ENERGY SUPPLY OUTLOOK

FOR EASTERN AND SOUTH-EASTERN AUSTRALIA

(UPDATING THE ENERGY ADEQUACY ASSESSMENT PROJECTION, AND GAS AND ELECTRICITY STATEMENTS OF OPPORTUNITIES)

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AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

IMPORTANT NOTICE

Purpose

This Energy Supply Outlook provides an update to the Electricity Statement of Opportunities, and Gas Statement of Opportunities. It also includes the Energy Adequacy Assessment Projection.

Specifically, this report updates the November 2016 *Update: Electricity Statement of Opportunities* (ESOO) and the March 2017 *Gas Statement of Opportunities* (GSOO), and incorporates a new Energy Adequacy Assessment Projection (EAAP).

It is published in accordance with clause 3.13.3(r) and rule 3.7C of the National Electricity Rules, and rule 135KD of the National Gas Rules.

This Energy Supply Outlook is based on information available at 1 May 2017, although AEMO has endeavoured to incorporate more recent information where practical.

The rapid evolution of the energy industry means the supply and demand position is continually changing, and some recently announced changes (since 1 May 2017) have not been included in modelling for this Energy Supply Outlook. In this fluid environment, AEMO intends to release more frequent energy supply outlook updates.

Disclaimer

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Acknowledgement

AEMO acknowledges the support, co-operation, and contribution of market participants in providing data and information used in this publication.

Version control

Version	Release date	Changes
1	15/6/2017	
2	17/6/2017	Added footnote to Figure 6, page 20, to clarify the date on which actual demand was recorded.

EXECUTIVE SUMMARY

AEMO expects all National Electricity Market (NEM) regions will meet the reliability standard set in the National Electricity Rules (NER)[1] over the next two years, based on the generation and storage expected to be available.

There is, however, still a risk of electricity supply falling short of demand, especially in extreme conditions. The security of the power system will be tested on extremely hot summer afternoons and evenings when consumer demand is highest, with the risk increasing if, at the same time, wind and photovoltaic (PV) generation drops to low levels, other generation stops unexpectedly, or electricity flow is constrained between regions.

In this assessment, South Australia is considered most at risk of breaching the reliability standard. To meet the standard, existing generation capacity must be available and operating, Pelican Point Power Station must return to full service, and the new battery storage and diesel generation contracted for by the government must be available as planned.

Domestic gas supply and demand remain finely balanced. Whether sufficient gas is available to meet demand will depend on:

- The actual quantities of gas available to the domestic market after liquefied natural gas (LNG) exports.
- The level of domestic gas demand for gas-powered generation of electricity (GPG).
- The adequacy of coal supplies for coal-powered generation. The amount of GPG needed to secure electricity supplies will depend on how much coal-powered generation contributes, particularly in New South Wales.

AEMO is working collaboratively with the energy industry and governments to pursue comprehensive approaches to reduce risks to the reliable supply of electricity and gas all year round to Australian business and household consumers. Key initiatives include:

- Minimising risks to electricity generation from fuel supply. AEMO engages with generation businesses to enable adequate supplies of fuel to be available during critical times, including supplies of water for hydro generation, diesel for oil-fired generation, coal for coal-fired generation, and, particularly, gas supplies for GPG.
- Working with industry so that sufficient gas is available to meet demand, including for GPG. Following updated projections of gas production, gas supply and demand remain finely balanced.
  - Gas supply shortfalls may arise if domestic gas demand for GPG increases as currently mothballed gas-fired units are returned to service, if proposed new renewable generation is delayed, or if black coal-fired generation does not generate as much as projected. Summer GPG needs must also be managed to avoid unintended consequences for reliable gas supply for peak winter heating load in southern states.
  - Variations in the amount of gas demanded by LNG exports could be pivotal in determining whether a gas shortfall arises. This reinforces that strong collaboration between AEMO and the gas industry is imperative so AEMO can use accurate projections of gas supply and demand in its ongoing forecasts.
  - AEMO is working with the gas industry to implement the Gas Supply Guarantee, an arrangement designed to facilitate supplies of gas to GPG when needed.
  - AEMO will seek further information from gas producers, and will publish a new supply demand assessment later this year.

[1] Information about the reliability standard is in Section 1.1.

- Maximising the availability of generation and transmission when most needed. AEMO works with generators and transmission network companies, and gas producers and gas transmission companies, to coordinate all planned outages for maintenance across electricity generation and transmission, and gas production and pipelines, so they are outside of (and preferably before) the most critical periods in the coming summer. AEMO is also seeking up to 670 megawatts (MW)[2] of additional reserves from supply and demand sources through the Reliability and Emergency Reserve Trader (RERT) provisions to minimise the risk of shortfalls at peak demand times this summer.
- Facilitating new generation and storage across the NEM.
  - The South Australian government's Energy Plan aims to deliver 100 MW of battery storage, and up to 200 MW of temporary diesel generation, for use in emergency situations during summer 2017-18, if extreme conditions create a supply shortfall that cannot be met in other ways.
  - The Victorian Government's Energy Storage Initiative aims to deliver 40 MW of battery storage for summer 2017–18.
  - Across the NEM, 500 MW of new solar and wind generation has been committed or is very advanced for summer 2017–18, with a further 880 MW committed or very advanced for summer 2018–19. While these amounts have been included in the modelling for this assessment, a further 392 MW of new renewable generation has confirmed commercial use dates since the modelling was completed.
- Anticipating and managing peak demand from the consumer side. AEMO is:
  - Seeking demand-based resources, as well as supply, through the RERT provisions.
  - Working with the Australian Renewable Energy Agency (ARENA) to procure 100 MW of new demand side participation from industry.
- Acting on the 19 recommendations made by AEMO following the 2016 South Australia Black System. Six are complete and the remainder are progressing and on track for completion before the end of this year.

AEMO is also looking over the longer term, beyond this report's two-year horizon, and will continue to work with industry and governments to identify and act on initiatives to secure the grid and promote efficient market operation in consumers' long-term interests:

- AEMO will work with the Australian Energy Market Commission (AEMC) Reliability Panel in its review of the NEM reliability standard, considering current and future power system needs.
- AEMO will work with the AEMC, governments, and industry to improve investment signals and markets for demand response to meet the needs of a more agile future power system.

AEMO welcomes the findings of Australia's Chief Scientist, Dr Alan Finkel, in his *Independent Review into the Future Security of the National Electricity Market.*[3] AEMO supports the view of the Finkel report that the design of the grid of the future must be fit-for-purpose to deliver the key outcomes of increased security, future reliability, rewarding consumers, and a lower emissions trajectory. AEMO looks forward to continuing its work with government policy-makers, and its engagement with industry and consumers, to enable an efficient and secure Australian energy market for future generations.

[2] This number is subject to continued review, based on changing market circumstances.
[3] *Independent Review into the Future Security of the National Electricity Market: Blueprint for the Future*, June 2017. Available at: http://www.environment.gov.au/system/files/resources/1d6b0464-6162-4223-ac08-3395a6b1c7fa/files/electricity-market-review-final-report.pdf.

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CHAPTER 1. PURPOSE AND SCOPE

The National Electricity Rules (NER) clause 3.13.3 (r), and the National Gas Rules (NGR) rule 135KD, require AEMO to publish updates to the *Electricity Statement of Opportunities* (ESOO) for the National Electricity Market (NEM), and the *Gas Statement of Opportunities* (GSOO) for eastern and south-eastern Australia, when significant new information becomes available relating to supply or demand projections.

This *Energy Supply Outlook* (ESO) also incorporates the latest *Energy Adequacy Assessment Projection* (EAAP) update, in accordance with rule 3.7C of the NER, which determines whether any energy limitations on generators, or varying levels of rainfall, could impact the expected level of electricity reliability over the next two years.

This ESO provides updated projections for gas and electricity supply and demand for the next two years, based on information to 1 May 2017.

New information since the November 2016 updates to the ESOO and EAAP, and the March 2017 GSOO, which has been included in ESO modelling, includes:

- Domestic gas producers have provided updated information on their gas supply projections.
- New generation projects have been planned for development within the next two years.
- Pelican Point Power Station has committed to returning to full service from July 2017, adding an additional 239 megawatts (MW) of available capacity in South Australia.
- The Queensland government's commitment to return Swanbank E Power Station to service from the first quarter of 2018, adding an additional 385 MW of available capacity in Queensland.
- The South Australian and Victorian governments have committed to adding 100 MW and 40 MW of battery storage respectively before summer 2017–18.
- Additionally, the South Australian government has committed to adding up to 200 MW of temporary emergency diesel generation, for use in emergency situations during summer 2017–18, if extreme conditions create a supply shortfall that cannot be met in other ways.
- Queensland forecast annual consumption and peak demands have been updated in accordance with the March 2017 *Update: National Electricity Forecasting Report* (NEFR).[4]
- New information from generators on energy constraints for some generating units, obtained through the Generation Energy Limitations Framework (GELF) survey.

The state of the energy industry, both gas and electricity, is highly fluid and continues to rapidly evolve. Some recent developments, announced in the gas and electricity industry as this report was being prepared, were not included in ESO modelling. These included:

- Over 392 MW of new renewable generation projects across the NEM have been announced as very advanced, with commercial use dates within the next two years, in addition to those included in ESO modelling.
- Export liquefied natural gas (LNG) demand during the 2017 calendar year so far has been lower than forecast in the Neutral scenario of the 2016 *National Gas Forecasting Report* (NGFR) and the 2017 GSOO.
- Arrow Energy has announced planned investment to expand capacity at its Daandine and Tipton fields, bringing Arrow's Surat gas production to more than 170 terajoules a day (TJ/d), or

[4] AEMO. March 2017 NEFR Update. Available at: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/NEFR/2017/Update-to-2016-National-Electricity-Forecasting-Report-NEFR.pdf.

62 petajoules a year (PJ/a). This is an increase of 28 PJ/a for Arrow from 2017 GSOO forecast production.[5]

While these developments are not included in this assessment, AEMO is seeking information from relevant parties and will reassess the implications in a further update later in 2017.

In this report:

- Chapter 1 describes the foundation concepts.
- Chapter 2 describes the modelling outcomes and resultant assessments of risks to security and reliability of energy supplies.
- Chapter 3 describes the initiatives AEMO is undertaking to manage these risks, working with industry and governments to secure power and gas supplies for the next two years.

1.1 Reliability

Unserved energy is the amount of energy that cannot be supplied to consumers, resulting in involuntary load shedding (loss of customer supply), because there is insufficient generation capacity, demand side participation, or network capability, to meet demand.

In the NEM, the NER define a reliability standard for electricity, set by the Australian Energy Market Commission (AEMC) Reliability Panel and applied to each NEM region. The reliability standard is measured in terms of maximum expected unserved energy (USE) per region. It refers to the amount of electricity required by consumers that cannot be supplied. There is no equivalent standard in gas, and gas supply adequacy is simply assessed against projected demand.[6]

The NEM reliability standard specifies that the level of expected USE should not exceed 0.002% of consumption per region, in any financial year.[7] Meeting the reliability standard does not preclude USE from occurring; supply shortfalls can occur within the standard. The USE that contributes to the reliability standard excludes power system security incidents resulting from multiple or non-credible generation and transmission events, network outages not associated with inter-regional flows, or industrial action.

For instance, South Australian energy consumption for 2015–16 was 12,934 gigawatt hours (GWh).[8] To meet the reliability standard, relevant region-wide USE should not have exceeded 259 MW for one hour in that year, or 130 MW for two hours (or other combinations that are equal to 259 megawatt hours (MWh)).

The reliability standard represents a trade-off between the cost of USE when it occurs and the cost of developing an increasingly reliable power system. In simple terms, it balances the increasing cost of improving the reliability of the power system to prevent load shedding under extreme and rare events against the costs incurred in load shedding.

The reliability standard is used for planning purposes to assess whether there is sufficient supply to meet forecast demand over the medium to long term. Projected supply shortfalls provide market signals that more supply development is required.

In the short term (the operational timeframe), AEMO uses Lack of Reserve (LOR) values to identify times when extra reserves may be required to avoid the need for load shedding to maintain or restore power system security. This is discussed further in Section 1.1.1 below.

[5] Arrow Energy media release, "Arrow enters FEED for substantial Surat asset expansion", 8 May 2017. Available at: https://www.arrowenergy.com.au/media-centre/latest-news/pages/2017/arrow-enters-feed-for-substantial-surat-asset-expansion.

[6] In the gas Declared Transmission System in Victoria, supply adequacy is measured against the ability to meet a 1-in-20-year gas demand.

[7] AEMC, 2015. *Fact Sheet: the NEM Reliability Standard.* Available at: http://www.aemc.gov.au/getattachment/2f4045ef-9e8f-4e57-a79c-c4b7e9946b5d/Fact-sheet-reliability-standard.aspx.

[8] AEMO, 2016. *South Australian Electricity Report*. Available at: http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/South-Australian-Advisory-Functions.

AEMO is collaborating with the AEMC to support its Reliability Panel in a review of the reliability standard. The review will assess whether the standards and settings remain suitable for the NEM. The final report is scheduled to be published by 30 April 2018.[9]

1.1.1 NEM Reserve levels

The AEMC Reliability Panel has recently adjusted its view on use of both USE and reserve levels as indicators to assess the reliability of the NEM.[10]

AEMO uses LOR values to identify when additional reserves of generation or load reduction capacity may be required to reduce the risk of involuntary load shedding and maintain reliability. The LORs, described in clause 4.8.4 of the NER, have three threshold values:

- LOR 1: Available MW reserve is less than twice the amount of the largest credible contingency[11] in the region.
- LOR 2: Available MW reserve is not sufficient to cover the occurrence of the largest credible contingency in the region.
- LOR 3: There is no MW reserve available in the region. Customer load shedding has either commenced, or is imminent.

[9] AEMC, 2017. *Reliability Standard and Settings Review 2018*. Available at: http://www.aemc.gov.au/Markets-Reviews-Advice/Reliability-Standard-and-Settings-Review-2018#.

[10] AEMC. *Annual Market Performance Review 2016*. Available at: http://www.aemc.gov.au/Markets-Reviews-Advice/Annual-market-performance-review-2016. The 2016 AMPR is the first to report on the combination of USE and reserve levels (measured by Lack of Reserve notices) to indicate reliability in the NEM, after previous reports considered USE alone.

[11] Credible contingencies can mean loss of large generators, interconnectors, or load.

CHAPTER 2. INTEGRATED SUPPLY ADEQUACY ASSESSMENT

The 2016 ESOO Update and EAAP Update (both issued in November 2016) projected that the withdrawal of Hazelwood Power Station by March 2017 could potentially result in breaches of the reliability standard in Victoria and South Australia in 2017–18 under existing market conditions, where the following "short-term withdrawn" generators did not return to service:

- Pelican Point Power Station unit in South Australia (239 MW).
- Tamar Valley Power Station in Tasmania (208 MW).[12]
- Swanbank E Power Station in Queensland (385 MW).

The 2016 ESOO Update also highlighted that returning these short-term withdrawn generators to service would be sufficient to meet the reliability standard, provided there were adequate gas supplies available.

The March 2017 GSOO identified risks to electricity generation, due to projected shortfalls in gas available for gas-powered generation of electricity (GPG) that could impact the reliability of electricity supplies from summer 2018–19. This was based on information available at the time from gas producers and the gas industry (including LNG exporters).

This ESO re-evaluates these conclusions in light of industry developments to 1 May 2017, and recently announced government initiatives[13], and incorporates the latest EAAP into the assessment.

AEMO recognises that further developments have been announced since this time, including revised information on gas production and demand, and electricity generation capacity (see Chapter 1). AEMO will seek updated information from the relevant parties, and will reassess the implications in further updates to be provided later in 2017.

AEMO has completed a range of modelling assessments to examine the range of dynamics and risks impacting the energy industry (see Table 1 below). In this assessment, a base case and four sensitivities have been modelled, each focusing on a core set of market assumptions defined in AEMO's Neutral scenario.[14]

Section 2.2 details risks to electricity supply adequacy, and Section 2.4 covers risks to gas supply adequacy. Chapter 3 describes the initiatives AEMO is implementing to manage these risks.

2.1 Projected electricity supply adequacy

These assessments of electricity supply adequacy take into account both:

- Market responses since the previous ESOO Update and GSOO, up to 1 May 2017.
- Government generation and storage initiatives in Victoria, South Australia, and Queensland over recent months.

These assessments consider modelling based on the latest information at hand, and using a base case with sensitivities to test the range of risks and uncertainties (as summarised in Table 1 below).

[12] Hydro Tasmania, owner of the Tamar Valley Power Station, advised AEMO that this plant will be withdrawn after May 2017, but available for operation with less than three months' notice. See 5 June 2017 Tasmania information at http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Generation-information.

[13] The assessment includes government initiatives up to and including the Queensland Government's 4 June announcement about Swanbank E.

[14] Neutral scenario is defined in AEMO's 2016 *National Electricity Forecasting Report* (Chapter 1.2), available at: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/NEFR/2016/2016-National-Electricity-Forecasting-Report-NEFR.pdf.

Table 1 **Range of modelled assumptions**

Case/sensitivity	Key assumptions	Section
Base case	Generation (including Pelican Point, Swanbank E and Tamar Valley power stations) operating at capacity, with no planned outages over critical periods. Government battery initiatives operating as planned for next two summers.	2.1.3
Less GPG returning	Neither Swanbank E nor Tamar Valley power stations operating by summer 2017–18.	2.2.1
EAAP	Generation availability according to MT PASA (including planned outages, and excluding generation that cannot be returned with less than 24 hours' notice).	2.2.2
Extreme weather	Repeat of hot summer conditions of February 2017.	2.2.3
Lower black coal-fired generation	New South Wales black coal-fired generation not reaching projected levels to help replace Hazelwood generation, due to coal supply or other factors.	2.2.4

2.1.1 Approach

AEMO conducted a range of modelling simulations for each of the cases defined in Table 1, to assess the range of variables that impact reliability, such as weather, demand, and generator outages. This included an assessment of six alternate weather patterns (reflecting observed conditions in the financial years 2009–10 through to 2014–15) with each 'reference year' having different:

- Peak demand conditions.
- Peak demand timing.
- Peak demand coincidence across NEM regions.
- Frequency of demand conditions near to the peak.
- Energy contributions from intermittent generators (including wind and solar photovoltaic (PV) generation).
- Contributions of intermittent generation to peak demand.

AEMO also examined two alternate peak demand levels for each region within each reference year:

- An extreme maximum demand with 10% probability of exceedance (POE)[15], expected to be exceeded once in every ten years, typically when temperatures exceed 40 degrees Celsius.
- An average maximum demand with 50% POE, expected to be exceeded once in every two years.

Each reference year has been modelled with a number of independent Monte Carlo simulations to capture the variable nature of forced generator outages. Generation dispatch was then modelled on an hourly resolution for each reference year, taking into account network and energy constraints.

AEMO's approach applied a weighted probability to the outcomes from both of the reference years' peak demand levels (10% POE and 50% POE) to determine expected levels of supply shortfalls. The final supply shortfall levels for the case or sensitivity represent an average of each simulated reference year. Further descriptions on the modelling methodology and approach are available in AEMO's published ESOO methodology report.[16]

To assess the range of risks and uncertainties impacting the industry, regional results are presented for both a base case and a range of sensitivities. It is important to interpret the analysis considering the following key dynamics:

- Availability of fleet – the availability of generation plant, and whether any outages are planned before or during summer.

[15] Probability of exceedance (POE) refers to the likelihood that a maximum demand forecast will be met or exceeded.
[16] Available at: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/NEM_ESOO/2016/2016-NEM-ESOO-Methodology.pdf.

- Black coal – the role black coal-fired generation will play in providing energy, and whether coal supplies and contracts will support this generation increasing its output above historical levels.
- Gas – the balancing role of GPG in maintaining the electricity supply demand balance, and how gas supplies for GPG depend on a variety of factors including gas production estimates, pipeline capacity, demand for gas for LNG exports, and, importantly, the ability to contract and transport quantities of gas to power stations at the right time.
- Water – the availability of water reserves and conservation of water ahead of summer for critical hydro generation and irrigation periods.

2.1.2 Impact of Hazelwood Power Station closure

Approximately 10 terrawatt hours (TWh) of annual generation was withdrawn from the electricity market when the 1,600 MW Hazelwood Power Station retired on 31 March 2017.

In the two months since the Hazelwood closure, plant across the NEM that have operated to replace the lost energy (and capacity) previously provided by Hazelwood have been variable:

- Black coal-fired generation contributed less in April than in March, aligned with lower demand for electricity and outages of some generation. It increased its contribution in May, compared to April, responding to higher demand and the return of withdrawn units.
- GPG contribution increased in April and dropped in May, while hydro contribution reduced in April before a large increase in contribution from hydro ahead of winter.

This short-term variability in market outcomes in the NEM is not uncommon, and demonstrates that it is too early to draw conclusions on how Hazelwood's closure will impact the generation mix based on actual market outcomes. In addition, there have not been any peak demand days since the Hazelwood closure that would test the reliability implications of the generation capacity withdrawal. The probabilistic assessments currently provide the most robust view of how Hazelwood's closure could impact power system reliability over the next 12–24 months.

AEMO projects the energy previously supplied by Hazelwood Power Station to be replaced by:

- Increased output from black coal-fired generators in New South Wales.
- New renewable generation projects.
- Increased output from GPG, including the effect of mothballed generators returning to service.

Advice from generators indicates that coal-fired generators in aggregate have sufficient capability to operate at the higher levels which will be critical to avoid the need for GPG to demand more gas.

This requires black coal-fired generators in New South Wales to increase output above recently observed levels, which in turn requires contracting for sufficient coal supplies. Chapter 3 outlines steps being undertaken in this area.

Over the last three years, Victoria's net energy balance[17] has averaged just below 8 TWh net export. Following the closure of Hazelwood Power Station, without any market response, AEMO expects Victoria to become a net importer of electricity. The weighted average of the simulations run for this ESO indicate Victoria's net energy balance would be approximately 3.3 TWh net import in 2017–18, reducing to 3 TWh net import in 2018–19 as more renewable generation starts operating in the region.

2.1.3 Base case

Figure 1 below shows levels of projected USE outcomes for New South Wales, South Australia, and Victoria over the next two years as a percentage of total demand, and compares these with the reliability standard. (Queensland and Tasmania are not shown, because USE outcomes from the modelling are negligible.) The megawatt hour (MWh) USE data is shown in Table 2.

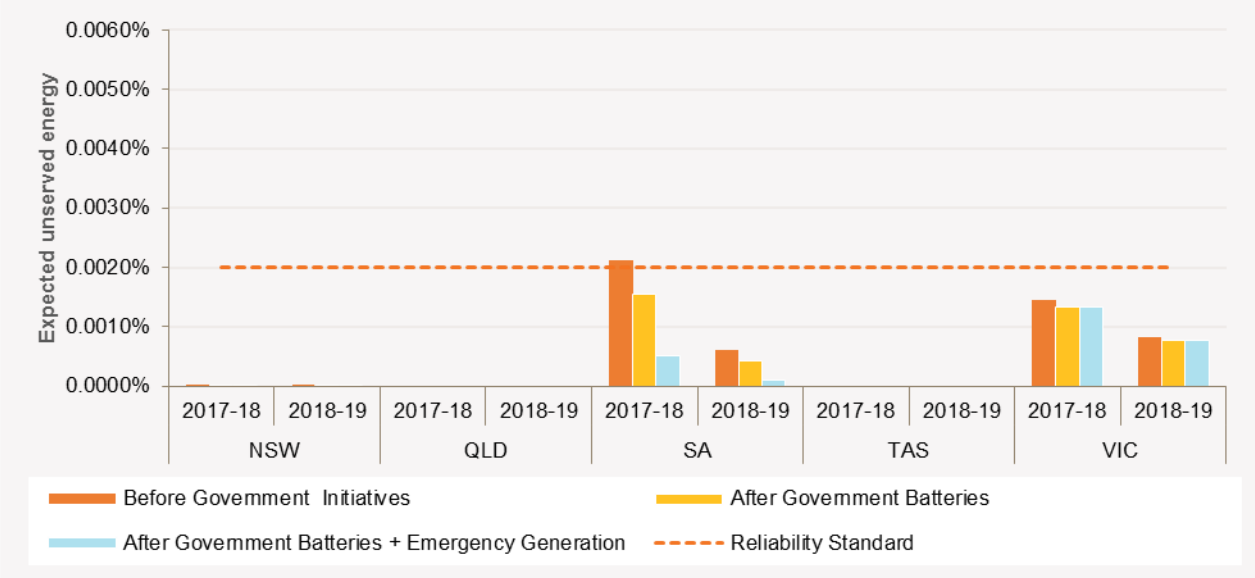
[17] Net energy balance refers to the net flow of electricity between interconnected regions. For Victoria, this includes flows between New South Wales, South Australia, and Victoria across four unique interconnectors.

In this probabilistic assessment, the expected volume of USE is not forecast to breach the reliability standard in any region, assuming the following:

- Government-initiated energy storage facilities are in service by summer 2017–18.
- There are no planned outages of generators during critical periods over summer.
- Short-term withdrawn generators return to service as follows:
  - Pelican Point Power Station unit from 1 July 2017.
  - Swanbank E Power Station for summer 2017–18.[18]
  - Tamar Valley Power Station for summer 2017–18.[19]

South Australia's energy storage and diesel generation procurement programs are expected to reduce occurrences of USE over the coming summer, helping to maintain USE below the reliability standard. The chart shows a forecast reduction in USE in South Australia in 2018–19, due to new generation and lower demand (the nature of the probabilistic assessment also means that assessment years are not directly comparable).

Figure 1 Supply adequacy (base case)



Government Batteries includes the South Australian and Victorian battery storage initiatives.
Emergency generation includes South Australia's plan to operate 200 MW of diesel generation for summer 2017–18, replaced by 250 MW of GPG for summer 2018–19.

While the reliability standard is expected to be met under the base case conditions (see Section 2.1.3), there remains a risk of supply shortfalls occurring in South Australia and Victoria over the next two years which could result in load shedding, especially during extreme conditions.

Extreme weather conditions typically occur on summer weekdays, between 4.00 pm and 8.00 pm, when temperatures exceed 40 degrees Celsius with little wind. The risk of supply shortfalls is higher if these conditions were to coincide with either:

- Generation outages (planned or unplanned).
- Low levels of inter-regional support due to interconnector constraints.[20]

[18] An announcement on 4 June 2017 stated that Swanbank E Power Station intends to be operating from the first quarter of 2018.
[19] Hydro Tasmania advised AEMO that Tamar Valley will be withdrawn after May 2017, but available for operation with less than three months' notice. See 5 June 2017 Tasmania information at http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Generation-information.
[20] Interconnector constraints can be due to planned or unplanned outages, or other events such as bushfires or severe weather.

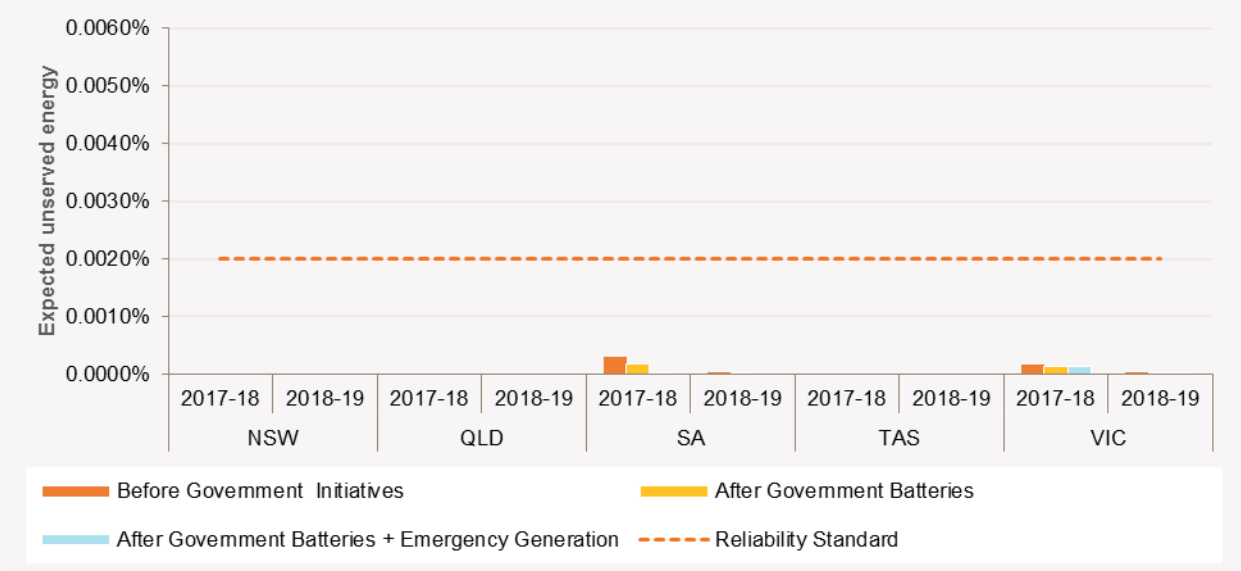
Table 2 Projected USE (base case)

Region	Year	Reliability Standard (MWh)	USE Before Government initiatives (MWh)	USE After Government batteries (MWh)	USE After Government batteries + thermal generation (MWh)	Weighted number of observations (Hours)
NSW	2017–18	1,388	4	4	4	0.02
	2018–19	1,396	3	3	3	0.01
SA	2017–18	251	266	194	65	1.24
	2018–19	250	76	54	13	0.46
VIC	2017–18	895	645	598	598	1.78
	2018–19	894	369	343	343	1.14
QLD	2017–18	1,085	0	0	0	0
	2018–19	1,094	0	0	0	0
TAS	2017–18	214	0	0	0	0
	2018–19	215	0	0	0	0

When averaged over each sample year, the number of USE observations projected in this hourly assessment is low. The weighted average number of USE observations across the 10% POE and 50% POE conditions is shown in the final column of Table 2 above. In 10% POE conditions for summer 2017–18 only, there were fewer than four USE observations in South Australia and five in Victoria. This demonstrates how rarely USE observations are expected to occur, even in extreme conditions.

Under average summer conditions (50% POE), the risk of supply shortfalls in any NEM region is considered much lower, as demonstrated in Figure 2 below.

Figure 2 Supply adequacy (base case – average summer conditions)



2.2 Electricity supply adequacy risk assessments

AEMO has conducted additional supply adequacy risk assessments to examine how a range of factors could impact NEM reliability. The risk assessments AEMO examined include:

- The impact if Swanbank E and Tamar Valley power stations are not in service.

- The EAAP Update, in which AEMO modelled the impacts of lower availability of thermal generation in South Australia, using generator bid information supplied to AEMO via the Medium Term Projected Assessment of System Adequacy (MT PASA).
- The impact of extreme weather conditions.
- The impact of coal-fired generation remaining at historical contracted levels.

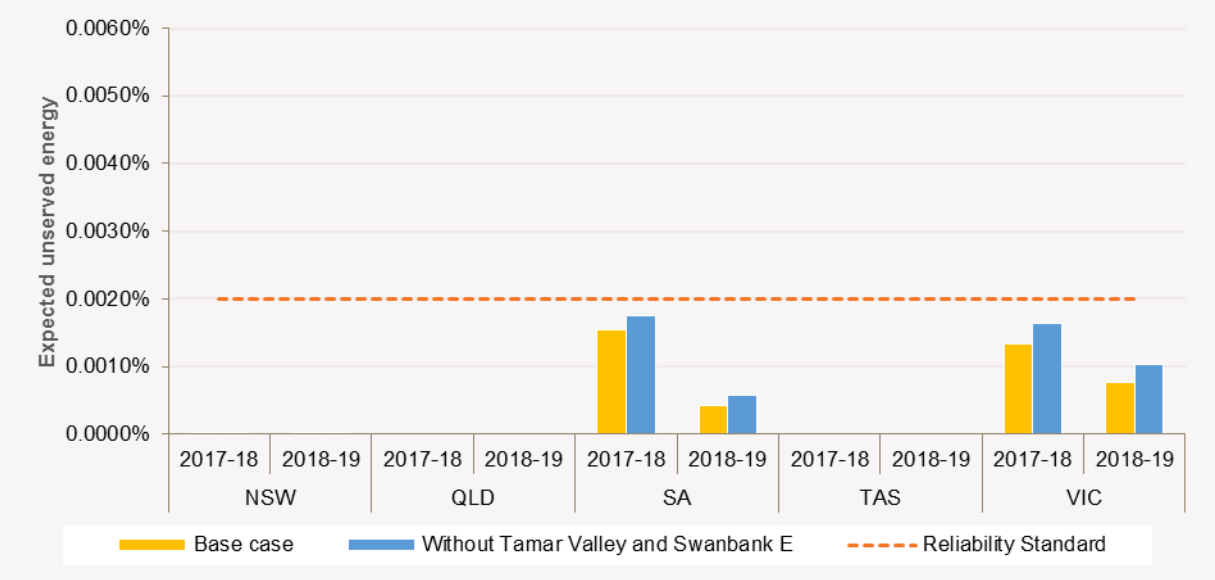
In this risk assessment, leveraging advice provided by participants, AEMO has assumed that sufficient coal is available to manage GPG demand within forecast gas production volumes. Section 2.2.4 covers AEMO's projection of gas requirements for GPG. Chapter 3 outlines a number of initiatives that AEMO is undertaking, with governments and industry, to increase gas availability for GPG.

2.2.1 Swanbank E and Tamar Valley Power Stations

While the return of the second unit at Pelican Point Power Station was announced in March 2017, the return to service of Swanbank E Power Station for the beginning of 2018 has only recently been announced.[21] Swanbank E was previously expected to return for summer 2018–19. No announcement has been made to date on the operation of Tamar Valley Power Station.

The figure below compares the USE outlook both with and without Swanbank E and Tamar Valley Power Stations. Both projections assume government batteries are operating in South Australia and Victoria for summer 2017–18.

Figure 3 Supply adequacy with and without Swanbank E and Tamar Valley power stations



This analysis highlights that having both these generators in operation for the 2017–18 summer could reduce the risk of USE in South Australia and Victoria. While the improvement would be limited by these generators' location and remoteness from the affected states, due to transmission constraints between Queensland and New South Wales (Swanbank E), and across Basslink (Tamar Valley), the additional capacity could reduce the risk of supply shortfalls next summer.

[21] Queensland Government media statement, "Swanbank E Power Station fires up again", 4 June 2017. Available at: http://statements.qld.gov.au/Statement/2017/6/4/swanbank-e-power-station-fires-up-again.

Full operation of both these gas-fired generators is estimated to require additional gas supplies of approximately 18 petajoules (PJ) per annum.[22] This would increase pressure on domestic gas supplies, in an already tight gas supply demand balance (see Section 2.2.4).

2.2.2 Energy Adequacy Assessment Projection Update

The EAAP Update is a further reliability assessment that is published as soon as practicable after new material information becomes available. AEMO determined an EAAP Update was appropriate after new information from gas producers became available after the 2017 GSOO, and AEMO sought further information on whether any non-hydro fuel constraints could impact generator capability through the GELF survey.

The EAAP also quantifies the impact of potential energy constraints on energy availability for a range of rainfall scenarios, as specified in the EAAP guidelines.[23] The EAAP was based on information available at 1 May 2017, and assumes that Pelican Point Power Station returns to service from July 2017, Swanbank E Power Station returns to service for summer 2018–19 and that Tamar Valley Power Station remains withdrawn from service for the next two years.

Another key difference between the EAAP and the ESO base case is that the EAAP assumes planned availability of existing scheduled and semi-scheduled generation used in the MT PASA, which only includes generating units available for recall within 24 hours. No attempt has been made in the EAAP analysis to optimise the timing of these planned outages.

- The ESO base case applied the summer and winter rated capacities advised by generators in AEMO's annual generator survey, which obtained a single rating for each summer and winter. This analysis assumes all generation capacity is available during the critical summer period, with no scheduled outages (although forced outages are modelled).
- By contrast, the MT PASA schedule used for EAAP is based on daily capacity ratings submitted by generators on an ongoing basis, includes planned outages scheduled by generators throughout the year but no forced outages, and considers only generation that is available for recall within 24 hours.

For example, during summer the MT PASA capacity ratings for thermal generation in South Australia are approximately 240 MW below the ratings in the ESO base case. This is shown in Figure 4 below.

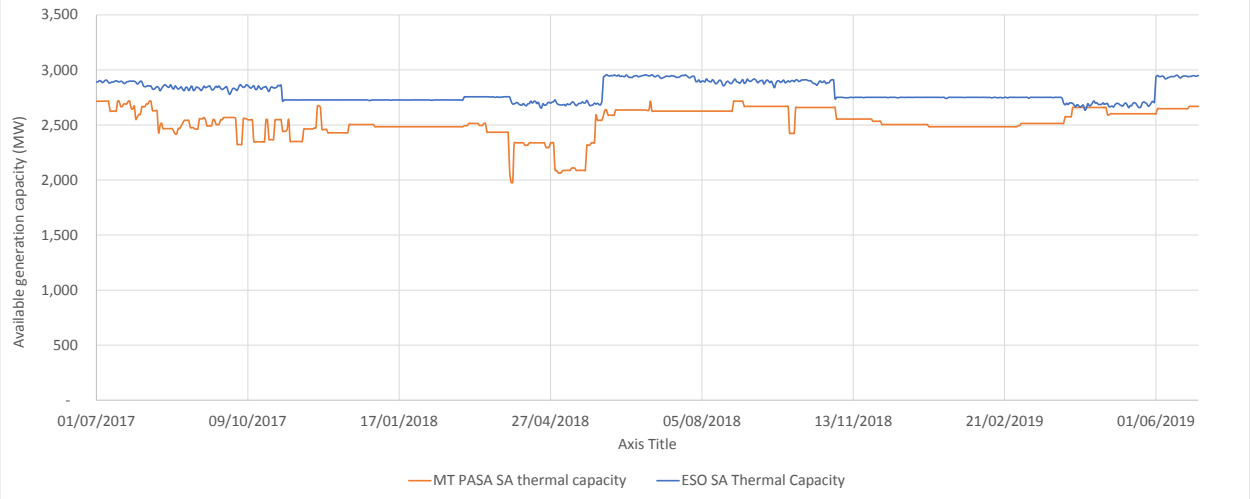
In the EAAP, with about 240 MW[24] less generation available over summer than in the base case due to planned outages, reliability standard breaches are projected in South Australia for the next two years, shown in Figure 5.

The reliability standard breaches shown in the EAAP reinforce the importance of continued operation of all currently operating generation capacity, and the return to full service of the Pelican Point Power Station.

The sustained outage of a single large unit, or power station, in South Australia could result in reliability standard breaches. A sustained outage of a large unit in Victoria may also threaten the standard, if coincident with high demand periods and low inter-regional support.

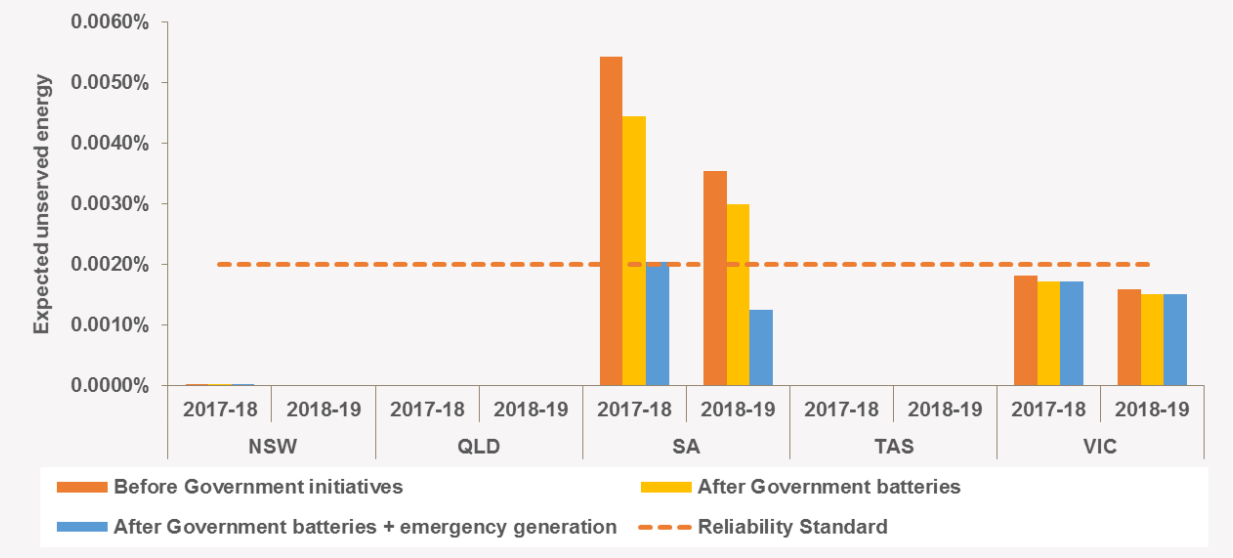
[22] This is based on Swanbank E and Tamar Valley generating at 2013–14 levels.
[23] AEMO. EAAP Guidelines, 28 October 2016. Available at: http://www.aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/Electricity_Consultations/2016/EAAP/EAAP_Guidelines.pdf.
[24] Gas plant capacity of 240 MW in South Australia is roughly equivalent to one of the following: one Pelican Point unit, two Torrens Island A units, one Torrens Island B unit, the entire Hallett GT Power Station, or the entire Quarantine Power Station. The modelling reasonably depicts outcomes associated with the withdrawal or unavailability of any of these units/power stations.

Figure 4 South Australian thermal generation capacity, advised by generators



The MT PASA trace shown is from 16 May 2017.

Figure 5 EAAP with 240 MW of gas-fired generation unavailable in South Australia



Varying levels of hydro generation

The EAAP assesses anticipated energy constraints under three different rainfall scenarios, including:

- Scenario 1: Low rainfall – based on rainfall between 1 July 2006 and 30 June 2007 for all regions except New South Wales. New South Wales is based on rainfall between 1 June 2006 and 31 May 2007.[25]
- Scenario 2: Short-term average rainfall – based on the average rainfall recorded over the past 10 years.
- Scenario 3: Long-term average rainfall – based on the average rainfall recorded over the past 50 years, or the longest period for which rainfall data is available, if less than 50 years (depending on the data available to participants).

[25] Analysis of this period ensures the lowest rainfall for New South Wales is reflected in the low rainfall scenario.

All rainfall conditions result in similar levels of expected USE over the next two years (projected monthly USE levels for each rainfall scenario are in Appendix B). Rainfall conditions are not expected to be drivers of supply shortfalls, so long as coal and GPG generators have sufficient access to fuel to compensate for any reduction in output from hydro generators.

Table 3 shows the range of forecast USE across all rainfall scenarios, where the government batteries are operating in time for summer 2017–18.

Table 3 Range of forecast USE across all rainfall scenarios, after government batteries

	2017–18 USE (MWh)	2017–18 USE (% of regional native consumption)	2018–19 USE (MWh)	2018–19 USE (% of regional native consumption)
New South Wales	17 to 36	0.0000% to 0.0001%	0	0.0000%
Queensland	0	0.0000%	0	0.0000%
South Australia	544 to 558	0.0043% to 0.0044%	351 to 375	0.0028% to 0.0030%
Tasmania	0	0.0000%	0	0.0000%
Victoria	727 to 799	0.0016% to 0.0018%	663 to 673	0.00148% to 0.00151%

AEMO continues to closely monitor projected storage levels and requirements for hydro generation over critical periods in summer, against inflow conditions, storage levels, and actual generation and market strategies. AEMO will also continue to closely monitor any changes to energy constraints for other generators, for example through changes that could limit fuel supply for coal or GPG.

2.2.3 Extreme weather conditions

The weather events observed during 8–10 February 2017 placed the power system under strain. Coincident heatwaves occurred across South Australia, New South Wales, and Northern Victoria, with Queensland also enduring extreme temperatures several days later.

The high ambient temperatures caused very high demand levels, while also affecting the capability and reliability of some generation units across the NEM. During these peaks, output from wind generation was low due to low wind speed conditions, particularly in South Australia and Victoria. South Australia experienced thermal generation forced outages, or units unable to start, of almost 500 MW capacity on 8 February 2017[26], while New South Wales experienced thermal generation-forced outages of 1,008 MW capacity on 10 February 2017.[27]

On 8 February 2017, AEMO directed load shedding in South Australia. On 10 February 2017, AEMO also directed load shedding in New South Wales.

AEMO has modelled the impact of the demand, wind, and solar conditions observed during the first two weeks in February, to assess the resilience of the power system to a repeat of these events over the next two summers.

A reoccurrence of the same conditions in summer 2017–18 would be likely to result in similar levels of USE in South Australia and New South Wales, and some USE in Victoria, in the absence of additional initiatives.

As both Victoria and South Australia are expected to import electricity to meet periods of high demand coinciding with low renewable generation, there will be greater reliance on transmission infrastructure to import electricity from Queensland and New South Wales.

[26] AEMO, 2017. *System event report, South Australia, 8 February 2017.* Available at: https://www.aemo.com.au/Media-Centre/System-event-report-South-Australia-8-February-2017.

[27] AEMO, 2017. *System event report, New South Wales, 10 February 2017*. Available at: https://www.aemo.com.au/Media-Centre/Incident-Report-NSW-10-February-2017.

Hydro, coal, gas, and diesel generation, in all regions, will also be critical to meeting demand during these times. Any plant, operating, or transmission limitations that reduce generation during extreme conditions could exacerbate risks of supply shortfalls.

To mitigate the risk of supply shortfalls, it is important to focus on the very few hours per year when USE may occur, by:

- Increasing the amount of demand side participation (DSP) [28] available to reduce demand during these hours.
- Planning generation and transmission outages to avoid critical summer periods.
- Introducing additional sources of firm capacity, such as battery storage, diesel generation, or GPG, where efficient to do so.

Market participants, government jurisdictions, and AEMO are all expected to play a role in facilitating additional resources so reliability and security can be maintained for summer 2017–18. Initiatives being undertaken to manage this risk are described in Chapter 3.

2.2.4 Black coal-fired generation at historical contracted levels

Following the closure of Hazelwood Power Station, current advice from coal-fired generators provided through the GELF indicates there are no expected limitations to hinder an aggregate increase in coal-fired generation to largely replace the withdrawn generation. This would, however, require an increase in coal-fired generation from historical levels across the remaining coal-fired generation fleet.

AEMO has conducted a risk assessment to examine the impact on gas supply (as GPG is often the marginal source of generation) if remaining coal-fired generation is not able to increase production from historical levels for any reason. Possible reasons for restrictions to coal-fired generation increases include coal supply limits associated with current supply contracts or operational limitations to reduce the risk of unplanned outages.

Restricted coal-fired generation at historical levels would increase GPG requirements to a projected GPG demand for gas supply of between 225 PJ to 235 PJ per annum. The expected amount of gas available for GPG demand in 2017–18 is approximately 170 PJ (discussed in Section 2.4 below).

If no other generation was available, a shortfall in gas supply for GPG of 55–65 PJ would equate to electricity supply shortfalls of 5.6 TWh to 6.8 TWh. Market participants have advised that about a quarter of the NEM GPG capacity is capable of operating on a secondary fuel, given sufficient notice of requirement. This capability would reduce the risk of electricity shortfalls in a short-term gas shortage situation.

This demonstrates the level of integration between the gas and electricity supply demand balances. When assessing power system reliability, it is critical to utilise accurate information on any limitations to fuel supply that could restrict generation across the fleet. AEMO continues to seek the latest information from industry to apply in upcoming Energy Supply Outlooks.

2.3 A need for new capacity

Despite an expectation that the reliability standard will be met in all regions over the next two years, the risk assessments in this ESO demonstrate the continued risks of supply shortfalls if generator availability is lower than expected or if extreme summer conditions prevail over the next two years.

To reduce the risk of supply shortfalls, there is an immediate development need for capacity in the NEM that can reliably contribute towards meeting demand when it is required.

[28] DSP can refer to a wide range of short-term demand responses by customers, to electricity price signals and network reliability signals.

Most recent market responses involve proposals for new renewable generation projects that are expected to become operational over the next two years, and have been included in the assessments:

- Approximately 470 MW of this is to be developed in South Australia and Victoria, while over 900 MW will be located in Queensland and New South Wales.
- Over 500 MW is projected to be operational for summer 2017–18, with an additional 880 MW available for summer 2018–19.

Since the modelling for this ESO assessment was completed, a further 392 MW of new renewable generation projects across the NEM have been announced as very advanced developments, with commercial use dates expected within the next two years. Although these will not contribute their full rated capacity at times of peak demand, it demonstrates the speed at which new projects are facilitated by the Large-scale Renewable Energy Target (LRET).

Notably, these initiatives are largely proposed without associated battery storage. New renewable generation will contribute much more to reliability if it can consistently supply energy at the critical peak demand times, typically in late afternoon or early evening of summer, irrespective of solar or wind conditions. This highlights a development need for battery storage and/or DSP to be paired with new renewable generation proposals to maximise its potential benefit to the power system.

The South Australian and Victorian governments have each announced battery storage initiatives as part of their energy plans. AEMO is working with these governments on selection and specification of the technological requirements so that integration of this new technology realises the benefits intended under the policy objectives.

Approximately 950 MW of DSP capacity across the NEM, identified in the 2016 NEFR[29], is included in each assessment for this ESO.

DSP can complement potential supply-side market responses and provide greater contribution at peak demand times. DSP can also be deployed rapidly, and there is potential for a large quantity of additional DSP to contribute towards reliability for summer 2017–18 if suitable initiatives can be created and deployed in time.

AEMO and the Australian Renewable Energy Agency (ARENA) have announced a three-year DSP initiative, beginning in summer 2017–18 in South Australia and Victoria, to manage peak demand in real time and free up temporary supply during extreme weather and unplanned outages. This initiative is seeking to secure 100 MW of additional DSP capacity.

AEMO is also seeking offers of additional reserves for summer 2017–18 through the Reliability and Emergency Reserve Trader (RERT) provisions. The RERT allows AEMO to procure additional generation or DSP capacity not normally available to the market, to maintain the reliability or security of the power system.

2.4 Projected gas supply adequacy

2.4.1 Updated GPG demand projections

AEMO has updated its GPG forecasts to incorporate the returned full capacity of Swanbank E, Pelican Point, and Tamar Valley gas-fired power stations, in addition to assuming the energy contribution from GPG observed in 2016–17 continues in 2017–18.

As a result, updated forecast GPG demand has increased between 5 PJ/a and 23 PJ/a across the next five years, compared to the March 2017 GSOO forecast. The updated projection is for approximately 183 PJ of gas to be required by GPG in 2017–18 (to supply about 20.0 TWh of electricity).

[29] AEMO, 2016 NEFR. Available at: https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/National-Electricity-Forecasting-Report.

Actual demand for gas by GPG will depend on electricity and gas markets, including contract levels, generation strategies, market prices, availability of gas, and the ability to secure gas on short notice, as well as weather (for example, more GPG may be needed if the summer was hotter than the average trend).

As noted in Section 2.2.4, should black coal-fired generators continue operating at current contract or historical levels, demand for gas by GPG would need to increase further to avoid USE. This would require an approximate additional increase of 55–65 PJ, potentially bringing GPG gas demand as high as 234 PJ in 2017–18.

2.4.2 Updated supply projections

AEMO has updated its projections of domestic gas supply adequacy, using production guidance provided in April 2017 by gas producers. Producers revised the annual forecast gas supply in the next five years up by between 33 PJ and 147 PJ, compared to earlier information used in March 2017 GSOO modelling.

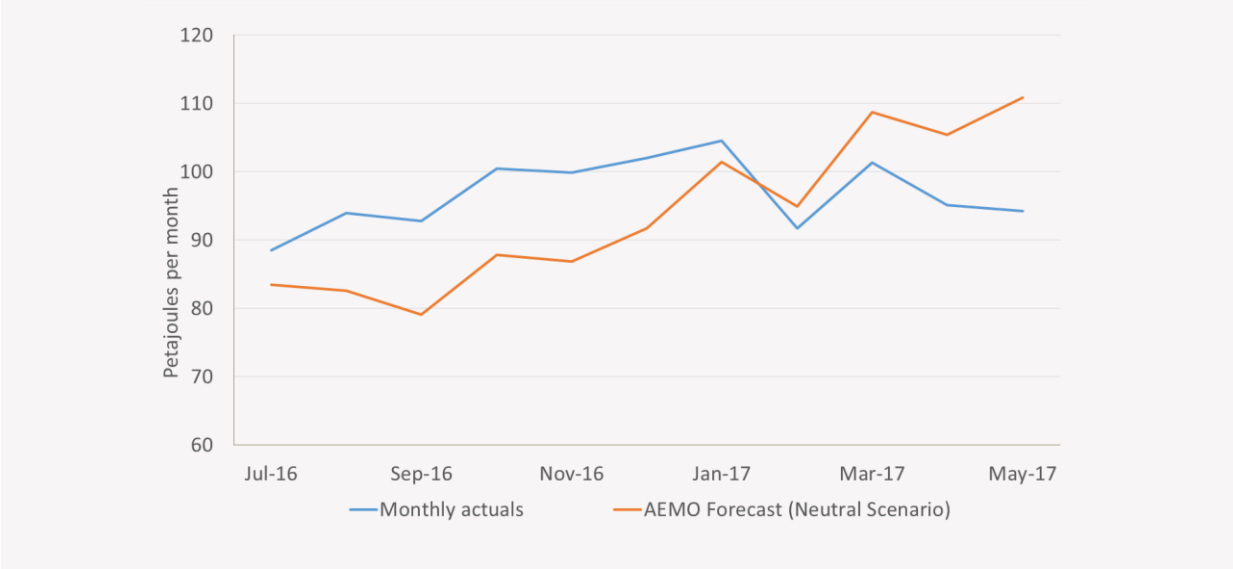
2.4.3 Updated supply demand projections

Following these updated production forecasts from gas producers, gas supply and demand remain finely balanced, with continued risks of shortfalls. Variations in the amount of gas demanded by LNG exports could, however, be pivotal in determining whether a gas shortfall arises.

Based on updated production projections, and using the March 2017 GSOO forecasts of gas demand for LNG exports, AEMO projects that approximately 170 PJ of gas will be available for supply to GPG in 2017–18. This would not be sufficient to meet the potential additional GPG demand in Section 2.4.1.

Gas demanded by Curtis Island LNG trains has, however, recently been observed to trend down from the projections used in the March 2017 GSOO Neutral scenario. Actual demand was lower than the forecast by up to 17 PJ in May 2017, as shown in Figure 6 below.

Figure 6 Monthly variation in gas for Curtis Island exports (Actuals v AEMO Neutral scenario forecast, petajoules)



May-17 actuals as at 28 May 2017.

Should the operational trend for LNG demand observed over the last two months continue longer-term, additional gas may be available for contracting by the domestic market. These dynamics are critical to the future adequacy of domestic gas supplies. Continuing flexibility in gas demand for LNG exports will

be important for management of unexpected events in the gas supply chain, or new increases in gas demand by GPG to maintain power system security and reliability.

This reinforces that strong collaboration between AEMO and the gas industry is imperative, so AEMO's ongoing forecasts use accurate projections of gas supply and demand. AEMO will seek updated projections of gas production, reserves, facility capacities, and gas demand for LNG exports from all relevant parties, and use this information in future assessments of the adequacy of, and risks to, future gas and electricity supplies.

2.4.4 Winter gas outlook

Summer GPG needs must also be managed to avoid unintended consequences for reliable gas supply for peak winter heating load in southern states.

Updated gas production forecasts from producers indicate there is increased capacity at Victorian production facilities for winter 2017 (compared with the previous winter). Based on information from the Gas Bulletin Board, Longford Gas Plant capacity has increased from approximately 1,020 TJ/d in winter 2016 to 1,110 TJ/d for winter 2017. Otway Gas Plant has increased from approximately 120 TJ/d during winter 2016 to 192 TJ/d for winter 2017. The commencement of the new "TasHub" injection facility will also supply linepack[30] from the Tasmanian Gas Pipeline on peak days.

As Iona Underground Gas Storage (UGS) is a critical supply source for the winter period, AEMO is closely monitoring storage throughout winter to identify any potential supply concerns.

During winter 2016, Iona UGS fell to approximately 50% storage inventory by the end of June. As of the start of May 2017, Iona UGS was at almost 22 PJ (85% of total storage capacity of 26 PJ), which is understood to be its contracted capacity for winter 2017. If storage reduces to a low level again early in winter, AEMO will work with industry and the Victorian Government to examine alternate supply options or mandatory restrictions. If storage was to be emptied before the end of winter and a peak gas system demand day occurred, a gas supply shortfall may occur which could result in the curtailment of gas customers. Based on current conditions, AEMO assesses this as unlikely for winter 2017.

AEMO's 2017 *Victorian Gas Planning Report*[31](VGPR) identified that, under gas production forecasts updated in January 2017, there should be sufficient gas production available to refill Iona UGS facility each summer, but due to a South West Pipeline (SWP) transportation capacity constraint for flow towards Port Campbell, refilling of Iona UGS is uncertain for winter 2018 and is unlikely for each subsequent winter from 2019 onwards. Failure to refill Iona UGS during the summer, when demand is lower, may result in Victorian gas supply shortfalls during the following winter.

As a result of this constraint being identified in the 2017 VGPR, AEMO has issued a notice of a threat to system security and sought to have the SWP transportation capacity towards Port Campbell increased. AEMO is working with APA Group, the owner of the Victorian gas Declared Transmission System (DTS), and the Australian Energy Regulator to increase the SWP transportation capacity by:

- Temporarily increasing compression capacity from 1 September 2017.
- Fast-tracking a piping reconfiguration at the Brooklyn Compressor Station.
- Adding bi-directional flow capability to Winchelsea compressor.

As the operator of the DTS, AEMO is working with APA Group to implement this capacity expansion. The Brooklyn and Winchelsea works were expected to be completed by May 2018, but APA Group is accelerating this work. The stretch target completion date is late 2017 or early 2018.

[30] Linepack refers to gas in pipelines – it provides gas storage, and also maintains gas pressure.
[31] AEMO. *Victorian Gas Planning Report*, March 2017. Available at: http://www.aemo.com.au/Gas/National-planning-and-forecasting/Victorian-Gas-Planning-Report.

CHAPTER 3. WHAT IS AEMO DOING TO PREPARE FOR NEXT SUMMER?

AEMO is continually updating its east coast operational strategy to maintain system security and reliability in the electricity and gas systems. The strategy for meeting the reliability standard next summer is focused in the following areas.

Maximising existing and new supply availability and capacity

- AEMO is working with generators to schedule generator outages outside the summer period, where there is no risk to safety or reliability of the units.
- AEMO is working with generation businesses and government to better understand capacity or energy limitations on plant, and working with parties to either address or manage risks.
- AEMO is working with generators and governments to return as many mothballed plants to service as possible.

Minimising risks to fuel supplies to generation

- AEMO is working with generation businesses to understand any operational, energy, or fuel risks for summer from both commercial and physical aspects. To the extent that any limits are found that may impact on the security of the power system, AEMO will work with industries and governments to facilitate a suitable resolution.
- AEMO is closely monitoring reliability of future supplies from hydro generation, and working with generators to assess risks on water storages for use when supply is tight next summer.
- AEMO is working with gas producers and LNG consortia, so it can use the latest information available on projections of production, reserves, facility capacity limitations, and demand for gas for export in its risk assessments.
- AEMO will collaborate with gas production and pipeline businesses to coordinate maintenance of facilities. By minimising maintenance outages of pipeline and production facilities during critical NEM periods, the aim is to maximise the capacity of the gas transmission system to deliver gas supplies to GPG at these times, without increasing operational risk in other periods as well.
- AEMO is collaborating with industry representatives, peak industry associations, market institutions, and jurisdictions to prepare a high-level design for the Gas Supply Guarantee mechanism for peak electricity demand. This measure will introduce enhanced short-term energy arrangements, which will support industry with improved information on (and management of) short-term transportation and supply risks to GPG. This in turn will provide market participants with greater opportunity to manage any potential shortfalls through market or commercial arrangements. This measure will also inform industry arrangements to make gas more available (including linepack) for GPG during critical NEM demand periods, while not compromising gas supply to southern states during winter.

Encouraging and maximising demand side participation

- AEMO is actively promoting increasing levels of DSP.
- AEMO is working with ARENA and governments to pilot a demand response initiative for summer 2017–18, and is encouraging other market responses to provide firm capacity, particularly in the next two years.
- AEMO is working with ARENA to continue developing new innovative products to support the introduction of additional DSP.

Seeking additional reserves

- AEMO is seeking offers of additional reserves for summer 2017–18 through the Reliability and Emergency Reserve Trader (RERT) provisions.
- The RERT allows AEMO to procure additional generation or load reduction capacity not normally available to the market, to maintain the reliability or security of the power system.
- AEMO is working with industry to promote DSP and the potential for DSP to participate in RERT.

Maximising transmission network availability and capacity

- AEMO is working with Transmission Network Service Providers (TNSPs) to minimise planned outages impacting interconnector capacity or constraining generators during critical periods.
- AEMO will facilitate TNSPs' preventative maintenance where possible prior to October 2017, subject to operational requirements and requirements for building of energy constrained reserves for use during summer.
- AEMO is finalising an initiative with the Australian Energy Regulator (AER), asset owners, and TNSPs to complete upgrade works known to constrain transfer capabilities across interconnectors.
- AEMO will manage minor augmentations in Victoria to effect marginal increases to interconnectors where possible.
- AEMO will complete contingency planning and conduct joint gas/electricity response exercises during 2017 to test contingency plans and emergency management arrangements.

Dispatch forecasting initiatives

- Security of electricity supplies will become much more sensitive to the management of the impacts of daily and within day changes in weather on the power system. Variations in coal, gas, and hydro generation are typically not dependent on within day weather conditions. With wind and PV generation taking much more of the share of electricity supply, secure and reliable NEM operation will be more sensitive to the ability to balance the system when the output of intermittent generation is low, or varies materially over short timeframes.
- AEMO's ability to forecast this intermittent output accurately ahead of the day and within each hour of the day is critically important to keep the system in balance.
- AEMO is continually developing its operational demand and supply forecasting capabilities by:
  - Collaborating with weather forecasting suppliers to obtain detailed alerts on weather-related events that could impact power system operation, such as sudden changes in wind or cloud conditions.
  - Developing tools and systems to provide real time alerts when weather events cause forecasting uncertainty to increase. This will allow power system controllers to take pre-emptive action, such as reconfiguring the network and/or increasing the availability of reserves, in case actual events differ greatly from the forecasts.
  - Developing new forecasting tools based on machine learning (or artificial intelligence) to enhance AEMO's operational forecasting models, particularly during extreme weather events.

South Australian Black System recommendations

- AEMO's final report[32] on the South Australian Black System of 28 September 2016 recommended practical measures to be implemented to:
  - Reduce the risk of islanding of the SA region.
  - Increase the likelihood that, in the event of islanding, a stable electrical island can be sustained at least in part of SA.
  - Improve the performance of the system restart process.
  - Improve market and system operation processes required during periods of market suspension.
- 19 recommendations were made (see Appendix C), of which six are complete and the remainder are progressing and on track for completion before the end of this year.

Facilitating government initiatives

- The South Australian and Victorian governments have undertaken initiatives to avoid USE within their regions, which have been incorporated into this report. These initiatives include:
  - The Victorian government's Energy Storage Initiative targeting 40 MW and 100 MWh energy storage, assumed to be operational by January 2018.[33]
  - South Australia's Energy Plan[34], including:
    - A 100 MW, 200 MWh battery, assumed to be operational before summer 2017–18.
    - 200 MW of temporary emergency diesel generation, for use in emergency situations during summer 2017–18, if extreme conditions create a supply shortfall that cannot be met in other ways.
    - 250 MW of GPG to be switched on in times of emergency, assumed to be operational before summer 2018–19 and replacing the temporary diesel generation available during summer 2017–18.
- AEMO is assisting in the implementation of these initiatives, advising each government on technology requirements involved in each initiative, with a view to facilitating the connection of suitable technology to deliver the policy objectives and secure power system supplies.
- AEMO will work with the South Australian Government to identify key risks and opportunities around the Energy Minister's recently introduced powers of direction in relation to electricity supply disruptions.
- The Council of Australian Governments (COAG) has received the recommendations of Australia's Chief Scientist, Dr Alan Finkel, in his *Independent Review into the Future Security of the National Electricity Market*.[35] AEMO supports the view of the Finkel report that the design of the grid of the future must be fit-for-purpose to deliver the key outcomes of increased security, future reliability, rewarding consumers, and a lower emissions trajectory.
- AEMO looks forward to continuing its work with government policy-makers, and its engagement with industry and consumers, to enable an efficient and secure Australian energy market for future generations.

[32] AEMO. *Black System, South Australia, 28 September 2016*, March 2017. Available at: http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Market-notices-and-events/Power-System-Operating-Incident-Reports.
[33] Government of Victoria 2017. *Energy Storage Initiative*. Available at: http://www.delwp.vic.gov.au/energy/energy-storage.
[34] Government of South Australia 2017. *Our Energy Plan*. Available at: http://ourenergyplan.sa.gov.au/.
[35] *Independent Review into the Future Security of the National Electricity Market: Blueprint for the Future*, June 2017. Available at: http://www.environment.gov.au/system/files/resources/1d6b0464-6162-4223-ac08-3395a6b1c7fa/files/electricity-market-review-final-report.pdf.

CHAPTER 4. LINKS TO SUPPORTING INFORMATION

The table below provides links to additional resources, or related AEMO planning information.

Table 4 Links to supporting information

Information source	Website address
Energy Adequacy Assessment Projection Update	https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Energy-Adequacy-Assessment-Projection
NEM Electricity Statement of Opportunities	http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/NEM-Electricity-Statement-of-Opportunities
NEM Electricity Statement of Opportunities Methodology	http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/NEM-Electricity-Statement-of-Opportunities
Gas Statement of Opportunities	https://www.aemo.com.au/Gas/National-planning-and-forecasting/Gas-Statement-of-Opportunities
Gas Statement of Opportunities Methodology	https://www.aemo.com.au/Gas/National-planning-and-forecasting/Gas-Statement-of-Opportunities
AEMO Generation Information page	http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Generation-information
National Electricity Forecasting Report	https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/National-Electricity-Forecasting-Report
2016 National Electricity Forecasting Report – Demand Side Participation	https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/NEFR/2016/Demand-Side-Participation---2016-National-Electricity-Forecasting-Report.pdf
National Gas Forecasting Report	https://www.aemo.com.au/Gas/National-planning-and-forecasting/National-Gas-Forecasting-Report
National Transmission Network Development Plan	http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/National-Transmission-Network-Development-Plan
Victorian Gas Planning Report	https://www.aemo.com.au/Gas/National-planning-and-forecasting/Victorian-Gas-Planning-Report

APPENDIX A. NEWLY COMMITTED AND VERY ADVANCED GENERATION DEVELOPMENTS

The table below shows generation developments newly committed or very advanced since the November 2016 ESOO Update.

Table 5 Newly committed and very advanced generation developments as at 1 May 2017[A]

Project	Technology type	Nameplate capacity (MW)	Full commercial use date	First summer available	State
Gullen Range Solar Farm (expansion)	Solar	10	Sep-17	2017–18	NSW
Griffith Solar	Solar	29.9	Nov-17		NSW
Parkes Solar	Solar	55	Nov-17		NSW
Sapphire Wind Farm	Wind	270	Dec-17		NSW
Hornsdale Wind Farm Stage 3	Wind	109	Dec-17		SA
Kiata WF	Wind	31.05	Dec-17		VIC
Clare Solar Farm	Solar	150	Jan-18	2018–19	QLD
Kidston Solar Project Phase One 50MW	Solar	50	Feb-18		QLD
Hamilton Solar Farm	Solar	58	Mar-18		QLD
Whitsunday Solar Farm	Solar	58	Mar-18		QLD
Tailem Bend – Diesel	Diesel	28.8	TBA		SA
Manildra Photovoltaic Solar Farm	Solar	50	Apr-18		NSW
Gannawarra Solar Farm	Solar	52.8	Apr-18		VIC
Yaloak South	Wind	29	Jul-18		VIC
Bungala Solar Farm	Solar	220	Aug-18		SA
Mount Emerald	Wind	181	Sep-18		QLD
Silverton Wind Farm[B]	Wind	199	Mar-19	2019–20	NSW

A Since the modelling for this assessment was completed, a further 392 MW of new renewable generation projects are very advanced, with commercial use dates expected within the next two years.
B Since the modelling for this assessment was completed, Silverton Wind Farm has advised the full commercial use date has advanced to July 2018.

APPENDIX B. EAAP – DETAILED MONTHLY RESULTS

The following tables show the EAAP results for average monthly regional energy demand (in megawatt hours) at risk.

Low rainfall scenario

Table 6 Forecast USE after government batteries in low rainfall scenario, MWh

Month	NSW	QLD	SA	TAS	VIC
July 2017	0	0	0	0	0
August 2017	0	0	0	0	0
September 2017	0	0	0	0	0
October 2017	0	0	0	0	0
November 2017	0	0	73	0	307
December 2017	0	0	0	0	0
January 2018	23	0	443	0	376
February 2018	0	0	30	0	7
March 2018	0	0	0	0	37
April 2018	0	0	0	0	0
May 2018	0	0	0	0	0
June 2018	0	0	0	0	0
July 2018	0	0	0	0	0
August 2018	0	0	0	0	0
September 2018	0	0	0	0	0
October 2018	0	0	0	0	0
November 2018	0	0	0	0	0
December 2018	0	0	0	0	0
January 2019	0	0	350	0	596
February 2019	0	0	1	0	0
March 2019	0	0	0	0	67
April 2019	0	0	0	0	0
May 2019	0	0	0	0	0
June 2019	0	0	0	0	0

Short-term average rainfall scenario

Table 7 Forecast USE after government batteries in short-term average rainfall scenario, MWh

Month	NSW	QLD	SA	TAS	VIC
July 2017	0	0	0	0	0
August 2017	0	0	0	0	0
September 2017	0	0	0	0	0
October 2017	0	0	0	0	0
November 2017	0	0	73	0	306
December 2017	0	0	0	0	0
January 2018	17	0	455	0	421
February 2018	0	0	30	0	7
March 2018	0	0	0	0	36
April 2018	0	0	0	0	0
May 2018	0	0	0	0	0
June 2018	0	0	0	0	0
July 2018	0	0	0	0	0
August 2018	0	0	0	0	0
September 2018	0	0	0	0	0
October 2018	0	0	0	0	0
November 2018	0	0	0	0	0
December 2018	0	0	0	0	0
January 2019	0	0	374	0	607
February 2019	0	0	1	0	0
March 2019	0	0	0	0	66
April 2019	0	0	0	0	0
May 2019	0	0	0	0	0
June 2019	0	0	0	0	0

Long-term average rainfall scenario

Table 8 Forecast USE after government batteries in long-term average rainfall scenario, MWh

Month	NSW	QLD	SA	TAS	VIC
July 2017	0	0	0	0	0
August 2017	0	0	0	0	0
September 2017	0	0	0	0	0
October 2017	0	0	0	0	0
November 2017	0	0	73	0	304
December 2017	0	0	0	0	0
January 2018	36	0	441	0	451
February 2018	0	0	30	0	7
March 2018	0	0	0	0	37
April 2018	0	0	0	0	0
May 2018	0	0	0	0	0
June 2018	0	0	0	0	0
July 2018	0	0	0	0	0
August 2018	0	0	0	0	0
September 2018	0	0	0	0	0
October 2018	0	0	0	0	0
November 2018	0	0	0	0	0
December 2018	0	0	0	0	0
January 2019	0	0	372	0	603
February 2019	0	0	1	0	0
March 2019	0	0	0	0	68
April 2019	0	0	0	0	0
May 2019	0	0	0	0	0
June 2019	0	0	0	0	0

APPENDIX C. RECOMMENDATIONS FROM SOUTH AUSTRALIA BLACK SYSTEM REPORT

The table below shows the status of AEMO's implementation of its recommendations from its final report[36] on the South Australia Black System on 28 September 2016.

#	Recommendation	Status
1	AEMO to propose to ESCOSA changes to generator licensing conditions, and also to request similar changes to the NER, to address deficiencies in performance standards identified through this investigation.	Completed
2	AEMO to put in place more rigorous processes to monitor weather warnings for changes to forecasts, to trigger reassessment of reclassification decisions where relevant.	Completed
3	AEMO to review and implement, following consultation, a more structured process for reclassification decisions when faced with power system risks due to extreme wind speeds.	In progress
4	AEMO to assess options for improved forecasting of when wind speeds will exceed protection settings on wind turbines, which would lead to 'over-speed cut-outs'.	In progress
5	AEMO to consider development of a new reclassification process to manage 'type' risks, including how information about potential risks will be sought, and the most appropriate methods to manage power system security during such a generator reclassification.	In progress
6	AEMO to work with ElectraNet to determine the feasibility of developing a special protection scheme to operate in response to sudden excessive flows on the Heywood Interconnector, and to initiate load shedding with a response time fast enough to prevent separation.	In progress
7	AEMO to modify existing transfer limits on the Heywood Interconnector to take into account the fact that the largest credible generator contingency under conditions of high wind generation is greater than previously assumed.	Completed
8	AEMO to modify operational procedures for SA island operation to: • Take into account the fact that, under islanded conditions, system strength may fall to a level where some wind farms might not be able to ride through credible voltage disturbances. • Ensure that maintenance of adequate system strength is incorporated into the transmission planning process in a more systematic manner.	In progress Completed
9	AEMO to support ElectraNet to identify and address any specific risks to the operation of protection systems due to the low levels of system strength that may be experienced if SA is islanded.	In progress
10	AEMO to support ElectraNet in reassessing control strategies to achieve very rapid switching of reactive plant to manage the risk of severe over voltages in SA that might occur due to large levels of under frequency load shedding following separation.	In progress
11	AEMO to review its reclassification procedures to address any remaining material risk due to multiple voltage disturbances, and to approach relevant Generators to review the feasibility of increasing plant limits for the maximum number of multiple voltage disturbances that can be tolerated over a 30-minute period.	Completed
12	AEMO, together with the South Australian System Restart Working Group, to review the system restart process in detail to determine efficiencies and to implement relevant recommendations from the Reliability Panel. These learnings will be shared across all Australian jurisdictions.	In progress
13	Any differences between system restart ancillary services (SRAS) test plans and the restart process set out in a system restart plan and associated local black system procedures to be identified and explained by AEMO, to ensure the test simulates, as far as practicable, the conditions that will be encountered in a real restart situation.	Completed
14	Similarly, where the restart procedure depends initially on starting a low voltage generator, the start of this generator alone to be tested on a regular basis, in addition to the annual test of the entire SRAS source.	In progress
15	AEMO to develop detailed procedures for in power system operations during periods of market suspension, and identify if any NER changes are desirable to improve the process.	In progress

[36] AEMO. *Black System, South Australia, 28 September 2016*, March 2017. Available at: http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Market-notices-and-events/Power-System-Operating-Incident-Reports.

#	Recommendation	Status
16	AEMO to investigate a better approach to ensuring that the minimum stable operating levels of generating units are taken into account in the dispatch process.	In progress
17	AEMO to review market processes and systems, in collaboration with participants, to identify improvements and any associated NER or procedure changes that may be necessary to implement those improvements.	In progress
18	AEMO to develop a more structured process in consultation with participants to source and capture data after a major event in a timely manner and to co-ordinate data requests.	In progress
19	AEMO to investigate with participants the possibility of introducing a process to synchronise all high speed recorders to a common time standard.	In progress