AEMC

REVIEW

Reliability Panel AEMC

Final report

Reliability and Security Frameworks in the NEM – An Explanatory Statement

21 May 2026

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About the Reliability Panel

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

Acknowledgement of Country

The AEMC acknowledges and shows respect for the traditional custodians of the many different lands across Australia on which we all live and work. We pay respect to all Elders past and present and the continuing connection of Aboriginal and Torres Strait Islander peoples to Country. The AEMC office is located on the land traditionally owned by the Gadigal people of the Eora nation.

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Citation

To cite this document, please use the following:
AEMC, Reliability and Security Frameworks in the NEM – An Explanatory Statement, Final report, 21 May 2026

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1 Introduction

This explanatory statement accompanies the Reliability Panel's (the Panel) *National Electricity Market Reliability & Security Report* (RASR)[1]It is designed to guide readers through key concepts discussed in the RASR, including the reliability and security frameworks in the NEM, and should be read in conjunction with the RASR in its relevant year to understand the Panel's reporting. It is updated annually to accompany the RASR and present the most up to date explanation of the current frameworks.

The explanatory statement:

- sets out the role of the Panel and RASR process
- describes the concepts and frameworks that are relevant to power system reliability and security in the National Electricity Market (NEM)
- identifies the set of metrics used by the Panel to monitor and report on reliability and security outcomes in the NEM, for the purposes of RASR reporting.

1.1 The Reliability Panel and National Electricity Market Reliability & Security Report

The Panel is a specialist body established by the Australian Energy Market Commission (AEMC) in accordance with section 38 of the National Electricity Law (NEL).

Among other things, the Panel is required to:

- monitor, review and report on, in accordance with the National Electricity Rules (NER), the safety, security and reliability of the national electricity system.
- at the request of the AEMC, provide advice in relation to the safety, security and reliability of the national electricity system.
- undertake any other functions and powers conferred on it under the NER and the NEL.

The RASR is one of the Panel's core review functions and is undertaken by the Panel as required by the NER and in accordance with the terms of reference provided by the AEMC.[2] Each year, the RASR covers reliability, security and safety outcomes over the preceding financial year and includes observations and commentary of the NEM primarily relating to that period. It also provides commentary on current and emerging trends and issues, including the market and regulatory changes underway.[3]

In December 2025, the terms of reference were updated to account for two changes, being the inclusion of new requirements to report on inertia-related metrics, and the removal of the requirement to report on safety.[4] Accordingly, the sub-section on inertia in this Explanatory Statement has been expanded to provide details relevant to the new requirement to report on inertia-related metrics (see section 4.3.4).

1 It fulfils the Panel's obligations under the AEMC's Terms of Reference to the Reliability Panel.

2 For the complete standing terms of reference, see AEMC, Reliability & Security Report — AEMC Terms of Reference to the Reliability Panel, 3 December 2025.

3 Clause 8.8.3(b) of the NER requires the Panel to conduct a review of the performance of certain aspects of the market, at least once every financial year and at other such times as the AEMC may request.

4 See the previous Terms of Reference at: AEMC, Annual Market Performance Review — AEMC Terms of Reference to the Reliability Panel, 26 July 2022

While safety will not be reported on in the FY2025 RASR, the section on Safety remains in the Explanatory Statement because under the NEL, the AEMC may still request that the Panel provide advice in relation to the safety of the national electricity system.[5]

The Panel must conclude each RASR by the end of the following financial year to which the review relates. The Panel must conduct the RASR in terms of:[6]

- reliability of the power system
- the power system security and reliability standards
- the system restart standard
- the guidelines referred to in clause 8.8.1(a)(3) of the NER[7]
- the policies and guidelines referred to in clause 8.8.1(a)(4) of the NER[8]
- the guidelines referred to in clause 8.8.1(a)(9) of the NER.[9]

The Panel comprises industry and consumer representatives who represent a range of participants in the NEM, including small and large consumers, generators, network businesses, retailers and the Australian Energy Market Operator (AEMO). Its purpose, constitution and review process are set out in Chapter 8 Part E of the NER.

5 NEL s.38(2)(b).

6 Clause 8.8.3(b) of the NER.

7 The guidelines govern how AEMO exercises its power to issue directions in connection with maintaining or re-establishing the power system in a reliable operating state.

8 The policies and guidelines govern how AEMO exercises its power to enter into contracts for the provision of reserves.

9 The guidelines identify, or provide for the identification of, operating incidents and other incidents that are of significance for the purposes of the definition of 'reviewable operating incident' in clause 4.8.15 of the NER

2 What is security and reliability in the National Electricity Market?

Power system reliability and power system security are distinct concepts, but they both involve 'keeping the lights on'. A power system needs to be:

- **Reliable** – have enough capacity (generation, demand response and networks) to supply customers.
- **Secure** – able to operate within defined technical limits, even if there is an incident such as the loss of a major transmission line or large generator.

This chapter explains the concepts of reliability and security in the NEM and describes their relationship and relevance to the Panel's RASR process. The specific frameworks for delivering reliability and security in the NEM, along with the metrics used to report on security and reliability outcomes, are presented in section 3.7 and section 4.4.

2.1 What is power system reliability?

A reliable power system can supply consumers with the energy they demand with a very high degree of confidence. It is a system that has sufficient:

- generation to meet consumer demand
- demand response, that is, consumers voluntarily reducing demand during peak periods
- transmission and distribution network capacity to transport power to consumers.

A reliable power system requires adequate investment and retirement as well as effective operational decisions so that supply and demand are in balance at any particular point in time. In a reliable power system, the expected level of supply should always include a buffer, known as reserves, that can be used if there are variances in supply and/or demand. The presence of reserves allows the actual demand and supply of the system to be kept in balance, even in the face of credible disturbances.

Reliability events on the power system arise when there is a shortage of available generation and network capacity to meet end-user demand. Reliability issues can occur and customer supply interrupted if there is insufficient generation, demand response and/or network capacity to meet customers' energy demand. This is known as 'lost load'.

The core objective of the reliability framework in the NEM is to deliver efficient reliability outcomes through market mechanisms. Market mechanisms send price signals which provide commercial incentives to businesses, rewarding generation or demand response at times of high demand (relative to supply). These incentives encourage market participants to make investment, retirement and operational decisions that support reliability.

AEMO provides projections and forecasts relevant to reliability outcomes and has tools to intervene, when needed, to maintain power system reliability consistent with relevant standards.[10] Further information on the frameworks used to deliver reliability in the NEM is provided in chapter 3.

Reliability issues have historically occurred at times of peak demand for electricity, generally on very hot or cold days, where unexpected generator or interconnector outages have resulted in

10 The NEM reliability standard and interim reliability measure (IRM) are the standards relevant to reliability in the NEM. These are further described in section 3.1.

insufficient capacity to satisfy demand. Under such circumstances, the *Power System Security Guidelines* [11] ouline AEMO's available hierarchy of interventions to manage potential power system security issues. The order is broadly:

1. **Implement agreed plans -** Use pre-arranged contingency plans or network support agreements.
2. **Reconfigure the network -** Take steps to switch transmission elements, adjust reactive support, return plant to service, implement sacrificial switching if needed
3. **Use RERT (Reliability and Emergency Reserve Trader) -** Activate contracted reserves if there is sufficient notice.
4. **Issue directions or clause 4.8.9 instructions -** Direct generators, loads, or network providers to operate in a certain way for security purposes.
5. **Reduce FCAS risk -** reduce the size of the largest contingency riskConstrain large generators or loads to manage frequency control risk
6. **Manual load shedding -** as a Last resort, AEMO instructs disconnection of customer load to preserve overall system stability.

However, as the power system transitions to a variable renewable energy (VRE) dominated system, reliability issues during times of peak demand may no longer be the case. Under this system, weather is likely to have an increasingly strong influence on unserved energy (USE). For example, low sun and low wind days, combined with synchronous unit outages, may mean reliability gaps arise as there is not enough electricity supply to meet demand. This was explored in the Panel's, 'Review of the form of the reliability standard and administered price cap'.[12]

Lost load can also occur due to security issues, which are discussed in chapter 4.

Note that the NEM uses different terminology from overseas jurisdictions when it refers to reliability. Reliability in the NEM corresponds to the internationally used term 'resource adequacy'.

2.2 What is power system security?

Power system security involves maintaining components within their allowable equipment ratings, maintaining the system in a stable condition within defined technical limits, and returning the power system to operate within normal operating conditions following a disturbance. Power system disturbances for power system security are referred to as contingency events.[13]

AEMO manages the power system by dispatching the market such that it remains within a 'technical envelope' required to maintain the power system in a 'secure' state. When the power system is in a secure state, technical parameters such as power flows, voltage and frequency remain within the bands defined by relevant power system security standards. In this state, the power system is also able to remain stable without load shedding after a credible contingency event, such as the loss of a single transmission line or single generator.

The power system can also experience severe disturbances that require emergency interventions, including potentially load shedding to avoid a larger, more costly, disturbance to the system. These emergency response systems are provided to prevent a black system event or major supply

11 *AEMO Power System Reliability Guidelines, December 2025*

12 Reliability Panel, *Review of the form of the reliability standard and administered price cap*, 27 June 2024.

13 Credible and non-credible contingency events are further described in section 4.1.1.

disruption following a serious non-credible disturbance, such as the co-incident loss of multiple transmission lines or generators.[14] During a non-credible disturbance, if load shedding is required, it occurs through automatic systems that can respond quickly to rebalance supply and demand.

Reliability and security are distinct concepts managed by different NEM frameworks. The two are, however, closely related operationally and it is not always simple to separate them within operational timescales. While a reliable power system will also be a secure power system, the converse is not necessarily true; a power system can be secure even when it is not reliable. For example, the NER requires AEMO to intervene in order to maintain the power system in, and return the power system to, a secure operating state within 30 minutes following a disturbance.[15] This compromises short-term reliability in order to maintain security.

14 A black system event is a large-scale blackout of the power system, typically across entire regions or sub-regions. "The sudden, unexpected loss of a major source of energy supply can cause very rapid changes in system frequency. When this happens, networks and generators automatically disconnect in order to protect people and equipment from harm." Reliability Panel, *Fact Sheet: Black System Events*, AEMC, 15 December 2016.

15 The range of interventions available to AEMO are outlined in section 2.1

3 How is reliability delivered in the National Electricity Market?

This chapter introduces the key frameworks for reliability in the NEM that are relevant to the Panel's RASR reporting. As noted in chapter 2, reliability in the NEM is delivered using market prices that incentivise market participant investment, retirement and operating decisions that provide sufficient generation and network capacity to satisfy customer demand. AEMO also supports market participant decision-making by providing information and is authorised to intervene should the market not deliver appropriate levels of reliability.

This chapter introduces:

- the reliability standard
- the market price settings
- contract markets and their role in the NEM
- AEMO information and forecasting processes
- AEMO intervention mechanisms
- the performance of NSPs.

The Panel's approach to monitoring reliability performance is discussed in each of these areas. Metrics for monitoring reliability outcomes in the NEM are presented in Table 3.1.

3.1 The reliability standard describes the efficient level of unserved energy in the NEM

The National Electricity Objective (NEO)[16] is designed to promote the long-term interests of electricity consumers. A key component of the NEO is reliability, as shown in Box 1.

Box 1: The National Energy Objective

"to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to:

- price, quality, safety and reliability and security of supply of electricity
- the reliability, safety and security of the national electricity system
- the achievement of targets set by a participating jurisdiction–
  - for reducing Australia's greenhouse gas emissions; or
  - that are likely to contribute to reducing Australia's greenhouse gas emissions."

The reliability standard in the NEM is a measure that expresses the efficient level of USE, given the trade-off between the cost of investing in power system resources and the value that customers attach to a more reliable power system.

There is a fundamental tension in the reliability standard between:

- price, and by extension, the costs borne by consumers, and
- the investment and operating costs associated with achieving a reliable electricity supply

16 Section 7 of the NEL.

The higher the level of reliability, the more investment in capacity (e.g. more generation, demand-side resources or network assets) is required, which imposes additional costs on consumers. Conversely, USE (an amount of customer demand that cannot be supplied) also has a cost. For example, if a customer has their electricity supply interrupted, they face losses associated with what they would have used the energy consumption for, if they could have consumed. These could be lost production if it is a business; or a colder/hotter home for residential customers with air conditioning.

It is not in the long-term interests of consumers to have no USE. Such an approach would be inefficient as the investment and operating costs of supplying energy at certain times would exceed the value placed on it by consumers. The reliability standard is therefore the level of USE that seeks to minimise total system costs by balancing the cost of power system capacity investment and operating costs, and the cost of any USE that would be borne by consumers. In FY2025, the standard targeted a maximum expected USE in a region of 0.002% of the total energy demand in each region for a given year.[17]

The reliability standard is not a regulatory or performance standard that is “enforced”. Instead, it is intended to indicate an efficient level of generation, demand response and inter-regional transmission capacity sought for the NEM f or the purpose of informing the market and AEMO processes. The Panel’s RASR sets out the forecast USE versus the reliability standard, as well as monitors historical actual reliability outcomes against the standard.

2026 Reliability Standard and Settings Review

The Panel considers the appropriateness of the level of the reliability standard in the NEM every four years in its reliability standard and settings review (RSS review).[18] The latest review was completed in April 2026, in which the Panel submitted a rule change request to the AEMC to modestly relax the reliability standard from 99.998 per cent to 99.997 per cent reliability for the period 1 July 2027 to 30 June 2032.[19]

During the 2022 RSS review, the Panel recommended a more detailed review to determine if the form of the reliability standard is fit-for-purpose for consumers and the power system as the NEM transitions. The Panel completed this review of the form of the standard in 2024, recommending no changes and noted the standards remain fit for purpose as the NEM transitions.[20]

Form of the reliability standard

The reliability standard is expressed as an ‘expected’ amount of USE.[21] An ‘expected value’ statistically represents a weighted average of all possible outcomes in a probability distribution. The reliability standard of 0.002% expected USE in a region in a financial year, represents the expected, probability-weighted, average of all possible USE outcomes, where each outcome is weighted by its probability of occurrence.

A reliability standard of 0.002% expected USE does not imply actual USE will be less than 0.002%. Outcomes with levels of USE far higher (or indeed, lower) than 0.002% are possible, although are low probability and correspondingly discounted when assessing their impact against the reliability standard. The possibility of these more extreme low probability outcomes is referred to as tail risk.

The value of customer reliability

17 Clause 3.9.3C(a) of the NER, version 243.

18 Reliability Panel, *2026 Reliability Standard and Settings Review*, April 2026.

19 AEMC, *Amendment of the Market Price Cap, Cumulative Price Threshold and Administered Price Cap*, April 2026.

20 Reliability Panel, Review of the form of the reliability standard and APC — Final Report, 27 June 2024.

21 Clause 3.9.3C of the NER.

An understanding of the value consumers place on reliability is required to trade-off power system resource operating and investment costs and consumer willingness to pay for reliability. This is the value of customer reliability (VCR).

The VCR in the NEM is calculated by the Australian Energy Regulator (AER) for standard outages (i.e. outages up to twelve hours in duration) using a combination of contingent valuation and choice modelling survey techniques. Contingent valuation techniques directly ask respondents to state their willingness to pay (WTP) to avoid a baseline outage scenario (defined as two localised one-hour outages in a year, occurring in winter in off-peak times). Choice modelling techniques ask respondents to pick their preferred outage scenarios, to determine the value (or cost) respondents place on specific outage attributes relative to a baseline outage scenario. Attributes tested in the choice model were peak (7-10 am and 5-8 pm) and off-peak time of day, season (winter / summer), day of week (weekday / weekend), severity (localised / widespread) and duration (1 hour, 3 hours, 6 hours, 12 hours).

The contingent valuation and choice modelling results are then combined to calculate the dollar value a customer cohort places on specific outage scenarios. The dollar values for the outage scenarios are then used to derive the standard outage VCR for the customer segment.

On 18 December 2024, the AER released a final report with the purpose of reviewing the VCR methodology and updating the VCR. The report concluded the current VCR methodology remains fit for purpose, though a different data source will be used to estimate residential USE, which is a key input in calculating residential VCR.[22] The AER adjusts the VCR annually in accordance with the VCR methodology, using the latest available all groups Consumer Price Index (CPI) at the time of the adjustment.[23]

The interim reliability measure and retailer reliability obligation

The interim reliability measure (IRM) is a second reliability measure that applies in addition to the reliability standard in the NEM. The IRM for generation and inter-regional transmission elements in the NEM is a maximum expected USE in a region of 0.0006% of total energy demand in each region for a given financial year.[24]

The IRM was introduced into the regulatory framework to improve the reliability of the electricity system through interim measures while more enduring reforms are developed.[25]

In September 2023, the AEMC made a rule change to extend the application of the IRM to the retailer reliability obligation (RRO), moving the expiration date from 30 June 2025 to 30 June 2028.[26]

The IRM is not used to determine market price settings (further described below) and instead:

- up to 31 March 2025, informed AEMO's procurement of any interim reliability reserves – a mechanism for AEMO intervention which is discussed further in section 3.5.1
- triggers the RRO.

The RRO is an obligation for retailer forward contracting. The RRO commenced on 1 July 2019, providing stronger incentives for market participants to invest in the right technologies in regions where it is needed, to support reliability in the NEM. AEMO will identify any potential reliability

22 AER, *Values of Customer Reliability*, 18 December 2024.

23 AER, *Values of Customer Reliability 2025 Annual Adjustment,* 18 December 2025, available here

24 Clause 3.9.3C(a1) of the NER.

25 Department of Climate Change, Energy, the Environment and Water (DCCEEW), *Interim Reliability Measures*, 2020.

26 AEMC, *Extension of the application of the IRM to the RRO*, 21 September 2023.

gaps in each NEM region against the IRM in the coming five years. If AEMO identifies a material gap three years and three months out, it will trigger obligations for retailers to enter into sufficient qualifying contracts to cover their share of a one-in-two year peak demand.[27]

On 14 November 2024, the AEMC made a rule change that exempts connection points for batteries, pumped hydro energy storage and other forms of storage assets from application of the RRO. The exemption took effect on 3 December 2024.[28]

While the Panel does not have a role in considering the appropriateness of the IRM as it does for the reliability standard, its RASR reporting considers actual and forecast reliability outcomes in the NEM against the IRM in addition to the reliability standard.

3.2 Market prices provide signals to support new investment in the NEM

The existing reliability framework in the NEM aims to deliver efficient reliability outcomes through market mechanisms to the extent possible. These mechanisms provide strong financial incentives for participants (generators, retailers, aggregators and customers) to make investment, retirement and operational decisions that support reliability.

The NEM is a wholesale electricity market where all electricity supplied and consumed is settled in 5-minute intervals, with the price in each interval determined by the marginal power system resource dispatched to meet demand.

Wholesale markets that are settled in the market in real-time, such as the NEM, provide for periods of high market prices that reflect the scarcity of supply. This is known as scarcity pricing and is the primary mechanism via which investment supporting reliability outcomes is supported in the NEM. Scarcity pricing is complemented by financial contract markets which allow market participants to manage financial risk supporting their investment and operating decisions. The market price settings (market price cap, cumulative price threshold, market floor price, and administered price cap) define the limits to scarcity pricing in the NEM and are introduced below.

In its RASR reporting, the Panel monitors wholesale market price trends including market price cap and market price floor events, diurnal wholesale electricity price profile evolution and wholesale price distribution. Monitoring wholesale market price outcomes allows the Panel to consider the investment environment and trends relevant to commercial incentives for investment and retirement affecting future reliability outcomes.

The market price settings

The limits of scarcity pricing in the NEM are defined by the market price settings. The market price settings are designed to be high enough to incentivise the investment in new generation needed to meet the reliability standard, but not so high that they pose systemic financial risks or compromise market stability.

The level of the market price settings are therefore critical parameters in the delivery of reliability under current NER frameworks.[29]

- The market price cap (MPC)[30] places an upper limit on wholesale market prices that can be reached in any trading interval. It serves as a limit on generator bids, preventing them from offering more than a set amount for energy in any dispatch interval. The MPC is updated on 1

27 AER, *Retailer Reliability Obligation*, 2019.

28 AEMC, *Retailer Reliability Obligation Exemption for Scheduled Bi-directional Units*, 14 November 2024.

29 Reliability Panel, *2022 Reliability Standard and Settings Review*, 1 September 2022.

30 The calculation of the market price cap is defined in Clause 3.9.4 of the NER.

July each financial year, indexed relative to inflation, in addition to any increases scheduled in the most recent RSS review. Over the 2024-2025 financial year, the value of the MPC was set at $17,500/MWh.

- The cumulative price threshold (CPT) has two purposes that are closely related to the MPC.[31] The CPT aims to cap the total price risk to which market participants are exposed over a given time period, and maintain the effectiveness of the MPC, by not hindering the market price signals for efficient operational decisions and efficient investment in generation capacity and/or demand-side response. An administered price period (APP) is triggered should the rolling sum of market prices exceed the CPT in a region. The CPT is updated on 1 July each financial year, indexed relative to inflation, in addition to any increases scheduled in the most recent RSS review.[32] For the period from 1 July 2024 to 30 June 2025 the CPT was $1,573,700.[33]
- The administered price cap (APC)[34] is the maximum market price paid to participants, measured as a $/MWh value, that can be reached in any dispatch interval and any trading interval during an APP and the prevailing dispatch price that applies during a period when prices exceed the CPT. The APC, combined with the CPT, is a mechanism to minimise financial instability risks to the market arising from an extended period of supply scarcity and corresponding high prices. It is, however, intended to be at a level sufficiently high to incentivise generation to make itself available during an APP. The administered price cap is currently set at $600/MWh.[35] On 27 June 2024, the Panel completed a review of the reliability standard and the APC, recommending maintaining the reliability standard and the APC in their current form.[36]
- The market floor price (MFP) sets a lower limit on wholesale market prices that can be reached in any trading interval measured in $/MWh. The purpose of the MFP is to allow the market to clear during low demand periods, while preventing market instability by imposing a negative limit on the total potential volatility of market prices. The level of the MFP is specified in the NER and is currently set at -$1,000/MWh.[37]

The Panel assesses the level of each market price setting every four years in its RSS review, making recommendations to the AEMC to be progressed through a rule change if it considers these should be changed.[38]

3.3 Contract markets in the NEM support investment by allowing market participants to manage risk

Scarcity pricing in the NEM allows for volatile spot price outcomes which may vary between the market floor price (-$1,000/MWh) and market price cap ($17,500 /MWh in FY24-25) on a 5-minute basis. This potential volatility creates a significant level of financial risk. Wholesale market

31 The calculation of the cumulative price threshold is defined in Clause 3.14.1 of the NER. Between 1 July 2025 and 1 July 2027, the threshold value, rounded to the nearest $100, will progressively increase from $1,674,000/MWh (equivalent to 7.5 hours at the unrounded MPC or 90 trading intervals) to $2,325,600/MWh (equivalent to 8.5 hours at the unrounded MPC or 102 trading intervals). See AEMC, *Amendment of the Market Price Cap, Cumulative Price Threshold and Administered Price Cap*, 7 December 2023.

32 AEMC, *Schedule of Reliability Settings*, 27 February 2025.

33 The base CPT was multiplied by six on 1 October 2021 with the commencement of the five-minute settlement.

34 Clause 3.14.1 of the NER.

35 AEMC, *Amending the Administered Price Cap*, 17 November 2022.

36 Reliability Panel, *Review of the Form of the Reliability Standard and APC*, 27 June 2024.

37 Clause 3.9.6 of the NER.

38 Clause 3.9.3A of the NER. The most recent review took place between June 2025 and April 2026, see: AEMC, *2026 Reliability Standard and Settings Review*, April 2026.

participants typically enter into various wholesale hedging contracts to manage these financial risks and increase certainty over their wholesale energy costs.

Both buyers and sellers in the wholesale market are exposed to variations in the spot price in the wholesale market but in the opposite direction. Buyers and sellers in the market are therefore natural counterparties who have the incentive to agree to contracts that convert volatile spot revenues and costs to a more certain cash flow. The stable cash flows provided by financial contracts also help to finance new investments in both generation and retail assets.

While the primary role of entering into these contracts is to manage risk and cash flows, contracts can also be considered as another means of expressing the expected price of the same underlying product, meaning that contract prices provide information about market participants' expectations for future spot prices. The price of hedging contracts reflects the balance of expectations as to the level and volatility of future wholesale spot price outcomes and therefore supports reliability by informing forward-looking investment and operational decisions.

Contracts in the NEM are traded either on the ASX, FEX or bilaterally. Swaps and caps are two examples of commonly traded contracts.

Properties of a swap contract:

- A given volume of energy is traded during a fixed period for a fixed price (normally 1 MW for a quarter at the strike price).
- The variable wholesale market spot price is, in effect, swapped for the fixed strike price.
- The contract is settled through payment between the contract parties based on the difference between the spot price and the strike price.

Properties of a cap contract:

- A fixed volume of energy is traded during a fixed period for a fixed price but only when the spot price exceeds a specified price.
- It provides electricity purchasers with insurance against high prices.
- The standard cap contract traded in the market is a "$300 cap". This means the seller of a cap is required to pay to the buyer the difference between the spot price and $300/MWh every time the spot price exceeds $300/MWh during the specified contract period.

Changes to contract market operation, including strengthening contract market liquidity to support the energy transition by establishing a permanent market making obligation framework for key derivatives contracts, were recommended as part of the National Electricity Market Wholesale Market Settings review.[39] The Energy and Climate Change Ministerial Council (ECMC) has agreed to these recommendations in principle. [40]

3.4 AEMO operationalises the reliability standard and provides information to the market on reliability outcomes

Maintaining reliability through a market is also supported by the provision of information (forecasts and notices) to inform market participants of the need for future investment. AEMO operationalises the reliability standard to provide information to the market about reliability outcomes over investment and operating time scales.

39 DCCEEW, National Electricity Market Wholesale Market Settings Review, Final Reprot, December 2025.

40 Energy and Climate Change Ministerial Council Meeting, Meeting Communique, 16 December 2025.

The Panel uses AEMO information provision in its RASR as a key indicator of current and emerging reliability challenges.

3.4.1 Electricity Statement of Opportunities

AEMO publishes the electricity statement of opportunities (ESOO) annually to inform market participants, new investors, and jurisdictional bodies of possible reliability gaps on investment timescales.[41] The ESOO includes projections of future USE (both in terms of the reliability standard and IRM) over a ten-year period. Within this timeframe, it provides a reliability forecast to identify any reliability gaps in the coming five years and an indicative projection of any reliability gaps in the second five years of the forecast.[42]

The Panel considers ESOO projections in the RASR when reporting on possible USE outcomes and supply-side challenges given expected generator retirements and the new investment pipeline.

3.4.2 Projected Assessment of System Adequacy and Energy Adequacy Assessment Projection

A market reserve level indicates the amount of potential available resources in the market to meet demand. For example, the supply that could be used to meet demand, but has not yet been dispatched. Reserves help cater for unplanned power system events, such as unplanned transmission outages, sudden loss of generation (for example by a fault, or a reduction in renewable energy resources) or a sudden increase in system load.

AEMO performs projected assessment of system adequacy (PASA) assessments on a short-term and medium-term basis to inform the market of the potential for insufficient reserve levels as real-time is approached. In addition, AEMO also projects energy adequacy through the energy adequacy assessment projection (EAAP) to inform the market of the reliability risks associated with energy limited plant, such as hydro during drought conditions.

In its RASR, the Panel considers market reserve level outcomes indicated by AEMO's PASA and energy limitations identified in the EAAP when considering near-term reliability risk.

Short-Term PASA

AEMO conducts its short-term PASA (ST PASA) process that includes forecasts of the level of reserves between real-time and seven days in the future.

ST PASA provides information to market participants on the expected level of short-term capacity reserve and hence the likelihood of interruptions due to a shortage of power. It can also provide a benchmark for AEMO to intervene in the market.

Information from ST PASA can encourage market participants and transmission network service providers (TNSPs) to respond by providing more capacity into the market or by shifting planned outages, respectively. For example, generators may offer more supply, or consumers may reduce their demand in response to reserve levels indicated in ST PASA. Both responses have the effect of improving market reserve margins, helping maintain power system reliability.

Medium-Term PASA

AEMO uses its medium-term PASA (MT PASA) reports to provide regular assessments of any projected shortage of market reserves that may result in a failure to meet the reliability standard over a 2-3 year timeframe. This enables market participants to make decisions about supply,

41 AEMO, *NEM Electricity Statement of Opportunities (ESOO)*, 2025.

42 As required under clause 3.13.3A of the NER, the ESOO also includes projections of aggregate demand and energy requirements for each region, generating capabilities of existing and committed units, planned plant retirements, and committed network development.

demand, and the timing of planned outages of transmission network and generation assets for periods up to three years in advance.

Through the MT PASA process, AEMO collects information on the capacity that each dispatchable unit can make available given 24 hours of notice. Participants submit their expected plant availability for the next 36 months and are required to update their PASA submission on an ongoing basis to ensure it matches their current intentions and best estimates.

Energy Adequacy Assessment Projection (EAAP)

The EAAP report provides information on the impact of potential energy constraints, such as water storage during drought conditions or constraints on fuel supply for thermal generation, on supply adequacy in the NEM over a two-year period.

Under the EAAP's data collation process, all scheduled generators in the NEM are required to submit information to AEMO regarding the effect of energy supply limitations on their production outputs. This data provides a broad assessment of impacts of energy limited plan on supply and reliability in the NEM.[43]

3.4.3 AEMO demand and intermittent generation forecasting

AEMO's information and market processes are informed by forecasts of demand and intermittent generation outcomes.[44]

Due to the variable nature of intermittent generation and demand, there is potential for material variations in the availability of these resources which may have implications for operational power system reliability outcomes. At times of peak demand, even small variations within a tight time-frame can create reliability issues, especially if firming capacity is not available to replace this generation.

Forecasting accuracy is therefore a key factor in NEM reliability outcomes. Forecasting systems and forecasting improvements, along with the appropriate market structures and operational tools, are increasingly important tools to promote efficient NEM dispatch, pricing, system reliability and security, as renewable generation continues to make up a larger share of the generation mix.

The Panel considers the accuracy of AEMO's forecasting in its RASR to assess how well the market is managing the growing uncertainty associated with demand and intermittent generation.

Demand forecasting

Accurate demand forecasting is crucial to a reliable power system to ensure there is sufficient capacity to meet customer demand for energy. AEMO is responsible for producing electricity demand forecasts for the NEM. AEMO's Forecasting Data Portal has been in operation since 2015 and includes operational consumption, maximum demand and minimum demand forecasts.[45]

Demand is defined in three key ways:[46]

- **Demand** – describes electricity consumed by end users at a particular time (MW).
- **Consumption** – refers to electricity consumed over a period of time (MWh).
- **Operational Demand –** operational demand (MW) refers to the electricity used by residential, commercial and large industrial consumers, as supplied by scheduled, semi-scheduled and

43 AEMO, Energy Adequacy Assessment Projection (EAAP), 2025.

44 Intermittent generation refers to generation from a generating unit whose output is not readily predictable, including, without limitation, solar generators, wave turbine generators, wind turbine generators and hydro-generators without any material storage capability.

45 AEMO, *Electricity and Gas Forecasting*, 2026.

46 AEMO, *Operational Consumption Definition*.

significant non-scheduled generating units. The demand satisfied by behind-the-meter generation such as residential solar PV is subtracted to calculate operational demand.

AEMO's demand forecasting accounts for uncertainty through 90%, 50% and 10% probability of exceedance (POE) demand forecasts and are published for the next 24 months. AEMO also forecasts minimum demand given its increasing significance for system security.

Intermittent generation forecasting

AEMO prepares forecasts of the available capacity of semi-scheduled generators to schedule sufficient generation in the dispatch process.[47] AEMO also prepares an unconstrained intermittent generation forecast (UIGF) to be used in PASA processes for reserve assessment purposes.

Three forecasting systems are used for this purpose:

- **Australian solar energy forecasting system (ASEFS)** – produces forecasts for any solar farm greater than or equal to 30 MW registered capacity and any solar farms that AEMO is required to model in network constraints for power system security reasons.[48]
- **ASEFS2 –** produces forecasts for aggregated regional solar generation forecasts for small-scale PV systems (less than 100 kW system capacity).[49]
- **Australian wind energy forecasting system (AWEFS) –** produces wind generation forecasts for all semi-scheduled and non-scheduled wind generators in the NEM.[50]

In addition to the centralised forecasts provided by ASEFS, ASEFS2, and AWEFS, market participants can optionally provide dispatch self-forecasts of the unconstrained intermittent generation from their semi-scheduled generating units for use in dispatch. These forecasts are only subject to technical factors and do not reflect the participant's market intentions. AEMO anticipates that the use of self-forecasting will deliver system-wide benefits by reducing generation forecast error and providing greater autonomy to existing semi-scheduled generators.[51]

3.4.4 Lack of reserve notice

AEMO provides advanced warning to the market of reliability issues on operational timescales by forecasting and then declaring actual lack of reserve (LOR) conditions. LOR notices are published to elicit a market response to address a possible reliability issue prior to AEMO intervening in the market to maintain reliability.

The Panel monitors the number and type of LOR events declared by AEMO in each region in its RASR. This assessment allows the Panel to identify actual and emerging reliability threats.

AEMO declares LOR conditions when it determines there is a non-remote probability of load shedding due to a shortfall of available capacity reserves over a seven-day period (corresponding

47 Semi-scheduled generators are intermittent renewable generators such as grid-scale wind and solar farms.

48 AEMO uses the following inputs to produce solar generation forecasts for large-scale solar power stations: Real-time supervisory control and data acquisition (SCADA) measurements from the solar power station; Numerical weather prediction data from multiple weather data providers; Standing data from the solar power station as defined in the ASEFS energy conversion model; Additional information provided by the solar power station, including inverters under maintenance and the upper limit MW on the solar farm; Solar radiation imagery from the Himawari-9 satellite.

49 ASEFS2 uses the following inputs to produce aggregated regional solar generation forecasts for small-scale PV systems: Numerical weather prediction data from multiple weather data providers; Output measurements and static data from selected household rooftop PV systems from PvOutput.org and Solar Analytics; Aggregate kilowatt capacity by installed postcode for small-scale solar systems as recorded by the Clean Energy Regulator (CER); Imagery from the Himawari-8 satellite.

50 AWEFS produces forecasts from the following inputs: Real-time SCADA measurements from the wind farms; Numerical weather predictions from weather forecasters from around the world; Standing data from the wind farms; Availability information provided by the wind farms, including turbines under maintenance and the upper MW limit of the wind farm.

51 AEMO, *Participant Forecasting*, 2026.

to the ST PASA time horizon).[52] There are three levels of LOR notices that AEMO can issue depending on market conditions. These are:

- **Lack of reserves 1 (LOR 1)** – actual and forecast LOR 1 conditions will be declared for a region(s):
  - (actual LOR1) when the consecutive occurrence of both the largest and the second largest relevant credible contingency events would result in load shedding occurring as a result of a shortfall of available capacity reserves, or
  - (forecast LOR1) for a period when available capacity reserves in the ST PASA or pre-dispatch schedule are forecast to be less than the largest and the second-largest credible risk; or less than the forecast uncertainty measure (FUM)[43] for the relevant period and region.
- **Lack of reserves 2 (LOR 2)** – actual and forecast LOR 2 will be declared for a region(s):
  - (actual LOR2) when the occurrence of the largest relevant credible contingency event would result in load shedding as a result of a shortfall of available capacity reserves, or
  - (forecast LOR2) for a period when the forecast of available capacity reserves in the ST-PASA or pre-dispatch schedule is less than the largest relevant credible risk; or less than the FUM[53] for the relevant period and region.
- **Lack of reserves 3 (LOR 3)** – actual and forecast LOR 3 will be declared for a region(s):
  - (actual LOR3) when load shedding is occurring as a result of a shortfall of available capacity reserves,. or
  - (forecast LOR3) for a period when the forecast of available capacity reserves in the short-term PASA or pre-dispatch schedule is at or below zero.

3.5 AEMO can intervene should the market deliver insufficient levels of reliability

AEMO can intervene in the market to help maintain power system reliability should the market not sufficiently respond to LOR notices and other information provided by AEMO.[54] AEMO intervention is an acknowledged and important feature of the NEM's market design, however, the use of such mechanisms requires careful consideration as to the flow-on effects for investment and operational signals, as well as costs to consumers. As such, interventions are used as a last resort[55]

Three of the primary AEMO intervention mechanisms for reliability are:

- RERT
- reliability directions
- instructions for load shedding.

The Panel considers the number, frequency and type of AEMO interventions in the market to maintain reliable supply. The causes and costs of AEMO interventions are important signposts for current and emerging reliability challenges.

52 AEMO, *Reserve Level Declaration Guidelines*, 2 May 2024.

53 The FUM introduces a probabilistic element into the determination of LOR levels alongside the traditional deterministic approach which allows for the impact of estimated reserve forecasting uncertainty in the prevailing conditions when calculating the LOR levels. These estimates are made on the basis of modelling past reserve forecasting performance for demand, output of intermittent generation and availability of scheduled generation.

54 Clause 4.8.9 of the NER.

55 The *Power System Security Guidelines* describes the full list of actions available to AEMO to proportionately respond to threats to system security.

3.5.1 Reliability and emergency reserve trader

RERT is an intervention mechanism that allows AEMO to contract for additional emergency reserves for use when supply shortfall is forecast. These emergency reserves include generation or demand response that are not otherwise available in the market. RERT resources are contracted in addition to the reserve buffer that is already made available by the market (and assessed via PASA processes) as part of the market's usual operation.

These emergency reserves are used as a safety net to avoid or reduce the need for involuntary load shedding when the market has not provided sufficient reserves.[56] RERT is activated when there is insufficient market reserve to keep the power system in a reliable operating state, or, where practicable, to maintain power system security.[57]

The RERT guidelines specify three types of RERT based on how much time AEMO has to procure the RERT prior to the projected reserve shortfall occurring:[58]

- **Long-notice RERT** – At least ten weeks' notice of a projected reserve shortfall.
- **Medium-notice RERT** – Between one and ten weeks' notice of a projected reserve shortfall.
- **Short-notice RERT** – Between three hours and seven days' notice of a projected reserve shortfall.

Under the NER, AEMO may enter reserve contracts to ensure the reliability of supply.[59] Historically, AEMO has set up a RERT panel of providers for both the medium-notice and short-notice RERT and only triggers the procurement contract when it has identified a potential shortfall and after seeking offers from RERT panel members. However, from 2020-21 onward AEMO will only set up a panel of providers for short-notice RERT. There is no panel for the long-notice RERT; rather, contracts are signed following the close of a public tender process. Under the long-notice RERT framework, AEMO may enter into a multi-year reserve contract for a region for up to 3 years.[60]

There are several safeguards in place when entering into multi-year reserve contracts, including the precondition that any multi-year contracts must be at a lower-cost than the aggregate payments AEMO would have made under reserve contracts for the same period.[61]

Up until 31 March 2025, AEMO was also able to procure interim reliability reserves if a breach of the IRM was forecast to occur (ref. clause 11.128).

3.5.2 Reliability directions

AEMO may issue directions to registered participants, such as scheduled generators, where it is necessary to do so to maintain or return the power system to a reliable operating state.[62] AEMO can issue directions to generators to vary their output or a scheduled load to vary its consumption for reliability purposes. Reliability directions can be used alongside and in addition to the dispatch of any RERT reserves that may be available in an affected region.

Reliability directions are only used under supply shortage conditions when generation may be technically available to generate but is otherwise not participating in the market. These circumstances have traditionally been uncommon in the NEM as LOR 2 and 3 conditions have

56 AEMO, *Reliability and Emergency Reserve Trader (RERT)*, 2026.
57 Clause 3.20.2(a) of the NER.
58 Reliability Panel, *Reliability and Emergency Reserve Trader Guidelines*, 21 August 2020.
59 Clause 3.20.2(a) of the NER.
60 Clause 11.128.4(f).
61 Clause 11.128.4(g)
62 Clause 4.8.9(a)(1) of the NER.

generally occured at times when market prices are very high and provide a strong signal for generation to make itself available for dispatch - though this pattern is becoming uncertain. There has been occasions where AEMO has directed for reliability, most notably during the administered price period and market suspension that occurred in June 2022.[63]

3.5.3 Load shedding instructions

An instruction differs from a direction in the types of market participants that AEMO can require to act and the nature of the action taken. Instructions often involve AEMO requiring a NSP or large energy user to shed load.[64]

Controlled load shedding or involuntary disconnection of customer supply for reliability purposes is implemented when there is a shortage of electricity supply to meet customer demand while also keeping the power system in a secure state (an actual LOR3).

Load shedding for reliability purposes is manually initiated as a last-resort response to bring supply and demand securely into balance. Under manual load shedding, a limited number of customers experience load shedding for a short period (generally on a rotational basis). Load shedding is the deliberate shutdown of power to parts of the electricity network to reduce the volume of electricity usage to maintain system stability and the supply-demand balance. Each state and territory has a plan for how load shedding will be carried out.

3.6 The Reliability Panel monitors network performance

The Panel considers the performance of networks by monitoring outage minutes, upgrades and other performance outcomes in the RASR. In assessing reliability performance in the NEM, the Panel may consider the performance of:

- interconnectors
- transmission networks
- distribution networks.

The Panel analyses the performance of the interconnectors between the different regions of the NEM. These interconnectors allow sharing of generation and reserves between regions. As the geographical and technological diversity of the VRE generators and batteries in the NEM continue to develop, the role and value of interconnectors in providing reliability in each region will continue to increase. This trend is also being accompanied by a number of new interconnectors being built, or being considered.[65]

The scope of reliability-related USE in the NEM is limited to inter-regional transmission outages. Unplanned intra-regional transmission and distribution network outages result in lost load that is not counted towards USE for the purposes of the reliability standard.

The performance of distribution networks, and the reliability standards that must be met, fall within the responsibility of each jurisdiction. As such, reliability is governed by jurisdictional level frameworks. All jurisdictions have their own monitoring and reporting frameworks for the reliability of distribution network service providers (DNSPs).

While the performance of intra-regional transmission and distribution networks are outside the scope of the Panel's responsibilities with respect to reliability, the Panel may elect to consider

63 AEMO, *NEM Market Suspension and Operational Challenges in June 2022*, 2022.

64 Clause 4.8.9 of the NER.

65 AEMO, *Interconnector Capabilities, September 2025*, 2025.

indicators of distribution network reliability. Two important indicators of distribution network reliability are:

- system average interruption duration index (SAIDI)
- system average interruption frequency index (SAIFI).

SAIDI is a measure of the average duration of time customers are without electricity, measured annually. It is calculated by dividing the total duration of all sustained customer interruptions by the total number of customers served. The index excludes exceptional events beyond the distribution network's control.

Network reliability standards are often measured in terms of SAIDI. It is calculated for different parts of each DNSP's network, for example, the reliability on long rural lines is calculated differently to the reliability on CBD networks. The reliability targets for these different parts of the network are also different.

SAIFI measures the average number of outages for each customer served by the DNSP.

3.7 Panel metrics for RASR monitoring of reliability outcomes in the NEM

This section presents the metrics the Panel considers in its reliability monitoring. The Panel considers metrics that cover:

- trends in generation, demand, investment, and market price outcomes that provide insight into the factors and incentives influencing generation investment and retirement decisions
- operational reliability metrics which indicate the sufficiency of power system resources over the review periods.

The metrics in each of these areas are summarised in the following tables.

Table 3.1: Metrics for monitoring market trends that influence reliability outcomes in the NEM

Trends or outcome	Description	Metrics-monitored
Supply-side trends	These trends indicate how the power system is evolving, particularly in relation to the growth of variable renewable electricity and the withdrawal of thermal generation. Movements on the supply side of the power system have important implications for reliability and security and how this may be impacted in future years.	Generator entry and exits and installed capacity (NEM installed capacity by technology over the previous 10 years)
		The change in generation output (NEM capacity by technology)
		Investment environment (installed capacity in MWs in the investment time frame)
		Availability of solar and wind (quarterly volume weighted wind available capacity factors)
Demand-side trends	Demand-side trends have implications on power system security and reliability, including how much Distributed Energy Resources (DER) are influencing system load	Maximum and minimum system load (in MWs by state)
		Diurnal system load profile evolution (in MWs by state and by season)

Trends or outcome	Description	Metrics-monitored
	trends in the NEM. These trends highlight intra-day system load variability (the difference between daily minimum and maximum system load) and whether this is increasing or decreasing, as well as the impact on both maximum and minimum system load.	
Market price outcomes	Spot and contract market price outcomes provide an indication of the investment environment and financial incentives available to new generation to enter to support reliability.	Market price cap and market price floor events
		Wholesale price distributions

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Table 3.2: Operational reliability metrics

Measure of reliability	Description	Metrics monitored
Actual levels of USE	Whether the reliability standard was met and the amount of customer demand that was not supplied within a region due to a shortage of generation or interconnector capacity, and the forecasts for unserved energy in the future.	Actual levels of USE (MWh) and performance against reliability standard
Actual reliability events	Details of the occasions, if any, where customers experienced supply interruptions specifically because demand was higher than the available supply. This includes the frequency, depth, duration and location of actual reliability events.	Characteristics of USE events (MW, duration, frequency, location)
AEMO market interventions	Whether AEMO intervened in the market to maintain reliable supply using the three key intervention mechanisms related to reliability: the RERT, directions and instructions, and controllable load shedding.	RERT dispatch events and procurement costs
		Directions for reliability
		Instructions for load shedding
Forecast accuracy	How accurate forecasts have been. Forecasts help inform operational and investment decisions to deliver reliability.	Demand forecast accuracy
		Intermittent generation accuracy

Measure of reliability	Description	Metrics monitored
Network performance	Outage minutes, upgrades, and other performance outcomes from interconnectors, transmission networks and distribution networks. As in previous reports of the RASR, these indicators have been examined to assess the overall reliability of the NEM.	SAIDI
		SAIFI
		Transmission interruption minutes

4 How is system security delivered in the National Electricity Market?

Power system security involves keeping the power system stable across a range of system conditions including during and following common and uncommon disturbance events.[66]

AEMO has primary responsibility for system security in the NEM and operates the power system within a technical envelope of constraints that are defined for this purpose.[67] AEMO also procures system security services, and may issue directions to participants to maintain or re-establish the power system to a secure operating state following a disturbance.[68]

The Panel plays an important role in determining standards that are required to deliver a secure, reliable, and safe power system in the most efficient way in order to minimise costs for consumers. This chapter introduces the key frameworks for delivering system security in the NEM along with the metrics the Panel uses to monitor system security outcomes in its RASR. In particular:

- system security events and maintaining power system security
- technical performance requirements
- system security services
- AEMO security intervention and minimum load framework.

4.1 Understanding system security events

System security relates to maintaining a stable power system, with key technical parameters within appropriate limits following a disturbance. Power system disturbances for the purposes of AEMO's maintenance of system security are referred to as contingency events. System security frameworks manage the impact of contingency events depending on AEMO's assessment of their probability of occurrence.

4.1.1 Credible and non-credible contingency events

Contingency events are disturbances that pose a risk to, and uncertainty in, the stable and secure operation of the power system. Contingency events have historically been defined as events affecting the power system which AEMO expects would likely involve the failure or removal from operational service of one or more generating units and/or transmission elements.[69]

In addition to the failure or removal from service of generation or transmission elements, the types of power system disturbances which qualify as contingency events was expanded in the AEMC's 'enhancing operational resilience to indistinct events rule' to include:

- the failure or removal from operational service of plant
- a sudden and unplanned change to the level of output consumption or power flow of plant.

The revised definition of contingency event applied from 9 March 2023 and expanded the contingency framework to capture events that can impact multiple generators or transmission

66 The NER defines power system security as the safe scheduling, operation and control of the power system on a continuous basis in accordance with the power system security principles. See clause 4.2.6 of the NER.

67 Clauses 4.2.6(a), 4.2.4(a), 4.2.4(b)(2), 4.2.5(c)(2) of the NER.

68 Clause 4.2.6(b) of the NER.

69 Clause 4.2.3(a) of the NER.

lines in an unpredictable and uncertain manner, such as major storms, widespread fires, and cyber attacks.[70]

The NER divides the set of all possible contingencies, involving the failure or removal from service or sudden unplanned change to output or power flow of plant into two categories depending on their probability of occurrence:[71]

- **Credible contingency events** – a reasonably possible event in the prevailing conditions that AEMO expects would likely involve the failure or removal from operational service of plant or sudden unplanned change due to the level of power flow from a plant.
- **Non-credible contingency events** – those that AEMO considers are not reasonably possible, given prevailing conditions. These are termed non-credible contingencies and are generally considered to be events that are rare in occurrence, such as the combination of several credible contingency events occurring at the same time.

Non-credible contingencies occur, but the probability of their occurrence is sufficiently low to make them not reasonably possible. Power system security frameworks typically require the implementation of emergency frequency control schemes, as a last line of defence preventing a black system or major supply disruption due to the occurrence of a non-credible contingency.

Protected events are a special class of non-credible contingencies. The Panel can declare a non-credible contingency event to be a protected event where AEMO identifies it can be managed cost-effectively. If the Panel declares a protected event, AEMO can take additional steps to proactively manage the risk.[72]

The Panel considers the number and type of non-credible contingency events in the RASR to provide insight into any changes in the NEM's system security risk profile.

4.1.2 The technical envelope and secure power system

The current system security arrangements in the NER impose an obligation on AEMO to operate the power system, to the extent practicable, to prevent the loss of any load following the occurrence of a credible contingency event. This obligation is referred to as being in a secure operating state.[73]

A secure power system has the following characteristics:

- It can maintain a satisfactory operating state following the occurrence of a credible contingency event.[74]
- A satisfactory operating state is achieved when power system frequency, voltage, current, and plant operation all remain within appropriate limits as specified by the power system security standards.[75]

To maintain the power system in a secure state, AEMO defines a "technical envelope" within which generation is dispatched and the market and power system operated.[76] The technical envelope represents the operating limits applied to each element of the power system. The technical envelope is implemented through constraints applied to the operation of the power system. These

70 AEMC, *Enhancing Operational Resilience in Relation to Indistinct Events*, Rule determination, 3 March 2022.

71 Clauses 4.2.3(b) and (e) of the NER.

72 Clause 4.2.4(b) of the NER, with clause 4.2.2(a) requiring a satisfactory operating state to exclude under-frequency load shedding.

73 Clause 8.8.4 of the NER.

74 Clause 4.3.1(k) of the NER.

75 Clause 4.2.2 of the NER.

76 Clause 4.2.5 of the NER.

constraints include limits to generator dispatch and reflect thermal, voltage, and transient stability limits in the power system such that it remains stable and without load shedding following a credible contingency.[77]

Constraints prevent the NEM Dispatch Engine (NEMDE) from producing a dispatch outcome that leads to load shedding following a credible contingency. This way, NEMDE minimises total dispatch cost but always subject to the requirement that the power system is in a secure state.

AEMO derives network constraints from NSP's providing advice about the technical limits of the system. Constraint equations are changed or added to for several reasons including:

- new advice from the NSP
- an item of plant (such as a generator) was commissioned or decommissioned
- adjustments were made to improve the performance of the constraint equation
- power system studies identified a new condition that needs to be managed by a constraint equation
- a new FCAS requirement being identified.

The Panel considers the number of occasions and length of time in which the power system is not in a secure state in its RASR reporting, as well as changes to constraint equations.

4.1.3 Reclassification

As noted above, a credible contingency is "reasonably possible" given the prevailing circumstances and AEMO is required to maintain the power system in a secure state for all credible contingencies.[78]

Events which are not reasonably possible, and therefore non-credible, under normal conditions may under abnormal conditions become reasonably possible, and therefore credible.[79] The NER defines abnormal conditions as conditions posing added risks to the power system including, without limitation, severe weather conditions, lightning, storms, and bushfires.[80] AEMO is required to develop and publish criteria for deciding whether any non-credible contingency has become 'reasonably possible' in such conditions.[81]

AEMO is required to re-classify the normally non-credible contingency as credible under such conditions and notify the market.[82] The decision to reclassify allows AEMO to take ex-ante action to maintain the system in a secure state for the event, including by:

- adjusting the technical envelope (such as by limiting inter-connector flows)
- procuring appropriate levels of ancillary services to maintain voltage and frequency within appropriate bands following the occurrence of the event.

The Panel considers the number and causes of reclassification events in its RASR reporting to understand the extent to which abnormal conditions are leading to an increase in power system security risk.

77 AEMO, *Reliability, Security and Safety Frameworks in the NEM*, 2023.

78 Clause 4.2.3(b) of the NER.

79 Clause 4.2.3A(e) of the NER. Assessment of what is and is not reasonably possible given the presence of an abnormal decision for AEMO to make having regard to all relevant facts and circumstances.

80 Clause 4.2.3A(a) of the NER.

81 Clause 4.2.3B of the NER.

82 Clause 4.2.3A of the NER.

4.1.4 Reviewable operating incident reporting

AEMO has the responsibility to investigate and review all major power system operational incidents and publish detailed incident reports. This allows AEMO to assess the adequacy of the provision and response of facilities or services, and the appropriateness of actions taken to restore or maintain power system security.[83] A reviewable operating incident is an incident identified, in accordance with guidelines set by the Panel under the NER,[84] to be of significance in the operation of the power system or a significant deviation from normal operating conditions.[85]

AEMO is currently required to report on the following categories of incidents as reviewable operating incidents, including:

- a non-credible contingency event or multiple contingency events on the transmission system
- a black system condition
- an event where the frequency of the power system is outside limits specified in the power system security standards
- an event where the power system is not in a secure operating state for more than 30 minutes
- an event where AEMO issues a clause 4.8.9 instruction for load shedding
- an event where AEMO's oscillatory and transient stability monitoring systems detect potential generator instability for more than 30 minutes
- incidents that result in the operation of under-frequency or over-frequency protection and control schemes
- incidents where the power system is not in a satisfactory state for more than five minutes. AEMO may also report on other significant events or systemic issues at its discretion or be requested to review particular events by the Panel.

AEMO's reviewable operating incident reports are a source of information on key power system events that are made publicly available to all market participants. They provide a structured process for capturing learning from major power system events to inform the evolution of NER risk management frameworks.[86]

The RASR reports the number and type of reviewable operating incidents and gives detailed consideration on incidents of a particularly material nature.

4.2 Technical performance requirements underpin system security

A set of standards define technical performance requirements for the NEM. Currently, the Panel is responsible for determining two of these standards: the frequency operating standard (FOS) and the system restart standard (SRS).[87]

The NER also defines a set of system standards for system stability, voltage, protection system operations and fault levels. These standards are contained in Schedule 5.1a of the NER. NSPs maintain and operate their networks in accordance with system standards and the requirements of the NER more generally.[88]

83 Clause 4.8.15(b) of the NER.

84 Reliability Panel, *2022 Reviewable operating incident guideline review*, *final report*, 29 September 2022.

85 Clause 4.8.15(a) of the NER.

86 All incidents can be found on the AEMO website at Power System Operating Incident Reports

87 NER clause 8.8.1(a)(1a) and NER clause 8.8.1(a)(2).

88 Clause S5.1.8 of the NER requires NSPs to plan for non-credible contingencies that pose a risk to the stability of the power system, and develop emergency control schemes to manage these risks.

This section introduces performance requirements that are key to the Panel's RASR monitoring of technical performance outcomes in the NEM.

4.2.1 Frequency performance and the frequency operating standard

Controlling or maintaining frequency is a key element of power system security. All generation, transmission, distribution, and load components connected to the power system are standardised to operate at a normal system frequency of 50 Hz. The power system must therefore stay at or close to this level for equipment to stay connected to the system and continue to operate within technical bounds. Uncontrolled changes in frequency can cause cascading failures leading to major supply disruptions or black system events. To protect against this, it is important that there are sufficient measures in place to provide frequency control.

To maintain a stable system frequency at or close to 50 Hz, AEMO must always balance the supply of electricity with demand. When there is more generation than load, the frequency will increase. When there is more load than generation, the frequency will fall. AEMO relies on a number of processes and factors to ensure that frequency remains within the acceptable window, including:

- **The dispatch process** – balances forecast supply and demand on a five-minute basis.
- **FCAS regulation services** – balances supply and demand on a four-second basis, accounting for changes that occur within a dispatch interval.
- **FCAS contingency services** – response that is on standby to arrest the fall in frequency following a contingency event and return frequency to the normal operating band.
- **Local generator frequency responses** – generators vary their output within a defined envelope, to correct deviations in frequency in real-time, as measured by the generators.

Under the NER, AEMO must keep the power system stable and securely operating at a frequency in line with the NER's power system security requirements set out in the FOS.[89] Where frequency deviates from 50 Hz, the FOS defines the range of allowable frequencies for the power system under different conditions, including normal operation and following contingencies. It is reviewed and updated periodically by the Panel.

The Panel last reviewed the FOS and published a final determination in April 2023. The determination revised key elements of the FOS and the following changes came into effect on 9 October 2023:[90]

- introducing system limits for the rate of change of frequency (RoCoF) following contingency events
- changes to the settings that relate to the limits and thresholds for contingency events
- changes to the FOS that applies during system restoration following a major system disturbance
- confirming the allowable ranges for frequency during normal operation, the primary frequency control band (PFCB) and the target frequency as 50 Hz
- removing the limit for accumulated time error.

On 7 March 2024, the Commission made a rule change clarifying the mandatory primary frequency response (PFR)[91] obligations of scheduled bidirectional units (i.e. batteries with a

89 Clause 4.4.1 of the NER.

90 Reliability Panel, *Review of the Frequency Operating Standard*, 6 April 2023.

91 Primary frequency response is an automatic change in a generating system's active power output, to oppose or arrest frequency changes, measured at or behind the generating system's connection point.

capacity of 5MW or greater). Under the final rule, scheduled bidirectional units will be required to comply with the primary frequency response requirements (PFRR) when:

- they receive a dispatch instruction to generate a volume greater than zero MW
- they receive a dispatch instruction to charge (consume electricity) at a volume greater than zero MW (except when solely powering auxiliary loads)
- they receive a dispatch instruction to provide a regulation service.

Figure 4.1: NEM frequency bands

	NORMAL (HZ)		ISLAND (HZ)		SYSTEM RESTORATION (HZ)
	MAINLAND	TASMANIA	MAINLAND	TASMANIA	MAINLAND
primary frequency control band	49.985 – 50.015				
normal operating frequency band	49.85 – 50.15		49.5 – 50.5	49.0 – 51.0	49.5 – 50.5
normal operating frequency excursion band	49.75 – 50.25		49.5 – 50.5	49.0 – 51.0	49.5 – 50.5
operating frequency tolerance band	49.0 – 51.0	48.0 – 52.0	49.0 – 51.0	48.0 – 52.0	49.0 – 51.0
extreme frequency excursion tolerance limit	47.0 – 52.0	47.0 – 55.0	47.0 – 52.0	47.0 – 55.0	47.0 – 52.0

Source: Reliability Panel, Review of the Frequency operating standard, 6 April 2023

4.2.2 System Restart Standard

While the NEM and its regulatory frameworks are designed to avoid the occurrence of a black system, major supply disruptions or black system events are still possible. Should a major supply disruption or black system occur, specially procured resources are called on to supply energy to restart power stations, and assist the process of re-energising the power system and restoring customer supply. These resources are referred to as system restart ancillary services (SRAS).

The Panel is responsible for determining the system restart standard (SRS). The SRS specifies the parameters for restoring generation and transmission system operations after a major supply disruption, including a black system event, and acts as the targets AEMO must satisfy in its procurement of SRAS. SRS targets are defined for a set of electrical sub-networks declared by AEMO. There is at present a single electrical sub-network for each region of the NEM.[92]

The parameters included in the SRS are:

- the maximum time in which a specified level of generation capability (MW) must be restored in each sub-network
- the aggregate level of reliability of restart services in each sub-network, that is, the overall reliability of the SRAS procured for the sub-network rather than for any individual source of SRAS.

The SRS applicable to the reporting period was determined by the Panel in January 2021 following consultation with energy users, industry, jurisdictional system security coordinators and state and territory governments. It came into effect on 28 January 2021. Under the standard:

92 The SRS also defines sub-regional level requirements including the requirement for AEMO to procure SRAS sufficient to also independently restart, form and maintain at least one restoration island north of Sydney within two hours of a major supply disruption without drawing power from the power system, with an aggregate reliability of at least 75 per cent; and SRAS sufficient to also independently restart, form and maintain at least one restoration island north of Bundaberg within two hours of a major supply disruption without drawing power from the power system, with an aggregate reliability of at least 80 per cent.

- The level and time components are tailored for each electrical sub-network to reflect the speed at which the generation can be restored, the characteristics of the transmission network and the economic circumstances that apply to the sub-network.
- Costs of SRAS are minimised by specifying the minimum level of generation and transmission capacity to be restored by SRAS in each sub-network in accordance with a detailed economic assessment of procuring different levels of SRAS.
- The aggregate reliability of the SRAS procured for each electrical sub-network is included. This requirement better specifies the performance of the procured SRAS, and includes a requirement for AEMO to consider the reliability and damage to the transmission network following a major supply disruption when it calculates aggregate reliability.

The following table presents the time, level and aggregate reliability required for each NEM electrical sub-network.

Table 4.1: SRS requirements

1. Electrical sub-network[1]	2. Level of restoration (MW)	3. Restoration time (hours)	4. Required Aggregate Reliability
Queensland	1650	4	90%
New South Wales	1500	2.0	90%
Victoria	1100	3.0	90%
South Australia	330	2.5	90%
Tasmania	300	2.5	95%

Source: Reliability Panel, *SRS Review – System Restart Standard*, 28 January 2021

Note: [1]The electrical sub-network boundaries are defined in the AEMO 2020 SRAS Guideline.

Note: [2]The restoration time in column 3 is the maximum time allowed to restore supply(generation and transmission capability) to the level in column 2, subject to the aggregate reliability. This restoration time does not refer to the time required to restore supply to all customers in the affected electrical sub-network, which could be significantly longer.

The energy transition has introduced new challenges in maintaining system restart capability, which were considered as part of the Panel's periodic review of the *System Restart Standard*, completed on 11 December 2025.[93] As part of this review, AEMO highlighted a number of challenges affecting the provision of System Restart Ancillary Services (SRAS) and system restart planning, including:

- reduced availability and participation of restart-capable units, which affects their the ability to meet the Standard
- high penetration of distributed photovoltaic (PV) generation at consumer locations, which can impact the ability to stabilise restart islands
- increased complexity of the power system, necessitating greater resilience and flexibility in restart pathways.

The Panel also determined a revised Standard to address these challenges.

The revised standard provides AEMO with increased flexibility in planning for system restoration and supporting the procurement of restoration support services. Stakeholder feedback to the Panel's draft determination noted strong support for the revised targets. Restoration support services are expected to be required to enable the restoration of a renewable-dominated grid. It is expected that these services will be used in the future to help balance and stabilise large-scale

93 Reliability Panel, Review of the System Restart Standard, Final report, 11 December 2025.

renewable generation during system restoration and provide stable load during periods of high generation from distributed rooftop solar PV.

The restoration targets in the revised Standard are for AEMO to be able to:

- form one or more restoration islands in an electrical sub-network within 2 hours of the major supply disruption
- restore supply in each electrical sub-network to be able to meet 50% of forecast average annual underlying demand within 8 hours of the major supply disruption.

4.3 AEMO procures system security services

In addition to the constraints making up the technical envelope, AEMO also ensures that there are sufficient system security services procured in line with standards to maintain voltage, frequency and other system parameters in line with power system standard following a credible, or non-credible disturbance.

System security services in the NEM include:

- frequency control ancillary services (FCAS)
- network support and control ancillary services (NSCAS)
- system restart ancillary services (SRAS)

AEMO operates ten separate markets for the delivery of FCAS, and purchases NSCAS, and SRAS under agreements with service providers.

AEMO also publishes an annual report called the Transition Plan for System Security.[94] This report focuses on maintaining power system security as the NEM transitions towards lower emissions. It provides a structured approach for the energy sector to navigate key upcoming Transition Points – events that require material changes in the operational approach to managing power system security – over at least the next 10 years

The report is also where AEMO meets its reporting obligations of:

- the TPSS
- system strength reporting
- inertia reporting
- NSCAS gap declaration and reporting.

The Panel monitors AEMO's procurement of these services in the RASR, to provide an insight into system security issues and risk in the NEM.

4.3.1 FCAS markets and primary frequency control

FCAS services are used to raise system frequency if it has fallen (by increasing generation or reducing load) and to lower system frequency if it has risen (by decreasing generation or increasing load) outside acceptable bounds. The different FCAS types are intended to work together to maintain a steady frequency during normal operation, and to stabilise and restore the frequency by reacting quickly and smoothly to contingency events that cause frequency deviations.

FCAS markets are divided into two types:

94 AEMO, Transition Plan for System Security (TPSS).

- **Regulation** – Regulation frequency control can be described as the ongoing correction of the generation/demand balance in response to minor deviations in load or generation. Regulation FCAS is provided by generators on Automatic Generation Control (AGC). The AGC system allows AEMO to continually monitor the system frequency and to send control signals every four seconds to generators providing regulation services to increase or decrease generation in such a manner that the frequency is maintained within the normal operating band of 49.85Hz to 50.15Hz on an ongoing basis.
- **Contingency** – Contingency frequency control refers to the correction of a sudden generation/demand imbalance following a major contingency event such as the loss of a generating unit/major industrial load, or a large transmission element. Contingency FCAS corrects frequency following a contingency event such that the frequency deviation remains within the contingency band defined by the FOS and is returned to the normal operating band within five minutes. Contingency frequency control uses technologies that locally detects the frequency deviation and respond in a manner that corrects the frequency.[95]

During each and every trading interval of the market, NEMDE must enable a sufficient amount of each of the FCAS products, from the FCAS bids submitted, to meet the FCAS MW requirement required to achieve the FOS. The FCAS markets are co-optimised with the energy market and dispatched every five minutes for this purpose.

In FY2025, ten FCAS markets were in operation. This included two additional FCAS markets that commenced operation on October 9, 2023, at 1:00 pm. [96] These new markets include a very fast one-second raise and a very fast one-second lower service. Both were introduced to ensure stable frequency, provide incentives to foster faster responding technologies and deliver lower costs for consumers. The 10 markets for procuring FCAS products include:

- **Regulation Raise:** Regulation service used to correct a minor drop in frequency.
- **Regulation Lower:** Regulation service used to correct a minor rise in frequency.
- **Contingency Very Fast Raise (1 Second Raise):** 1 second response to arrest a major drop in frequency following a contingency event.
- **Contingency Very Fast Lower (1 Second Lower):** 1 second response to arrest a major rise in frequency following a contingency event.
- **Contingency Fast Raise (6 Second Raise):** 6 second response to arrest a major drop in frequency following a contingency event.
- **Contingency Fast Lower (6 Second Lower):** 6 second response to arrest a major rise in frequency following a contingency event.
- **Contingency Slow Raise (60 Second Raise):** 60 second response to stabilise frequency following a major drop in frequency.
- **Contingency Slow Lower (60 Second Lower):** 60 second response to stabilise frequency following a major rise in frequency.
- **Contingency Delayed Raise (5 Minute Raise):** 5 minute response to recover frequency to the normal operating band following a major drop in frequency.

95 Some examples of these technologies include: Generator Governor Response: where the generator governor reacts to the frequency deviation by opening or closing the turbine steam valve and altering the MW output of the set accordingly. Contracted load shedding: where a load can be quickly disconnected from the electrical system (can act to correct a low frequency only). Rapid Generation: where a frequency relay will detect a low frequency and correspondingly start a fast generator (can act to correct a low frequency only). Rapid Unit Unloading: where a frequency relay will detect a high frequency and correspondingly reduce a generator output (can act to correct a high frequency only).

96 AEMC, *Fast Frequency Response Market Ancillary Service*, 15 July 2021. Implementation information can be found on the AEMO website here.

- **Contingency Delayed Lower (5 Minute Lower):** 5 minute response to recover frequency to the normal operating band following a major rise in frequency.

On 2 December 2021, the AEMC published the 'Integrating energy storage systems into the NEM' rule change that allows DC-coupled systems and aggregators of small generation and storage units to provide market ancillary services from 31 March 2023.[97]

The amount of FCAS AEMO enables in each market, and the cost of that FCAS, are key parameters the Panel monitors in the RASR.

4.3.2 Network support and control ancillary service

NSCAS are non-market ancillary services that may be procured by AEMO to maintain power system security and reliability and to maintain or increase the power transfer capability of the transmission network. AEMO is required to assess NSCAS needs in the NEM on a five-year assessment cycle. When AEMO identifies an NSCAS gap, the NER gives TNSPs the primary responsibility for putting arrangements in place to address the gap.[98] AEMO will be required to acquire NSCAS only to ensure power system security and reliability if the NSCAS gaps remain unmet after TNSP's attempt to procure services.[99]

Network control ancillary services can be subdivided into the following types:

- **Voltage Control Ancillary Service (VCAS)** – AEMO must control the voltage on the electrical network to within specified tolerances defined in the system standards.[100] One method of controlling voltages on the system is through the procurement and dispatch of VCAS. Under these ancillary services, contracted generators absorb or generate reactive power from or onto the electricity grid and control the local voltage accordingly.
- **Network Loading Control Ancillary Service (NLCAS)** – NLCAS involves services are used, by AEMO, to control the flow on inter-connectors to within short term limits.
- **Transient and Oscillatory Stability Ancillary Service (TOSAS)** – TOSAS provide for services to maintain power system stability within the requirements defined in the system standards.[101] These services can include the control and fast regulation of the network voltage, increase the inertia of rotating mass connected to the power system or rapidly increase/reduce load connected to the power system.

The Panel considers AEMO's procurement of NSCAS as well as any identified NSCAS gaps in its RASR.

4.3.3 System restart ancillary service

SRAS enable the recovery of the power system following a major disturbance, where large parts of the power system have collapsed to a "black system" condition.[102] There are two types of SRAS - black start services and restoration support services. Black start services are typically provided by generators with the capability to start or remain in service without electricity being provided from the grid. AEMO may procure restoration support services to aid the process of re-energising the

97 AEMC, *Integrating Energy Storage Systems into the NEM*, 2 December 2021.

98 Clause 3.11.3(a) of the NER.

99 Clause 3.11.3(c) of the NER.

100 Clauses S5.1a.4 of the NER- Power frequency voltage, Clause S5.1a.5 of the NER Voltage fluctuations, Clause S5.1a.6 of the NER – Voltage waveform distortion, and Clause S5.1a.7 of the NER - Voltage unbalance of the NER set out requirements for voltage performance.

101 Clause S5.1a.3 of the NER.

102 A black system condition is defined in Chapter 10 of the NER as the absence of voltage on all or a significant part of the transmission system or within a region during a major supply disruption affecting a significant number of customers.

power system following the black system event. AEMO sets out the technical requirements for black start services and restoration support services in the SRAS Guideline, as described below.

Generators consume electricity to power auxiliary plant required for the generator's operation. Auxiliary plant includes the internal power station equipment such as coal conveyors, crushers, and pumps. Auxiliary plant requires energisation prior to the main generating system commencing generation. No electricity is available from the power system in a black system condition for this purpose. SRAS capable generators can start their auxiliary systems locally to commence generation without supply from the wider network.[103]

Once an SRAS provider has restarted its own plant, it provides energy to re-energise the connected transmission network elements to restart other generators and commence the processes required for system restoration. There is an additional cost involved to equip generating plant with this capability and not all generators have it. Payments under SRAS contracts provide for these additional costs.

The SRAS Guideline describes principles and processes designed to ensure AEMO procures SRAS in a manner that meets the system restart standard (set by the Panel) at the lowest long-term cost.[104] This includes setting out the technical requirements for SRAS (for both black start services and restoration support services) and commercial processes in acquiring these services. AEMO must use reasonable endeavours to acquire sufficient SRAS for each defined electrical sub-network to meet the requirements of the SRS as described in section 4.2.2. On 11 December 2025, the Panel published a final determination for its periodic review of the System Restart Standard.[105] This included the publication of a new SRS, which will take into effect from 1 July 2027.

The Panel considers AEMO's procurement of SRAS, and any occasions in which it is used, in its RASR reporting.

4.3.4 System strength and inertia services

Historically, most generation in the NEM has been synchronous. As such, the inertia and system strength provided by these generators have not been separately valued from the wholesale market price of energy. However, inverter-based resources (IBRs), such as wind and solar generation and batteries, do not inherently provide inertia and system strength as a by-product of their generation. Therefore, as the generation mix increasingly shifts towards these resources, AEMO faces additional challenges in maintaining the power system in a secure operating state.

On 28 March 2024, the AEMC published a final determination to improve market arrangements for security services.[106] The final rule:

- aligned the existing inertia and system strength frameworks' procurement timeframes
- removed the exclusion to procuring inertia network services and system strength in the NSCAS framework
- adjusted TNSP cost recovery procedures for non-network security options to support efficient contracting arrangements and minimise volatility for electricity consumers

103 Generators who are able to remain in service sufficient to maintain auxiliary supply following a black system event are known as having 'trip to house load' SRAS capability.

104 AEMO, System Restart Ancillary Services Guideline, 2021.

105 AEMC, *Review of the System Restart Standard*, Final report, December 2025.

106 AEMC, *Improving security frameworks for the energy transition*, 28 March 2024.

- created a new transitional non-market ancillary services (NMAS) framework for AEMO to procure security services necessary for the energy transition and to trial new sources of security services
- empowered AEMO to enable (or 'schedule') security services with a whole-of-NEM perspective
- improved directions transparency
- introduced new requirements for AEMO to publish daily enablement outcomes
- introduced a new annual reporting requirement on AEMO, the TPSS, in which AEMO will report annually on the steps it will take to manage security through the transition.

System Strength

System strength can be understood as the ability of the power system to maintain and control the voltage wave form at any given location in the power system, both during steady state operation and following a disturbance. A smooth, consistent and predictable voltage waveform is critical to the power system's voltage remaining within the parameters required for a safe and secure transfer of energy from generators to consumers.[107]

The exit of large thermal synchronous generation, together with an increasing proportion of IBRs like batteries, wind and solar, has contributed to decreases in system strength in some areas of the power system. A reduction in system strength in certain areas of the network may mean that generators are no longer able to meet their technical performance standards and may be unable to remain connected to the system at certain times. It may also lead to voltage instability and a reduction in the effectiveness of the protection systems used by network businesses, generators and large customers. If not addressed, these effects could lead to system instability and potential major supply interruptions.

The system strength framework was updated in 2021, by an AEMC rule on Efficient management of system strength on the power system.[108] This rule evolved the prior system strength provision framework to a more proactive framework that plans for system strength needs in advance of any shortfall occurring. Under the evolved framework, AEMO must provide an annual assessment of system strength requirements in the NEM for the coming decade, against a new power system standard comprising:

- a minimum fault level requirement for power system security at each system strength node
- a requirement for stable voltage waveforms at connection points to host AEMO's forecast levels of IBR (also known as the efficient level of system strength) at each system strength node.

Each NEM region's system security service provider (SSSP), being the relevant TNSP, must plan to meet the power system standard (both minimum and efficient levels) from December 2025 onwards.[109] In 2022 AEMO published its first annual assessment of system strength requirements.[110] System strength requirements are now included in AEMO's annual Transition Plan for System Security.[111]

Inertia

107 The system strength at a given location is proportional to the fault level at that location, inversely proportional to effective grid-following inverter based resource (IBR) penetration seen at that location. System strength is also a function of the severity of system events on the stability of IBR (for example, loss of a major transmission line connecting the aforementioned location to the broader power system, resulting in sudden changes in fault level and voltage angle at that location). For more information see AEMO, *System Strength Explained*, March 2020.

108 AEMC, *Efficient management of system strength on the power system*, Final determination, 21 October 2021.

109 AEMC, *Efficient management of system strength on the power system*, Final determination, 21 October 2021.

110 AEMO, *2022 System Strength Report*, December 2022

111 AEMO, Appendix A2 — Network Requirements — An appendix to the Transition Plan for System Security, December 2025.

System black events can occur when a sudden, unexpected loss of a major source of supply causes very rapid changes in system frequency which undermines the security of the electrical system. Power system inertia, primarily associated with the spinning masses of synchronous generator turbines, acts to slow the rate of change of frequency occurring in response to a power system disturbance.

Generators and networks automatically disconnect or 'trip' when there is an excessively rapid change in frequency to protect equipment and personnel from harm. The disconnection of multiple generators can lead to cascading failures and ultimately a black system if not addressed in time by emergency measures.

AEMO determines and publishes inertia requirements annually by December, forecasting needs over the next ten years.[112] These requirements specify the level of inertia needed to maintain the power system in a secure operating state at all times.[113] Inertia Service Providers are responsible for meeting their region's allocated inertia requirement at the lowest cost.[114] This can be achieved by contracting with Registered Participants to supply synchronous inertia (or synthetic inertia, subject to AEMO's approval), or by procuring and incorporating synchronous condensers into their network.[115] Since the largest credible contingencies rarely occur during real-time operations, inertia contracts must be coordinated and enabled by AEMO to ensure minimum requirements are met at all times.[116]

The Commission determined in the Efficient Provision of Inertia final rule determination that there are unlikely to be net benefits of introducing a new operational procurement mechanism for inertia in the near term..[117] The Panel has been tasked with monitoring and reporting on metrics that affect the potential economic benefits of operationally procuring inertia.[118]

The Panel will use inertia metrics as the basis for monitoring whether the current arrangements for meeting inertia needs are fit for purpose, or whether there may be a benefit in considering alternative ways of meeting inertia needs.

The updated RASR terms of reference set out the inertia-related metrics that the Panel could report on. These include:[119]

- The inertia requirements specified and published annually by AEMO.[120] Inertia requirements refer to the secure and satisfactory levels of inertia required in each sub-network and across the NEM. An increase in inertia requirements may lead to changes in the costs and benefits of meeting these needs under the current framework and/or a reason to consider alternative ways of meeting these needs.
- The estimated cost to consumers from Inertia Service Providers meeting their inertia obligations, such as the cost of NSPs procuring inertia via contracts. These are reported annually by AEMO.[121] Monitoring for an increase in the expected costs to consumers of

112 Clause 5.20B.2 of the NER; and AEMO, Appendix A2 — Network Requirements — An appendix to the Transition Plan for System Security, December 2025.

113 The power system is in a secure operating state if, after experiencing a credible contingency event or protected event, it would be in a satisfactory operating state (that is, a secure operating state is akin to operating at an 'n-1' contingency level). See NER clauses 4.2.2 and 4.2.4.

114 Clause 5.20B.4(f)

115 Clause 5.20B.4(d)

116 AEMC, *Efficient Provision of Inertia*, Directions Paper, December 2024.

117 AEMC, Efficient Provision of Inertia, Rule determination, October 2025.

118 ibid, p.2

119 AEMC, Reliability & Security Report — AEMC Terms of Reference to the Reliability Panel, 3 December 2025.

120 NER rule 5.20.5

121 NER rule 4.4A.7

meeting inertia needs would help determine if there may be a benefit in establishing a real-time inertia market.

- The 1-second raise and lower contingency FCAS market prices, which are reported by AEMO.[122]. The provision of inertia is intrinsically linked with the ability to control the frequency performance of the power system. While not completely interchangeable, very fast frequency response can act as a partial alternative to inertia. A sustained increase in contingency FCAS prices may result in a change in the net benefits of a real-time inertia market.
- The marginal value of rate of change of frequency (RoCoF) constraints, as reported by AEMO.[123] The operational procurement of inertia could help relieve RoCoF dispatch-related constraints. Monitoring for an increase in the value of RoCoF-related constraints (including the value of any new constraints that AEMO may formulate to maintain secure operation) will help determine when the operational procurement of inertia may become more likely to deliver net benefits to consumers.
- Any other metrics that the Panel considers relevant to assessing benefits from the potential operational procurement of inertia.

The Panel started reporting on available inertia metrics in the 2025 RASR and will seek stakeholder feedback on the metrics, how they are reported and if there are any other metrics stakeholders consider relevant to assessing benefits from the potential operational procurement of inertia.

4.3.5 AEMO security intervention

Consistent with its overall obligation to maintain power system security, AEMO has powers to intervene in the market to maintain the power system in a secure state.[124]

AEMO intervenes for security purposes using (described in section 3.4):

- the RERT
- clause 4.8.9 directions
- instructions for manual load shedding.

While AEMO can dispatch RERT resources for security reasons if it has procured RERT resources, it is unable to explicitly procure RERT to manage security.

AEMO's primary intervention mechanism to maintain system security is through the use of 'directions'.[125] AEMO has extensively utilised security directions and the Panel considers AEMO's security directions in RASR.

AEMO intervention to manage low operational demand

Minimum operational demand refers to the lowest level of demand from the grid in any given day, week or year. While minimum operational demand has traditionally occurred during the early morning, increasing behind-the-meter residential solar PV penetrations have seen minimum operational demand shift to occur during the daytime.

One of the challenges of minimum or low operational demand is maintaining sufficient levels of essential system services, including frequency control, system strength, voltage management and inertia. Minimum load constraints must be taken into account when AEMO determines and revises

122 Clause 3.11.2A of the NER

123 There is no specific requirement for AEMO to report this data. It is a by-product other data in the NEMDE.

124 Clause 4.8.5A(c) of the NER.

125 Clause 4.8.9 of the NER.

the technical envelope.[126] In periods of very low operational demand, these services need to be sourced from elsewhere or, if that is not possible, AEMO must intervene to keep the grid in a secure operating state.[127] AEMO's interventions under low operational demand conditions include:

- directing NSPs to return lines or elements to service
- directing available loads to increase consumption
- directing TNSPs to maintain demand at required threshold which may involve dialling down or disconnecting rooftop solar systems.

In July 2024, Australia's Energy and Climate Change Ministerial Council agreed on a National Consumer Energy Resources roadmap.[128] This roadmap included measures to support ongoing power system security, including the requirement for emergency backstop mechanisms to be in place by the end of 2025 to ensure the operational security of the power system when required. "Emergency backstop" capability refers to operational measures to reduce aggregate DER generation if required for system security, when other options have been exhausted. This is a critical tool to keep the power system secure under extreme conditions before higher customer impact measures are enacted.[129]

Minimum System Load framework

Minimum System Load (MSL) refers to operational conditions where there is a risk that operational demand may fall below levels required for safe and secure system operation. AEMO has established an MSL framework that sets out how it manages conditions of low operational demand.[130] but excludes the contribution from non-scheduled intermittent generation ≥ 30 MW.

There are three MSL levels, each with an associated threshold level of demand, measured in MW.[131] Numerous interdependent factors determine the thresholds, and so MSL levels may change continuously as the power system status changes. The MSL 3 threshold defines the lower limit for operational demand required to maintain secure system operation.

Market notices are issued both when demand is forecast to go below the threshold for a level and when actual demand goes below the defined MSL threshold .

Market notices issued under the framework are used to inform the market of emerging low-demand conditions and when interventions may be required to maintain system security. The notices provide a signal for market response, such as additional load, prior to operational measures being taken. [132]

This process for managing a minimum system load mirrors the LOR notice process and is set out in the table below.

126 Clause 4.2.5(c) of the NER.

127 Clause 4.8.9(A) of the NER.

128 Department of Climate Change, Energy, the Environment and Water, Canberra, *National Consmer Energy Resources (CER) Roadmap*, July 2025.

129 AEMO, *Learnings from industry implementation of emergency backstop mechanisms for distributed resources*, Q2 2025

130 Where this procedure refers to demand, the value used is the demand used in Projected Assessment of System Adequacy (PASA), which refers to operational demand. Operational Demand in a region is demand that is met by local scheduled generating units, semi-scheduled generating units, and non-scheduled intermittent generating units of aggregate capacity ≥ 30 MW, and by generation imports to the region and by Wholesale Demand Response. It excludes the demand met by non-scheduled non-intermittent generating units, non-scheduled intermittent generating units of aggregate capacity < 30 MW, exempt generation (e.g. rooftop solar, gas tri-generation, very small wind farms, etc), and demand of local scheduled loads.

131 AEMO, NEM Spring Readiness Industry Briefing, 20 August 2025; and AEMO, Minimum System Load Thresholds, September 2025.

132 For more information, see AEMO, *Minimum System Load Thresholds*, September 2025.

Table 4.2: MSL framework

Notice level	Definition	AEMO actions
MSL 1	Forecast or actual demand is two credible load contingencies away from MSL 3	Monitor the situation. Publish MSL market notice with MSL thresholds when forecast, which can be up to a week ahead.
MSL 2	Forecast or actual demand is one credible load contingencies away from MSL 3	Take available actions to clear the MSL2 condition if possible. Take actions required to land satisfactory and return to and remain secure within 30 minutes following a credible load contingency.
MSL 3	Forecast or actual demand is insufficient to maintain a secure operating state.	Additionally, instruct NSPs to maintain demand above the MSL 3 threshold.

Source: AEMO, *Minimum System Load Thresholds,* September 2025

4.4 Panel metrics for RASR monitoring of system security outcomes

Table 4.3: Panel metrics for RASR monitoring of system security outcomes

Security outcome	Description	Metric monitored
Constraint changes and performance	Constraints aim to prevent the power system from operating in a state that is vulnerable to supply disruptions in response to a credible contingency event. Constraint changes measure the changing congestion patterns over the previous financial year.	Total number of constraint changes
		Binding hours of constraints
Frequency performance	AEMO is required to keep the power system at, or close to, 50Hz.	NEM frequency distribution
		Breakdown of events outside FOS ranges
Security services	System ancillary services are used by AEMO to manage the power system safely, securely, and reliably. This includes: • Frequency Control and Ancillary Markets (FCAS) • System Restart and Ancillary Services (SRAS) • Network Support and Control Ancillary Services (NSCAS)	Cost, volume and variation of FCAS per quarter
		Cost and volume of SRAS contracts across each state
		Cost and volume of NSCAS contracts across each state
Market notices	AEMO issues market notices to communicate to participants events that impact the market, including interventions, reserves notices, power system events and minimum system load notices.	Lack of reserve notices (by region and by the percentage set by the forecasting uncertainty measure)
		Minimum system load notices (forecast and actual)
Security directions	AEMO may direct registered participants to take relevant actions to maintain or restore the security or reliability of the power system, or for	Number of security directions (by region)

Security outcome	Description	Metric monitored
	reasons of public safety.	
Scheduling errors	A scheduling error occurs when AEMO fails to follow the central dispatch process or determines that the dispatch interval contains an incorrect input.	Number of scheduling errors
Operating incident reporting	AEMO's operating incident reports provide details on security events and the sufficiency of responses and systems for managing non-credible and other significant deviations from normal operating conditions.	Reviewable operating incidents by number and type
		Number of periods the power system is insecure > 30 minutes
		Special reporting on particularly material events
Inertia	Power system inertia acts to slow the rate of change of frequency occurring in response to a power system disturbance.	Inertia requirements
		Estimated costs of meeting inertia needs
		Contingency FCAS prices, primarily for the 1-second service
		Number value of RoCoF-related constraints

5 Safety

Under the NEL, the AEMC may request that the Panel provide advice in relation to the safety of the national electricity system.[133]

The Panel has previously been required to report on safety under the terms of reference. However, this requirement was removed from the terms of reference that were updated in December 2025 and accordingly, the Panel has not advised on the safety of the power system.[134]

133 NEL section.38(2)(b).

134 See the updated standing terms of reference at: AEMC, Reliability & Security Report — AEMC Terms of Reference to the Reliability Panel, 3 December 2025; and the previous Terms of Reference at: AEMC, Annual Market Performance Review — AEMC Terms of Reference to the Reliability Panel, 26 July 2022.

Glossary

Available capacity	The total MW capacity available for dispatch by a scheduled generating unit or scheduled load (i.e. maximum plant availability) or, in relation to a specified price band, the MW capacity within that price band available for dispatch (i.e. availability at each price band).
Busbar	A busbar is an electrical conductor in the transmission system that is maintained at a specific voltage. It is capable of carrying a high current and is normally used to make a common connection between several circuits within the transmission system. The rules define busbar as 'a common connection point in a power station switchyard or a transmission network substation'.
Cascading outage	The occurrence of a succession of outages, each of which is initiated by conditions (e.g. instability or overloading) arising or made worse as a result of the event preceding it.
Contingency events	These are events that affect the power system's operation, such as the failure or removal from operational service of a generating unit or transmission element. There are several categories of contingency event, as described below: • credible contingency event is a contingency event whose occurrence is considered "reasonably possible" in the circumstances. For example: the unexpected disconnection or unplanned reduction in capacity of one operating generating unit; or the unexpected disconnection of one major item of transmission plant • non-credible contingency event is a contingency event whose occurrence is not considered "reasonably possible" in the circumstances. Typically a non-credible contingency event involves simultaneous multiple disruptions, such as the failure of several generating units at the same time.
Directions	Under s. 116 of the NEL, AEMO may issue directions. Section 116 directions may include directions as issued under clause 4.8.9 of the NER (e.g. directing a scheduled generator to increase output) or clause 4.8.9 instructions (e.g. instructing a network service provider to load shed). AEMO directs or instructs participants 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 NER rule 3.8, 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.
Distribution network service provider (DNSP)	A person who engages in the activity of owning, controlling, or operating a distribution network.
Emergency backstop	Emergency backstop capability refers to the operational measures to reduce aggregate DER generation required for system security when other options have been exhausted. This is a critical tool to keep the power system secure under extreme conditions before higher customer impact measures are enacted.
Frequency control ancillary services (FCAS)	Those ancillary services concerned with balancing, over short intervals, the power supplied by generators with the power consumed by loads (throughout the power system). Imbalances cause the frequency to deviate from 50 Hz.
Interconnector	A transmission line or group of transmission lines that connect the transmission networks in adjacent regions.
Jurisdictional planning body	The transmission network service provider responsible for planning a NEM jurisdiction’s transmission network.
Lack of reserve	This is when reserves are below specified reporting levels.
Load	A connection point (or defined set of connection points) at which electrical power is delivered, or the amount of electrical power delivered at a defined instant at a connection point (or aggregated over a defined set of connection points).
Load event	In the context of frequency control ancillary services, a load event: involves a disconnection or a sudden reduction in the amount of power consumed at a

	connection point and results in an overall excess of supply.
Load shedding	Reducing or disconnecting load from the power system either by automatic control systems or under instructions from AEMO. Load shedding will cause interruptions to some energy consumers' supplies.
Medium term projected assessment of system (MT PASA) (also see ST PASA)	A comprehensive programme of information collection, analysis and disclosure of medium-term power system reliability prospects. This assessment covers a period of 24 months and enables market participants to make decisions concerning supply, demand and outages. It must be issued weekly by AEMO.
Ministerial Council on Energy (MCE)	The MCE is the national policy and governance body for the Australian energy market, including for electricity and gas, as outlined in the COAG Australian Energy Market Agreement of 30 June 2004.
National electricity market (NEM)	The NEM is a wholesale exchange for the supply of electricity to retailers and consumers. It commenced on 13 December 1998, and now includes Queensland, New South Wales, Australian Capital Territory, Victoria, South Australia, and Tasmania.
National Electricity Law (NEL)	The NEL is contained in a schedule to the National Electricity (South Australia) Act 1996. The NEL is applied as law in each participating jurisdiction of the NEM by the application statutes.
National Electricity Rules (NER)	The NER came into effect on 1 July 2005, replacing the National Electricity Code.
Network	The apparatus, equipment and buildings used to convey and control the conveyance of electricity. This applies to both transmission and distribution networks.
Network capability	The capability of a network or part of a network to transfer electricity from one location to another.
Network control ancillary services (NCAS)	Ancillary services concerned with maintaining and extending the operational efficiency and capability of the network within secure operating limits.
Network event	In the context of frequency control ancillary services, the tripping of a network resulting in a generation event or load event.
Network service providers (NSPs)	An entity that operates as either a transmission network service provider (TNSP) or a distribution network service provider (DNSP).
Network services	The services (provided by a TNSP or DNSP) associated with conveying electricity and which also

	include entry, exit, and use-of-system services.
Operating state	The operating state of the power system is defined as satisfactory, secure or reliable, as described below. 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) • the severity of any potential fault is within the capability of circuit breakers to disconnect the faulted circuit or equipment. The power system is in a **secure** operating state when: • it is in a satisfactory operating state • it will return to a satisfactory operating state following a single credible contingency event. The power system is in a **reliable** operating state when: • AEMO has not disconnected, and does not expect to disconnect, any points of load connection under NER clause 4.8.9 • no load shedding is occurring or expected to occur anywhere on the power system under NER clause 4.8.9 • in AEMO's reasonable opinion the levels of short term and medium term capacity reserves available to the power system are at least equal to the required levels determined in accordance with the power system security and reliability standards.
Participant	An entity that participates in the national electricity market.
Power system reliability	The measure of the power system's ability to supply adequate power to satisfy demand, allowing for unplanned losses of generation capacity.
Power system security	The safe scheduling, operation and control of the power system on a continuous basis.
Probability of exceedance (POE)	POE relates to the weather/temperature dependence of the maximum demand in a region. A detailed description is given in the AEMO ESOO.
Reliable operating state	Refer to operating state.
Reliability of supply	The likelihood of having sufficient capacity (generation or demand-side response) to meet

	demand (the consumer load).
Reliability standard	The Reliability Panel's current standard for reliability is that there should be sufficient generation and bulk transmission capacity so that the maximum expected unserved energy 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.
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).
System average interruption frequency index (SAIFI)	The total number of sustained customer interruptions, divided by the total number of distribution customers. SAIFI excludes momentary interruptions (one minute or less duration).
Satisfactory operating state	Refer to operating state.
Scheduled load	A market load which has been classified by AEMO as a scheduled load at the market customer's request. A market customer may submit dispatch bids in relation to scheduled loads.
Secure operating state	Refer to operating state.
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 (ST PASA) (also see MT PASA)	The PASA in respect of the period from two days after the current trading day to the end of the seventh day after the current trading day inclusive in respect of each trading interval in that period.
Spot market	Wholesale trading in electricity is conducted as a spot market. The spot market allows instantaneous matching of supply against demand. The spot market trades from an electricity pool, and is effectively a set of rules and procedures (not a physical location) managed by AEMO (in conjunction with market participants and regulatory agencies) that are set out in the NER.

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	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 network service provider (TNSP)	An entity that owns operates and/or controls a transmission network.
Unserved energy (USE)	The amount of energy that is required (or demanded) by consumers but which is not supplied due to a shortage of generation or interconnection capacity. Unserved energy does not include interruptions to consumer supply that are caused by outages of local transmission or distribution elements that do not significantly impact the ability to transfer power into a region.

Abbreviations

AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AGC	Automatic Generation Control
AMPR	Annual Market Performance Review
APC	Administered price cap
APP	Administered price period
ASEFS	Australian solar energy forecasting system
AWEFS	Australian wind energy forecasting system
CER	Clean Energy Regulator
Commission	See AEMC
CPT	Cumulative price threshold
DCCEEW	Department of Climate Change, Energy, the Environment and Water
EAAP	Energy adequacy assessment projection
ESOO	Electricity statement of opportunities
DER	Distributed energy resources
DNSP	Distribution network service providers
FCAS	Frequency control ancillary services
FOS	Frequency operating standard
FUM	Forecast uncertainty measure
IBR	Inverter-based resources
IRM	Interim reliability measure
LOR	Lack of reserve
MFP	Market floor price
MPC	Market price cap
MSL	Minimum system load
MT PASA	Medium-term PASA
MW	Megawatt
MWh	Megawatt hour
NEL	National Electricity Law
NEM	National Electricity Market
NEMDE	NEM Dispatch Engine
NEO	National electricity objective
NER	National Electricity Rules
NERO	National energy retail objective
NLCAS	Network loading control ancillary service
NMAS	Non-market ancillary services
NSCAS	Network support and control ancillary services
NSP	Network service provider

Panel	The Reliability Panel
PASA	Projected assessment of system adequacy
PFCB	Primary frequency control band
PFR	Primary frequency response
PFRR	Primary frequency response requirements
PHES	Pumped hydro energy storage
RASR	National Electricity Market Reliability & Security Report
RERT	Reliability and emergency reserve trader
RoCoF	Rate of change of frequency
RRO	Retailer reliability obligation
RSS review	Reliability standard and settings review
SAIDI	System average interruption duration index
SAIFI	System average interruption frequency index
SCADA	Supervisory control and data acquisition
SRAS	System restart ancillary services
SRS	System restart standard
SSSP	System security service provider
ST PASA	Short-term PASA
TNSP	Transmission network service provider
TPSS	Transition plan for system security
TOSAS	Transient and oscillatory stability ancillary service
USE	Unserved energy
VCAS	Voltage control ancillary service
VCR	Value of customer reliability
WTP	Willingness to pay