ENERGY ADEQUACY ASSESSMENT PROJECTION

NOVEMBER 2016 UPDATE

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AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

IMPORTANT NOTICE

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EXECUTIVE SUMMARY

On 3 November 2016, majority owner Engie announced that Hazelwood Power Station in Victoria would retire by end of March 2017[1]. The closure of this brown coal-fired power station will remove 1,600 megawatts (MW) – or 13.8% of scheduled and semi-scheduled generation capacity – from Victoria, and will reduce the surplus generation Victoria has traditionally exported.

This update to the September 2016 Energy Adequacy Assessment Projection (EAAP) assesses the impact of potential energy constraints on the level of expected unserved energy (USE) for a range of rainfall scenarios (low rainfall, short-term average rainfall, and long-term average rainfall) as specified in the EAAP guidelines[2], in light of this significant new information.

The National Electricity Market (NEM) reliability standard specifies that the level of expected USE, in megawatt hours (MWh), should not exceed 0.002% of consumption per region, in any financial year.

Following the withdrawal of Hazelwood Power Station, this November 2016 EAAP analysis highlights that:

- There is a projected risk of a reliability standard breach in Victoria over summer 2017−18, in the absence of any market response.
- Reliability standard breaches may also occur in South Australia over summer 2017−18 if there is low export of supply from Victoria coinciding with high demand in South Australia.
- Market responses to maintain reliability could include the return to service of withdrawn generators on short-term recall, as highlighted in the November 2016 Electricity Statement of Opportunities update[3].
- Conserving water in storage this year can help to mitigate the risk of reliability standard breaches next summer, but this market response alone is not projected to be sufficient to avoid expected reliability standard breaches in the three rainfall scenarios.
- There is an increased risk of reliability standard breaches in both Victoria and South Australia in 2017−18 under a low rainfall scenario.
- Unserved energy projected under short-term average rainfall conditions is primarily due to generation and transmission capacity limitations rather than energy constraints. Therefore, higher rainfall conditions do not reduce the risk of reliability breaches in Victoria over summer 2017−18.

The material changes in supply and demand since the September 2016 EAAP are:

- Hazelwood Power Station (1,600 MW) is expected to cease generation by end of March 2017.
- Hornsdale wind farm stage 2 (102.4 MW) is now expected to generate from June 2017.
- Mt Gellibrand wind farm (66 MW) is now expected to generate from June 2018.

[1] Available at : http://www.engie.com/en/journalists/press-releases/hazelwood-power-station-australia/. Viewed on 29 November 2016.
[2] Available at : http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Energy-Adequacy-Assessment-Projection. Viewed on 29 November 2016.
[3] Available at: http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/NEM-Electricity-Statement-of-Opportunities. Viewed on 29 November 2016.

CONTENTS

1. ENERGY ADEQUACY ASSESSMENT PROJECTION

1.1 Introduction

The EAAP quantifies the impact of potential energy constraints on energy availability for a range of rainfall scenarios, specified in the EAAP guidelines[4] and described below. AEMO identifies potential periods of USE, and quantifies projected annual USE that may breach the reliability standard.

Clause 3.9.3C of the National Electricity Rules (NER) defines:

- The reliability standard, which measures the sufficiency of installed capacity to meet demand. It is defined as the maximum expected USE, as a percentage of total energy demanded[5], allowable in a region over a financial year. It is currently set at 0.002%.
- The USE that contributes to the reliability standard. This excludes USE resulting from power system security events, network outages not associated with inter-regional flows, and industrial action or acts of God.

The EAAP is published annually, with more frequent updates as required if AEMO becomes aware of new information that may materially alter the previously published EAAP. This update to the September 2016 EAAP follows the announced withdrawal[6] of Hazelwood Power Station in Victoria at the end of March 2017.

The analysis covers the period from 1 October 2016 to 30 September 2018, and includes anticipated energy constraints under these three specified rainfall scenarios:

- 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.[7]
- 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).

1.2 Key modelling inputs and methodology

The EAAP guidelines also specify modelling inputs and assumptions used in the EAAP analysis.

The EAAP uses the following inputs in its forecasting models:

- Existing scheduled and semi-scheduled generation.
- Committed scheduled and semi-scheduled generation.
- Planned increases in capacities of existing scheduled and semi-scheduled generation used in the Medium Term Projected Assessment of System Adequacy (MTPASA).

[4] Available at: http://www.aemo.com.au/Electricity/Resources/Reports-and-Documents/~/media/Files/Other/electricityops/EAAP_Guidelines.ashx. Viewed on 29 November 2016.
[5] To calculate the USE percentage, AEMO assumes that total energy is equivalent to native consumption, defined in AEMO's 2015 *Forecasting Methodology Information Paper*, available at http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/National-Electricity-Forecasting-Report. Viewed on 29 November 2016.
[6] Available at : http://www.engie.com/en/journalists/press-releases/hazelwood-power-station-australia/. Viewed on 29 November 2016.
[7] Analysis of this period ensures the lowest rainfall for New South Wales is reflected in the low rainfall scenario. Viewed on 29 November 2016.

- Demand profiles consistent with the *2016 National Electricity Forecasting Report* (NEFR) energy and demand projections.[8]

The EAAP modelling process uses confidential information submitted by participants in the form of MTPASA available capacity offers and Generator Energy Limitation Framework (GELF) parameters. The GELF parameters are designed to take into account the following (as explained in the EAAP guidelines):

- Hydro storage including pump storage.
- Thermal generation fuel.
- Cooling water availability.
- Gas supply limitations.

This EAAP update takes into account information provided by participants, through GELF as at 5 August 2016. A further revision to GELF data was not deemed necessary as Engie's annoucement came within two months of the previous EAAP and was unrelated to energy constraints.

AEMO uses a market model to forecast the next two years at hourly resolution for the three rainfall scenarios. This involves using time-sequential Monte Carlo market dispatch simulations, accounting for uncertainties in generator availability and weather-sensitive demand. In total, 400 simulations are performed for each rainfall scenario using both 10% and 50% Probability of Exceedance (POE) demand forecasts. The model uses a probability-weighted USE assessment to identify any potential reliability standard breaches.

1.3 Changes in generation capacity

1.3.1 Availability changes from existing generation capacity

Table 1 lists future changes to existing generating units' availability that are included in the modelling.

Table 1 Changes in generating plants' availability

Station	State	Capacity (MW)	Changes in plant status
Tamar Valley CCGT	Tasmania	208	Expected to be available during summer 2016–17.
Hazelwood Power Station	Victoria	1,600	Expected to close end of March 2017.
Swanbank E	Queensland	385	Expected to return to service in summer 2018–19.

1.3.2 Committed scheduled and semi-scheduled generation capacity

Table 2 lists the committed scheduled and semi-scheduled generating units included in the modelling for this November 2016 EAAP. Proponents have advised that these units are expected to be operational within the next two years.

[8] AEMO. *National Electricity Forecasting Report*, June 2016. Available at: http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/National-Electricity-Forecasting-Report. Viewed on 29 November 2016.

Table 2 Committed scheduled and semi-scheduled generating units

Station	State	Capacity (MW)	Commercial operation date
Hornsdale Wind Farm Stage 1	South Australia	102.4	November 2016
Waterloo expansion	South Australia	19.8	November 2016
Hornsdale Wind Farm Stage 2	South Australia	102.4	June 2017
Ararat Wind Farm	Victoria	240.0	July 2017
Mt Gellibrand Wind Farm	Victoria	66.0	June 2018

1.4 Changes in network capability

1.4.1 Heywood Inteconnector limit

The Heywood Interconnector between South Australia and Victoria is currently being upgraded. The upgrade aims to increase capacity from a nominal 460 MW to 650 MW in both directions, but the realised capacity may be lower under certain operating conditions.

AEMO is currently assessing the implications of operating the interconnector beyond 600 MW (Victoria to South Australia direction). Until the analysis has concluded, the increase in this nominal capacity will be restricted to 600 MW.

This EAAP observes the following capacity increases for the Heywood interconnector:

- maximum flow of 500 MW from South Australia to Victoria
- maximum flow of 600 MW MW from Victoria to South Australia.

1.4.2 Victoria – New South Wales interconnector (Vic-NSW) limit

Improvements have been made to the constraint equation that limits the aggregate dispatch of Vic-NSW interconnector and Murray generation. This combined limit has been reduced to 1500 MW for the purposes of this EAAP to better reflect the maximum transfer capability permitted under typical pre-dispatch conditions.

1.5 EAAP results

Following withdrawal of Hazelwood Power Station, breaches of the NEM reliability standard are projected to arise in Victoria over summer 2017–18 in the absence of adequate market response. Short-term market responses could include:

- Increasing generation from existing generators in the NEM, primarily New South Wales black coal-fired and South Australia gas-fired generation, to decrease reliance on Victorian exports.
- Conservation of water storage this year for use when supply is tight next summer.
- Returning withdrawn generation plant to service in the NEM to increase generation availability.
- Demand-side participation (DSP), which can refer to a wide variety of short-term demand responses by customers to electricity price and/or network reliability signals.
- Committing already-proposed generation, network, or non-network projects in the NEM.
- Permanent demand reduction in response to anticipated increases in market prices. AEMO's current modelling assumes no demand response from major industrial, commercial, or residential loads.

Appendix A lists average monthly USE results for all regions under all three rainfall scenarios, considering only the first two market responses listed above.

Key points from the results are:

- The withdrawal of Hazelwood Power Station increases the risk of reliability standard breaches in both Victoria and South Australia in 2017-18, in the absence of any market response. USE may occur in Victoria and South Australia during summer periods under all three rainfall scenarios. In summer 2017-18, USE ranging between 990 MWh and 5735 MWh is projected in Victoria while in South Australia, USE ranging between 222 MWh and 1019 MWh is projected over the same summer period. This USE occurs typically at times of high coincident demand, with low wind conditions, or when imports are limited.
- Conserving water in storage this year, for example at the Murray hydroelectric plant, helps mitigate the risk of reliability standard breaches next summer, but this market response alone is not projected to be sufficient to avoid expected reliability standard breaches in the three rainfall scenarios.
- Unserved energy projected under short-term average rainfall conditions is primarily due to generation and transmission capacity limitations rather than energy constraints. Therefore, higher rainfall conditions do not reduce the risk of reliability breaches over summer 2017–18.
- While some USE may be experienced in New South Wales, Queensland and Tasmania under all rainfall scenarios, the projected levels are well below the reliability standard.

The following tables show the average yearly regional native energy consumption (in MWh) at risk. All regional native demand data is sourced from AEMO's 2016 NEFR.

Table 3 Forecast yearly USE in low rainfall scenario

Low rainfall scenario	October 2016 to September 2017 USE (MWh)	October 2016 to September 2017 USE (% of regional native consumption)	October 2017 to September 2018 USE (MWh)	October 2017 to September 2018 USE (% of regional native consumption)
New South Wales	9.33	0.00001%	0.40	-
Queensland	0.55	-	14.03	0.00003%
South Australia	5.66	0.00004%	1018.59	0.00810%
Tasmania	0.19	-	8.91	0.00008%
Victoria	7.54	0.00002%	5752.95	0.01285%

Table 4 Forecast yearly USE in short-term average rainfall scenario

Short-term average rainfall scenario	October 2016 to September 2017 USE (MWh)	October 2016 to September 2017 USE (% of regional native consumption)	October 2017 to September 2018 USE (MWh)	October 2017 to September 2018 USE (% of regional native consumption)
New South Wales	10.12	0.00001%	0.51	-
Queensland	0.41	-	14.01	0.00003%
South Australia	5.04	0.00004%	225.41	0.00179%
Tasmania	0.18	-	0.20	-
Victoria	7.16	0.00002%	1021.32	0.00228%

Table 5 Forecast yearly USE in long-term average rainfall scenario

Long-term average rainfall scenario	October 2016 to September 2017 USE (MWh)	October 2016 to September 2017 USE (% of regional native consumption)	October 2017 to September 2018 USE (MWh)	October 2017 to September 2018 USE (% of regional native consumption)
New South Wales	10.13	0.00001%	0.33	-
Queensland	0.43	-	13.96	0.00003%
South Australia	5.43	0.00004%	222.34	0.00177%
Tasmania	0.20	-	0.13	-
Victoria	7.08	0.00002%	989.59	0.00221%

1.6 Differences between MTPASA and EAAP

AEMO runs two processes to implement the reliability standard over a two year period:

1. EAAP, to forecast USE for *energy* constrained scenarios.
2. MTPASA, to forecast peak *capacity reserve* conditions over a two year projection.

These processes use similar inputs, but the methodologies are different, reflecting their different purposes and frequency of projections. Their similarities and differences are described in more detail in the *Reliability Standard Implementation Guidelines* (RSIG).[9]

The MTPASA is run at least weekly and, as part of a broader process, identifies potential capacity shortfalls known as Low Reserve Conditions (LRCs). An LRC is declared if capacity reserves are projected to be inadequate on any given day. Capacity reserves are the difference between the availability participants have offered and expected demand estimated by AEMO. To assess supply adequacy, these capacity reserves are compared against estimated Minimum Reserve Levels (MRLs). This provides a fast and timely assessment of supply adequacy without needing to compute USE explicitly using a large number of Monte Carlo simulations.

Applying MRL in the MTPASA assists to identify potential reserve shortfalls in the National Electricity Market (NEM). However, given the approximate nature of the MTPASA process, AEMO conducts probabilistic studies such as EAAP to confirm the LRC findings of MTPASA before intervening in response to projected shortfalls.

1.6.1 MTPASA projections for Victoria and South Australia

LRCs over summer 2016–17

Since Alinta Energy's October 2015 announcement about the withdrawal of the Northern and Playford B power stations, MTPASA has been projecting LRCs in South Australia over the summer of 2016–17.

The EAAP analysis indicates that these LRCs in South Australia are not expected to result in a breach of the reliability standard in the next year, although some supply shortfalls may be experienced in South Australia at times when high demand coincides with low wind generation, plant outages, or low levels of imports.

[9] Available at: http://www.aemo.com.au/Stakeholder-Consultation/Consultations/Reliability-Standard-Implementation-Guidelines. Viewed on 29 November 2016.

LRCs over summer 2017–18

Since Engie's announcement of closure of Hazelwood[10] Power Station from end of March 2017, MTPASA has been projecting LRCs in South Australia and Victoria over summer 2017–18. The EAAP analysis projects that these LRCs may result in a breach of the reliability standard for 2017–18, particularly in Victoria, in the absence of adequate market response.

1.7 Differences between EAAP and ESOO November 2016 update

Following the withdrawal of Hazelwood Power Station from end of March 2017, both EAAP and ESOO are projecting a reliability standard breach for Victoria over summer 2017−18. The ESOO is also projecting a breach in South Australia, whereas the EAAP is projecting USE levels just below the reliability standard in this region in all but the low rainfall scenario.

The extent of the breach reported for Victoria and South Australia over summer 2017−18 varies in case of EAAP and ESOO primarily due to input assumption and modelling differences, such as:

- EAAP assesses the impact of energy constraints on the level of expected USE for a range of rainfall scenarios using GELF information provided by participants. Hydro utilisation is optimised across the two year outlook period, with water being conserved in one year to use in another if desirable. ESOO assumes the same level of hydro utilisation in every year of the ten year outlook period and does not include GELF information. Nor does it include MTPASA information on generation availability.
- Differences in the modelling approach to pain sharing impacts how USE is apportioned across regions.
- EAAP does not capture as much variability between demand and intermittent generation as the ESOO. EAAP only uses one demand reference year to determine the load and intermittent generation profiles used in the Monte Carlo simulations (the 2009−10 year). In contrast, the ESOO samples multiple reference years in assessing the distribution of annual USE.
- EAAP allows better conservation of water for peak USE periods which helps alleviate the extent of USE, as compared to ESOO.
- EAAP models only Short Term Projected Assessment of System Adequacy (STPASA) constraints which are less restrictive than the equivalent Pre Dispatch formulations used by ESOO model. These Pre Dispatch constraints observe much tighter dynamic limits for the network on the whole, hence leading to higher USE figures reported in the ESOO.

Despite these differences, the key message remains the same - in the absence of any market response, both regions are at risk of breaching the reliability standard over summer 2017–18.

[10] Available at: http://www.engie.com/en/journalists/press-releases/hazelwood-power-station-australia/. Viewed on 29 November 2016.

APPENDIX A. DETAILED MONTHLY RESULTS

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

A.1 Low rainfall scenario

Table 6 Forecast USE in low rainfall scenario, MWh

Month	NSW	QLD	SA	TAS	VIC
October 2016	0.0	0.0	0.0	0.0	0.0
November 2016	7.8	0.3	3.9	0.0	0.3
December 2016	1.5	0.0	0.0	0.0	0.0
January 2017	0.0	0.0	0.0	0.0	0.1
February 2017	0.0	0.0	0.2	0.0	0.7
March 2017	0.0	0.0	0.0	0.0	0.0
April 2017	0.0	0.0	0.0	0.0	0.0
May 2017	0.0	0.0	1.6	0.2	6.4
June 2017	0.0	0.0	0.0	0.0	0.0
July 2017	0.0	0.0	0.0	0.0	0.0
August 2017	0.0	0.2	0.0	0.0	0.1
September 2017	0.0	0.0	0.0	0.0	0.0
October 2017	0.0	0.0	0.0	0.0	0.0
November 2017	0.0	0.1	35.5	0.0	216.6
December 2017	0.0	1.1	0.0	0.0	5.7
January 2018	0.0	0.0	112.2	0.0	1000.2
February 2018	0.4	0.0	816.1	0.2	3987.9
March 2018	0.0	0.0	5.3	0.0	44.3
April 2018	0.0	0.0	0.1	0.0	57.4
May 2018	0.0	1.7	49.3	8.7	440.9
June 2018	0.0	1.1	0.0	0.0	0.0
July 2018	0.0	10.0	0.0	0.0	0.0
August 2018	0.0	0.0	0.0	0.0	0.0
September 2018	0.0	0.0	0.0	0.0	0.0

A.2 Short-term average rainfall scenario

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

Month	NSW	QLD	SA	TAS	VIC
October 2016	0.0	0.0	0.0	0.0	0.0
November 2016	8.6	0.2	3.3	0.0	0.3
December 2016	1.6	0.0	0.0	0.0	0.0
January 2017	0.0	0.0	0.0	0.0	0.0
February 2017	0.0	0.0	0.1	0.0	0.5
March 2017	0.0	0.0	0.0	0.0	0.0
April 2017	0.0	0.0	0.0	0.0	0.0
May 2017	0.0	0.0	1.6	0.2	6.3
June 2017	0.0	0.0	0.0	0.0	0.0
July 2017	0.0	0.0	0.0	0.0	0.0
August 2017	0.0	0.2	0.0	0.0	0.1
September 2017	0.0	0.0	0.0	0.0	0.0
October 2017	0.0	0.0	0.0	0.0	0.0
November 2017	0.0	0.1	29.9	0.0	179.3
December 2017	0.0	1.1	0.0	0.0	4.2
January 2018	0.0	0.0	7.1	0.0	67.9
February 2018	0.3	0.0	185.9	0.1	753.5
March 2018	0.0	0.0	0.0	0.0	0.0
April 2018	0.0	0.0	0.0	0.0	1.6
May 2018	0.3	1.7	2.5	0.1	14.7
June 2018	0.0	1.1	0.0	0.0	0.0
July 2018	0.0	10.0	0.0	0.0	0.0
August 2018	0.0	0.0	0.0	0.0	0.0
September 2018	0.0	0.0	0.0	0.0	0.0

A.3 Long-term average rainfall scenario

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

Month	NSW	QLD	SA	TAS	VIC
October 2016	0.0	0.0	0.0	0.0	0.0
November 2016	8.5	0.2	3.8	0.0	0.3
December 2016	1.7	0.0	0.0	0.0	0.0
January 2017	0.0	0.0	0.0	0.0	0.0
February 2017	0.0	0.0	0.2	0.0	0.6
March 2017	0.0	0.0	0.0	0.0	0.0
April 2017	0.0	0.0	0.0	0.0	0.0
May 2017	0.0	0.0	1.5	0.2	6.2
June 2017	0.0	0.0	0.0	0.0	0.0
July 2017	0.0	0.0	0.0	0.0	0.0
August 2017	0.0	0.2	0.0	0.0	0.1
September 2017	0.0	0.0	0.0	0.0	0.0
October 2017	0.0	0.0	0.0	0.0	0.0
November 2017	0.0	0.1	29.0	0.0	168.7
December 2017	0.0	1.1	0.0	0.0	4.0
January 2018	0.0	0.0	7.2	0.0	66.9
February 2018	0.3	0.0	184.5	0.0	733.4
March 2018	0.0	0.0	0.0	0.0	0.0
April 2018	0.0	0.0	0.0	0.0	1.6
May 2018	0.0	1.7	1.6	0.1	14.9
June 2018	0.0	1.1	0.0	0.0	0.0
July 2018	0.0	9.9	0.0	0.0	0.0
August 2018	0.0	0.0	0.0	0.0	0.0
September 2018	0.0	0.0	0.0	0.0	0.0

APPENDIX B. MEASURES AND ABBREVIATIONS

Units of measure

Abbreviation	Unit of Measure
MW	Megawatts
MWh	Megawatt hours

Abbreviations

Abbreviation	Expanded Name
AEMO	Australian Energy Market Operator
CCGT	Combined Cycle Gas Turbine
EAAP	Energy Adequacy Assessment Projection
ESOO	Electricity Statement of Opportunities
GELF	Generator Energy Limitation Framework
LRC	Low Reserve Conditions
MRL	Minimum Reserve Levels
MT PASA	Medium Term Projected Assessment of System Adequacy
NEM	National Electricity Market
NEFR	National Electricity Forecasting Report
NER	National Electricity Rules
POE	Probability of Exceedance
RSIG	Reliability Standard Implementation Guidelines
USE	Unserved energy

Glossary

The EAAP uses many terms that have meanings defined in the National Electricity Rules (NER). The NER meanings are adopted unless otherwise specified.

Term	Definition
Heywood Interconnector	The Heywood Interconnector is a connection between the Victorian and South Australian power systems. It consists of two 275 kV AC electricity transmission lines, between Heywood Terminal Station in Victoria and South East Switching Station in South Australia.
Low Reserve Conditions (LRC)	When AEMO considers that a region's reserve margin (calculated under 10% Probability of Exceedance (POE) scheduled and semi-scheduled maximum demand conditions) for the period being assessed is below the reliability standard.
probability of exceedance (POE) maximum demand	The probability, as a percentage, that a maximum demand level will be met or exceeded (for example, due to weather conditions) in a particular period of time. For example, a 10% POE maximum demand for a given season means a 10% probability that the projected level will be met or exceeded – in other words, projected maximum demand levels are expected to be met or exceeded, on average, only one year in 10.
reliability standard	The standard specified in clause 3.9.3C of the National Electricity Rules.