Reliability Panel
AEMC

REVIEW

Reliability Panel AEMC

FINAL REPORT

Annual Market Performance Review

27 March 2013

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About the AEMC

The Council of Australian Governments (COAG), through its then Ministerial Council on Energy (MCE), established the Australian Energy Market Commission (AEMC) in July 2005. In June 2011, COAG established the Standing Council on Energy and Resources (SCER) to replace the MCE. The AEMC has two main functions. We make and amend the national electricity, gas and energy retail rules, and we conduct independent reviews of the energy markets for the SCER.

About the AEMC Reliability Panel

The Panel is a specialist body within the AEMC and comprises industry and consumer representatives. It is responsible for monitoring, reviewing and reporting on reliability, security and safety of the national electricity system and advising the AEMC in respect of such matters. The Panel's responsibilities are specified in section 38 of the National Electricity Law.

Foreword

I am pleased to present this final report setting out the findings of the Reliability Panel's annual review of market performance. The Panel carried out this review in accordance with the requirements of the National Electricity Rules where we have reviewed the performance of the national electricity market in terms of reliability, security and safety over the 2011-2012 financial year.

The last financial year involved some notable changes and unusual events. The National Electricity Market (NEM) regions experienced fewer extreme weather events than the previous year and the temperatures in summer and winter were milder than average across most of the NEM. Average demand declined and long-term demand projections were significantly revised down. Floods impacted power generation in New South Wales, and the Latrobe Valley experienced a 5.4 magnitude earthquake that had ramifications for the power system across Victoria, South Australia, New South Wales and Tasmania.

Our report provides the Panel's considerations and comments on specific events that occurred in the last year as well as assessment of the performance of the NEM against various reliability and security measures. To provide a comprehensive overview of reliability and security issues, our report also includes details that have been provided to us about the reliability performance of transmission and distribution networks.

To assist with readability and comprehension, our report also provides detailed background information explaining the concepts being considered and some key operational matters.

Our draft report was published in November 2013 and we invited comments on the content and the format of the report. We also held a public meeting for this review on 13 February 2013, which was attended by a number of stakeholders. We did not receive any written submissions on the draft report and no substantive issues were raised at the public meeting. However, the Panel will continue to consider ways of improving this report going forward.

The preparation of this report could not have been completed without the assistance of the Australian Energy Regulatory, the Australian Energy Market Operator, transmission and distribution network service providers, and the State regulatory agencies in providing relevant data and information. I acknowledge their efforts and thank them for their assistance.

Neville Henderson
Chairman, AEMC Reliability Panel
Commissioner, AEMC

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1 Introduction

This report has been prepared under the Reliability Panel's annual market performance review (AMPR). The review is a requirement of the National Electricity Rules (rules), where the Panel must carry out an annual review of the performance of the national electricity market (NEM) in terms of reliability and security of the power system.[1]

1.1 Purpose and scope

The purpose of this report is to set out the review's findings for the 2011-2012 financial year. In conducting this review the Panel considered publicly available information as well as information obtained directly from relevant stakeholders and market participants. The Panel's findings include observations and commentary on various aspects of the power system performance and this report also consolidates key market information relating to the reliability, security and safety of the NEM.

The scope of this review is to consider the reliability, security and safety of the NEM in terms of the performance against the standards and guidelines determined by the Panel under the rules. That is, the performance to be reviewed under the rules more directly relates to the bulk wholesale electricity systems rather than the local transmission or distribution networks.[2] However, where the information is available, the Panel has also included relevant performance results at the local level to provide a comprehensive overview of power system performance.[3]

Information on performance at a local level has been provided to the Panel by network service providers, jurisdictional bodies and the Australian Energy Regulator (AER). The information sets out the performance of the local networks in the context of impacts on consumers' experiences and is discussed in Section 3.3 and Appendix D. This consideration of consumer experiences in the 2012 AMPR is to address a recommendation of the AEMC review of the effectiveness of NEM security and reliability arrangements in light of extreme weather events, which was supported by the Ministerial Council on Energy's policy response to that review.[4]

1.2 Draft report and consultation process

As required by the rules, the Panel has been conducting this annual review since 2006.[5] The Panel would like to ensure that this report provides useful information and is continuously improved to meet the needs of stakeholders. The Panel published the

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1 Clause 8.8.3(b) of the rules.

2 These concepts are explored further in Chapter 2 of this report.

3 Details of network performance are set out in detail in Appendix D and, discussed throughout other relevant sections of this report.

4 Ministerial Council on Energy Policy Response to the AEMC Final Report for the Review of the Effectiveness of NEM Security and Reliability Arrangements in light of Extreme Weather Events, June 2012, available at: http://www.scer.gov.au/workstreams/energy-market-reform/extreme-weather-events/

5 Reports of prior annual reviews are available on the AEMC website http://www.aemc.gov.au/Market-Reviews/Completed.html.

draft report on 8 November 2012. The Panel invited comments on the content and format of the draft report. Submissions were due by 6 December 2012 and no submissions were received on the draft report.

In addition, the Panel held a public meeting on 13 February 2013 for this review. The public meeting was attended by stakeholder representatives from generators, transmission network service providers, retailers and industry consultants. No substantive issues were raised on the draft report at the meeting.

1.3 Structure of this report

The remainder of this report is set out as follows:

- **Chapter 2 - Key concepts and relevant standards and guidelines:** provides an explanation of the key concepts used throughout the report;
- **Chapter 3 - Year in review:** provides an overview of the power system performance in the 2011-2012 financial year against the key market performance indicators;
- **Chapter 4 - Power system incidents:** provides an analysis of the power system incidents that occurred in 2011-2012;
- **Chapter 5 - Reliability performance assessment:** builds upon relevant aspects of Chapter 2 and provides a more detailed analysis of the performance of the power system from a reliability perspective;
- **Chapter 6 - Security performance assessment:** builds upon relevant aspects of Chapter 2 and provides a more detailed analysis of the performance of the power system from a security perspective;
- **Chapter 7 - Safety performance assessment:** builds upon the relevant aspects of Chapter 2 and provides a more detailed analysis of the performance of the power system from a safety perspective; and
- **Appendices:** a number of appendices provide background information on various aspects of power system management and performance. A separate appendix (Appendix D) also provides details of the performance of the transmission and distribution networks provided by network service providers and jurisdictional bodies.

1.4 Obligations under the rules

This review is carried out under clause 8.8.3(b) of the rules. The specific requirement of the rules and the relevant sections of this report that address each requirement are outlined as follows:

- review of the market in terms of reliability of the power system (Chapter 3 and Chapter 5);
- review of the market in terms of the power system security and reliability standards (Chapter 5 and Chapter 6; specific issues are noted and discussed in Chapter 4);

- review of the guidelines governing the exercise of AEMO's power of directions (Chapter 6); and
- review of the guidelines governing reviewable operating incidents (Chapter 4).

The Panel notes that it is also required to review the 'system restart standard', however this has not been included in this report as the Panel's review of this standard has been carried out separately with the review being completed in April 2012. This is discussed in further detail in section 3.5 of this report.

The Panel is also required to review the policies and guidelines governing AEMO's power to enter into contracts for the provisions of reserves. The Panel notes that AEMO has not exercised this power, which is discussed briefly in Chapter 5 of this report.

2 Key concepts and relevant standards and guidelines

The focus of this review is on the reliability, security and safety performance of the NEM. These concepts are discussed below, with an explanation of the relevant standards and guidelines.

2.1 Reliability

Reliability is generally associated with ensuring there is enough capacity to generate and transport electricity to meet all consumer demand.[6]

Reliability is measured in terms of unserved energy (USE) which refers to an amount of energy that is required by customers (or demanded) but cannot be supplied.[7] From 1 July 2012, a new Reliability Standard applies that is expressed in terms of the maximum expected unserved energy (USE), or the maximum amount of electricity expected to be at risk of not being supplied to consumers, per financial year.

As this report considers the performance of the NEM from 1 July 2011 to 30 June 2012, the Panel's assessments are against the Reliability Standard that applied during that period. The Panel's Reliability Standard that was in place during the year under review (2011-2012) set the maximum permissible USE, or the maximum allowable level of electricity at risk of not being supplied to consumers, at 0.002 per cent of the annual energy consumption for the associated region or regions per financial year. It also involved measuring compliance with the Reliability Standard over the long-term, using a moving average of the actual observed levels of annual USE for the most recent ten financial years.

For the purpose of measuring reliability, "bulk transmission" capacity in effect equates to interconnector capability.[8] Consequently, only constraints in the transmission network that affect interconnector capability are considered when assessing the availability of reserves in a region.[9] The Reliability Standard does not take into account USE that is caused by outages of local transmission or distribution elements that do not significantly impact the ability to transfer power into the region where the USE occurred. Such events are outside the scope of the Panel’s responsibility, and failures of that type have not been catered for in setting the Reliability Standard. The performance of local transmission and distribution networks is monitored by the relevant jurisdiction. Summaries of the transmission and distribution network

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6 Reliability is an economic construct to the extent that it must be cost-effective for generators and networks to have enough capacity to meet demand at all times; whereas security is a technical concept as discussed in section 2.2.

7 'Unserved energy' is a defined term under the rules.

8 The reason for this is that the reliability standard is measured on a regional basis, and the standard is met when sufficient generation capacity is available in a region. This capacity is calculated as the sum of local generation available within the region itself and of interstate generation available via an interconnector.

9 In the Comprehensive Reliability Review, the Panel clarified the definition of 'bulk transmission'. See AEMC Reliability Panel, 2007, Comprehensive Reliability Review, Final Report, Sydney, pp.32-33.

reliability in the NEM have been provided to the Panel by the relevant network service provider or jurisdictional body and are included in Appendix D of this report.

The Reliability Standard also does not consider any USE that is the result of non-credible (or multiple) contingency events. Interruption of consumer load in these circumstances is a controlled response to prevent power system collapse, rather than the result of insufficient generation or bulk transmission capacity being made available. These non-credible contingency events are formally classified as power system security issues and are addressed separately in this report.[10]

2.2 Security

While reliability relates to ensuring sufficient capacity to meet demand, security of the power system refers to the technical requirement of ensuring that power system equipment is maintained within their operating limits. Security issues are managed directly by the Australian Energy Market Operator (AEMO) and network operators in accordance with applicable technical standards.[11]

Maintaining the security of the power system is one of AEMO's key objectives. The power system is deemed secure when all equipment is operating within safe loading levels and will not become unstable in the event of a single credible contingency. Secure operation depends on the combined effect of controllable plant, ancillary services, and the underlying technical characteristics of the power system plant and equipment.

AEMO determines the total technical requirements for all services needed to meet the different aspects of security from: the Panel's power system security and reliability standards; market rules obligations; knowledge of equipment performance; design characteristics; and modelling of the dynamic behaviour of the power system. This allows AEMO to determine the safe operating limits of the power system and associated ancillary service requirements.

Some of the requirements are inherent in the frequency sensitivity of demand and generator plant, for example, the inertia of generator rotors. Others rely on the correct operation of network protection and control schemes. The rest are procured as part of the scheduling process from commercial ancillary services, the mandatory capability of generators and, as a last resort, load shedding arrangements. If necessary, AEMO may direct participants to provide services.

There is some scope for scheduled sources to make good any deficiencies from inherent sources. It is not always feasible, however, to pre-test or measure every possible contribution without the test itself threatening security. Consequently, there is heavy reliance on measurements of system disturbance when they occur.

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10 Power system incidents are discussed in Chapter 4.

11 Technical standards are explained in section 2.4.

2.3 Safety under the NEL

While safety of the NEM and safety of equipment, power system personnel and the public is an important consideration under the National Electricity Law (NEL) in general terms, there is no national safety regulator for electricity. Jurisdictions have specific provisions that explicitly refer to safety duties of transmission and distribution systems.[12] The Panel has included an overview of some of the jurisdictional safety provisions in Chapter 7 of this report.

The Panel's safety considerations in the NEM are closely linked to the security of the power system and operating assets and equipment within their technical limits. For example, if a transmission line was overloaded, the lines could sag below minimum ground clearances. This would present a danger to people or vehicles near the transmission lines. Safety therefore can be managed by ensuring that the power system is operated within ratings and technical limits. The Panel notes that this is a narrow definition of safety. The Panel has deliberately limited the definition of safety for the purpose of this review given the scope of this work under the rules.[13]

Under this limited scope, maintaining security of the power system could be considered as maintaining a 'safe' power system to meet the requirements for safety in a general sense.[14]

2.4 Relevant standards and guidelines

In addition to the Reliability Standard discussed above, the performance of the power system is measured against various standards and guidelines which form the technical standards framework. The technical standards framework is designed to maintain the security and integrity of the power system by establishing clearly defined standards for the performance of the system overall. The technical standards framework comprises a hierarchy of standards:

- **System standards** define the performance of the power system and the quality of power supplied. The system standards include the frequency operating standards as discussed further in Appendix C. These standards are tightly linked with access standards.
- **Access standards** specify the quantified performance levels that plant (consumer, network or generator) must have in order to connect to the power system. Access standards define the range within which power operators may negotiate with network service providers, in consultation with AEMO, for access to the network. AEMO and the relevant network service providers need to be satisfied that any access granted to the power system will not negatively affect the ability of the network to meet the relevant system standards.

12 See section 2D(a) of the NEL.

13 The scope of this review is discussed in Chapter 1.

14 Although it is noted that some system security considerations do not relate to safety, for the purpose of our considerations, where the power system has been maintained in a secure state, it is considered that it is also 'safe'.

- **Plant standards** set out the technology specific standards that if met by particular facilities would ensure compliance with the access standards. Plant standards can be used for new or emerging technologies. The standard allows a class of plant to be connected to the network if that plant meets some specific standard such as an international standard. To date, the Panel has not been approached to consider a plant standard.

The performance of all generating plant must also be registered by AEMO as a performance standard. Registered performance standards represent binding obligations. To ensure a plant meets its registered performance standards on an ongoing basis, participants are also required to set up compliance monitoring programs. These programs must be lodged with AEMO. It is a breach of the rules if the plant does not continue to meet its registered performance standards and compliance program obligations.[15]

15 The Panel developed a template in 2009 to assist generators in designing their compliance programs and this template was reviewed by the Panel in 2011-2012, as discussed in section 3.5 of this report.

3 Year in review

This chapter provides an overview of a number of key market performance indicators for the 2011-2012 financial year. It also provides a summary of key learnings based on the Panel's consideration of relevant issues and events from 2011-2012.

3.1 Key lessons

From the Panel's review of power system performance of the NEM in 2011-2012, the Panel makes the following key observations:

- **Reliability** - there was no USE due to reliability events and the average USE for all regions continues to remain within the Reliability Standard. AEMO was not required to issue any directions for reliability and it was not required to exercise the Reliability and Emergency Reserve Trader mechanism.
- **Security** - the Panel notes there were 40 power system operating incidents that AEMO was required to report on in 2011-2012. Some of these incidents resulted in disruption to customer load, though generally the past financial year has been relatively uneventful compared to other years when more extreme weather events impacted security. There were also some incidents where the frequency was outside the frequency operating standards on the mainland and in Tasmania. One of the incidents resulted in under-frequency load shedding in Tasmania.
- **Safety** - the Panel is not aware of any incidents where AEMO has not achieved its obligations with respect to safety in the NEM.

Other considerations of the overall market outcomes are discussed in this chapter. Specific reliability, security and safety considerations are discussed in subsequent chapters.

3.2 Overall market conditions

As discussed in Chapter 2, reliability of the NEM considers whether there is sufficient capacity to meet demand. As an assessment of the overall market conditions, the Panel has considered the general trends in capacity and demand growth.

A total of 739 MW of new capacity (including new registrations and increases in capacity of existing plant) was commissioned in the NEM in 2011-2012.[16] Of this new capacity, 633 MW is located in Victoria, 60 MW in New South Wales and the remaining 53 MW in South Australia.

A total of 125 MW was retired in 2011-2012 with the retirement of the coal-fired Swanbank B Power Station Unit 3. Beyond the year under review, a further 600 MW was retired in July 2012 in New South Wales with the retirement of the coal-fired Munmorah Power Station. AEMO was also advised of changes to the expected availabilities of 845 MW of generation capacity to occur over the next two years (at

16 The new capacity includes scheduled/semi-scheduled and non-scheduled plant.

least) and an additional retirement of 34 MW is expected to take place in 2016. These changes have been incorporated into AEMO's supply-demand outlook for the next ten years.[17] Since the time of AEMO publishing its annual forecasts, additional expected changes to plant availabilities have been reported affecting over 1000 MW of additional capacity.[18]

As at March 2012, there were five committed generation projects in the NEM totalling 689 MW in capacity – this is mostly wind generation capacity.[19] Current investment interest is focussed on renewable and peaking generation, with publicly announced proposals involving over 13,000 MW of wind generation and over 11,000 MW of open-cycle gas turbine (OCGT) generation.[20]

Peak demand has grown steadily in most NEM regions since 2006-2007 but declined in 2011-2012.[21] For example, summer peak demand in New South Wales in 2011-2012 was around 2670 MW (18 per cent) lower than the previous year. Victoria's summer peak demand has been steadily decreasing since 2008-2009 and in 2011-2012 it declined to a level similar to 2006-2007.

The general trend in decreasing peak demand in 2011-2012 coincided with milder temperatures in most regions in the NEM in 2011-2012. Summer temperatures across Australia averaged 0.55 degrees Celsius below normal and 2011-2012 was the 11th coolest year in the 62 years on record.[22] Winter was also milder than normal, with day time and overnight temperatures above average across most of Australia. A more detailed 2011-2012 weather summary is provided in Appendix A.

Annual energy increased by an average of 3.4 per cent from 2000–2001 to 2005–2006, followed by moderate average growth of 1.7 per cent until 2008–2009, and decreasing by 1.7 per cent (on average) from 2009–2010 to 2011–2012.[23]

In 2012, average annual demand growth projections were revised to 1.7 per cent per annum, which is lower than the 2.3 per cent growth rate forecast in 2011.[24] AEMO revised its 10 year forecasts of electricity demand downwards, as expected growth in

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17 AEMO Electricity Statement of Opportunities, August 2012, p. 2-23

18 One unit at Yallourn Power Station in Victoria, further information available at: energyaustralia.com.au; and two units at Tarong Power Station in Queensland, further information available at: www.stanwell.com.

19 This information is collected annually by AEMO as part of its Electricity Statement of Opportunities. The 689 MW of new capacity consists of the 420 MW Macarthur Wind Farm in Victoria to be commissioned in 2013, the 168 MW Musselroe Wind Farm in Tasmania to be commissioned in 2013, the 21 MW Quenos Cogeneration Facility in Victoria to be commissioned in late 2012, the 20 MW Morton's Land Wind Farm in Victoria to be commissioned in late 2012 and the 60 MW upgrade to Eraring Power Station in New South Wales to be completed in late 2012. Further information: AEMO Electricity Statement of Opportunities, August 2012, p. 2-22.

20 AEMO Electricity Statement of Opportunities, August 2012, p. iv

21 A key exception is Tasmania where peak demand in summer and winter moderately increased in 2011-2012.

22 New South Wales had a particularly cool summer; its second coolest on record.

23 AEMO Electricity Statement of Opportunities, August 2012, p. 3-2.

24 Id, p. ii.

average and peak demand has not occurred as rapidly as previously predicted. The potential causes of this are numerous and include the effects of sectoral change, global economic trends and improved energy efficiency in the Australian economy. AEMO also stated that increased entry of small scale, residential level solar photovoltaic (PV) generation may also be contributing to these forecast decreases, as are other forms of direct commercial and residential consumer response to rising electricity costs.

AEMO has published detailed forecasts out to 2021-2022 which show peak demand continuing to grow at a faster rate than average demand in all states except for Queensland and New South Wales (NSW).[25]

This year marked the beginning of a new process for forecasting demand in the NEM, with AEMO conducting independent electricity forecasts for all five NEM regions and four sub-regions. The new forecasting system was introduced on 15 November 2011 and AEMO has advised that the system has delivered greater accuracy for NEM regional demand forecasts in the near-real time, compared to the previous manual forecasting process.

AEMO has also altered the way it reports information, with the details of annual demand forecasts now being provided in a new publication, the National Electricity Forecasting Report (NEFR). The existing AEMO publication, the Electricity Statement of Opportunities (ESOO), now incorporates high-level demand forecast summaries.[26]

3.3 Overall power system performance

Reliability of the energy market is measured by comparing the component of any energy not supplied to consumers as a result of insufficient generation or bulk transmission capability against the Reliability Standard. This excludes energy not supplied due to management of security and performance of local transmission or distribution networks, and therefore only part of the overall measure of continuity of supply to consumers. However, from a consumer point of view, reliability is also impacted by the performance of distribution and local transmission networks, where measures for reliability are different.

The Panel has considered the overall power system performance in terms of the impact on end-use consumers. Consumer impact has been measured in terms of the length of time of where energy has not been supplied to consumers – or the 'unsupplied system minutes'. Unsupplied system minutes could arise from interruptions in generation, transmission networks and distribution networks and, due to the different reliability standards that apply, unsupplied system minutes need to be interpreted differently for each of these sectors.

The remainder of this section below provides a summary and explanation of the performance of the generation, distribution and transmission sectors in each region. The data does not include each region's 'excluded events' or 'major event days'. These events are outlier events or events that are beyond the reasonable control of the

25 AEMO, National Electricity Forecasting Report, Australian Energy Market Operator, June 2012.

26 These publications are discussed in further detail in Appendix B of this report.

participant as determined by each jurisdiction. The participants are permitted by the jurisdictions to exclude these events from their performance assessments.[27]

3.3.1 Generation performance

The performance of generation as experienced by consumers in each region has been calculated with reference to the Reliability Standard. The reliability standard, as explained in detail in section 2.1, is 0.002 per cent of USE. To convert this standard to system minutes, the total amount of time in a year has been multiplied by 0.002 per cent. There were no USE for 2011-2012.

Table 3.1 Generation performance for 2011-2012[28]

Region (generation)	System minutes unsupplied	
	Standard (minutes)	**Actual**
QLD	**10.51**	0.00
NSW	**10.51**	0.00
VIC	**10.51**	0.00
SA	**10.51**	0.00
TAS	**10.51**	0.00

3.3.2 Transmission network performance

The performance of transmission networks, and the reliability standards that must be met, fall within the responsibility of the jurisdictions. System minutes unsupplied in the transmission network are calculated as the amount of energy (MWh) not supplied to consumers, divided by the maximum demand (MW), and then multiplied by 60 to convert to minutes. That is, system minutes unsupplied for the transmission network is a total of all the outages that have occurred in a year in each jurisdiction.

Table 3.2 shows the performance of the transmission network as experienced by consumers in each region. The information has been supplied by transmission network service providers.

27 For example, performance during extreme weather events may be excluded in some regions.

28 There are some exceptions to this time period as noted below.

Table 3.2 Transmission networks unsupplied system minutes for 2011-2012

Region (transmission)	System minutes unsupplied
QLD	**1.90**
NSW	**0.44**
VIC	0.00
SA	**2.8**
TAS	**8.72**

3.3.3 Distribution network performance

The performance of distribution networks, and the reliability standards that must be met, also fall within the responsibility of the jurisdictions. For distribution networks, reliability standards are measured in terms of system average interruption duration index (SAIDI) and the system average interruption frequency index (SAIFI).[29]

SAIDI measures the average duration of network outages. It is the sum of the duration of each sustained customer interruption, divided by the total number of customers. It is calculated for different categories such as CBD, urban, short rural and long rural. Unplanned SAIDI relates to unplanned outages. These outages may result from operational error and damage caused from extreme weather and trees.

The Panel has calculated an average SAIDI figure across different feeder and network businesses for each region. These averages are set out in Table 3.3 as the 'system minutes unsupplied'. The Panel understands different exclusion methodologies, variances in customer numbers by feeder, and different geographic conditions apply and that these averages are to represent a summary only.

29 Some jurisdictions also use additional indicators such as 'CAIDI' and 'MAIFI'. These terms are explained further in section D.2 of this report.

Table 3.3 Distribution network unsupplied system minutes for distribution for 2011-2012

Region (distribution)	System minutes unsupplied[30]
QLD	**241.42**[31]
NSW	**221.5**
ACT	**78.4**[32]
VIC	**100.69**[33]
SA	**158.9**[34]
TAS	**198**

3.4 Reliability and security

As discussed in Chapter 2, the reliability of the power system is measured in terms of the Reliability Standard. To consider the performance of the NEM in the 2011-2012 financial year against the Reliability Standard, the Panel has considered the USE experienced in each region. The Panel notes that the Reliability Standard has been met in 2011-2012 as the USE was below 0.002 per cent in each region for the financial year and also on average for the previous 10 years.

The table below shows the performance of the NEM against the Reliability Standard for the past ten years. The Panel notes that the Reliability Standard is a probabilistic measure. In applying a probabilistic measure, the benefits of an augmentation would be measured and investments would only proceed if the benefits outweighed the costs. That is, although the Reliability Standard has not been exceeded, the Panel notes that investments would not have been made unless they were expected to provide net benefits to customers.

30 Source: each region's state government, or jurisdictional regulator, unless otherwise stated.

31 This figure is calculated based on the unplanned SAIDI (less exclusions) provided by Ergon Energy and Energex.

32 This figure covers both planned and unplanned SAIDI.

33 This is for the 2011 calendar year. Victoria differs to other regions in that its data is collected by calendar year.

34 This figure includes severe weather events.

Table 3.4 Regional USE for the past 10 years

Year	Queensland	New South Wales	Victoria	South Australia	Tasmania[35]
2011-2012	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
2010-2011	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
2009-2010	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
2008-2009	0.0000%	0.0000%	**0.0040%**	**0.0032%**	0.0000%
2007-2008	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
2006-2007	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
2005-2006	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
2004-2005	0.0000%	**0.00005%**	0.0000%	0.0000%	0.0000%
2003-2004	0.0000%	0.0000%	0.0000%	0.0000%	
2002-2003	0.0000%	0.0000%	0.0000%	0.0000%	
Average	**0.0000%**	**0.0000%**	**0.0004%**	**0.0003%**	**0.0000%**

Specific power system incidents and detailed reliability and security performance assessments are discussed in the following chapters.

3.5 Related Reliability Panel and AEMC work

In 2011-2012, the Reliability Panel and the AEMC completed a number of projects that related to the management of power system performance. A summary of the projects that were completed in the 2011-2012 financial year is provided below. Additional information on these projects and the projects that were still underway as at 30 June 2012 is available on the AEMC website.[36]

Reliability Panel review - System restart standard (completed in April 2012)

Under the rules, the Panel is required to determine the system restart standard, which sets out the requirements that are to be met by AEMO in acquiring sufficient system restart ancillary services (SRAS) for the NEM. The rules also provide that AEMO was to determine an interim standard. The Panel notes that an interim standard has been in place since November 2006.

On 12 April 2012, the Panel made its final determination of the system restart standard that would apply for the acquisition of SRAS by AEMO. The final standard largely retains key aspects of the interim standard with some minor amendments. The minor

35 Tasmania joined the NEM in May 2005.

36 See: www.aemc.gov.au.

amendments were for clarification purposes and did not have any material impacts. The standard will apply from 1 August 2013.

The Panel notes that AEMO has commenced a review on the SRAS arrangements in the NEM, which is examining whether AEMO's method for assessing and procuring SRAS appropriately meets the requirements under the rules. Should AEMO identify any aspects of the system restart standard that it considers should be amended, it can raise this with the Panel. The Panel would then consider whether a review should be conducted to amend the standard. Any review of the standard would be carried out by the Panel in accordance with the provisions under the rules, which include the requirement to consult with stakeholders.

Reliability Panel review - Template for generator compliance programs (completed in June 2012)

The first template for generator compliance programs provides clarity to generators by defining an appropriate compliance framework to assist generators with developing compliance programs to meet their relevant technical requirements. The template also assists the AER with the enforcement and monitoring of generators' compliance with the technical requirements under the rules.

The template was established by the Panel in 2009 in accordance with the requirements under the rules. The rules also require that the template be reviewed at least once every three years to provide opportunities for its improvement and to ensure that it remains consistent with the rules. The Panel completed its review of the template for generator compliance programs in June 2012. The Panel has made some minor amendments as a result of this review to improve the template's ease of use, clarify the template's purpose and clarify specific provisions within the template.

Generators are required to modify their compliance programs to ensure they are consistent with amendments to the template by no later than six months after the amended template is published (by 27 December 2012). As the amendments are minor, the Panel considers the changes to the template will not have significant operational impacts on participants.

AEMC Rule determination - Reliability Settings from 1 July 2012 (Final determination in June 2011)[37]

This was a rule change request proposed by the Reliability Panel concerning the frequency of conducting reviews of the reliability settings and introducing a mechanism to index the market price cap (MPC) and cumulative price threshold (CPT) on an annual basis.

The AEMC made a more preferable rule, which commenced on 1 July 2012. The rule as made incorporates many of the features proposed in the rule change request, including the introduction of a mechanism to index the MPC and CPT. The MPC and CPT play an important role in balancing supply and demand to meet reliability (and other) requirements in the longer term. The MPC sets the upper limit to which generators can

37 The determination was made at the end of the 2010-2011 financial year, but has been included in this year's AMPR as it was not discussed in the 2011 AMPR.

price their supply into the market. The CPT is a pricing mechanism that is triggered once a particular threshold of protracted high prices is reached and acts to dampen them via the imposition of an administered price cap, thereby limiting the financial exposure of market participants.

The rule adopts the Consumer Price Index (CPI) to index the MPC and CPT and includes a requirement for a four-yearly comprehensive review of the Reliability Standard and Settings, including indexation, to be undertaken by the Reliability Panel. This will replace the previous requirement of a two-yearly review of the Reliability Standard and Settings. The rule change was made to maintain the real values of the MPC and CPT over time through indexation, and secondly, to implement changes to the regular review process.

The indexation was applied to the MPC and CPT in February 2012 and the MPC and CPT values apply from 1 July 2012.[38] The first four-yearly comprehensive review is to be completed by 30 April 2014.

AEMC Rule determination - Expiry of the Reliability and Emergency Reserve Trader (Final determination in March 2012)

The AEMC made a rule in March 2012 that will retain the Reliability and Emergency Reserve Trader (RERT) for four years until 30 June 2016. The RERT was due to expire on 30 June 2012. The new rule also removes the need for the Reliability Panel to review the RERT a year prior to its expiry.

The RERT is a safety net mechanism that allows the market operator to procure additional reserves to help achieve a reliable and secure supply of electricity to customers. It is only used in emergencies where ordinary market mechanisms are unlikely to deliver an adequate supply of electricity to meet customer demand.

AEMO's decision to use the RERT is informed by forecasts of reserve capacity and energy adequacy for each NEM region. If AEMO forecasts inadequate generation capacity to meet periods of high demand then it may choose to enter into a tendering process for reserves. If a load shedding event is likely, AEMO is then able to dispatch the additional reserves secured under the reserve contracts. To date, AEMO has entered into reserve contracts over the summer periods of 2005 and 2006. In both instances AEMO decided to not dispatch the additional reserves available under the reserve contracts.

The AEMC considered that deferring the RERT's expiry was a temporary measure primarily directed at accommodating a period of market uncertainty that may be a result of the transition to new policy settings. Market uncertainty is expected to have abated by 2016, and the AEMC considers that another review of the RERT prior to its expiry is unnecessary. Removing the requirement for the Panel to review the RERT should also give market participants greater certainty as to the status of the RERT.

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38 The indexation is applied by the AEMC and the methodology and indexed values are set out in a schedule on the AEMC website.

4 Power system incidents

This chapter discusses the power system incidents in 2011-2012 identified under the System Operating Incident Guidelines (and relevant frequency standards where applicable).[39] Where any incidents have impacted reliability and security, this has been noted.

4.1 System operating incident guidelines

As the market operator, AEMO is responsible for reviewing system operating incidents of significance that occur in the NEM power system. In accordance with requirements under the rules, the Panel established guidelines to set out when an operating incident should be reviewed. The power system operating incidents that should be reviewed by AEMO include the following:

- an incident defined as a multiple contingency event;
- a black system condition;
- an incident where the frequency is outside the operational frequency tolerance band (currently set by the Panel at 49 to 51 Hz on the mainland and 47.5 to 52 Hz in Tasmania);
- an incident where the power system is insecure for more than 30 minutes;
- an incident where there is load shedding due to a clause 4.8.9 instruction;[40] or
- other incidents determined by the Panel and described in the Panel's guidelines.

4.2 Contingency events

In the 2011-2012 financial year there were 40 contingency events that were reviewable under the operating incident guidelines. AEMO has published a report for each event. Of the 40 contingency events, AEMO classified 27 of these as multiple contingency events. The Panel notes that the numbers of events were marginally higher than the previous financial year which experienced 36 reviewable contingency events (with 20 of these being classified as multiple contingencies). The categorisation and number of contingency events are set out in Table 4.1.

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39 The guidelines for identifying reviewable operating incidents can be found on the AEMC Reliability Panel website http://www.aemc.gov.au/Panels-and-Committees/Reliability-Panel/Guidelines-and-standards.html.

40 Clause 4.8.9 of the Rules sets out AEMO's powers to issue directions to Registered Participants.

Table 4.1 Reviewable operating incidents 2010-2011

Event description	Number of incidents
Transmission related incidents (excluding busbar trips)[41]	11
Generation related incidents	1
Combined transmission/generation incidents	7
Busbar related reviewable incidents	13
Power system security related	8

Source: AEMO

Some of the events resulted in customer load interruptions in order to maintain power system security. There were no load interruptions due to power system reliability issues.

Part of AEMO's review process involves considering whether further actions should be recommended for relevant participants to undertake. These recommendations can help to directly or indirectly reduce the likelihood of incident recurrence. Examples include recommending that a TNSP investigate and conduct site testing to resolve inappropriate functioning of equipment, recommending a generator modify a protection scheme, or recommending AEMO provide further simulation training to control room operators to improve awareness and responses to future situations.

As a result of AEMO's review of incidents that occurred in 2011-2012, 52 actions were recommended for completion within a specific time frame. As at January 2013, 41 recommended actions had been completed, 4 was overdue for completion, and 7 to be completed.[42] The Panel considers this process is being effectively managed and is supportive of AEMO's recent introduction of quarterly reporting on the progress of recommended actions. The Panel expects this formal tracking process will support timely implementation of recommendations and accountability for actions to reduce incident recurrence.

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41 A busbar is an electrical conductor in the transmission system that is maintained at a specific voltage. It is capable of carrying a high current and is normally used to make a common connection between several circuits within the transmission system. The Rules define busbar as 'a common connection point in a power station switchyard or a transmission network substation'.

42 Recommendations arising from power system operating incident reports - progress of implementation by September 2012, 9 October 2012, available at: http://www.aemo.com.au/Electricity/Resources/Reports-and-Documents/Progress-on-Operating-Incident-Recommendations/Recommendations-arising-from-PSOI-Reports_Progress-of-Implementation-by-Sep-2012; and
Recommendations arising from power system operating incident reports – period November 2012 - January 2013, 12 February 2013, available at: http://www.aemo.com.au/Electricity/Resources/Reports-and-Documents/Progress-on-Operating-Incident-Recommendations/Recommendations-arising-from-PSOI-Report-Status-Jan2013.

4.3 Major incidents

Based on the Panel's review of the power system incident reports published by AEMO, the Panel has considered the following more significant events in detail. The Panel has considered these incidents as being more significant as they:

- resulted in material levels of load shedding and therefore would have more directly impacted consumers' experiences; and/or
- involved multiple generation/network elements and therefore may indicate issues requiring more serious attention.

Relevant details from AEMO's operating incident reports are summarised and discussed as follows. AEMO's full reports for each of the 40 operating incidents in 2011-2012 can be accessed from AEMO's website.[43]

4.3.1 Trip of Chalumbin-Woree 275 kV line and loss of load (1 December 2011)

Type of event

This event was a non-credible transmission (transmission lines) multiple contingency that occurred in December 2011 in Queensland where the trip of a 275 kV line resulted in the loss of 132 kV supply to the Woree, Cairns, Kamerunga and Barron Gorge substations. This led to a loss of 188 MW of customer load in the Cairns area.

Summary of event details

The incident was caused by the unexpected operation of protection systems on one of the 275 kV Chalumbin-Woree transmission lines. An investigation of the incident revealed that the protection system operated due to faulty components of the line protection relay. The trip of this line was concurrent with the planned outage of the parallel 275 kV line. This caused a loss of the 132 kV network to Tully and Innisfail, resulting in the loss of supply to far north Queensland. Barron Gorge Power Station was also disconnected from the power system but both generating units were out of service at the time.

The Panel's comments and observations

The Panel notes AEMO's advice that Powerlink has carried out the appropriate work to mitigate the risk of a similar incident occurring in the future by replacing the faulty components in the protection relay. The power system remained in a secure operating state throughout the incident. While the incident does not appear to reflect broader power system security issues, the Panel has included the incident as an example of the material customer impacts that can arise from equipment faults.

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43 Available at: http://www.aemo.com.au/Electricity/Resources/Reports-and-Documents/Power-System-Operating-Incident-Reports.

4.3.2 Potential insecure power system operation in Tasmania due to NCSPS operation (18 April 2012)

Type of event

This event was a non-credible transmission (transmission lines) multiple contingency that occurred in April 2012 in Tasmania where 227 MW of generation was interrupted. A decision was made to disable the Tasmanian Network Control System Protection Scheme (NCSPS) on an ongoing basis, following the incident investigation.

Summary of event details

An unplanned opening of a circuit breaker at the Sheffield substation occurred while work was being undertaken to remove redundant cables. This resulted in the trip of a 220 kV transmission line and the subsequent operation of the NCSPS to trip two generating units. After the generating units were tripped, the Tasmanian frequency fell to a minimum of 49.24 Hz. In response to the fall in Tasmanian frequency, Basslink rapidly reduced transfer from Tasmania to Victoria from an initial transfer of 360 MW to a minimum of 85 MW, before stabilising again at 170 MW.

The operation of the NCSPS was unexpected and resulted in generation interruption of 226 MW. While the NCSPS acted in accordance with its design, it was not necessary for the NCSPS to trip generation to manage transmission line loadings on this occasion.

Investigations by Transend determined that the generation trip occurred due to issues with the synchronisation and latency of measurements of line current and circuit breaker status used by the NCSPS. These issues ultimately related to the performance of Transend's SCADA system. Similar issues were subsequently detected at other switchyards in Tasmania. On 1 May 2012, Transend disabled the NCSPS to ensure the ongoing security of the Tasmanian power system, and the scheme remains disabled.

The Panel's comments and observations

The Panel notes that subsequent investigation of this incident by Transend determined that the Tasmanian power system may have been operated insecurely on a number of previous occasions due to the potential action of the NCSPS tripping more generation than could be compensated for by either Basslink or generation within Tasmania.

During this incident, all power system voltages remained within the normal operating bands and the Tasmanian frequency remained within the band required for a load or generation event.

The Panel considers that, while market impacts can be considered outside of the scope of the Panel's report, it is worth noting that this incident led to very high Tasmanian energy prices of $12 500, $5 735.28 and $11 243.89 per MWh for three dispatch intervals. A high Tasmanian fast raise frequency control ancillary services (FCAS) price of $1 358.40 per MWh also occurred for one interval.[44]

44 A separate pricing report was published by AEMO covering this outcome: http://www.aemo.com.au/en/Electricity/Market-and-Power-Systems/NEM-Reports/Pricing-Event-Reports-April-2012.

AEMO has recommended Transend modify the implementation or design of the NCSPS to ensure security of the Tasmanian power system. Transend is to advise AEMO of any changes made to the implementation or design of the NCSPS prior to it returning to service, to allow AEMO to confirm the security of the Tasmanian power system.

An additional recommendation of the review was for AEMO to investigate whether a constraint equation could be improved to provide a more accurate indication of the requirement in the pre-dispatch time frame. The Panel understands AEMO has completed its investigation, and it considered the pre-dispatch performance was adequate. Therefore the Panel understands that no changes to constraint equations will be made.[45]

4.3.3 Trip of Sydney West 132 kV B busbar (28 March 2012)

Type of event

This event was a non-credible transmission (busbar) contingency that occurred in March 2012 in New South Wales where between 150 and 170 MW of customer load was interrupted.

Summary of event details

The incident resulted from the failure of a busbar circuit breaker in Sydney West, causing the busbar to trip. The busbar trip resulted in the disconnection of four transformers and seven 132 kV lines.

At the time of the incident, part of the Sydney West busbar was out of service for planned maintenance and the Mt Druitt and Mamre 132 kV substations were being radially supplied. As a consequence, the busbar trip led to the interruption of 80-90 MW of customer load supplied by those substations and a further 70-80 MW reduction in load was observed. The latter was believed to be caused by the operation of the customers' internal protection systems.

The Panel's comments and observations

The Panel notes that the power system remained in a secure operating state throughout the incident. This incident has been included in this report due to the impact on customer load and the potential that other circuit breakers may have similar vulnerabilities.

TransGrid's investigation of the incident indicated that the circuit breaker failure was due to insufficient mechanical damping of the circuit breaker operating mechanism.[46] TransGrid has identified and assessed the population of circuit breakers of the same

45 http://www.aemo.com.au/Electricity/Resources/Reports-and-Documents/Progress-on-Operating-Incident-Recommendations/Recommendations-arising-from-PSOI-report-status-Oct2012.

46 AEMO, Power system operating incident report – trip of Sydney west 132 kV B busbar on 28 March 2012.

type and has reported to AEMO that it is in the progress of developing a longer term strategy for managing the circuit breaker population.[47]

4.3.4 Multiple contingency event in North West Tasmania (6 April 2012)

Type of event

This event was a non-credible transmission (transmission lines) multiple contingency that occurred in April 2012 in Tasmania where 65 MW of customer load and 86 MW of generation were interrupted.

Summary of event details

A fault on the high voltage North West Tasmanian power system caused eleven transmission lines to trip (ranging between 110 kV and 220 kV in nominal voltage) and resulted in the North West Tasmanian power system disconnecting from the rest of the Tasmanian power system. Woolnorth wind farm tripped, interrupting 86 MW of generation and leading to a black out of the affected part of the power system. Approximately 65 MW of customer load was interrupted.

Site inspections by Transend found evidence of a lightning strike on one of the transmission towers between Sheffield and Burnie. Transend investigations also revealed some issues with the operation of protections that may be due to the high tower footing resistance.

The Panel's comments and observations

The Panel notes that the power system remained in a secure operating state throughout the incident.

The Panel notes that Transend is investigating the operation of its protection systems during this incident and will provide a report to AEMO. Transend has replaced distance protection schemes along the corridor with differential protection schemes to avoid these issues in future.

4.3.5 Multiple contingency event following an earthquake in Victoria (19 June 2012)

Type of event

An earthquake of magnitude 5.4 occurred in the Latrobe Valley region of Victoria in June 2012, resulting in approximately 2000 MW of generation interruption and 400 MW of load shed. Of this, 200 MW was under-frequency load shed in Tasmania and 2 MW in Queensland. An internal emergency SMS was issued via the AEMO Emergency Communication System warning of a Power System Emergency Condition.

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47 http://www.aemo.com.au/Electricity/Resources/Reports-and-Documents/Progress-on-Operatin g-Incident-Recommendations/Recommendations-arising-from-PSOI-report-status-Oct2012.

Summary of event details

The earthquake occurred at 20:53 lasting 40 seconds and at 20:54 there were simultaneous trips of two transformers in Victoria, three generating units at Loy Yang in Victoria (1710 MW), one unit at Yallourn in Victoria (200 MW), one unit at Torrens Island in South Australia (45 MW) and four loads due to under-frequency load shedding. Fourteen minutes later, a 220 kV line tripped in Victoria between Yallourn and Rowville.

At the time of the incident, Victoria was directing approximately 500 MW to New South Wales across the interconnector and the flow was reversed to approximately 500 MW following the incident. Tasmania was directing 120 MW to Victoria and this increased to 580 MW in response to the event. Only a small change in flow occurred on the Victoria-South Australia interconnector.

The Panel's comments and observations

Victoria has experienced 63 earthquakes since the beginning of 2008, most below a magnitude of 4 (generally between 1 and 2) with the exception of two earthquakes in Korumburra in 2009 with magnitudes of 4.6. The last earthquake of a magnitude of 5 or above in Victoria was on 29 August 2000 in Boolarra.[48] It is rare for an earthquake of this magnitude to occur in an urbanised/industrialised area of Australia where there are potential power system security implications. Notwithstanding this, the Panel considers it important that AEMO and market participants are able to respond quickly and effectively to protect the power system in the case of emergencies, regardless of their cause.

The power system was restored to a secure operating state 58 minutes after the earthquake had occurred. Given the complexity of this event, the Panel notes that AEMO and the network service providers responded well, and efficiently restored the system to a secure operating state within this timeframe.

The Panel notes that the frequency operating standard for the Tasmania region was met. The frequency operating standard for the mainland regions of the NEM was largely met except for a delay of 26 seconds in returning to the stabilisation band.

Further, the Panel notes that AEMO has reviewed the performance of FCAS during the incident and it determined that the power system responded adequately to the multiple contingency event, and that actions undertaken during the event were appropriate.[49]

48 Geoscience Australia, earthquake activity database, available at: http://www.ga.gov.au/earthquakes/searchQuake.do.

49 AEMO, Multiple contingency event following an earthquake in Victoria on 19 June 2012-FCAS review, 15 January 2013.

5 Reliability performance assessment

This chapter sets out the Panel's assessment and discussion of the power system reliability performance and the mechanisms to measure reliability performance. Additional background information is set out in Appendix B.

5.1 Minimum reserve levels

AEMO calculates minimum reserve levels (MRLs) to meet the Reliability Standard operationally, where AEMO's objective is to maintain reserve levels above the MRLs. These calculations take into account plant performance characteristics such as forced outage rates, the characteristics of demand including weather, market price sensitivity and the capability of the network.

Table 5.1 Revised minimum reserve levels[50]

	Queensland*	New South Wales	Victoria & South Australia	Victoria	South Australia*	Tasmania
2005-2006	610 MW	-290 MW	530 MW		265 MW	144 MW
2006-2007	480 MW	-1 490 MW	615 MW		-50 MW	144 MW
2007-2008	560 MW	-1 430 MW	615 MW		-50 MW	144 MW
2008-2009	560 MW	-1 430 MW	615 MW		-50 MW	144 MW
2009-2010	560 MW	-1 430 MW	615 MW		-50 MW	144 MW
2010-2011	829 MW	-1 548 MW		653 MW[51]	-131 MW	144 MW
2011-2012	913 MW	-1 564 MW		297 MW	-168 MW	144 MW
2012-2013	913 MW	- 1564 MW		297 MW	-168 MW	144 MW

* This is a local requirement and must be met by generation within the region assuming 0 MW supporting flow from neighbouring regions.

Reserve levels are forecast and monitored by AEMO through a number of tools discussed in the following section. These tools allow AEMO and the market to understand any potential for reserve levels being below the MRL threshold and allow the management of reliability in the NEM.

50 AEMO calculates the minimum reserve levels, which includes the use of a reserve sharing analysis that identifies the reserve requirement relationships between neighbouring regions. This could result in negative minimum reserve levels for some regions as shown in Table 5.1. Details of AEMO's calculation processes are outlined in AEMO's ESOO.

51 For Victoria only. In previous years, a single point was used on the reserve sharing curve to determine reserve sharing for Victoria and South Australia. This process is described in the 2010 ESOO, Chapter 6, Section 6.3.1.

5.2 Reserve projections and demand forecasts

Market information on reserve projections and demand forecasts are published by AEMO in various forms. In this section, the Panel considers these forecasts for the 2011-2012 financial year. Background information providing detailed explanations of each type of market information is outlined in Appendix B section B.4.

The Panel notes that there are often difficulties and complications associated with demand forecasting. This AMPR is based on statistics collected by the AER and based on these results the Panel considers there have been improvements in forecasting over time. The Panel also notes AEMO's continued commitment to improve its forecasting methods.

5.2.1 Electricity Statement of Opportunities

AEMO publishes the Electricity Statement of Opportunities (ESOO) on an annual basis in August. The 2012 ESOO differs from historic versions, with AEMO changing the way it presents energy market information across its publication types. This includes publishing some of the historic ESOO content in separate reports, which has resulted in an abridged ESOO that focusses primarily on providing concise and accessible information about the NEM’s investment environment.[52]

As noted in section 3.2, AEMO's 2011 ESOO forecasts were considerably revised in 2012. Under the revised forecasts, capacity reserves are projected to be at a sufficient level until the low reserve conditions (LRC) point is reached in 2018-2019 for Victoria, 2019-2020 for South Australia, 2020-2021 for Queensland and beyond 2021-2022 in New South Wales and Tasmania. This represents a deferral of the LRC point of four, five and seven years for Victoria, South Australia and Queensland respectively.[53]

The 2012 ESOO provides an analysis of electricity supply and demand over a 10 year outlook period. It also includes historical information about the changing electricity generation mix and trends in electricity demand, which is combined with information from energy market participants and AEMO’s latest electricity demand forecasting, to assess supply adequacy for the next 10 years.

While summarising the investment environment for each NEM region, including the supply-demand outlook and current generation investment interest, the ESOO also highlights NEM-wide generation and demand-side investment opportunities by analysing the key factors influencing this type of investment in 2012.

Under clause 3.13.3(u) of the Rules, AEMO is required to provide to the Panel a report on the accuracy of the demand forecasts in the ESOO by 1 November each year. Details of AEMO's assessment are outlined in this report, which is published on the AEMC Reliability Panel website. AEMO continuously reviews and updates its methodologies.

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52 A list of the changes to the format of the ESOO is provided on page 1-1 in the 2012 ESOO, available at: http://www.aemo.com.au/Electricity/Planning/Reports/Electricity-Statement-of-Opportunities.

53 Ibid.

In February 2013, AEMO published 2012 ESOO Update due to recent changes in the electricity generation fleet such as deregistrations, revised availability, or reclassification.

Since publication of the 2012 ESOO, two power stations have reduced their availability in the short term.[54] The Panel notes that the 2012 ESOO Update has determined that the changes in the generation fleet have had minimal impact on the Low Reserve Condition (LRC) outlook provided in the 2012 ESOO.[55]

5.2.2 National Electricity Forecasting Report

As noted in the section above, this year AEMO changed the way it presents information to stakeholders. In addition to changing the structure of its reporting, AEMO has also changed the way that demand is forecast in the NEM. In 2012, AEMO published its first edition of the NEFR, which represents the first time AEMO has developed independent electricity demand forecasts on a consistent basis for the five NEM regions.

The findings of the 2012 NEFR include:

- Forecast annual energy for 2012-2013 is projected to remain flat (zero growth), which represents an 8.8 per cent reduction from the 2011 ESOO forecast.
- Average growth in annual energy for the 10-year period is now forecast to be 1.7 per cent, down from the 2.3 per cent forecast in the 2011 ESOO.
- Maximum demand forecasts across the five regions are much lower than in previous years, but are expected to continue to grow into the future.
- Annual peak demand for the ten year period is projected to grow by an average of 2.5 per cent in Queensland, 1.6 per cent in Victoria, 1.2 per cent in New South Wales, 1.1 per cent in Tasmania and 1 per cent in South Australia.

The Panel notes that these forecasts signal an expected delay for new generation and network investment and the possibility that the operational behaviour of some existing generation capacity in the NEM may change if lower demand levels persist.

The Panel notes that in its 2012 ESOO Update, AEMO was not aware of any notable changes in the demand components that would impact the maximum demand projections reported in the 2012 NEFR.

5.2.3 Power System Adequacy - two year outlook

On an annual basis for the last two years, AEMO has published the Power System Adequacy (PSA) in the lead up to summer. The PSA is a two year outlook to assess the electricity supply over the next two years, complementing the 10 year outlook provided by the ESOO.[56]

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54 Tarong Power Station reduced from 1400 MW to 700 MW until after summer 2014-15; Wallerawang Power Station reduced from 1000 MW to 500 MW until winter 2014.

55 AEMO, 2012 ESOO Update, p. 1.

56 Producing and publishing the PSA is not a rules requirement.

The 2012 PSA established the following key points:[57]

- The reserve capacity and energy adequacy assessment indicates that the power system will have sufficient supply capacity to meet the Reliability Panel's reserve requirements, and (as at the time of publication) AEMO is not expecting to invoke the RERT tender process to maintain supply reliability in the NEM.
- The operational capacity assessment indicates that significant new operational issues are unlikely.
- An area of possible concern involves the adequacy of frequency control during periods of high wind generation and the electrical separation of parts of the transmission network. AEMO is currently working to address this issue, which involves the design of over-frequency generator trip schemes and assessing options to ensure frequencies in the affected regions remain within the operating standards.

5.2.4 National Transmission Network Development Plan

Under its role as the National Transmission Planner, AEMO publishes the National Transmission Network Development Plan (NTNDP) on an annual basis. The NTNDP outlines the long-term efficient development of the power system including future and current capability of the national transmission network and development options.

AEMO commenced consultation on the 2012 NTNDP in January 2012 in order to determine how AEMO's planning documents can usefully address issues that are emerging in the energy market.

The 2012 NTNDP was published in December 2012. The report found that overall, there have been changes in the energy environment including lower electricity demand and energy forecasts, and higher projected gas costs. The report shows less transmission investment is required compared to previous estimates, and there is clear opportunity to achieve integration and efficiency from this investment.

Due to the lower forecast demand growth, the previous estimate of $7 billion in the main transmission networks over 20 years has been revised to $4 billion in the 2012 NTNDP. For the same reason, estimated required generation investment of $65 billion over the next 20 years has been revised to $26 billion.[58]

In relation to transmission investment, other key findings from the 2012 NTNDP were:[59]

- Investment will be needed to replace old assets and augment transmission networks.

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57 AEMO Power System Adequacy, August 2012, available at: http://www.aemo.com.au/Electricity/Resources/Reports-and-Documents/Power-System-Adequacy.

58 AEMO, 2012 NTNDP, pp. iii, V.

59 Id, p. iii.

- There is generally sufficient capability in the main transmission network for new generation to connect at locations which allow for growth avoiding the need for significant new transmission investment.

The 2012 NTNDP also incorporates a suite of documents including a 2012 Network Support and Control Ancillary Service (NSCAS) assessment report. This report shows that the only gap for maintaining security is identified in New South Wales, requiring up to 800 MVAr for absorbing reactive power for the next five years.

The Panel notes that the NTNDP takes a least-cost approach to the development of the power system and reflects AEMO's best estimate of economic and policy outlooks.

The efficient integration of different energy sources and technologies will becoming increasingly important in the energy markets. The Panel understands that AEMO will continue to explore alternative scenarios and opportunities to support further market integration.

The Panel also notes that the AEMC completed in December 2012 its latest investigation into whether to exercise the last resort planning power (LRPP). The AEMC determined that all inter-regional flow paths were being adequately addressed and, as a result, it would not issue a direction to a Registered Participant under the LRPP in 2012.[60]

5.2.5 Energy Adequacy Assessment Projection

As required by the rules from March 2010, AEMO has published the Energy Adequacy Assessment Projection (EAAP) each quarter. The EAAP provides information of the impact of energy constraints on energy availability over a 24 month period under a range of scenarios. The energy constraints are based on information provided by scheduled generators including information on planned outages, power transfer capability of the NEM and demand forecasts that are provided by jurisdictional planning bodies for the purposes of the ESOO.

The EAAP reports provide USE projections for each region under three scenarios - low rainfall, short term average rainfall and long term average rainfall. In addition to annual projections, USE projections for each region are also provided for each month in the forecast period.

EAAP consists of two reports, EAAP public report and private EAAP reports for each Generator who owns scheduled generating units or hydro power schemes. The most recent publicly available EAAP determined that the forecast unserved energy is below the Reliability Panel Standard of 0.002 per cent for all regions for both years in the three scenarios covered in the September EAAP. This indicates that the availability of energy

60 Under the Rules the AEMC has the LRPP, which is an oversight power that allows the AEMC to direct any registered participant in the NEM to apply the regulatory investment test for transmission (RIT-T) which the AEMC considers is likely to address any inter-regional transmission investment shortfall (clause 5.6.4 of the Rules). (AEMC, 2012, Last Resort Planning Power: 2012 review, 11 December 2012, Sydney, pp. i, 9).

in these NEM regions meets the reliability standard for supply adequacy over the coming 24 month period.[61]

The Panel has conducted a review of the EAAP in accordance with the requirements under the rules, which assessed a range of costs and benefits associated with the current arrangements. The AEMC provided the Panel with terms of reference in July 2012 for the Panel to consider whether the EAAP meets its purpose under the rules, whether it could potentially have other purposes, and whether the principles in the rules remain relevant and applicable.

The review was completed on 21 February 2013. The Panel considered that the EAAP provided benefits to the market and to stakeholders while imposing minimal ongoing costs. The Panel found the existing EAAP arrangements under the rules were operating well and, as such, no changes to the EAAP arrangements were recommended.[62]

5.2.6 Medium-term Projected Assessment of System Adequacy

As required under the Rules, AEMO publishes the medium-term projected assessment of system adequacy (MT PASA) reports, which sets out the aggregate supply and demand balance at the time of anticipated daily peak demand for each day over the next two years (based on a 10 per cent probability of exceedance).

Table 5.2 summarises the percentage of days when actual demand was greater than MT PASA forecast demand, as well as the average amount by which actual demand exceeded forecast demand for those days. The table shows that Victoria was the only region where demand on weekdays was greater than the 10 per cent POE forecast. However, for weekend days, three regions experienced demand greater than the 10 per cent POE forecast - Victoria, South Australia and Tasmania.

For example, in Victoria, the actual demand was greater than the 10 per cent POE forecast for 0.4 per cent of weekdays (around 10 weekdays in total that year) and for 2.9 per cent of weekend days (around 3 weekend days that year); and on average across the year, the actual weekday demand values for Victoria differed from the forecast value by 0.3 per cent.

The Panel notes that overall, the accuracy of the medium-term PASA forecasts across the NEM improved on average from the previous year, with the average proportion of weekdays where the demand was greater than the 10 per cent POE forecast decreased from 1.8 per cent in 2010-2011 to 0.08 per cent in 2011-2012.

61 AEMO EAAP Report Update, September 2012: http://www.aemo.com.au/Electricity/Resources/Reports-and-Documents/EAAP.

62 The Panel did make a recommendation that a cross-reference in the rules be updated. The Panel recommended that this change be progressed by the AEMC as a 'minor' rule change.

Table 5.2 Medium-term PASA demand forecasts comparison 2011-2012

	QLD	NSW	VIC	SA	TAS
Proportion of weekdays where demand greater than 10 per cent POE forecast	0.0%	0.0%	0.4%	0.0%	0.0%
Proportion of weekend days where demand greater than 10 per cent POE forecast	0%	0%	2.9%	2.9%	4.8%
Average demand deviation from forecast for weekdays	0%	0%	0.3%	0%	0%
Average demand deviation for weekend days	0%	0%	0.5%	9.7%	2.6%

Source: AER

5.2.7 Short-term Projected Assessment of System Adequacy

In addition to MT PASA reports, AEMO also publishes short-term projected assessment of system adequacy (ST PASA) reports. As opposed to MT PASA, which makes projections over a two year period, ST PASA makes projections over the following seven day period on a half-hourly basis.

Table 5.3 shows the average short-term PASA demand forecast accuracy for two, four and six days ahead. For example, the table shows for Victoria that on average, the 12 hours ahead forecasts were within 2.4 per cent of the actual demand outcomes.

The Panel notes that overall the accuracy of the ST PASA demand forecasts has marginally declined from the previous financial year where the absolute percentage deviation for all regions and all categories increased from 3.51 per cent in 2010-2011 to 3.62 per cent in 2011-2012. On average across the four forecast categories, the accuracy remained the same as the previous financial year for Queensland and Tasmania, marginally improved for Victoria and South Australia, and declined for New South Wales (from 2.4 per cent to 2.7 per cent).

Table 5.3 Accuracy of short-term PASA demand forecasts 2009-2010

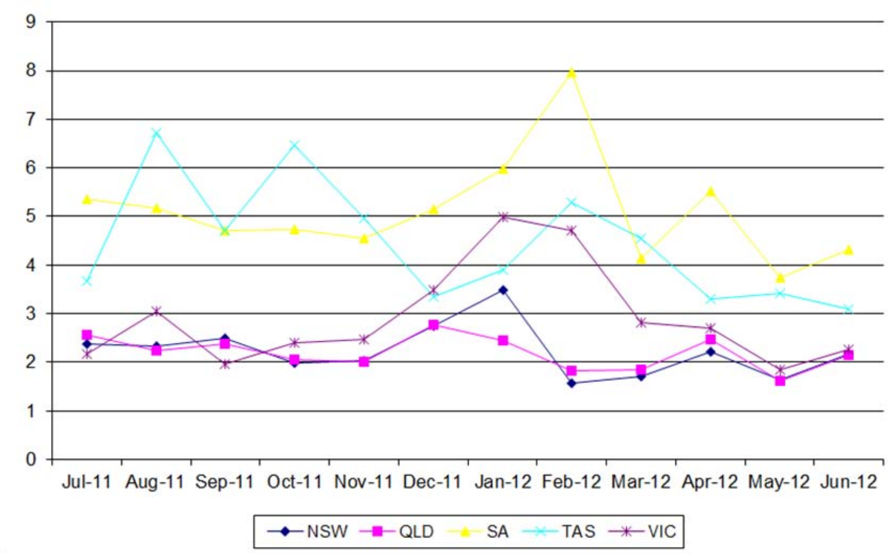
Short-term PASA demand forecast absolute percentage deviation	QLD	NSW	VIC	SA	TAS
12 hours ahead	1.8%	1.9%	2.4%	4.3%	3.6%
2 days ahead	2.2%	2.2%	2.9%	5.1%	4.5%

Short-term PASA demand forecast absolute percentage deviation	QLD	NSW	VIC	SA	TAS
4 days ahead	2.4%	2.5%	3.3%	6.1%	4.8%
6 days ahead	2.7%	2.9%	3.9%	7.6%	5.2%

Source: AER

The Panel has also examined the accuracy of ST PASA based on the mean absolute percentage error (2 days ahead). The Panel observes that demand forecasts, as shown in Figure 5.1, were relatively consistent for New South Wales, Queensland and Victoria where the mean error was around two to four per cent for the duration of the year. With the exception of Tasmania, the mean errors were higher for all regions over the summer months, most notably for South Australia where the errors peaked at 7.97 per cent in February 2012. The mean error for Tasmania was highest in August and October 2012. The results are demonstrated in the following figure.

Figure 5.1 Mean absolute percentage error (2 day ahead - ST PASA)



Source: AER

5.2.8 Pre-dispatch

Pre-dispatch provides an aggregate supply and demand balance comparison for each half-hour of the next day. The information is provided to relevant participants to assist with their operations management, and the data is available publicly the following day. The Panel notes that the accuracy of the demand forecasts used by AEMO in the pre-dispatch process is an important determinant of the accuracy of the pre-dispatch outcomes overall.

The Panel notes that perfect alignment between dispatch and pre-dispatch outcomes cannot be expected as the dispatch process utilises more complex constraint equations and real-time information whereas pre-dispatch uses less complex constraints and approximation of some terms in those equations. The quality of the forecasts is important but obtaining better forecasts will only address one issue in improving the alignment between dispatch and pre-dispatch.

AEMO introduced a Demand Forecasting System (DFS) on 15 November 2011 to its market systems. AEMO is currently forecasting electricity demand for the five NEM regions and four sub-regions using the DFS. The DFS generates half hourly forecasts, updated every half-hour, up to eight days ahead. The DFS has delivered greater accuracy for NEM regional demand forecasts in the near-real time, compared to the previous manual forecasting process. The DFS has also delivered greater accuracy for sub-regional demand forecasts up to eight days ahead, compared to the previous method of deriving sub-regional forecasts by scaling NEM regional forecasts. This has improved the accuracy of constraint equations in pre-dispatch and ST PASA.

The Panel notes that AEMO routinely reviews the performance of the pre-dispatch process in order to continuously implement updates and improvements to constraint information where possible.

The Panel has considered the number of trading intervals affected by statistically significant variations between pre-dispatch and actual prices during the 2011-2012 financial year, as well as the most probable reasons for the variations. The data that the Panel has considered is set out in Table 5.4. For example, the table shows that for South Australia, a total of 1340 trading intervals in 2011-2012 were affected by significant price variations which represents 8 per cent of trading intervals in total. Of these 8 per cent, 44 per cent of the price variations were due to variances in the demand values and 40 per cent were due to changes in plant availability.

The Panel considers that pre-dispatch has been working satisfactorily as an indicator of reliability and security. Its utility to the market however, will always be affected by the accuracy of demand forecasts. The Panel notes that load forecasting is a continuing challenge.

Table 5.4 Trading intervals affected by price variation

Reason for price variation	Number of trading intervals affected by variations									
	QLD		NSW		VIC		SA		TAS	
Total trading intervals affected	1052	6%	684	4%	1071	6%	1340	8%	4286	24%
Demand	485	39%	299	39%	493	42%	678	44%	804	19%
Availability	478	39%	356	46%	508	43%	611	40%	3488	80%
Combination (e.g. of changes in plant availability, demand, rebidding activities)	192	16%	115	15%	166	14%	207	14%	0	0%

Reason for price variation	Number of trading intervals affected by variations									
	QLD		NSW		VIC		SA		TAS	
Network (e.g. network outages)	80	6%	0	0%	16	1%	30	2%	46	1%

Source: AER

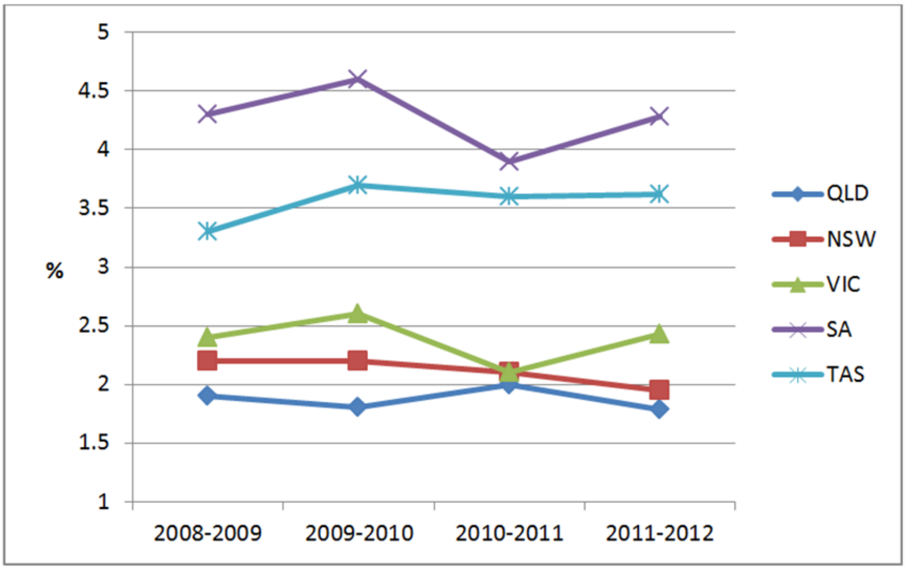
Note: The number of trading intervals affected for each of the reasons above (in rows 2 to 4) do not necessarily equal the total number of trading intervals affected (row 5). A number of forecasts are published for each trading interval, multiple variations, sometimes with different reasons can occur in the one trading interval.

The table illustrates that while there are a large number of trading intervals that are affected by significant variations between forecast and actual prices, the proportion of trading intervals is less than 10 per cent for every region except for Tasmania. With the exception of Tasmania, the total number of trading intervals affected this year is relatively consistent with last year[63]. The proportion of intervals affected in Tasmania is greater than the last financial year, with 24 per cent this year and 9 per cent last year. The Panel notes, however, that last year was lower than previous years. In 2009-2010, 23 per cent of trading intervals were affected in Tasmania and 31 per cent were affected in 2008-2009. Therefore, the Panel does not consider this to reflect a material deterioration in performance.

The Panel has also considered the accuracy of the pre-dispatch demand forecasts (12 hours ahead basis). Figure 5.1 below shows accuracy further improved in 2011-2012 for New South Wales and in Queensland. Accuracy remained relatively stable for Tasmania at around 3.6 per cent and marginally declined for South Australia and Victoria to levels consistent with previous years.

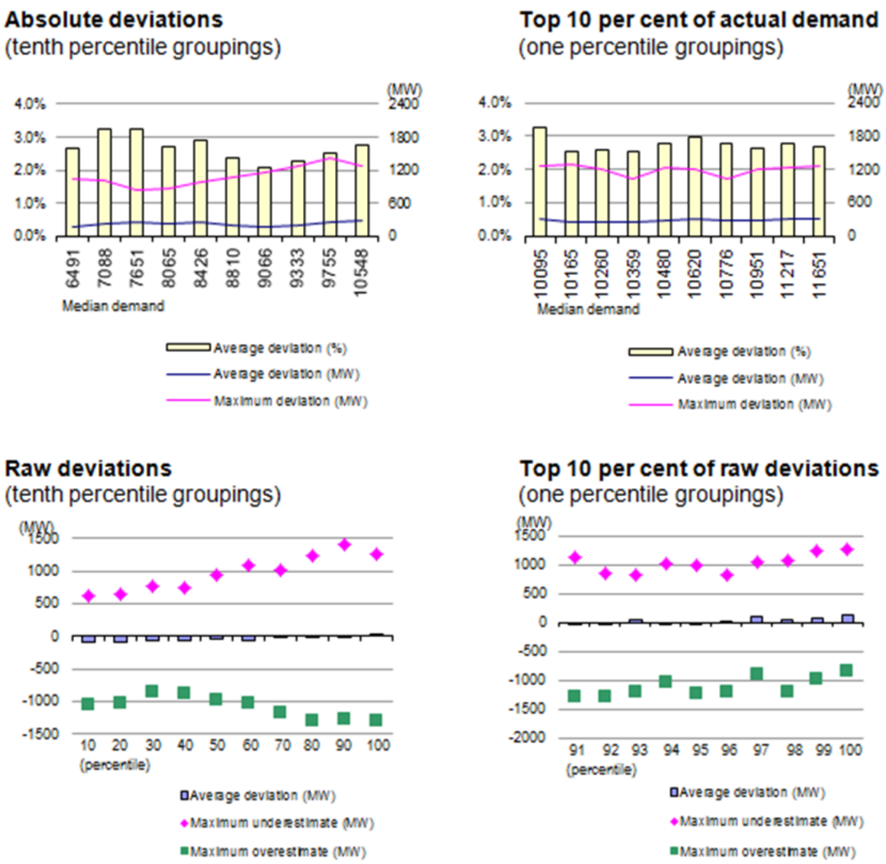
63 In 2010-2011, the total trading intervals affected (percentage wise) were: QLD 6%, NSW 5%, VIC 5%, SA 7%, TAS 9%.

Figure 5.2 **Accuracy of pre-dispatch demand forecasts (12 hours ahead) (absolute percentage deviation - actual demand compared to 12 hours ahead forecast)**



As the accuracy of demand forecasts play a crucial role in the pre-dispatch process, the Panel has also assessed the performance of the four hour ahead demand forecasts for the summer period. The Panel has considered all regions, with New South Wales shown in the figure below as an example. Other regions are outlined in further detail in Appendix B section B.4.6.

Figure 5.3 **New South Wales demand forecast deviation four hours ahead**



The graphs show the deviation (actual demand minus forecast demand) for the four hour ahead forecasts (a detailed description is contained in Appendix B). The outcomes above for New South Wales show that the maximum deviation between forecast and actual demand in 2011-2012 ranged from 1420 MW lower than forecast to 1280 MW higher than forecast. On average, the deviations were between 2 and 3.3 per cent for the top tenth percentile of demand.

The magnitude and pattern of deviation differs for each NEM region. Generally speaking, the Panel notes that the four hour ahead demand forecasts:

- appear to be biased towards under estimation of high demand periods;
- appear to have maximum under estimates that could be difficult to cover on notice shorter than four hours; however
- the average deviation for all regions (at the top tenth percentile) is below four per cent, with the exception of South Australia (between four and five per cent).

5.2.9 Wind forecasts

The Australian Wind Energy Forecasting System (AWEFS) was implemented by AEMO where 'phase 1' of the project was implemented internally in 2008 and then 'phase 2' was completed in June 2010. The development of the AWEFS was funded by the Commonwealth Department of Resources, Energy and Tourism involving a 'world first' integrated system designed specifically for the NEM by a European consortium.[64]

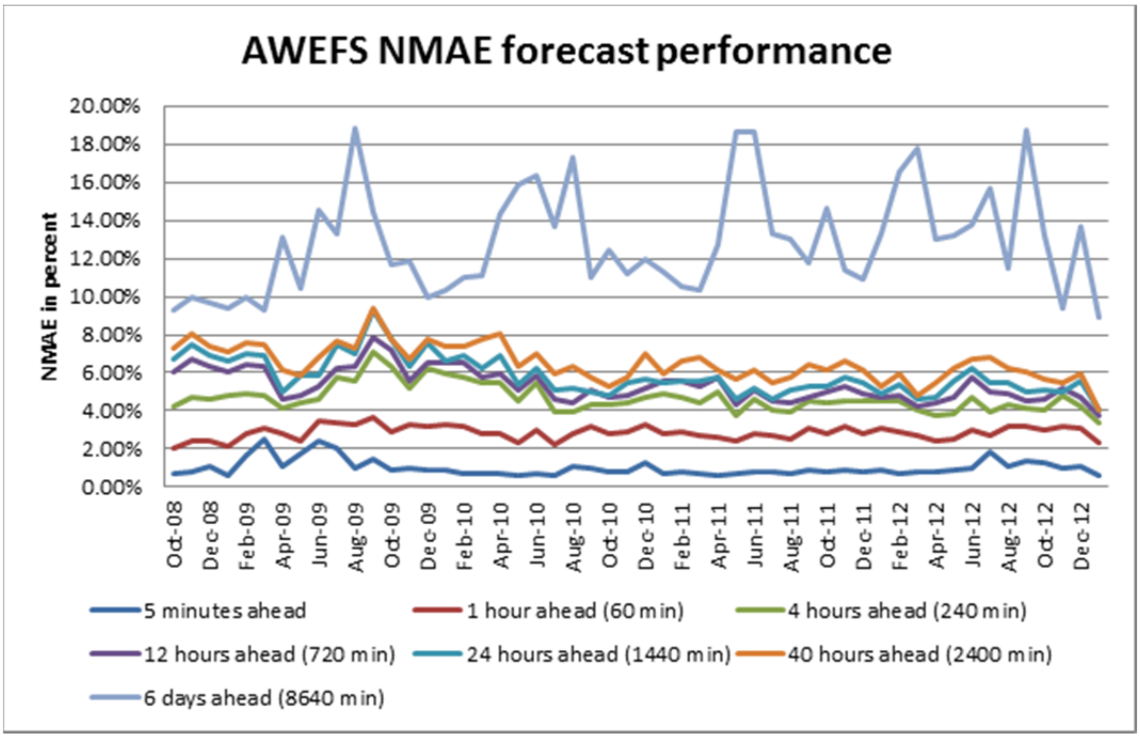
The AWEFS involves statistical, physical and combination models to provide wind generation forecasts using a range of inputs including historical information, standing data (wind farm details), weather forecasts, real time measurements and turbine availability information.

The AWEFS was established in response to the growth in intermittent generation in the NEM and the increasing impact this growth was having on NEM forecasting process. The Panel recognises that wind generation capacity in the NEM is expected to continue to grow under Australia's Renewable Energy Target and the AWEFS will continue to be an important tool for promoting efficiencies in NEM dispatch, pricing, network stability and security management.

The Panel has considered the performance of AWEFS based on the average per cent error across all regions in the NEM across various timeframes. The performance is shown in Figure 5.4.

64 Further background on the AWEFS is available at: http://www.aemo.com.au/Electricity/Market-Operations/Dispatch/Process-Documents/AWEFS

Figure 5.4 Accuracy of AWEFS (normalised mean absolute error)



In relation to Figure 5.4, the Panel notes that:

- as could be expected, the accuracy of the forecasting improves as the forward looking timeframe shortens;
- the percentage error for the 6-day ahead forecast was the lowest during the summer months for 2008-2009 and 2009-2010, however this was not the case in the most recent financial year where the summer/autumn months exhibited the highest percentage of inaccuracy for 2011-2012;
- the highest NMAE values correspond to situations when forecasting is difficult, i.e. periods with very high or very low wind speeds. For the analysis, AEMO has taken into account all farms with suitable measurements during the evaluation period (2010-2012); and
- with the exception of the 6-day ahead forecast, the system performance variability appears to have marginally improved since its introduction and the Panel will continue to review performance annually.

5.3 Reliability safety net

AEMO has the power to issue directions as a last resort measure, or to contract for the provision of reserves to maintain power system security and reliability. AEMO's powers of direction are set out in clause 4.8.9 of the rules. The terms secure operating state, satisfactory operating state and reliable operating state are defined under the rules and set out in the glossary of this report.

AEMO may direct a registered participant to take specific action in order to maintain or re-establish the power system to a secure operating state, a satisfactory operating state, or a reliable operating state. Where a direction affects a whole region, intervention or 'what if' pricing would be required (where spot prices are determined as if the direction had not occurred).

As noted in section 3.1, the Panel notes that AEMO did not exercise the RERT mechanism in 2011-2012.

The Panel also notes that AEMO did not issue any directions for Reliability in 2011-2012.

6 System security performance assessment

This chapter sets out the Panel's assessment of the performance of the system from a security perspective. The Panel has considered the performance with respect to the relevant technical standards. Additional background information is set out in Appendix C.

6.1 Frequency

The control of power system frequency is a crucial element of managing power system security. The Panel has considered the number of times in the past financial year where events have exceeded the frequency operating standards. The mainland and Tasmanian frequency operating standards are detailed in Appendix C.

Mainland NEM

Based on data available to the Panel at the time of publication, there were four frequency events on the mainland in the 2011-2012 financial year that exceeded the frequency operating standards. The Panel notes that this is one more than in 2010-11, but fewer than the previous years where there were ten events in 2009-2010 and 20 events in 2008-2009. The number of events is shown in Table 6.1 below.

Table 6.1 Frequency events on the mainland 2011-2012

Number of events	Total	Low frequency	High frequency
outside normal operating frequency band	4	4	0
outside normal operating frequency excursion band	3	3	0
Events where duration exceeds 300 seconds[65]	4	4	0

Source: AER

The Panel notes that four low frequency incidents all resulted in the frequency being outside the normal operating band for more than 300 seconds. The four events were caused by generator trips, the details of which involved:

- a 740 MW generating unit trip at Kogan Creek power station in Queensland on 18 October 2011 that lasted 438 seconds (~7.3 minutes);
- a 720 MW generating unit trip at Kogan Creek on 4 November 2011 lasting 312 seconds (~5.2 minutes);
- a 500 MW generating unit trip at Loy Yang A in Victoria on 7 November 2011 lasting 316 seconds (~5.3 minutes); and

65 The frequency operating standards required recovery to the normal band within 300 seconds for generators, load and network events.

- a 495 MW generation trip at Newport power station in Victoria on 29 November 2011 lasting 396 seconds (~6.6 minutes) - the normal operating frequency excursion band was not exceeded for this incident.

On no occasion did the frequency of the NEM mainland exceed the upper limit of the normal operating frequency band in 2011-2012.

Tasmania

There were 50 events in Tasmania in the 2011-2012 financial year where the frequency exceeded Tasmania's frequency operating standards. The Panel notes that six of the 50 incidents resulted in the frequency being outside the normal operating band for more than 300 seconds. The number of events is shown in Table 6.2 below.

Table 6.2 Frequency events in Tasmania 2011-2012

Number of events	Total	Low frequency	High frequency
outside normal operating frequency band	50	42	8
outside normal operating frequency excursion band	50	42	8
Events where duration exceeds 300 seconds	6	6	0

Source: AER

The number of events in 2011-2012 is materially higher than in previous years, where there were seven events in 2010-2011, two events in 2009-2010 and five events in 2008-2009. AEMO has advised that the higher number of events this year related to Basslink transitioning through the 'no-go zone' for market-related reasons.[66] Based on this advice, the Panel does not consider these higher numbers represent any system or security issues. However, as there were a number of events outside the bounds of the frequency standard, the Panel will seek the support of Transend and AEMO to better understand the underlying causes before deciding whether further action would be required.

The two incidents of the longest duration occurred on 6 December 2011 for 1144 seconds (~19.1 minutes) and on 15 December 2011 for 1280 seconds (~21.3 minutes). Both events exceeded the lower limit of the normal operating frequency excursion band (49.75 Hz), reaching 49.31 Hz and 49.42 Hz respectively. Both events were caused by Basslink targets changing from export (Tasmania to Victoria) to import (Victoria to Tasmania), where the actual flow on Basslink did not follow the import targets.[67] The

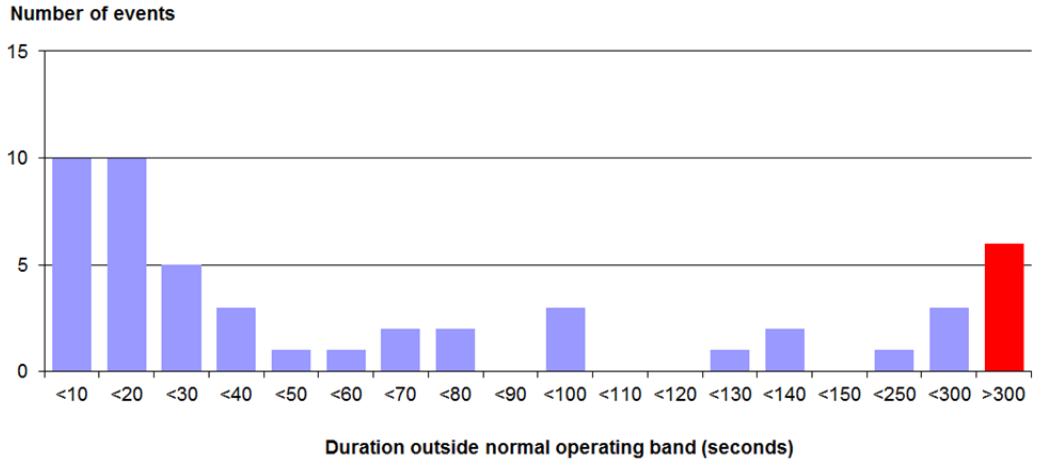
66 Basslink is to be unable to operate with a flow between -50 MW and +50 MW. It can only operate in one direction at a time and it takes time to switch the flow of energy (direction). Therefore, when changing the flow of energy Basslink must be taken from the minimum level (50MW) to 0MW. This takes a few minutes before the energy flow can operate at 50MW.

67 For further detail, refer to the AEMO report: Power System Frequency and Time Deviation Monitoring December 2011, available at:

Panel notes that one of the events involved under-frequency load shedding. This event was on 19 June 2012 and occurred following a magnitude 5.4 earthquake in Victoria. The incident is discussed in further detail in section 4.3.5 of this report.

The duration of the majority of frequency events in Tasmania in 2011-2012 was less than 80 seconds as shown in Figure 6.1.

Figure 6.1 Frequency excursion duration - Tasmania



6.2 Voltage limits

In addition to maintaining the frequency of the power system, the voltage of the power system is also important for the security of the power system. AEMO and transmission network service providers (TNSPs) agree on the technical envelope within which the transmission network voltage is maintained. AEMO's systems monitor the voltage performance levels against the limits advised by TNSPs. The Panel notes that an adequate supply of suitably located responsive reactive power to reduce voltage instability is vital in maintaining power system stability.

The Panel understands that AEMO was generally able to maintain voltages within advised limits throughout the 2011-2012 financial year.

6.3 Interconnector performance

The Panel is not aware of any incidents in the 2011-2012 financial year where an interconnector was above its secure line rating limit.

While the power system operates in a dynamic environment, there are instances where interconnectors exceed their secure limit for small periods of time; however, this is generally corrected within a dispatch interval.

Potential overloads are reported through AEMO's online management system.

http://www.aemo.com.au/Electricity/Resources/Reports-and-Documents/~/media/Files/Other/reports/December_2011_Freq_Report.ashx.

6.4 System stability

In addition to managing frequency and voltage levels to maintain system security, AEMO has a number of real time monitoring tools which help it meet its security obligations including power flow and contingency analysis software. This includes monitoring equipment that detects oscillatory disturbances that could lead to a security threat and the online Dynamic Security Assessment (DSA) tool. The DSA uses real time data from AEMO's energy management system to simulate the behaviour of the power system for a variety of critical network, load and generator faults.

The Panel notes that AEMO uses these real-time monitoring tools to actively manage and operate the power system. These tools provide AEMO with the ability to respond to issues as they arise and provide critical information on the performance of the system against technical limits.

6.5 Other factors

The Panel notes that various other factors, such as the correct operation of individual pieces of equipment and the correct performance of protection and control systems, affect the security performance of the system. These are considered further in section C.2. The Panel notes that AEMO investigates and reports on power system events as further discussed in Chapter 4.

6.6 Power system directions by AEMO

AEMO is able to issue power system directions to registered participants to direct that they take certain action to maintain the power system in a secure operating state.

The Panel notes that AEMO did not issue any directions in the 2011-2012 financial year. Table 6.3 sets out the directions issued in the previous financial years.

Table 6.3 Number of security directions issued by AEMO

	QLD	NSW	VIC	SA	TAS	Total
2011-2012	0	0	0	0	0	0
2010-2011	0	0	0	0	0	0
2009-2010	4	1	0	1	1	7
2008-2009	2	1	5	4	0	12
2007-2008	5	0	0	1	1	7
2006-2007	3	0	6	1	0	10
2005-2006	1	52	0	0	8	61
2004-2005	8	0	0	34	0	42

Source: AER

7 Safety assessment

This chapter sets out the Panel's assessment of the performance of the system from a safety perspective.

As discussed in Chapter 2, the scope of the Panel's considerations primarily relate to the bulk transmission system of the NEM. The Panel's assessment of the safety of the NEM is therefore limited to considerations of links to the security of the power system and maintaining the system within relevant standards and technical limits. For the 2011-2012 financial year, the Panel is not aware of any incidents where AEMO's management of power system security has resulted in a safety issue with respect to maintaining the system within relevant standards and technical limits.

The Panel notes that where AEMO issues a direction, the directed participant may choose not to comply on the grounds that complying with the direction would affect the safety of its equipment or personnel. As AEMO did not issue any directions in 2011-2012 (see section 6.6), the Panel notes that there were no safety issues related to a direction from AEMO.

Network service providers and other market participants have specific responsibilities to ensure the safety of personnel and the public. The electrical system is designed with extensive safety systems to ensure the protection of the system itself, workers and the public. Each NEM region is subject to different safety requirements as set out in the relevant jurisdictional legislation. State and territory legislation governs the safe supply of electricity by network service providers and broader safety requirements associated with electricity use in households and businesses.

Examples of the different jurisdictional safety arrangements are provided below. The Panel considers it is of benefit to provide an overview of some of the jurisdictional arrangements to provide context to issues that may be relevant to stakeholders. The Panel notes this is not an exhaustive summary of safety requirements in each region[68].

7.1 Australian Capital Territory

The Australian Capital Territory Planning and Land Authority (ACTPLA) administers the *Electricity Safety Act 1971* and *Electricity Safety Regulation 1971* in the ACT. This legislation ensures electrical safety, particularly in relation to:

- the installation, testing, reporting and rectification of electrical wiring work for an electrical installation and its connection to the electricity distribution network (the Wiring Rules are the relevant standard);
- the regulation and dealings associated with the sale of prescribed and non-prescribed articles of electrical equipment;
- the reporting, investigation and recording of serious electrical accidents by responsible entities;

68 Unless stated otherwise, the information below has been drawn directly from the websites of the relevant jurisdictional entities.

- enforcement by ACTPLA and its electrical inspectors (including inspectors' identification, entry powers, seizing evidence, disconnection of unsafe installations and articles, powers to collect verbal and physical evidence and respondents' rights);
- the appeals system; and
- miscellaneous matters such as certification of evidence.[69]

7.2 New South Wales

In New South Wales, the Independent Pricing and Regulatory Tribunal (IPART) is the jurisdictional regulator for network technical and safety licensing. The Department of Industry & Investment NSW is responsible for monitoring of network performance and safety as part of licensing regime and network management regime under the *Electricity Supply Act 1995* and the *Electricity Supply (Safety and Network Management) Regulation 2008*.

The NSW Office of Fair Trading monitors the safety of customer electrical installations under the Electricity (Consumer Safety) Act 2004 and Electricity (Consumer Safety) Regulation 2006. It also authorises accredited service providers under the *Electricity Supply Act 1995* and *Electricity Supply (General) Regulation 2001*. Workcover NSW monitors the safety of work places under the NSW Occupation Health and Safety Act and Regulations.

The NSW Department of Trade & Investment oversees electricity transmission and distribution system operators so they provide an adequate, reliable and safe supply of electricity of appropriate quality in NSW. Under the provisions of the *Electricity Supply Act 1995*, the Department requires that each network operator produce an annual report covering the major issues concerning the operation of their networks, including safety issues in the areas of public safety, network employee safety, customer installation safety, bushfire risk management and public electrical safety awareness campaigns. These reports are available on the websites of NSW distribution and transmission network service providers.

7.3 Queensland

In Queensland, the Electrical Safety Office is electrical safety regulator that undertakes a range of activities to support electrical safety with the key objective of reducing the rate of electrical fatalities in Queensland. The *Electrical Safety Act 2002* places obligations on people who may affect the electrical safety of others. This stand-alone legislation fundamentally changed Queensland's approach to electrical safety; establishing a Commissioner for Electrical Safety, an Electrical Safety Board and three Board committees to advise the Minister on electrical safety issues. Additionally, an independent State-wide electrical safety inspectorate was established to administer and enforce the new legislative requirements.

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69 ACT Planning and Land Authority Annual Report 2010-11, p. 7. Available at: http://www.actpla.act.gov.au/__data/assets/pdf_file/0015/25431/1131-ACTPLA_-Annual_report-2011-TaggedWeb.pdf.

One of the responsibilities of the Electrical Safety Board is the development of a five year strategic plan for improving electrical safety in Queensland. The intent of the plan is to identify priority areas for improvement in electrical safety, and strategies to reduce electrical incidents and subsequent fatalities, serious injury and property damage in these priority areas. The Electrical Safety Plan for Queensland 2009–2014 was published in 2008 and sets out strategies designed to achieve the Board's goal of eliminating all preventable electrical deaths in Queensland by 2014.

7.4 South Australia

In South Australia, the Office of the Technical Regulator is responsible for the administration of the *Electricity Act 1996* and *Energy Products (Safety and Efficiency) Act 2000*. The primary objective of these Acts is to ensure the safety of workers, consumers and property as well as compliance with legislation, technical standards and codes in the electricity industries.

The principal functions of the Office of the Technical Regulator under the *Electricity Act 1996* are:

- monitoring and regulation of safety and technical standards in the electricity supply industry;
- monitoring and regulation of safety and technical standards relating to electrical installations;
- administration of the provisions of the Act relating to clearance of vegetation from power lines; and
- fulfilling any other function assigned to the Technical Regulator under the Act.

The activities undertaken by the electrical infrastructure, electrical installations and electrical appliances sections of the regulator are discussed in detail in its Annual report on electricity[70].

7.5 Tasmania

Until 1 June 2010, several safety functions were vested with the Tasmanian Economic Regulator under the *Electricity Industry Safety and Administration Act 1997* (EISA Act) and the *Electricity Supply Industry Act 1995*. The EISA Act:

- provides for electrical contractors and workers to be appropriately qualified and regulated;
- establishes safety standards for electrical equipment and appliances; and
- provides for the investigation of electrical safety accidents in the electricity industry.

Safety-related responsibilities were transferred to Workplace Standards Tasmania (WST) via an amendment to the EISA Act in 2009.

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70 Available at: http://www.sa.gov.au/government/entity/959/About+us+-+Office+of+the+Technical+Regulator/What+we+do/Annual+reports#Electricity.

7.6 Victoria

Electricity safety in Victoria is regulated by Energy Safe Victoria (ESV). The role of ESV involves overseeing the design, construction and maintenance of electricity networks across the state and ensuring every electrical appliance in Victoria meets safety and energy efficiency standards before it is sold. ESV oversees a statutory regime that requires major electricity companies to submit and comply with their Electricity Safety Management Scheme, submit bushfire mitigation plans annually for acceptance and electric line clearance management plans annually for approval, and to actively participate in ESV audits to test compliance of their safety systems.

In August 2012, the ESV released its report on the 2011 Safety Performance Report on Victorian Electricity Distribution and Transmission Businesses. The report focuses on key safety indicators reported by the businesses, ongoing critical safety programs, the progression of directions placed on the distribution businesses to meet the recommendations of the 2009 Victorian Bushfires Royal Commission and the Powerline Bushfire Safety Taskforce (PBST), and the operation of the Electricity Safety Management Schemes. ESV also reports on audits undertaken, including those to assess the readiness of the distribution businesses for the bushfire season.

A 2011-2012 Weather summary

The weather can have significant impact on the delivery of electricity. During periods of hot weather, demand for electricity can be very high and the heat can restrict the ability of generating plant to produce at rated production levels. In addition, hot weather and bushfires can also adversely affect transmission and distribution network capability.

Long periods of drought can seriously affect generation availability as hydro generators require sufficient reservoir levels and some thermal generators require water for cooling. While storms and floods may have an immaterial effect on demand levels, they can cause supply interruptions through damage to the transmission and distribution networks, such as lightning strikes to transmission lines or trees falling on distribution lines. Below is a summary of the climate for the 2011-2012 financial year by each season:[71]

- **Winter**

  Winter 2011 involved below average rainfall levels, with the exception of parts of the east coast. It was a milder winter than normal with day time and overnight temperatures above average across most of Australia, except the tropical north – parts of Queensland recorded minimum temperatures that ranked in the coolest 10 per cent of records. Large areas of New South Wales, South Australia, Tasmania and Victoria recorded daytime temperatures which ranked in the warmest 10 per cent of records, with Tasmania and Victoria recording their second warmest winters on record, and NSW its third.

- **Spring**

  Spring 2011 saw a return to wet conditions following a dry winter. Maximum temperatures averaged over Australia were 0.3°C above normal for spring. Much of Australia recorded temperatures within a degree of the average with southeastern Australia recording above average day time temperatures. Southern and eastern Victoria, southeastern SA, northern Tasmania as well as parts of southwest New South Wales and far northern Queensland recorded very much above average maximum temperatures ranking in the top 10 per cent of springs on record. The most notable statewide daytime temperatures were recorded in Tasmania, which experienced its second warmest spring on record with an anomaly of +1.2°C (the record is +1.4°C in 2009). National overnight temperatures averaged over Australia were slightly above average (+0.1°C). Victoria recorded its third warmest spring on record for overnight temperatures and Tasmania recorded its fourth warmest spring on record for mean temperatures.

71 Information in this appendix has been obtained from the Australian Bureau of Meteorology, Australian seasonal climate summary archive, http://www.bom.gov.au/climate/current/season/aus/archive.

- **Summer**

  Summer 2011-2012 was generally wet over large parts of Australia, with the exception of parts of the tropical north and southeast of the country. Particularly heavy falls over northern NSW and southern Queensland resulted in moderate to major flooding over parts of those regions. Maximum temperatures averaged across Australia were 0.55°C below normal, 11th coolest in 62 years of record. Maximum temperatures were generally close to normal, though parts of eastern Australia experienced a cool summer. New South Wales had a particularly cool summer, with an anomaly of −1.71°C, the 2nd coolest on record. A large part of northeast NSW recorded its coolest summer on record (29 per cent of the New South Wales area). Conversely, Tasmania had a particularly warm summer, measuring its 3rd warmest summer.

- **Autumn**

  Autumn 2012 was the 17th coolest on record, which was milder than in the previous year when Australia experienced the coldest mean temperatures for autumn on record (since 1950). The Australia-wide maximum temperature average for 2012 autumn was 0.37°C below normal. Nationally averaged overnight temperatures were 0.93°C below normal, the 4th coolest on record, and the coldest since 1994.

B Reliability performance - detailed background information

This appendix provides detailed background information on reliability management and measuring power system reliability performance. For a discussion of the Panel's assessment of performance in the 2011-2012 financial year, please refer to Chapter 5.

B.1 Reliability management

The overall arrangement for ensuring the Reliability Standard is met, including the safety mechanism arrangements if the market mechanisms fail, is illustrated in the reliability model in Figure B.1. The operation of each element of the model is explained and analysed in detail in this section.

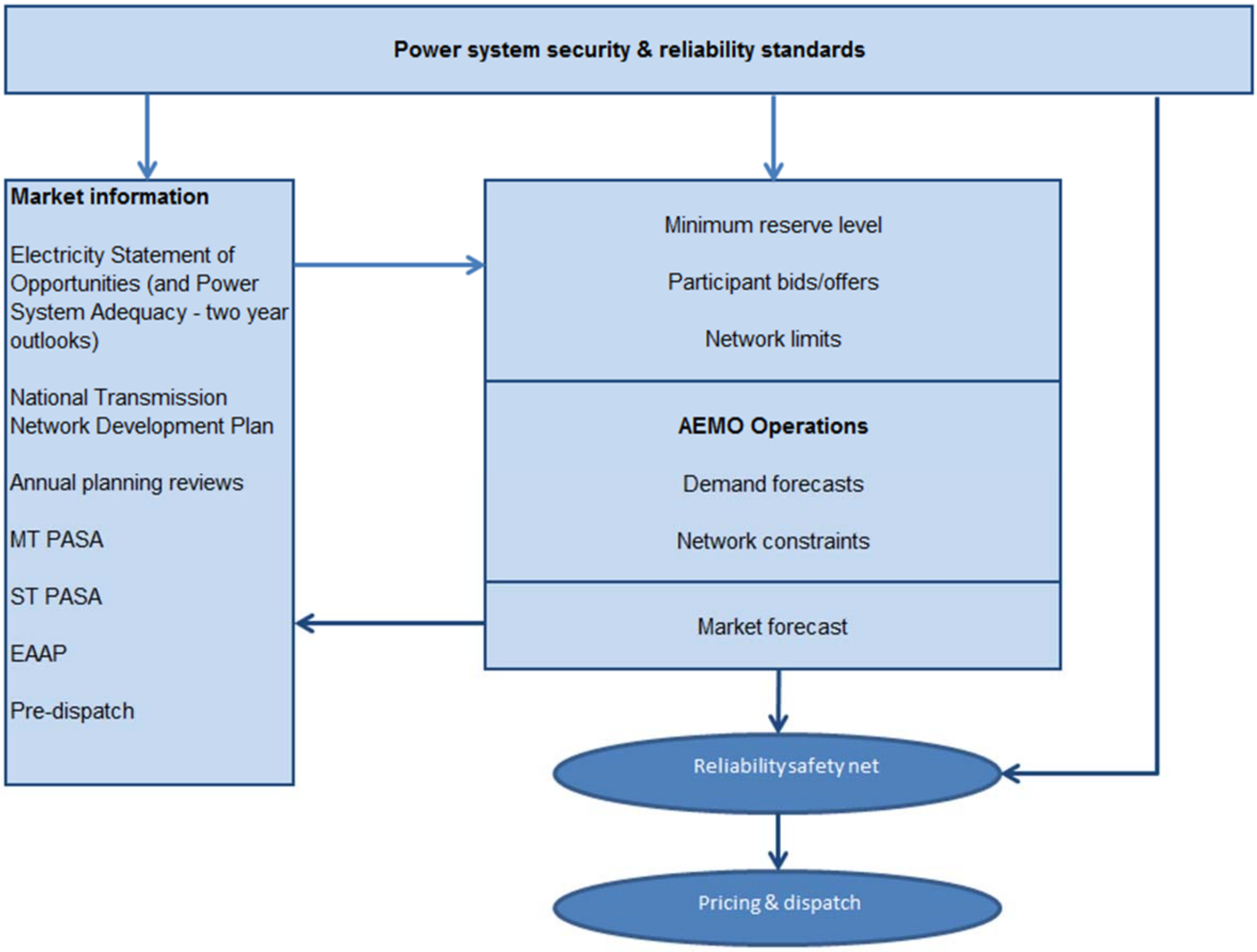
The national market aligns incentives for decisions by market participants about plant operation with overall reliability outcomes. There is an extensive suite of information published by AEMO to support those decisions.

Market information provides data and projections with increasing levels of detail closer to the time of dispatch. The annual ESOO provides information for ten years ahead. The shortest time period, called the pre-dispatch schedule, provides five minute projections of dispatch, consumer demand and market price.

Market information is derived from technical data and advice of the commercial intentions for plant operation provided to AEMO by participants. AEMO develops forecasts of demand and aggregates participant information to produce overall forecasts for publication. Participants are encouraged to adjust their intentions and are obliged to provide revised data to AEMO. The final data is used by AEMO to operate the power system and facilitate the operation of the market.

In addition, the reliability safety net allows AEMO to monitor the level of reserve in each region and may intervene if these reserves fall below the margins necessary to meet the Reliability Standard determined by the Panel.

Figure B.1 Reliability Model



B.2 Reliability Standard

The Reliability Standard of 0.002 per cent USE is designed to measure whether there is sufficient available capacity to meet demand. It is the basis for AEMO's calculation of minimum reserve levels (MRLs) for market information purposes, and if necessary intervention through reserve contracting under the RERT, or its directions powers. Reliability within a market region depends on the reserve within that region and other regions and on the capability of interconnectors.

Reliability of the energy market is measured by comparing the component of any energy not supplied to consumers as a result of insufficient generation or bulk transmission capability against the Reliability Standard. This excludes energy not supplied due to management of security and performance of local transmission or distribution networks, and is therefore only part of the overall measure of continuity of supply to consumers. However, from a consumer point of view, reliability is also impacted by the performance of the distribution and local transmission networks. Appendix D provides a summary of the performance of these networks in order to provide context for the Reliability Standard.

Reliability is driven by the adequacy of investment and level of generating and transmission plant presented to AEMO for dispatch in the market. The market design relies on commercial signals in the market price to create incentives for market participants to bring capacity online. The Reliability Standard sets the threshold at which AEMO may intervene in the operation of the market to ensure sufficient available capacity. Security, however, is the product of the technical performance characteristics of plant and equipment connected to the power system and how it is operated by AEMO and network service providers.

B.3 Minimum reserve levels

The Reliability Standard of 0.002 per cent USE is a statistical risk of not meeting consumer demand over time. To meet the Standard operationally, AEMO calculates MRLs for each region and combination of regions. These calculations take into account plant performance characteristics such as forced outage rates, the characteristics of demand including weather, market price sensitivity and the capability of the network.

MRLs provide AEMO with an operational trigger for intervention to maintain supply reliability. AEMO may intervene using reserve contracting or its power for directions if the reserves delivered by the market are below the designated MRL. The medium-term and short-term projected assessment of system adequacy (PASA), pre-dispatch schedule and market notices (see section B.4) alert the market to the potentiality of reserve levels being below the MRL threshold. This information and the responses by participants are central aspects of the management of reliability in the NEM.

The methodology used by AEMO to determine the MRLs is probabilistic. The calculation process first requires determining a minimum level of generation capacity that will deliver the Reliability Standard in all regions (i.e. expected USE = 0.002 per cent). The MRLs are derived by comparing the minimum generation requirement with a demand condition which has all regions at their maximum 10 per cent POE demand and taking into account reserves available across interconnectors.

In 2010 AEMO identified some changes to the methodology used to determine the MRLs. The recalculated MRLs use a historic level of demand diversity across regions, rather than an artificially low level of demand diversity. In addition, AEMO calculated the relationships that relate to reserve sharing between regions.

B.4 Reserve projections and demand forecasts

Market information is provided in a number of formats and time frames ranging from the annual ESOO which contains projected information for the next ten years, to the detailed five minute and thirty minute price and demand pre-dispatch schedule. Market information also includes Annual Planning Reviews, the NTNDP, the PSA - two year outlook, medium-term PASA, short-term PASA and market notices. Each is described and analysed below.

AEMO’s forecasts of demand are crucial to all processes and inaccurate forecasts can contribute to less efficient market actions. Accurate forecasting is in part dependent on the quality of weather forecasts and knowledge of participant demand management activities.

B.4.1 Market information

Each year AEMO publishes an ESOO for the following ten years.[72] The 2012 ESOO provides an analysis of electricity supply and demand over a 10-year outlook period. It also includes historical information about the changing electricity generation mix and trends in electricity demand, which is combined with information from energy market participants and AEMO's latest electricity demand forecasting, to assess supply adequacy for the next 10 years.

While summarising the investment environment for each NEM region, including the supply-demand outlook and current generation investment interest, the ESOO also highlights NEM-wide generation and demand-side investment opportunities by analysing the key factors influencing this type of investment in 2012.

AEMO has also begun publishing a separate demand forecast report – the National Electricity Forecast Report. In the past, AEMO has published demand forecasts via a series of AEMO planning publications, namely the Electricity Statement of Opportunities (ESOO), the Victorian Annual Planning Report (VAPR), and the South Australian Supply and Demand Outlook (SASDO). From 2012, the NEFR will be the only AEMO publication presenting electricity demand forecasts for the NEM.

These reports are complemented by Annual Planning Reviews that are prepared by each TNSP. The Annual Planning Review focuses on networks and includes forecasts of transfer capacities, potential constraints and possible intra-regional augmentations.

In addition, AEMO publishes the PSA on an annual basis, which assesses the electricity supply outlook over the next two years. The PSA is not a rules requirement but has been published on an annual basis by AEMO since 2010. The PSA examines specific scenarios and projections of system outcomes. The 2012 PSA examined two key scenarios:[73]

- the Expected Scenario which represents the most likely power system outcomes, and is based on the most probable forecasts and anticipated generation availability. The connection of wind farms recently classified as advanced proposals is also considered when they potentially impact power system operations; and
- the Sensitivity Scenario which examines the outcomes from a particular event, which will be updated each year in response to emerging trends and options. The 2012 PSA examines the potential impact of the withdrawal of 1,000 MW of older generation distributed across the NEM.

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72 In August 2010, AEMO indicated that it would begin to provide the supply-demand outlook in two documents. One is the Power System Adequacy report which presents operational information and the supply-demand outlook for the summers of the next two years and assesses potential operational issues for this period. The other is the ESOO which would present the investment outlook for the NEM supply capacity for years 3 to 10 of the 10 year outlook.

73 AEMO, 2011 Power System Adequacy for the National Electricity Market, 2011, p. 1-1.

Each of the scenarios used in the PSA also considers component studies involving low and high wind generation.[74]

In December 2010, AEMO published its inaugural NTNDP, which is an independent strategic plan for the NEM transmission network and AEMO updates the plan on an annual basis. In preparing the plan, AEMO explores a wide range of scenarios to determine the impact of certain drivers on the transmission network - the most prominent drivers being demand growth and carbon price. In developing the NTNDP each year, AEMO undertakes extensive consultation with stakeholders to consider the scope and purpose of the report and to seek feedback on proposed methodologies.

These documents provide technical and market data, in addition to useful information about market opportunities, for both existing registered and intending market participants. The information includes:

- forecasts of energy use, peak demands, generator capabilities and other means of meeting electrical energy requirements, and ancillary service requirements necessary for the secure operation of the power system;
- forecasts of inter and intra-regional transmission network capabilities and a summary of network augmentation projects that will affect these capabilities (the inter-regional transfer capabilities reflect the network's ability to exchange energy between regions within the NEM);
- AEMO's assessment of the adequacy of supply, referred to as the supply/demand balance; and
- a brief summary of significant initiatives and projects expected to influence market development over the coming years.

B.4.2 Energy Adequacy Assessment Projection (EAAP)

The EAAP is a quarterly information mechanism which will provide the market with projections of the impact of generation input constraints on energy availability.[75]

Both the AEMC and the Panel consider that the EAAP functions as an additional source of information for the market regarding when and where energy constraints may impact on energy availability. As noted in section 5.2, the Panel has completed a review of the EAAP in February 2013.

B.4.3 Medium-term Projected Assessment of System Adequacy

Medium-term PASA is a comparison of the aggregate supply and demand balance at the time of anticipated daily peak demand, based on a 10 per cent POE for each day over the next two years.

Medium-term PASA information is provided:

74 Ibid.

75 The reporting requirement was introduced following a Rule change request resulting from a Rule proposal from the Panel.

- to assist participants in planning for maintenance, production planning and load management activities over the medium term; and
- as the basis for any intervention decisions by AEMO, for example invoking the RERT.

Demand forecasts are prepared by AEMO. Generation and demand-side daily availability estimates are submitted by participants under clause 3.7.2(d) of the Rules. In addition, planned network outages are submitted to AEMO by network service providers under clause 3.7.2(e) of the Rules.

The ability to forecast network capability and in particular interconnector capability is important for the reliable and efficient operation of the market. Every month, AEMO and the TNSPs publish planned network outage information for the following 13 months. AEMO also determines and publishes an assessment of the projected impact of network outages on intra and inter-regional power transfer capabilities, and provides limit equation information and plain English descriptions of the impact for all TNSPs.

Interconnector capability can be a function of the pattern of generation, availability of reactive support and certain network services.

In some circumstances, outages are scheduled at short notice by taking advantage of the most recent market information without compromising the supply reliability; however, short notice outages can also increase uncertainty for market participants and for the management of reliability and power system security. Other outages have little effect on reliability.

The medium-term PASA demand forecast is a 10 per cent POE forecast with a daily resolution. This forecast has historically used the summer and winter weekday 10 per cent POE demand forecasts consistent with the most recent ESOO and sculpts the remainder of the year by estimating seasonal and weekend fluctuations.

B.4.4 Short-term Projected Assessment of System Adequacy

Short-term PASA is an aggregate supply and demand balance comparison for each half-hour of the following seven days.[76]

Demand forecasts are prepared by AEMO. Generation and demand side availabilities are submitted by participants in accordance with clause 3.7.3(e) of the Rules. Transmission outage programs are supplied by TNSPs under clause 3.7.3(g) of the Rules. This information is to assist participants in optimising short-term physical and commercial planning for maintenance, production planning and load management activities.

PASA in the pre-dispatch timeframe (PD PASA) has been improved to have a closer alignment with pre-dispatch results. This has been achieved by using some outputs from the pre-dispatch run as inputs to PD PASA.

76 For further information see www.aemo.com.au/data/stpasa.shtml.

B.4.5 Pre-dispatch

Pre-dispatch is an aggregate supply and demand balance comparison for each half-hour of the next day. It contains forecasts of market price and its sensitivity to changes in demand. Forecasts of individual scheduled generators and scheduled loads are presented to relevant participants, but not to other parties until the following day.

Demand forecasts are prepared by AEMO. Generation and demand-side availabilities are submitted by participants. The effects of transmission outages scheduled by TNSPs are incorporated. Forecasts of reserves in each region are also published. Scheduled outages should not breach the power system security and reliability standards.

Pre-dispatch information is used to assist participants in optimising very short-term physical and commercial planning for maintenance, production planning and load management activities in conjunction with the other information mechanisms available.

There is also a five minute pre-dispatch process designed to enhance information on demand and supply for the subsequent hour. This is particularly significant for the operation of fast start generators.

B.4.6 Demand forecast assessment

Figure B.2 to Figure B.6 depict the demand forecast four hours ahead for the summer period to assess whether forecast performance varies with levels of demand. Note that the horizontal axis in each graph denotes the median value of demand.

For each region there are four graphs. The first graph examines the absolute deviations for equal sized samples of demand. Demand is grouped into samples of tenth percentile, with the median values of each grouped sample shown on the horizontal axis of the graph. For each group of demand samples, the average and maximum forecast demand deviations are plotted.

The second graph shows the top 10 per cent of actual demand in one percentage groupings.

The third graph examines raw deviations in tenth percentile groupings and plots the average raw deviation and the maximum demand forecast deviation for each grouped sample. Similarly, the fourth graph plots the raw deviations in one percentile groups for the top tenth percentile demand level. Any underlying bias (imbalance of overs and unders) in forecasting would be expected to show up here.

The graphs for each region show that forecasting is generally less reliable towards the top end of demand.

The 2011-2012 graph for Queensland shows an anomaly in the demand forecasts. A system error occurred associated with the data upload software in the AEMO forecasting system on 2 February 2012. The error resulted in demand underestimations of up to 4200 MW. Market notices were published by AEMO at the time. The error did not occur in dispatch and there were no system security or reliability impacts resulting from the forecast deviation. AEMO has advised that the software problem was rectified and it does not expect the issue to happen again. This maximum deviation of 4200 MW is not shown in the graphs as it would distort the scale.

Figure B.2 Queensland demand forecast deviation four hours ahead

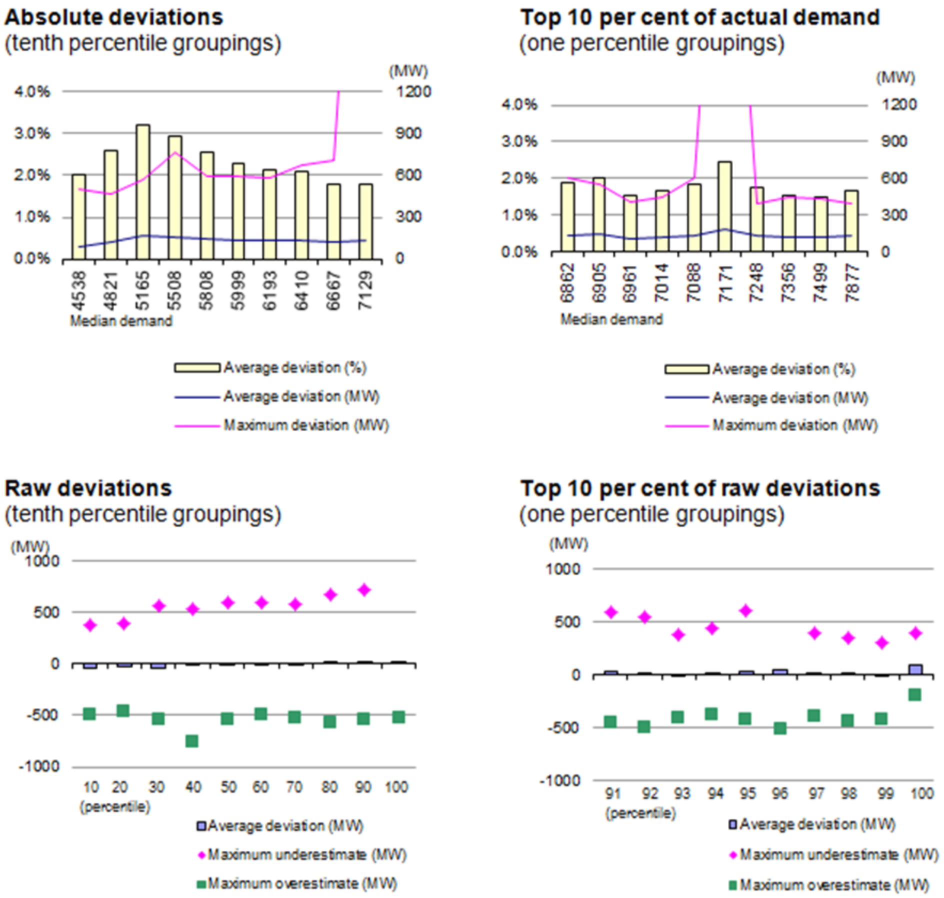


Figure B.3 New South Wales demand forecast deviation four hours ahead

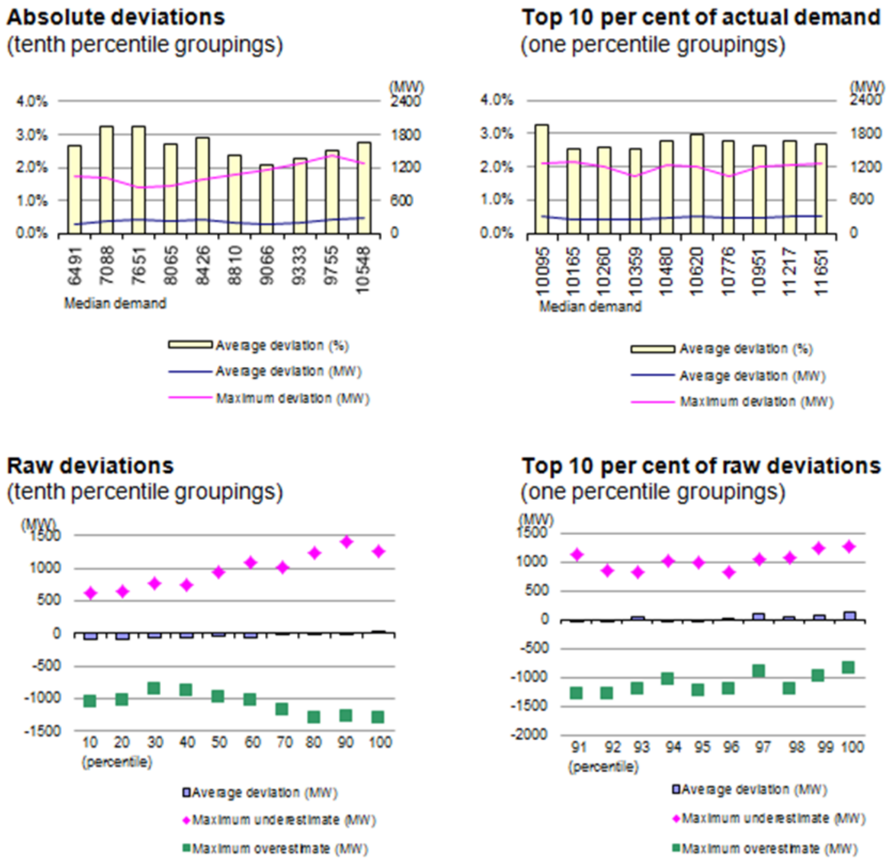


Figure B.4 Victoria demand forecast deviation four hours ahead

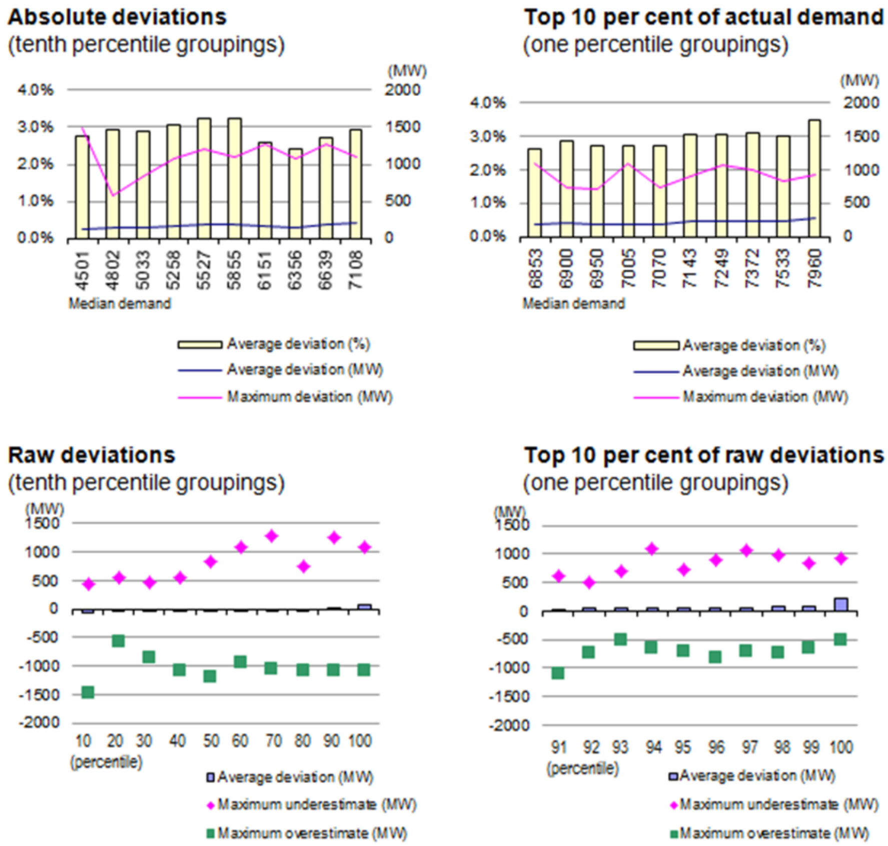


Figure B.5 South Australia demand forecast deviation four hours ahead

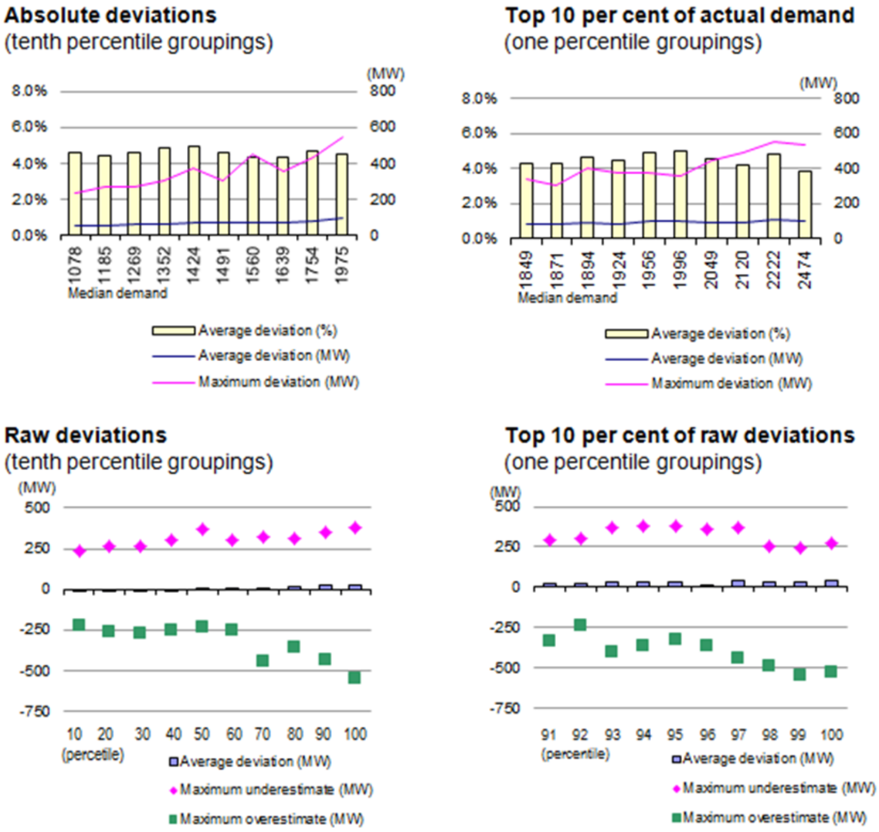
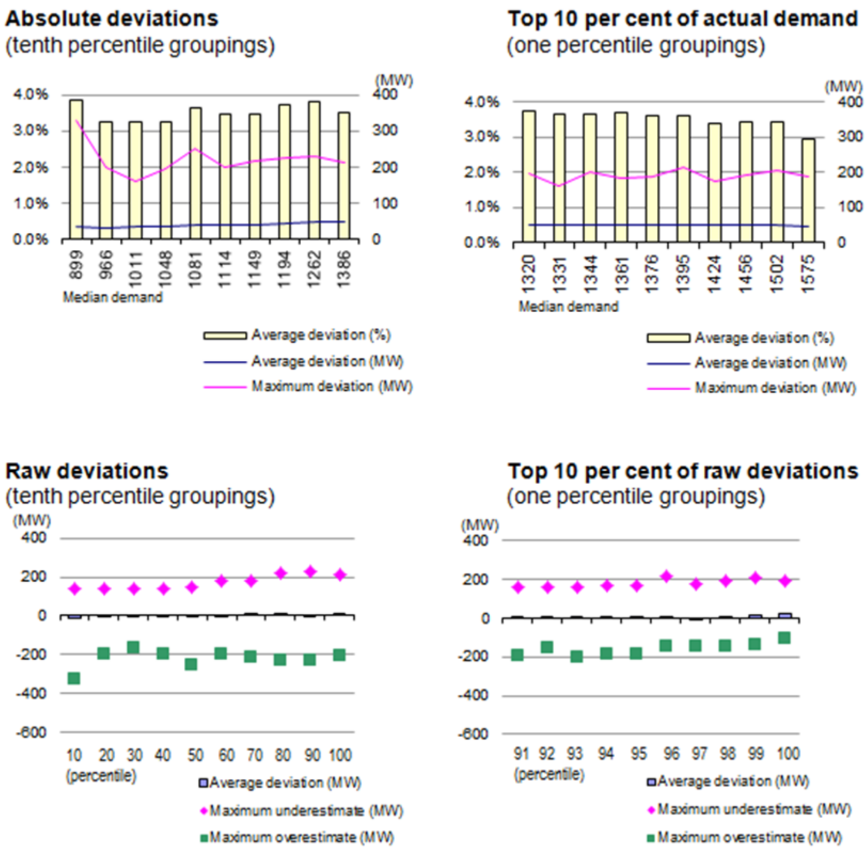


Figure B.6 Tasmania demand forecast deviation four hours ahead



B.4.7 Market notices

Market notices are ad hoc notifications of events that impact on the market, such as advance notice of Low Reserve Conditions, status of market systems, or price adjustments. They are electronically issued by AEMO to market participants to allow them a more informed market response.

There were 3577 market notices issued by AEMO during the 2011-2012 financial year. These notices are summarised by type in Table B.1.

Table B.1 Market notices

Type of notice	Number of notices
Administered Price Cap	0
General notice	221
Inter-regional transfer	268
Market intervention	0
Market systems	97
Manual priced dispatch Interval	1
NEM systems	0
Non-conformance	1270
Power system events	59
Price adjustment	1
Process review	0
Reclassify contingency	880
Reserve notice	291
Settlements residue	81
Total	3577

Source: AER

Overall, market notices are considered to be an effective method of communicating with market participants and the wider public. The quality of the notices, and/or their timeliness has not been considered by the Panel in its assessment.

C System security performance - detailed background information

This appendix provides detailed background information on system security management and measuring power system security performance. For a discussion of the Panel's assessment of performance in the 2011-2012 financial year, please refer to Chapter 6.

C.1 Security management

Maintaining the security of the power system is one of AEMO's key objectives. The power system is deemed secure when all equipment is operating within safe loading levels and will not become unstable in the event of a single credible contingency. Secure operation depends on the combined effect of controllable plant, ancillary services, and the underlying technical characteristics of the power system plant and equipment.

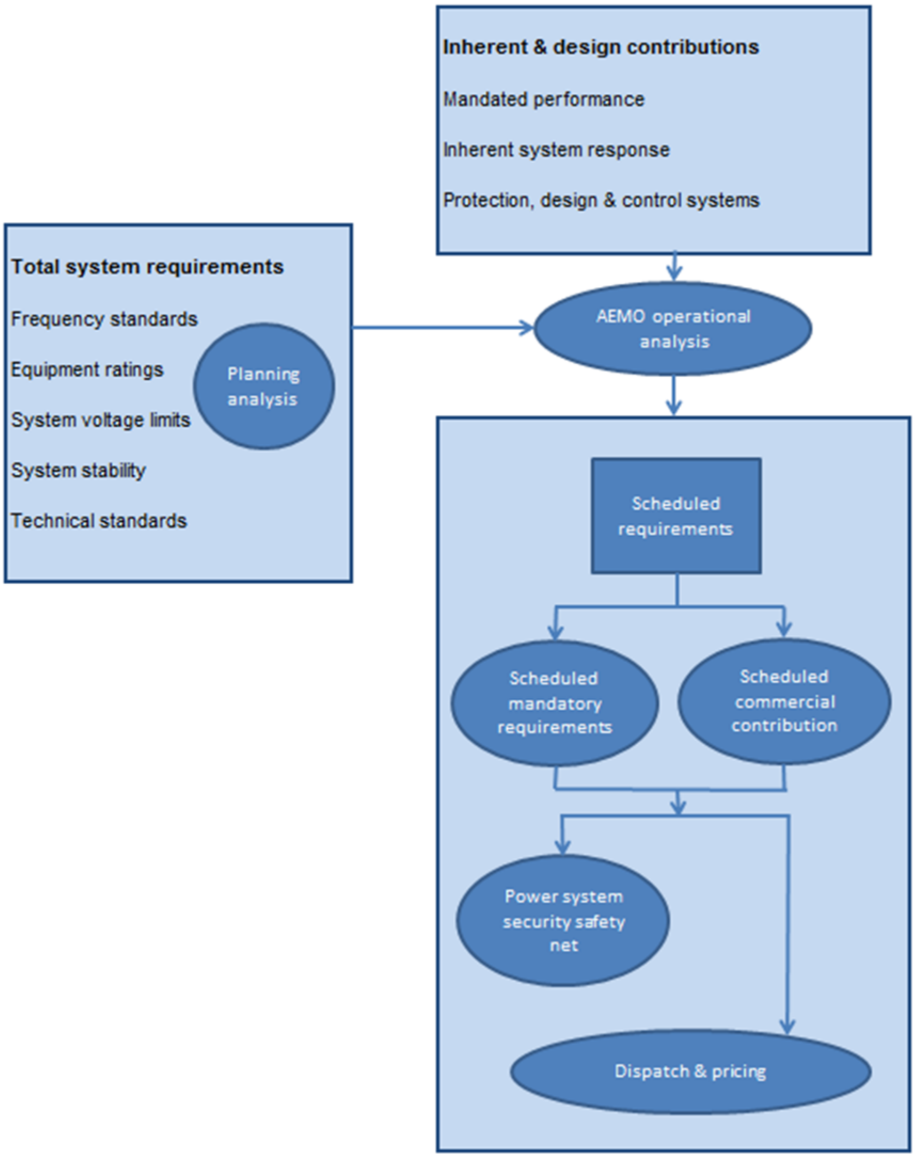
AEMO determines the total technical requirements for all services needed to meet the different aspects of security from: the Panel's power system security and reliability standards; market rules obligations; knowledge of equipment performance; design characteristics; and modelling of the dynamic behaviour of the power system. This allows AEMO to determine the safe operating limits of the power system and associated ancillary service requirements.

Some of the requirements are inherent in the frequency sensitivity of demand and generator plant, for example, the inertia of generator rotors. Others rely on the correct operation of network protection and control schemes. The rest are procured as part of the scheduling process from commercial ancillary services, the mandatory capability of generators and, as a last resort, load shedding arrangements. If necessary, AEMO may direct participants to provide services.

There is some scope for scheduled sources to make good on any deficiencies from inherent and designed sources. It is not always feasible, however, to pre-test or measure every possible contribution without the test itself threatening security. Consequently, there is heavy reliance on measurements from the occasional system disturbance.

Figure C.1 illustrates the overall arrangements for security. The operation of each element is explained and analysed in this section.

Figure C.1 Security model



C.2 System technical requirements

To meet the power system security standards, a number of technical requirements must be satisfied. They include the technical standards, frequency operating standards, equipment ratings, system voltage limits, system stability criteria, and generator performance standards. These requirements are addressed by AEMO as part of its planning and operational activities and are discussed below.

C.2.1 Technical standards framework

The technical standards framework is designed to maintain the security and integrity of the power system by establishing clearly defined standards for the performance of the system overall. The framework comprises a hierarchy of standards:

- **System standards** define the performance of the power system and the quality of power supplied.
- **Access standards** specify the quantified performance levels that plant (consumer, network or generator) must have in order to connect to the power system.
- **Plant standards** set out the technology specific standards that, if met by particular facilities, would ensure compliance with the access standards.

The system standards comprise standards covering:

- frequency;
- system stability;
- power frequency voltage;
- voltage fluctuations;
- voltage waveform distortion;
- voltage unbalance; and
- fault clearance times.

The access standards define the range within which power operators may negotiate with network service providers, in consultation with AEMO, for access to the network. AEMO and the relevant network service provider need to be satisfied that the outcome of these negotiations is consistent with their achieving the overall system standards. The access standards also include minimum standards below which access to the network will not be allowed.

The system and access standards are tightly linked. For example, the access standard is designed to meet the frequency operating standards, which is a system standard. In defining the frequency operating standards, consideration would need to be given to the cost of plant in meeting the required access standards.

The plant standards can be used for new or emerging technologies, such as wind power. The standard allows a class of plant to be connected to the network if that plant meets some specific standard such as an international standard. To date, the Panel has not been approached to consider a plant standard.

C.2.2 Registered performance standards

The performance of all generating plant must be registered with AEMO as a performance standard. Registered performance standards represent binding obligations. To ensure a plant meets its registered performance standards on an ongoing basis, participants are also required to set up compliance monitoring programmes. These programmes must be lodged with AEMO. It is a breach of the Rules if plant does not continue to meet its registered performance standards and compliance programme obligations.

The technical standards regime, which came into effect in late 2003, "grandfathered" the performance of existing plant. This established a process to specify the registered standard of existing plant as the capability defined through any existing derogation, or connection agreement or the designed plant performance.[77]

A plant's performance standard once set, does not vary unless an upgrade is required, which would need a variation in the connection agreement.

Changes to performance standards

The AEMC has conducted a number of reviews which have resulted in some changes to the process where the performance standards of a generator are registered. They include:

- Review into the enforcement of and compliance with technical standards;[78]
- Technical Standards for Wind and Other Generator Connections Rule change;[79]
- Resolution of Existing Generator Performance Standards Rule change;[80]
- Performance Standard Compliance of Generators Rule change;[81]and
- Reliability Panel Technical Standards Review.[82]

In addition, the Panel undertook and completed a review into a program for generator compliance. This culminated in the construction of a Template for Generator Compliance Programs that was published by the Panel in July 2009. The Panel performed its first review of the template in 2011-2012 and adopted a template with minor amendments in its June 2012 final report.[83]

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77 While the changes to the Rules were introduced in March 2003, the period between November 2003 and November 2004 allowed for all existing generators to register their existing performance with NEMMCO.

78 AEMC 2006, Review of enforcement of and compliance with technical standards, Report, 1 September 2006, Sydney, www.aemc.gov.au/Market-Reviews/Completed/Review-into-the-enforcement-of-and-compliance-with-technical-standards.html.

79 AEMC 2007, National Electricity Amendment (Technical Standards for Wind and other Generator Connections) Rule 2007, Rule Determination, 8 March 2007, Sydney, www.aemc.gov.au/Electricity/Rule-changes/Completed/Technical-Standards-for-Wind-Generation-and-Other-Generator-Connections.html.

80 AEMC 2006, National Electricity Amendment (Resolution of existing generator performance standards) Rule 2006 No. 21, Rule Determination, 7 December 2006, Sydney, www.aemc.gov.au/Electricity/Rule-changes/Completed/Resolution-of-existing-generator-performance-standards.html.

81 AEMC 2008, National Electricity Amendment (Performance Standard Compliance of Generators) Rule 2008 No. 10, 23 October 2008, Sydney, www.aemc.gov.au/Electricity/Rule-changes/Completed/Performance-Standard-Compliance-of-Generators.html.

82 AEMC Reliability Panel, Reliability Panel Technical Standards Review, Final Report, 30 April 2009, Sydney, www.aemc.gov.au/Market-Reviews/Completed/Reliability-Panel-Technical-Standards-Review.html.

83 The Panel's final report is available on the AEMC website under the project reference: "REL0047".

C.2.3 Frequency operating standards

Control of power system frequency is crucial to security. To this end, the Panel determines the frequency operating standards that cover normal conditions, as well as the period following critical events when frequency may be disturbed. The frequency operating standards also specify the maximum allowable deviations between Australian Standard Time and electrical time (based on the frequency of the power system). The frequency operating standards are the basis for determining the level of quick acting response capabilities, or ancillary service requirements necessary to manage frequency. Tasmania has separate frequency operating standards to the mainland NEM.

The frequency operating standards require that during periods when there are no contingency events or load events, the frequency must be maintained within the normal operating frequency band (49.85 Hz to 50.15 Hz in both Tasmania and the NEM mainland) for no less than 99 per cent of the time. The frequency operating standards also require that following a credible contingency event, the system frequency should not exceed the normal operating frequency excursion band for more than five minutes on any occasion. Following either a separation or multiple contingency event, the system frequency should not exceed the normal operating frequency excursion band for more than ten minutes.

NEM mainland frequency operating standards

The frequency operating standards that apply on the NEM mainland to any part of the power system other than an island are shown in Table C.1.

Table C.1 NEM mainland frequency operating standards (except "islands")

Condition	Containment	Stabilisation	Recovery
Accumulated time error	5 seconds	n/a	n/a
No contingency event or load event	49.75 to 50.25 Hz[84] 49.85 to 50.15 Hz 99% of the time[85]	49.85 to 50.15 Hz within 5 minutes	
Generation event or load event	49.5 to 50.5 Hz	49.85 to 50.15 Hz within 5 minutes	
Network event	49 to 51 Hz	49.5 to 50.5 Hz within 1 minute	49.85 to 50.15 Hz within 5 minutes
Separation event	49 to 51 Hz	49.5 to 50.5 Hz within 2 minutes	49.85 to 50.15 Hz within 10 minutes
Multiple	47 to 52 Hz	49.5 to 50.5 Hz within	49.85 to 50.15 Hz

84 This is known as the normal operating frequency excursion band.

85 This is known as the normal operating frequency band.

Condition	Containment	Stabilisation	Recovery
contingency event		2 minutes	within 10 minutes

The frequency operating standards that apply on the NEM mainland to any part of the power system that is islanded are shown in Table C.2.

Table C.2 NEM mainland frequency operating standards for "island" conditions

Condition	Containment	Stabilisation	Recovery
No contingency event or load event	49.5 to 50.5 Hz	n/a	
Generation event, load event or network event	49 to 51 Hz	49.5 to 50.5 Hz within 5 minutes	
The separation event that formed the island	49 to 51 Hz or a wider band notified to AEMO by a relevant Jurisdictional Coordinator	49.0 to 51.0 Hz within 2 minutes	49.5 to 50.5 Hz within 10 minutes
Multiple contingency event including a further separation event	47 to 52 Hz	49.0 to 51.0 Hz within 2 minutes	49.5 to 50.5 Hz within 10 minutes

On 16 April 2009 the Panel published its final determination for the review of the mainland frequency operating standards during periods of supply scarcity. In its final determination, the Panel amended the frequency operating standards for the NEM mainland that apply in an islanded region during periods of load restoration. Table C.3 outlines the minimum allowable frequency for a single generator contingency event during load restoration, following an islanding event. That is:

- 48.0 Hz for the Queensland and South Australia regions;
- 48.5 Hz for the New South Wales and Victoria regions; and
- in cases where an island incorporates more than one region, the critical frequency to be adopted is the maximum value of the critical frequencies for these regions.

Table C.3 NEM mainland frequency operating standards during supply scarcity

Condition	Containment	Stabilisation	Recovery
No contingency event or load event	49.5 to 50.5 Hz	n/a	
Generation event, load event or	48 to 52 Hz (Queensland and	49.0 to 51.0 Hz within 2 minutes	49.5 to 50.5 Hz within 10 minutes

Condition	Containment	Stabilisation	Recovery
network event Refer to notes below for specific requirements to be satisfied prior to use of this provision	South Australia) 48.5 to 52 Hz (New South Wales and Victoria)		
Multiple contingency event or separation event	47 to 52 Hz	49.0 to 51.0 Hz within 2 minutes	49.5 to 50.5 Hz within 10 minutes

The mainland frequency operating standards during supply scarcity apply if:

1. a situation of supply scarcity is current;
2. in cases where an island incorporates more than one region, then the critical frequency to be adopted is the maximum value of the critical frequencies for these regions (e.g. for an island comprised of the regions of Victoria and South Australia the critical frequency would be 48.5 Hz);
3. the power system has undergone a contingency event, the frequency has reached the recovery frequency band and AEMO considers the power system is sufficiently secure to begin load restoration;
4. the estimated amount of load available for under-frequency load shedding within the power system or the island is more than the amount required to ensure that any subsequent frequency excursions would not go below the proposed Containment and Stabilisation bands as a result of a subsequent generation event, load event, network event or a separation event during load restoration; or
5. the amount of generation reserve available for frequency regulation is consistent with AEMO's current practice.

Tasmanian frequency operating standards

Although Tasmania is a part of the NEM, the Tasmanian power system is not synchronised with that of the NEM mainland. This is due to the Basslink interconnector between the two systems being an asynchronous direct current (DC) connection.

The frequency operating standards adopted in Tasmania allow for wider variations than the NEM mainland equivalents. This is due to the State's small size, predominately hydro-electric generation mix and the relatively large contingencies that can occur there. Importantly, Tasmanian consumers have not experienced any significant problems as a result of the wider range of frequencies.

On 18 December 2008, the Panel submitted its final report outlining the amended frequency operating standards to apply in Tasmania to the AEMC for publication.[86] The amended frequency operating standards for Tasmania took effect on 28 October 2009. The frequency operating standards that apply in Tasmania to any part of the power system other than an island are shown in Table C.4.

Table C.4 Tasmanian frequency operating standards (except "islands")

Condition	Containment	Stabilisation	Recovery
Accumulated time error	15 seconds		
No contingency event or load event	49.75 to 50.25 Hz, 49.85 to 50.15 Hz 99% of the time	49.85 to 50.15 Hz within 5 minutes	
Load and generation event	48.0 to 52.0 Hz	49.85 to 50.15 Hz within 10 minutes	
Network event	48.0 to 52.0 Hz	49.85 to 50.15 Hz within 10 minutes	
Separation event	47.0 to 55.0 Hz	48.0 to 52.0 Hz within 2 minutes	49.85 to 50.15 Hz within 10 minutes
Multiple contingency event	47.0 to 55.0 Hz	48.0 to 52.0 Hz within 2 minutes	49.85 to 50.15 Hz within 10 minutes

The size of the largest single generator event is limited to 144 MW,[87] which can be implemented for any generating system with a capacity that is greater than 144 MW by the automatic tripping of load.

86 AEMC 2008, Review of Frequency Operating Standards for Tasmania , Final Report, 18 December 2008, Sydney, Appendix A. http://www.aemc.gov.au/Market-Reviews/Completed/Review-of-Frequency-Operating-Standards-for-Tasmania.html.

87 AEMO may, in accordance with clause 4.8.9 of the rules, direct a Generator to exceed 144 MW contingency limit if AEMO reasonably believes this would be necessary in order to maintain a reliable operating state.

The frequency operating standards that apply in Tasmania to any part of the power system that is islanded are outlined in Table C.5.

Table C.5 Amended Tasmanian frequency operating standards for "island" conditions

<table>
<tr><th>Condition</th><th>Containment</th><th>Stabilisation</th><th>Recovery</th></tr>
<tr><td>No contingency event or load event</td><td>49.0 to 51.0 Hz</td><td colspan="2"></td></tr>
<tr><td>Load and generation event</td><td>48.0 to 52.0 Hz</td><td colspan="2">49.0 to 51.0 Hz within 10 minutes</td></tr>
<tr><td>Network event</td><td>48.0 to 52.0 Hz</td><td colspan="2">49.0 to 51.0 Hz within 10 minutes</td></tr>
<tr><td>Separation event</td><td>47.0 to 55.0 Hz</td><td>48.0 to 52.0 Hz within 2 minutes</td><td>49.0 to 51.0 Hz within 10 minutes</td></tr>
<tr><td>Multiple contingency event</td><td>47.0 to 55.0 Hz</td><td>48.0 to 52.0 Hz within 2 minutes</td><td>49.0 to 51.0 Hz within 10 minutes</td></tr>
</table>

The size of the largest single generator event is limited to 144 MW,[88] which can be implemented for any generating system with a capacity that is greater than 144 MW by the automatic tripping of load.

C.2.4 System stability

Transferring large amounts of electricity between generators and consumers over a wide area presents technical challenges to stability of the power system. One of AEMO's core obligations is to ensure that stability of the power system is maintained. The primary means of achieving this is to carry out technical analysis of threats to stability. Under the rules, generators and TNSPs monitor indicators of system instability and report their findings to AEMO. AEMO then analyses the data to determine whether the standards have been met. AEMO also uses this data to confirm and report on the correct operation of protection and control systems.

AEMO has a number of real time monitoring tools which help it meet its security obligations and which provide valuable feedback on the planning process. These tools include State estimator, power flow and contingency analysis software. In recent years, AEMO has introduced a number of additional tools.

The first consists of monitoring equipment that detects oscillatory disturbances on the power system that could lead to a security threat. This equipment, set up in conjunction with Powerlink, measures small changes in the power flow on key interconnectors and analyses these changes to determine the state of the power system. A system upgrade in 2006-2007 permitted a larger number of locations to be observed simultaneously and to enhance historical analysis of power system oscillatory stability.

The second key security analysis tool is the online DSA tool. The DSA uses real time data from the AEMO energy management system to simulate the behaviour of the power system for a variety of critical network, load and generator faults. This type of

88 Ibid.

analysis has traditionally been performed by off-line planning staff. The DSA tool uses actual system conditions and network configuration to automatically assess the power system.

In addition, AEMO has been working with TNSPs to develop a NEM-wide high speed monitoring system (HSM). The HSM complements AEMO’s oscillatory stability monitoring capability and enhances observability of power system disturbances in operational time frames and for post contingency analysis.

AEMO's review of significant events in recent times showed system damping times were generally within the stipulated requirements. However, AEMO has highlighted the need to maintain adequate monitoring using high speed monitors and advanced analysis techniques to ensure that causes of poor damping can be located and addressed in a timely manner.

There have been a number of occasions (including difficult to predict, unlikely and unknown cases) when these real-time monitoring tools identified the need to reduce transfer capability. On these occasions, the power system conditions at the time were used to review limits and constraints. It is important for transparency and predictability in dispatching the market, to ensure that these more restrictive limits are fed back into the processes for determining limits and constraint equations are used to manage those limits.

Some dispatch scenarios and power system configurations were not considered when system limits were originally determined. Online real time monitoring allows for these scenarios to be defined and fed back to the relevant TNSP. This real time monitoring is an important tool for circumstantial indication of security in particular cases. However, it might not concur that significant increase in analysis for the '–1' condition would be of greater benefit. A higher level of 'N-X' limit analysis might mean an exponential increase in the amount of work to derive and implement and even then, might result in a very conservative market impact.

D Network performance

While the Panel is responsible for dealing with reliability and security matters in the wholesale bulk electricity market and the transmission network, the ultimate level of reliability and security which consumers receive is also impacted by the performance of the local transmission and distribution network. Although the Panel is not involved with local supply matters, this section includes an overview of the jurisdictional arrangements for managing the reliability performance of the NEM transmission and distribution networks.

D.1 Transmission network performance

D.1.1 Transmission - Queensland[89]

The mandated reliability obligations and standards are contained in Schedule 5.1 of the rules, the Queensland Electricity Act, Powerlink's transmission authority, and in connection agreements with the distribution networks. In addition, the AER sets and administers reliability-based service standards targets which involve an annual financial incentive (bonus/penalty).

Consistent with the rules, its Transmission Authority requirements and connection agreements with Energex, Ergon Energy and Essential Energy, Powerlink plans future network augmentations so that the reliability and power quality standards of Schedule 5.1 of the rules can be met during the worst single credible fault or contingency (n–1 conditions) unless otherwise agreed with affected participants. This is based on satisfying the following obligations:

- to ensure as far as technically and economically practicable that the transmission grid is operated with enough capacity (and if necessary, augmented or extended to provide enough capacity) to provide network services to persons authorised to connect to the grid or take electricity from the grid (Electricity Act 1994, S34(2));
- the transmission entity must plan and develop its transmission grid in accordance with good electricity industry practice such that … the power transfer available through the power system will be adequate to supply the forecast peak demand during the most critical single network element outage (Transmission Authority No T01/98, S6.2(c)); and
- the Connection Agreements between Powerlink and Energex, Ergon Energy and Essential Energy include obligations regarding the reliability of supply as required under Schedule 5.1.2 of the rules. Capacity is required to be provided such that forecast peak demand can be supplied with the most critical element out of service, i.e. n–1. Following the EDSD report in 2004, Energex and Ergon are required to plan their subtransmission networks (which interact with the Powerlink transmission network) to the n–1 criterion.

89 This section has been completed with the assistance of Powerlink.

D.1.2 Transmission - New South Wales[90]

TransGrid is obliged to meet the requirements of Schedule 5.1 of the rules. In addition to meeting requirements imposed by the rules, connection agreements, environmental legislation and other statutory instruments, TransGrid must meet the statutory obligations contained in the New South Wales Electricity Supply (Safety and Management) Regulation 2008. This includes lodging and then complying with a Network Management Plan with the Department of Trade and Investment (DT&I). TransGrid issued an updated Network Management Plan in early 2011. The plan is required to be reviewed every two years and a new plan is currently being prepared.

In accordance with a direction on behalf of the NSW Government issued by the Director General of Industry and Investment NSW on 23 December 2010, TransGrid's current Network Management Plan sets out TransGrid's network planning approach to ensure the Government's Transmission Design Reliability Standard for NSW – December 2010 are fully implemented. The legal authority for the Reliability Design Standard for NSW arises from the operation of Electricity Supply (Safety and Network Management Plan) Regulation 2008. Accordingly, the Transmission Design Reliability Standard for NSW – December 2010 represents legal obligations that must be met by TransGrid.

In general terms this Standard requires TransGrid to plan and develop its transmission network on an "–1" basis, except under conditions such as radial supplies, inner metropolitan areas, and the CBD. Transmission network developments servicing the inner metropolitan and CBD areas are planned on a modified "–2" basis or, when required, to accommodate AEMO's operating practices. Furthermore, this Standard interlinks TransGrid's planning obligations with the distribution licence obligations imposed on all distribution network service providers in NSW. The specific requirements are set out in TransGrid's Network Management Plan.[91]

D.1.3 Transmission - Victoria[92]

AEMO is responsible for planning and directing augmentations of the Victorian electricity declared shared network in accordance with its obligations under the rules.

AEMO publishes a Victorian Annual Planning Report (VAPR), which provides forecasts for energy demand and supply, identifies existing and emerging transmission network limitations and future transmission development needs for the declared shared network.

AEMO assesses new augmentations under the RIT-T as specified by the AER. In accordance with the RIT-T requirements, AEMO identifies the benefits of various network and non-network investment options using a probabilistic planning process that calculates, amongst other things, reduction in expected unserved energy,

90 This section has been completed with the assistance of TransGrid.

91 TransGrid's Network Management Plan can be located on TransGrid's website www.transgrid.com.au.

92 This section has been completed with the assistance of AEMO.

reduction in generation fuel costs, transmission loss reductions, and capital plant deferrals. These benefits are then balanced against the cost of investments, and if a transmission augmentation is selected AEMO proceeds with the credible option that delivers the highest net economic benefit out of the range of options.

AEMO calculates the benefits of reductions in expected unserved energy by application of a value of customer reliability (VCR). AEMO also considers a sector specific VCR where the transmission constraint affects only a reasonably distinguishable subset of the load.

D.1.4 Transmission - South Australia[93]

In addition to the reliability performance obligations set out in Schedule 5.1 of the rules, ElectraNet is also subject to the Electricity Transmission Code (ETC) administered by the Essential Services Commission of South Australia (ESCOSA)[94]. The ETC sets specific reliability standards which are determined probabilistically and expressed on a deterministic basis (N, –1, –2 etc) for each transmission exit point. ElectraNet also participates in the Service Targets Performance Incentive Scheme administered by the AER, which applies an annual financial incentive (bonus/penalty) based on performance against reliability-based service standards targets.

ESCOSA concluded a review of the specific reliability standards under clause 2.2.2 of the ETC in 2006. The associated changes to the ETC took effect from 1 July 2008 to align with the AER's current revenue determination for ElectraNet.[95] As part of the review, ESCOSA sought to clarify network reliability standards for the Adelaide CBD, which is supplied jointly by ElectraNet and ETSA Utilities. Under the terms of the ETC, ElectraNet was required to install a new transmission connection point to the CBD by the end of 2011. This augmentation was completed in December 2011.

ESCOSA has completed its subsequent 5-year review of the specific reliability standards under clause 2.2.2 of the ETC[96] and published a revised version of the ETC[97] that will take effect from 1 July 2013, aligning with the start date of the next revenue determination for ElectraNet. This review resulted in additional clarity of accountabilities for the maintenance of reliability standards together with minor changes to the reliability standards at a small number of connection points.

93 This section has been completed with the assistance of ElectraNet.

94 ESCOSA, 2008, Electricity Transmission Code, http://www.escosa.sa.gov.au/library/110628-ElectricityTransmissionCode_ETC06.pdf.

95 ESCOSA, 2006, Review Of The Reliability Standards Specified In Clause 2.2.2 Of The Electricity Transmission Code Final Decision, http://www.escosa.sa.gov.au/webdata/resources/files/060906-R-ReviewReliabilityElectricityTransmissionCodeFinalDec.pdf.

96 ESCOSA 2012, Review of the Electricity Transmission Code, http://escosa.sa.gov.au/projects/165/review-of-the-electricity-transmission-code.aspx.

97 ESCOSA, 2013, Electricity Transmission Code,http://www.escosa.sa.gov.au/library/120217-ElectricityTransmissionCode-TC07_0.pdf.

D.1.5 Transmission - Tasmania[98]

In addition to the network performance requirements located in Schedule 5.1 of the rules, Transend is obliged to meet the requirements of its transmission licence, ESI (Network Performance Requirements) Regulations 2007, and the terms of its connection agreements. The connection agreements between Transend and its customers include obligations regarding the reliability of supply as required under Chapter 5 of the rules.

The objective of the ESI (Network Performance Requirements) Regulations 2007 is to specify the minimum network performance requirements that a planned power system of a TNSP must meet in order to satisfy the rules. Transend is required by the terms of its licence to plan and procure all transmission augmentations to meet these network performance requirements. Transend publishes an Annual Planning Review, which includes discussion of any forecast supply shortfalls against the ESI (Network Performance Requirements) Regulations 2007, and proposed remedial actions.

The Tasmanian Government's Department of Energy, Industry and Resources has undertaken a review of the requirements of the ESI (Network Performance Requirements) Regulations 2007. The Review's findings recommended some changes to the Regulations to account for changes in the regulatory environment since 2007 (most notably the introduction of the RIT-T) and some clarification in wording and definitions. The Review found no need to change the current performance requirements.

The AER's Service Target Performance Incentive Scheme (STPIS) sets and administers reliability based service standards targets which involve an annual financial incentive (bonus/penalty) incorporated in Transend's 2009 – 2014 revenue determination. The STPIS covers all prescribed transmission services except where transmission customers have agreed to varying levels of connection services under their connection agreements.

98 This section has been completed with the assistance of Transend.

D.2 Distribution network performance

All jurisdictions have their own monitoring and reporting frameworks for reliability of distribution networks, and in addition, the Steering Committee on National Regulatory Reporting Requirements (SCONRRR)[99] has adopted four indicators of distribution network reliability that are widely used in Australia and overseas.[100] These are the System Average Interruption Frequency Index (SAIFI), System Average Interruption Duration Index (SAIDI) and Customer Average Interruption Duration Index (CAIDI) and Momentary Average Interruption Frequency Index (MAIFI).[101] While all jurisdictions report on SAIDI and SAIFI, DNSP performance data may not be directly comparable between jurisdictions due to minor jurisdictional differences in approach, such as variation in inclusions and exclusions. In some cases, the data reported by each jurisdiction is subject to qualification. Stakeholders should refer to the respective jurisdictional publications for a detailed understanding of these variations.

D.2.1 Distribution - Queensland[102]

The Queensland *Electricity Act 1994* and the *Electricity Regulation 2006* define the arrangements for the Queensland DNSPs. Performance standards for Queensland DNSPs were introduced in September 2007.

The Queensland Electricity Industry Code (QEIC) requires that the Queensland Competition Authority review the Minimum Service Standards (MSS) and Guaranteed Service Level (GSL) requirements to apply at the beginning of each regulatory period. Following a review in early 2009,[103] the Queensland Competition Authority set the current MSS and GSL, which applied from 1 July 2010.

The MSS require gradual improvements in performance each year, although the MSS applying to Energex have recently been flat-lined at the 2011-2012 levels.[104] Reflecting the differences in their networks, the MSS for Energex are more stringent than those for Ergon Energy.

The DNSPs report quarterly to the Authority on their performance relative to their MSS. The Authority also monitors their GSL performance.

Table D.1 provides a summary of the performance of the Queensland DNSPs including target and actual performance for each DNSP.

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99 SCONRRR is a working group established by the Utility Regulators Forum.

100 Utility Regulators Forum, 2002, National regulatory reporting for electricity distribution retailing businesses, discussion paper.

101 See the Glossary for further information.

102 This section was prepared with the assistance of the Queensland Competition Authority.

103 Queensland Competition Authority, April 2009, Final Decision on the Review of Minimum Service Standards and Guaranteed Service Levels to Apply in Queensland from 1 July 2010, www.qca.org.au/electricity/service-quality/RevMinServStandLev.php.

104 This was to reflect the 2011 recommendations of the Electricity Network Capital Program Review. See: Electricity Network Capital Program Review 2011, Detailed report of the independent panel, released on 8 December 2011, available from: www.business.qld.gov.au.

Table D.1 Performance of the Queensland DNSPs for 2011-2012

DNSP	Feeder	SAIDI (minutes)		SAIFI (interruptions)	
		Target	Actual	Target	Actual
Energex	**CBD**	15	8.16	0.15	0.04
	urban	102	66.65	1.22	0.74
	short-rural	216	201.81	2.42	1.73
Ergon	**urban**	148	136.28	1.96	1.41
	short-rural	418	391.95	3.90	3.55
	long-rural	948	1041.58	7.30	7.02

SAIDI and SAIFI performance data for 2011-2012 were based on data provided by DNSPs under the QEIC. This data excludes certain interruptions, such as those caused by generators and transmission networks.

Table D.1 shows that Energex met its SAIDI and SAIFI targets for all feeder categories during 2011-2012. Ergon Energy met five out of its six MSS targets (the exception being long-rural SAIDI).

Ergon Energy's performance in 2011-2012 was consistent with its performance in 2010-2011 (where it also met five out of its six MSS targets) and a significant improvement on its performance in 2008-2009 and 2009-2010, where it only met one of its MSS targets.

Ergon Energy reported that its 2011-2012 long-rural performance was significantly impacted by adverse weather conditions and bush fires. While Ergon Energy reported that the impact of the most severe weather days was excluded in accordance with the exclusion criteria in the QEIC, it noted that there were several severe weather days which were close to meeting the exclusion criteria.

D.2.2 Distribution - New South Wales[105]

The Electricity Supply Act 1995 requires NSW DNSPs to be licenced. Network performance standards for the NSW DNSPs have been set by the Minister for Energy through licence conditions. These licence conditions were set in 2007 and are published on the Independent Pricing and Regulatory Tribunal's (IPART's) website (conditions (14-19).[106]

The performance of the NSW DNSPs against the performance standards is monitored by IPART by various means including:

- periodic self-exception reporting;
- compliance audits;
- Energy and Water Ombudsman's complaints;
- industry complaints; and
- media reports.

Table D.2 shows a summary of the performance of the New South Wales DNSPs including an overall target for each DNSP and the actual performance by feeder classification. More detailed performance information is available from network performance reports available on each of the DNSPs websites.

The DNSPs are required by the Electricity Supply (Safety and Network Management) Regulation 2008 to publish annual reports on network performance, against their Network Management Plans. IPART also produces a licence compliance report, which from 2007 includes compliance with the reliability standards.

The network performance standards are enforced under the Electricity Supply Act 1995, Schedule 2, clauses 8 and 8A. Under Schedule 2 clause 8, the Minister can impose fines or cancel a distribution licence if the holder of the licence has knowingly contravened the requirements of this Act or the regulations, the conditions of the licence, or an endorsement attached to the licence.

Table D.2 Performance of the New South Wales DNSPs for 2011-2012[107]

DNSP	Feeder	SAIDI (minutes)		SAIFI	
		Target	Actual	Target	Actual
Essential Energy (previously	Urban	125	80	1.8	1.16
	Short rural	300	238	3.0	2.21

105 This section was prepared with the assistance of the NSW Department of Trade and Investment, Regional Infrastructure and Services.

106 IPART is the independent body that oversees regulation of the water, gas, electricity and public transport industries in New South Wales.

107 The data in this table is based on the NSW Reliability Licence conditions criteria and methodology that differs from that used by, and reported to, the AER by the businesses.

DNSP	Feeder	SAIDI (minutes)		SAIFI	
		Target	Actual	Target	Actual
known as Country Energy)	Long rural	700	478	4.5	3.28
	All	n/a	237	n/a	2.14
Ausgrid (previously known as EnergyAustralia)	CBD	45	5.55	0.3	0.04
	Urban	80	72.42	1.2	0.83
	Short rural	300	156.12	3.2	1.74
	Long rural	700	527.33	6.0	4.64
	All	n/a	82.4	n/a	0.9
Endeavour Energy (previously known as Integral Energy)	Urban	80	60.9	1.2	0.8
	Short rural	300	183.4	2.80	1.84
	Long rural	n/a	322.3	n/a	3.1
	All	n/a	81.8	n/a	1.0
NSW	CBD	n/a	5.6	n/a	0.04
	Urban	n/a	69.4	n/a	0.85
	Short rural	n/a	207.9	n/a	2.02
	Long rural	n/a	478.7	n/a	3.31
	All	n/a	119.4	n/a	1.24

Table D.2 shows that Ausgrid, Essential Energy and Endeavour Energy each met all SAIDI and SAIFI targets for all feeder categories during 2011-2012.[108]

D.2.3 Distribution - Australian Capital Territory[109]

The Utilities Act (2000) underpins all codes and performance and compliance requirements for the Australian Capital Territory DNSP.

The Independent Competition and Regulatory Commission (ICRC) sets the performance standards for the Australian Capital Territory DNSP. These standards are

108 The Panel notes this is an improvement on 2010-2011, where Ausgrid did not meet its SAIDI targets for urban feeders due to a 7-day heatwave period (31 January to 6 February 2011).

109 This section was completed with the assistance of ActewAGL.

available in the Electricity Distribution Supply Standards Code[110] and in the Consumer Protection Code,[111] which also has minimum service standards.

The DNSP and other licensed utilities must report annually to the ICRC on their performance and compliance with their licence obligations. The ICRC publishes the results in its compliance and performance reports.

Table D.3 shows a summary of the performance of the Australian Capital Territory DNSP for 2011-12. More detailed performance information is available from network performance reports available on the ICRC website.

In comparison with the DNSP performance for the previous year, SAIDI performance improved for all categories. SAIFI performance improved for all categories except for Rural Short where there was a minor decrease attributed to unplanned interruptions.

Table D.3 Performance of the Australian Capital Territory DNSP 2011-12

Feeder		SAIDI (minutes)		SAIFI		CAIDI	
		Target	Actual	Target	Actual	Target	Actual
Urban	Overall	n/a	77.9	n/a	0.80	n/a	96.9
	Distribution network - planned	n/a	46.0	n/a	0.22	n/a	212.2
	Distribution network - unplanned	n/a	31.8	n/a	0.59	n/a	54.2
	Normalised distribution network - unplanned	n/a	31.8	n/a	0.59	n/a	54.2
Rural short	Overall	n/a	99.7	n/a	1.33	n/a	75.0
	Distribution network - planned	n/a	40.5	n/a	0.20	n/a	205.2
	Distribution network - unplanned	n/a	59.2	n/a	1.13	n/a	52.3
	Normalised distribution network - unplanned	n/a	59.2	n/a	1.13	n/a	52.3

110 ICRC, 2000, Electricity Distribution (Supply Standards) Code, http://www.icrc.act.gov.au/__data/assets/pdf_file/0016/16630/electricitydistributionsupplystandardscodecw.pdf.

111 ICRC, 2007, Consumer Protection Code, http://www.icrc.act.gov.au/__data/assets/pdf_file/0011/47909/Consumer_Protection_Code.pdf.

Feeder		SAIDI (minutes)		SAIFI		CAIDI	
		Target	**Actual**	**Target**	**Actual**	**Target**	**Actual**
Network	Overall	91.0	78.4	1.2	0.82	74.6	96.0
	Distribution network - planned	n/a	45.9	n/a	0.22	n/a	212.1
	Distribution network - unplanned	n/a	32.5	n/a	0.60	n/a	54.1
	Normalised distribution network - unplanned	n/a	32.5	n/a	0.60	n/a	54.1

D.2.4 Distribution - Victoria[112]

The following information relates to the 2011 calendar year.

The Electricity Industry Act 2000 and the Essential Services Commission Act 2001 cover the network performance requirements for the Victorian DNSPs. From 1 January 2009, responsibility for the compliance monitoring and enforcement of the DNSPs' distribution licence conditions was transferred from the Essential Services Commission of Victoria (ESC) to the AER.[113]

The ESC set performance targets for unplanned SAIFI, unplanned SAIDI and MAIFI for calculation of the financial incentive for improving supply reliability. The AER has set the revenue and service levels for the 2011–15 regulatory period. Information about the AER's 2011–15 distribution determination is available from the AER's website.[114]

The Victorian DNSPs had a long standing trend of improving performance in terms of the number of minutes-off-supply since accurate reporting began in 1996. However, from 2005 to 2009—in part due to extreme storms in 2008, the January heatwave in 2009 and other unusual events—there was an increasing trend in total minutes-off-supply.

In 2011, the overall reliability of electricity supply improved in terms of the average total minutes-off-supply experienced by a Victorian customer. The average total minutes-off-supply in 2011 was less than in 2010. All Victorian DNSPs reported a reduction in the number of minutes-off-supply in 2011 compared to 2010. CitiPower reported the greatest reduction in the average total minutes-off-supply in 2011 compared to 2010 of 44 per cent. The reliability of electricity supply appears to be returning to pre-2009 average levels, which suggests that 2009 was an abnormal year.

The enforcement of the network performance standards is through adjustment to the DNSP's revenue, based on the unplanned SAIDI, SAIFI and MAIFI values, performance of the distribution call centres, and through payments to customers where the GSL requirements are not met.

Table D.4 shows the performance data for the Victorian DNSPs with the impact of a number of extreme events excluded from the service performance data. The table includes target and actual performance values for each DNSP in Victoria. More detailed performance information is available from network performance reports available on the AER's website.

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112 This section was completed with the assistance of the AER. Latest available information has been used.

113 The ESC is still responsible for regulatory framework rule making regarding DNSPs' licence conditions in Victoria.

114 At http://www.aer.gov.au/networks-pipelines/determinations-and-access-arrangements.

Table D.4 Performance of the Victorian DNSPs for 2010 - impact of excluded events[115] removed

		SAIDI (minutes)				SAIFI			
		Unplanned		Planned		Unplanned		Planned	
DNSP	**Feeder**	**Target**	**Actual**	**Target**	**Actual**	**Target**	**Actual**	**Target**	**Actual**
Jemena	**Urban**	68.498	52.8	n/a	17.62	1.127	0.89	n/a	0.06
	Short rural	153.150	92.8	n/a	61.98	2.588	1.04	n/a	0.22
CitiPower	**CBD**	11.27	7.52	n/a	5.97	0.186	0.07	n/a	0.02
	Urban	22.36	26.00	n/a	6.62	0.45	0.48	n/a	0.02
Powercor	**Urban**	82.467	65.26	n/a	17.37	1.263	0.84	n/a	0.07
	Short rural	114.807	108.67	n/a	38.85	1.565	1.33	n/a	0.18
	Long rural	233.759	293.59	n/a	61.00	2.54	2.28	n/a	0.32
SP AusNet	**Urban**	101.803	78.459	n/a	911	1.448	1.029	n/a	0.349
	Short rural	208.542	196.095	n/a	143.865	2.632	2.406	n/a	0.575
	Long rural	256.578	236.669	n/a	199.005	3.378	3.143	n/a	0.908
United Energy	**Urban**	55.085	46.37	n/a	30.87	0.899	0.72	n/a	0.09

115 Excluded events are "upstream events", such as transmission outages and load shedding events, and "major event days" exceeding the relevant daily unplanned SAIFI thresholds set by the ESC for the 2006-2010 regulatory period.

		SAIDI (minutes)				SAIFI			
		Unplanned		Planned		Unplanned		Planned	
DNSP	Feeder	Target	Actual	Target	Actual	Target	Actual	Target	Actual
	Short rural	99.151	128.83	n/a	54.49	1.742	2.22	n/a	0.18

D.2.5 Distribution - South Australia[116]

Following amendments to the National Electricity (South Australia) Act 1996, and the National Electricity Law and National Electricity Rules (NER) made under that Act, new regulatory arrangements have been put into place in relation to distribution pricing arrangements for the 2010-2015 regulatory period. Whereas ESCOSA was formerly responsible for making the relevant price determination and setting all aspects of the Service Standard Framework, under the new arrangements the AER is responsible for making the price determination and setting the SI scheme element of the Service Standard Framework. The AER made a distribution determination for ETSA Utilities[117] for the 2010-2015 regulatory period in May 2010.

ESCOSA does, however, retain a central role in the regulatory process, insofar as it continues to be responsible for setting the remaining elements of the Service Standard Framework to apply to ETSA Utilities for the 2010-2015 regulatory period: the average service standards and the GSL scheme. In that context, the Commission remains responsible for setting the South Australian jurisdictional service standards to apply to ETSA Utilities.

The Commission has established annual standards for frequency and duration interruptions for seven geographic regions within the ETSA network; these are specified by the Commission as best endeavours annual targets in the Electricity Distribution Code. While there are no such annual targets specified for the entire network (state-wide), there are implied state-wide targets based on the customer-weighted averages of the implied regional targets; for the 2010-2015 regulatory period, these are 179 minutes per annum for duration interruptions and 1.68 interruptions per annum for frequency interruptions.

An outcome of the review of distribution service standards for 2010-2015 was that restoration targets would not be included and so 'time to restore supply performance' is no longer reported.

The Electricity Distribution Code establishes Guaranteed Service Level (GSL) payments, within Part B of the Electricity Distribution Code (the standard connection and supply contract between ETSA Utilities and its customers) in relation to a number of timeliness matters (e.g. timeliness of appointments; connections; and street light repair). It also requires the DNSP to make specified payments if the frequency of interruptions or the duration of any single interruption exceeds the thresholds set out in the Code. Following a review, from 1 July 2010 payments range from, $90 for a single outage which is 12-15 hours duration, to $370 for a single outage exceeding 24 hours and $90 for 9-12 interruptions per annum, to $185 for more than 15 interruptions per annum.

Also as part of the revised service standards arrangements, the Commission introduced a new reporting regime for poorly performing segments of the distribution network, assessed by reference to low reliability distribution feeders. This covers those

116 This section was completed with the assistance of ESCOSA.

117 ESTA Utilities is in the process of changing its name to SA Power Networks.

feeders that have an individual SAIDI outcome greater than 2.1 times the SAIDI target for the region that feeder is located, for at least 2 consecutive years.

DNSP reliability performance is reported to ESCOSA on a quarterly basis pursuant to Electricity Guideline 1. The DNSP and other regulated entities are required to provide verification of compliance with relevant regulatory obligations and codes on an annual basis pursuant to the requirements set out in Guideline 4. ESCOSA publishes the results in annual compliance and performance reports available from its website.

The performance of the South Australian DNSP for the 2011-2012 fiscal year is illustrated in Table D.5.

Table D.5 Performance of the South Australian DNSP for 2011-2012

Region	SAIDI (minutes)		SAIFI	
	Target	Actual	Target	Actual
Adelaide Business Area	25	12	0.25	0.14
Major Metropolitan Areas	130	104	1.45	1.21
Central	260	279	1.8	1.61
Eastern Hills/Fleurieu Peninsular	295	320	2.8	2.53
Upper North and Eyre Peninsular	425	382	2.3	1.71
South East	295	244	2.5	2.01
Kangaroo Island	450	337	n/a	n/a
Total network	179	159	1.68	1.40

D.2.6 Distribution - Tasmania[118]

The Tasmanian Economic Regulator sets network performance requirements through the Tasmanian Electricity Code (TEC), price determinations and regulations.

On 1 January 2008, the Regulator amended the TEC to incorporate new distribution network supply reliability standards, which were developed jointly by the Office of the Tasmanian Energy Regulator, the Tasmanian Office of Energy Planning and Conservation, and Aurora Energy. These form part of the price/service package reflected in the Regulator's 2007 price determination and are designed to align the reliability standards more closely to the needs of the communities served by the network. Further details on the standards are contained in Chapter 8 of the TEC.[119]

The distribution network supply reliability standards have two parts:

- minimum network performance requirements specified in the TEC for each of five community categories: Critical Infrastructure, High Density Commercial, Urban and Regional Centres, Higher Density Rural and Lower Density Rural; and
- a guaranteed GSL supported by the TEC and relevant guidelines.[120]

The following table shows the performance of the Tasmanian DNSPs against the network performance standards in the TEC that applied in 2011-2012.

Table D.6 Performance of the Tasmanian DNSP 2011-2012

Community category	SAIDI (minutes)		SAIFI	
	TEC (12 month category limit)	Performance	TEC (12 month category limit)	Performance
Critical infrastructure	30	24.65	0.20	0.22
High density commercial	60	31.99	1.00	0.27
Urban and regional centres	120	84.71	2.00	1.03
Higher density rural	480	258.9	4.00	2.29
Lower density rural	600	497.57	6.00	3.72

118 This section was completed with the assistance of the Office of The Tasmanian Energy Regulator.

119 Office of the Tasmanian Economic Regulator, 2005, Tasmanian Electricity Code, http://www.economicregulator.tas.gov.au.

120 Office of the Tasmanian Economic Regulator, 2007, Guideline - Guaranteed Service Level (GSL) Scheme, http://www.economicregulator.tas.gov.au.

In 2011-2012, the performance of all five community categories achieved the frequency and duration standards set by the TEC, except critical infrastructure which recorded a SAIFI of 0.22 interruptions against the standard of 0.20.

The following table shows the performance indices for each individual community in the Tasmanian region.

Table D.7 Individual community performance indices (2011-2012)

Community category	Average number of interruptions		Average minutes off supply		Total no. of communities below the limit for either frequency of duration	Total no. of communities below the limit in both frequency and duration
	TEC Community limit	No. of non-complying communities	TEC Community limit (mins)	No. of non-complying communities		
Critical infrastructure	0.2	1/1	30	0/1	1/1	0/1
High density commercial	2.0	0/8	120	1/8	1/8	0/8
Urban and regional centres	4.0	1/32	240	5/32	5/32	1/32
Higher density rural	6.0	3/33	600	3/33	4/33	2/33
Lower density rural	8.0	2/27	720	6/27	7/27	1/27
Total		7/101		15/101	18/101	4/101

A total of 18 communities were classified as poor performing due to exceeding the TEC limits of frequency or duration over the 12 month period ending 30 June 2012. These communities represent 12 per cent of the connected load in the distribution network.

The critical infrastructure community failed to meet the outage frequency standard due to an unplanned incident caused by operator error that resulted in supply being interrupted to the Hobart CBD for approximately 30 minutes.

There were 15 communities classified as poor performing based on the duration measure. Of the 15, five communities experienced major storm events that directly contributed to their poor performance. Two communities was classified as poor performing as they experienced prolonged outages due to a 'major event day' in the period. The remaining communities were classified as poor performing due to a combination of unplanned and planned outages.

E Glossary & Abbreviations

The following definitions are provided to assist the reader and should not be relied upon as the legal definition of the term. Formal definitions of some of these terms can be found in the rules. Some of these definitions have been sourced with permission from AEMO's ESOO.

E.1

Term	Explanation
AEMC	Australian Energy Market Commission
AEMO	Australia Energy Market Operator
AER	Australian Energy Regulator
available capacity	The total MW capacity available for dispatch by a scheduled generating unit or scheduled load (i.e. maximum plant availability) or, in relation to a specified price band, the MW capacity within that price band available for dispatch (i.e. availability at each price band).
busbar	A busbar is an electrical conductor in the transmission system that is maintained at a specific voltage. It is capable of carrying a high current and is normally used to make a common connection between several circuits within the transmission system. The rules define busbar as 'a common connection point in a power station switchyard or a transmission network substation'.
CAIDI	Customer Average Interruption Duration Index (CAIDI). The sum of the duration of each sustained customer interruption (in minutes) divided by the total number of sustained customer interruptions (SAIDI divided by SAIFI). CAIDI excludes momentary interruptions (one minute or less duration).
cascading outage	The occurrence of a succession of outages,

Term	Explanation
	each of which is initiated by conditions (e.g. instability or overloading) arising or made worse as a result of the event preceding it.
contingency events	These are events that affect the power system's operation, such as the failure or removal from operational service of a generating unit or transmission element. There are several categories of contingency event, as described below. **credible contingency event** A contingency event whose occurrence is considered "reasonably possible" in the circumstances. For example: the unexpected disconnection or unplanned reduction in capacity of one operating generating unit; or the unexpected disconnection of one major item of transmission plant. **non-credible contingency event** A contingency event whose occurrence is not considered "reasonably possible" in the circumstances. Typically a non-credible contingency event involves simultaneous multiple disruptions, such as the failure of several generating units at the same time.
directions	These are instructions NEMMCO issues to participants under clause 4.8.9 of the rules to take action to maintain or re-establish the power system to a secure operating state, a satisfactory operating state, or a reliable operating state.
dispatch	The act of initiating or enabling all or part of the response specified in a dispatch bid, dispatch offer or market ancillary service offer in respect of a scheduled generating unit, a scheduled load, a scheduled network service, an ancillary service generating unit or an ancillary service load in accordance with clause 3.8 (NER), or a direction or operation of capacity the subject of a reserve contract

Term	Explanation
	as appropriate.
distribution network	The apparatus, equipment, plant and buildings (including the connection assets) used to convey and control the conveyance of electricity to consumers from the network and which is not a transmission network.
DNSP	distribution network service provider
ESOO	Electricity Statement of Opportunities
frequency control ancillary services	Those ancillary services concerned with balancing, over short intervals, the power supplied by generators with the power consumed by loads (throughout the power system). Imbalances cause the frequency to deviate from 50 Hz.
interconnector	A transmission line or group of transmission lines that connect the transmission networks in adjacent regions.
jurisdictional planning body	The transmission network service provider responsible for planning a NEM jurisdiction's transmission network.
lack of reserve	This is when reserves are below specified reporting levels.
load	A connection point (or defined set of connection points) at which electrical power is delivered, or the amount of electrical power delivered at a defined instant at a connection point (or aggregated over a defined set of connection points).
load event	In the context of frequency control ancillary services, a load event: involves a disconnection or a sudden reduction in the amount of power consumed at a connection point and results in an overall excess of supply.
load shedding	Reducing or disconnecting load from the

Term	Explanation
	power system either by automatic control systems or under instructions from NEMMCO. Load shedding will cause interruptions to some energy consumers' supplies.
low reserve condition	This is when reserves are below the minimum reserve level.
MAIFI	Momentary Average Interruption Frequency Index (MAIFI). The total number of customer interruptions of one minute or less duration, divided by the total number of distribution customers.
medium-term Projected Assessment of System (medium-term PASA) (also see short-term PASA)	A comprehensive programme of information collection, analysis and disclosure of medium-term power system reliability prospects. This assessment covers a period of 24 months and enables market participants to make decisions concerning supply, demand and outages. It must be issued weekly by AEMO
minimum reserve level	The minimum reserve margin calculated by AEMO to meet the Reliability Standard.
Ministerial Council on Energy (MCE)	The MCE is the national policy and governance body for the Australian energy market, including for electricity and gas, as outlined in the COAG Australian Energy Market Agreement of 30 June 2004.
National Electricity Code	The National Electricity Code was replaced by the National Electricity rules on 1 July 2005.
National Electricity Market (NEM)	The National Electricity Market is a wholesale exchange for the supply of electricity to retailers and consumers. It commenced on 13 December 1998, and now includes Queensland, New South Wales, Australian Capital Territory, Victoria, South Australia, and Tasmania.

Term	Explanation
National Electricity Law (NEL)	The NEL is contained in a Schedule to the National Electricity (South Australia) Act 1996. The NEL is applied as law in each participating jurisdiction of the NEM by the application statutes.
National Electricity Rules (NER)	The National Electricity Rules came into effect on 1 July 2005, replacing the National Electricity Code.
national electricity system	The generating systems, transmission and distribution networks and other facilities owned, controlled or operated in the states and territories participating in the National Electricity Market.
network	The apparatus, equipment and buildings used to convey and control the conveyance of electricity. This applies to both transmission networks and distribution networks.
network capability	The capability of a network or part of a network to transfer electricity from one location to another.
network control ancillary services (NCAS)	Ancillary services concerned with maintaining and extending the operational efficiency and capability of the network within secure operating limits.
network event	In the context of frequency control ancillary services, the tripping of a network resulting in a generation event or load event.
network service providers	A person who operates as either a transmission network service provider (TNSP) or a distribution network service provider (DNSP).
network services	The services (provided by a TNSP or DNSP) associated with conveying electricity and which also include entry, exit, and use-of-system services.

Term	Explanation
NTNDP	National Transmission Network Development Plan
operating state	The operating state of the power system is defined as satisfactory, secure or reliable, as described below. **satisfactory operating state** The power system is in a satisfactory operating state when: • it is operating within its technical limits (i.e. frequency, voltage, current etc. are within the relevant standards and ratings) and • the severity of any potential fault is within the capability of circuit breakers to disconnect the faulted circuit or equipment. **secure operating state** The power system is in a secure operating state when: • it is in a satisfactory operating state and • it will return to a satisfactory operating state following a single credible contingency event. **reliable operating state** The power system is in a reliable operating state when: • AEMO has not disconnected, and does not expect to disconnect, any points of load connection under clause 4.8.9 (NER) • no load shedding is occurring or expected to occur anywhere on the power system under clause 4.8.9 (NER), and • in AEMO's reasonable opinion the levels of short term and medium term capacity reserves available to the power system are at least equal to the required levels determined in accordance with the power system security and reliability standards.

Term	Explanation
participant	An entity that participates in the National Electricity Market.
plant capability	The maximum MW output which an item of electrical equipment is capable of achieving for a given period.
power system reliability	The measure of the power system's ability to supply adequate power to satisfy demand, allowing for unplanned losses of generation capacity.
power system security	The safe scheduling, operation and control of the power system on a continuous basis.
Probability of Exceedance (POE)	POE relates to the weather/temperature dependence of the maximum demand in a region. A detailed description is given in the AEMO ESOO.
PSA	Power System Adequacy
reliable operating state	Under clause 4.2.7 of the rules, the power system is assessed to be in a reliable operating state when: (a) AEMO has not disconnected, and does not expect to disconnect, any points of load connection under clause 4.8.9 of the rules; (b) no load shedding is occurring or expected to occur anywhere on the power system under clause 4.8.9 of the rules; and (c) in AEMO's reasonable opinion the levels of short term and medium term capacity reserves available to the power system are at least equal to the required levels determined in accordance with the power system security and reliability standards.
reliability of supply	The likelihood of having sufficient capacity (generation or demand-side response) to meet demand (the consumer load).

Term	Explanation
Reliability Standard	The Panel's current standard for reliability is that there should be sufficient generation and bulk transmission capacity so that, over the long term, no more than 0.002% of the annual energy of consumers in any region is at risk of not being supplied, or to put it another way, so that the maximum permissible unserved energy (USE) is 0.002%.
reserve	The amount of supply (including available generation capability, demand side participation and interconnector capability) in excess of the demand forecast for a particular period.
reserve margin	The difference between reserve and the projected demand for electricity, where: • Reserve margin = (generation capability + interconnection reserve sharing) – peak demand + demand-side participation.
Rules	National Electricity Rules (also see NER)
SAIDI	System Average Interruption Duration Index (SAIDI). The sum of the duration of each sustained customer interruption (in minutes), divided by the total number of distribution customers. SAIDI excludes momentary interruptions (one minute or less duration).
SAIFI	System Average Interruption Frequency Index (SAIFI). The total number of sustained customer interruptions, divided by the total number of distribution customers. SAIFI excludes momentary interruptions (one minute or less duration).
satisfactory operating state	Under clause 4.2.2 of the rules, the power system is defined as being in a satisfactory operating state when: (a) the frequency at all energised busbars of the power system is within the normal operating frequency band, except for brief

Term	Explanation
	excursions outside the normal operating frequency band but within normal operating frequency excursion band; (b) the voltage magnitudes at all energised busbars at any switchyard or substation of the power system are within the relevant limits set by the relevant network service providers in accordance with clause S5.1.4 of Schedule 5.1 (of the rules); (c) the current flows on all transmission lines of the power system are within the ratings (accounting for time dependency in the case of emergency ratings) as defined by the relevant network service providers in accordance with Schedule 5.1 (of the rules); (d) all other plant forming part of or impacting on the power system is being operated within the relevant operating ratings (account for time dependency in the case of emergency ratings) as defined by the relevant network service providers in accordance with Schedule 5.1 (of the rules); (e) the configuration of the power system is such that the severity of any potential fault is within the capability of circuit breakers to disconnect the faulted circuit or equipment; and (f) the conditions of the power system are stable in accordance with requirements designated in or under clause S5.1.8 of Schedule 5.1 (of the rules).
scheduled load	A market load which has been classified by AEMO as a scheduled load at the market customer’s request. A market customer may submit dispatch bids in relation to scheduled loads.
secure operating state	Under clause 4.2.4 of the rules, the power system is defined to be in a secure operating

Term	Explanation
	state if, in AEMO's reasonable opinion, taking into consideration the appropriate power system principles (described in clause 4.2.6 of the rules): (1) the power system is in a satisfactory operating state; and (2) the power system will return to a satisfactory operating state following the occurrence of any credible contingency event in accordance with the power system security and reliability standards.
separation event	In the context of frequency control ancillary services, this describes the electrical separation of one or more NEM regions from the others, thereby preventing frequency control ancillary services being transferred from one region to another.
short-term Projected Assessment of System Adequacy (short-term PASA) (also see medium-term PASA)	The PASA in respect of the period from two days after the current trading day to the end of the seventh day after the current trading day inclusive in respect of each trading interval in that period.
spot market	Wholesale trading in electricity is conducted as a spot market. The spot market allows instantaneous matching of supply against demand. The spot market trades from an electricity pool, and is effectively a set of rules and procedures (not a physical location) managed by AEMO (in conjunction with market participants and regulatory agencies) that are set out in the rules.
spot price	The price for electricity in a trading interval at a regional reference node or a connection point.
supply-demand balance	A calculation of the reserve margin for a given set of demand conditions, which is used to minimise reserve deficits by making use of available interconnector capabilities.

Term	Explanation
technical envelope	The power system’s technical boundary limits for achieving and maintaining a secure operating state for a given demand and power system scenario.
transmission network service provider (TNSP)	A person who owns, operates and/or controls the high-voltage transmission assets that transport electricity between generators and distribution networks.
transmission network	The high-voltage transmission assets that transport electricity between generators and distribution networks. Transmission networks do not include connection assets, which form part of a transmission system.
unserved energy (USE)	The amount of energy that cannot be supplied because there are insufficient supplies (generation) to meet demand.