RELIABILITY STANDARD IMPLEMENTATION GUIDELINES

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<table>
<thead>
<tr>
<th>Version</th>
<th>Effective Date</th>
<th>Summary of Changes</th>
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<tbody>
<tr>
<td>1.0</td>
<td>18 December 2015</td>
<td>Initial version following consultation.</td>
</tr>
<tr>
<td>1.3</td>
<td>10 October 2016</td>
<td>Update RSIG in accordance with Schedule 2 of the National Electricity Amendment (Energy Adequacy Assessment Projection timeframes) Rule 2016 No. 3.</td>
</tr>
<tr>
<td>1.4</td>
<td>10 May 2018</td>
<td>Changes related to MT PASA – Reliability Assessment Methodology following the recommended solution proposed by Ernst &amp; Young (EY) and suggested by consulted persons during the RSIG consultation. Updated intermittent generation and network constraint approach used in ESOO.</td>
</tr>
<tr>
<td>2.0</td>
<td>25 June 2018</td>
<td>Update RSIG to be consistent with Rules clause 4.8.4A and new format</td>
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1 INTRODUCTION

1.1 Purpose and scope
These are the reliability standard implementation guidelines (RSIG or Guidelines) made under clause 3.9.3D of the National Electricity Rules (NER). They outline current processes that evaluate the market against the reliability standard.

These Guidelines have effect only for the purposes set out in clause 3.9.3D of the NER. The NER and the National Electricity Law prevail over these Guidelines to the extent of any inconsistency.

The Guidelines set out how the Australian Energy Market Operator (AEMO) implements the reliability standard, and the approach and assumptions AEMO uses to implement the reliability standard in relation to:

- Demand for electricity.
- Reliability of existing and future generation.
- Intermittent generation.
- Energy constraints.
- The treatment of extreme weather events.
- Network constraints.
- Factors considered in determining whether additional Energy Adequacy Assessment Projection (EAAP) reporting is required.

1.2 Definitions and interpretation

1.2.1 Glossary
The words, phrases and abbreviations in the table below have the meanings set out opposite them when used in these Procedures.

Terms defined in the National Electricity Law and the NER have the same meanings in these Procedures unless otherwise specified in this clause.

Defined terms/Terms defined in the NER are intended to be identified in these Procedures by italicising them, but failure to italicise a defined term does not affect its meaning.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>AEMO</td>
<td>Australian Energy Market Operator</td>
</tr>
<tr>
<td>ASEFS</td>
<td>Australian Solar Energy Forecasting System</td>
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<tr>
<td>AWEFS</td>
<td>Australian Wind Energy Forecasting System</td>
</tr>
<tr>
<td>DER</td>
<td>Distributed Energy Resources</td>
</tr>
<tr>
<td>DFS</td>
<td>Demand Forecasting System</td>
</tr>
<tr>
<td>EAAP</td>
<td>Energy adequacy assessment projection</td>
</tr>
<tr>
<td>ESOO</td>
<td>Electricity statement of opportunities</td>
</tr>
<tr>
<td>EV</td>
<td>Electric Vehicles</td>
</tr>
<tr>
<td>GELF</td>
<td>Generator Energy Limitation Framework</td>
</tr>
<tr>
<td>GWh</td>
<td>Gigawatt hours (energy)</td>
</tr>
<tr>
<td>LOR</td>
<td>Lack of reserve</td>
</tr>
<tr>
<td>LRC</td>
<td>Low reserve condition</td>
</tr>
<tr>
<td>MT PASA</td>
<td>Medium term PASA</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>---------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>MW</td>
<td>Megawatt</td>
</tr>
<tr>
<td>NEFR</td>
<td>National Electricity Forecasting Report</td>
</tr>
<tr>
<td>NEM</td>
<td>National Electricity Market</td>
</tr>
<tr>
<td>NER</td>
<td>National Electricity Rules</td>
</tr>
<tr>
<td>NTNDP</td>
<td>National Transmission network Development Plan</td>
</tr>
<tr>
<td>NSCAS</td>
<td>Network Support and Control Ancillary Services</td>
</tr>
<tr>
<td>PASA</td>
<td>Projected assessment of system adequacy process</td>
</tr>
<tr>
<td>POE</td>
<td>Probability of Exceedance</td>
</tr>
<tr>
<td>RERT</td>
<td>Reliability and emergency reserve trader</td>
</tr>
<tr>
<td>RSIG</td>
<td>Reliability standard implementation guidelines</td>
</tr>
<tr>
<td>ST PASA</td>
<td>Short term PASA</td>
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<tr>
<td>USE</td>
<td>Unserved energy</td>
</tr>
</tbody>
</table>

1.2.2 Interpretation

The following principles of interpretation apply to these Procedures unless otherwise expressly indicated:

(a) These Procedures are subject to the principles of interpretation set out in Schedule 2 of the National Electricity Law.

(b) References to time are references to Australian Eastern Standard Time.

1.3 Related documents

Table 2 Related Documents

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
<th>Location</th>
</tr>
</thead>
</table>
1.4 The reliability standard

The reliability standard is a measure of the effectiveness, or sufficiency, of installed capacity to meet demand. It is defined in clause 3.9.3C of the NER as the maximum expected unserved energy (USE), as a percentage of total energy, in a region over a financial year, and is currently set at 0.002%. USE is measured in gigawatt hours (GWh).

The USE that contributes to the reliability standard is defined in clause 3.9.3C (b) of the NER and excludes unserved energy associated with power system security incidents that result from multiple contingencies, protected events or non-credible contingency events, network outages not associated with inter-regional flows and industrial action or acts of God.

The NER does not give specific direction to AEMO on how to implement the reliability standard, but it does require AEMO to perform the following functions in accordance with the RSIG:

(a) Clause 3.7.2 MT PASA - (f)(6) Identify and quantify any projected failure to meet the reliability standard as assessed in accordance with the RSIG.

(b) Clause 3.7.3 ST PASA - (h)(5) Identify and quantify any projected failure to meet the reliability standard as assessed in accordance with the RSIG.

(c) Clause 4.2.7 Reliable Operating state – (c) Assess whether the power system meets, and is projected to meet, the reliability standard, having regard to the RSIG.
(d) Clause 4.3.1 Responsibility of AEMO for power system security -

(l) Monitor demand and generation capacity in accordance with the RSIG and, if necessary, initiate action in relation to a relevant AEMO intervention event.

(m) Publish as appropriate, information about the potential for, or the occurrence of, a situation which could significantly impact, or is significantly impacting, on power system security, and advise of any low reserve condition for the relevant periods determined in accordance with the RSIG.

(e) Clause 4.8.4 Declaration of conditions -

(a) AEMO may declare a low reserve condition when it considers that the balance of generation capacity and demand for the period being assessed does not meet the reliability standard as assessed in accordance with the RSIG.

(b) AEMO may declare a lack of reserve level 1, 2 or 3 when AEMO determines in accordance with the reserve level declaration guidelines that the probability of involuntary load shedding is, or is forecast to be, more than remote.

1.5 AEMO’s process for managing low reserve or lack of reserve conditions

If AEMO declares a lack of reserve (LOR) or low reserve condition (LRC), AEMO will follow the processes set out in clauses 4.8.5A and 4.8.5B. This includes publishing any foreseeable circumstances that may require AEMO to implement an AEMO intervention event.

The aim of implementing an AEMO intervention event is to maintain the reliability of supply and power system security where practicable, when a low reserve or lack of reserve condition exists. AEMO intervention events include:

(a) Issuing an instruction or direction in accordance with clause 4.8.9; or

(b) Exercising the reliability and emergency reserve trader in accordance with rule 3.20.

Details on these can be found in the Intervention, Direction and Clause 4.8.9 Instructions document and the Procedure for the Dispatch and Activation of Reserve Contracts SO_OP3717 document listed in Section 1.3.

2 RELIABILITY STANDARD IMPLEMENTATION PROCESSES

AEMO implements the reliability standard using forecasts and projections over different timeframes. AEMO uses the following processes:

(a) Electricity Statement of Opportunities (ESOO) to provide market information over a ten-year projection to assist planning by existing and potential generators and Market Participants.

(b) Energy Adequacy Assessment Projection (EAAP) to forecast USE for energy constrained scenarios over a two-year projection.

(c) Medium Term Projected Assessment of System Adequacy (MT PASA) to forecast USE over a two-year projection.

(d) Short Term Projected Assessment of System Adequacy (ST PASA) to forecast capacity reserve over a six-day projection.

As noted above, AEMO runs two processes to implement the reliability standard over a two year period: EAAP and MT PASA. The main difference between EAAP and MT PASA is that the EAAP is assessed under a range of predefined energy scenarios and is published at least once every 12 months, whereas the MT PASA is based on participants’ best expectation of generation availability and is published on a weekly basis.

Detailed information about each process and methodologies applied can be found on AEMO’s website (links as listed in section 1.3).
This section of the Guidelines describes how each process evaluates key components that contribute to AEMO’s forecast of reliability. Different assumptions used under the various processes reflect the study timeframe and hence level of uncertainty in the inputs.

Table 3 explains the processes AEMO undertakes to forecast reliability, inform Market Participants and Network Service Providers if the reliability standard is likely to be breached, and intervene where necessary.

### Table 3  Summary of processes that AEMO uses to implement the reliability standard

<table>
<thead>
<tr>
<th>Process</th>
<th>Study Time Frame/Publication Frequency</th>
<th>Assessment Method</th>
<th>Primary Action</th>
<th>Second Action</th>
<th>Assumption for Potential Breach of Reliability Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESOO</td>
<td>10 year/Annually</td>
<td>USE</td>
<td>Inform</td>
<td></td>
<td>Forecast USE&gt;0.002% in any forecast year</td>
</tr>
<tr>
<td>EAAP</td>
<td>2 year/Annually</td>
<td>USE</td>
<td>Inform</td>
<td>4.8.9 instruction, RERT or direction</td>
<td>Forecast USE&gt;0.002% in any forecast year</td>
</tr>
<tr>
<td>MT PASA</td>
<td>2 year/Weekly</td>
<td>USE</td>
<td>Inform</td>
<td>4.8.9 instruction, RERT or direction</td>
<td>Forecast USE&gt;0.002% in any forecast year</td>
</tr>
<tr>
<td>ST PASA</td>
<td>6 day/2 hours</td>
<td>Capacity</td>
<td>Inform</td>
<td>4.8.9 instruction, RERT or direction</td>
<td>LOR2 or LOR3</td>
</tr>
</tbody>
</table>

### 2.1 Electricity Statement of Opportunities

AEMO is required to publish an ESOO annually under clause 3.13.3(q) of the NER. The ESOO provides information that can help stakeholders plan their operations over a ten-year outlook period, including information about the future supply demand balance.

The ESOO also indicates when generation or demand management capacity or augmentation of the power system is required to meet the reliability standard, using probabilistic modelling to determine the regional USE at an hourly resolution. This involves using time-sequential, security-constrained optimal dispatch simulations, incorporating Monte-Carlo simulations. AEMO compares the probability-weighted USE assessment against the reliability standard, and identifies potential future breaches. Detail on this approach and assumption can be found in the ESOO methodology document.

AEMO then publishes details of any forecast LRC where the reliability standard may be breached. AEMO generally does not take further action to ensure a response to any potential breaches of the reliability standard identified in the ESOO.3 The purpose of the ESOO is to provide technical and market data that informs the decision-making processes of Market Participants, new investors and jurisdictional bodies as they assess opportunities in the NEM over a 10-year period.

The following sub-sections outline some key inputs to the ESOO model. A detailed description of the ESOO modelling methodology is available on the ESOO webpage as listed in section 1.3.

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1. The frequencies shown in this table correspond with the NER and will be updated if changes are made to the underlying rules.
3. Unless the breach is identified in the National Transmission Network Development Plan (NTNDP) as an NSCAS gap and will not be met by the relevant Transmission Network Service Provider.
2.1.1 ESOO generation capacity

For the generation component of the ESOO assessment, AEMO uses the total of current generation capacity plus any committed future generation and withdrawals, obtained from operators of generating plant in the National Electricity Market (NEM). AEMO does not assume or forecast any further new generation capacity. Generic annual planned outages are scheduled and optimised in lower demand periods, and forced outages are stochastically modelled using probabilities derived from historical performance or expert advice where historical information is not available.

2.1.2 ESOO intermittent generation

For intermittent generation, AEMO prepares ten-year intermittent generation profiles based on historical performance, where available, and/or meteorological data for new or committed generation. At least five different intermittent generation profiles are developed for each generator, based on historical weather traces, and sampled as part of the Monte-Carlo simulations. These generation profiles are linked to the corresponding demand trace based on that same historical weather pattern to ensure any correlation between intermittent generation and demand is preserved. Detail on this approach and assumptions can be found in the ESOO methodology document.

2.1.3 ESOO energy constraints

The ESOO process accounts for projected energy constraints via inputs to the ESOO model. Any energy constraint, such as low water levels of dams used by hydroelectric Generators, is an input to the model as total energy available for the particular Generator. These assumptions are based on historical observations, and long-term average hydroelectric yields assessed by AEMO in consultation with relevant stakeholders. The same principle applies for any other energy limitation affecting a Generator in the model.

2.1.4 ESOO forecast demand

For the forecast demand component of the ESOO, AEMO uses the most recent National Electricity Forecasting Report (NEFR). The NEFR projects energy and maximum demand forecasts for the NEM. AEMO converts the energy and maximum demand forecasts into hourly, or half-hourly, demand profiles based on historical weather patterns. The demand profile also incorporates NEFR assumptions on future distributed energy resources (DER), such as rooftop photovoltaic (PV), battery storage penetration and electric vehicles (EV).

Extreme weather events are considered by using demand profiles derived from the 10% probability of exceedance (10% POE) maximum demand forecasts. At a minimum, a combination of 50% POE and 10% POE demand profiles from at least five historical reference years are sampled probabilistically in the Monte-Carlo simulations to develop the expected USE. At AEMO’s discretion, more POE demand profiles (such as 90% POE) may be included, if USE outcomes are expected to be materially different from 50% POE outcomes.

2.1.5 Network constraints

AEMO continues to update and refine network constraints through its modelling projects during the year. ESOO uses the latest version of ST PASA formulation constraints as a base set, with additional customised constraints, and network constraints to model future network and generation upgrades.

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4 Committed future generators represent generation that is considered to be proceeding based on AEMO’s commitment criteria. For more detail see the AEMO Generation Information page: http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Generation-information.


7 Probability of exceedance is the chance that the observed value is greater than the reported value. A 10% probability of exceedance means there is a 10% chance that the outcome is greater than the reported value.
Given the ten-year outlook period, ESOO constraint equations need to make assumptions on the future status of the network. Such assumptions are made using long-term averages or estimates based on demand levels.

Detailed information on network constraints can be found in the network constraints documents listed in section

2.2 Energy Adequacy Assessment Projection

The EAAP implements the reliability standard over a two-year timeframe. As well as the demand outlook, generation capacity availability and network constraints, the EAAP particularly focuses on the impact of potential energy constraints, such as water shortages during drought conditions, and identifies and reports forecast USE that exceeds the reliability standard.

AEMO is required to publish an EAAP in accordance with NER clause 3.7C. The EAAP makes available to the market an analysis that quantifies the impact of potential energy constraints on energy availability for a range of scenarios, specified in the EAAP guidelines. AEMO identifies potential periods of USE and quantifies projected annual USE that may breach the reliability standard.

The energy constraints that AEMO considers for the EAAP are defined in the EAAP guidelines. AEMO uses a market model to forecast two years at hourly resolution for these energy constraint scenarios. This involves using time-sequential Monte-Carlo market dispatch simulations. It uses a probability-weighted USE assessment to identify any potential reliability standard breaches.

The following sub-sections outline key inputs to the EAAP model and factors for additional EAAP reporting. A detailed description of EAAP modelling is available on AEMO’s website as listed in section 1.3.

2.2.1 EAAP generation capacity

Generation capacity is an input to the EAAP model. AEMO uses the most recent MT PASA offers to derive total capacity and planned outage information.

2.2.2 EAAP intermittent generation

Intermittent generation forecasts are the same generation profiles used in ESOO, which are based on historical performance where available or meteorological data for new or committed generation.

The semi-scheduled intermittent generation forecasts are aggregated per region and then added to the scheduled generation capacity of the associated region. Semi-scheduled intermittent generation is added to scheduled generation to make up the total generation dispatched by the central dispatch mechanism.

The non-scheduled intermittent generation forecasts are aggregated per region and then subtracted from the associated regional demand forecast. Non-scheduled intermittent generation is subtracted from demand because it is not dispatched by the central dispatch mechanism and thereby appears as negative demand.

2.2.3 EAAP energy constraints

AEMO’s approach is to model EAAP scenarios that reflect credible energy constraints, as identified in the EAAP guidelines. The energy constraint information is provided to AEMO by participants through the Generator Energy Limitation Framework (GELF).

2.2.4 EAAP demand

AEMO converts the most recent NEFR energy and maximum demand forecasts into an hourly demand profile based on historical demand patterns. The simulations assess both 50% and

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8 See Rules 3.7C (b) (g) to (j).
10% POE maximum demand profiles. Extreme weather events are considered using demand profiles derived from the 10% POE maximum demand forecasts.

2.2.5 Network constraints
The EAAP simulations model network power transfer capability using system normal constraint equations only. Detailed information on the preparation of EAAP network constraints can be found in the EAAP guidelines. The EAAP currently uses the same constraint equations as ST PASA, see section 1.3. AEMO is investigating whether it is feasible to use the more detailed ESOO constraint set for EAAP modelling in future. Any change in methodology will be communicated to stakeholders before it is applied, and highlighted in the EAAP guidelines.

2.2.6 Factors for additional EAAP reporting
Without limitation, AEMO will consider the following factors in determining whether it has an obligation to publish an additional EAAP:

- Hydro storage levels.
- A major transmission limitation.
- A prolonged interconnection outage that results in a major restriction in energy transfers between NEM regions.
- A prolonged power station outage or fuel supply interruption that results in a material energy constraint.
- The requirement for AEMO to exercise the RERT under rule 3.20.
- A major change in operational consumption.
- Any other events or emerging events that may materially impact reliability by way of energy limitations.

AEMO will also consider publishing additional EAAPs if a Market Participant informs AEMO of an event or circumstances it considers may result in a material energy constraint.

2.3 Projected Assessment of System Adequacy

AEMO’s projected assessment of system adequacy (PASA) processes collect, analyse, and publish information that will inform the market about forecasts of supply and demand.

PASA is administered in two timeframes:

1. Medium-term PASA (MT PASA) – a 24-month projection reported at daily resolution (although modelled at a 30 minute resolution).
2. Short-term PASA (ST PASA) – a six-day projection at 30 minute resolution.

Separate reserve assessments are applied for MT PASA and ST PASA processes. MT PASA identifies LRC while ST PASA identifies LOR conditions based on determined capacity reserve levels.

AEMO’s response to an LRC or LOR, depends on the extent of the projected supply shortfall, and the timeframe in which it is projected to arise. AEMO’s potential responses include:

(a) Notifications to the market via reports, data, or market notices.
(b) Intervening in the market via directions under NER clause 4.8.9.
(c) Intervening in the market by dispatching contracted reserve.

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AEMO assumes that if a period of LRC or LOR is identified, there is a risk that the reliability standard may be breached.

2.3.1 Medium Term PASA (MT PASA)

AEMO implements the reliability standard over a two-year timeframe by providing an estimate of expected annual USE as part of the MT PASA process, which is run at least weekly.

MT PASA uses probabilistic modelling to estimate the likelihood and magnitude of USE in each half hour based on the availability that Registered Participants have offered, the expected demand estimated by AEMO, intermittent generation forecasts and estimated transmission constraints. This involves using time-sequential, security-constrained optimal dispatch simulations, incorporating Monte-Carlo simulations.

If the expected annual USE, averaged across the simulations, exceeds the maximum level specified by the reliability standard, a LRC is identified. The reliability standard is implemented by identifying, disclosing and responding to periods of forecast LRC.

AEMO’s response to projected LRC identified in MT PASA may be to take direct action in the form of directions – for example, directing a Generator to reschedule an outage – or using the RERT. The RERT currently allows AEMO to contract for reserves up to nine months ahead of a period where reserves are projected to be insufficient to meet the reliability standard (known as a projected reserve shortfall). AEMO is able to dispatch these reserves to manage power system reliability and, where practicable, security. From 1 November 2017, this period will reduce to ten weeks as the AEMC seeks to minimise the market distortionary effects of the RERT.

A detailed description of the MT PASA process is available on AEMO’s website as listed in section 1.3.

2.3.1.1 MT PASA generation capacity

AEMO uses the most recent MT PASA offers to derive total generation capacity and planned outage information on a half-hourly basis. The information is derived from several sources:

- Scheduled Generators are required to submit to AEMO a daily PASA availability.\(^\text{13,14}\) The availabilities submitted represent the generation capacity that could be made available within 24 hours, taking into account the ambient weather conditions at the time of 10% POE demand.
- Intermittent Generators submit capacity information, which is then used in AEMO’s process of forecasting available intermittent generation capacity (see section 2.3.1.1).
- Committed generation development and retirement projects are included in the capacity forecast by using expected commissioning and decommissioning timeframes and associated availabilities.

Forced outages are assessed probabilistically as part of MT PASA modelling. The probability of forced outages is based on historical performance or expert advice where historical performance is not available.

2.3.1.2 MT PASA intermittent generation

Modelling of intermittent generation is consistent with the ESOO. Intermittent generation profiles are derived for each generator from at least five historical weather years. Meteorological data, historical correlations and geographic locations are used to estimate output from new or committed intermittent generation. The probabilistic model samples from these generation profiles, maintaining linkages between the sampled intermittent generation profile and the corresponding demand profile. This allows the model to capture the varying

\(^{13}\)For MT PASA see NER Clause 3.7.2(d) and for ST PASA see NER Clause 3.7.3(e)(2).
\(^{14}\)PASA availability is a defined term in the NER: The physical plant capability (taking ambient weather conditions into account in the manner described in the procedure prepared under clause 3.7.2(g)) of a scheduled generating unit, scheduled load or scheduled network service available in a particular period, including any physical plant capability that can be made available during that period, on 24 hours’ notice.
contributions of wind and solar output to total supply, which is particularly relevant at times of high demand.

Significant non-scheduled intermittent generation (>30MW) is modelled explicitly as this generation can impact network constraints. Non significant non-scheduled intermittent generation is accounted for through adjustments to demand traces.

### 2.3.1.3 MT PASA energy constraints

As part of the MT PASA process, energy constrained Generators submit weekly energy limits. While these may represent the maximum energy available in any given week, units may not be capable of operating up to these weekly limits indefinitely. There may also be annual energy limits that are more constraining. Since the reliability standard is assessed annually, AEMO may also use information provided under the GELF or through generator surveys to set relevant annual energy constraints for MT PASA modelling. MT PASA modelling then allocates energy constrained generation to periods where forecast demand is high with respect to available capacity to minimise USE over the year.

### 2.3.1.4 MT PASA demand

For implementing the reliability standard, the forecast demand component of MT PASA is the same as used in the ESOO, with the exception that MT PASA uses “as generated” operational demand and ESOO uses “sent out” operational demand. The difference between “as generated” and “sent out” demand is the auxiliary load. AEMO will continue to report demand “as generated” for easy comparison against generation availability, and will calculate the auxiliary load within the MT PASA model as a function of generation dispatch. AEMO will use the best quality consultant and stakeholder information that can be accessed to forecast the auxiliary load.

AEMO converts the energy and maximum demand forecasts from the NEFR into at least five half-hourly demand profiles for each region, based on historical weather patterns. The demand profiles also incorporate NEFR assumptions on future DER such as rooftop PV, battery storage penetration and EV.

Extreme weather events are considered by using demand profiles derived from the 10% POE maximum demand forecasts. At a minimum, a combination of 50% POE and 10% POE demand profiles are sampled probabilistically in the Monte-Carlo simulations to develop the expected USE. At AEMO’s discretion, more POE demand profiles (such as 90% POE) may be included, if USE outcomes are expected to be materially different from 50% POE outcomes.

### 2.3.1.5 Network constraints

MT PASA uses the latest version of ST PASA formulation constraints (see Section 1.3) as a base set, with additional customised constraints, and network constraints to model future (committed) network and generation upgrades. AEMO constructs system normal and outage constraint equations for the MT PASA time frame.

Information to formulate network constraint equations is provided to AEMO by Transmission network Service Providers (TNSPs) via the Network Outage Scheduler (NOS) and limit advice. Within AEMO’s market systems, constraint equations are marked as system normal if they apply for all plant in service. To model network or plant outages in the power system, separate outage constraint equations are formulated and applied alongside the system normal constraint equations.

Detailed information on network constraints can be found in the network constraints documents listed in section 1.3.

### 2.3.2 Short Term PASA (ST PASA)

AEMO implements the reliability standard over a six-day timeframe by providing a capacity reserve assessment as part of the ST PASA process. Available capacity reserves are assessed.

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taking into account credible contingency events and estimated forecasting errors for the available capacity of scheduled generating units, the unconstrained intermittent generation forecast and Operational Demand, to indicate if supply is sufficient to meet demand and thereby avoid USE. If necessary, AEMO declares a LOR in accordance with clause 4.8.4 of the NER. The three levels of LOR are defined in the reserve level declaration guidelines which are developed according to the process established under clause 4.8.4A of the NER. In the ST PASA timeframe, it is not realistic to consider USE over a financial year in a six-day ST PASA timeframe. As ST PASA has access to short-term weather and participant offer information, it therefore has less input uncertainty than is the case for longer term forecasts such as MT PASA and ESOO. Given the proximity to operational timeframes, intervention decisions aim to minimise expected USE, with intervention being considered to address a forecast LOR2 or LOR3.

A detailed description of the ST PASA process is available on AEMO’s website.

2.3.2.1 ST PASA generation capacity reserve assessment
For the ST PASA six-day timeframe, AEMO assesses capacity reserve\(^\text{16}\) using a deterministic reserve assessment. If the reserve level for any region is less than the LOR1 level for that region, AEMO advises the existence of LOR1 condition for that region to the market. If the reserve level indicates a LOR2 or LOR3, AEMO may take action to restore the required reserve capacity by implementing an AEMO intervention event.

2.3.2.2 ST PASA intermittent generation
AEMO uses the Australian Wind Energy Forecasting System (AWEFS) and Australian Solar Energy Forecasting System (ASEFS) models to forecast ST PASA intermittent generation. The model outputs for ST PASA are a half-hourly generation contribution, based on 50% POE per facility.

The semi-scheduled intermittent generation forecasts are aggregated per region and then added to the scheduled generation capacity (participant PASA offers) of the associated region. Non-scheduled intermittent generation is subtracted from the associated regional demand forecast.

2.3.2.3 ST PASA scheduled generation capacity
The ST PASA draws information on scheduled generation from the availability data submitted with generators’ market offers. When a slow-start generating unit plans to be off-line at a specific time but could operate had it received a direction 24 hours previously, the PASA availability of that unit will indicate what capacity AEMO can assume at that specific time.

2.3.2.4 ST PASA demand
For the demand component, AEMO uses a 50% POE, 30 minute resolution, demand forecast\(^\text{17}\) for each NEM region. This forecast is produced by AEMO’s automated Demand Forecasting System\(^\text{18}\) (DFS).

The main inputs to the DFS are:
- a) Half-hourly historical demand for NEM regions.
- b) Historical and forecast weather data.
- c) Non-scheduled wind generation forecasts from AWEFS.
- d) Non-scheduled solar generation forecasts from ASEFS.


e) Calendar information such as weekday/weekend, school holidays, public holidays, and daylight savings information.

2.3.2.5 Energy constraints

As part of the ST PASA process, energy constrained generators submit daily energy availability forecasts. The ST PASA process then allocates this energy limited generation over the forecast period, maximising capacity reserves throughout the PASA period.

AEMO’s approach in the ST PASA timeframe is thereby to allocate constrained generation efficiently, usually to periods of high demand. AEMO assumes that this best reflects a likely market outcome that appropriately minimises forecast capacity shortfalls.

Capacity reserve is then assessed in accordance with the ST PASA process.

2.3.2.6 Network constraints

Capacity reserve is assessed in accordance with the ST PASA process. Even in the ST PASA timeframe, assumptions similar to those made in the ESOO process need to be made in formulating ST PASA network constraint equations, to address uncertainty around future power system conditions. The difference between ST PASA and ESOO constraints is that ST PASA assesses half-hourly snapshots of capacity reserves without taking into account the previous period’s dispatch. This means ST PASA cannot use certain types of data that are available to the dispatch and pre-dispatch systems, such as supervisory control and data acquisition (SCADA) terms. These terms provide previous period feedback in network constraints to reflect the real-time data collections. More detail on the preparation of PASA network constraints can be found in the ST PASA process description in section 1.3.

2.3.2.7 Extreme temperature events

Extreme ambient temperatures affect generation availability and forecast demand in the ST PASA timeframe.

For generation availability, the capacity offered by Generators is based on a predetermined temperature. In the event of an anticipated extreme weather event, Generators are required to revise their availability offers, with respect to a revised forecast temperature covering the extreme weather event. The revised generation availability offers are then assessed in accordance with the ST PASA process.

When forecast temperatures exceed regional reference temperatures, AEMO publishes a market notice reminding Generators to review the available capacities in their dispatch offers consistent with the forecast extreme temperature conditions. Further details are available in the Short Term Reserve Assessment operating procedure in section 1.3.

For demand, the AEMO DFS is periodically updated with forecast weather over the six-day forecast. Therefore extreme temperature events are automatically incorporated into the DFS as the event moves into the six-day forecast timeframe.
## 2.4 Summary of assumptions

### Table 4  Summary of assumptions

<table>
<thead>
<tr>
<th>ESERO</th>
<th>EAAP</th>
<th>MT PASA</th>
<th>ST PASA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>How is reliability standard implemented?</strong></td>
<td>Directly assess USE expectations based on probabilistic modelling.</td>
<td>Directly assess USE expectations based on probabilistic modelling.</td>
<td>Directly assess USE expectations based on probabilistic modelling.</td>
</tr>
<tr>
<td><strong>Demand</strong></td>
<td>Sampling 10% POE and 50% POE hourly profiles based on NEFR and historical weather patterns.</td>
<td>10% POE and 50% POE hourly profiles based on NEFR and historical weather patterns.</td>
<td>Sampling at least 10% POE and 50% POE half-hourly profiles based on NEFR and historical weather patterns.</td>
</tr>
<tr>
<td><strong>Intermittent generation</strong></td>
<td>Sampling hourly profiles based on historic weather patterns.</td>
<td>Sampling hourly profiles based on NEFR and historical weather patterns.</td>
<td>Sampling half-hourly profiles based on historic weather patterns.</td>
</tr>
<tr>
<td><strong>Scheduled generation capacity and outages</strong></td>
<td>Annual survey</td>
<td>MT PASA offers.</td>
<td>MT PASA offers.</td>
</tr>
<tr>
<td><strong>Energy constraints</strong></td>
<td>Monthly inflow of water assumed for hydro plants based on historical observations.</td>
<td>Provided through GELF.</td>
<td>Weekly energy constraints submitted by participants. Monthly inflow of water assumed for hydro plants based on historical observations. GELF information or additional voluntary information provided by participants may also be used where appropriate to assist in modelling annual energy constraints.</td>
</tr>
<tr>
<td><strong>Extreme weather events</strong></td>
<td>Use of both 10% POE and 50% POE.</td>
<td>Scenarios defined in the EAAP guidelines.</td>
<td>Use of both 10% POE and 50% POE.</td>
</tr>
<tr>
<td><strong>Network constraints</strong></td>
<td>System normal ST PASA type constraints, supplemented with customised constraints where appropriate.</td>
<td>System normal constraints.</td>
<td>System normal ST PASA type constraints, supplemented with customised constraints where appropriate. Planned outage constraints derived from the Network Outage Schedule information.</td>
</tr>
</tbody>
</table>