



---

# 2019 Reliability Forecasting Methodology Paper

---

**July 2019**

Calculating information required for reliability forecasts under the Retailer Reliability Obligation

---

# Important notice

## PURPOSE

This document outlines the methodology to be used by AEMO to calculate information required to produce a reliability instrument request for the purposes of the retailer reliability obligation (RRO) under Chapter 4A of the National Electricity Rules introduced on 1 July 2019.

It will be replaced with the Interim Reliability Forecasting Guidelines to be developed by the end of 2019, and as such is only expected to be applied in AEMO's 2019 Electricity Statement of Opportunities.

## DISCLAIMER

This document or the information in it may be subsequently updated or amended. This document does not constitute legal or business advice, and should not be relied on as a substitute for obtaining detailed advice about the National Electricity Law, the National Electricity Rules, or any other applicable laws, procedures or policies. AEMO has made every reasonable effort to ensure the quality of the information in this document but cannot guarantee its accuracy or completeness.

Accordingly, to the maximum extent permitted by law, AEMO and its officers, employees and consultants involved in the preparation of this document:

- make no representation or warranty, express or implied, as to the currency, accuracy, reliability or completeness of the information in this document; and
- are not liable (whether by reason of negligence or otherwise) for any statements or representations in this document, or any omissions from it, or for any use or reliance on the information in it.

## VERSION CONTROL

Version	Release date	Changes
1	12/7/2019	Initial publication

# Contents

<b>1.</b>	<b>Introduction</b>	<b>4</b>
1.1	Regulatory framework and terminology	4
1.2	RRO reliability forecasts	4
1.3	Structure of this document	4
1.4	Supplementary materials	5
<b>2.</b>	<b>Declaring a reliability gap</b>	<b>6</b>
2.1	Reliability forecast components	6
2.2	Forecast reliability gap materiality	6
<b>3.</b>	<b>Reliability gap period and likely trading intervals</b>	<b>7</b>
<b>4.</b>	<b>Size of the reliability gap</b>	<b>11</b>
<b>5.</b>	<b>Forecast one-in-two year peak demand</b>	<b>13</b>
5.1	Demand definitions	13
5.2	The one-in-two year peak demand forecast	14
<b>6.</b>	<b>Information published in a reliability instrument request</b>	<b>15</b>

## Figures

Figure 1	Monthly probability of lost load assessment	9
Figure 2	Weekday/weekend probability of lost load assessment	9
Figure 3	Time of day probability of lost load assessment (all months)	10
Figure 4	Conceptual example of the reliability gap	11
Figure 5	Conceptual example of the reliability gap	12
Figure 6	Operational demand definition, sent out versus as generated	13
Figure 7	Distribution of USE across months	15
Figure 8	Distribution of USE by time-of-day	16
Figure 9	Duration of USE events	16

## Tables

Table 1	Supplementary material	5
---------	------------------------	---

# 1. Introduction

## 1.1 Regulatory framework and terminology

The Retailer Reliability Obligation (RRO) was introduced into the National Electricity Law (NEL) and National Electricity Rules (NER) with effect from 1 July 2019 when the *National Electricity (South Australia) (Retailer Reliability Obligation) Amendment Act 2019 (SA)* came into force. The key components of the RRO can be found in Part 2A of the NEL and Chapter 4A of the NER.

This document used several terms that are defined in the NEL or the NER for the purposes of the RRO, and other NER-defined terms relevant to the preparation of reliability forecasts for the National Electricity Market (NEM). Please refer to the NEL and NER for definitions of these terms, including the reliability forecast, material reliability gap, reliability gap period, reliability instruments, reliability standard and unserved energy (USE).

## 1.2 RRO reliability forecasts

A key component of the RRO is the calculation of a five-year reliability forecast for each NEM region, to be published in AEMO's Electricity Statement of Opportunities (ESOO). If the forecast identifies a material reliability gap, this would trigger AEMO to submit a reliability instrument request to the Australian Energy Regulator (AER).

From the 2020 ES00, AEMO will be required to produce reliability forecasts in accordance with interim or final Forecasting Best Practice Guidelines to be developed by the AER, and Reliability Forecast Guidelines to be established subsequently by AEMO. However, the first reliability instrument could be triggered from the 2019 ES00, before these Guidelines are in place.

This methodology paper outlines the methodology to be used by AEMO in the 2019 ES00 to calculate key information to be included in the reliability forecast, and submitted with any reliability instrument request. The methodology was developed in consultation with industry between April and June 2019, and is intended to provide transparency of AEMO's forecasting approach in advance of formal Guidelines being developed.

The methodology describes how AEMO will determine the content of a reliability forecast, including the reliability gap, reliability gap period, and trading intervals subject to compliance.

This methodology paper will be superseded by the Interim Reliability Forecasting Guidelines to be developed by AEMO by the end of 2019.

## 1.3 Structure of this document

This methodology paper explains the key inputs and assumptions AEMO will use to determine whether a the reliability gap exists, and the methodology for determining the parameters of any reliability gap:

- Section 2 details the process for determining any reliability gap.
- Section 3 explains the process for determining the reliability gap period, and the trading intervals when shortfalls are likely to occur.
- Section 4 covers how the size of any reliability gap is calculated in megawatts (MW).
- Section 5 provides the definition used for the one-in-two year peak demand forecast.
- Section 6 outlines other information to be provided in a reliability instrument request.

## 1.4 Supplementary materials

This methodology paper focuses on the reliability forecast information calculations. For wider information about supply inputs and assumptions, demand forecasts, and the calculation of USE, refer to the supplementary information listed below.

**Table 1 Supplementary material**

Deliverable	Link
ESOO methodology paper – draft update	<a href="http://aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/ESOO-Methodology-Document-v2---draft-2019">http://aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/ESOO-Methodology-Document-v2---draft-2019</a>
Electricity Demand Forecasting Information paper – draft update	<a href="http://aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/Electricity-Demand-Forecasting-Methodology-Information-Paper---draft-2019">http://aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/Electricity-Demand-Forecasting-Methodology-Information-Paper---draft-2019</a>
Reliability Standard Implementation Guidelines – draft update	<a href="http://aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/Reliability-Standard-Implementation-Guidelines---draft-2019">http://aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/Reliability-Standard-Implementation-Guidelines---draft-2019</a>
Inputs and Assumptions workbook	<a href="https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/Inputs-Assumptions-Methodologies/2019/2019-Input-and-Assumptions-workbook.xlsx">https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/Inputs-Assumptions-Methodologies/2019/2019-Input-and-Assumptions-workbook.xlsx</a>

## 2. Declaring a reliability gap

AEMO's methodology for calculating expected USE uses the current ESOO framework, inputs, and assumptions specified in the Reliability Standard Implementation Guidelines (RSIG)<sup>1</sup> and explained in detail in the ESOO Methodology Document<sup>2</sup>.

### 2.1 Reliability forecast components

The components to be published by AEMO as part of any reliability forecast are defined in NER clause 4A.B.2:

*A reliability forecast and indicative reliability forecast for a region for each financial year must include the following:*

- (a) *AEMO's unserved energy forecast and whether or not there is a forecast reliability gap;*
- (b) *if there is a forecast reliability gap:*
  - (1) *the expected unserved energy for the forecast reliability gap period;*
  - (2) *the size of the forecast reliability gap (in MW);*
  - (3) *the forecast reliability gap period; and*
- (c) *if there is a forecast reliability gap in a reliability forecast, the trading intervals during the forecast reliability gap period in which the forecast unserved energy observed during the forecast reliability gap is likely to occur.*

AEMO's approach to calculate the reliability gap period and likely trading intervals is discussed in Section 3, while the size of the forecast reliability gap is explained in Section 4.

### 2.2 Forecast reliability gap materiality

The forecast reliability gap and its materiality are defined in NER clause 4A.A.2:

*For the purposes of section 14G(1) of the National Electricity Law, a forecast reliability gap occurs in a region in a financial year if identified in a reliability forecast and is material if it exceeds the reliability standard.*

#### **Note**

Section 14G(1) of the *National Electricity Law* states –

*A forecast reliability gap occurs when the amount of electricity forecast for a region, in accordance with the Rules, does not meet the reliability standard to an extent that, in accordance with the Rules, is material.*

The expected USE to compare against the reliability standard will be calculated using the same approach as applied in the ESOO, and in accordance with the RSIG. While AEMO may assess the reliability gap under a range of scenarios, the reliability gap that triggers a reliability instrument request will be based on the scenario AEMO considers most likely to eventuate, that is, a neutral or central scenario.

<sup>1</sup> Available at [http://aemo.com.au/-/media/Files/Stakeholder\\_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/Reliability-Standard-Implementation-Guidelines---draft-2019](http://aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/Reliability-Standard-Implementation-Guidelines---draft-2019).

<sup>2</sup> Available at [http://aemo.com.au/-/media/Files/Stakeholder\\_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/ESOO-Methodology-Document-v2---draft-2019](http://aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/ESOO-Methodology-Document-v2---draft-2019).

# 3. Reliability gap period and likely trading intervals

Where a material reliability gap is forecast for either T-3 or T-1, AEMO must (as in NER clause 4A.C.1) request the AER to consider making a reliability instrument.

AEMO's request for a reliability instrument must include at a minimum<sup>3</sup> the information required under section 14I(4) of the NEL:

- (i) the region in which the forecast reliability gap is forecast to occur;
- (ii) the first and last days of the forecast reliability gap period;
- (iii) for a request for a T-3 reliability instrument—the trading intervals, during the forecast reliability gap period, for which liable entities may be required to hold net contract positions that are sufficient to meet their share of the one-in-two year peak demand forecast for the forecast reliability gap period;  
*Example—*  
the trading intervals between 4pm and 8pm each weekday during the forecast reliability gap
- (iv) for a request for a T-1 reliability instrument—the trading intervals, during the forecast reliability gap period, for which liable entities will be required to hold net contract positions that are sufficient to meet their share of the one-in-two year peak demand forecast for the forecast reliability gap period if the T-1 reliability instrument is made;  
*Example—*  
the trading intervals between 4pm and 8pm each weekday during the forecast reliability gap
- (v) AEMO's one-in-two year peak demand forecast for the forecast reliability gap period.

AEMO determines the reliability gap period and likely trading intervals based on the interval USE outcomes observed in the market simulations.

AEMO uses thresholds on the probability of lost load to determine the reliability gap period and set of likely trading intervals where a reliability gap has been identified. This methodology and the thresholds have been adopted to eliminate the impact of outlier events influencing simulation results, and to instead focus on likely periods which would cover the majority of load shedding events in simulations, when annual USE is forecast to exceed the reliability standard.

To provide greater decision-making support, AEMO provides additional information that illustrates the distribution of USE events observed in the simulations with respect to month, day-of-the-week, and time-of-day, to help inform participants of the characteristics of the resources that could close the reliability gap.

The following approach is applied in determining the reliability gap period and the likely trading intervals both for T-3 and T-1:

- Months – the reliability gap is declared to exist in a month if the probability of lost load in that month exceeds 10%. The months identified are then used to determine the start and end date of the reliability gap period. AEMO applies a 'sense test' that could tighten the start- and end-dates of the reliability gap periods within each month, if all the risk in the simulations occurs in, say, the first or last weeks of the month.

---

<sup>3</sup> The AER's Reliability Instrument Guidelines, once developed, may expand on these minimum requirements.

- Day of the week – within each month that meets the lost load threshold, weekdays are declared as being within the reliability gap period. The weekends are declared as being within the reliability gap period if the probability of lost load on weekends exceeds 10%. The day-of-the-week classification will be used to describe the likely trading intervals of a shortfall.
- Time-of-day – a consistent time-of-day is applied across all month/day-of-the-week periods within a reliability gap period. The range of trading intervals is identified by determining the earliest and latest time-of-day where the probability of lost load exceeds 10%. All periods between these trading intervals are included.
- Excluded periods – consideration is given to whether there is a period of time within the reliability period that should be excluded, such as the Christmas/New Year period, or discrete months where likelihood of supply shortfalls is low, as per discussion below.

The reasoning behind this approach was detailed in AEMO’s addendum to its Reliability Forecasting Methodology Issues Paper<sup>4</sup> and Final Report<sup>5</sup>.

### **Approach to months within the reliability period that do not meet the threshold**

The reliability period may contain months which do not meet the lost load thresholds described above. AEMO applies the following treatment with regards to issuing a Reliability Instrument Request:

- Where there is no consecutive two-month period that does not meet the threshold (for example, November, January, and March are above the lost load threshold but December and February are not), a single instrument request is made which includes the month/s which did not meet the threshold.
- Where there is a consecutive period of two (or more) months that does not meet the threshold, two reliability instrument requests are submitted with different reliability gap period specifications. For the purpose of calculating the MW size of the reliability gap, the two (or more) reliability gap periods are considered together, due to the need to assess the additional MW required to meet the annual reliability standard.

If there is a single month or another period (for example, the weeks over the holiday period) where the risks of load shedding are observed to be low in the simulations, this period is excluded explicitly in the likely trading intervals. This removes the possible need for contracting cover during periods where the risk of load shedding is low while maintaining the administrative simplicity of a single instrument request in most cases.

This attempts to balance the cost of contracting for longer reliability gap periods against the risk of confusion and administrative burden if multiple reliability instrument requests are requested in the same financial year.

#### **Example**

The figures below (Figure 1 to Figure 3) show probabilities of lost load for a simulation at monthly, weekday/weekend, and time-of-day level. Based on the criteria above, the reliability gap period and trading intervals for T-3 would be defined as follows:

- Start date: 1 January.
- End date: 28/29 February.
- Weekends are excluded in both months.
- Trading intervals: 1.00 pm – 8.00 pm.

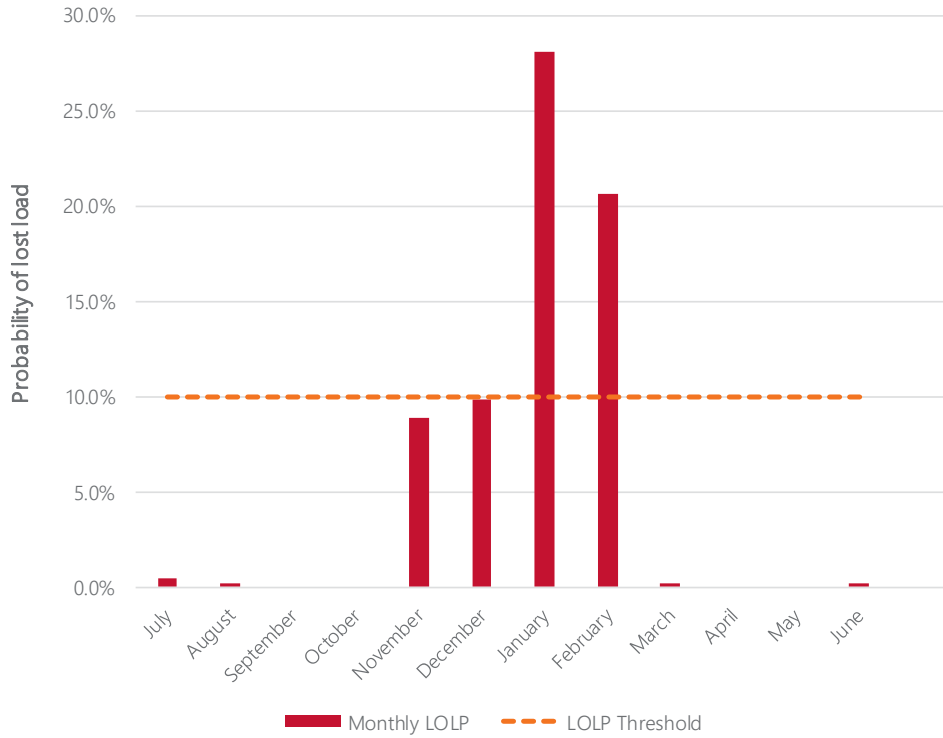
<sup>4</sup> See [https://www.aemo.com.au/-/media/Files/Stakeholder\\_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/Reliability-Forecasting-Methodology-Issues-Paper-addendum.pdf](https://www.aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/Reliability-Forecasting-Methodology-Issues-Paper-addendum.pdf).

<sup>5</sup> See [http://aemo.com.au/-/media/Files/Stakeholder\\_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/Reliability-Forecasting-Methodology-Final-Report.pdf](http://aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/Reliability-Forecasting-Methodology-Final-Report.pdf)

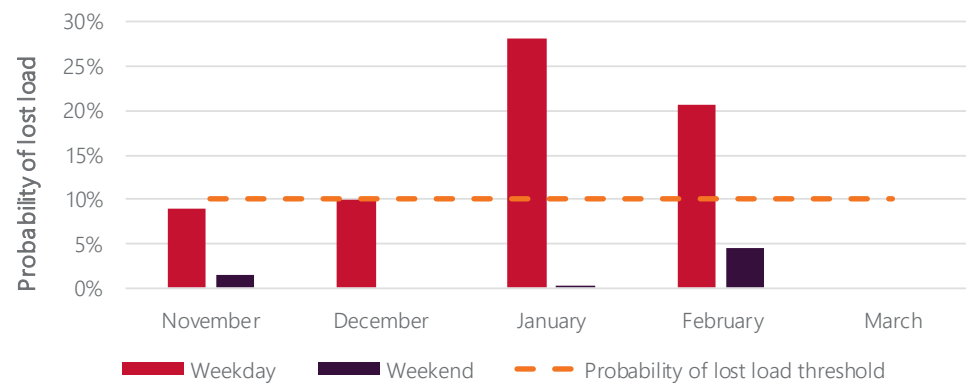


For T-1 reliability instrument requests, the reliability gap period and trading intervals are determined using the same approach, but are further confined to being a subset of the T-3 reliability instrument request reliability gap period and trading intervals.

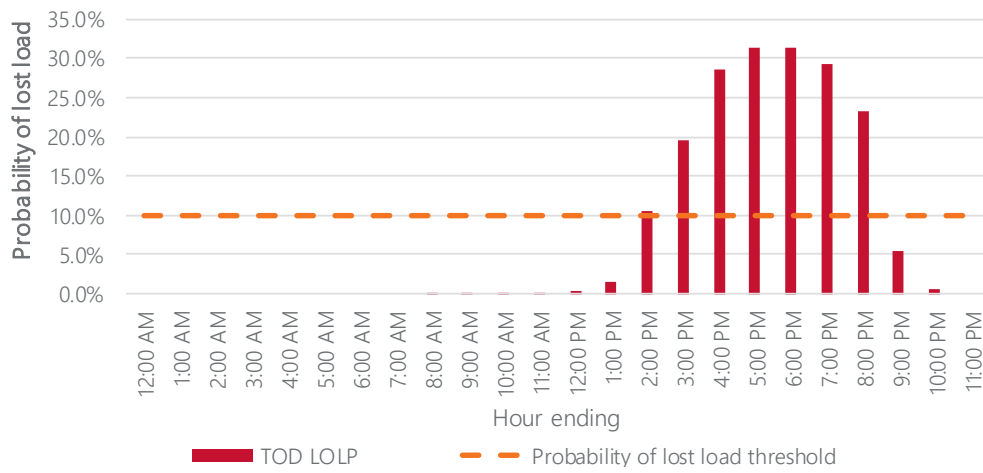
**Figure 1 Monthly probability of lost load assessment**



**Figure 2 Weekday/weekend probability of lost load assessment**



**Figure 3 Time of day probability of lost load assessment (all months)**



# 4. Size of the reliability gap

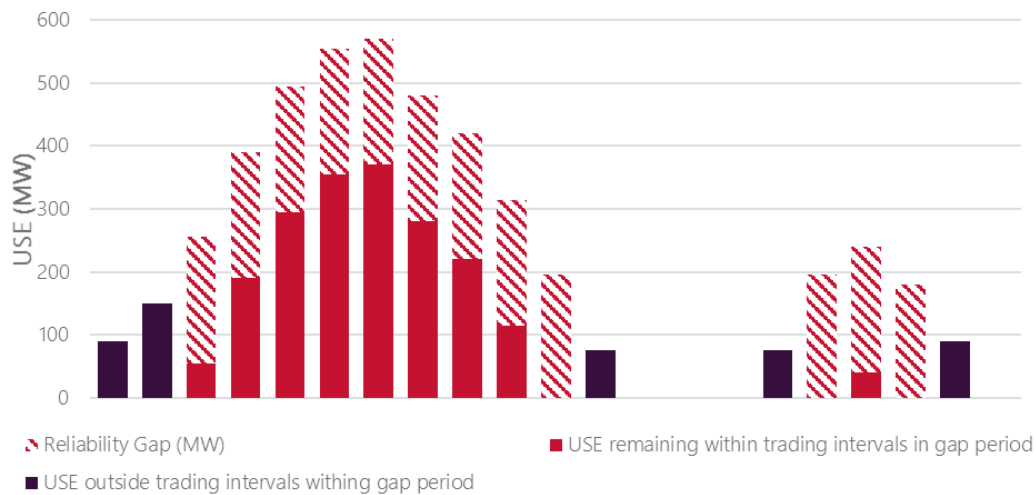
The size of the reliability gap, expressed in megawatts, is determined by analysing the interval level USE across all simulations in each region where the USE exceeds the reliability standard. The size of the gap is calculated as the additional megawatts of capacity, assumed to be 100% available, during all identified trading intervals within the reliability gap period only, that is required to reduce the annual expected USE to the reliability standard.

To better align with the actions available to liable entities under the RRO to ensure they have adequate contract coverage over the reliability gap period, the size of the gap is determined based on the effective response that additional reserves could provide if only procured to cover the reliability gap period and likely trading intervals identified. This means the gap (in megawatts) may be slightly larger than would otherwise be the case if those reserves were assumed to be available for the entire financial year.

The additional megawatts are assumed to be perfectly reliable and have no constraints such as a maximum hours of operation. Only a single megawatt value will be assessed per region for the entire reliability gap period. Different megawatt values may apply for multiple reliability instrument requests within a financial year, although the objective is still to assess the additional reserves required to bring expected USE below the reliability standard.

A conceptual example is provided below in Figure 4. In this example, some of the USE periods are specified as falling outside the reliability gap period. The figure shows the impact of 200 MW of additional capacity applied to USE periods that occur during the reliability gap period and likely trading intervals identified.

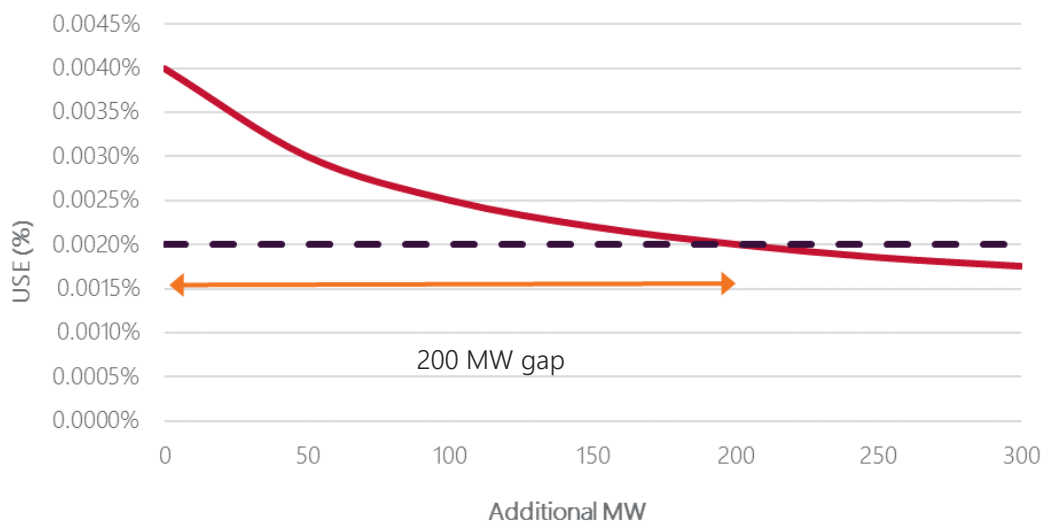
**Figure 4 Conceptual example of the reliability gap**



Note the x axis here represents two conceptual days (not necessarily contiguous) with the intervening time where no USE occurred being removed for the purpose of illustration.

Figure 5 follows from the example above, and shows the impact on annual USE from the application of the 200 MW of additional capacity. Here the reliability gap is calculated as 200 MW, the level of additional capacity required to bring USE to within the reliability standard when applied to USE in the relevant trading intervals within the reliability gap period.

**Figure 5 Conceptual example of the reliability gap**



### Sharing additional reserves

As the gap is determined independently in each region where the level of USE exceeds the reliability standard, the methodology does not consider the impact additional resources in one region may have on the size or existence of a gap in another.

For example, tight supply-demand conditions in Victoria and South Australia are often highly correlated. As such, it is frequently observed that additional capacity in Victoria would reduce the level of USE in Victoria but also in South Australia, and vice versa.

By determining the size of the gap in each region independently, the combined gap in megawatts may be bigger than the level that would be required to have both regions meet the reliability standard when allowing for reserve sharing.

AEMO considers this is not an issue for the purpose of the reliability gap calculation, because the relative size of the gap is used only for the allocation of any Procurer of Last Resort (POLR) cost to non-compliant parties between the two (or more) regions. The calculation of the quantity of any Reliability and Reserve Trader (RERT) procured (and therefore the total cost of RERT) will consider the effect of inter-regional reserve sharing.

# 5. Forecast one-in-two year peak demand

## 5.1 Demand definitions

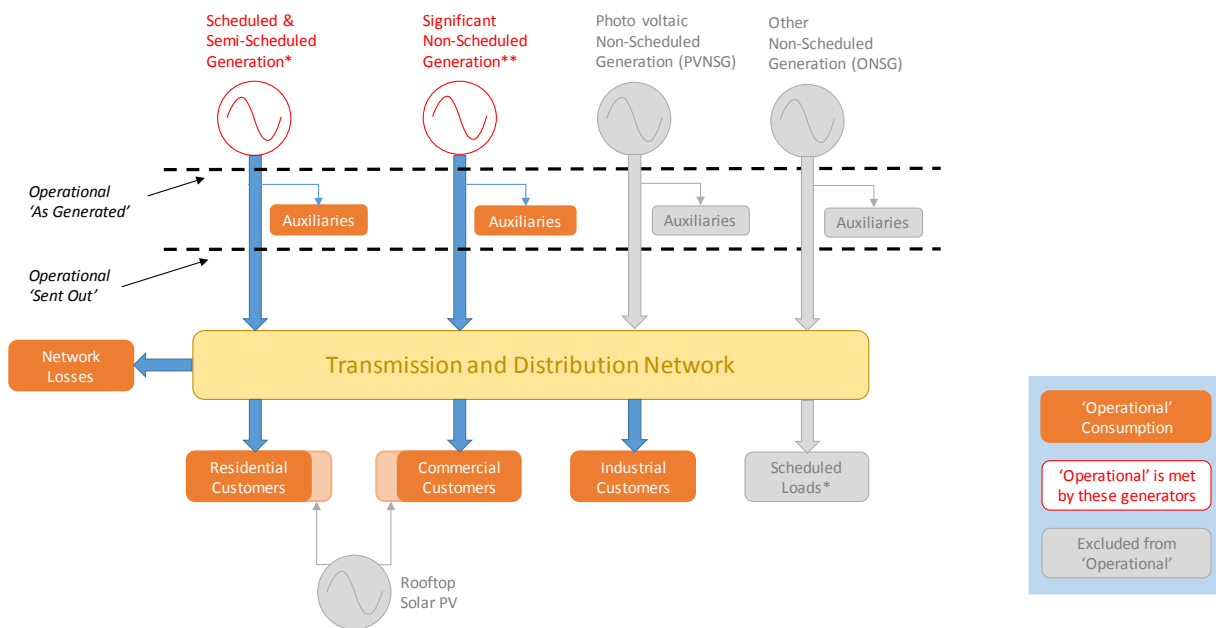
Demand can be measured at different points in the electricity network. AEMO’s reliability modelling is based on operational consumption/demand. This represents demand delivered from the transmission grid as produced by all scheduled, semi-scheduled, and significant non-scheduled generators<sup>6</sup>.

Operational demand can be defined in two different ways depending on where the generation delivered to the transmission grid is measured:

- **As generated** – this definition reflects the total generation produced by the generator before subtracting any internal consumption at that site, known as the auxiliary load or auxiliaries.
- **Sent out** – this definition reflects the generation actually delivered to the transmission grid.

This is illustrated in Figure 6.

**Figure 6 Operational demand definition, sent out versus as generated**



AEMO forecasts ‘sent out’ operational demand for the ESOO, because this directly reflects the consumption supplied from the grid. ‘As generated’, on the other hand, requires assumptions about how many coal-fired plants (which have by far the highest auxiliary loads) are generating at the time, which is uncertain due to forced outages in the shorter term and changes to the generation mix in the longer term.

However, because the NEM requires generator availability to be submitted on an ‘as generated’ basis, AEMO also uses this for its generator capacities in the ESOO supply modelling and models auxiliary load<sup>7</sup> to match the demand provided as ‘sent out’. The modelled auxiliary load at time of peak is provided as a forecast for auxiliary load and is used to convert the ‘sent out’ forecast of maximum demand to ‘as generated’.

<sup>6</sup> For a full explanation of AEMO’s demand definitions, see [http://www.aemo.com.au/-/media/Files/Electricity/NEM/Security\\_and\\_Reliability/Dispatch/Policy\\_and\\_Process/Demand-terms-in-EMMS-Data-Model.pdf](http://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Dispatch/Policy_and_Process/Demand-terms-in-EMMS-Data-Model.pdf).

<sup>7</sup> See [http://aemo.com.au/-/media/Files/Stakeholder\\_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/ESOO-Methodology-Document-v2---draft-2019](http://aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/ESOO-Methodology-Document-v2---draft-2019).

## 5.2 The one-in-two year peak demand forecast

The one-in-two year peak demand forecast is defined in the RRO Rules clause 4A.A.3:

For the purposes of section 14C of the *National Electricity Law*, the one-in-two year peak demand forecast for a *region* is:

- (a) the forecast made in accordance with the *Reliability Forecast Guidelines*; and
- (b) specified in a *reliability forecast* to be that forecast for that *region* for that *financial year*.

Note

Section 14C of the *National Electricity Law* states the one-in-two year peak demand forecast, for a region during a specified period, means the peak demand forecast in accordance with the *Rules* –

- (a) to occur for a *region* during the period; and
- (b) where the likelihood is that the forecast amount will be exceeded once in any two-year period.

For the purpose of the RRO, AEMO uses its 50% Probability of Exceedance (POE) operational forecast, converted from 'sent out' to 'as generated' forecast auxiliary load, as the one-in-two year peak demand forecast.

The use of 'as generated' for the one-in-two year peak demand forecast allows stakeholders to readily compare against demand in real time, because actual historical demand is reported ongoing by AEMO using this point of measurement<sup>8</sup>. Allowing comparison of forecast against actual demand in near to real time should provide liable entities with the opportunity to take action to reduce load when actual demand approaches the one-in-two year peak demand forecast.

---

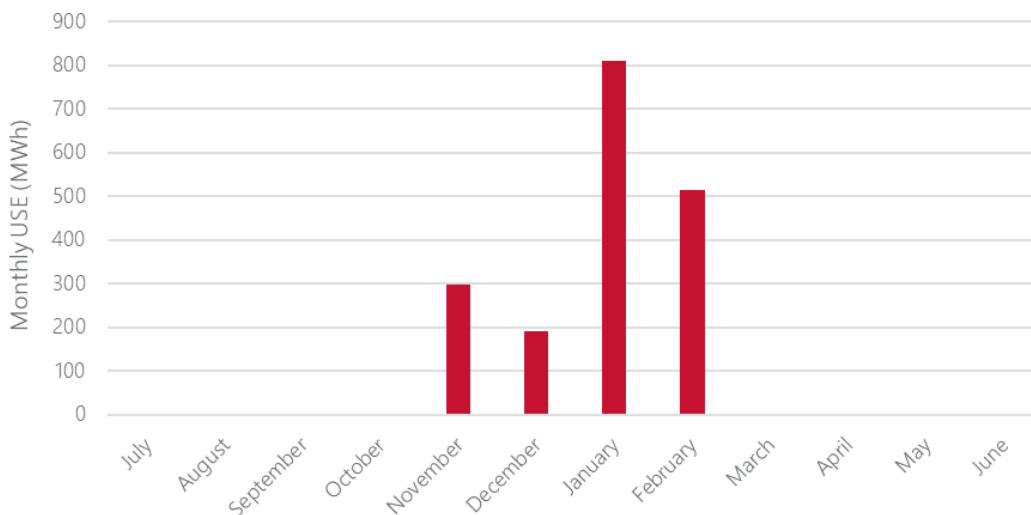
<sup>8</sup> See <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Data-dashboard#operational-demand>.

## 6. Information published in a reliability instrument request

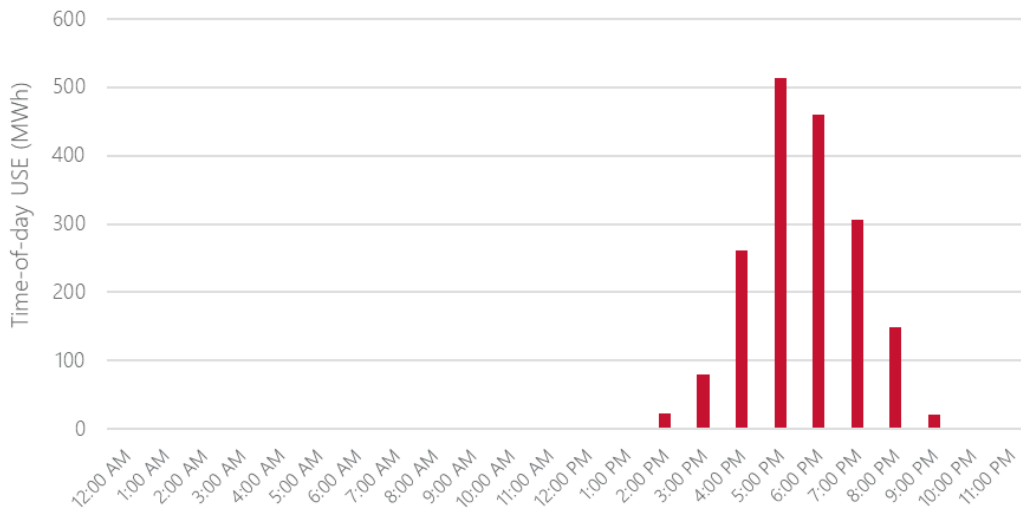
The NEL (Section 14I) specifies minimum information requirements for inclusion in a reliability instrument request. The AER's Reliability Instrument Guidelines will expand on these minimum requirements and outline the information that AEMO must provide when making a T-3 or a T-1 reliability instrument request for a region. At a minimum, AEMO provides the following:

- The forecast reliability gap, in megawatts, calculated using the method described in Section 4.
- The additional reserves required to reduce expected USE to below the reliability standard, assuming these reserves are available in all hours of the financial year (for information purposes only).
- First and last days of the reliability gap period, which will be based on the assessment of monthly USE as described in Section 3.
- The trading intervals during the reliability gap period where supply shortfalls are most likely to occur, which will consist of the specification of weekends/weekdays and the time-of-day range within the reliability gap period.
- The one-in-two year peak demand forecast as outlined in Section 5.
- The sensitivity of USE to additional capacity available during the reliability gap period.
- Additional information that helps illustrate observed USE in the simulations, including but not limited to the distribution of USE across months, and the distribution of USE duration. Example outputs are displayed below.

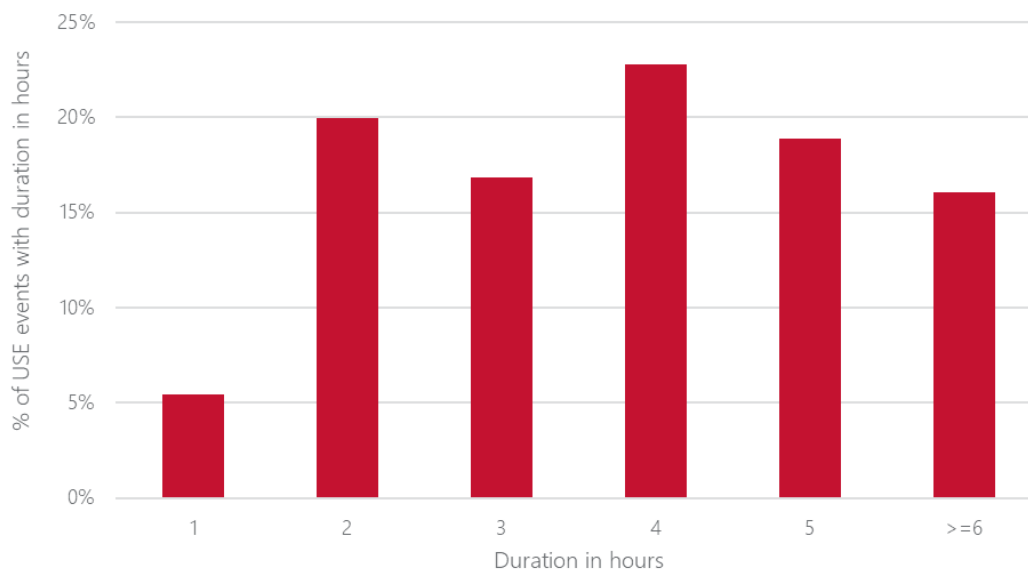
**Figure 7** Distribution of USE across months



**Figure 8** Distribution of USE by time-of-day



**Figure 9** Duration of USE events



A public version of the PLEXOS database used to perform the USE assessment will also be published along with all demand, intermittent generation, and distributed energy resources (DER) half-hourly traces. While confidential information will be obscured through aggregation, this should allow stakeholders to run their own analysis to better understand supply scarcity risks.