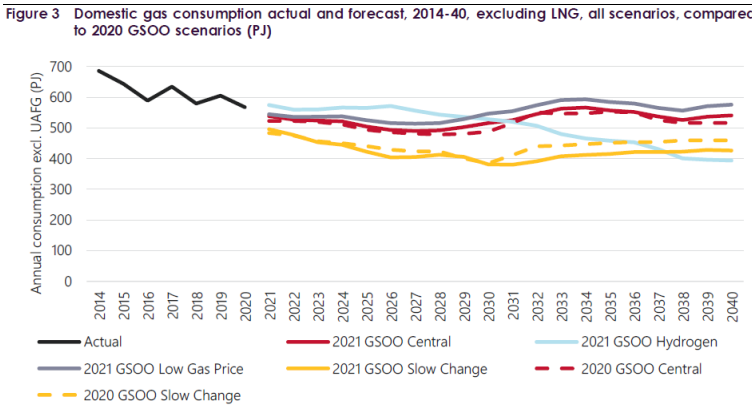
- The outlook of demand in the East Australia gas market;
- New supply assumed to the developed and assumptions regarding anticipated gas being available;
- The need for "resilience" of future gas supply options.

A4.1. Demand

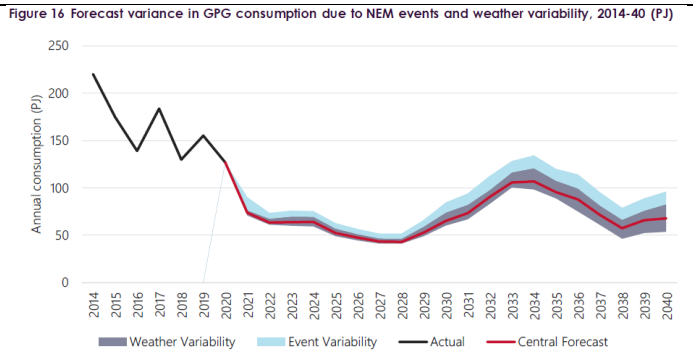
Demand is expected to be flat and slightly higher than as projected in the 2020 GSOO. This includes an assessment of reduced gas used in Gas Powered Generation (GPG). Figure 17 below presents Figure 3 and Figure 16 contained in the 2021 GSOO that presents the outlook of annual gas demand (PJ) and annual gas used by GPG (PJ) for the East Australian gas market.

Figure 17 GSOO Outlook Graphs of Total Market Demand and GPG

2021 GSOO Demand Outlook (PJ p.a.)



2021 GSOO GPG Outlook (PJ p.a.)



Source: AEMO 2021 GSOO

Appendix 5 presents the peak day demand forecasts (TJ/day) from the 2021 GSOO.

A4.2. Gas Supply (PJ)

Post 2030 new gas supply is required. This is evident in Figure 27 of the 2021 GSOO which is shown in Figure 9 of the Oakley Greenwood report.

This shows that the East Australia gas market requires the delivery of anticipated gas supply from 2023. AEMO assume this will be delivered.

AEMO write[47] (and this in presented in the Oakley Greenwood report[48])

> Provided all committed and anticipated projects are developed, there is projected to be sufficient supply to cover both extreme peak demand conditions and seasonal demand requirements until at least 2029….
>
> The figure shows that new supply options will be required across eastern and south-eastern Australia towards the end of the decade to ensure domestic and LNG export demand is met to the end of the outlook period

Marsden Jacob observe that the gas outlook in the 2021 GSOO is based on an assumption that the anticipated gas reserves are likely to be developed.

AEMO write in Footnote 52:

> Contingent resources are not yet considered commercially viable; 2C is considered the best estimate of those sub-commercial resources.[49]

AEMO qualify their presented outlook in Footnote 68 that states:

> The figure displays the supply from developed, committed and anticipated developments, showing the utilisation of anticipated production as early as 2022. Without this anticipated production, developed and committed production can service 2022 and 2023 consumption and maximum daily demand but these fields would then be depleted earlier than shown in this figure.

Marsden Jacob note that as the definition used by AEMO that has anticipated reserves to include 2C reserves, the assumption of gas being available does present risks of less gas supply being available than assumed.

A4.3. Gas supply Adequacy

The GSOO projects gas supply capacity shortfalls commencing in 2029. These are shown in figures 30 and 31 of the GSOO. Figure 32 of the GSOO summarises the gas supply capacity gap and this is shown in the figure below. This shows a growing level of gas capacity (TJ/day) shortfall in the southern gas market.

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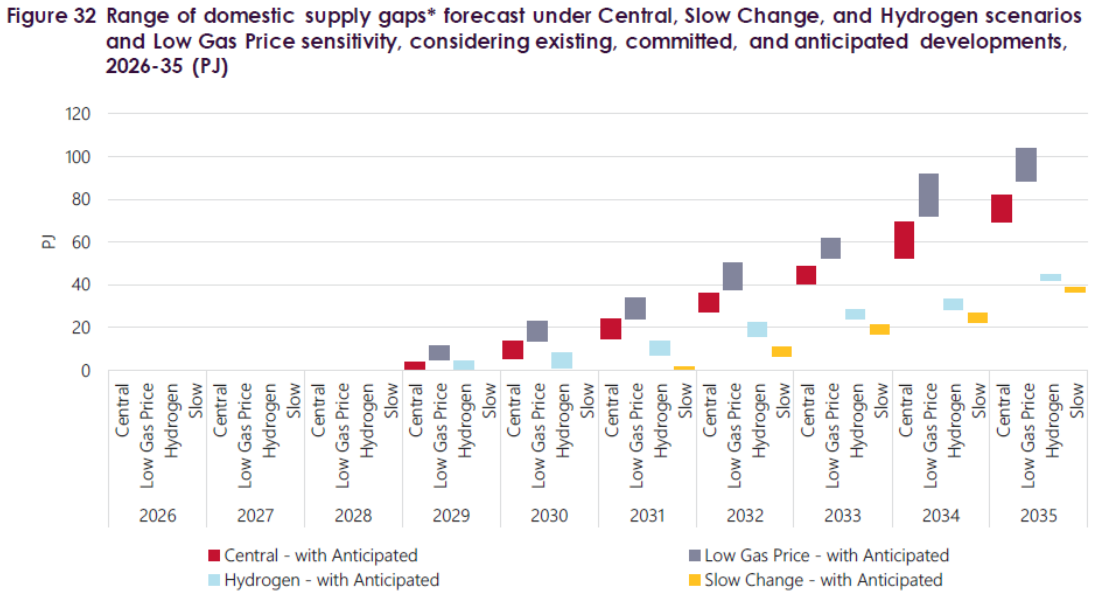
[47] AEMO, 2021 GSOO, pages 6 and 54

[48] Page 22

[49] 2C Reserves are defined by the internationally recognised Petroleum Resources Management System as the best estimate of contingent resources, where contingent resources as those quantities of petroleum which are estimated, on a given date, to be potentially recoverable from known accumulations, but which are not currently considered to be commercially recoverable.

Figure 18 Figure 32 from the 2021 AEMO GSOO



Source: AEMO 2021 GSOO Figure 32

A4.4. New Supply Options and Resilience Needed

Chapter 5 in the 2021 GSOO (titled "Adding resilience to the eastern and south eastern gas markets") considers the actions necessary and that the "resilience" of these options are important. By resilience is meant robustness the events that can occur.

AEMO write (page 60):

> With the development of newly committed infrastructure there is increased supply in the gas sector. However, while existing and committed supply has substantially increased, there are several key single point dependencies that result in a system that still has little resilience – especially since the LNG cargoes are relied on during peak days, and delayed shipments occur much more frequently than production outages.
>
> Developing both committed and anticipated projects will go a long way to mitigating risk of peak shortfalls in the next five years, and will strengthen the gas system's resilience. This section considers some of the additional investments or actions that may be considered now or in the future to enable an even stronger, more robust domestic gas market that is better able to meet the current and future needs of energy consumers.
>
> Conceptually, the additional investments or actions considered cover one, or a combination, of several options (descriptions under the options has been removed)
>
> • Focus on demand options to manage the supply-demand balance.
>
> • Minimise investment in midstream infrastructure and expand existing assets.
>
> • Increase access to new basins to take advantage of untapped gas resources.
>
> • Additional LNG import terminals.

In relation to Expanded existing assets AEMO write (page 61):

> Expanding the SWP could improve access to the full capacity from Iona UGS, providing an additional source of near-term capacity. Expansion via additional compression is relatively cheap, timely and has low environmental impact so could feasibly be delivered ahead of winter 2023. However, expanding the SWP via compression alone would likely result in only a small increase in capacity, (up to 60 TJ/d based on AEMO's preliminary assessments), and may not be enough to protect against peak day shortfalls under 1-in-20 demand conditions, in the event that LNG cargoes are delayed.
>
> Compression expansion along MSP and SWQP could also be delivered as early as 2023 or in staged increments as required73, and would provide southern states with greater access to northern gas supplies, including redirected LNG. APA has proposed options to expand MSP and SWQP by an additional approximately 300 TJ/d and 200 TJ/d respectively, although the projects have not yet reached FID and have not been included in the supply adequacy assessments.
>
> Further expansion of the southwards flow on the EGP, up to around 400 TJ/d, would enable greater peak support to Victoria.

Appendix 5. 2021 GSOO Demand Forecasts

This appendix presents the peak day (TJ/day) demand forecasts from the 2021 GSOO. These are shown for demand excluding GPSG and then GPG demand on the day of maximum demand.

The tables are taken directly from the 2021 GSOO.

A5.1. Daily maximum Demand Excluding GPG

Tables 3 and 4 from the 2021 GSOO are shown below for summer (top table) and winter (bottom table).

Table 3 Total 1-in-2 and 1-in-20 forecast maximum demand, summer, all sectors excluding GPG, including UAFG (TJ a day [TJ/d])

	NSW		QLD (incl LNG)		QLD (excl LNG)		SA		TAS		VIC	
	1-in-2	1-in-20	1-in-2	1-in-20	1-in-2	1-in-20	1-in-2	1-in-20	1-in-2	1-in-20	1-in-2	1-in-20
2020*	251		4,331		330		94		19		410	
2021	283	306	4,519	4,540	351	372	107	115	21	23	453	585
2023	285	309	4,537	4,558	351	372	108	116	21	23	442	571
2025	286	311	4,556	4,578	341	363	108	116	22	24	435	563
2030	288	312	4,537	4,556	322	341	108	116	22	24	442	573
2040	295	320	4,538	4,558	323	343	108	116	24	26	483	636

* The 2020 values show actual maximum demand.

Table 4 Total 1-in-2 and 1-in-20 forecast maximum demand, winter, all sectors excluding GPG, including UAFG (TJ/d)

	NSW		QLD (incl LNG)		QLD (excl LNG)		SA		TAS		VIC	
	1-in-2	1-in-20	1-in-2	1-in-20	1-in-2	1-in-20	1-in-2	1-in-20	1-in-2	1-in-20	1-in-2	1-in-20
2020*	438		4,347		346		147		21		1,213	
2021	457	485	4,527	4,549	359	381	156	165	23	25	1,153	1,265
2023	463	489	4,545	4,566	359	380	158	166	23	25	1,124	1,237
2025	465	493	4,565	4,586	350	371	158	166	23	25	1,101	1,205
2030	468	497	4,546	4,565	331	350	158	167	24	26	1,144	1,252
2040	478	507	4,548	4,568	333	353	158	167	26	28	1,267	1,390

* The 2020 values show actual maximum demand.

Source: AEMO 2021 GSOO

A5.2. Daily Maximum GPG Demand

Tables 5 and 6 from the 2021 GSOO are shown below for summer (bottom table) and winter (top table).

Table 5 Actual and forecast GPG daily demand range at the time of maximum gas demand, winter, Central, 1-in-20 year peak conditions (TJ/d)

	NSW	QLD**	SA	TAS	VIC
2020*	91	228	314	19	65
2021	98-356	177-245	169-245	0-5	23-81
2023	129-173	188-260	184-227	1-6	25-100
2025	12-163	203-232	119-172	0-0	21-125
2030	111-283	202-254	147-248	0-2	35-98
2040	232-463	364-446	56-93	4-20	20-166

* The 2020 values show actual GPG consumption demand, estimated from the electricity dispatch observed on the peak day.
** For Queensland, the coincident peak GPG demand considers the peak demand from domestic consumption (residential and commercial consumption, and GPG itself), and does not consider daily variations in LNG consumption.

Table 6 Actual and forecast GPG daily demand range at the time of maximum gas demand, summer, Central,1-in-20 year peak conditions (TJ/d)

	NSW	QLD**	SA	TAS	VIC
2020*	179	266	300	6	299
2021	100-234	180-323	224-333	0-6	179-355
2023	110-202	147-232	186-273	0-0	0-203
2025	120-253	99-307	164-257	0-9	0-190
2030	61-205	190-229	143-244	0-13	0-169
2040	113-227	250-415	37-60	0-14	0-78

* The 2020 values show estimated, actual GPG consumption demand, estimated from the electricity dispatch observed on the peak day.
** For Queensland, the coincident peak GPG demand considers the peak demand from domestic consumption (residential and commercial consumption, and GPG itself), and does not consider daily variations in LNG consumption.

Source: AEMO 2021 GSOO

Appendix 6. Anticipated and Potential Developments

The table below presents anticipated and potential developments

Table 8 Anticipated and Potential Developments

Anticipated Developments	Type	Timing	Description
Golden Beach	Production / Storage	Start-up from mid --2022 to late 2023	Production of native gas, then storage. Capability: Production: up to 100TJ/d then Injection into storage: up to 125 TJ/d Withdrawal from storage: up to 250 TJ/d Disposition Longford compressor station to EGP or LMP Supply 43 PJ (from ~ 70 PJ reserves?) over 18 months from start-up Storage volume 12.5 PJ
Kipper Phase 1B	Production	2024	Further development of Kipper offshore field – no increase in supply, but defers Kipper decline beyond 2024
Pt Kembla LNG Import	LNG Import Terminal	Committed 2Q23	Pt Kembla, lateral to EGP
Viva LNG Import	LNG Import Terminal	Potential 2024	Geelong, connected to SWP at Lara. 500 – 600 TJ/d, but would back out Pt Campbell (so marginal increase in supply capacity without SWP augmentation)
Vopak LNG Import	LNG Import Terminal	No date?	Avalon, connected to SWP at Avalon. Like Viva (above) would back out Pt Campbell (so marginal increase in supply capacity without SWP augmentation)
GasDock			Newcastle
SWP Expansion Ph I (The WORM)	System de-constraint	Prior winter 2023	Addition of: • 51 km of 500 mm pipeline connecting the Plumpton PRS to Wollert. • A new PRS at Wollert, from the WORM to flow into the Pakenham to Wollert pipeline. • A third Centaur 50 compressor at Wollert CS B.
SWP Expansion Ph II	System de-constraint	Potential 2023	Additional compression and/or looping to increase the capacity of the SWP towards Melbourne

Anticipated Developments	Type	Timing	Description
		(or 12-18 months from FID)	
Enterprise Gas Field (Beach)	New Supply	Potential No date	161 PJ 2P reserves. Expected to be processes via Otway Gas Plant. No extra supply (due SWP constraint), but could defer Otway decline Geographe 4 and 5 drilled. Next year Thylacine Nth and 3 other wells. Should be significant new supply (or at least existing decline replaced) by winter 2023?
Additional Qld Supply	New supply		Expansion of SWQP and MSP, along with a new gas contract (Origin with APLNG) to bring extra Queensland CSM to the southern market. Increase supply from northern region by 100 TJ/d
Hydrogen	Supply replacement		Alternative to natural gas from electrolysis of water (or perhaps steam methane reforming SMR with carbon capture and storage CCS and carbon offsets). Replacement for natural gas (or blend below 20% hydrogen?)
Biogas	Supply augmentation		Alternative (to fossil fuel) and perhaps distributed source of natural gas from anaerobic fermentation of biological waste. Blend or replace with existing gas. Expected less than 100 TJ/d prior 2025, but ultimately 4–5 PJ/yr
Electrification of gas load	Demand erosion		Conversion of residential or commercial space heating, water heating and cooking appliances to electricity.
Gippsland decline	Supply erosion		Due to depletion of large legacy oil and gas fields in Bass Strait
Otway decline	Supply erosion		Due to depletion of large legacy oil and gas fields in Otway Basin of Pt Campbell
GPG Increase			Support of intermittent renewable generation
Athena Gas Plant	New supply	2Q22	$55m purchase and refurbishment of the Minerva Gas Plant to process gas from the existing Casino #4,#5, Henry #2 and Netherby #1 fields in the VIC L24/L30 (16 PJ). Plant capacity up to 150 TJ/d [Sept 2020] Awaiting pipeline connection. Current production (via Iona Gas Plant) ~ 30 TJ/d. Production should increase (lower inlet pressure) when Athena is commissioned and take over processing. Prospect: • Annie 55 PJ (2C) Discovery. Development: 2 wells • Henry #3 48 PJ (2P) Cooper Energy 50% Mitsui 50%
Orbost Gas Plant			[COE Operations and Finance Update 2Oct 2021] 45 TJ/d max, Avg ~39 TJ/d ex Sole Prospective: Manta 121 PJ (2C)

Anticipated Developments	Type	Timing	Description
Lang Lang Gas Plant			Prospective: Trefoil 60 PJ (2C)
Narrabri CSG			Gunnedah NSW FID 2021-22, Online 2023 (20PJ production 34PJ in 2024) Connection not finalised. Either: • Via proposed Hunter pipeline 220-450 TJ/d to Newcastle, or • Proposed Western Slopes pipeline to MSP at 200 TJ/d
Other LNG Import			GasDock – Newcastle Pt Adelaide

Source: Marsden Jacob

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