ESSAY B


Robert Rough (Fairfax Images)

RELIABILITY IN THE NATIONAL ELECTRICITY MARKET

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Reliability refers to the continuity of electricity supply to end-users and is a key performance indicator for customer service. As electricity cannot easily be stored, a reliable supply requires the generation and network sectors to produce and transport the needs of households and business users in real time.

From time to time the electricity supply can be interrupted by outages in generation or in the networks that deliver power to customers. To maintain a reliable power system, it is important to pinpoint the causes of interruptions. In particular, clear signals are needed to ensure that generators and network operators address any weak spots in the power system through investment, maintenance or other solutions.

This essay looks at:

- the causes and effects of reliability issues
- reliability standards
- the measurement of reliability
- the reliability of electricity supply in the National Electricity Market (NEM), from generation through to the transmission and distribution networks that deliver power to customers.

There is a common perception that a lack of generation capacity or overloaded transmission systems cause most power system outages. As this essay will show, the Australian data indicates there is no chronic shortage of generation or transmission capability. Rather, when 'the lights go out' for electricity customers, it is generally caused by an issue in the local distribution network.

B.1 What causes unreliability?

Various factors—planned and unplanned—can interrupt the power supply. These may occur in generation or in the networks that deliver power to customers.

> A planned outage may occur for maintenance or construction works. Such interruptions can be timed for minimal impact.

> Unplanned outages occur when equipment failure causes the supply of electricity to be disconnected unexpectedly. For example, trees, birds, possums, vehicle impacts and vandalism can cause outages in distribution networks. Networks can also be vulnerable to extreme weather, such as bushfires or storms. There may be ongoing reliability issues in any part of the power system that is inadequately maintained or is used near the limits of its capacity.

Table B.1 lists examples of outages stemming from each sector of the electricity chain. In addition, some electricity users might experience outages due to their own faulty equipment or wiring, or due to their failure to pay an electricity bill. Such outages do not relate to the reliability of power supply delivery and are not considered in this essay.

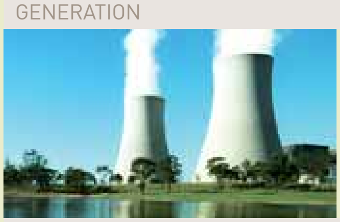
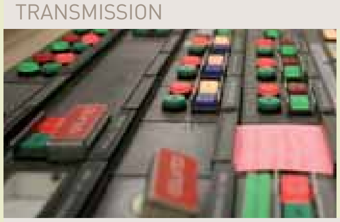
Whether a power supply interruption arises in generation, transmission or distribution, the underlying cause can usually be traced to one or a combination of:

> the quality and capacity of infrastructure—for example, there is a higher risk of outages if generators or networks are aging or are being used near their capacity limits

> inadequate maintenance, monitoring and/or operating procedures—for example, poor vegetation management around power lines or inadequate generator maintenance will increase the risk of outages

> extreme events that are not provided for in contingency planning—for example, a severe storm may cause power line damage.

Table B.1 Examples of power outages

SOURCE OF OUTAGE	EXAMPLES
GENERATION	
	In December 2004 the power system operator requested that 200 MW of load be shed in New South Wales after a generator tripped (shut down) during a low reserve period.
TRANSMISSION	
	On 20 March 2006 gale force winds associated with Cyclone Larry caused severe damage to the transmission network and the loss of 132 kV supply to Innisfail, Kamerunga, Tully, Cardwell, Kareeya and Barron Gorge bulk supply substations.
DISTRIBUTION	
	A bird eating grubs on high voltage equipment in rural Victoria shorts an insulator, causing a fuse on a transformer to blow. This led to an outage for the 100 customers connected to the transformer. Storms in Queensland in January 2004 caused significant outages in local distribution networks. This led to the Queensland Government commissioning a report into the state of the networks.

An assessment of the underlying causes of power system outages can help to determine whether the appropriate response requires capital investment, improved maintenance or better monitoring and operating procedures.

B.2 Effects of reliability issues

The effect of a power system outage varies, depending on the sector affected. A major generation or transmission failure could potentially shift generation and consumption out of balance and cause the power system to collapse—affecting hundreds of thousands of customers. The power system operator, the National Electricity Market Management Company (NEMMCO), can manage this in several ways. Some quick start peaking generators can be switched on to supply electricity to the market within half an hour. In the interim, NEMMCO can manage the effect of lost supply and out of balance events through controlled load shedding (disconnections). Jurisdictional security coordinators determine the order in which customers are load shed.[1]

While NEMMCO can manage the effects of a generation or transmission outage, a distribution outage usually has a localised impact. For instance, an outage caused by a collision with a suburban power line will result in nearby residents losing supply. Affected customers may not be reconnected until the physical damage to the network is repaired.

B.3 Reliability standards—how reliable is reliable?

Governments and regulators set standards for acceptable reliability. There are trade-offs between reliability and cost in each sector of the power system, making it inefficient to try to eliminate every possible source of interruption. Rather, an efficient outcome reflects the level of service that customers are willing to pay for. There has been some research on the willingness of electricity customers to pay higher prices for a reliable electricity supply. A 1999 Victorian study found that more than 50 per cent of customers were willing to pay a higher price to improve or maintain their level of supply reliability.[2] However, a 2003 South Australian survey indicated that customers were willing to pay for improvements in service only to poorly serviced customer areas.[3]

In practice, the trade-offs between improved reliability and cost mean that reliability standards tend to be high for generation and transmission because an outage can have a widespread geographical effect and potentially high socio-economic costs. In comparison, standards tend to be less stringent for distribution networks, where the impact of an outage may be localised. At the same time, the capital intensive nature of distribution networks[4] makes it expensive to build in high levels of redundancy (spare capacity) to improve reliability.

1 NEMMCO manages load shedding in accord with priorities set by the jurisdictional system security coordinators, which make judgments as to which customers are least affected by the loss of supply. Rule 4.1.1(b) of the National Electricity Rules stipulates that the jurisdictional system security coordinators must submit to NEMMCO a schedule of all the sensitive loads in the jurisdiction, and the order in which loads may be shed if NEMMCO deems that load shedding is required.

2 KBA, *Understanding customers' willingness to pay: components of customer value in electricity supply*, 1999.

3 The survey found that 85 per cent of consumers were satisfied with their existing level of service and were generally unwilling to pay for improvements in these levels. It found that there was a willingness to pay for improvements in service only to poorly served consumers. On this basis, the South Australian regulator has focused on providing incentives to improve the reliability performance for the 15 per cent of worst served consumers, while maintaining average reliability levels for all other customers. See ESCOSA, *2005–10 Electricity distribution price determination, Part A*, April 2005; KPMG, *Consumer preferences for electricity service standards*, March 2003.

4 The combined regulated asset base of distribution networks in the NEM is more than double that of transmission networks.

Table B.2 Agencies that report on power system reliability

AGENCY	REPORT	MARKET SECTOR		
		GENERATION	TRANSMISSION	DISTRIBUTION
Australian Energy Market Commission	Reliability Panel's Annual Report	✓	✓[1]	
Australian Energy Regulator	Electricity Regulatory Report		✓	
National Electricity Market Management Company	Statement of Opportunities	✓	✓	
Jurisdictional regulators	Performance reports for distribution networks businesses			✓
Energy Supply Association of Australia	Electricity Gas Australia	✓	✓	✓

1. Bulk transmission only.

Table B.3 Duration below minimum reserve levels (hours)

YEAR	NEW SOUTH WALES	VICTORIA	QUEENSLAND	SOUTH AUSTRALIA
2005–06	0	0	0	1
2004–05	2	0	0	0
2003–04	1	4	0	6
2002–03	1	0	0	0
2001–02	0	0	0	0
2000–01	0	3	0	24
1999–00	4	36	5	88

Tasmania, which was interconnected with the NEM in 2006, had zero minutes below the minimum reserve level in 2005–06.

Source: AEMC Reliability Panel, *Annual electricity market performance review: reliability and security 2006*.

B.4 Who measures reliability?

Various agencies report on the reliability of Australia's power system (table B.2). Most report on only one or two sectors of the electricity supply chain.

B.5 Reliability of electricity generation

The Australian Energy Market Commission (AEMC) Reliability Panel, established under the National Electricity Law, reports annually on the reliability of the wholesale market. The panel has set a reliability standard that requires sufficient generation and bulk transmission capacity to ensure that in the long term, no more than 0.002 per cent of energy demand in any region[5] is at risk of not being supplied (or being 'unserved'). NEMMCO determines minimum reserves of generator capacity above the demand for electricity in each region of the NEM, which aim to ensure that this standard is met. The panel also aims to set a wholesale market price cap at a level that will stimulate sufficient investment in generation capacity to meet the reliability standard.

The Reliability Panel reports performance against the reliability standard and the minimum reserve levels set by NEMMCO. Table B.3 shows the number of hours of insufficient generation capacity available to meet the minimum reserve levels. The data indicates that reserve levels are rarely breached and that generator capacity across all regions of the market is generally sufficient to meet peak demand and allow for a reserve margin. The performance of generators in maintaining reserve levels has improved since the NEM began in 1998, notably in South Australia and Victoria. This reflects significant generation investment and improved transmission interconnection capacity between the regions.

5 As at May 2007, the NEM has six regions, four of which are based on state boundaries (Victoria, Queensland, South Australia and Tasmania). The other two regions are New South Wales including the Australian Capital Territory, and the Snowy, which is located in Southern New South Wales.

In practice, generation has proved highly reliable, with only two instances of insufficient capacity to meet consumer demand since the NEM began. One was in Victoria in early 2000 when a coincidence of industrial action, high demand and temporary loss of generating units resulted in load shedding. The other was in New South Wales on 1 December 2005 when a generator failed during a period of record summer demand caused by hot weather. The restoration of load began within ten minutes.

Table B.4 sets out the performance of the generation sector in selected states against the 0.002 per cent reliability standard. While all states now operate within the standard, Victoria and South Australia's long-term averages fall outside because of the events that occurred in early 2000. Both states have met the standard since that year.

Table B.4 Unserved energy: long-term averages from December 1998 to 30 June 2006

STATE	UNSERVED ENERGY
New South Wales	0.0001%
Victoria	0.0101%
Queensland	0%
South Australia	0.0025%

Source: AEMC Reliability Panel, *Annual electricity market performance review: reliability and security 2006*.

The Reliability Panel excludes some supply interruptions from its reliability data and focuses on credible (likely) reliability events. The power system is operated so capacity can cope with credible supply interruptions. These events are foreseeable, and can be avoided through investment in generation capacity.

Some power supply interruptions are caused by events that are non-credible. Typically, they occur simultaneously or in a chain reaction. For example:

> several generating units might fail at the same time
> a transmission fault might cause the tripping of a generator.

It would not be feasible to operate the power system to cope with non-credible events (also called multiple contingency events). The events are uncommon, and the cost of power system infrastructure would be significantly greater if they were accommodated. For similar reasons, non-credible events are excluded from reliability statistics. As the events are not considered foreseeable, they do not reflect a lack of investment in generation capacity. But such events do affect the continuity of electricity supplies. A non-credible event may require NEMMCO to interrupt electricity supplies to customers to avoid a power system collapse.

Multiple contingency events in Queensland and Tasmania caused a significant amount of unserved energy in 2005–06, including outages caused by Cyclone Larry in Queensland in March 2006. The Reliability Panel noted that these events seriously affect continuity of supply, and that from a consumer perspective the effect is not clearly distinguishable from that of reported reliability events. The panel indicated it will reconsider its approach to the reporting of multiple contingency events.[6]

Investment in generation and long-term reliability

The NEM combines a number of mechanisms to ensure high levels of reliability in the generation sector. In the short term, NEMMCO can manage shortfalls in reserves by directing peak generators. In the longer term, a reliable power supply needs sufficient investment in generation to meet the needs of customers.

Price signals

A central element in the design of the NEM is that spot prices respond to a tightening in the supply–demand balance. Wholesale prices and projections in the supply–demand balance are also factored into forward prices in the contract market. Regions with potential generation shortages (which could lead to reliability issues) will therefore exhibit rising prices in the spot

6 AEMC Reliability Panel, *Annual electricity market performance review: reliability and security 2006*, p. 9. The panel is undertaking a comprehensive reliability review and released an interim report in March 2007.

and contract markets. High prices may eventually lead to some demand-side management response if suitable metering is available. For example, retailers might offer a customer financial incentives to reduce consumption at times of high demand to ease pressure on prices. There is some demand-side response in the NEM. In the longer term, higher prices create signals to invest in generation capacity, which helps prevent a potential future reliability problem from becoming a reality.

Price differences between regions help to attract investment to the areas where it is needed. For example, supply shortages and high demand growth forced up average wholesale prices in Queensland to around $50 to $60 a megawatt hour (MWh) in the 1990s. This led to significant investment in new generation and the commissioning of new transmission interconnectors. Similarly, high prices in South Australia in 1999 and 2000 led to significant investment in new capacity (see figure 1.10, chapter 1). This, combined with improved interconnection with Victoria, helped to ease spot prices after 2000.

Seasonal factors (for example, summer peaks in air conditioning loads) also create a need for 'top-up' generation to cope with periods of extreme demand. The NEM allows for extreme pricing during peak demand to provide incentives to invest in 'peaking' generation capacity needed to meet that demand. The market allows a price cap of $10 000 a MWh—called the value of lost load—which may be reached when demand approaches generation capability (including imports) in a particular region. While this may appear extreme compared to long-term average prices of around $30 to $40, the price cap is not often reached, and customers are shielded from the impact by retailers hedging their exposure in financial markets. The significance of extreme prices is the incentive they provide to hedge against the associated risks. For example, the risk of high prices encourages investment in peaking generation plants and contracting with customers to provide a demand-side response.

The price cap is necessarily high to encourage investment in peaking plant, which is expensive to run. Peaking plant is only profitable when high demand or tight supply drives prices well above average. It may only be profitable for some generators to run for a few hours a year. This means that peaking generators have few opportunities to recoup fixed costs. But unlike base load plants, they can come online quickly, and are therefore responsive to price movements. Over the longer term, peaking plants play a critical role in ensuring there is adequate generation capacity (and therefore reliability) in the NEM. Victoria and South Australia have invested in significant peaking generation capacity (see figure 1.5, chapter 1).

Forecasts and planning

NEMMCO publishes short, medium and long-term forecasts of electricity supply and demand (table B.5). The forecasts can enhance reliability by highlighting opportunities for generation investment to fill gaps in the supply–demand balance before a shortfall occurs.

Long-term forecasts provide regional investment signals to fill future supply gaps, helping to avert future stresses on the power system. Medium and short-term forecasts highlight imminent gaps in the supply–demand balance, which can help electricity businesses to plan maintenance outages. NEMMCO also uses a reliability safety net that allows it to take action to address potential reserve shortfalls. For example, a forecast supply gap in the near future might be averted by:

- postponing scheduled generation or network maintenance until peak demand eases
- NEMMCO contracting for reserve capacity (which occurred for Victoria and South Australia in February 2005 and February 2006).

Transmission Lines

Table B.5 NEMMCO planning instruments

PLANNING INSTRUMENT	DESCRIPTION
Statement of opportunities	Ten year outlook on demand and new generation capacity. Provides information to potential NEM participants to assist investment decisions.
Medium-term projected assessment of system adequacy	Aggregate supply and demand balance at the anticipated daily peak demand, based on a 10 per cent probability of exceedence for each day of the next two years.
Short-term projected assessment of system adequacy	Aggregate supply and demand balance comparison for each half hour of the coming week.
Pre-dispatch	Aggregate supply and demand balance comparison for each half hour of the next trading day (up to 40 hours).
Annual national transmission statement	Integrated overview of the current and projected state of national transmission flow paths, with forecasts of constraints and options to relieve them.

Source: NEMMCO

B.6 Transmission reliability

Many factors can potentially interrupt the flow of electricity on a transmission network. Interruptions may be planned (for example, scheduled maintenance of equipment) or unplanned (for example, equipment failure caused by bushfires, lightning strikes or hot weather raising air conditioning loads above the capability of a network). A serious network failure might require the power system operator to load-shed some customers.

While there are differences in the reliability standards applied in each jurisdiction, all transmission networks are designed to deliver high rates of reliability. They are engineered with sufficient capacity to act as a buffer against planned and unplanned interruptions in the power system. More generally the networks enhance the reliability of the power supply as a whole by allowing a diversity of generators to supply electricity to end markets. In effect, the networks provide a mix of capacity that can be drawn on to help manage the risk of a power system failure.

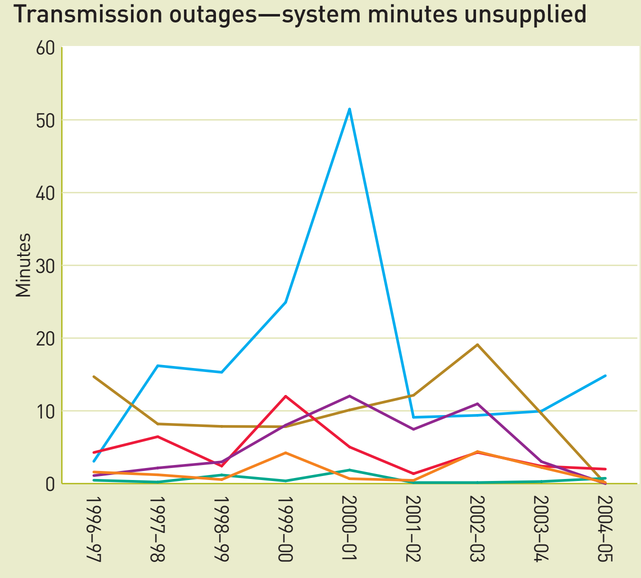
The Energy Supply Association of Australia (ESAA) and the Australian Energy Regulator (AER) report on the reliability of Australia's transmission networks.

Energy Supply Association of Australia data

The ESAA publishes survey data from transmission network businesses on network reliability, based on system minutes of unsupplied energy to customers (figure B.1). The data is normalised in relation to maximum regional demand to allow comparability.

The data indicates that NEM jurisdictions have generally achieved high rates of transmission reliability. In 2003–04, there were fewer than 10 minutes of unsupplied energy in each jurisdiction due to transmission faults and outages, with New South Wales, Victoria and South Australia each losing less than three minutes. The networks again delivered high rates of reliability in 2004–05. Much of the volatility in Tasmania's data can be traced to a single incident in 2001. This suggests that the reliability of Australia's transmission networks is generally so high that a single incident can significantly alter measured performance.

Figure B.1
Transmission outages—system minutes unsupplied



Note: System minutes unsupplied is calculated as megawatt hours of unsupplied energy divided by maximum regional demand. ESAA data not available for Queensland and Western Australia in 2004–05.

Source: ESAA, *Electricity gas Australia 2006* and previous years.

Australian Energy Regulator data

While Australian transmission networks are generally very reliable, the AER applies service incentive schemes to maintain or further enhance their performance. The schemes provide financial bonuses and penalties to network businesses that meet (or fail to meet) performance targets, including for reliability. A business can receive +/-1 per cent of its regulated revenue for over or under performance against a target. The AER sets separate standards for each network that take account of specific circumstances, rather than applying a common benchmark. The targets are based on the network's past performance. For this reason, the raw data collected by the AER does not easily lend itself to comparisons between firms.

The AER standardises the results for each transmission network service provider (TNSP) to derive an 's-factor' indicator that ranges from -1 to +1. This standardised measure determines financial penalties and bonuses. An s-factor of -1 represents the maximum penalty, while +1 represents the maximum bonus. Zero represents a revenue neutral outcome. Table B.6 sets out the s-factors for each network since the scheme began in 2003. While caution must be taken in drawing conclusions from three years of data, it is interesting to note that the major networks in eastern and southern Australia have consistently outperformed their targets.

Table B.6 AER s-factor values 2003–05

TNSP	2003	2004	2005
ElectraNet (SA)	0.74	0.63	0.71
SP AusNet (Vic)	(0.03)	0.22	0.09
Murraylink (interconnector)	na	(0.80)	0.15
Transend (Tas)	na	0.55	0.19
TransGrid (NSW)	na	0.93	0.70
Energy Australia (NSW)	na	1.00	1.00

na not applicable.

Note: An incentive scheme for Powerlink (Queensland) begins in 2007.

Sources: AER, Annual regulatory reports from 2003–04 to 2005–06, and AER letters to respective network businesses.

There has nonetheless been industry concern that congestion in some transmission lines (often cross-border interconnectors) periodically blocks electricity flows in parts of the NEM, leading to higher cost electricity generation. New work by the AER with help from NEMMCO is developing measures of how transmission network congestion can affect electricity costs. The preliminary outcomes suggest that there is some significant congestion and that the impact has risen since 2003–04. Total costs nonetheless appear to be relatively modest given the scale of the market. Section 4.7 of this report provides a more detailed discussion of AER work in this area.

Transmission investment and long-term reliability

Several regulatory and planning instruments help to ensure there is appropriate investment in transmission infrastructure to avoid potential reliability issues. The instruments include:

- capital expenditure allowances for network businesses, administered by the AER
- service standard incentive schemes administered by the AER
- planning obligations applied by state governments
- the annual national transmission statement (ANTS), published by NEMMCO.

In regulating transmission networks, the AER uses a mix of capital expenditure allowances and incentive schemes to ensure that investment is both efficient and sufficient for reliability needs. Every five years the AER sets a revenue cap for each network that provides an allowance for investment. A network business can spend this allowance on the projects it deems appropriate without the risk of any future review by the regulator.

To encourage efficient network spending, the AER uses incentive schemes that permit network businesses to retain the returns on any underspending against their investment allowance. This helps avoid 'gold plating' the networks with unnecessary spending, for which customers must ultimately pay. If used in isolation, however, the schemes might also encourage businesses to delay expenditure that would improve reliability.

Recognising this, the AER uses service quality incentive schemes alongside the capital expenditure schemes. As noted, the service quality schemes reward network businesses for maintaining or improving service quality and penalise any deterioration in performance. In combination, the capital expenditure allowances and the twin incentive schemes encourage efficient investment in transmission infrastructure to help avoid potential reliability issues.

Investment decisions are also guided by planning requirements set by state governments in conjunction with standards set by NEMMCO. There is considerable variation in the approaches of state governments to planning. The responsible body ranges from the network business itself (in New South Wales and Queensland), to a not-for-profit entity (in Victoria), a statutory authority (in South Australia) and the jurisdictional regulator (in Tasmania).[7] Reliability standards applied by each jurisdiction also differ.

To address concerns that jurisdiction-by-jurisdiction planning might not adequately reflect a national perspective, NEMMCO began to publish in 2004 the ANTS to provide a wider focus. It aims, at a high level, to identify future transmission requirements to meet reliability needs.

Acting on the recommendations of the Energy Reform Implementation Group, the Council of Australian Governments agreed in 2007 to establish a National Energy Market Operator (NEMO) by June 2009. As well as becoming the operator of the electricity and gas wholesale markets, NEMO will be responsible for national transmission planning. As one of its functions it will release an annual national transmission network development plan, to replace the current ANTS process.

B.7 Distribution reliability

As in transmission, electricity distribution networks can be affected by planned and unplanned interruptions. The impacts of planned outages can be managed more easily than unplanned outages. Some unplanned outages can be traced to inadequate maintenance or capacity issues.

Jurisdictions track the reliability of distribution networks against performance standards. The standards are set out in monitoring and reporting frameworks, service standard incentive schemes and guaranteed service level payment schemes. All NEM jurisdictions monitor reliability outcomes and provide guaranteed service level payments to customers who receive unsatisfactory service. Victoria, South Australia and Tasmania currently apply a service standards incentive scheme.

In effect, service standards weigh the costs of improved reliability (through investment, maintenance and other solutions) against the benefits, taking account of specific network characteristics. As noted in section B.3, the trade-offs between improved reliability and cost tend to result in reliability standards for distribution being less stringent than for generation and transmission. For similar reasons, standards tend to be higher for a central business district (CBD) network with a large customer base and a concentrated customer and load density than for a highly dispersed rural network with a small customer base and small load density—the costs of redundancy in the rural network would be high in relation to the loads likely to be affected by an outage.

Utility Regulators Forum framework

All jurisdictions have their own monitoring and reporting framework on reliability. In addition, the Utility Regulators Forum (URF) developed a national framework in 2002 for electricity distribution businesses to report against national criteria.[8] The URF proposed four reliability indicators that are widely used in Australia and overseas. The indicators relate to the average frequency and duration of network interruptions or outages (table B.7).

7 In South Australia and Tasmania, the network businesses have ultimate responsibility for investment.

8 Utility Regulators Forum, *National regulatory reporting for electricity distribution and retailing businesses*, Discussion paper, 2002.

Mark Wilson

Pole top transformer

Table B.7 **Reliability measures—distribution**

INDEX		MEASURE/DESCRIPTION
SAIDI	System average interruption duration index	Average total number of minutes that a distribution network customer is without electricity in a year (excludes interruptions of one minute or less)
SAIFI	System average interruption frequency index	Average number of times a customer's supply is interrupted per year
CAIDI	Customer average interruption duration index	Average duration of each interruption (minutes)
MAIFI	Momentary average interruption frequency index	Average number of momentary interruptions (of one minute or less) per customer per year

Source: Utility Regulators Forum, *National regulatory reporting for electricity distribution and retailing businesses*, 2002.

Distribution businesses report annually to the jurisdictional regulators on the performance of their networks against these indicators. The regulators and the regulated businesses publish the SAIDI, SAIFI and CAIDI data, typically down to feeder level (CBD, urban and rural) for each network.

Tables B.8 and B.9 set out summary data for the SAIDI and SAIFI indicators for NEM jurisdictions. PB Associates developed the data for the AER from the reports of jurisdictional regulators and from reports prepared by distribution businesses for the regulators.

There are several issues with the published data that limit the validity of any performance comparisons. In particular, the accuracy of the network businesses' information systems may differ. There are also geographical, environmental and other differences between the states and between networks within particular states. Technical differences, such as the age of the networks, can also affect reliability outcomes—but might also raise issues about the adequacy of investment and maintenance.

There are also differences in regulatory approach between the jurisdictions, for example, the treatment of exclusions. The URF agreed that in some circumstances, reliability data should be normalised to exclude interruptions that are beyond the control of a distribution business. The URF excludes outages that:

> exceed a threshold SAIDI impact of three minutes
> are caused by exceptional natural or third party events
> the distribution business cannot reasonably be expected to mitigate the effect through prudent asset management.

In practice, jurisdictions differ in the approval and reporting of exclusions. More generally, there is no consistent approach to auditing performance outcomes.

Noting these caveats, the SAIDI data indicates that since 2000–01, the average duration of outages per customer tended to be lower in Victoria and South Australia than other jurisdictions—despite some community concerns that privatisation might adversely affect service quality (table B.8). While New South Wales tended to record higher SAIDI outcomes, it has recorded a decline in average outage time over each of the past three years. The average duration of outages in Queensland tended to be higher than in other jurisdictions. It should be noted that Queensland is subject to significant variations in performance, in part due to its large and widely dispersed rural networks, and its exposure to extreme weather events. These characteristics make it more vulnerable to outages than some other jurisdictions.

The NEM-wide SAIDI averages rely on the jurisdictional data and are therefore subject to the caveats outlined above. In addition, the NEM averages include several assumptions to allow comparability over time (see notes to tables B.8 and B.9). Noting these cautions, the data indicates that distribution networks in the NEM have delivered reasonably stable reliability outcomes over the past few years. NEM-wide SAIDI remained in a range of about 200–270 minutes between 2000–01 and 2005–06. This estimate excludes the effect of a Queensland cyclone in 2006.

Table B.8 System average interruption duration index—SAIDI (minutes)

	OUTAGE DURATION						
STATE	1999–00	2000–01	2001–02	2002–03	2003–04	2004–05	2005–06
Vic	156	183	152	151	161	132	165
NSW and the ACT		175	324	193	279	218	191
Qld		331	275	332	434	283	315
SA		164	147	184	164	169	199
NEM weighted average	156	211	246	211	268	202	211

Table B.9 System average interruption frequency index—SAIFI

	OUTAGE FREQUENCY INDEX						
STATE	1999–00	2000–01	2001–02	2002–03	2003–04	2004–05	2005–06
Vic	2.1	2.1	2.0	2.0	2.2	1.9	1.8
NSW and the ACT	1.7	2.5	2.6	1.4	1.6	1.6	1.8
Qld		3.0	2.8	3.3	3.4	2.7	2.7
SA		1.7	1.6	1.8	1.7	1.7	1.9
NEM weighted average	1.6	2.4	2.4	2.1	2.2	1.9	2.0

Notes: PB Associates developed the data for the AER from the reports of jurisdictional regulators and from reports prepared by distribution businesses for the regulators. Queensland data for 2005–06 is normalised to exclude the effect of a severe cyclone. Victorian data is for the calendar year ending in that period (for example, Victorian 2005–06 data is for calendar year 2005). NEM averages exclude New South Wales and Queensland (2000–01 only) and Tasmania (all years).

Sources: PB Associates (unpublished) and performance reports published by ESC (Vic), IPART (NSW), QCA (Qld), ESCOSA (SA), OTTER (Tas), ICRC (ACT), EnergyAustralia, Integral Energy and Country Energy.

There appears to have been an overall improvement in the average frequency of outages (SAIFI) across the NEM since 2000 (table B.9). On average distribution customers in the NEM experience outages around twice a year, but two to three times a year in Queensland.

Given the diversity of network characteristics, it is often more meaningful to compare network reliability on a feeder category basis (CBD, urban and rural) than a statewide basis. Section 5.6 of this report sets out SAIDI outcomes by feeder for distribution networks in the NEM. While care needs to be taken in making performance comparisons, the data indicates that CBD and urban feeders tend to be more reliable than rural feeders.

B.8 Whole of power system reliability

It is difficult to form an holistic assessment of reliability across the electricity supply chain as each sector uses different reliability indicators. One basis for comparison is the reliability data submitted by distribution businesses to jurisdictional regulators. This data distinguishes supply interruptions that can be traced to generation and transmission from interruptions that originate in the distribution networks.[9] It is therefore possible to estimate the contribution of each sector to reliability outcomes. The estimates should be taken only as broad indicators, given the measurement issues noted in section B.7.

Figure B.2 sets out whole of power system reliability data for 2005–06 at a national level. The charts distinguish between 'normalised' and 'excluded' distribution outages. Across all feeders, over 90 per cent of the duration of electricity outages originated in the distribution networks. This trend is most pronounced in the CBD, where distribution accounts for virtually all outages. About 40 per cent of distribution outage time is excluded from the normalised data. Less then 5 per cent of the total duration of outages was traceable to generation and transmission interruptions. While there is some variation across the feeders, it is clear that distribution networks were the principal source of power system outages.

9 The data does not disaggregate generation and transmission outages. It aggregates all outages that originate in those sectors, including those caused by non-credible events.

Figure B.2
SAIDI: NEM averages, 2005–06

Note: Data for 2005–06 financial year, except for Victoria—2005 calendar year and Tasmania and the Australian Capital Territory—2004–05 financial year.

Sources: Distribution network performance reports published by ESC (Vic), IPART (NSW), QCA (Qld), ESCOSA (SA), OTTER (Tas), ICRC (ACT), EnergyAustralia, Integral Energy and Country Energy.

While the data suggests that distribution networks are the main source of reliability issues, it does not necessarily follow that the networks have underperformed. An assessment of performance adequacy would need to compare outcomes with performance standards.

As noted, reliability standards in generation and transmission tend to be more conservative than in distribution, and require higher levels of built-in redundancy to cope with emergencies. While a generation or transmission outage could affect hundreds of thousands of downstream customers, a distribution outage usually has more confined effects. Distribution networks are designed to a cost and a standard that reflect these considerations and normally allow for some level of interruptions.

Two other considerations should be noted.

- Distribution networks are often longer than transmission networks. For example, South Australia's distribution network is around 14 times longer than the transmission network.[10] The discrepancy between reliability in transmission and distribution would often be reduced on a per kilometre assessment. The size of distribution networks relative to transmission networks also has implications for the relative cost of improving their reliability.
- While NEMMCO can often act to minimise the effect of generation and transmission incidents, the localised nature of distribution outages can make their effects difficult to manage.

The appropriate level of capital investment and operating expenditure to achieve a reliable electricity supply depends on the quality of service that consumers are willing to pay for. When distribution networks are meeting performance targets that reflect community choices, their reliability would be considered satisfactory. As noted, there remain some differences between the jurisdictions in the measurement of distribution reliability. A more consistent approach to auditing and the treatment of exclusions would likely help the community to better assess reliability performance.

From time to time, performance does not meet community standards. The case study in box B.1 considers an investigation into the performance of Queensland's distribution networks in 2004. It highlights the range of factors that can affect reliability, some of which are difficult to manage. It also illustrates how indicators such as SAIDI can gauge the adequacy of reliability performance. Finally, it provides examples of the type of action that can be taken to improve performance.

10 ElectraNet is around 5600 km, while the ETSA distribution network is around 80 000 km.

Box B.1 Case study—Queensland's Somerville report

The Queensland Government established an independent panel to investigate the performance of the state's distribution networks after a series of storms and hot weather caused significant outages in 2004. It granted the panel wide terms of reference covering assessments of reliability and levels of capital and operating expenditure. The panel's report (the Somerville report)[11] noted the timeliness of the review, given that many network components were approaching replacement age (40–50 years).

The panel compared the reliability of Queensland distributors Ergon Energy and ENERGEX against Victorian and New South Wales distributors. It found that Ergon Energy had the most and longest outages of these distributors. ENERGEX performed relatively well for the Brisbane CBD against the SAIDI and SAIFI performance measures. However, its performance for urban and rural short feeders was below the peer group average.

The panel considered several possible reasons for poor network reliability. It noted that Queensland is prone to extreme weather and that its networks have larger coverage areas and a more dispersed customer base than networks in New South Wales and Victoria. While the panel recognised that these characteristics would place Queensland networks at the upper end of SAIDI performance, it considered their performance to be unacceptably poor.

In particular, the panel considered that investment, maintenance (for example, vegetation management) and operating systems were inadequate. It considered that a lack of regulated service standards in combination with perverse regulatory incentives contributed to poor performance. In particular, these factors allowed distributors to benefit by delaying or avoiding expenditure that would improve reliability.

The panel reviewed the adequacy of investment to cater for current and future demand. It considered that it would be inefficient to build out all outages by 'gold plating' the networks, and recognised a trade off between service quality and expenditure. It noted that having a network with spare capacity at peak times is costly, and that Queensland has summer peaks of extended length. Nonetheless the distributors had undertaken insufficient expenditure to maintain the networks to satisfy customer demand.

The report found differences between the issues facing each network. The capacity of the ENERGEX network was constrained by management decisions to reduce spare capacity and increase system utilisation to improve financial results. This led to ENERGEX utilising the network at around 76 per cent in 2002, compared with the Australian average of around 56 per cent. ENERGEX has since undertaken to return network utilisation to 60–65 per cent.

Ergon Energy inherited six networks of 'varying quality' after the industry was restructured. The panel considered that Ergon Energy had been slow to take remedial action in some of the poorly maintained parts of the networks, and that a significant percentage of its substations were operating under capacity or voltage constraints.

The Queensland government launched an action plan in response to the review in August 2004. In 2005, the government introduced a new electricity code, setting guaranteed levels of service and performance requirements for ENERGEX and Ergon Energy. The standards are based on achieving an overall improvement in electricity reliability of about 25 per cent over the five years to June 2010.

11 Independent Panel (Chair: Darryl Somerville), *Electricity distribution and service delivery for the 21st century*, Summary report, Queensland, 2004.