Reliability Panel
AEMC

REVIEW

Reliability Panel AEMC

FINAL REPORT

Annual Market Performance Review

1 March 2012

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Final Report

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About the AEMC

The Council of Australian Governments, through its Ministerial Council on Energy (MCE), established the Australian Energy Market Commission (AEMC) in July 2005 to be the rule maker for national energy markets. The AEMC is currently responsible for rules and providing advice to the MCE on matters relevant to the national energy markets. We are an independent, national body. Our key responsibilities are to consider rule change proposals, conduct energy market reviews and provide policy advice to the MCE as requested, or on AEMC's initiative.

About the AEMC Reliability Panel (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 report setting out the findings of the Reliability Panel's (Panel's) annual review of market performance. The Panel has 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 (NEM) in terms of reliability, security and safety over the 2010-2011 financial year.

The 2010-2011 financial year has been a relatively stable one. Although Tropical Cyclone Yasi affected northern Queensland in February 2011 and took down a number of transmission lines, the summer months were generally more manageable than we've experienced in recent times.

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.

The Panel is continuously reviewing the way in which we undertake, and report on, this annual review. To this end, in the consultation process on the draft report, we sought comments on the information and format of the report. We would like to thank TRUenergy on making a submission in this process and note that its comments have been considered and responded to in this final report. Considering ways in which this report can be improved will be on-going.

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

Reliability Panel Members

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1 Introduction

This chapter outlines the purpose and scope of this report.

1.1 Purpose and scope

Under the National Electricity Rules (Rules), the Reliability Panel (Panel) is to 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] The purpose of this report is to set out the findings from the Panel's review of performance in the 2010-2011 financial year. In conducting this review the Panel has 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 being reviewed more directly relates to the bulk wholesale electricity systems and does not include performance at a local transmission or distribution level.[2] However, as the performance of the local networks impacts on consumers' experiences, where the information is available, the Panel has included relevant performance results at the local level so that this report may provide a comprehensive overview of power system performance.[3]

1.2 Consultation process

As required by the Rules, the Panel has been conducting this annual review since 2006.[4]The Panel would like to ensure that this report provides useful information and is continuously improved to meet the needs of stakeholders. To this end, the Panel invited comments on the content and format of the draft report. TRUenergy made a submission on the draft report and the issues it raised are considered throughout this final report. In addition, the Panel planned a public meeting to be held on 1 February 2012. However, due to there being a lack of registered attendees, the public meeting was cancelled.

1.3 Structure of this report

The remainder of this report is set out as follows:

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1 Clause 8.8.3(b) of the Rules.

2 These concepts are explored further in the 'key concepts' section below.

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

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

- **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 2010-2011 financial year against the key market performance indicators;

- **Chapter 4 - Power system incidents:** provides an analysis of the power system incidents that occurred in 2010-2011;

- **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 transmission 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 addressed each requirement is 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 determination of this standard is being carried out separately. 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 as follows as well as 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.[5]

Currently in the NEM, 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.[6] The Panel's current standard for reliability (the Reliability Standard) is that the maximum permissible USE, or the maximum allowable level of electricity at risk of not being supplied to consumers, is 0.002 per cent of the annual energy consumption for the associated region or regions per financial year. Compliance with the Reliability Standard is measured over the long-term using a moving average of the actual observed levels of annual USE for the most recent ten financial years.[7]

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 Panel, however, summarises the transmission and distribution network reliability in the NEM in Appendix D of this report.

5 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; where as security is a technical concept as discussed in section 2.2

6 'Unserved energy' is a defined term under the Rules.

7 The current Reliability Standard applies until 30 June 2012, after which a new Reliability Standard will apply. The new Reliability Standard sets out that the performance against the Reliability Standard should be considered using the actual observed levels of annual USE for the most recent financial year.

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.

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.

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'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 as 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, the nature of the electrical network and the quality of power supplied. The system standards establish the target performance of the power system overall and are 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

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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'.

access granted to the power system will not negatively affect the ability of the network to meet the relevant system standards.

- **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.

3 Year in review

This chapter provides an overview of a number of key market performance indicators for the 2010-2011 financial year. It also provides a summary of key learning based on the Panel's consideration of relevant issues and events from 2010-2011.

3.1 Key lessons

From the Panel's review of power system performance of the NEM in 2010-2011, the Panel makes the following key observations:

- **Reliability** - in 2010-2011 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 that there were 36 power system incidents for which AEMO was required to report on in 2010-2011. Some of these incidents resulted in disruption to customer load although generally the past financial year has been relatively uneventful compared to recent years when more extreme weather events impacted security. There were also some incidents where frequency was outside the normal frequency operating band on the mainland and also in Tasmania. However, none of these incidents resulted in under-frequency load shedding. Voltage was generally maintained within advised limits.

- **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 below in this chapter. Specific reliability, security and safety considerations are discussed in the following chapters.

3.2 Overall market conditions

As discussed above 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 demand and capacity growth.

Since 2005-2006, maximum summer demand (scheduled and non-scheduled) on the NEM has grown by 4 613 MW or 14 per cent with an average growth rate of approximately 2.9 per cent. Over this time, projected summer aggregate scheduled and semi-scheduled generation capacity has risen by 4 233 MW or 13 per cent with additional increases from smaller unscheduled plant.[15]

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15 Scheduled generating plant participates in the central dispatch process operated by AEMO, while non-scheduled generating plant is not subject to central dispatch.

A total of 636 MW of new capacity (including new registrations and increases in capacity of existing plant) has been registered with AEMO in 2010-2011 to be brought into service.[16]

3.3 Overall power system performance

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 unsupplied system minutes across the NEM in terms of unsupplied minutes arising from interruptions in generation, and the transmission and distribution networks.

The table below shows the latest available data on the performance of the generation, distribution and transmission sectors as experienced by consumers in each region.

Table 3.1 Unsupplied system minutes in the NEM for 2010-2011[17]

	Region	System minutes unsupplied	
		Standard	Actual
Generation[18]	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
Transmission[19]	QLD	n/a	1.06[20]
	NSW	n/a	1.28
	VIC	n/a	1.20
	SA	n/a	9.37[21]

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

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

18 For generation, the standard is determined using the Reliability Standard (0.002% of unserved energy) multiplied by time in a year.

19 For transmission, system minutes unsupplied is calculated as the amount of energy (MWh) not supplied to consumers divided by maximum demand (MW) (multiplied by 60 to convert to system minutes). The latest available transmission data is for 2009-2010. Source: Energy Supply Association of Australia, 2011, Electricity Gas Australia, p.42, unless otherwise stated.

20 2010-2011 financial year, excluding natural disasters (South-East Queensland floods 2.6 system minutes; Cyclone Yasi 0.4 system minutes). Source: Powerlink.

21 2010-2011 financial year. Note that this figure is higher than long-run average due to abnormally high storm activity on the Eyre and Yorke Peninsulas experienced in the year. Source: ElectraNet.

	Region	System minutes unsupplied	
		Standard	Actual
	TAS	n/a	10.95
Distribution[22]	QLD	312.7	281.6
	NSW	292.2	198.5
	ACT	91.0	102.0
	VIC[23]	124.8	188.8
	SA[24]	268.57	217.9
	TAS	258.0	215.2

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 2010-2011 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 2010-2011 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.

Table 3.2 Regional USE for the past 10 years

Year	Queensland	New South Wales	Victoria	South Australia	Tasmania[25]
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%

22 For distribution, system minutes unsupplied is calculated using the unplanned system average interruption duration index (SAIDI) figures and is averaged across feeders and networks. SAIDI is the sum of the duration of each sustained customer interruption, divided by the total number of customers.

23 Based on 2009 calendar year.

24 Based on 2009-2010 data.

25 Tasmania joined the NEM in May 2005.

Year	Queensland	New South Wales	Victoria	South Australia	Tasmania[25]
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%	
2001-2002	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 2010-2011, the Reliability Panel and the AEMC carried out various projects that related to the management of power system performance. These projects are briefly discussed as follows. Additional information on these projects may also be found on the AEMC website.

Reliability Panel Review - Review of the Reliability and Emergency Reserve Trader (RERT) (completed in April 2011)

The Reliability and Emergency Reserve Trader (RERT) mechanism is a provision that allows AEMO to contract for capacity reserves when a shortfall of reserves is projected. The Panel was required under the Rules to conduct a review of the need for the RERT, which currently has a sunset date of 30 June 2012. The Panel completed this review in April 2011 and determined that the RERT mechanism should be discontinued as it considered that the RERT was distortionary and was not required to ensure that the reliability of supply meets the Reliability Standard. To provide stakeholders with additional time to manage and prepare for the cessation of the RERT mechanism, it was considered that the sunset date of the RERT be extended from 30 June 2012 to 30 June 2013. The Panel prepared a Rule change proposal in accordance with its findings, which was submitted to the AEMC. The AEMC commenced the Rule change process in September 2011 and the AEMC published its draft Rule determination in December 2011. The AEMC's draft determination was to postpone the expiry of the RERT for a period of four years to 30 June 2016. A final determination is due to be made in March 2012. Additional details are published on the AEMC website.

AEMC Rule determination - Scale Efficient Network Extensions (Rule determination made on 16 June 2011)

In response to a Rule change request from the Ministerial Council on Energy arising from work completed by the AEMC in the Review of Energy Market Frameworks in light of Climate Change Policies, the AEMC made a Rule on scale efficient network extensions (SENEs). The Rule as made was a 'more preferable rule', which requires transmission businesses to undertake and publish, on request, specific locational studies to reveal to the market potential opportunities for efficiency gains from the coordinated connection of expected new generators in a particular area. Such studies would help potential investors make informed, commercial decisions to fund a SENE. Decisions to fund, construct, operate and connect to a SENE would then be made by market participants and investors within the existing framework for connections in the Rules.

AEMC Rule determination - Amendment to PASA-related Rules (Rule commenced 16 December 2010)

AEMO proposed amendments to the Rules to remove its obligation to prepare and publish the reserve requirements and load forecasts 'for each region' used in its medium term projected assessment of system adequacy process. AEMO considered that the proposed change to the Rules would allow it to use reserve requirements that apply across multiple regions so that sharing of capacity reserves across regions would be more accurately captured. In addition, the Rule change sought to address a number of inconsistencies between the Rule requirements and what was carried out in practice. The AEMC determined to make the Rule as proposed with some minor amendments.

4 Power system incidents

This chapter reviews the power system incidents in 2010-2011 against the System Operating Incident Guidelines (and relevant frequency standards where applicable). Where any incidents have impacted reliability and security, these have 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 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 should be reviewed by AEMO include the following:[26]

- an incident defined as a multiple contingency event;
- 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; and
- an incident where there is load shedding due to a clause 4.8.9 instruction.[27]

4.2 Contingency events

In the 2010-2011 financial year there were 36 contingency events that were reviewable under the system operating incident guidelines and for each event, AEMO has published a report. Of the 36 contingency events, AEMO classified 20 of these as multiple contingency events. The Panel notes that the number of events were fewer than the previous financial year which experienced 58 reviewable contingency events (with 34 of these being classified as multiple contingencies). The categorisation, and number, of the contingency events are set out in the following table.

Table 4.1 Reviewable operating incidents 2010-2011

Event description	Number of incidents
Transmission related incidents (excluding busbar trips)[28]	11

[26] 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.

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

Event description	Number of incidents
Generation related incidents	3
Combined transmission/generation incidents	2
Busbar related reviewable incidents	20
Power system security related	0

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. Major incidents reviewed by the Panel are discussed in the following section.

The Panel notes that there may have been other incidents that occurred throughout the last financial year that had significant impacts on customers, such as the Victorian and Queensland floods. However, the Panel's considerations are based on the significant incidents on the transmission network where AEMO had an obligation to produce system incident reports.[29] The Panel understands that, for example, the floods in Victoria and Queensland had greater impact on the distribution networks.[30]

With respect to the Queensland floods, the Panel understands that, despite the record flooding across most of Queensland, the generation and transmission networks were able to maintain bulk electricity supplies to meet 99.99% of customer needs during the period. Damage to the transmission network was repaired within one to two weeks and included: the inundation of the 275/110 kV Rocklea substation; the collapse of a transmission tower on the Tarong-South Pine 275 kV transmission line due to a landslip; erosion of the Brisbane River bank which affected a 275 kV steel pole at Karalee; and flood encroachment of some 60 transmission towers.

4.3 Major incidents

Based on its 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 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.

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28 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'.

29 See section 4.1 and the guidelines for identifying reviewable operating incidents.

30 As noted above, the South-East Queensland floods resulted in 2.6 system minutes unsupplied (transmission).

Relevant details from AEMO's system incident reports are summarised and discussed as follows. .[31]

4.3.1 Trip of Sydney North 132kV 'A' and 'B' section 1 busbars (7 July 2010)

Type of event

This event was a non-credible transmission (busbar) multiple contingency that occurred on 7 July 2010 in NSW where both 132kV 'A' and 'B' section 1 busbars at Sydney North tripped and consequently a number of transmission lines were off-loaded. As a result, approximately 148 MW of customer load was interrupted.

Summary of event details

On 7 July 2010, a cable trench fire destroyed numerous control and protection cables affecting services on the Sydney North 132 kV 'A' and 'B' section 1 busbars. As a result, both busbars and several transmission elements tripped and interrupted supplies to the Pennant Hills, Hornsby and Berowra areas where approximately 148 MW of customer load was interrupted. The likely cause of the fire was determined to be a high impedance fault in a low voltage AC supply cable and the damage to the AC supply cable was suspected to be caused by rodents. In light of this incident, the transmission network service provider, TransGrid, considered the adoption of additional pest control measures and changes to substation designs to limit impact of low voltage AC cable faults.

The Panel's comments and observations

The Panel notes AEMO's power system security assessment that the power system frequency remained well within the frequency operating standard throughout the incident and that all affected equipment was returned to service promptly. TransGrid's actions to consider taking action to prevent similar faults from occurring are also noted.

4.3.2 Tropical Cyclone Yasi (2 and 3 February 2011)

Type of event

This event was a non-credible transmission (transmission lines) multiple contingency that occurred in February 2011 in Queensland where Tropical Cyclone Yasi caused twelve 132kV transmission lines to trip out of service.

Summary of event details

Tropical Cyclone Yasi was a category 5 severe tropical cyclone that affected the north Queensland coast on 2 and 3 February 2011. On 2 February Powerlink undertook precautionary measures including taking Woree Static VAR Compensators (SVC) and

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31 AEMO's full reports can be accessed from its website http://www.aemo.com.au/reports/nemreports.html#ops

Townsville East substation out of service to avoid possible storm surge damage. These actions did not result in any loss of supply due to reliability reasons.

Extremely high winds from the cyclone resulted in damage to twelve 132kV transmission lines, which tripped out of service, and four bulk supply 132kV substations and one power station automatically disconnected from the power system. At one stage during the incident, the 275kV transmission network in north Queensland experienced higher than normal voltage levels. The high voltage level was caused by reduced demand in north Queensland due to damage to the distribution network, and the deactivation of the Woree 132kV SVC. In order to ensure the voltage remained at satisfactory levels, two 275kV lines were taken out of service.

The Panel's comments and observations

The Panel notes that despite the extent of damage caused by Tropical Cyclone Yasi, the power system remained in a secure operating state for the duration of the incident. From information provided by Powerlink, the Panel understands the unsupplied energy due to Cyclone Yasi damaging the network has been estimated at 0.4 system minutes as most of the customer load was already disconnected by damage to the distribution network and because Powerlink was able to restore the transmission network within a short period.

The Panel notes that Powerlink and AEMO were able to manage the incident by taking appropriate precautionary measures and addressing issues as they arose. AEMO also reported that throughout the incident there was adequate operational coordination between AEMO and Powerlink. The damage to the north Queensland 132kV transmission network was repaired and bulk supply restored by 11 February 2011.

4.3.3 Simultaneous trip of Robertstown-Para and Robertstown-Tungkillo lines

Type of event

This event was a non-credible transmission (transmission lines) multiple contingency that occurred on 11 February 2011 in South Australia where 170 MW of load was interrupted.

Summary of event details

A lightning strike in the vicinity of the double circuit tower line approximately 100km from Robertstown is believed to have caused the simultaneous faults on the Robertstown-Para and Robertstown-Tungkillo 275 kV lines. The time of the incident and fault location correlated with the time the lightning strike was observed by ElectraNet's lightning detection system.

Approximately 170 MW of load was interrupted due to this incident. The loss of load was distributed across South Australia with a higher proportion occurring close to the location of the transmission line fault with an average of nine per cent load lost across South Australia. The load loss was attributed to the voltage depression experienced during the network fault. Gradual load recovery was carried out within approximately

20 to 25 minutes. The transmission lines were patrolled and returned to service within 3.5 hours.

The Panel's comments and observations

The power system was in an insecure operating state for 54 minutes after the lines tripped. The Panel notes that AEMO and ElectraNet worked closely to maintain the power system in a satisfactory operating state. This included AEMO using its constraint automation tool to build new constraint equations and, at AEMO's suggestion, ElectraNet reconfiguring the network. The Panel also notes that AEMO, in accordance with its procedures, added the Robertstown-Para and Robertstown-Tungkillo 275 kV double circuit transmission lines to its list of 'Vulnerable Transmission Lines' with a category of 'Probable' to ensure that appropriate constraint sets are more readily able to be deployed. Following from this incident, the Panel also notes that both ElectraNet and AEMO undertook further investigations to review lessons learnt from this incident in an effort to improve the overall management of the power system.

4.3.4 Other incidents

A number of other power system incidents throughout 2010-2011 resulted in load shedding. Although the impact of these events individually may have been minor and/or restricted to one customer, the Panel has reviewed these events to consider whether there was any specific learning that may be gained.

Type of events

A number of non-credible transmission (busbar or transmission line) contingencies occurred that resulted in load shedding.

Summary of event details

The power system incidents in 2010-2011 that resulted in load shedding include the incidents as set out in the following table.

Table 4.2 Selected power system incidents that resulted in load shedding

	Date of incident	Incident	Description	Load shed	Panel's comments and observations
1	29 July 2010	Trip of Point Henry No. 1 220 kV Busbar	Resulting from an operation error by staff at the Point Henry smelter, where a handheld meter was dropped onto a protection relay, the correct operation of a 22 kV busbar back up protection resulted in the 220 kV busbar being tripped.	105 MW (VIC)	The Panel notes that Alcoa of Australia Limited, who owns the Point Henry smelter, has revised its work practices to avoid the reoccurrence of such incidents.
2	24 October 2010	Trip of Kurri to Rothbury 132 kV line and the Hydro Aluminium Potlines	A fault caused by the failure of an overhead earth wire which came into contact with the C phase conductor of the 95R Kurri-Rothbury 132 kV line caused the line to trip. Immediately after the trip of the 95R line, all three potlines of Hydro Aluminium tripped on the operation of their internal protections, interrupting approximately 300 MW of load.	300 MW (NSW)	The Panel notes that the operation of the line protection systems successfully cleared the fault within the required timeframes under the Rules. The Hydro Aluminium potlines were able to start restoring power within 17 minutes. The Panel notes that immediately following the incident AEMO declared the loss of Kurri to Rothbury 132 kV line and three Hydro Aluminium potlines as a credible contingency.
3	5 February 2011	Trip of Cowra 132 kV busbar	An incomplete restoration of secondary systems contributed to the loss of the 132 kV busbar, where thunderstorm activity was experienced at the time of the incident.	50 MW (NSW)	The Panel notes that AEMO determined it was not required to reclassify the loss of the Cowra 132 kV busbar as a credible contingency as TransGrid had investigated the incident and undertaken appropriate remedial measures. As a result, a further incident was considered unlikely.

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[32]

	Queensland*	New South Wales	Victoria& South Australia	South Australia*	Tasmania
2005-06	610 MW	-290 MW	530 MW	265 MW	144 MW
2006-07	480 MW	-1 490 MW	615 MW	-50 MW	144 MW
2007-08	560 MW	-1 430 MW	615 MW	-50 MW	144 MW
2008-09	560 MW	-1 430 MW	615 MW	-50 MW	144 MW
2009-10	560 MW	-1 430 MW	615 MW	-50 MW	144 MW
2010-11	829 MW	-1 548 MW	552 MW	-131 MW	144 MW
2011-12	913 MW	-1 564 MW	297 MW[33]	-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 as 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.

32 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.

33 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 2010-2011 financial year. Background information providing detailed explanations of each type of market information is outlined in Appendix B section B.4.

In its submission on the draft report, TRUenergy expressed concern at the level of variability in demand forecasts, in particular for high demand days where underestimation is problematic and concern about the provision of information in the pre-dispatch period.[34] TRUenergy considers that erratic demand forecasts contribute to the requirements for rebidding, which in turn increases volatility and that this uncertainty then creates issues for participants.[35] The Panel notes that there are often difficulties and complications associated with demand forecasting. This Annual Market Performance Review 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 change and improve its forecasting methods. For future reports, the Panel will consider different ways to assess and analyse the performance statistics.

5.2.1 Electricity Statement of Opportunities (ESOO)

AEMO publishes the Electricity Statement of Opportunities (ESOO) on an annual basis in August, which sets out forecasts of demand and supply for the NEM for the following ten years. The Panel notes that AEMO coordinates the assessment of the energy and demand projections used in the ESOO through utilising a number of different review methodologies. These include a back assessment (to compare previous projections with actual outcomes); backcasting (to validate the methodology used to develop the current projections); and probability of exceedence (POE) estimates (to test the procedures used to allocate the POE values to actual demand values). 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. As mentioned above, the Panel also notes that AEMO continuously reviews and updates its methodologies. AEMO's work in this area includes its current National Forecasting program of work that is aimed at providing greater transparency on demand forecasts to market participants.

5.2.2 Power System Adequacy (PSA) - 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

34 TRUenergy, submission on draft report, 4 January 2012, p. 1.

35 ibid

electricity supply over the next two years, complementing the 10-year outlook provided by the ESOO.[36]

The Panel notes that the PSA provides detailed information about specific scenarios and projections of supply and demand as well as AEMO's analysis and conclusions about the two-year outlook. The PSA also sets out AEMO's processes in reviewing power system adequacy including information about underlying assumptions and modelling provisions. The Panel considers that the PSA provides a useful tool to market participants in understanding the system adequacy projections and acknowledges the PSA as complementary to the ESOO where it provides more detailed consideration of the shorter-term outlook.

5.2.3 National Transmission Network Development Plan (NTNDP)

Under its role as the National Transmission Planner, AEMO publishes the National Transmission Network Development Plan (NTNDP) on an annual basis, which outlines the long-term efficient development of the power system including future and current capability of the national transmission network and development options. The Panel notes that the 2011 NTNDP builds upon information included in the 2010 NTNDP and includes changes and additions in response to comments from stakeholders. The Panel also notes that AEMO intends on conducting a comprehensive review of its key planning documents, including the NTNDP in the coming year in order to increase AEMO's responsiveness to energy sector needs.

The Panel also notes that the AEMC completed in December 2011 its latest investigation into whether to exercise the last resort planning power (LRPP) and that it decided that there was no material reason for the exercise of the LRPP in 2011.[37]

5.2.4 Energy Adequacy Assessment Projection (EAAP)

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 Panel notes that the EAAP reports provide USE projections for each region under three scenarios - low rainfall, short term average rainfall and long term average

36 Producing and publishing the PSA is not a Rules requirement.

37 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). In exercising the LRPP, the AEMC takes into consideration the information contained in the NTNDP (AEMC, 2010, Investigation into the Exercise of the Last Resort Planning Power: 2010, 10 November 2010, Sydney, p. 3).

rainfall. In addition to annual projections, USE projections for each region is also provided for each month in the forecast period. The Panel considers that this information would be useful to market participants to provide up-to-date and direct information on where energy constraints may impact on energy availability. It is likely that the information contained in the EAAP reports could be used to provide an improved market response to projected shortfalls in reserve.

5.2.5 Medium-term Projected Assessment of System Adequacy (MT PASA)

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. For example, the table shows for NSW, that for 0.4 per cent of weekdays the actual demand was greater than the 10 per cent POE forecast and for 3.8 per cent of weekend days; and that on average, the actual weekday demand values for NSW differed from the forecast value by 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, where the average proportion of weekdays where the demand was greater than the 10 per cent POE forecast decreased from 2.1 per cent in 2009-2010 to 1.8 per cent in 2010-2011.

Table 5.2 Medium-term PASA demand forecasts comparison 2010-2011

	QLD	NSW	VIC	SA	TAS
Proportion of weekdays where demand greater than 10 per cent POE forecast	0.0%	0.4%	4.2%	1.5%	2.7%
Weekdays demand deviation	0%	3%	2%	8%	2%
Weekend days where demand greater than 10% POE forecast	0.0%	3.8%	12.5%	5.8%	11.5%

Source: AER

5.2.6 Short-term Projected Assessment of System Adequacy (ST PASA)

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 looks out over a two year period, ST PASA looks out 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 2.1 per cent of the actual demand outcomes.

The Panel notes that overall the accuracy of the ST PASA demand forecasts has generally improved from the previous financial year where the absolute percentage deviation for all regions and all categories decreased in 2010-2011. On average across all regions, the absolute percentage deviation for 12 hours and 2 days ahead forecasts have improved from 3.0 to 2.7 per cent and 3.7 to 3.3 per cent respectively.

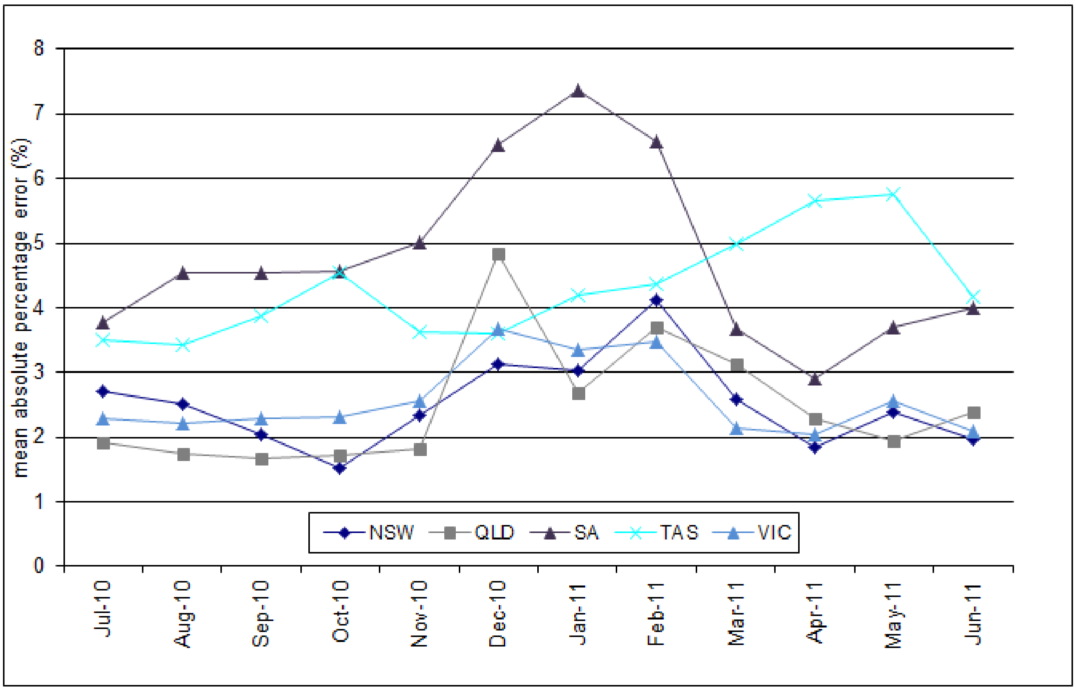
Table 5.3 Accuracy of short-term PASA demand forecasts 2009-2010

Short-term PASA demand forecast absolute percentage deviation	QLD	NSW	VIC	SA	TAS
12 hours ahead	2.0%	2.1%	2.1%	3.9%	3.6%
2 days ahead	2.5%	2.5%	2.6%	4.8%	4.3%
4 days ahead	2.7%	2.8%	3.0%	5.9%	4.7%
6 days ahead	2.0%	3.2%	3.4%	6.9%	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 most regions where the mean error was around two to four per cent for the duration of the year. The Panel notes that the mean errors were higher for South Australia and Tasmania, particularly over the summer months in South Australia. The results are demonstrated in the following figure.

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



Source: AER

5.2.7 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 has advised that it is currently testing a new automated Demand Forecasting System which is due to be implemented by the end of 2011. This new system will replace AEMO's current manual forecasting process and will generate short-term forecasts, updated every half-hour, up to eight days ahead. The system will deliver greater accuracy and more timely regional forecasts and, by increasing the number of sub-regional demand projections, will improve the accuracy of network constraint modelling 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 2010-2011 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 1224 trading intervals in 2010-2011 were affected by significant price variations which represents 7 per cent of trading intervals in total. Of these 7 per cent, 51 per cent of the price variations were due to variances in the demand values and 34 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	1005	6%	812	5%	853	5%	1224	7%	1653	9%
Demand	690	56%	575	59%	509	52%	734	51%	342	20%
Availability	331	27%	261	27%	342	35%	482	34%	1357	80%
Combination (e.g. of changes in plant availability, demand, rebidding activities)	182	15%	142	15%	121	12%	202	14%	0	0%
Network (e.g. network outages)	27	2%	0	0%	4	0%	8	1%	2	0%

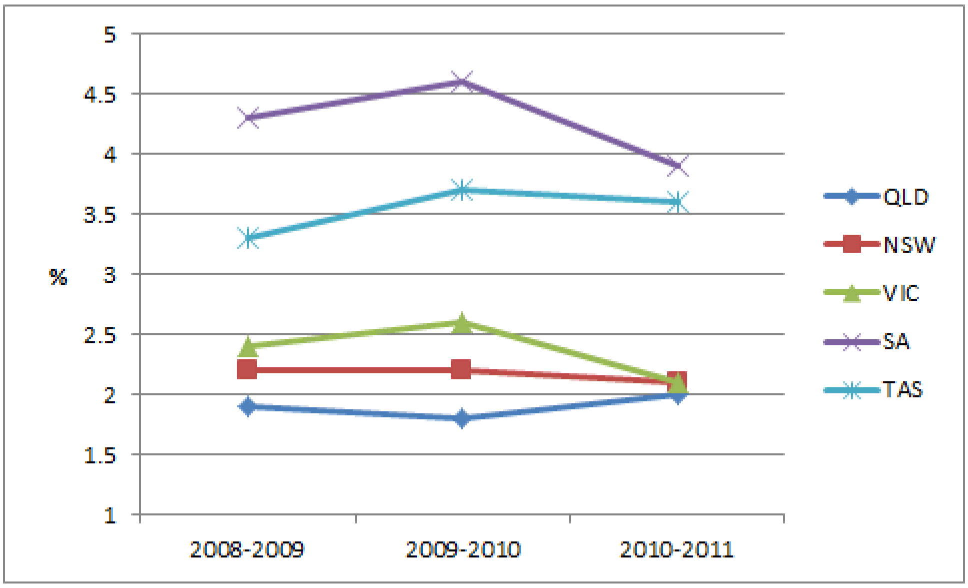
Source: AER

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 each region. The Panel also notes that the total number of trading intervals affected have decreased this year compared to the previous year particularly for Tasmania.[38]

The Panel has also considered the accuracy of the pre-dispatch demand forecasts (12 hours ahead basis) and notes the accuracy has generally improved from the previous year. However, the accuracy over the past three years has remained relatively consistent as demonstrated in the following figure.

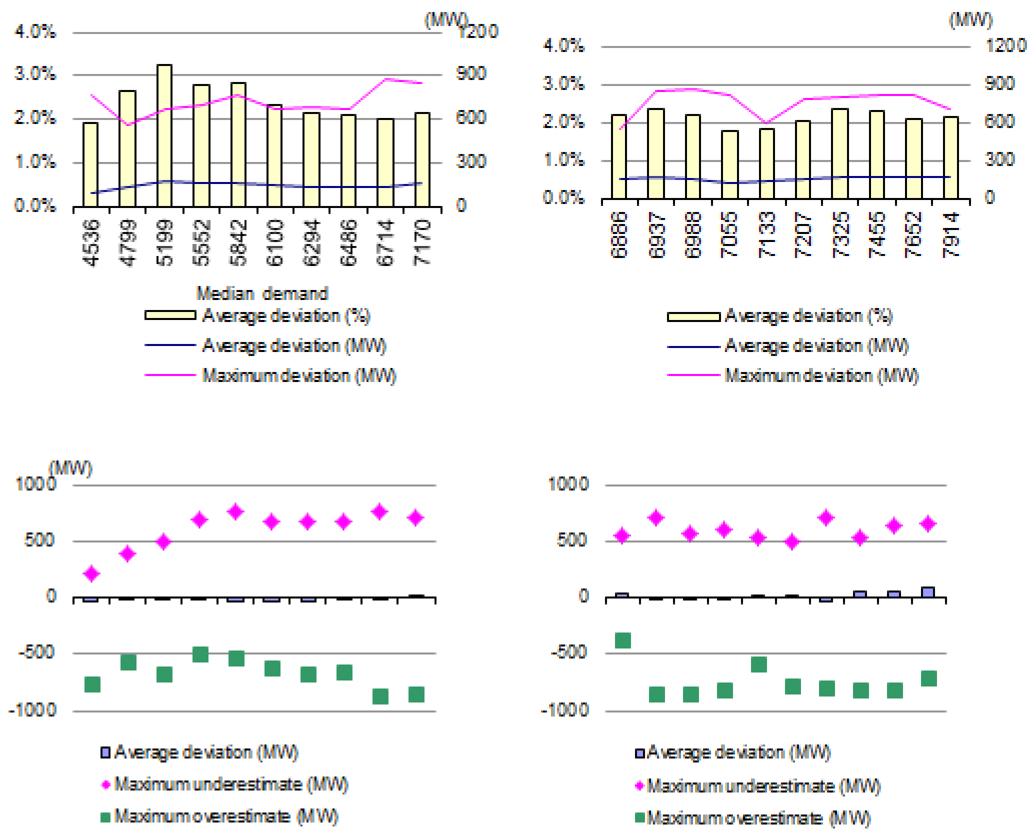
Figure 5.2 Accuracy of pre-dispatch demand forecasts (12 hours ahead) (absolute percentage deviation - actual demand compared to 12 hours ahead forecast)



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 Queensland shown in the figure below as an example. Other regions are outlined in further detail in Appendix B section B.4.6.

38 In 2009-2010, the total trading intervals affected (percentage wise) were: QLD 8%, NSW 7%, VIC 8% SA 10% and TAS 23%.

Figure 5.3 Queensland demand forecast deviation four hours ahead



The outcomes above for Queensland show that the maximum deviation between forecast and actual demand in the top tenth percentile ranges from 800 MW lower than forecast to 760 MW higher than forecast. This relative magnitude pattern of deviation is broadly reflective with the outcomes for other NEM regions. Generally speaking, the Panel notes that the four hour ahead demand forecasts:

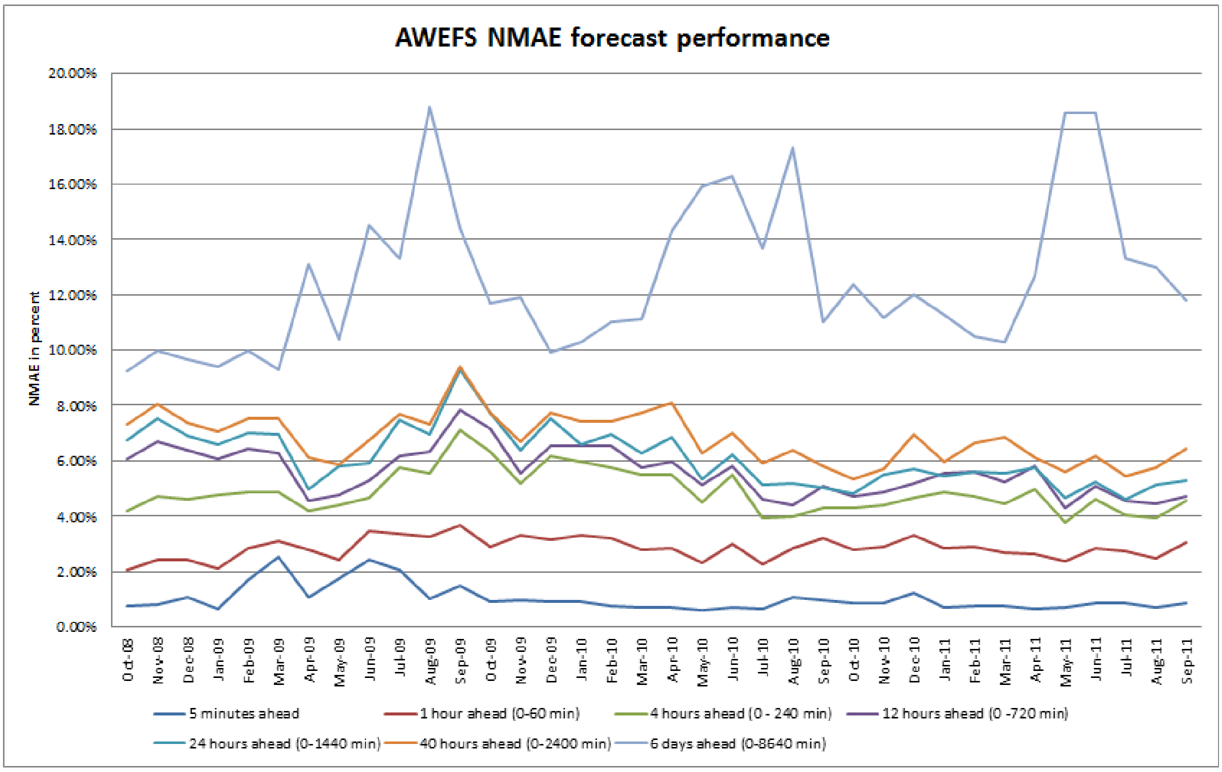
- appear to be consistently biased towards under estimation of high demand periods;
- appear to have maximum under estimates that could be difficult to cover on notice shorter than four hours; however
- the average deviation for all regions (at the top tenth percentile) is four per cent or less.

5.2.8 Wind forecasts

Given the recent growth in intermittent generation in the NEM, 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 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 below in Figure 5.4.

Figure 5.4 Accuracy of AWEFS (normalised mean absolute error)



The Panel notes that:

- as could be expected, the accuracy of the forecasting improves as the forward looking timeframe shortens;
- there seems to be a cyclical impact on accuracy, which is most obvious in the 6-day ahead forecast where the percentage error increases during the autumn/winter months; and
- given that the system is relatively new, it is expected that performance will improve going forward. The Panel will review performance in subsequent annual reviews.

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 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.[39] 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 2010-2011.

The Panel also notes that AEMO did not issue any directions for Reliability in 2010-2011.

39 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.

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 frequency has been outside the normal operating frequency band.

Mainland NEM

Based on data available to the Panel at the time of publication, there were three frequency events on the mainland in the 2010-2011 financial year where the frequency moved outside the normal operating band. The Panel notes that this is fewer than the previous years where there were ten events in 2009-2010 and 20 events in 2008-09. The number of events are shown in Table 6.1 below

The Panel notes that three low frequency incidents all resulted in the frequency being outside the normal operating band for more than 300 seconds due to tripping of power station/s. The Panel further understands that these events did not result in any under-frequency load shedding. On no occasions did the frequency of the NEM mainland exceed the upper limit of the normal operating frequency band in 2010-2011.

Table 6.1 Frequency events on the mainland 2010-11

Number of events	Total	Low frequency	High frequency
outside normal operating frequency band	3	3	0
outside normal operating frequency excursion band	3	3	0
Events where duration exceeds 300 seconds[40]	3	3	0

Source: AER

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

Tasmania

Based on data available to the Panel at the time of publication, there were seven frequency events in Tasmania in the 2010-2011 financial year where the frequency moved outside the normal operating band. The Panel notes that all the incidents resulted in the frequency being outside the normal operating band for more than 300 seconds. The number of events are shown in Table 6.2 below.

The Panel notes that the incident of the longest duration occurred on 1 February 2011 for 1364 seconds where frequency exceeded the upper limit of the normal operating frequency band due to the capacity of Basslink being limited due to high temperature at the Loy Yang converter station. The Panel further notes that no events resulted in under-frequency load shedding in Tasmania.

Table 6.2 Frequency events in Tasmania 2010-2011

Number of events	Total	Low frequency	High frequency
outside normal operating frequency band	7	5	2
outside normal operating frequency excursion band	7	5	2
Events where duration exceeds 300 seconds	7	5	2

Source: AER

In its submission on the draft report, TRUenergy noted that no analysis is provided on why the frequency standard was breached on these occasions as outlined above and whether sufficient FCAS were being procured. The Panel notes that in preparing this report, AEMO's system incident reports were reviewed for all these incidents and the Panel did not consider that there were any evidence that insufficient FCAS were being procured. As noted above, these AEMO reports are publicly available for review. The Panel also notes that the number of frequency events was not significantly different from previous years.

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 2010-2011 financial year.

6.3 Interconnector performance

The Panel is not aware of any incidents in the 2010-2011 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.

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. In recent years AEMO has also introduced 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 provides 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 2010-2011 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
2010-2011	0	0	0	0	0	0
2009-10	4	1	0	1	1	7
2008-09	2	1	5	4	0	12
2007-08	5	0	0	1	1	7
2006-07	3	0	6	1	0	10
2005-06	1	52	0	0	8	61
2004-05	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 relate to the bulk transmission system of the NEM and, in this regard, its assessment of safety of the NEM is limited to considerations of links to the security of the power system and maintaining the system within relevant standards and technical limits. The Panel acknowledges that network service providers and other market participants have specific responsibilities to ensure the safety of personnel and the public, and that the electrical system is designed with extensive safety systems to ensure the protection of the system itself, workers and the public.

For the 2010-2011 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 2010-2011 (see section 6.6), the Panel notes that there were no safety issues related to a direction from AEMO.

A 2010-2011 Australian climate 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 2010-2011 financial year by each season:[41]

- **Winter**

  Winter 2010 was a generally wet season over much of Australia, with near-normal daytime temperatures and warmer than normal overnight temperatures. Victoria and South Australia had their coolest winter in thirteen years, and NSW in a decade, while the northern tropics had a very warm winter, especially their overnight minima, of which there were areas of highest on record. Significant rainfall fell over the northern and eastern regions of Australia.

- **Spring**

  This spring was the wettest spring on record for Australia. Individually, most states had a very wet season, with the NT, Queensland and NSW all having their wettest spring on record, and all states except Tasmania in the top 10 wettest. Maximum temperatures were generally much cooler than normal. Minimum temperatures were close to normal: cooler than average conditions dominated the interior, while coastal areas tended to be warmer than normal.

- **Summer**

  Summer 2010-2011 has been the second wettest on record for Australia with Victoria recording its wettest summer on record, SA recording its third wettest and NSW recording its fifth wettest summer on record. Maximum temperatures were generally cooler than normal whilst overnight minima were mostly above normal, with SA recording its fourth warmest summer on record for minimum temperatures.

41 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.

- **Autumn**

  Autumn 2011 was the coldest on record for mean temperatures (mean temperature records began in 1950) and the fourth wettest on record nationally. Daytime temperatures were particularly cool across most of Australia and ranked as the second coldest on record.

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 2010-2011 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.

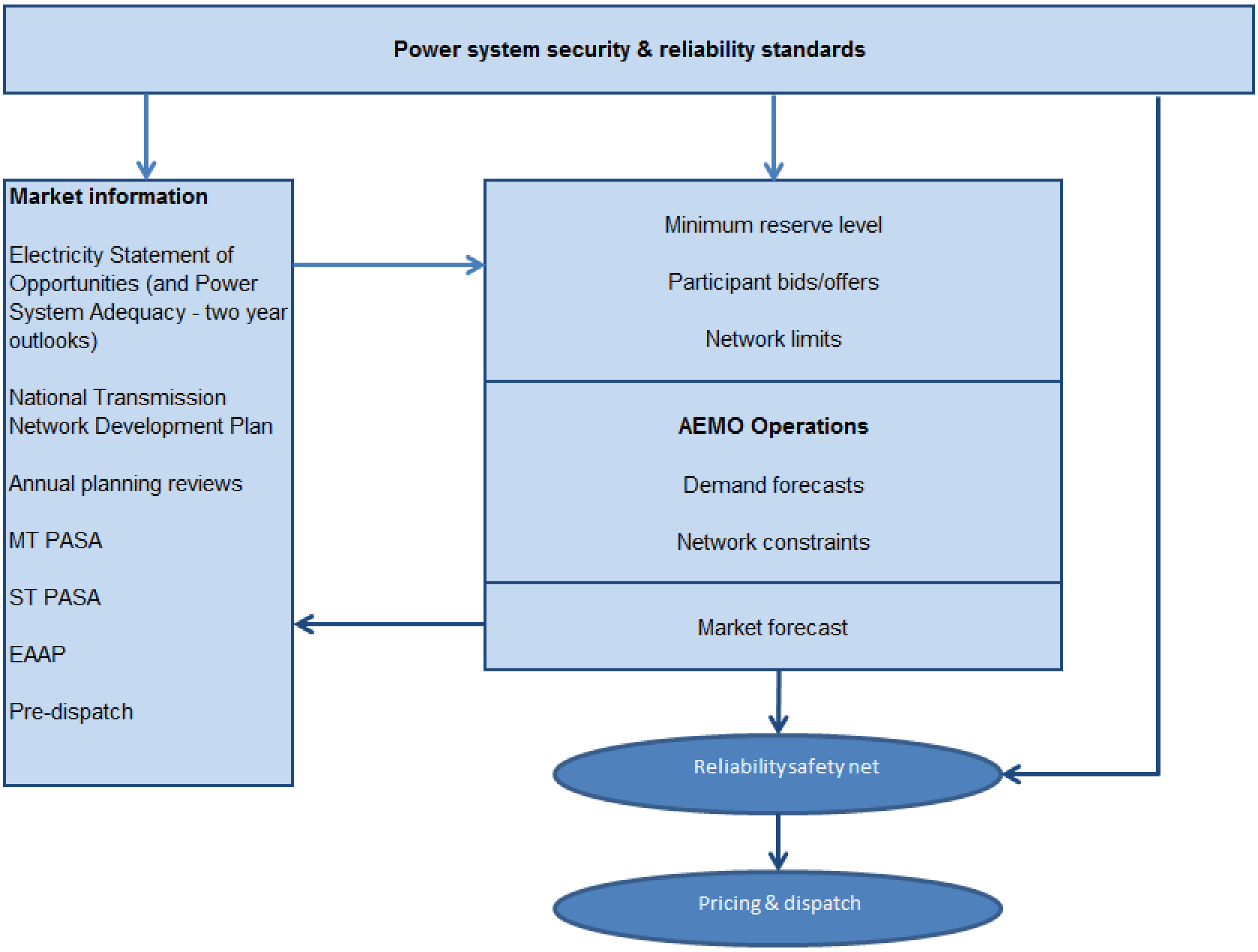
The national market aligns incentives for decisions by market participants about plant operation with overall reliability outcomes. There is an extensive suite of information published by AEMO to support those decisions.

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% 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% 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%). 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.[42] This is 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.

Complementary to the ESOO, AEMO also 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 2011 PSA examined two key scenarios:[43]

- 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 2011 PSA examines the potential impact of the withdrawal of 1,000 MW of older generation distributed across the NEM.

Each of the scenarios used in the PSA also considers component studies involving low and high wind generation.[44]

In December 2010, AEMO published its inaugural NTNDP, which is an independent strategic plan for the NEM transmission network. AEMO will update 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.

42 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.

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

44 ibid

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

The EAAP is a quarterly information mechanism which will provide the market with projections of the impact of generation input constraints on energy availability.[45]

Both the AEMC and the Panel consider that the EAAP will function as an additional source of information for the market regarding when and where energy constraints may impact on energy availability. It is anticipated to also lead to an improved market response to projected shortfalls in reserve.

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:

- 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.

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

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 scheduled at short notice improve overall reliability and market efficiency by taking advantage of the most recent market information; 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 uses 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.[46]

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.

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

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

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.

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

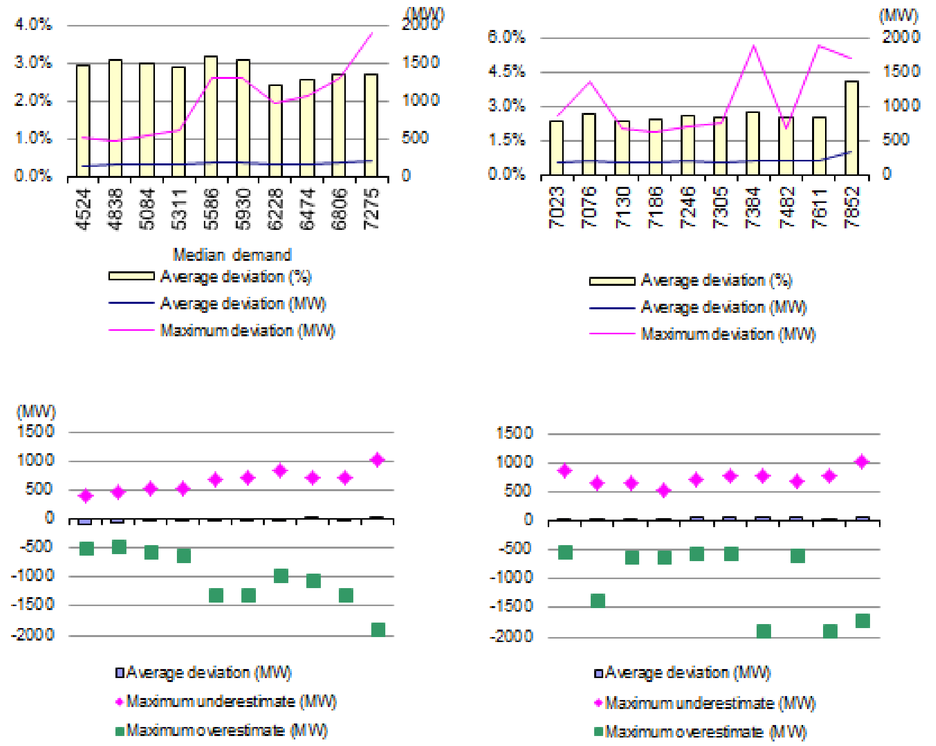


Figure B.5 South Australia demand forecast deviation four hours ahead

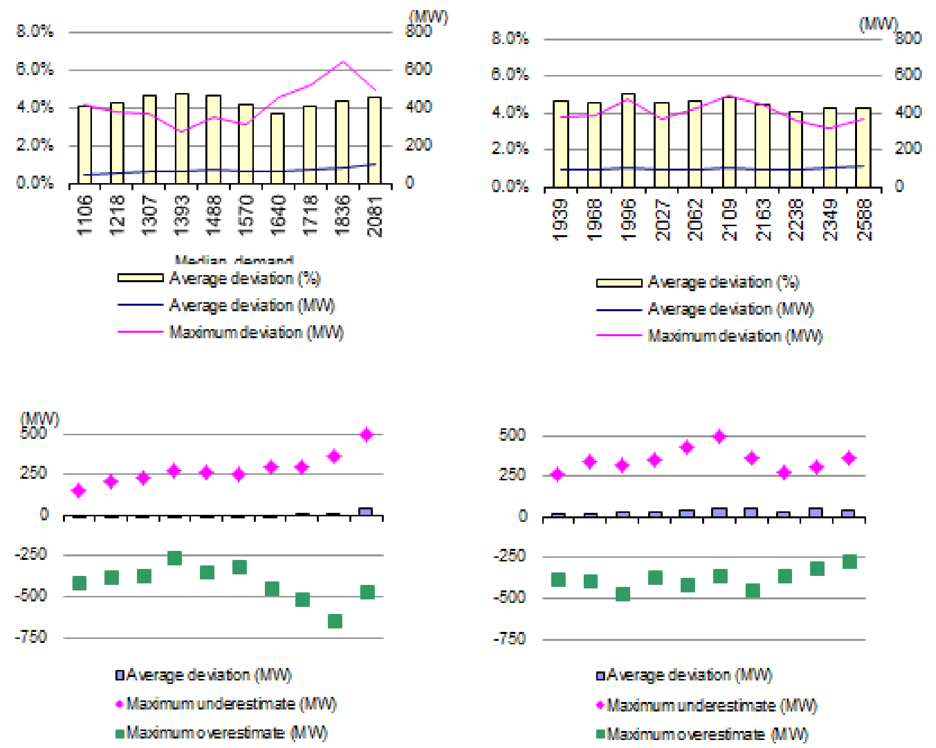
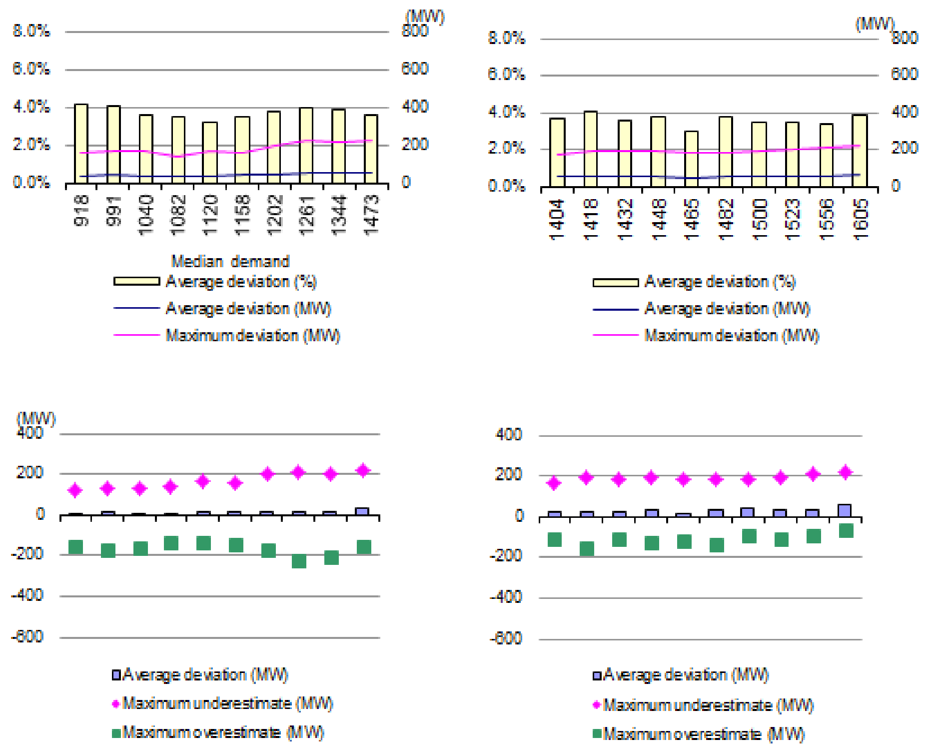


Figure B.6 Tasmania demand forecast deviation four hours ahead



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 3207 market notices issued by AEMO during the 2010-2011 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	1
General notice	59
Inter-regional transfer	244
Market intervention	2
Market systems	124

Type of notice	Number of notices
Manual priced dispatch Interval	5
NEM systems	2
Non-conformance	1680
Power system events	46
Price adjustment	4
Process review	1
Reclassify contingency	738
Reserve notice	271
Settlements residue	30

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 2010-2011 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.

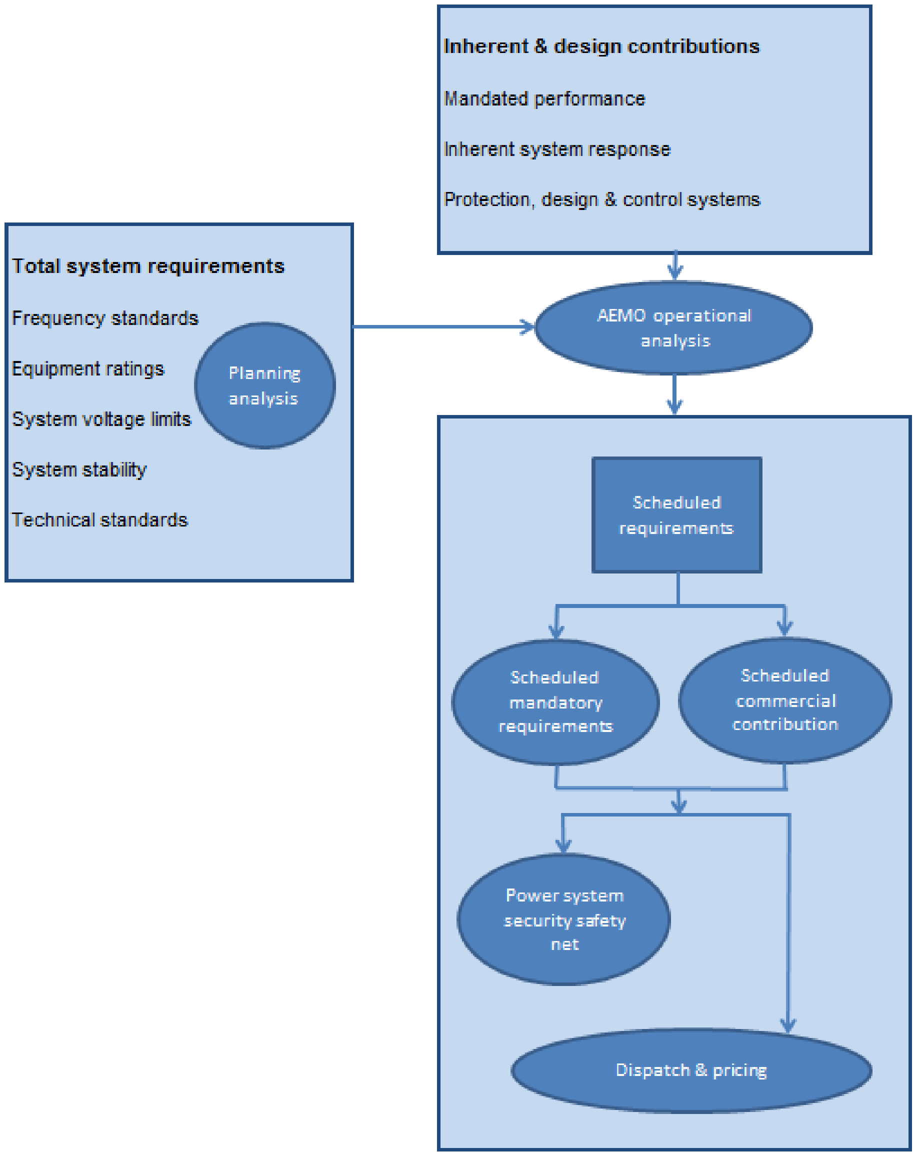
AEMO determines the total technical requirements for all services needed to meet the different aspects of security from: the Panel's power system security and reliability standards; market rules obligations; knowledge of equipment performance; design characteristics; and modelling of the dynamic behaviour 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 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, the nature of the electrical network 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 establish the target performance of the power system overall.

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.[47]

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;[48]
- Technical Standards for Wind and Other Generator Connections Rule change;[49]
- Resolution of Existing Generator Performance Standards Rule change;[50]
- Performance Standard Compliance of Generators Rule change;[51] and
- Reliability Panel Technical Standards Review.[52]

In addition, as a result of the making of AEMC 2008, National Electricity Amendment (Performance Standard Compliance of Generators) Rule 2008 No. 10, 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.

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47 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.

48 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.

49 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.

50 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.

51 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.

52 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.

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[53] 49.85 to 50.15 Hz 99% of the time[54]	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

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

54 This is known as the normal operating frequency band.

Condition	Containment	Stabilisation	Recovery
Multiple contingency event	47 to 52 Hz	49.5 to 50.5 Hz within 2 minutes	49.85 to 50.15 Hz 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	49.5 to 50.5 Hz	n/a	

Condition	Containment	Stabilisation	Recovery
event or load event			
Generation event, load event or network event Refer to notes below for specific requirements to be satisfied prior to use of this provision	48 to 52 Hz (Queensland and South Australia) 48.5 to 52 Hz (New South Wales and Victoria)	49.0 to 51.0 Hz within 2 minutes	49.5 to 50.5 Hz within 10 minutes
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.

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.[55] 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,[56] which can be implemented for any generating system with a capacity that is greater than 144 MW by the automatic tripping of load.

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

Condition	Containment	Stabilisation	Recovery
No contingency event or load event	49.0 to 51.0 Hz		
Load and generation event	48.0 to 52.0 Hz	49.0 to 51.0 Hz within 10 minutes	

55 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.

56 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.

<table>
<tr><th>Condition</th><th>Containment</th><th>Stabilisation</th><th>Recovery</th></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,[57] 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 2006-07 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 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.

57 Ibid.

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

This section includes an overview of the jurisdictional arrangements for managing the reliability performance of the NEM transmission networks.

D.1.1 Queensland[58]

The mandated reliability obligations and standards are contained in Schedule 5.1 of the Rules, the Queensland Electricity Act, the 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 (–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©)); 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

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

out of service, i.e. –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 –1 criterion.

D.1.2 New South Wales[59]

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 NSW Department of Water and Energy. TransGrid issued an updated Network Management Plan in early 2011. The plan is required to be reviewed every two years.

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 incorporates the Government's Transmission Design Reliability Standard for NSW – December 2010. The legal authority for this direction 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.[60]

D.1.3 Victoria[61]

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.

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

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

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

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, 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). The VCR as at 2011 is set at $57,877 per MWh. AEMO also considers a sector specific VCR where the transmission constraint affects only a reasonably distinguishable subset of the load.

D.1.4 South Australia[62]

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).[63] The ETC sets specific reliability standards (N, –1, –2 etc) for each transmission exit point.

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.[64] 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 has been required to install a new transmission connection point to the CBD by the end of 2011. This augmentation will ensure that future CBD demand growth can be met with a greater level of reliability. ElectraNet has developed a proposed solution to meet this requirement which satisfies the requirements of the Regulatory Test, and is currently proceeding to complete this augmentation within the required time frame.

ESCOSA is undertaking its current 5-year review of the specific reliability standards under clause 2.2.2 of the ETC, and commissioned advice on this matter from AEMO in 2010. ESCOSA expects to finalise the changes proposed to the ETC by the end of December 2011. The final changes will take effect from 1 July 2013, aligning with the start date of the next price determination for ElectraNet.

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

63 ESCOSA, 2008, Electricity Transmission Code, http://www.escosa.sa.gov.au/webdata/resources/files/060906-R-ElecTransCodeET05.pdf.

64 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.

D.1.5 Tasmania[65]

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.

At the time of writing, the Tasmanian Government's Department of Energy, Industry and Resources is reviewing the requirements of the ESI (Network Performance Requirements) Regulations 2007. Furthermore, the Office of the Tasmanian Energy Regulator is considering "...the adequacy of the present reliability standards..." in its 2011 Review of the Reliability of the Tasmanian Power System.

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.

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)[66] has adopted four indicators of distribution network reliability that are widely used in Australia and overseas.[67] 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).[68] 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,

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

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

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

68 See the Glossary for further information.

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 Queensland[69]

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,[70] 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. 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.

Table D.1 Performance of the Queensland DNSPs for 2010-2011

DNSP	Feeder	SAIDI (minutes)		SAIFI	
		Target	Actual	Target	Actual
Energex	**CBD**	15	6.05	0.15	0.01
	urban	106	79.75	1.26	0.92
	short-rural	218	201.58	2.46	2.05
Ergon	**urban**	149	148.88	1.98	1.63
	short-rural	424	425.74	3.95	3.53
	long-rural	964	827.35	7.40	5.27

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

70 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.

SAIDI and SAIFI performance data for 2010-2011 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 2009-10. Ergon Energy met five out of its six MSS targets (the exception being short-rural SAIDI).

Ergon Energy's performance in 2010-2011 was a significant improvement on the previous two years, where it failed to meet five out of its six MSS targets. In particular, Ergon Energy reported significant improvements in planned outage performance, due to the progressive reinstatement of live line work, combined with the replacement of defective air break switches, and improved planned outage coordination.

Ergon Energy also indicated that, prior to the commencement of the extreme weather events in late 2010, it was on track to meet all six MSS targets. While it reported that the impact of the most severe weather events was excluded in accordance with the exclusion criteria in the QEIC, some events that adversely impacted performance (such as Tropical Cyclone Tasha) were not.

D.2.2 New South Wales[71]

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).[72]

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.

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

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

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 2010-2011

DNSP	Feeder	SAIDI (minutes)		SAIFI	
		Target	Actual	Target	Actual
Essential Energy (previously known as Country Energy)	Urban	125	66	1.8	0.85
	Short rural	300	245	3.0	2.38
	Long rural	700	493	4.5	3.37
	All	n/a	238	n/a	2.14
Ausgrid (previously known as EnergyAustralia)	CBD	45	5.11	0.3	0.06
	Urban	80	82.62	1.2	0.97
	Short rural	300	225.10	3.2	2.06
	Long rural	700	467.57	6.0	4.31
	All	n/a	98.59	n/a	1.08
Endeavour Energy (previously known as Integral Energy)	Urban	80	52.5	1.2	0.7
	Short rural	300	149.3	2.80	1.4
	Long rural	n/a	922.7	n/a	2.1
	All	n/a	72	n/a	0.8
NSW	CBD	n/a	5.1	n/a	0.06
	Urban	n/a	72.0	n/a	0.88
	Short rural	n/a	220.2	n/a	2.10
	Long rural	n/a	493.4	n/a	3.39
	All	n/a	125.2	n/a	1.28

Table D.2 shows that Ausgrid did not meet its SAIDI targets for urban feeders in 2010-2011 due to a 7-day heatwave period (31 January to 6 February 2011). Ausgrid, Essential Energy and Endeavour Energy each met all other SAIDI and SAIFI targets for all feeder categories during 2010-2011.

D.2.3 Australian Capital Territory[73]

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 available in the Electricity Distribution Supply Standards Code[74] and in the Consumer Protection Code,[75] 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 2010-11. More detailed performance information is available from network performance reports available on the ICRC website.

Table D.3 Performance of the Australian Capital Territory DNSP 2009-10

Feeder		SAIDI (minutes)		SAIFI		CAIDI	
		Target	Actual	Target	Actual	Target	Actual
Urban	Overall	n/a	98.9	n/a	1.02	n/a	96.6
	Distribution network - planned	n/a	53.4	n/a	0.24	n/a	222.2
	Distribution network - unplanned	n/a	45.5	n/a	0.78	n/a	58.3
	Normalised distribution network - unplanned	n/a	45.5	n/a	0.78	n/a	58.3

73 This section was completed with the assistance of ActewAGL.

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

75 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
Rural short	Overall	n/a	149.2	n/a	1.07	n/a	139.9
	Distribution network - planned	n/a	56.7	n/a	0.24	n/a	241.6
	Distribution network - unplanned	n/a	92.5	n/a	0.83	n/a	111.1
	Normalised distribution network - unplanned	n/a	92.5	n/a	0.83	n/a	111.2
Network	Overall	91.0	102.0	1.2	1.04	74.6	98.2
	Distribution network - planned	n/a	54.3	n/a	0.24	n/a	222.9
	Distribution network - unplanned	n/a	47.7	n/a	0.80	n/a	60.0
	Normalised distribution network - unplanned	n/a	47.7	n/a	0.80	n/a	60.0

Compared with the DNSP performance last year, performance against the SAIDI, SAIFI and CAIDI has decreased for most categories. These decreases are broadly attributed to insufficient visibility of key substations resulting in delayed fault response.

D.2.4 Victoria[76]

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.[77]

The ESC sets performance targets for unplanned SAIFI, unplanned SAIDI and MAIFI for the 2006-10 regulatory period for calculation of the financial incentive for

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

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

improving supply reliability. Financial rewards and penalties apply to DNSPs depending on how their performance compares to their respective performance targets, in accordance with the S-factor scheme.[78] DNSPs are also required to make GSL payments to the worst served customers if there have been excessive sustained supply outages and momentary interruptions.[79]

The performance indicators for the Victorian DNSPs are reported to the AER for the calendar year. The distribution licence requires independent audits of these indicators on a rotating basis. All DNSPs were last audited in mid-2009. The AER publishes annual comparative performance reports for the distributors.[80]

The Extended heatwave and extremely high temperatures in late January and early February 2009 seriously impacted the level of supply reliability in Victoria. Temperatures in Melbourne exceeded 43°C for three days in a row from 28 to 30 January 2009. About one week later, on 7 February 2009 (black Saturday), temperatures in Melbourne reached a record 46.6°C.

The heatwave resulted in higher power usage, coupled with transmission and distribution network faults and outages, including the unavailability of the Bass Link connection to Tasmania. A series of load shedding events were initiated during these periods in order to keep the electricity system running. This contributed to a significant deterioration in supply reliability measures.

Table D.4 shows a summary of the performance of the Victorian DNSPs for 2009. This 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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78 Details of the S-factor scheme are available from the Electricity Distribution Price Review 2006-10 documents, available from the ESC's website at http://www.esc.vic.gov.au/public/Energy/Regulation+and+Compliance/Decisions+and+Determinations/Electricity+Distribution+Price+Review+2006-10.

79 Details of the guaranteed service level payments are contained in clause 6 of the Electricity Distribution Code (EDC), available at http://www.esc.vic.gov.au/public/Energy/Regulation+and+Compliance/Codes+and+Guidelines/.

80 Prior to January 2009, performance reports for the Victorian distributors were published by the ESC.

Table D.4 Performance of the Victorian DNSPs for 2009

		SAIDI (minutes)				SAIFI			
		Unplanned		Planned		Unplanned		Planned	
DNSP	**Feeder**	**Target**	**Actual**	**Target**	**Actual**	**Target**	**Actual**	**Target**	**Actual**
Jemena	**Urban**	73	122.59	6	8.97	1.27	1.86	0.03	0.03
	Short rural	113	239.74	14	21.37	2.25	4.33	0.08	0.08
CitiPower	**CBD**	14	34.66	6	5.02	0.25	0.46	0.02	0.03
	Urban	35	68.64	10	4.13	0.80	1.10	0.03	0.02
Powercor	**Urban**	98	232.96	16	12.52	1.63	2.78	0.09	0.06
	Short rural	118	263.98	35	21.74	1.80	3.03	0.15	0.11
	Long rural	297	459.00	70	50.67	3.30	4.12	0.25	0.34
SP AusNet	**Urban**	109	140.09	16	28.26	1.82	1.72	0.09	0.13
	Short rural	185	499.97	35	62.88	2.73	3.85	0.15	0.30
	Long rural	300	786.33	70	79.18	4.28	4.04	0.30	0.43
United Energy	**Urban**	59	121.76	16	22.47	1.06	1.49	0.10	0.07
	Short rural	96	228.12	35	46.45	2.03	3.48	0.15	0.14

Notes:

1. Performance figures are based on National Reporting Framework format and include both Planned and Unplanned interruptions.
2. An electricity Distribution Business Comparative performance report is available from the AER’s website at www.aer.gov.au.

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.5 shows the performance data for the Victorian DNSPs with the impact of a number of extreme events excluded from the service performance data.

Table D.5 Performance of the Victorian DNSPs for 2009 - impact of excluded events[81] removed

		SAIDI (minutes)				SAIFI			
		Unplanned		Planned		Unplanned		Planned	
DNSP	**Feeder**	**Target**	**Actual**	**Target**	**Actual**	**Target**	**Actual**	**Target**	**Actual**
Jemena	**Urban**	73	83.96	6	8.97	1.27	1.21	0.03	0.03
	Short rural	113	133.51	14	21.37	2.25	2.31	0.08	0.08
CitiPower	**CBD**	14	18.43	6	5.02	0.25	0.26	0.02	0.03
	Urban	35	31.98	10	4.13	0.80	0.62	0.03	0.02
Powercor	**Urban**	98	111.87	16	12.52	1.63	1.38	0.09	0.06
	Short rural	118	147.48	35	21.74	1.80	1.62	0.15	0.11
	Long rural	297	339.00	70	50.67	3.30	2.89	0.25	0.34
SP AusNet	**Urban**	109	132.05	16	28.26	1.82	1.41	0.09	0.13
	Short rural	185	491.99	35	62.88	2.73	3.52	0.15	0.30
	Long rural	300	478.62	70	79.18	4.28	3.77	0.30	0.43
United Energy	**Urban**	59	95.51	16	22.47	1.06	1.19	0.10	0.07

81 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 2006-10 regulatory period.

		SAIDI (minutes)				SAIFI			
		Unplanned		Planned		Unplanned		Planned	
DNSP	**Feeder**	**Target**	**Actual**	**Target**	**Actual**	**Target**	**Actual**	**Target**	**Actual**
	Short rural	96	200.71	35	46.45	2.03	2.89	0.15	0.14

D.2.5 South Australia[82]

The DNSP supply restoration and reliability standards are established by ESCOSA through the Electricity Distribution Code and the Electricity Distribution Price Determination 2005-2010 (EDPD).

The reliability and performance standards established by ESCOSA for the DNSP, ETSA Utilities, comprise three main elements:

- Average Standards

  Average service standards for network reliability performance measured by frequency and duration of supply interruptions experienced by customers. Standards are based on the DNSP performance averaged across all customers connected to the network within each of seven defined regions, expressed in terms of the performance over a 12 month period. The standards to be met for the 2005-2010 period were determined on the basis of historical reliability performance in the period 2000-2004. Customer service standards (e.g. telephone responsiveness) are based on historical performance levels and cover state-wide performance. Average standards underpin the distribution prices permitted to be charged by the DNSP and are specified in the Electricity Distribution Code.

- Incentives to improve reliability to poorly served customers

  Service Incentive (SI) Scheme provided for in the EDPD provides a financial incentive (increased revenue) for the DNSP to improve reliability service to the worst served consumers comprising approximately 15 per cent of the customer base. A penalty applies if performance worsens beyond established benchmarks. The SI scheme also includes telephone responsiveness, although this is focussed on all customers not solely on poorly served customers.

  The key difference between the SI scheme established for the DNSP in South Australia and those established in some other jurisdictions is that the SI scheme focuses on driving reliability performance improvements for poorly served customers, rather than for all customers.

  From 1 July 2010, the AER will be responsible for administering ETSA Utilities' entitlements under its newly established STPIS.

- GSL scheme

  Both the average standards and the SI scheme involve an assessment of DNSP performance as experienced by a group of customers (e.g. performance averaged across customers in the defined regions, or the worst served 15 per cent of customers). The third major component of the service standard framework for

82 This section was completed with the assistance of ESCOSA.

the DNSP is a GSL scheme, which involves payments for poor service by the DNSP to individual customers.

The Electricity Distribution Code establishes GSLs, 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.

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 2009-10 fiscal year is illustrated in Table 25.

Table D.6 Performance of the South Australian DNSP for 2009-2010

Region	SAIDI (minutes)		SAIFI	
	Target	Actual	Target	Actual
Adelaide Business Area	25	1	0.3	0.02
Major Metropolitan Areas	115	147	1.4	1.56
Central	240	337	2.1	2.28
Eastern Hills/Fleurieu Peninsular	350	438	3.3	3.49
Upper North and Eyre Peninsular	370	632	2.5	2.52
South East	330	278	2.7	2.54
Kangaroo Island	450	371	n/a	4.89
Total network	165	217	1.7	1.85

D.2.6 Tasmania[83]

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.[84]

The new 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.[85]

For 2010-2011, the Tasmanian DNSP has continued to report against the former supply reliability standards for the purposes of year-on-year comparison.

Table D.7 Performance of the Tasmanian DNSP 2010-2011 (against the former supply reliability standards)[86]

Feeder	SAIDI (minutes)	SAIFI	CAIDI
CBD	27	0.43	62.8
Urban	131	1.05	124.8
Rural	446	3.07	145.3
Network	219	1.81	121.0

Table D.7 shows a summary of the performance of the Tasmanian DNSP against the former supply reliability standards. Similarly, Table D.8 shows the performance of the Tasmanian DNSP against the network performance standards in the amended TEC.

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

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

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

86 System performance is for the distribution system only, and excludes outages caused by generators and transmission networks.

Table D.8 Performance of the Tasmanian DNSP 2010-2011 (against the amended TEC)

Community category	SAIDI (minutes)		SAIFI	
	TEC (12 month category limit)	Performance	TEC (12 month category limit)	Performance
Critical infrastructure	30	15	0.20	0.18
High density commercial	60	31	1.00	0.44
Urban and regional centres	120	114	2.00	1.01
Higher density rural	480	341	4.00	2.59
Lower density rural	600	575	6.00	3.51

In 2010-11, the performance of all five community categories achieved the frequency and duration standards set by the TEC. This is the first time all categories have met both standards since they were introduced in January 2008.

The following Table D.9 shows the performance indices for each individual community in the Tasmanian region.

Table D.9 Individual community performance indices (2010-2011)

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	0/1	30	0/1	0/1	0/1
High density commercial	2.0	0/8	120	0/8	0/8	0/8
Urban and regional centres	4.0	1/32	240	5/32	5/32	1/32
Higher density rural	6.0	0/33	600	2/33	2/33	0/33
Lower density rural	8.0	0/27	720	9/27	9/27	0/27
Total		1/101		16/101	16/101	1/101

A total of 16 communities were classified as poor performing due to exceeding the TEC limits of frequency or duration over the 12 month period ending 30 June 2011. These communities represent 12 per cent of the connected load in the distribution network.

There were 16 communities classified as poor performing based on the duration measure. Of the 16, eight communities experienced major storm events that directly contributed to their poor performance. One community was classified as poor performing as it experienced a large number of planned outages during the NBN rollout. The remaining seven 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, 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.

Term	Explanation
	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 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.

Term	Explanation
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 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

Term	Explanation
	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.
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.
NTNDP	National Transmission Network Development Plan

Term	Explanation
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.
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

Term	Explanation
	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).
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

Term	Explanation
	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 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

Term	Explanation
	(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 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.