The reliability standard

Power system reliability

Reliability in the electricity sector means that the power system has enough capacity to meet consumer demand. That is, the system has sufficient capacity (including generation, demand response and inter-state transmission assets) to produce and transport electricity to meet consumer demand.

The national electricity market (NEM) generally provides a high level of reliability. However, sometimes reliability issues occur when the balance of demand and supply in a region is tight.

Discussions about reliability are increasingly focused on hot weather. Hot summer days can affect both consumer usage patterns and the power system's ability to provide supply, particularly when extreme weather occurs on consecutive days:

- People tend to use more electricity when it is hot, especially on week days. Air conditioners are turned on in offices and homes, substantially increasing electricity demand. These effects are exacerbated when there are consecutive hot days.
- Hot weather also impacts electricity generators and the infrastructure used to transport electricity to our homes and offices. Many generators output becomes constrained in hot weather, especially after a number of consecutive days, caused by longer-than-usual periods of operation. It becomes harder to cool thermal coal and gas plants, while solar and wind plants may produce lower output at higher operating temperatures.

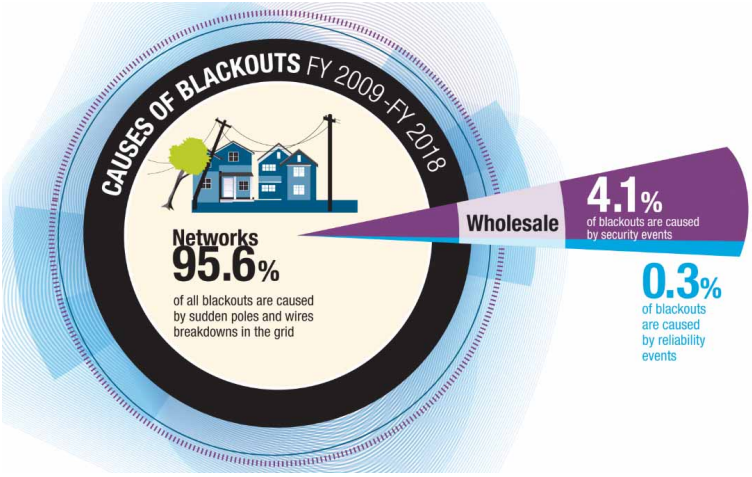
More recently, concerns are emerging about tight supply-demand balances in some regions during 'shoulder' periods. This is driven by the fact that maintenance on generators and transmission infrastructure is increasingly occurring in these periods, which reduces supply. On the demand side, changing weather patterns mean that demand during shoulder periods is less predictable than in the past.

Blackouts and unserved energy

Supply interruptions can originate anywhere in the power system—in generation or storage assets, in the poles and wires that transport power across states, or in towns and suburbs' power networks that distribute electricity to homes.

While customers' experience of power supply interruptions is the same irrespective of the cause, they are classified based on what part of the power system caused the interruption. This is because different parts of the power system have differing regulatory frameworks, involving different bodies and so requiring different solutions.

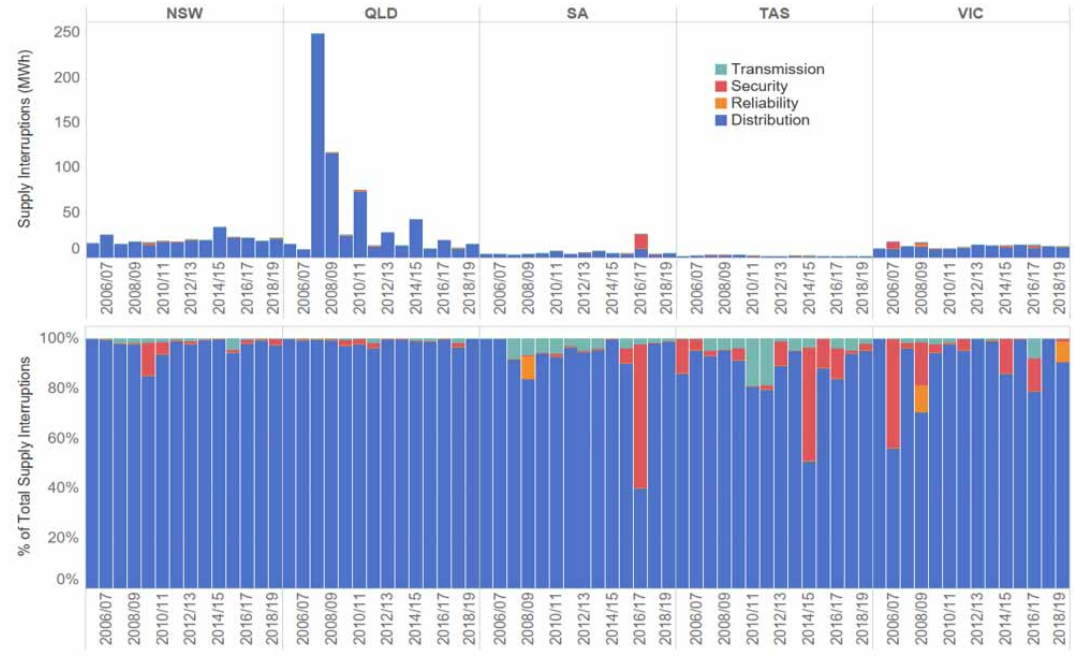
The following pie chart shows the causes of blackouts in the NEM from 2009 - 2018. It shows that over the past ten years across the whole of the NEM, the vast majority of blackouts have been caused by breakdowns in the grid's poles and wires. For example, when a power pole is knocked down in a storm or power lines are damaged in a bushfire (shown as "networks", 95.6%). Typically, these interruptions only affect small numbers of customers.



On the other hand, less than one per cent of blackouts in the NEM have been caused by a lack of supply (shown in the pie chart as "reliability events", 0.3%). When customers experience supply interruptions specifically because demand is higher than supply, we call the demand that went unmet 'unserved energy'.

The remaining four per cent of supply interruptions are caused by events that disrupt the frequency and voltage balance in the system (the "wholesale" slice of the pie chart, 4.1%). These 'system security' events are due to rare incidents, like large storms removing transmission lines from service coupled with generators tripping off.

The next two charts show how the causes of blackouts differ between NEM states, and how these have changed over time. The top chart presents supply interruptions in aggregate (MWh) and the bottom chart shows the causes as a proportion of all interruptions. Outages caused by reliability events (a shortage of supply) are shown in orange. The charts confirm that for each individual NEM region, reliability events very rarely cause blackouts.



Note: South Australia experienced reliability-related supply interruptions in 2016/17 and 2018/19 which are hard to see on the chart as they involved small amounts of unserved energy.

What is the reliability standard?

The NEM's reliability standard expresses the desired level of reliability sought from generation assets, demand response and the transmission lines that transport power

between states. It is crucial to the NEM as it underpins the operational and investment decisions that drive reliability. It counts only two per cent of interruptions, or the orange bars in the charts above.

Set in the national electricity rules (NER), the standard is expressed as the maximum forecast unmet demand (i.e. unserved energy) for each financial year, as a proportion of the total demand in that region. A region in the NEM can be determined as an area that is served by transmission lines and has major demand and generation centres. Current arrangements for regions are simple; they are divided by state boundaries.[1] The reliability standard is currently expressed as:

> a maximum expected unserved energy (USE) in a region of 0.002 per cent of the total energy demanded in that region for a given financial year.[2]

In other words, the reliability standard implies that we expect to have enough supply to meet demand 99.998 per cent of the time, in every region every financial year.

Currently, AEMO operationalises the reliability standard through its forecasting processes, which provide information to market participants and potential investors. These are described in more detail below. The NER give AEMO the flexibility to evolve and adapt its approach to how it operationalises the reliability standard over time.

BOX 1: AT A GLANCE: LOAD SHEDDING AND THE RELIABILITY STANDARD

Load shedding because demand exceeds supply has been uncommon historically. There have only been five instances since 2005 of any load shedding in the NEM related to reliability - twice in Victoria and three times in South Australia.[1]

When it does occur, what does load shedding look like?

When load is shed, it occurs in a controlled manner, by AEMO directing networks to reduce load by turning power off to some areas to maintain balance in the system. It is called rotational load shedding because the outages for consumers are typically kept to about 30-60 minutes, with load shedding rotated between suburbs and regions, based on a priority list set by each jurisdiction.

In Victoria on 25 January 2019 – the last time there was unserved energy in Victoria – approximately 270MW of demand went unmet for around two and a half hours. Assuming hypothetically this load shedding event would have been completely borne by households, then around 80,000 homes would have been affected by power outages. Typically, homes experience shorter, half-hour outages because load is shed on a rolling basis to different groups of houses. That is, individual houses wouldn't have been without power for two and a half hours.

How much demand does 0.002% represent?

In NSW 0.002 per cent of unserved energy could be avoided entirely if – on a very hot day – one in six of the NSW homes with air conditioning turned off their air-conditioners for three hours at peak demand. (Their air conditioners would have been running and cooled the house before being turned off).[2] As a rule of thumb, on a hot day, 1MW of demand response can be achieved by turning off approximately 550 average residential air conditioners.

Note: 1. Unserved energy was experienced in the following regions in the following period: Victoria in 2008-09 and 2018-19, and South Australia in 2008-09, 2016-17 and 2018-19.

Note: 2. The figures above use an average residential air conditioner consumption of 1.86kW per unit when running and assumes NSW experiences the entirety of the USE required to breach the Reliability Standard for the state in 2019 in a single evening peak (1434 MWh).

1 The ACT is considered to be a part of the NSW region.

2 3.9.3C(a) of the National Electricity Rules.

The reliability and cost trade-off

Some people question why the system cannot be 100 per cent reliable. Power systems cannot be reliable at all times. There will always be the potential for a combination of unlikely events to cause supply interruptions. Further, investing to try to achieve 100 per reliability would be very costly to electricity consumers.

All power systems incorporate a trade-off between what consumers pay for electricity and the cost of not having energy when it is needed. A balance is struck between having enough generation to meet consumers' electricity demand in the majority of circumstances, and keeping costs as low as possible for consumers.

A higher level of reliability requires more investment in capacity in the system. Recovering the costs of new generation plants, expanded inter-state transmission lines, and contracts with energy-intensive customers to reduce usage are all passed onto consumers through prices, and ultimately reflected in customer bills.

As an example, in 2018 the Reliability Panel conducted a desk-top study of the potential cost of moving close to zero unserved energy (the Panel noted that it is impossible to reduce expected unserved energy to zero in all possible modelled futures). In Victoria, as an example, it found an additional 1,000MW of capacity would be needed in 2020-21 to move close to zero expected unserved energy. For the additional plant to recover its fixed costs (excluding variable operating and maintenance costs), additional income would need to be generated in the market. This would equate to additional costs to customers of at least $200 million per year.[3]

In summary, no power system can be 100 per cent reliable. The reliability standard is an assessment of the appropriate a trade-off between the dual objectives of reliability and affordability. Reliability can be increased by installing more capacity in the system; however, this obviously comes with costs. A balance between the two, based on what consumers value in relation to reliability, is sought.

The reliability standard serves as a market signal and an operational driver

The role of the reliability standard in the NEM reflects the design of the NEM's reliability framework.

The reliability framework aims to deliver enough power supply and demand response to satisfy the reliability standard through market mechanisms to the greatest extent possible. The market drives investment in new generation, as well as plant retirement and operational decisions. A range of information is provided to the market that identifies, in both the short and long term, commercial opportunities for meeting forecast demand.

If the market still does not respond adequately, then the framework also includes tools that allow the system operator to intervene in specific circumstances to deliver reliability outcomes.

Coordinating this reliability framework requires detailed modelling to determine the right balance of market mechanisms, and accurate forecasting methods to determine if the system operator will need to intervene.

Every four years the Reliability Panel reviews the level of the standard and the reliability settings, which provide a 'price envelope' for participants, in order to best protect the integrity of the market. The level of the reliability standard is not automatically reassessed every review cycle. Rather, the Panel must apply a materiality test to determine if the reliability standard should be reassessed.

If the materiality threshold is not met, then the standard should remain as previously determined.

In order to review the reliability settings, the Panel undertakes wholesale market modelling in order to inform its recommendations on the settings. The wholesale market modelling forecasts the expected amount of unserved energy to consider whether the current standard should be met; there is then modelling to determine the theoretically optimal level at which the settings could be set, considering the expected unserved energy outcomes.

3 Reliability Panel, Reliability standard and settings review, 2018, p.72

As noted above, AEMO operationalises the reliability standard through a range of tools. Forecasting processes such as the projected assessment of system adequacy (PASA) allow AEMO the flexibility to change its reliability assessments about expected levels of unserved energy based on new information, including information about generation availability (e.g. whether a generator is out on maintenance or not) and changing weather conditions. AEMO considers different maximum demand outcomes, different weather conditions and different supply availability combinations in this forecasting, and updates its assessment at regular intervals as real-time approaches. This makes sure that market participants, and AEMO, always make decisions based on the latest and most accurate information available. AEMO uses this information to assess whether it needs to intervene in the market.

As such, the role of the reliability standard in the NEM's reliability framework is two-fold. It serves as:

- **a market signal** - the standard signals to the market commercial opportunities for more investment in generation, demand response and contracting.
- **an operational driver** - AEMO operates the system to meet the reliability standard.

The following sections summarise how the reliability standard serves these roles, through the mechanisms that comprise the reliability framework.

The reliability standard's role as a market signal

- Forecasts of the NEM's performance against the reliability standard are published up to ten years in advance to help market participants make commercial decisions to enter or expand (or divest from) generation, storage and demand response. In order to develop forecasts, AEMO uses inputs from participants (e.g. information about generator availability) to develop profiles of supply. AEMO then develops forecasts of demand that may occur, and which must be met by supply, which take account of weather effects and changing consumer preferences. Forecasts of tightening supply / demand balance[4], indicate potential future rises in spot and contract prices, which will inform operational decisions and incentivise entry and expansion, addressing any potential reliability problems as or before they arise. This allows the actual demand and supply to be kept in balance, even in the face of shocks to the system.
- A forecast breach of the reliability standard also serves as the trigger for the Retailer Reliability Obligation (RRO) T-3 Instrument (see over). In this way the standard serves as a signal to retailers to enter into contracts which would likely increase contracting of existing generators and/or unlock new investment, thereby assisting with reliability.
- The market price cap, cumulative price threshold, administered price cap and the market floor price are the reliability settings. They represent a trade-off that balances two priorities - protecting participants financially and incentivising investment in generation. The settings are used to contain the extent wholesale prices can rise and fall to protect and limit the financial exposure of prudent market participants. They are also set at a level such that prices over the long term incentivise enough new investment in generation and demand response so that the reliability standard is expected to be met.
- The standard serves as a market signal over the short, medium and long term. Participants take into account the reliability standard and settings, forward contract prices and historical spot prices, as well as a number of other factors when they make decisions about whether or not to invest.

The reliability standard's role as an operational driver

- AEMO operates the power system to maintain a reliable system. It implements the reliability standard in its forecasting and day-to-day operations in order for this to occur.
- AEMO provides information to the market through the various PASA and pre-dispatch processes, highlighting how much supply is in the market. If there is forecast to be shortages of supply, then this information encourages market participants to make different operational decisions (e.g. shift maintenance periods) in order to increase supply into the market, creating more 'in market reserves'.
- If a market response fails to address a projected breach of the reliability standard one year

4 Including for instance a declaration by AEMO of a lack of reserve or low reserve condition

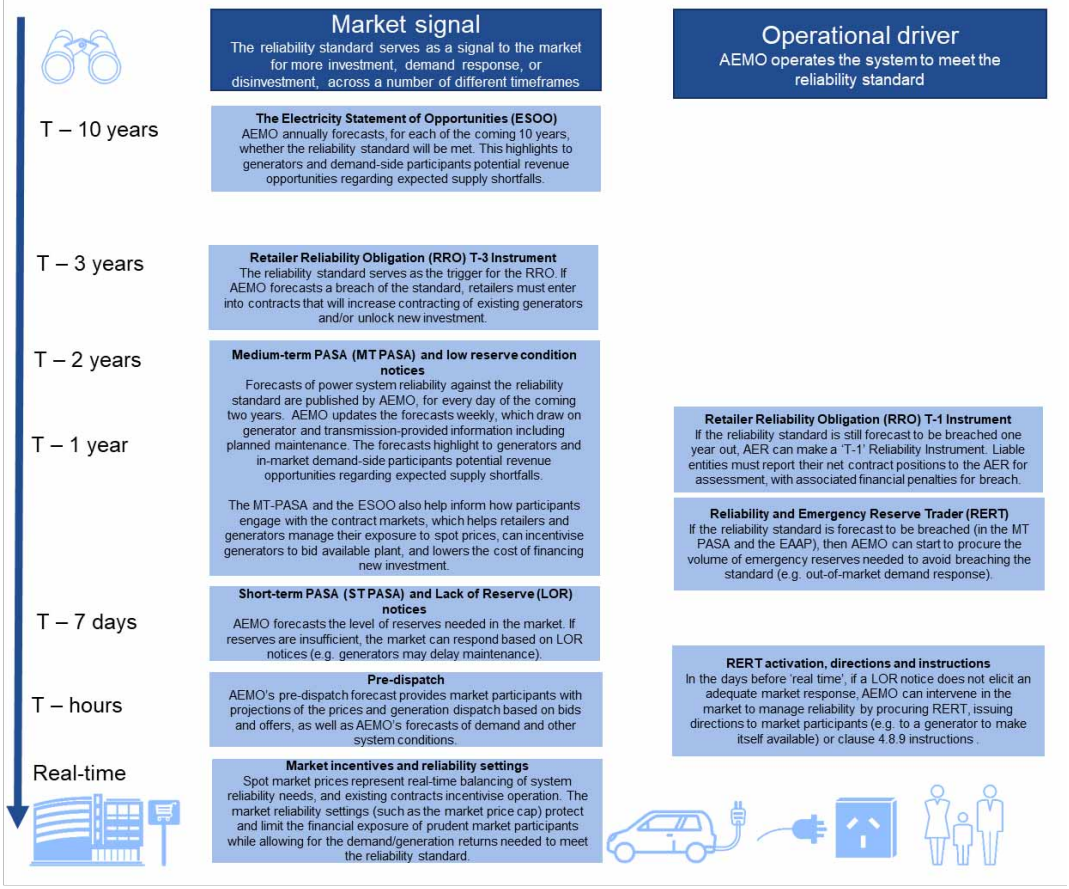
out from the breach by contracting enough 'in-market reserves', AEMO can procure emergency reserves through the Reliability and Emergency Reserve Trader (RERT) framework. Also, at T-1 AEMO can notify the AER to trigger a T-1 RRO Instrument (see over).

- Seven days ahead of real-time, AEMO's reliability assessment changes and AEMO targets zero unserved energy. AEMO continues to forecast whether or not there is a breach of the reliability standard, and provides this information to the market. These market notices of a lack of reserve condition again provide information to market participants, who may adjust their operational decisions in order to bring more supply to the market.
- If market participants do not respond to an expectation from AEMO that the reliability standard will not be met, by making more reserves available in the market, then AEMO can procure emergency reserves from the RERT, or issue directions or instructions to participants to maintain reliability.

Governance

The reliability standard has been a feature of the NEM since its inception in December 1998. It is reviewed by the Reliability Panel, comprising representatives from consumer groups, generators, retailers, network providers, and the AEMC and AEMO. The Reliability Panel's most recent review of the reliability standard was published in April 2018.[5] Under the National Electricity Rules, the review must be conducted at least every four years.

The role of the reliability standard in the reliability framework



5 www.aemc.gov.au/markets-reviews-advice/reliability-standard-and-settings-review-2018

Table 1: Abbreviations and Definitions

	MEANING	USE
PASA	Project Assessment of System Adequacy	A forecast produced by AEMO of whether supply is likely to meet demand, reported on over short and medium term time frames.
RERT	Reliability and Emergency Reserve Trader	A mechanism that allows AEMO to contract for emergency reserves that are out of the market.
RRO	Retailer Reliability Obligation	A mechanism that requires energy retailers and some large energy users to hold contracts or invest directly in generation or demand response if required
T-3	Three years before and three months before an identified gap	Refers to period out from an identified gap that a T-3 reliability instrument is triggered under the RRO
T-1	One year and three months before an identified gap	Refers to period out from an identified gap that a T-1 reliability instrument is triggered under the RRO

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