Annual Electricity Market Performance Review
Reliability & Security

2006

FINAL REPORT

RELIABILITY PANEL

December 2006

Foreword

A healthy, reliable national electricity system is of critical importance for all Australians. Consumers, energy supply and distribution organisations, and governments all have a direct interest in security and reliability.

In this report, the Reliability Panel (Panel) of the Australian Energy Market Commission (AEMC) reviews the performance of the interconnected national electricity system over the 2005-06 year in terms of reliability and security. The Panel includes people involved in electricity generation, transmission, distribution and retailing, as well as consumer representatives and the electricity system operator. The report has been prepared and published in accordance with the Panel's obligations under clause 8.8.3 of the National Electricity Rules.

The events, circumstances and activities that have either positively or adversely affected the supply of electricity to consumers are assessed in terms of two main criteria: the availability of adequate bulk supply to meet consumer demand (so called 'reliability'), and the technical security of the power system itself ('security'). Importantly, the Panel is responsible for dealing with reliability and security matters in the wholesale bulk electricity market and transmission. The ultimate level of reliability and security which customers receive is also impacted by the performance of the local distribution network. Although the Panel is not involved with local supply matters, this report also includes for the first time information from the jurisdictional regulators on the distribution network performance. This is included to provide a composite picture of the arrangements for managing reliability performance across the NEM.

Where appropriate, the Panel offers recommendations as to how performance in the areas in respect of which it has oversight can be improved in the coming years.

I wish to thank all Panel members for the generous and important contributions made in the 2005-06 year.

Ian C Woodward
Chair, Reliability Panel
Commissioner, Australian Energy Market Commission

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What this report is about

A reliable, secure supply of electricity is key to Australian households and businesses. Consumers of energy understand reliability and security in terms of the continuity and quality of delivered electricity, which is reliant upon all parts of the electricity supply chain including generation, high voltage transmission, and local network distribution.

The majority of customers' interruptions to supply occur in local distribution networks. These are presently regulated in each State and Territory and the local authority publicises standards of performance for these networks. This report provides a brief overview of information on this segment of electricity supply in section 3.

This report focuses on the performance of the two other areas, High Voltage Transmission and Generation in the National Electricity Market (NEM) connecting Queensland, NSW, ACT, Victoria, South Australia and Tasmania.

Specifically, it deals with:

- "reliability" which, for the purposes of this report, and consistent with the definitions in the National Electricity Rules (Rules), relates to availability of sufficient bulk electricity generation and transmission capability; and
- "security" which relates to operation of the power system within its technical limits.

How to use this report

- Read the two-page **Executive summary** for a brief outline of the purpose and scope of this performance review and for a summary of the Reliability Panel's main findings.
- Read **Year in review** for a discussion of the main events and activities that affected the national electricity system's performance in 2005-06 and for the Panel's analysis and recommendations.
- Read the **Technical performance assessment** for comprehensive statistical data on the system's reliability and security performance over the year and for an in-depth discussion of the mechanisms used to measure that performance.
- Read the **Network performance** section for an overview of the arrangements for managing the reliability of NEM distribution and transmission networks.
- If you are new to the subject matter of this report, please refer to the **Glossary** at the back for explanations of key terms and concepts.

Background

National Electricity Market

The NEM is a wholesale exchange for electricity in the participating states and territories of Queensland, New South Wales, Australian Capital Territory, Victoria, South Australia, and Tasmania. Its development was part of the broad energy reforms undertaken over the last decade. The NEM commenced operation on 13 December 1998.

Regulatory framework

In 2003, the Ministerial Council on Energy (MCE) decided to establish a new regulatory framework for Australia's energy market. It agreed to a package of reforms to governance, institutional arrangements, economic regulation, electricity transmission, user participation, and gas market development.

Under this regulatory framework, the objective of the National Electricity Market is defined as follows:

> The national electricity market objective is to promote efficient investment in, and efficient use of, electricity services for the long term interests of consumers of electricity with respect to price, quality, reliability and security of supply of electricity and the reliability, safety and security of the national electricity system.

To help achieve this objective National Electricity Rules (Rules) were drawn up to replace the previous National Electricity Code; the Australian Energy Market Commission (AEMC) was set up to manage market development and rule-making; and the Australian Energy Regulator (AER) was established to monitor compliance with the Rules. The Rules, the AEMC and the AER came into operation on 1 July 2005.

Australian Energy Market Commission

The responsibilities of the AEMC are to:

- administer and publish the National Electricity Rules
- undertake the rule-making process under the new National Electricity Law (NEL)
- make determinations on proposed rules
- undertake reviews on its own initiative or as directed by the MCE
- provide policy advice to the MCE in relation to the NEM.

The Reliability Panel

The Reliability Panel is established by the AEMC under section 38 of the NEL. It includes electricity industry and consumer representatives, and is chaired by a

Commissioner of the AEMC. Its responsibilities under clause 8.8.1(a) of the Rules include the following:

- determining the power system security and reliability standards
- determining and maintaining guidelines governing the exercise of NEMMCO's power to issue power system directions
- determining and maintaining guidelines and policies governing the exercise of NEMMCO's power to contract for the provision of reserves
- reviewing the performance of the market in terms of power system security and reliability
- determining the system restart standard on the advice of NEMMCO
- reviewing the system standards, as well as access, performance and plant standards for connecting to the network, in terms of their effects on power system security.

Until 30 June, 2005 the Reliability Panel was under the auspices of the National Electricity Code Administrator (NECA). On 1 July, 2005 the Reliability Panel was transferred to the AEMC. Section 4 of this report contains a list of the current Reliability Panel Members.

This Report contains information which was relevant to the first year following the transfer of the Panel to the AEMC, thus covering the period 1 July 2005 to 30 June 2006.

Executive summary

This report reviews the performance of the national electricity system in terms of reliability and security over the 2005-06 year. It examines the events, circumstances and activities that have either positively or adversely affected the supply of electricity to consumers (with the exception of local electricity distribution networks), and it offers recommendations to improve performance in the future.

Performance is reviewed by the Reliability Panel in terms of two main criteria: the availability of adequate bulk supply to meet consumer demand ('reliability'), and the technical security of the power system itself ('security'). The Panel is responsible, under the National Electricity Rules, for determining the standards for reliability and security against which the national electricity system's performance is to be assessed.

The 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 per cent 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 per cent (this is the 'Reliability Standard'). The Panel is further clarifying the definition of the Reliability standard in its Comprehensive Reliability Review[1]. The Panel intends to finalise this review in the second quarter of 2007.

Reliability of supply can be affected by many factors. For example, there may not be enough generating plant capacity available to meet demand in the first place; the plant that *is* available may be prevented from operating due to unexpected events; there may not be enough transmission capability available to convey the electricity to distribution networks; or the distribution networks themselves may not have sufficient capability.

Some matters that affect continuity of supply, such as the impact of distribution network failures, lie outside the scope of the Reliability Standard and the responsibility of the Panel to report on them. Also, where unserved energy is the result of a controlled response to prevent power system collapse due to multiple unanticipated disruptions[2], rather than as the result of insufficient generation or bulk transmission capacity being made available, this is formally classified as a *security* issue and is not considered part of the Reliability Standard. Such security issues are addressed in their own right in this Report.

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[1] Further details of the Panel's Comprehensive Reliability Review is available on the AEMC website at www.aemc.gov.au.

[2] See *contingency events* in the Glossary for full explanation.

Year in review: summary

In summary, the Panel's assessment of the National Electricity Market's performance is as follows:

- the Reliability Standard was not breached during the 2005-06 year. In the long term, since market start in December 1998, averages for unserved energy due to shortfall in available capacity indicate that New South Wales and Queensland remain within the Reliability Standard. South Australia and Victoria fell outside the Standard in the year 2000, when there was a coincidence of industrial action, high demand and temporary loss of generating units in Victoria; and their long-term averages remain outside the Standard due to that event. In every year since 2000, South Australia and Victoria have met the Reliability Standard.
- notwithstanding the fact that in 2005-06 the Reliability Standard was not breached, a number of incidents did affect levels of continuity and security of supply within the system:
  - four major incidents resulted in unserved energy during the year. In each case these were comprised non-credible (multiple) contingencies, where consumer load was shed to maintain power system security. No unserved energy occurred for reliability reasons.
  - with the exception of the four non-credible (multiple) contingency events, there were no instances where a transmission network element exceeded its ratings.
  - there was adequate available capacity to meet consumer demand throughout the year in all regions.
  - reserves were above the minima, set by the National Electricity Market Management Company (NEMMCO) to ensure the Reliability Standard is met, throughout the year in all regions.
  - a shortfall in reserves of 500 MW was forecast for Victoria and South Australia for February 2006. This was partially offset by NEMMCO contracting for 375 MW of reserve capacity. The forecast shortfall did not eventuate because the extremely hot days last summer occurred at the weekend and public holidays.
  - many frequency deviations occurred over the year but for the majority of events the frequency was restored to the normal operating band within the time allowed under the frequency standards. However, on 18 occasions on the mainland the frequency deviation took longer to restore to the normal operating band than the relevant standard allows. In Tasmania the frequency was not restored to the normal operating band within 600 seconds on 20 occasions.
- voltage was generally maintained within advised limits.
- system damping times for significant events were generally within requirements.
- over the year, an additional 328 MW of generating capacity (scheduled and non-scheduled)was brought into service .

The Panel received one submission on the draft of this report from Hydro Tasmania. The Panel welcomes Hydro Tasmania's comments and has addressed them in the body of the report.

Conclusions

Although the Reliability Standard was not breached, there has been over the past three years a significant amount of unserved energy due to non-credible (multiple) contingency events. The Panel continues to be concerned that these events are having a serious impact on the continuity of consumer supply, and that from a consumer perspective their impact is not clearly distinguishable from that of the reported *reliability* events, particularly as they occur at the bulk supply level.

The Panel indicated in its report last year that it intended in the future to focus more closely on identifying and addressing the underlying causes of non-credible (multiple) contingency events and other security related events particularly where they result in unserved energy. The Panel will work with relevant industry bodies to progress this more comprehensive approach to supply continuity. As part of that approach the Panel is currently reviewing , as part of the Comprehensive Reliability Review, available statistical information to identify whether there have been patterns in the non-credible contingency events since the start of the NEM.

The Panel has also included an overview of the reliability performance of transmission and distribution networks in section 3 in order to provide context for the bulk supply Reliability Standard.

Notwithstanding the issues raised following specific incidents, the reliability and security performance of the power system during the 2005-06 year appear to have been robust.

1 Year in review – Reliability and Security

This part of the report discusses and makes recommendations concerning the most significant incidents and issues that affected the performance of the national electricity system in 2005-06.

The performance review is organised under the following headings:

- Scope of the performance review: reliability and security
- The major power system incidents
- Other security issues
- Discussion: what can we learn?

(For technical information about the power system's performance in 2005-06, see Section 2 of this report, *Technical performance assessment*.)

Since the 1999-2000 summer, peak demand on the mainland has grown by 4 510 MW or 17.8 per cent, with annual growth averaging around 2.4 per cent. Over the same time, scheduled capacity has risen by more than 5 138 MW, with additional increases from smaller and unscheduled plant.

In the 2005-06 year, national summer peak demand reached 31 027 MW in January. National winter peak demand reached 31 197 MW in June. This is up from the record of 29 884 MW the previous summer and 30 776 MW the previous winter (inclusive of Tasmania). Record demands occurred in the 2005-06 year of 13 292 MW in New South Wales in February 2006, 8 730 MW in Victoria in February 2006, 8 280 MW in Queensland in February 2006, 2 876 MW in South Australia in January 2006 and 1 716 MW in Tasmania June 2005.

In terms of new capacity and changes to existing capacity in 2005-06, the Panel notes that:

- a total of 328 MW of new plant (scheduled and non-scheduled)[3] has been commissioned; and
- a number of minor changes have been made to the winter and summer ratings of existing plant.

[3] Scheduled generating plant participates in the central dispatch process operated by NEMMCO. Non-scheduled generating plant is not subject to central dispatch.

1.1 Scope of the performance review: reliability and security

The health of the power system is often discussed in terms of supply reliability and power system security.

Reliability is generally associated with the notion of measuring the continuity of electricity supply to consumers. This can be affected by factors ranging from the availability of adequate generating plant capacity to meet demand, the incidence of unexpected contingency events on generation and transmission equipment, the availability of adequate transmission capability to convey the electricity to distribution networks, and the performance of the distribution network down to the consumer's premises.

The Panel's 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 per cent of the annual energy of consumers in any region is at risk of not being supplied, or, the maximum permissible unserved energy is 0.002 per cent.

In applying this standard, the Panel does not take account of unserved energy that is caused by distribution network failures. Such events are outside the scope of the Panel's responsibility, and failures of that type have not been catered for in setting the standard.

In its 2004-05 Annual Market Performance Review[4] the Panel indicated that it intended to investigate the feasibility of including summary statistics in relation to distribution and transmission network reliability as this would assist in providing context for the bulk supply system reliability standard. The Panel notes that this area is subject to other regulatory jurisdictions and it intends to raise the desirability of reporting information collected by these other bodies as informative material for future reports in the Comprehensive Reliability Review. Section 3 of this report contains an overview of the transmission and distribution network reliability in the NEM.

Nor does the Panel consider in its reliability measurements any unserved energy that is the result of non-credible (or multiple) contingency events: the 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; unserved energy arising from these events is generally not counted against the Reliability Standard. The Panel is currently reviewing available statistical information to identify whether there have been patterns in the non-credible contingency events since the start of the NEM as part of the Comprehensive Reliability Review.

[4] The 2004-05 Annual Market Performance Review is available on the AEMC website at www.aemc.gov.au.

To regulate the performance of power system security, the Panel has determined the following frequency operating standards for the mainland[5] and for Tasmania[6]:

Frequency standards for the mainland

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

[1] This is known as the *normal operating frequency band*.

[2] This is known as the *normal operating frequency excursion bands*.

Frequency standards for Tasmania[7]

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 event	49.0 to 51.0 Hz	49.85 to 50.15 Hz within 10 minutes	
Generation event	47.5 to 51.0 Hz	49.85 to 50.15 Hz within 5 minutes	
Network event	47.5 to 53.0 Hz	49.0 to 51.0 Hz within 1 minute	49.85 to 50.15 Hz within 5 minutes
Separation event	46 to 55 Hz	47.5 to 51.0 Hz within 2 minutes	49.85 to 50.15 Hz within 10 minutes
Multiple contingency event	46 to 55 Hz	47.5 to 51.0 Hz within 2 minutes	49.85 to 50.15 Hz within 10 minutes

Variations to these standards apply when the power system is an *island* or becomes *islanded*. For more information on both this matter, see 'Frequency' in the *Technical performance assessment* section of the report.

[5] The mainland frequency standards were determined by the Panel in September 2001 and are available on the NECA website at www.neca.com.au.
[6] The Tasmanian frequency standards were determined by the Panel in May 2006 and are available on the AEMC website at www.aemc.gov.au.
[7] The Panel intends to review the Tasmanian frequency standards in 2007 following 12 months operation of the Tasmania power system with Basslink..

1.2 The major power system incidents

This section describes and offers comments on the four major power system incidents that occurred during the year:

- Tasmania, 25 November 2005
- Queensland, 20 March 2006
- Queensland, 21 April 2006
- Tasmania, 23 May 2006

Each of these incidents led to loss of consumer load. In accordance with clause 4.8.15 of the Rules, NEMMCO has investigated all four incidents and in each case published a report[8] on its findings.

Tasmania, 25 November 2005

Around 267 MW of automatic under-voltage load shedding occurred in Tasmania when an electrical storm resulted in both the two Sheffield – Georgetown 220 kV circuits and the Sheffield 220 kV bus tripping. This resulted in a split of the Tasmanian power system into two islands. Five generating units with a total output of 252 MW were also tripped and 267 MW of load was interrupted due to under-voltage.

> On the evening of Friday 25 November there was severe lightning activity in northern Tasmania and the simultaneous loss of both Sheffield to Farrell 220 kV circuits was classified as a credible contingency event (under clause 4.2.3(f) of the Rules) at 2040 hrs. Consequently, the network configuration was changed and NEMMCO invoked network and frequency control ancillary service (FCAS) constraints to manage this contingency event. This included splitting of the Farrell 220 kV busbar leaving the Bastyan Power Station supplying the main system via the 220 kV Farrell – Sheffield No 2 transmission circuit.
>
> At 23.43 during electrical storms, Sheffield - George Town No 1 and No 2 220 kV circuits tripped due to a lightning strike. The simultaneous loss of both Sheffield to George Town 220 kV circuits was not reclassified as a credible contingency because lightning activity was not detected in the vicinity of this double circuit transmission line. The 220 kV B Bus at Sheffield Substation then tripped about 200 ms later. The reason for the loss of the busbar has not been confirmed. The simultaneous loss of both circuits and the subsequent loss of the bus were each non-credible contingency events.
>
> As a consequence of the bus trip, the Sheffield - Farrell No 2 220 kV line and the Sheffield - Palmerston 220 kV line both tripped at the Sheffield end, causing a split across the Tasmanian power system at Sheffield. As a consequence of these line trips the Fisher, Lemonthyme, Bastyan and Rowallan power stations and the Woolnorth Wind Farm were disconnected or tripped.

[8] NEMMCO's system operating incidents reports are available on its website at www.nemmco.com.au.

The disturbance in the Tasmanian power system resulted in 267 MW of load loss due to under voltage conditions mainly in industrial loads. No load was shed due to the action of any automated systems in the transmission network such as under frequency load shedding schemes.

Comments

This incident was initiated by two non-credible contingencies: the tripping of a double circuit transmission and the tripping of a bus. This resulted in the splitting of the Tasmanian power system at Sheffield and the loss of five generating units. The load shedding in this event was significant, and was automatically initiated in order to prevent collapse of the power system voltage following the multiple generator trips.

The Panel considers that the simultaneous loss of both circuits of a double circuit transmission line due to severe lightning activity is not unusual. The event can be classified as a credible contingency when it is foreseen and can be managed using suitable network and FCAS constraints on the dispatch process. In this case the loss of both Sheffield - George Town circuits was not classified as a credible contingency because the risk of it occurring was not perceived to be significant.

However, even if the loss of both Sheffield - George Town circuits was classified as a credible contingency, the Panel considers that NEMMCO could not have been foreseen that the Sheffield 220 kV bus, and hence the Sheffield – Palmerston, would have tripped leading to the splitting of the Tasmanian power system.

The Panel is concerned that the reason for the Sheffield 220 kV bus trip has not been determined.

Queensland, 20 March 2006

Cyclone Larry resulted in multiple (12) unplanned outages of the 132 kV transmission lines and numerous outages of the distribution network. This resulted in significant losses of customer load.

At 04.28 on 20 March 2006 Cyclone Larry crossed the Queensland coast at Innisfail. The wind reached speeds of 290 km/h which resulted in multiple (12) unplanned outages and significant damage to the 132 kV transmission network. Supply was completely lost to the 132 kV bulk supply substations at Kamerunga, Innisfail, Tully and Cardwell. Kareeya and Barron Gorge (already unavailable) power stations also became isolated from the 132 kV system. Five towers were completely destroyed. Other damage included a broken conductor and earth wire, and debris and collapsed trees across lines.

> Restoration of the 132 kV s supplies commenced on Tuesday 21 March and was completed on Friday 24 March.

Comments

The Panel considers that loss of supply during a major cyclone cannot be avoided. It also considers that NEMMCO, Powerlink and Ergon used their best endeavours to restore supply to affected customers.

Queensland, 21 April 2006

The near simultaneous trip of Boyne Island no. 2 potline, no. 2 and no. 6 132 kV buses at Boyne Island substation, and the Gladstone no. 3 generator occurred following a fault on the Boyne Island – Gladstone 132 kV transmission line.

> At 17.30 on Friday 21 April 2006 a single phase fault occurred on the Boyne Island – Gladstone 132 kV transmission line (no. 7145). The fault was cleared in 98 ms. Circuit breaker fail protection was initiated by the failure of two local backup timer relays and both 7145 circuit breakers at Boyne Island tripped, isolating both no. 2 and no. 6 Boyne Island 132 kV buses. The tripping of these busbars disconnected all supply to the Boyne Island no. 2 potline.
>
> No. 3 generating unit at Gladstone tripped 30 seconds later. Enertrade advised that generating unit no. 3 was using the reserve cooling water pump during maintenance and that the system disturbance caused an under voltage on the 6.6 kV, resulting in the reserve pump tripping on under voltage which lead to the tripping of the generating unit.
>
> The supply to the Boyne Island no. 2 potline was restored from the 275 kV network after approximately 90 minutes.
>
> Powerlink advised that the fault on the Boyne Island – Gladstone 132 kV transmission line (7145) was caused by the earth wire on the other Boyne Island – Gladstone 132 kV transmission line (7146). Powerlink removed the faulty section of earth wire.
>
> Enertrade advised that a time delay would be installed on the under voltage protection for the reserve cooling water pump to prevent tripping during a normal system disturbance. This modification is not required on the main cooling pumps as they are not supplied from the 6.6 kV station supply.

Comments

The Panel notes that the causes of this multiple contingency, the earth wire on the 7146 line, the local back up timers in the Boyne Island switchyard and the reserve cooling pump at Gladstone power station, were addressed to reduce the probability of similar incidents occurring in the future.

Tasmania, 23 May 2006

The incident included the disconnection of the Butlers Gorge and Bastyan power stations, generating unit no. 2 at Gordon power station and generating units nos. 1, 2 and 3 at Wayatinah power station, the initial runback and subsequent increase of output at the Tungatinah power station and the shedding of 240 MW of load following the initiation of Under Frequency Load Shedding (ULFS).

> Prior to 07.50 on Tuesday 23 May 2006 over-constrained dispatch was triggered for a number of dispatch intervals as the FCAS requirements were not met in Tasmania. At 07.50 the FCAS requirements were satisfied by reversing the Basslink flow, changed to a flow from Victoria to Tasmania. In response Basslink flow reversed. The resulting over frequency in Tasmania was quickly controlled.
>
> At the 07.55 the flow on Basslink was reversed back to a small Tasmanian export. However, the resulting low frequency disturbance was not rapidly controlled. The Butlers Gorge and Bastyan power stations, and the no. 2 generating unit at Gordon power station and units nos. 1, 2 and 3 at Wayatinah power station disconnected causing 240 MW of under frequency load shedding.
>
> NEMMCO's power system incident report indicated that the main factors that contributed to the incident include:
> - difficulty in controlling Basslink manually;
> - ineffective attempts to control Basslink flow through constraint equations;
> - insufficient frequency control ancillary service delivery;
> - failure to follow dispatch instructions; and
> - inappropriate tripping of generating units (in NEMMCO's opinion).
>
> The incident also revealed a degree of over-correction by delayed frequency control ancillary services, excessive delays in frequency control ancillary service enablement, delayed restoration of NEMMCO's AGC after it was suspended and inadequate recording of frequency control ancillary service delivery.
>
> NEMMCO's recommendations to reduce the risk of further incidents of this type include review of NEMMCO's and National Grid Australia's operating procedures, review of delayed frequency control ancillary service design, and review of Hydro Tasmania's generation control systems, data recording facilities and generating unit protection.

Comments

This incident identified issues with a number of NEMMCO, Hydro Tasmania and National Grid Australia's systems.

The Panel notes that NEMMCO considers that the trips of the Butler's Gorge, Bastyan, Gordon and Wayatinah generating units was not consistent with the associated generating unit performance standards, while Hydro Tasmania does not agree with this interpretation.

1.3 Other security issues

A number of other security issues occurred during the year as follows.

Transmission events

Seven transmission-related non-credible contingency events were reported by NEMMCO during the year. (This compares with 7 in the previous year and 10 the year before that.) These seven events are in addition to the multiple contingency events of 25 November 2005, 20 March 2006, 21 April 2006 and 23 May 2006.

Directions

Sixty-one directions were issued by NEMMCO this year to manage local security issues:

- 52 were applied to DirectLink to make itself available for dispatch from New South Wales to Queensland;
- one was applied to a Queensland generator;
- one was applied in New South Wales to radialise a 132 kV line to facilitate dispatch from Queensland into New South Wales;
- six were applied in Tasmania to provide frequency services in Tasmania
- one was applied to Basslink to make itself available for dispatch in the direction Victoria to Tasmania

Intervention by direction is an important and effective last resort for maintaining power system security. Nevertheless, the continuing refinement of normal market mechanisms for ensuring reliable and secure operation *without* the need for frequent intervention remains an important priority.

Frequency deviations

During the year the frequency on the mainland deviated from the normal operating band on 56 occasions. On 18 of these, frequency remained outside the normal band for more than 5 minutes; but on only one of these was frequency outside the normal band for longer than the standard allows.

The frequency in Tasmania deviated from the normal operating band on 630 occasions. On 96 of these, frequency remained outside the normal band for more than 5 minutes; and on 20 of these was frequency outside the normal band for longer than the standard allows.

1.4 Discussion: what can we learn?

Reliability results

There was sufficient generation capacity to meet consumer demand at all times during the 2005-06 year. With the exception of the incident in NSW on 1 December 2004, there was sufficient capacity from the energy market to meet consumer demand at all times and in all regions for the fifth consecutive year.

Since market start in December 1998, the long-term averages for unserved energy due to supply shortages are as follows:

- New South Wales, 0.0001 per cent
- Queensland, 0 per cent
- South Australia, 0.0025 per cent
- Victoria, 0.0101 per cent.

South Australia and Victoria fell outside the Reliability Standard in the year 2000, when there was a coincidence of industrial action, high demand and temporary loss of generating units in Victoria during January and February; and their long-term averages remain outside the Standard due to that event. In every year since 2000, South Australia and Victoria have met the Reliability Standard. The Panel is reviewing the statistical basis for application of the standard over time as part of its Comprehensive Reliability Review.

In its submission to the Panel on the 2005 Annual Market Performance Review, the NGF suggested that USE due to industrial action should be excluded from the reported reliability statistics. The Panel considers that all sources of USE due to insufficient generation or bulk transmission capacity affect customers in the same manner and should be reported consistently. However, where appropriate, the reported statistics should explicitly note the categories of USE. This is being considered further in the Panel's Comprehensive Reliability Review.

Security results

While none of the four major incidents this year resulted in unserved energy due to insufficient supply, the Panel remains concerned that there has been a significant amount of unserved energy due to non-credible (or multiple) contingency events, which are formally classified as *power system security* issues.

Non-credible contingency events can have a serious impact on consumer supply, and from a consumer perspective their impact is not clearly distinguishable from that of reliability events, particularly as they occur at the bulk supply level.

These non-credible contingency events (other than the event caused by cyclone Larry) appear to indicate unexpected operation of plant at times when the power system is most stressed. When the power system is experiencing a credible contingency event, it is important that power system plant respond in accordance with defined performance standards to minimise the potential for cascading (i.e. non-credible contingency) events. The alternative, which is to operate the power system to cater for non-credible contingency events without having to shed consumer load, would result in very conservative operating limits, particularly in respect of interconnector flows.

It is therefore important to determine whether further assessment of non-credible contingency events could provide a leading indicator for any shortcomings emerging in relation to (a) the technical compliance of plant with defined performance standards, (b) the standards themselves, or (c) some other issue.

The Panel is reviewing available statistical information to identify whether there have been patterns in the non-credible contingency events since the start of the NEM as part of the Comprehensive Reliability Review.

2 Technical performance assessment

This part of the report contains comprehensive statistical data on the system's reliability and security performance over the year as well as discussion of the mechanisms used to measure that performance.

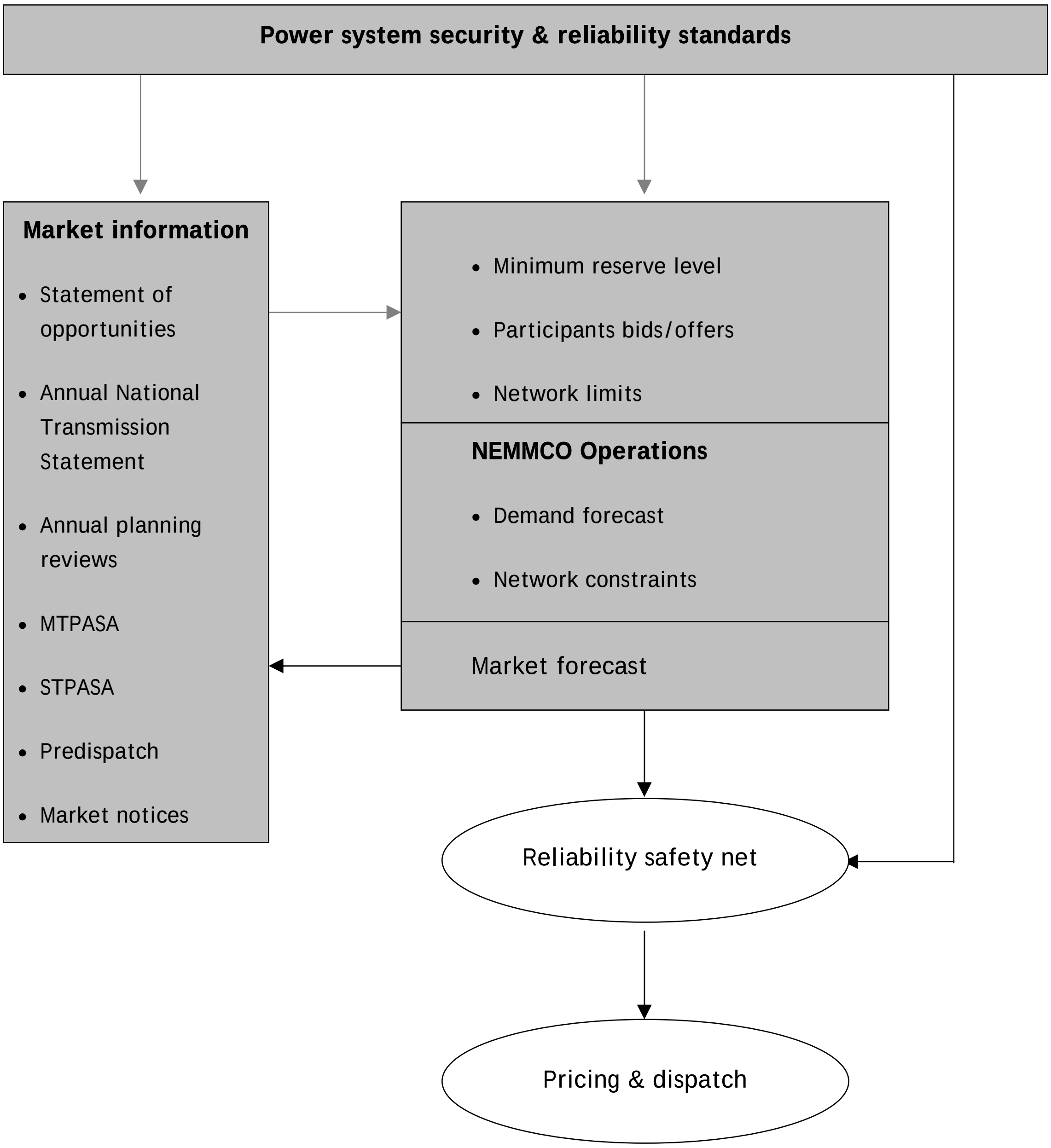
2.1 Reliability management

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 NEMMCO to support those decisions. NEMMCO monitors the level of reserve in each region and may intervene if these reserves fall below margins calculated by NEMMCO as necessary to meet the Panel's standard. Market information provides data and projections with increasing levels of detail closer to the time of dispatch. The annual Statement of Opportunities provides information for 10 years ahead. The shortest term information provides 5 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 NEMMCO by participants. NEMMCO 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 NEMMCO. The final data is used by NEMMCO to operate the market and power system.

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

Figure 1: Reliability model



2.2 Energy market Reliability Standard

The Reliability Standard of 0.002 per cent unserved energy is designed to deliver sufficient available capacity to meet demand. It is the basis for NEMMCO's calculation of minimum reserve levels for market information purposes, and if necessary intervention through reserve contracting or direction. Reliability within a market region depends on the reserve within that region and other regions and on the capability of interconnectors[9].

Reliability of the energy market is measured by comparing the component of any energy not supplied to consumers as a result of insufficient generating or bulk transmission capability against the standard. This excludes energy not supplied due to management of security and performance of distribution networks and is therefore only part of the overall measure of continuity of supply to consumers. As noted previously, section 3 of this report provides summary information on distribution network reliability in order to provide context for the Reliability Standard.

Reliability is driven by the adequacy of investment and level of plant presented to NEMMCO 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 to market. The Reliability Standard sets the threshold at which NEMMCO may intervene in the operation of the market to ensure sufficient capacity is presented. 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 NEMMCO and network service providers.

This year's report does not include any USE due to the impact of intra-network constraints on reliability. The Panel intends to undertake further work to more clearly define which events should be included in the reliability measures and this will be performed as part of the Comprehensive Reliability Review.

Performance assessment

No USE occurred during 2005-06 as a result of a reliability incident and, therefore, the reliability standard was met in all regions. For the fifth consecutive year there was sufficient capacity from the energy market to meet consumer demand at all times in all regions with the exception of one incident in New South Wales on 1 December 2004, which was reported in the 2005 Annual Electricity Market Performance Review[10].

[9] The reliability standard and associated reliability arrangements in the NEM are the subject of the Panel's Comprehensive Reliability Review, details of which are available at www.aemc.gov.au.
[10] The Panel's 2005 Annual Electricity Market Performance Review is available at www.aemc.gov.au.

2.3 Minimum reserve level

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

The Panel notes that NEMMCO has been working to improve its methodology for calculating the minimum reserve levels and has recently submitted revised calculations based on this methodology. In particular:

- NEMMCO and the NGF have developed recommendations via the Forced Outage Data Working Group for improving the quality of generator failure statistics and how these are modelled;
- NEMMCO has adopted these recommendations to calculate generator failure statistics for the 2006 minimum reserve level calculation; and
- NEMMCO has developed techniques to determine minimum reserve levels that target the delivery of the reliability standard in every region.

The industry will benefit from further refinement of the minimum reserve levels for different applications and time horizons. These different horizons could, for example, include forecasts of reserve one week ahead and 10 year projections of system adequacy in NEMMCO's annual Statement of Opportunities. In particular the work could focus on how the minimum reserve level criterion can best be applied in the short term to avoid the risk of excessive intervention.

Figure 2 shows the minimum reserve levels that operated in the NEM for the 2005-06 year. The figure also shows the minimum reserve levels submitted to the Panel by NEMMCO for the 2006-07 and 2007-08 years. The minimum reserve levels submitted by NEMMCO were noted by the Panel in September 2006 and will be implemented in medium-term PASA from 24 October 2006.

Figure 2: Revised minimum reserve levels – New South Wales and Queensland

	Qld *	NSW	Vic & SA	SA *	Tas
2005-06	610 MW	— 290 MW	530 MW	265 MW	144 MW
2006-07 **	480 MW	— 1490 MW	615 MW	-50 MW	144 MW
2007-08 **	560 MW	— 1430 MW	615 MW	-50 MW	144 MW

* This is a local requirement and must be meet by generation within the region assuming 0 MW supporting flow from neighbouring regions (only applies from 24 October 2006).

** The minimum reserve levels currently proposed by NEMMCO based on the most up to date methodology

The methodology used by NEMMCO to determine the minimum reserve levels 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 minimum reserve levels are derived by comparing the minimum generation requirement with a demand condition which has all regions at their maximum 10%POE demand and taking into account reserve available across interconnectors. In particular Snowy generation capacity is shared between Victoria and NSW.

The NSW minimum reserve level has been determined assuming Snowy provides 1878 MW support to NSW. Assuming a maximum import capability into NSW of approximately 4000 MW (2900 MW from Snowy and 1100 MW from Qld) there is 2122 MW spare import capability. This spare import capability provides NSW with access to share significant spare capacity with neighbouring regions. As a result NSW can have such large negative minimum reserve level.

NEMMCO recently reviewed the relevance of the -290 MW in the deterministic environment of PASA. This review identified that the amount of spare capability on interconnectors into NSW must be maintained at an appropriate level for medium-term PASA to correctly alert the market to low reserve conditions. Therefore, from 4 October 2005 NEMMCO implemented constraints in MTPASA to limit the transfer of reserves from New South Wales to support Queensland to 300 MW and from the Snowy and Queensland regions to New South Wales to 2 500 MW[11].

NEMMCO may intervene using reserve contracting or its power of direction if reserve delivered by the market is below the designated minimum reserve level. The medium-term and short-term assessments of system adequacy (medium-term PASA and short-term PASA), predispatch and market notices (see Section 2.8) alert the market to the potential of reserve levels below the threshold. This information and participants' responses are central parts of the management of reliability in the national market.

Performance assessment

In September 2003 NEMMCO began reporting both forecast and actual reserves for each trading interval and for each region. In late 2004 NEMMCO revised its approach in order to incorporate the effects of 'option 4 constraints'. This has improved the treatment of network constraints for the purpose of reserve assessment, both within and between regions.

Reserve was below the threshold level for intervention for around one hour across all regions during 2005-06. Figure 3 summarises the results in each region for the last five years and shows a general reduction in forecast and actual reserve shortfalls over that time, with the exception of South Australia during the Moomba crisis of January and February 2004.

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[11] Details of NEMMCO's approach are provided in the NEMMCO report "Interconnector limits forecast for MTPASA" of 1 June 2006, available at http://www.nemmco.com.au/dispatchandpricing/173-0198.pdf. NEMMCO's approach was previously conveyed to the market in NEM Communication No. 1928 of 30 September 2005.

Figure 3: Duration below the minimum reserve levels[12]

	Year	Qld	NSW	Vic	SA	Tas
Forecast duration below the threshold (hours)	2005 – 2006	0	0	0	0	0
	2004 – 2005	17.5	0	0	6	-
	2003 – 2004	11.5	4.5	17.5	645	-
	2002 – 2003	2.5	3.5	7	115.5	-
	2001 – 2002	1	0	0	45.5	-
	2000 – 2001	188	8	67	716	-
	1999 – 2000	43	33	145	699	-
Actual duration below the threshold (hours)	2005 – 2006	0	0	0	1[1]	0
	2004 – 2005	0	2	0	0	-
	2003 – 2004	0	1	4	6	-
	2002 – 2003	0	1	0	0	-
	2001 – 2002	0	0	0	0	-
	2000 – 2001	0	0	3	24	-
	1999 – 2000	5	4	36	88	-

[1] The one hour of reserve shortfalls was not flagged in market notices, although the reserve data recently supplied by NEMMCO identifies the trading intervals ending 4pm and 4.30pm on 30 December 2005.

There is still no distinction made between short and medium term minimum reserve levels in PASA and predispatch, even though there is greater certainty about demand in the short term. Again, this highlights the importance for the industry of developing minimum reserve levels for different applications and time horizons. Demand forecasting for different applications and time horizons is discussed further in section 2.9.

2.4 Market information

Market information is provided in a number of formats and timeframes ranging from the 10-year Statement of Opportunities to the detailed 5 minute and 30 minute price and demand predispatch. Market information also includes Annual Planning Reviews, the Annual National Transmission Statement, the Medium Term Projected Assessment of System Adequacy (medium-term PASA), the Short Term Projected Assessment of System Adequacy (short-term PASA), and market notices. Each is described and analysed below.

[12] Note: The values in this figure 3, whilst a good guide to duration below minimum reserve levels, are determined from analysis that treats all load and generation as if it was located at the Regional Reference Node. A simplified approach to constraints is also used in deriving the data. Some reporting anomalies can arise through these processes, and adjustments have been made to reflect actual conditions in some cases.

Statement of Opportunities, Annual National Transmission Statement and Annual Planning Reviews

Each year NEMMCO publishes a Statement of Opportunities (SOO) for the next 10 years. This is complemented by Annual Planning Reviews, prepared by transmission network service providers (TNSPs), which focus on networks and include forecasts of transfer capacities, potential constraints and possible intra-regional augmentations. The SOO also incorporates the Annual National Transmission Statement (ANTS), prepared by the NEMMCO in conjunction with the Inter-Regional Planning Committee (IRPC), which provides an integrated overview of the current state and potential future development of major national transmission flow paths.

These documents provide technical and market data, as well as useful information about market opportunities, for existing market participants, intending code participants and other interested parties. They include:

- forecasts of energy usage, 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 the regions of the national market.)
- NEMMCO's assessment of the adequacy of supply, referred to as the supply/demand balance
- a brief summary of significant initiatives and projects expected to influence market development over the coming years.

Performance assessment

Figure 4 compares the forecast demand, for medium growth and 10 per cent, 50 per cent and 90 per cent probability of exceedence (POE), with the actual maximum demands. The forecast demand values shown are from the 2005 SOO (apart from the 2006 winter values which were published in the 2006 Energy and Demand Projections: Summary Report July 2006, available at www.nemmco.com.au). In each case the actual maximum demand did not exceed the 10 per cent POE forecast maximum demand value, however, in a number of cases it did not reach the 90 per cent POE value.

In its submission to the Panel on the 2005 Annual Market Performance Review, the NGF suggested that the maximum demands in some regions did not reach the 90 per cent probability of exceedence forecast values published in the SOO. The Panel has raised the issue with NEMMCO to determine if it is a persistent problem.

The Panel notes that in 2005 NEMMCO engaged KEMA Consulting to review the processes used to prepare the load forecasts in the SOO. KEMA Consulting's report is available on the NEMMCO website[13].

In its review of the process for preparing the SOO load forecasts in 2005, KEMA recommended:

- extending the back cast process used to validate the demand projections further back in time to assess the performance of the current forecast algorithm, and
- that the errors between the back cast values and actual recorded values be used to calculate a measure of the forecast accuracy (backwards in time).

A number of the recommendations made by KEMA have already been incorporated into the load forecast preparation process. The Panel is aware that NEMMCO and representatives from each of the jurisdictional planning bodies are further considering KEMA's recommendations and are evaluating other potential improvements as part of the ongoing process to review and refine the forecasting models.

Figure 4: Statement of Opportunities maximum demand forecast comparison

Region	Qld	NSW	Vic	SA	Tas
Winter 2005					
2005 SOO Peak forecast (10% POE)	7 790	13 530	8 111	2 377	1 736
(50% POE)	7 644	13 140	7 877	2 334	1 718
(90% POE)	7 498	12 840	7 671	2 288	1 664
Actual maximum demand [1]	7 354	13 126	7 764	2 260	1 716
Summer 2005/2006					
2005 SOO Peak forecast (10% POE)	9 046	14 080	10 119	3 378	1 364
(50% POE)	8 702	13 120	9 260	3 091	1 346
(90% POE)	8 500	12 110	8 700	2 892	1 330
Actual maximum demand [1]	8 280	13 292	8 730	2 876	1 294
Winter 2006					
2006 SOO Peak forecast (10% POE)	7 875	13 780	7 891	2 409	1 811
(50% POE)	7 730	13 460	7 790	2 364	1 792
(90% POE)	7 584	13 160	7 680	2 315	1 738
Actual maximum demand [1]	7 628	13 076	7 863	2 362	1 684

[1] The demand for comparison with the SOO forecasts (up to 12 September 2006 for the 2006 winter).

In the 2005-06 year, national summer peak demand reached 31 027 MW in January. National winter peak demand reached 31 197 MW in June. This is up from the record of 29 884 MW the previous summer and 30 776 MW the previous winter (inclusive of Tasmania). Record demands occurred in the 2005-06 year of 13 292 MW in New South

[13] The KEMA report "Review of the process for preparing the SOO load forecasts", 17 June 2005, is available on the NEMMCO website at www.nemmco.com.au.

Wales in February 2006, 8 730 MW in Victoria in February 2006, 8 280 MW in Queensland in February 2006, 2 876 MW in South Australia in January 2006 and 1 716 MW in Tasmania June 2005.

Figure 5 shows the relationship between the regional peak demands and the coincident national peak, since market start.

Figure 5: Combined peak demand and demand for each region

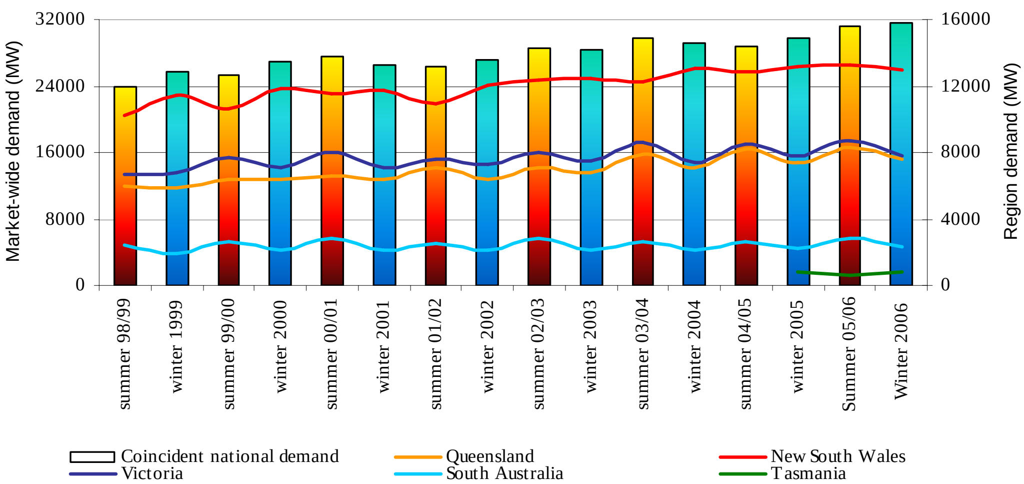
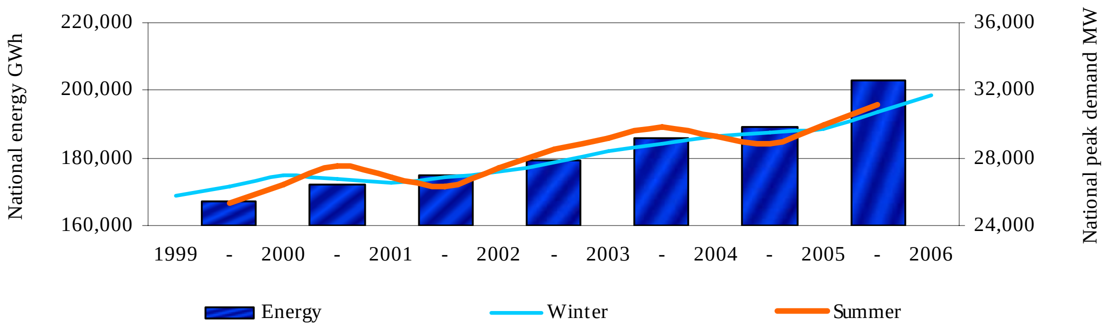


Figure 6 sets out the growth in annual total energy and the winter and summer national peak demands.

Figure 6: National energy requirements



2.5 Medium-term PASA (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 probability of exceedence, for each day for the next two years.

Demand forecasts are prepared by NEMMCO. Generation and demand-side daily availability estimates are submitted by participants. Transmission outage programs are supplied by TNSPs. This information is:

- to assist participants in planning for maintenance, production planning and load management activities over the medium term; and
- the basis for any intervention decisions by NEMMCO, for example the reserve trader process.

The ability to forecast network capability and in particular interconnector capability is important for the reliable and efficient operation of the market. Every month, NEMMCO and the TNSPs publish planned network outage information for the following 13 months. NEMMCO 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 for all TNSPs.

Interconnector capability can be a function of the pattern of generation, availability of reactive support, and certain network services. The results are summarised in Figure 7.

Figure 7: Transmission outages submitted to NEMMCO

	Qld	NSW [1]	Vic	SA	Tas	MurrayLink	Terranora	Total
Total outages [2]	964	1 127	1 195	657	522	13	9	4 487
Scheduled with less than 4 days notice	29%	24%	37%	27%	30%	50%	75%	30%
Forced outages [3]	7%	8%	8%	12%	10%	23%	56%	9%

[1] The NSW TNSP arranges Snowy outages.

[2] Only primary plant outages (affecting load carrying capability) are included.

[3] Outages not previously notified to NEMMCO, including failures and amendments by TNSPs in response to unforseen extreme conditions.

In some circumstances, outages scheduled at short notice increase overall reliability and market efficiency by taking advantage of unexpected system conditions, but short notice outages can also increase uncertainty for market participants and for the management of reliability and security. Other outages have little effect on reliability.

Performance assessment

In May 2005, medium-term PASA was enhanced to share reserve deficits across regions more equitably. This means that where a reserve shortfall exists, medium-term PASA reports this in each of the affected regions and attempts to share the reserve shortfall in proportion to region demands.

Medium-term PASA now also has the ability to produce two sets of results: one where there are no network outages modelled, and another where they are. The November 2005 release of the Market Management System saw further improvements to medium-term PASA including an assessment of network outages based on 50% probability of exceedence demand forecasts, while reliability will be assessed against 10% probability of exceedence demand forecasts[14].

NEMMCO is also undertaking ongoing work with Tasmanian participants to improve the modelling of energy limited plant in Tasmania. NEMMCO reported no progress on this issue over the past year.

Overall, medium-term PASA accuracy is generally satisfactory for its primary function of checking reliability at peak times well in advance of operation.

2.6 Short-term PASA (projected assessment of system adequacy)

Short-term PASA is an aggregate supply and demand balance comparison for each half-hour of the coming week.

Demand forecasts are prepared by NEMMCO. Generation and demand side availabilities are submitted by participants. Transmission outage programs are supplied by TNSPs. This information is to assist participants in optimising short-term physical and commercial planning for maintenance, production planning and load management activities.

Performance assessment

Enhancements have been made to improve consistency between the medium-term PASA and short-term PASA systems, most notably in the management of constraints and in the optimisation of the medium-term PASA, which now uses a common linear programme solver to short-term PASA.

2.7 Predispatch

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

[14] The NEMMCO report "MTPASA Process Description" of 27 April 2006, available at http://www.nemmco.com.au/dispatchandpricing/432-0004.pdf provides details of these changes.

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

Predispatch 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 5 minute predispatch process designed to enhance information on demand and supply for the next hour, in particular for the operators of fast start generators.

Performance assessment

Analysis of the predispatch information generally shows that when supply is tight, forecast prices are initially high until participants rebid to increase their availability. This is consistent with an appropriate market response. The forecast of high prices provides an incentive for additional capacity to be presented to the market.

Accuracy of the demand forecasts by NEMMCO used in predispatch is an important determinant of the accuracy of the predispatch overall.

Figure 8, provided by the AER, summarises the number of trading intervals affected by significant variations between forecast and actual prices during the 2005-06 period as well as the most probable reasons for the variations.

Figure 8: Trading intervals affected by price variation

Reason for price variation	Number of trading intervals affected by variations (%)									
	Qld		NSW		Vic		SA		Tas	
Demand	987	58%	1 102	62%	1 238	62%	1 526	64%	1 028	57%
Availability	359	21%	319	18%	323	16%	334	14%	209	12%
Combination (e.g. combination of changes in plant availability, demand, rebidding activities)	347	20%	334	19%	423	21%	506	21%	537	30%
Other (e.g. network outages)	16	1%	23	1%	28	1%	37	2%	42	2%
Trading intervals affected	1 269	7%	1 360	8%	1 540	9%	1 842	11%	1 444	8%

The percentage of price variations will not necessarily equal the total number of trading intervals affected. A number of forecasts are published for each trading interval, multiple variations, sometimes with different reasons can occur for the one trading interval. The Snowy region price variations have been excluded. Movements of availability in Snowy generation generally impact directly on neighbouring regions.

Overall, predispatch is working satisfactorily as an indicator of reliability and security. Its utility to the market continues to improve, although it will always be affected by the accuracy of demand forecasts. The Panel notes that forecasting is a continuing challenge which is likely to become more complex still with growth in non-scheduled generation such as wind farms.

2.8 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 NEMMCO to market participants to allow them a more informed market response.

Performance assessment

There were 1,662 market notices issued by NEMMCO during the year. Figure 9 summarises these notices by type.

Figure 9: Market notices

Type	Number of notices
General notice	379
Changes to inter-regional transfer capability	340
Reclassify contingency	225
Reserve notice	209
Market systems	154
Market intervention	123
Non-conformance	97
Settlements residue	48
Price adjustment	30
Manual priced dispatch interval	24
Power system events	15
NEM systems	12
Constraints	3
VoLL	3

Overall, market notices are considered to be an effective method of communicating with market participants and the wider public. The Panel's considerations do not extend to the quality of the notices.

2.9 Demand forecast

NEMMCO'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.

Performance assessment

The medium-term PASA demand forecast is a 10 per cent probability of exceedence (POE) forecast with a daily resolution. This forecast takes the summer and winter weekday 10 per cent POE demand forecasts and sculpts the remainder of the year by estimating seasonal and weekend fluctuations. This year NEMMCO reviewed its historical demand data and produced new curves to sculpt the seasonal variations of the daily maximum demands used in medium-term PASA.

Figure 10 summarises the percentage of days when actual demand was greater than forecast demand, as well as the average amount by which actual demand exceeded forecast demand for those days.

Figure 10: Medium-term PASA demand forecast comparison

	Qld	NSW	Vic	SA	Tas
Proportion of weekdays where demand greater than 10 per cent POE forecast	8.0%	1.1%	1.5%	2.7%	0%
Weekdays demand deviation	-2%	-2%	-2.2%	-3%	0%
Weekend days where demand greater than 10 per cent POE forecast	36.5%	22.1%	4.8%	7.7%	0%

The were 59 days in Queensland, 26 days in New South Wales, 9 days in Victoria and 15 days in South Australia where demand was greater than forecast. Weekend demands continue to often be higher than forecast in Queensland and New South Wales. The weekend days generally have lower demands and are less of a reliability concern.

Figure 11 shows the average short-term PASA demand forecast accuracy for 2, 4 and 6 days ahead.

Figure 11: Accuracy of short-term PASA demand forecast

Short-term PASA demand forecast absolute percentage deviation	Qld	NSW	Vic	SA	Tas
2 days ahead	2.4%	3.1%	3.0%	6.3%	4.0%
4 days ahead	2.8%	3.8%	3.4%	6.8%	4.4%
6 days ahead	2.8%	4.0%	3.4%	6.7%	

Figure 12 shows the average predispatch demand forecast deviation 12 hours ahead.

Figure 12: Accuracy of predispatch demand forecast

Predispatch absolute demand forecast deviation	Qld	NSW	Vic	SA	Tas
12 hours ahead	2.0%	2.5%	2.5%	5.7%	3.6%

Figures 13 to 17 assess for the summer period the demand forecast four hours ahead of dispatch to indicate whether forecast performance varies with different levels of demand.

For each region there are four graphs. The first graph examines the absolute deviation for equal sized samples of demand. For example, the bottom 10 per cent of actual demands are grouped, and the average and maximum demand forecast deviation is plotted. The median of that sample of demands is shown on the bottom axis. Similar grouping is performed on the other 10 percentiles of demand. The second graph examines the top 10 per cent of actual demand in 1 per cent groupings. The third and fourth graphs examine raw deviations on a similar basis and plot the average raw deviation and the maximum demand forecast deviation. Any underlying bias in forecasting would be expected to show up here.

The figures show for every region that forecasting is less reliable at the top end of demand. The maximum deviation between forecasts and actuals at the top 10 percentile is larger than the minimum reserve level. For example, the top 10 per cent of demand for Queensland, with a median of 7,479 MW, indicates an average deviation four hours ahead of dispatch of 160 MW. The deviations range from 543 MW lower than forecast to 770 MW higher than forecast. The top one per cent of demand for Queensland, with a median demand of 8006 MW, indicates an average deviation four hours ahead of dispatch of 182 MW. The deviations range from 269 MW lower than forecast to 555 MW higher than forecast.

Significant deviations between forecast and actual prices occur in approximately 13 per cent of trading intervals.

The method used in short-term PASA and predispatch to determine the 10 per cent probability of exceedence (POE) demand by scaling the 50 per cent demand does not vary with time to dispatch and can lead to significant but conservative deviations close to dispatch. Ideally, as the time to dispatch reduces, the 50 per cent POE (or most likely) and the 10 per cent POE demand forecasts should converge. This would improve reserve shortfall notification.

NEMMCO investigated the methods of introducing time varying scaling factors to determine half hourly 10% POE forecast demand using the 50% POE forecast demand. A project was undertaken to deliver the functionality required to use time varying scaling factors in short-term PASA and predispatch timeframes. It is anticipated that the time varying scaling factors will be incorporated into the NEMMCO market management systems (MMS) by January 2007.

The short-term PASA demand forecasts were, in general, less reliable than for the previous two years. The predispatch shows a deviation between forecast and actuals at the top end of demand.

Figure 13: Queensland demand forecast deviation 4 hours ahead

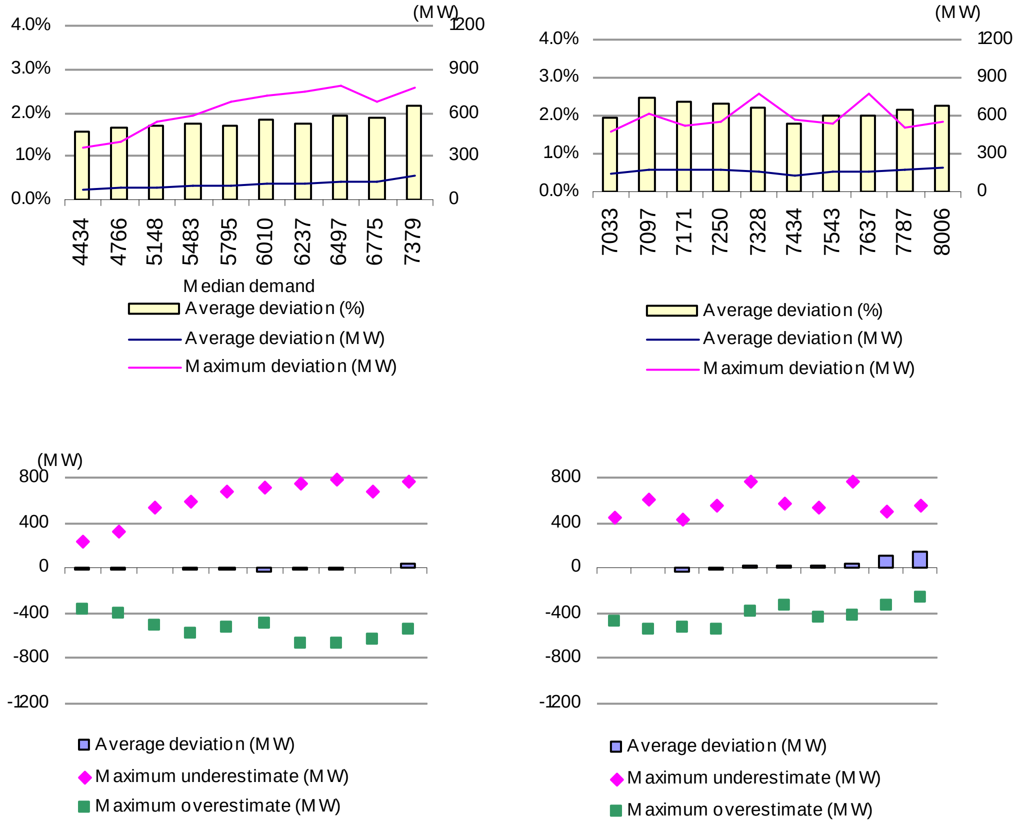


Figure 14: New South Wales demand forecast deviation 4 hours ahead

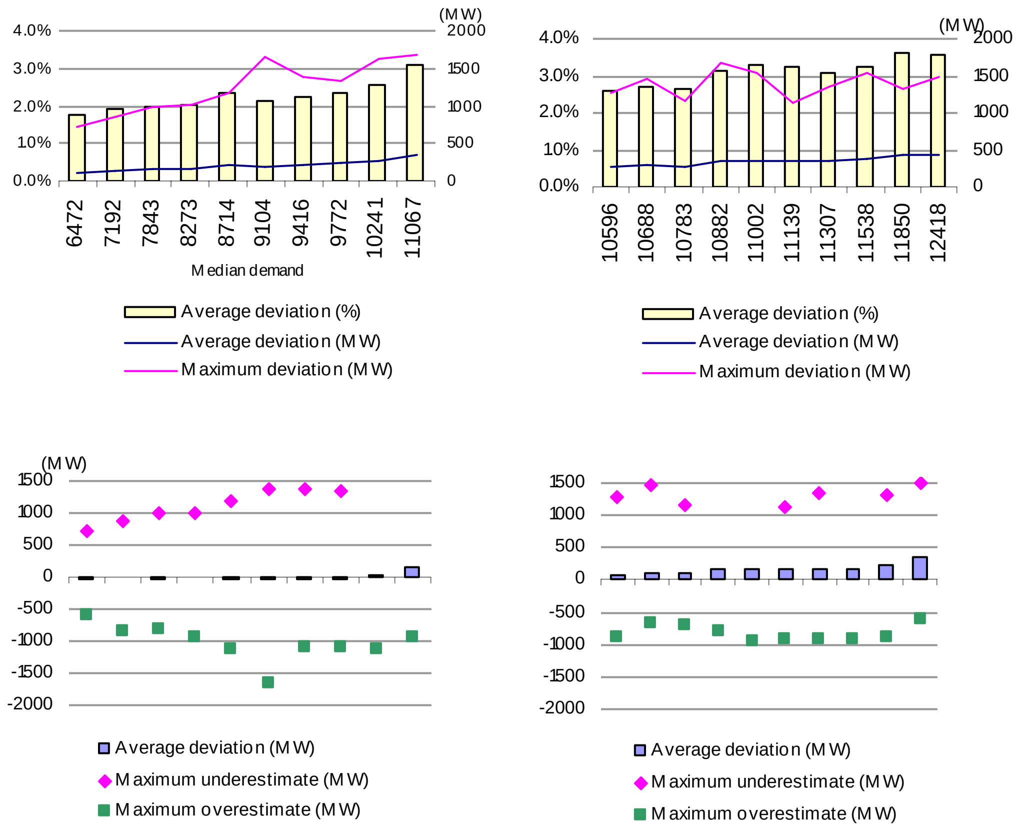


Figure 15: Victoria average demand forecast deviation 4 hours ahead

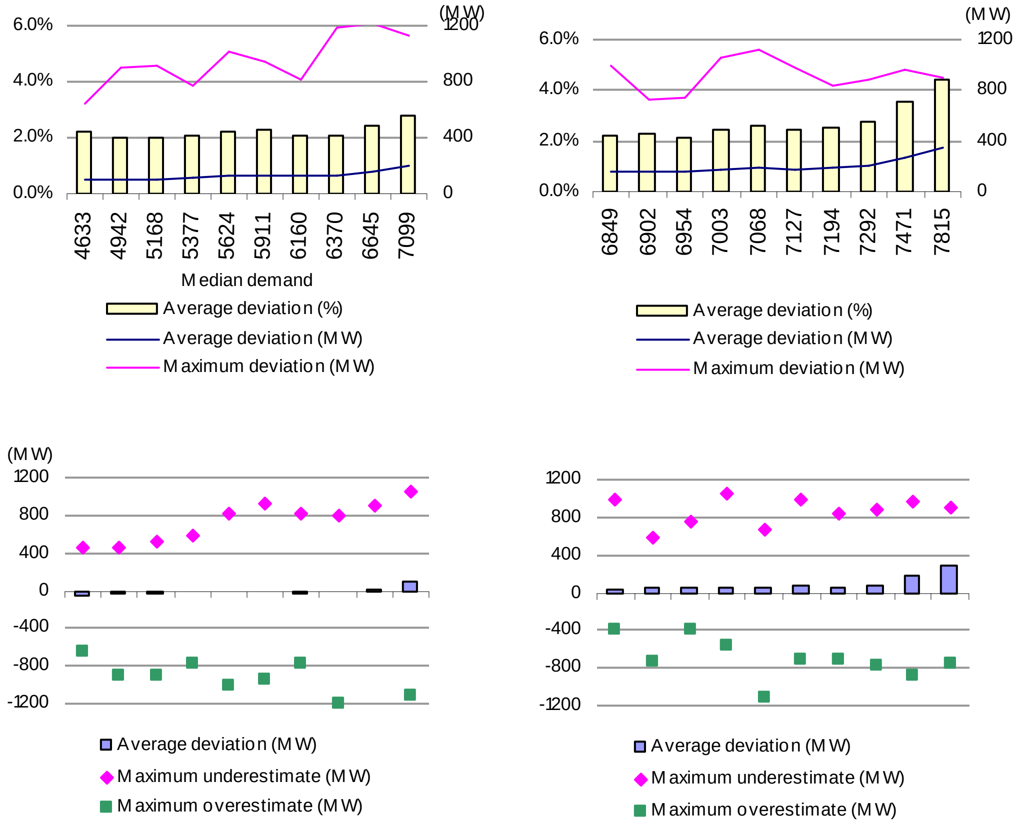


Figure 16: South Australia demand forecast deviation 4 hours ahead

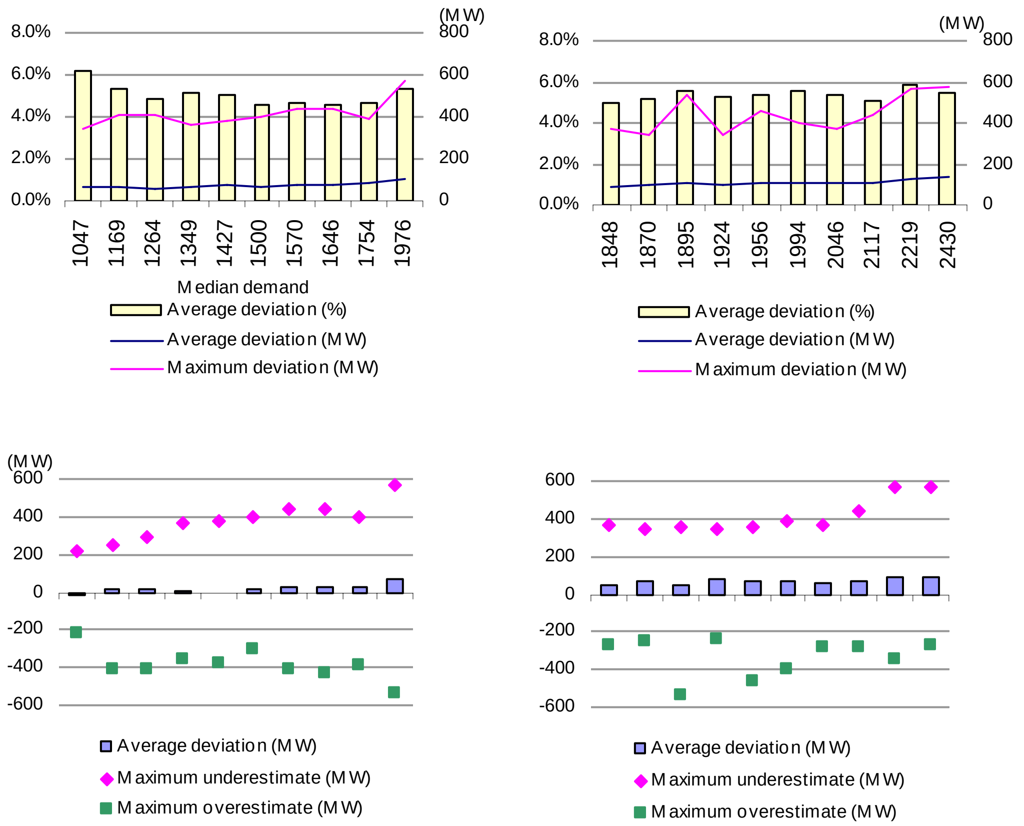
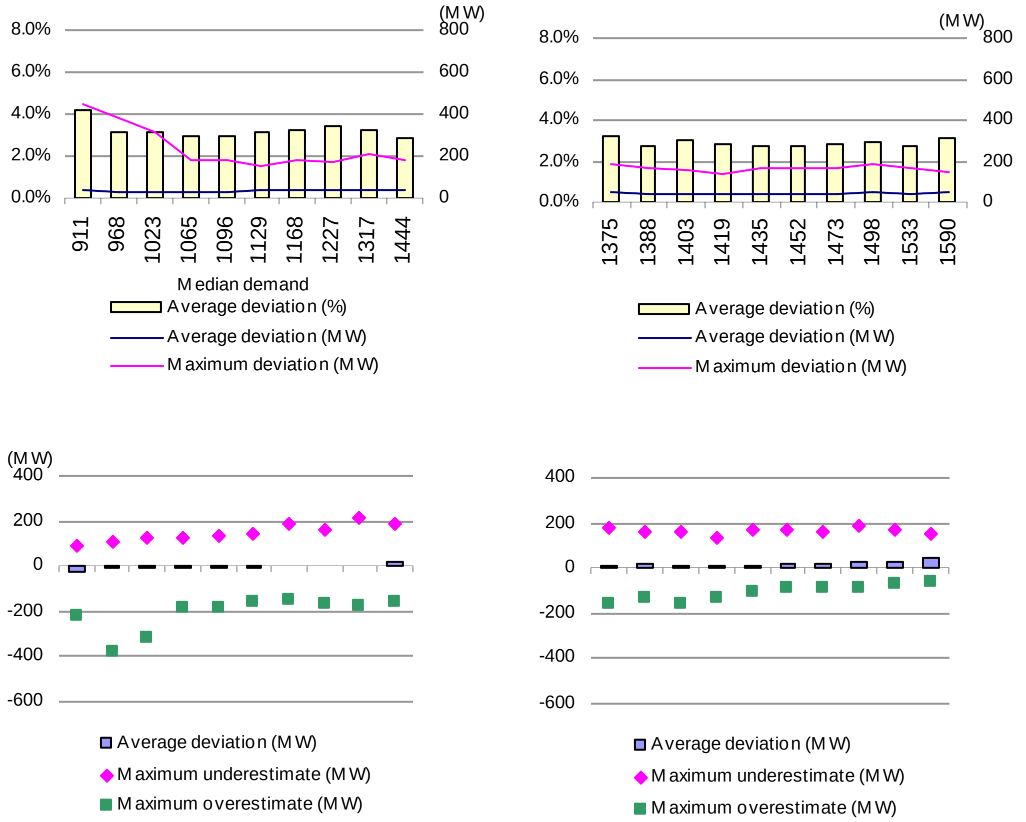


Figure 17: Tasmanian demand forecast deviation 4 hours ahead



2.10 Dispatch and pricing

This is the process of calling all or part of the bids and offers by scheduled generators, loads and network services to meet demand, and the calculating of associated market prices.

Efficient short-term market prices are an important part of reliability maintenance. The Panel is continuing to examine the standards for power system operation to ensure they are technically and economically well suited to a market environment.

Operational reliability management is essentially complete by the time of dispatch. The design of the dispatch and pricing provisions of the Rules are, however, fundamental to reliability outcomes in the market.

2.11 Reliability safety net

NEMMCO has powers to issue directions as a last resort measure or to contract for the provision of reserve to maintain reliability and power system security. Even though there is now no distinction between types of direction, there are different impacts on market pricing. So, for the purposes of this report, we make this distinction:

- reliability directions are those that affect a whole region and therefore require intervention or 'what-if' pricing (i.e. spot prices are determined as if the direction had not occurred)
- directions for local security issues, which do not affect pricing, are covered under *Security* (in the following pages).

Performance assessment

There were no directions for reliability for the period.

Following a tendering process in consultation with the Victorian and South Australian jurisdictions, NEMMCO contracted for 375 MW of reserve capacity for Victoria and South Australia for the period 16 January 2006 to 10 March 2006 inclusive. This reserve capacity was contracted for because medium-term PASA showed that available reserves were forecast to be 500 MW below the target level of 530 MW for the combined Victoria and South Australia regions during the peak demand periods in February 2006. NEMMCO estimated the costs to be in the range $4.4M to $4.9M, depending on the amount of activation and usage. In the event, the mild summer resulted in peak demands in South Australia and Victoria significantly lower than the 10 per cent demand forecasts. As a result, no reserve capacity was utilised and the actual cost was $4.352M. By agreement with the affected jurisdictions, being Victoria and South Australia, these costs were shared in accordance with their relative energy demands.

On 18 May 2006 the AEMC Commissioners made the National Electricity Amendment (Reliability Safety Net Extension) Rule 2006 No.7[15]. This extended NEMMCO's power to contract for additional reserves to meet the reliability standard from the then expiry date of 30 June 2006 to 30 June 2008. This extension allows sufficient time for the Panel undertake its Comprehensive Reliability Review that includes the need for, and the form of, the safety net.

[15] Further information of the reliability safety net extension Rule change is available on the AEMC website at www.aemc.gov.au.

2.12 Security

This section analyses the arrangements for security and assesses the performance of the national market against the security standards during 2005-06.

The security standards for the technical operation of the power system are set by a combination of the Rules and the determinations of the Panel. With few exceptions, these standards require that no consumer load should be involuntarily interrupted in order to manage power system security following single credible disturbances on the main power system, for example the unplanned shutdown of a single generating unit. The simultaneous unplanned shutdown of more than one unit is not, under normal circumstances, regarded as credible (see Glossary).

Security management

Maintaining the security of the power system is one of NEMMCO'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 disturbance such as the sudden breakdown of a large generator. Secure operation depends on the combined effect of controllable plant, ancillary services, and the underlying technical characteristics of power system plant and equipment.

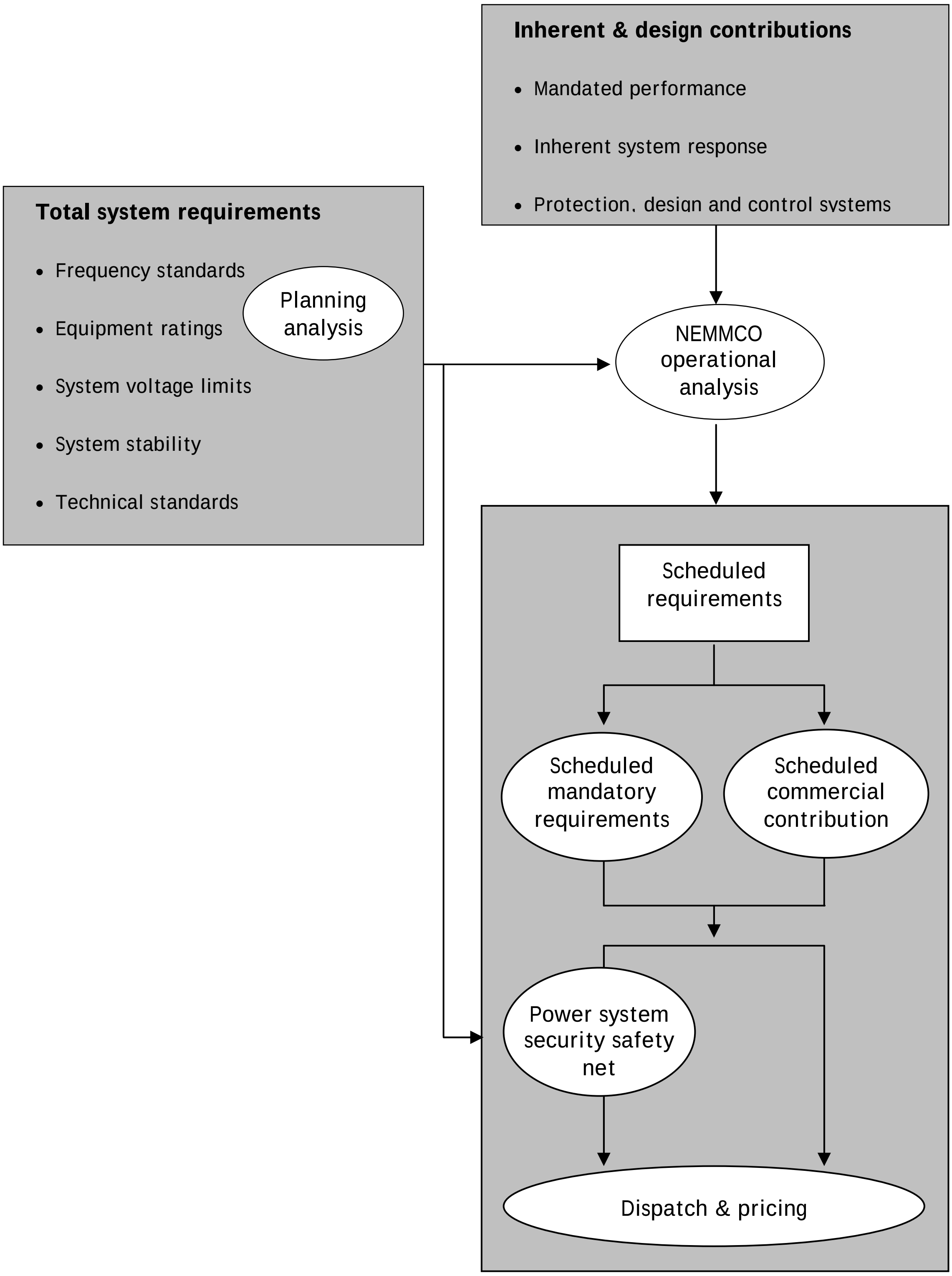
NEMMCO determines the total technical requirements for all services needed to meet the different aspects of security from: the Panel's standards; market rule obligations; knowledge of equipment performance; design characteristics; and modelling of the dynamic behaviour of the power system. This allows NEMMCO to determine safe operating limits for 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 from consumers. If necessary, NEMMCO 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 18 illustrates the overall arrangement for security. The operation of each element is explained and analysed in this section.

Figure 18: Security model



2.13 Total system 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 NEMMCO as part of its planning and operational activities. They are discussed below.

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 which, if met by particular facilities, would assure 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 plant operators may negotiate with network service providers, in consultation with NEMMCO, for access to the network. NEMMCO 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, in South Australia the maximum import capability across the Victoria to South Australia (Heywood) interconnector is 460 MW. This is the limit for maintaining safe operation of the power system whilst allowing for the largest step change in conditions, or *critical single credible contingency event*: in general terms, the loss of one network element or one generating unit; in South Australia, the loss of one fully loaded Northern power station unit. The power system is therefore operated to this limit so that following any such event the system standards will be maintained and there will no significant system-wide impacts. Any step change in conditions greater than a *credible contingency* is deemed a *non-credible contingency event*. In the case of a non-credible contingency event, the power system is not required to remain in a safe condition. This is because it is not practical to plan and operate the power system around the possibility of a non-credible contingency – otherwise the limit for imports into South Australia would be closer to 150 MW instead of 460 MW. However, to limit the effects of non-credible contingencies, emergency controls are required. They include loss of synchronism (LOS) and automatic under-frequency load shedding (UFLS) systems. These emergency controls are permitted to interrupt supply to consumers in order to prevent the total collapse of the power system.

The plant standards cater for new or emerging technologies, such as wind power. The standards mean that the Reliability Panel can allow a class of plant to be connected to the network if that plant meets some specific standard such as an international standard.

Registered performance standards

The performance of all generating plant must be registered with NEMMCO 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 NEMMCO. If plant does not meet its registered performance standards and compliance programme obligations, this is a breach of the market rules.

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

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

Phased implementation timeline

This technical standards framework has been phased in over the last five years. More recently, changes to the market rules were introduced in March 2003, with effect from 16 November of the same year. The period between November 2003 and November 2004 allowed for all existing generators to register their existing performance with NEMMCO. The last phase of the process is the obligation for a person to whom a performance standard applies, to establish a compliance monitoring regime within six months of the approval of the performance standard.

Changes to the performance standards registration process

The AEMC is performing a number of activities that may result in changes to processes in the Rules for registering performance standards, including:

- the recently completed (and published) review for the MCE of the enforcement of, and compliance with, technical standards;
- the evaluation of the 'Technical Standards for Wind and Other Generator Connections' Rule change proposal from NEMMCO; and
- the evaluation of the 'Resolution of existing generator performance standards' Rule change proposal from the NGF.

Further information is available on the AEMC website (www.aemc.gov.au).

Performance assessment

In the 2005-06 year there were four major multiple contingency events with an interruption customer supply:

- Tasmania, 25 November 2005
- Queensland, 20 March 2006
- Queensland, 21 April 2006
- Tasmania, 23 May 2006

A description and commentary on each incident can be found in the section 'Major power system incidents' in *Year in Review*.

In Summary the first two multiple contingency events resulted from storm activity which caused multiple and non-credible transmission line outages. The other two multiple contingency events arose from routine power system faults – credible contingencies – which on these occasions caused the activation of emergency control schemes to prevent the total collapse of the power system, which in turn resulted in the loss of consumer load. These events highlight the importance of ensuring that the technical standards framework is implemented correctly, including through the comprehensive assessment of such incidents.

Frequency standards

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

The frequency operating standards require that, during periods when there are no contingency events or load events, the frequency be maintained within the normal operating frequency band (49.85 Hz to 50.15 Hz in both the mainland and Tasmania) for 99% of the time, with larger deviations permitted within the normal operating frequency excursion band (49.75 Hz to 50.25 Hz in both the mainland and Tasmania) for no more than 1% of the time. The standard also requires that following a credible contingency event, the frequency should not exceed the normal operating frequency excursion band for more than 5 minutes on any occasion. Following either a separation or multiple contingency event the frequency should not exceed the normal operating frequency excursion band for more than 10 minutes.

The frequency standards in Figure 19 apply on the mainland to any part of the power system other than an *island*.

Figure 19: Mainland frequency standards (except 'islands')

Condition	Containment	Stabilisation	Recovery
accumulated time error	5 seconds		
no contingency event or load event	49.75 to 50.25 Hz[2], 49.85 to 50.15 Hz 99% of the time [1]	49.85 to 50.15 Hz within 5 minutes	
generation event or load event	49.5 to 50.5 Hz	49.85 to 50.15 Hz within 5 minutes	
network event	49 to 51 Hz	49.5 to 50.5 Hz within 1 minute	49.85 to 50.15 Hz within 5 minutes
separation event	49 to 51 Hz	49.5 to 50.5 Hz within 2 minutes	49.85 to 50.15 Hz within 10 minutes
multiple contingency event	47 to 52 Hz	49.5 to 50.5 Hz within 2 minutes	49.85 to 50.15 Hz within 10 minutes

[1] This is known as the *normal operating frequency band*.
[2] This is known as the *normal operating frequency excursion band*.

The frequency standards in Figure 20 apply on the mainland to a power system that is an *island* or becomes *islanded*.

Figure 20: Mainland frequency standards for 'island' conditions

Condition	Containment	Stabilisation	Recovery
no contingency event or load event	49.5 to 50.5 Hz		
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 NEMMCO 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

Tasmania's frequency standards

Tasmania entered the national market on 29 May 2005, but it will continue to use its existing frequency standards, determined by the Tasmanian Reliability and Network Planning Panel (TRNPP), until 30 May 2007. On this date, the frequency standards determined by the AEMC Reliability Panel on 28 May 2006 will take effect[16]. The Panel adopted the most recent TRNPP frequency standard in its own determination of the Tasmanian frequency standards. The Panel intends to review the Tasmanian frequency standard after approximately 12 months of Basslink operation.

In its submission on the draft review report Hydro Tasmania supported the view of NEMMCO that it would be impractical to impose the mainland frequency standard on the Tasmanian power system within the foreseeable future. Further Hydro Tasmania considers that there is no pressure from Tasmanian customers to reduce the range of frequencies. The Panel notes Hydro Tasmania's comments and it will take them into consideration when it undertakes it review of the Tasmanian frequency standards, intended to occur during the first half of 2007.

Although Tasmania has entered the national market, its power system is not synchronised to the mainland as Basslink is a DC connection.

The frequency standards adopted in Tasmania allow for wider variations than their mainland equivalents. This is due to the state's small size and the relatively large contingencies that can occur there. Importantly, Tasmanian customers have not experienced any significant problems as a result of the wider range of frequencies.

Figure 21 applies to any part of the Tasmanian power system other than an *island*.[17]

Figure 21: Tasmanian frequency 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 event	49.0 to 51.0 Hz	49.85 to 50.15 Hz within 10 minutes	
Generation event	47.5 to 51.0 Hz	49.85 to 50.15 Hz within 5 minutes	
Network event	47.5 to 53.0 Hz	49.0 to 51.0 Hz within 1 minute	49.85 to 50.15 Hz within 5 minutes
Separation event	46 to 55 Hz	47.5 to 51.0 Hz within 2 minutes	49.85 to 50.15 Hz within 10 minutes
Multiple contingency event	46 to 55 Hz	47.5 to 51.0 Hz within 2 minutes	49.85 to 50.15 Hz within 10 minutes

[16] The Panel's determination on the Tasmanian Reliability and Frequency standards is available on the AEMC website.

[17] Figures 21 and 22 are summaries of Tasmania's frequency operating standards. For full details, see *Tasmanian Reliability and Frequency Standards: Determination May 2006*, available from the AEMC website (www.aemc.gov.au).

The frequency standards in Figure 22 apply in Tasmania to a power system that is an *island* or becomes *islanded*.

Figure 22: Tasmanian frequency standards for 'island' conditions

Condition	Containment	Stabilisation	Recovery
No contingency event, or load event	49.0 to 51.0 Hz		
Generation event or network event	47.5 to 53.0 Hz (Note)	49.0 to 51.0 Hz within 5 minutes	
Load event	47.5 to 53.0 Hz (Note)	49.0 to 51.0 Hz within 10 minutes	
The separation event that formed the island	46 to 60 Hz	47.5 to 53.0 Hz within 2 minutes	49.0 to 51.0 Hz within 10 minutes
Multiple contingency event including a further separation event	46 to 60 Hz	47.5 to 53.0 Hz within 2 minutes	49.0 to 51.0 Hz within 10 minutes

(Note) Where it is not feasible to schedule sufficient frequency control ancillary services to limit frequency excursions to within this range, operation of the under frequency load shedding scheme or the over frequency generator shedding scheme is acceptable on the occurrence of a further contingency event.

Performance assessment

There were no incidents where the mainland regions of the market were not all synchronised and one incident on 25 November 2005 when the Tasmanian region was split.

A description and commentary on this incident can be found in the section 'Major power system incidents' in *Year in review*.

Maintaining frequency and time deviation within these limits is the responsibility of NEMMCO.

In summary the power system frequency was maintained within the limits set by the Panel.

Figure 23 shows, for the mainland regions of the national market, how many times the frequency moved outside the normal operating band during the year.

Figure 23: Frequency events on the mainland

Frequency events — Mainland regions	Total	Low frequency	High frequency
Number of events			
outside normal operating frequency band	56	56	0
outside normal operating frequency excursion band	7	7	0
Events where duration exceeded 300 seconds[1]	18	18	0
Events where duration exceeded 600 seconds (i.e. the frequency standard)	1	1	0

[1] The frequency standards require recovery to the normal band within 300 secs for generator, load and network events.

A minimum frequency of 49.541 Hz occurred on the mainland following the trip of a Loy Yang unit 1 October. On no occasions did the frequency on the mainland exceed the top of the normal operating frequency band. This compared to minimum and maximum frequencies of 47.61 Hz and 50.48 Hz the previous year, following the separation of the Victoria to South Australia interconnector on 14 March 2005 and the separation of the Queensland to New South Wales interconnector on 14 January 2005, respectively.

Figure 24 shows, for the 56 events on the mainland, the time spent outside the normal operating frequency band. It highlights the 18 events of more than 5 minutes duration.

Figure 24: Duration of frequency events on the mainland

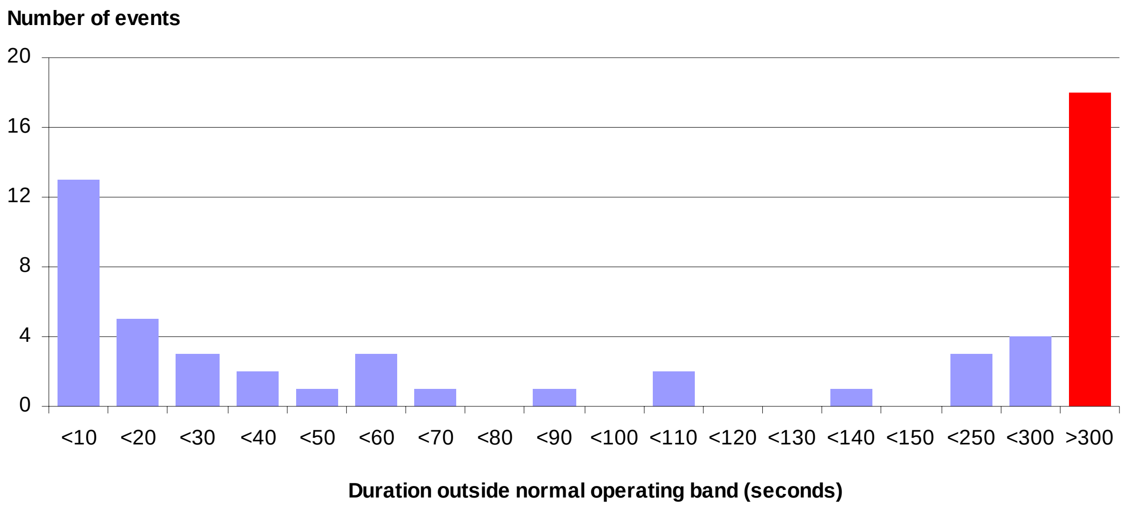


Figure 25 shows, for the Tasmanian regions of the national market, how many times the frequency moved outside the normal operating band during the year.

Figure 25: Frequency events in Tasmania

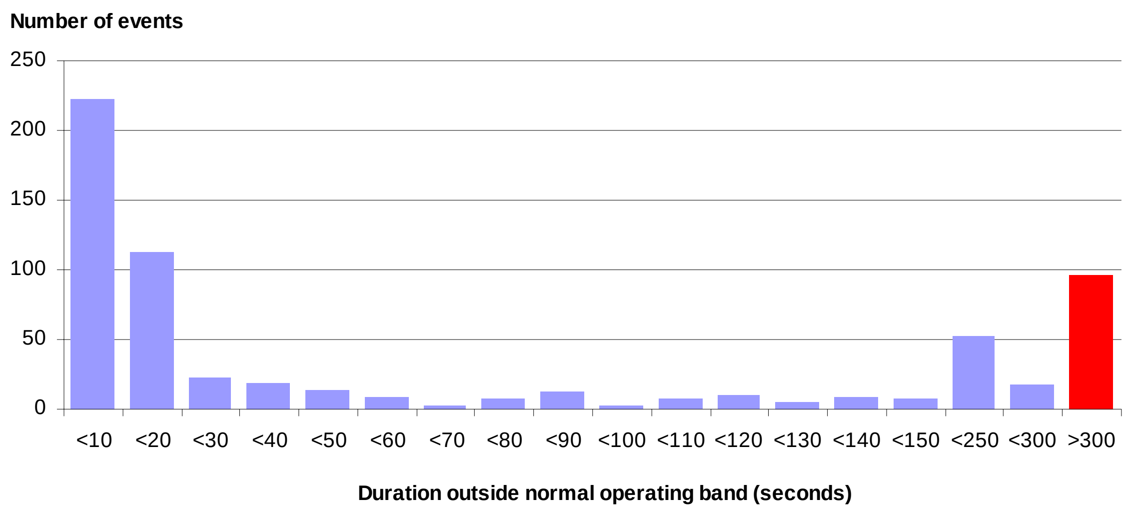
Frequency events – Mainland regions	Total	Low frequency	High frequency
Number of events			
outside normal operating frequency band	630	228	402
outside normal operating frequency excursion band	433	150	283
Events where duration exceeded 300 seconds	96	51	45
Events where duration exceeded 600 seconds (i.e. the frequency standard)	20	13	7

[1] The frequency standards require recovery to the normal band within 300 secs for generator and network events.

A minimum frequency of 47.466 Hz occurred in Tasmania on 25 November following approximately 96 MW of load being restored. A maximum frequency of 52.803 Hz occurred in Tasmania on 3 August 2005 following both Sheffield to George Town 220 kV lines tripping, demand reducing by 486 MW and the Bell Bay unit 1, Fisher and Lemonthyme generating units tripping.

Figure 26 shows, for the 630 events in Tasmania, the time spent outside the normal operating frequency band. It highlights the 96 events of more than 5 minutes duration.

Figure 26: Duration of frequency events in Tasmania



In 2001, the Panel introduced a probabilistic frequency standard. In response to that standard, the requirement for regulation frequency control ancillary services (FCAS) (raise and lower), which is used to manage minor fluctuations in frequency, has been progressively reduced by NEMMCO since June 2003. The reductions are shown in Figure 27.

Figure 27: Reductions to raise and lower regulation FCAS requirement

Month	Enabled regulation FCAS (MW)	
June 2003	250	
July 2003	220	
October 2003	200	
December 2003	180	
May 2004	160	
July 2004	150	
April 2005	140	
November 2005	130	
June 2006	130 (raise)	120 (lower)

Figure 28 shows for each day, since January 2003, the distribution of the measured frequency and the requirement for regulation FCAS (raise and lower) on the mainland. As the level of regulation FCAS decreased on the mainland the standard deviation of the frequency generally increased. A standard deviation below 0.05 Hz meets the Panel's standard.

Figure 28: Daily standard deviation of frequency and regulation FCAS enabled on the mainland

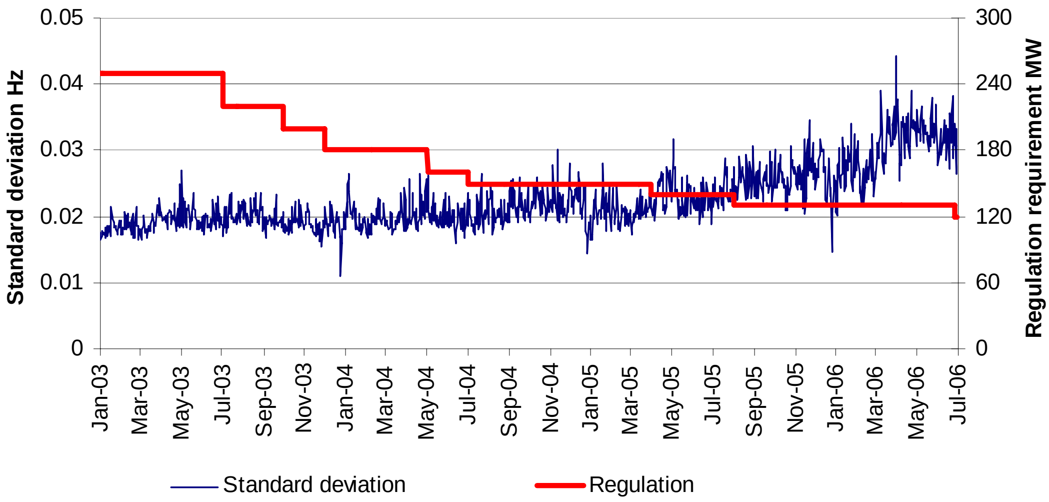
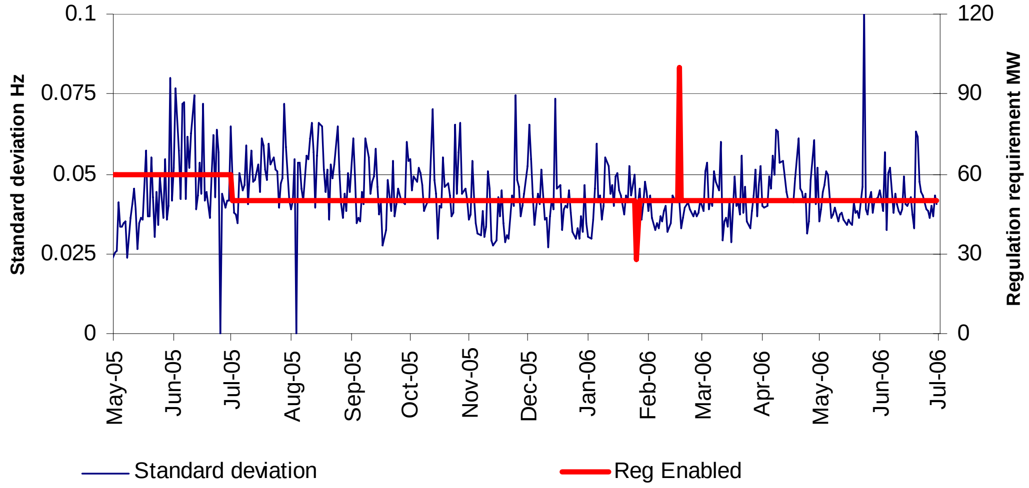


Figure 29 shows for each day, since 29 April 2005, the distribution of the measured frequency and the requirement for regulation FCAS (raise and lower) in Tasmania. A standard deviation below 0.05 Hz meets the Panel's standard.

Figure 29: Daily standard deviation of frequency and regulation FCAS enabled in Tasmania



The graph illustrates that the reduction in regulation requirement has not impacted significantly on the quality of the power system frequency.

The reduction in regulation is matched by an increase in the corresponding delayed contingency service. NEMMCO is working towards optimising the financial trade-off between regulation and the related contingency service.

Equipment ratings

Asset owners provide a statement about the envelope within which NEMMCO may operate individual items of plant and equipment. NEMMCO then allows for the occurrence of any single credible contingency event before the ratings are reached.

Performance assessment

There were no incidents where an interconnector was above the secure limit. However there were ten multiple contingency events, four of which were associated with load shedding. A description and commentary on each incident can be found in the section 'Major power system incidents' in *Year in review*. Apart from these multiple contingency events, and allowable short duration overloads that were removed automatically, there were no instances where a transmission network element exceeded its ratings.

Potential overloads have been managed through directions on 61 occasions. This is discussed further in section 2.20.

System voltage limits

This is the standard agreed between NEMMCO and the TNSPs for the envelope within which the transmission network voltage is maintained. NEMMCO has recently developed a system to monitor the performance of voltage levels against the limits advised by the TNSPs.

Performance assessment

NEMMCO was generally able to maintain voltages within advised limits throughout the 2005-06 year.

System stability

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

NEMMCO 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. Two additional tools have been introduced in the last couple of years. The first consists of monitoring equipment that detects 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.

The second key security analysis tool is the on-line Dynamic Security Assessment (DSA) tool. The DSA uses real-time data from the NEMMCO 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 approximately every 10 minutes, which is an improvement on the previous year's 20 minute intervals. NEMMCO is assessing further development of the DSA tool to reduce its cycle time and increase the number of contingencies it can analyse. NEMMCO recently introduced a new version of the monitoring tool for dynamic stability.

Performance assessment

NEMMCO's reviews of significant events showed system damping times were generally within requirements.

There were a number of occasions when these real-time monitoring tools identified the need to reduce transfer capability. 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 the constraint equations used to manage those limits.

2.14 Market rule standards

These are codified definitions and procedures. An example is the definition of a *credible contingency* and the requirement to return the power system to a secure state within 30 minutes (see Glossary). Automatic protection schemes, including consumer load shedding, protect the integrity of the overall system if multiple events occur within that 30 minute time frame. This is a similar criteria to that used for many years by state utilities.

Performance assessment

Six transmission-related non-credible contingency events were reported by NEMMCO during the year. (This compares with 7 in the previous year and 10 the year before that.) These six events are in addition to the multiple contingency events of 25 November 2005, 20 March 2006, 21 April 2006 and 23 May 2006

On 25 November 2005 the loss of both Sheffield to Farrell 220 kV circuits was classified as a credible contingency due to electricity storm. In fact the Sheffield to Georgetown 220 kV circuits tripped due to a lightning strike. This event is discussed in section 'Major power system incidents' in *Year in Review*.

2.15 NEMMCO planning analysis

NEMMCO is required to determine total operational requirements for frequency, voltage and stability management and operation within equipment ratings and Rules standards. Constraint equations used in the market systems and NEMMCO's operating procedures are derived in this process.

Performance assessment

The quality of NEMMCO's analysis is difficult to measure directly. An indirect measure of performance is provided by the overall technical performance of the power system compared with operating standards. Analysis in other sections of this report of the technical performance of the power system – for example, frequency, system stability, and loading against equipment ratings – suggests that NEMMCO is generally performing this function satisfactorily.

2.16 Inherent and design contributions

A portion of the total requirements for security is derived from the inherent response of consumer demand to variation in frequency and the fundamental physical characteristics of power system equipment. The inertia of the physical mass of generators, for example, determines how susceptible the power system is to disturbances. This inherent response is taken into account when determining the requirements for services scheduled by NEMMCO. The components of the inherent system response and design contributions include mandated performance, system response and the performance of protection and control systems. The components are described and analysed below.

The Panel will closely watch the effects of the introduction of alternative technologies, such as wind generation, over the coming years.

Mandated performance

In many cases satisfactory performance of the power system relies on both the correct operation of individual items of participant equipment and on the coordination of their operating characteristics. The market rules require the actual response to be measured by participants and reported to NEMMCO. NEMMCO also compares the actual system and participant response to power system events with the requirements of the market rules.

Inherent system response

Inherent system response is the automatic response of plant and equipment to disturbances over which there is no direct operational control. Examples include the change in demand placed on the system by consumer load when power system frequency or voltage varies from normal, and the rate at which a large generating unit can change speed or alter output. Although it is not a large contributor to overall security response, inherent response reduces the need for response from other sources such as ancillary services.

Inherent load relief is determined by NEMMCO based on analysis of system performance during frequency disturbances. This value is then taken into account when determining the requirements for frequency control ancillary services scheduled by NEMMCO.

Performance of protection and control systems

Protection and control systems are the automatic fast acting systems such as the facilities to isolate power system faults, and emergency control systems installed to enhance network transfer capability and safeguard the power system in the event of multiple contingency events. The provision of generator protection and control systems is documented through the registration process and connection agreements. Under the market rules, the performance is recorded by the plant operator and provided to NEMMCO following system disturbances.

Performance assessment

NEMMCO investigated and reported on four major power system events during the year. Generally these investigations did not result in the reporting of network protection operating incorrectly but the Panel notes that the reason for the tripping of the Sheffield 220 kV bus in Tasmania on 25 November 2005 was not determined and that failure of local the backup timers resulted in the tripping of the Boyne Island 132 kV bus in Queensland on 21 April 2006.

The Panel considers these are isolated incidents and not representative of systemic protection issues.

The Panel also notes that several generating units in Tasmania tripping on 23 May 2006 following during a frequency disturbance. This is the subject of further investigation by NEMMCO, Hydro Tasmania and Transend.

2.17 NEMMCO operational analysis

The inherent and design contributions are analysed by NEMMCO and compared with the total requirements to determine the requirements for scheduled contributions to ensure secure operation. The additional requirements are in the form of scheduled mandatory and commercial contributions and, if necessary, intervention. This analysis is performed close to dispatch.

Performance assessment

This analysis can have significant impact on commercial and system security outcomes. There were a number of occasions, for example, when NEMMCO's online monitoring tools identified the need to reduce interconnector transfer capability in order to maintain security. 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 the constraint equations used to manage those limits.

2.18 Scheduling

Scheduled services are added to the inherent and design contributions to ensure the total control capability meets the overall requirement. Scheduled services include mandatory requirements and commercially acquired services. Examples of scheduled mandatory requirements include generating unit reactive power output in accordance with the performance standard, governor performance, and capacitor bank switching for voltage control.

2.19 Scheduled commercial contribution

These are the commercially-sourced ancillary services required to balance the total requirement. Examples include generating unit reactive power output beyond the performance standard, and frequency control ancillary services. NEMMCO's scheduling process is reviewed in the market auditor's reports[18].

2.20 Power system directions

Power system directions are the power system security safety net mechanism available to NEMMCO to issue directions to maintain the power system in a secure operating state. For the purposes of this report, reliability directions are those that affect a whole region and therefore require intervention or 'what-if' pricing. A direction for a local security issue does not affect pricing.

Performance assessment

NEMMCO issued 61 directions throughout the year to manage local security issue. (This compares to 41 during 2004-05 with 31 in South Australia and 10 in Queensland). The majority (53) of these directions occurred in Queensland, with all but one applied to Directlink to make itself available for dispatch in the direction of New South Wales to Queensland. The other direction was to a generator in Queensland.

In New South Wales, TransGrid was instructed to open circuit one of its 132 kV transmissions lines to facilitate dispatch from Queensland into New South Wales.

Hydro Tasmania was directed six times to provide frequency services in Tasmania. Basslink was directed to be made available for dispatch in the direction Victoria to Tasmania on 23 May 2006.

[18] Market audit reports are available to registered market participants.

3 Network performance

While the Panel is responsible for dealing with reliability and security matters in the wholesale bulk electricity market and transmission, the ultimate level of reliability and security which customers receive is also impacted by the performance of the local 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 distribution and transmission networks.

3.1 Distribution network performance

New South Wales

The Electricity Supply Act 1995 covers the licensing framework for the New South Wales DNSPs. The network performance standards are implemented licence conditions imposed by the Minister.

From August 2005 the network performance standards for the New South Wales DNSPs have been set by the Minister for Energy through Ministerially imposed licence conditions. These licence conditions are published on the Independent Pricing and Regulatory Tribunal's (IPART[19]) website (conditions 14-19)[20].

The performance of the New South Wales 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.

Figure 30 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 the DNSP websites.

[19] IPART is the independent body that oversees regulation of the water, gas, electricity and public transport industries in New South Wales.
[20] The relevant licensing conditions are available at the IPART website at http://www.ipart.nsw.gov.au/electricity/documents/DesignReliabilityandPerformanceLicenceConditionsImposedonDistributionNetworkServiceProviders.PDF .

Figure 30: Performance of the NSW DNSPs for the 2004/05 year

DNSP	Index	Target	Performance				
		Organisation	Organisation	CBD	Urban	Rural short	Rural long
Energy Australia	SAIDI	98	154.37	10.23	122.74	506.88	1278.56
	SAIFI	<1.25	1.52	0.1	1.3	4.05	8.11
	CAIDI	78.4	101.71	106.43	94.3	125.26	157.59
Integral Energy	SAIDI	115	211.3	-	153.9	362.2	993.6
	SAIFI	1.23	1.79	-	1.23	2.91	4.57
	CAIDI	94	118	-	125	124	217
Country Energy	SAIDI	428	355	-	139	370	820
	SAIFI	3.64	2.97	-	1.66	3.11	5.62
	CAIDI	118	120	-	84	119	146

The DNSPs are required by the Electricity Supply (Safety and Network Management) Regulation 2002 to publish annual reports on network performance, against their Network Management Plans. IPART also produces a licence compliance report, which from 2007 will include compliance with the reliability standards.

The network performance standards are enforced under the Electricity Supply Act 1995, Schedule 2, Clauses 8 and 8A. Under 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.

Victoria

The Electricity Industry Act 2000 and the Essential Services Commission Act 2001 cover the network performance requirements for the Victorian DNSPs.

The Essential Service Commission of Victoria (ESC) sets performance targets for unplanned SAIFI, unplanned CAIDI, planned SAIDI and MAIFI for the calculations of the financial incentive for 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[21]. DNSPs are also required to make guaranteed service level (GSL) payments to the worst served customers if there have been excessive sustained supply outages and momentary interruptions[22].

The performance indicators for the Victorian DNSPs are reported to the ESC. The ESC requires independent audits of these indicators on a rotating basis. The ESC also publishes annual comparative performance reports of the distributors.

Figure 31 shows a summary of the performance of the Victorian DNSPs including target and actual performance values for each DNSP[23]. More detailed performance information is available from network performance reports available on the ESC website.

Figure 31: Performance of the Victorian DNSPs for the 2005 year

DNSP	Feeder	Target				Performance		
		Unplanned interruptions		Planned interruptions				
		SAIDI	SAIFI	SAIDI	SAIFI	SAIDI	SAIFI	CADI
AGL	Urban	73	1.27	6	0.03	78.3	1.27	61.5
	Short rural	113	2.25	14	0.08	256.1	3.22	79.6
CitiPower	CBD	15.5	0.25	5.9	15.5	18.8	0.19	97.2
	Urban	35	0.8	9.9	35	53.1	0.59	89.8
Powercor	Urban	98	1.63	16	98	76.4	1.27	60.1
	Short rural	118	1.8	32	118	114.4	1.54	74.5
	Long rural	312	3.5	71	312	298.8	3.31	90.4
AusNet	Urban	107	1.78	9	107	166	2.0	84
	Short rural	187	2.75	29	187	377	3.2	117
	Long rural	298	4.26	60	298	514	4.2	123
United Energy	Urban	56	1.06	13	56	94.2	1.04	91
	Short rural	96	2.03	21	96	121	1.87	65

The enforcement of the network performance standards is through adjustment to the DNSP's revenue, based on the SAFI and CAIDI values, and through payments to customers where the GSL requirements are not met.

[21] Details of the S-factor scheme are available from the Electricity Distribution Price Review For 2006-10 documents.

[22] Details of the guaranteed service level payments are contained in clause 6 of the Electricity Distribution Code (EDC), available from the ESC's website at http://www.esc.vic.gov.au/NR/rdonlyres/E2092E29-305A-404C-B074-9623519C0D87/0/RI_ElectDistCode_20060101_C05_13367.pdf .

[23] The Panel revised Figure 31 between the draft and final reports to include updated performance data for 2005.

Queensland

The Queensland Electricity Act 1994 and the Electricity Regulation 1994 define the arrangements for the Queensland DNSPs. The Queensland Department of Energy sets the performance standards for the Queensland DNSPs. The minimum service standards are in Chapter 4 and Schedule 1 of the Queensland Electricity Industry Code[24].

The Queensland Department of Energy collects service quality data to verify that the electricity distributors meet the minimum service standards. The Queensland Competition Authority (QCA) reports on the network performance[25].

Figure 32 shows a summary of the performance of the Queensland DNSPs including target and actual performance values for each DNSP. More detailed performance information is available from network performance reports available on the QCA website.

Figure 32: Performance of the Queensland DNSPs for the 2005/06 year

DNSP	Feeder	Target				Performance	
		SAIDI		SAIFI		SAIDI	SAIFI
		2004/05	2005/06	2004/05	2005/06	2005/06	2005/06
Energex	CBD	20	20	0.33	0.33	3.9	0.02
	urban	162	155	1.78	1.73	103.82	1.41
	Short-rural	272	265	2.84	2.77	306.35	3.29
Ergon	urban	220	215	2.75	2.7	218.95	2.26
	Short-rural	610	590	5.7	5.4	594.41	4.97
	Long - rural	1,180	1,150	9	8.75	1,332.03	9.57

The network performance standards are enforced at the discretion of the Queensland Department of Energy. The QCA also monitors service quality performance but there are no financial or other implications linked to performance.

South Australia

The Electricity Act requires a distributor to be licensed by the Commission and to comply with Codes made the Essential Services Commission of South Australia

[24] The Queensland Electricity Code is available on the Department of Energy website at http://www.energy.qld.gov.au/zone_files/Electricity/electricity_industry_code.pdf.
[25] Reports are available on the QCA website at http://www.qca.org.au/electricity/service-quality/reports.php

(ESCOSA). Performance Standards for the DNSPs are primarily established by ESCOSA in clause 1.2.3 of the Electricity Distribution Code[26]. Figure 33 shows the performance targets for the South Australian DNSP.

Figure 33: Reliability Targets of the South Australia DNSP

Feeder	SAIDI	SAIFI
Adelaide CBD	25	0.3
Major Metropolitan Areas	115	1.4
Barossa/Mid-Nth & Yorke Pen./Riverland/Murrayland	240	2.1
Eastern Hills/Fleurieu Peninsula	350	3.3
Upper North & Eyre Peninsula	370	2.5
South East	330	2.7
Kangaroo Island	450	N/A

Network performance is reported to ESCOSA on a quarterly basis pursuant to Electricity Guideline 1[27] and verification of compliance with relevant regulatory obligations and Codes is undertaken pursuant to the requirements set out in Guideline 4[28]. In addition, as part of the ESCOSA's periodic audit programme, the reliability and accuracy of operational performance data provided by the DNSPs is presently being audited. Figure 34 shows the performance of the South Australian DNSP for the 2004/05 year. Note that the feeder definitions changed with the 2005 - 2010 Electricity Distribution Price Determination[29].

[26] The Electricity Distribution Code is available on the ESCOSA website at http://www.escosa.sa.gov.au/webdata/resources/files/050623-D-ElecDistCodeEDC05.pdf.
[27] Electricity Guideline 1 is available on the ESCOSA website at http://www.escosa.sa.gov.au/webdata/resources/files/060614-ElectricityGuideline1.pdf.
[28] Guideline 4 is available on the ESCOSA website at http://www.escosa.sa.gov.au/webdata/resources/files/050629-M-EnergyGuidleine4Compliance.pdf.
[29] The 2005 - 2010 Electricity Distribution Price Determination is available on the ESCOSA website at https://www.escosa.sa.gov.au/webdata/resources/files/050405-EDPD_Part_A_StatementofReasons_Final.pdf

Figure 34: Performance of the South Australia DNSP 2004/05 year

Feeder	SAIDI	SAIFI	CAIDI
CBD	17	0.21	82
Urban	84	1.15	73
Rural short	329	2.7	122
Rural long	322	2.76	117

ESCOSA's enforcement processes comprise three distinct functions[30]:

- administrative functions – the exercise of its roles prescribed under legislation or arise in the ordinary course of performing its legislative functions;
- disciplinary functions – the exercise of powers granted under legislation to suspend or cancel a license; and
- prosecutorial functions – the exercise of powers granted under legislation to bring punitive action against an entity which does not comply with legislative requirements.

ESCOSA is also currently undertaking an inquiry into the performance of the distributor during a heatwave in January 2006.

ESCOSA recently increased the number of regions for the purpose of supply restoration and reliability standards from 4 regions (CBD, urban, rural and remote) to 7 regions (Adelaide Business Area; Major Metropolitan Areas, Barossa/Mid-North & Yorke Peninsula /Riverland/Murrayland; Eastern Hills /Fleurieu Peninsula; Upper North & Eyre Peninsula; South East; Kangaroo Island)[31].

ESCOSA also undertook a specific inquiry into the performance of the distributor during a heatwave in January 2006[32].

Tasmania

The Electricity Supply Industry Act 1995 covers the network performance requirements for the Tasmanian DNSP through the Tasmanian Electricity Code, price determinations and Regulations.

[30] ESCOSA's enforcement policy is available on its website at http://www.escosa.sa.gov.au/webdata/resources/files/040701-EnforcementPolicy.pdf.
[31] Details of this decision are available in the 2005 - 2010 Electricity Distribution Price Determination which is available at https://www.escosa.sa.gov.au/webdata/resources/files/050405-EDPD_Part_A_StatementofReasons_Final.pdf
[32] ESCOSA's findings are available on its website at https://www.escosa.sa.gov.au/webdata/resources/files/060907-HeatwaveInqFinalReport.pdf.

The Office of the Tasmanian Energy Regulator (OTTER) sets the performance standards for the Tasmanian DNSP. This has three parts:

- minimum and average network performance requirements on CBD, urban and rural feeders (specified in the Tasmanian Electricity Code[33]);
- the current price determination includes S factor for SAIDI and SAIFI that changes the revenue cap by ± $1.6m, or approximately 1.25% of the revenue requirement[34]; and
- the Tasmanian Electricity Code and relevant Guidelines include GSL scheme that provides for a payment of $80 to each affected customer for a long outage or a number of short outages[35].

Figure 35 shows a summary of the performance of the Tasmanian DNSP including target and actual performance values. More detailed performance information is available from network performance reports available on the OTTER website.

Figure 35: Performance of the Tasmanian DNSP 2004/05 year

Feeder	Target		Performance		
	SAIDI	SAIFI	CAIDI	SAIDI	SAIFI
CBD			102	36	0.35
Urban	17	0.21	72	79	1.1
Rural	84	1.15	116	410	3.54
System	329	2.7	108	244	2.25

The DNSP publishes a report that presents performance statistics for its network. This report is independently audited. The performance of the DNSP's network is enforced through the operation of Tasmanian Electricity Code, the S factor and the GSL scheme.

On 3 November 2006 OTTER announced that it is consulting on a proposed new distribution reliability framework and standards. Further information is available on the OTTER website.

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33 The Tasmanian Electricity Code is available on the OTTER website at http://www.energyregulator.tas.gov.au/domino/otter.nsf/LookupFiles/FullRevisedCode18May2005.pdf/$file/FullRevisedCode18May2005.pdf.

34 A description of the operation of this S factor is available in section 4.3.1.2 of the "Investigation of Prices for Electricity Distribution Services and Retail Tariffs on Mainland Tasmania Final Report and Proposed Maximum Prices", available on the OTTER website at http://www.energyregulator.tas.gov.au/domino/otter.nsf/LookupFiles/R_ElectPriceInvest_FinalReport.pdf/$file/R_ElectPriceInvest_FinalReport.pdf

35 A description of the Tasmanian GSL scheme is available on the OTTER website at http://www.energyregulator.tas.gov.au/domino/otter.nsf/LookupFiles/Guaranteed_Service_Level_Principles.pdf/$file/Guaranteed_Service_Level_Principles.pdf.

ACT

The Utilities Act underpins all of the codes and performance and compliance requirements for ACT DNSP.

The Independent Competition and Regulatory Commission (ICRC) sets the performance standards for the ACT DNSP. These standards are available in the Electricity Distribution Supply Standards Code[36] and in the Consumer Protection Code[37], which also has minimum service standards.

The ICRC performs a compliance audit on the DNSP performance every year and publishes the results in its Compliance report.

Figure 36 shows a summary of the performance of the ACT DNSP including target and actual performance values. More detailed performance information is available from network performance reports available on the ICRC website.

Figure 36: Performance of the ACT DNSP 2004/05 year

Index	Target	Performance		
		Urban	Rural short	Rural long
SAIDI	91	75.77	124.92	77.58
SAIFI	1.2	0.76	2.31	0.82
CAIDI	74.6	99.7	54.08	94.61

The IRCR does not have any specific enforcement mechanisms other than the payments to customers prescribed in the Consumer Protection Code. The IRCR has not adopted a service standard scheme either it considered there would be little potential benefit in the ACT and was unlikely to result in the efficient level of service quality[38].

36 The ACT Electricity Distribution Supply Standards Code is available on the IRCR website at http://www.icrc.act.gov.au/__data/assets/pdf_file/16630/electricitydistributionsupplystandardscodecw.pdf.

37 The ACT Consumers Protection Code is available on the IRCR website at http://www.icrc.act.gov.au/__data/assets/pdf_file/16673/consumerprotectioncode1july05.pdf.

38 Further information is available in the IRCR's Final Decision – Review of Efficiency and Service Standard Incentive Mechanisms", available on the IRCR website at http://www.icrc.act.gov.au/__data/assets/pdf_file/19121/report_16_of_2005_incentive_final.pdf.

3.2 Transmission network performance

New South Wales

TransGrid is obliged to meet the requirements of Schedule 5.1 of the Rules. TransGrid's planning obligations are also interlinked with the distribution licence obligations of "N-1" imposed on all DNSPs in NSW.

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 Electricity Supply Regulation (Safety and Management) 2002 TransGrid that includes lodging a five year Network Management Plan with the NSW Department of Utilities, Energy and Sustainability. In this plan TransGrid declares its planning and development of its transmission network on an "N-1" basis, except under conditions such as radial supplies, inner metropolitan areas, the CBD, which is planned on a modified "N-2" basis, or when required to accommodate NEMMCO's operating practices.

Victoria

In Victoria VENCorp is the TNSP responsible for planning the shared transmission network. It undertakes its responsibility in accordance with Victorian legislation, Licence obligations, the Rules and the Victorian Electricity System Code.

VENCorp typically assesses new augmentations under the market benefits limb of the AER's Regulatory Test, which considers both the benefits and costs of alternative options. VENCorp calculates the market benefits of options using a probabilistic planning process and explicitly values the risk of involuntary load curtailment or VCR, associated with transmission constraints. The VCR is currently set at $29,600. However VENCorp also considers a sector specific VCR where the transmission constraint affects only a reasonably distinguishable subset of the Victorian load.

Queensland

The mandated reliability obligations and standards are contained in Schedule 5.1 of the Rules, the Queensland Electricity Act, the transmission licence, and in Connection Agreements with the distribution networks. In addition, the economic regulator (AER) sets and administers reliability-based service standards targets which involve an annual financial incentive (bonus/penalty).

Consistent with the National Electricity Rules, its transmission authority requirements and Connection Agreements with ENERGEX, Ergon Energy and Country Energy, Powerlink plans future network augmentations so that the reliability and power quality standards of Schedule 5.1 of the Rules can be met during the worst single credible fault or contingency (N-1 conditions) unless otherwise agreed with affected participants. This is based on satisfying the following obligations:

- "to ensure as far as technically and economically practicable that the transmission grid is operated with enough capacity (and if necessary, augmented or extended to provide enough capacity) to provide network services to persons authorised to connect to the grid or take electricity from the grid" (Electricity Act 1994, S34.2);
- "The transmission entity must plan and develop its transmission grid in accordance with good electricity industry practice such that… the power transfer available through the power system will be adequate to supply the forecast peak demand during the most critical single network element outage" (Transmission Authority No T01/98, S6.2); and
- the Connection Agreements between Powerlink and ENERGEX, Ergon Energy and Country Energy include obligations regarding the reliability of supply as required under clause 5.1.2.2 of the Rules. Capacity is required to be provided such that forecast peak demand can be supplied with the most critical element out of service, i.e. N-1. Following the EDSD report in 2004, ENERGEX and Ergon are required to plan their subtransmission networks (which interact with the Powerlink transmission network) to the N – 1 criterion.

South Australia

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 ESCOSA[39]. The ETC sets specific reliability standards (N, N-1, N-2 etc.) for each transmission exit point.

ESCOSA recently undertook a review of the definitions of specific reliability in clause 2.2.2 of the ETC. The associated changes to the ETC take effect from 1 July 2008 to align with the AER's next price determination for ElectraNet[40]. As part of the review, ESCOSA has sought to clarify network reliability standards for the Adelaide CBD, which is supplied jointly by ElectraNet and ETSA Utilities, and ElectraNet will be required to install a new transmission connection point to the CBD by the end of 2011. This will ensure that future CBD demand growth can be met reliably.

Tasmania

The Office of the Tasmanian Energy Regulator has requested the Tasmanian Reliability and Network Planning Panel (TRNPP) to develop Transmission Network Security and Planning Criteria. The TRNPP's consultation paper is available at http://www.energyregulator.tas.gov.au. Transend will be required to construct its facilities to meet these planning criteria and to use the 'reliability limb' of the AER's 'regulatory test' as a justification for reliability driven augmentations of the transmission network. Until these criteria are developed Transend is required to use the market benefit

[39] The ETC can be found on the ESCOSA website at http://www.escosa.sa.gov.au/webdata/resources/files/060906-R-ElecTransCodeET05.pdf.

[40] ESCOSA's final determination is available on its website at http://www.escosa.sa.gov.au/webdata/resources/files/060906-R-ReviewReliabilityElectricityTransmissionCodeFinalDec.pdf.

limb of the regulatory test or compliance obligations with the Rules to justify augmentations. Transend's performance incentive scheme is part of its current revenue cap determination as set by the AER. Transend does have some connected party specific performance schemes as part of connection agreements performance standards are set in the Tasmanian Electricity Code, including average standards that apply to a class of feeders and lower bound reliability standards. In addition the price determination for Aurora includes reliability based incentives.

4 Reliability Panel Members

In 2005 the AEMC undertook the process required under the Rules for appointing new Members (other than the Chairman, previously appointed by the AEMC, and NEMMCO's representative, provided by NEMMCO itself) to the Panel. Those appointments took effect from 1 January 2006 and are for a period of two years. The Panel consists of the following Members:

Ian Woodward (Chair)
Commissioner
AEMC

Jeff Dimery
General Manager
AGL

Mark Grenning
Chief Advisor, Commercial Opportunities
Rio Tinto

Les Hosking
Managing Director and CEO
NEMMCO

Gordon Jardine
Chief Executive
Powerlink

George Maltabarow
Managing Director
EnergyAustralia

Stephen Orr
Commercial Director
International Power Australia

Jim Wellsmore
Senior Policy Officer
Public Interest Advocacy Centre

Geoff Willis
Former Chief Executive
Hydro Tasmania

5 Glossary[41]

AEMC	The Australian Energy Market Commission, which is established under section 5 of the Australian Energy Market Commission Establishment Act 2004 (SA).
AER	The Australian Energy Regulator, which is established by section 44AE of the Trade Practices Act 1974 (Cth).
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).
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.
Code	see *National Electricity Code*
contingency events	These are events that affect the power system's operation, such as the failure or removal from operational service of a generating unit or transmission element. There are several categories of contingency event, as described below. **credible contingency event** A contingency event whose occurrence is considered 'reasonably possible' in the circumstances. For example: the unexpected disconnection or unplanned reduction in capacity of one operating generating unit; or the unexpected disconnection of one major item of transmission plant. **single credible contingency event** An individual credible contingency event for which it could be reasonably expected, under normal conditions, that the design or operation of the relevant part of the power system would adequately cater, so as to avoid significant disruption to power system security.

[41] These definitions have been provided to assist the reader of this report 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 glossary of the National Electricity Rules. Some of these definitions have been sourced with permission from NEMMCO's 2004 Statement of Opportunities.

	critical single credible contingency event The credible contingency event that would have the most significant impact on the power system. This would generally be the instantaneous loss of the largest generating unit on the power system. **non-credible ('multiple') 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.
demand-side management (DSM)	The planning, implementation and monitoring of utility activities designed to encourage consumers to modify patterns of electricity usage, including the timing and level of electricity demand.
demand-side participation (DSP)	The situation where consumers reduce their electricity consumption in response to a change in market conditions, such as the spot price.
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
DSM	see *demand-side management*
DSP	see *demand-side participation*
FCAS	see *frequency control ancillary services*
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.
interconnector flow	The quantity of electricity (in MW) being transmitted by an interconnector.
jurisdictional planning body	The transmission network service provider responsible for planning a NEM jurisdiction's transmission network.
lack of reserve (LOR)	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.
LOR	see *lack of reserve*
low reserve condition (LRC)	This is when reserves are below the minimum reserve level.
LRC	see *low reserve condition*
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 Adequacy (medium-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 must be issued weekly by NEMMCO.
minimum reserve level	The minimum reserve margin calculated by NEMMCO 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 (AEMA) of 30 June 2004.
multiple contingency event	see *contingency events*

National Electricity Code	The National Electricity Code was replaced by the National Electricity Rules on 1 July 2005.
National Electricity Market (NEM)	The National Electricity Market is a wholesale exchange for the supply of electricity to retailers and consumers. It commenced on 13 December 1998, and now includes Queensland, New South Wales, Australian Capital Territory, Victoria, South Australia, and Tasmania.
National Electricity Market Management Company (NEMMCO)	The National Electricity Market Management Company established in 1996 to: • administer and manage the NEM in accordance with the National Electricity Rules • develop the market and improve its efficiency • coordinate power system planning.
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.
NCAS	See *network control ancillary services*
NEM	See *National Electricity Market*
NEMMCO	See *National Electricity Market Management Company*
NER	See *National Electricity Rules*
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 flow	The quantity of electricity (in MW) being transmitted by a network.

network service providers	A person who operates as either a transmission network service provider (TSNP) or a distribution network service provider (DNSP).
Network services	The services (provided by a TSNP or DSNP) associated with conveying electricity and which also include entry, exit, and use-of-system services.
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: • NEMMCO 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 NEMMCO'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.
PASA	see *medium-term Projected Assessment of System Adequacy* and *short-term Projected Assessment of System Adequacy*
plant capability	The maximum MW output which an item of electrical equipment is capable of achieving for a given period.
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 NEMMCO SOO.

power system	The National Electricity Market's entire electricity infrastructure (including associated generation, transmission, and distribution networks) for the supply of electricity, operated as an integrated arrangement.
regions	The National Electricity Market's electricity regions currently include Queensland, New South Wales, Victoria, Snowy, South Australia, Australian Capital Territory.
reliability (power system)	The measure of the power system's ability to supply adequate power to satisfy demand, allowing for unplanned losses of generation capacity.
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 per cent 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 per cent.
reserve	The amount of supply (including available generation capability, demand-side participation and interconnector capability) in excess of the demand forecast for a particular period.
reserve margin	The difference between reserve and the projected demand for electricity, where: • Reserve margin = (generation capability + interconnection reserve sharing) – peak demand + demand-side participation.
reserve trader	The role adopted by NEMMCO to contract for additional reserves, where: • reserves are forecast to fall below a minimum reserve margin • a market response appears unlikely.
Rules	See *National Electricity Rules*
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).

SCADA demand	The sum of the: • SCADA measurement of the scheduled generation (measured at the generator terminals) in a region *plus* • the net measured interconnector flow into a region (measured at the region boundary).
scheduled load	A market load which has been classified by NEMMCO as a scheduled load at the market customer's request. A market customer may submit dispatch bids in relation to scheduled loads.
security (power system)	The safe scheduling, operation and control of the power system on a continuous basis.
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)	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 NEMMCO (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.
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 (TSNP)	A person who owns, operates and/or controls the high-voltage transmission assets that transport electricity between generators and distribution networks.
transmission networks	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.
transmission system	The combination of a transmission network and connection assets, which is connected to other transmission systems or a distribution system.
TSNP	See *transmission network service provider*
unserved energy (USE)	The amount of energy that cannot be supplied because there are insufficient supplies (generation) to meet demand.
Value of Lost Load (VoLL)	A value set by the Reliability Panel, and assessed as the value of lost electrical consumption. The current spot price, price cap is set at $10 000 per MWh.