AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Reliability Forecasting Methodology

for the 2019 Electricity Statement of Opportunities

July 2019

Final Report

Important notice

PURPOSE

The publication of this Final Report concludes the consultation process conducted by AEMO on its proposed reliability forecasting methodology for the 2019 Electricity Statement of Opportunities for the National Electricity Market.

DISCLAIMER

This document or the information in it may be subsequently updated or amended.

AEMO has made every reasonable effort to ensure the quality of the information in this document but cannot guarantee its accuracy or completeness.

Anyone proposing to use the information in this document should independently verify and check its accuracy, completeness and suitability for purpose, and obtain independent and specific advice from appropriate experts.

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

Executive summary

The publication of this Final Report concludes the consultation process conducted by AEMO on its proposed reliability forecasting methodology for the 2019 Electricity Statement of Opportunities (ESOO) for the National Electricity Market (NEM), as outlined in AEMO's Reliability Forecasting Methodology Issues Paper[1].

This Report discusses the stakeholder submissions to the Issues Paper and explains the amendments AEMO has made in response.

The reliability forecasts are a critical input to triggering obligations under the Retailer Reliability Obligation (RRO) introduced on 1 July 2019.

Later in 2019, AEMO will commence consultation on interim Reliability Forecasting Guidelines that will apply for the 2020 ESOO and take into account the Australian Energy Regulator's Interim Forecasting Best Practice Guidelines.

In the absence of those Guidelines for the 2019 ESOO, AEMO has been consulting with all interested stakeholders on the methodology it will use to produce reliability forecasts for the 2019 ESOO. AEMO's objectives for this consultation were to apply the principles of transparency, accuracy, and engagement set out in the RRO rules, and to take account of reasonable stakeholder expectations in its forecasting approach.

AEMO began the consultation process on 17 April 2019, with the publication of the Reliability Forecasting Methodology Issues Paper. The Issues Paper sought industry feedback on whether the proposed methodology was appropriate for calculating key parameters required to accompany any reliability instrument request if triggered from the reliability forecasts to be published as part of the 2019 ESOO for the NEM. AEMO subsequently held an industry workshop on 9 May 2019, and invited written submissions until 22 May 2019.

AEMO received a number of valuable submissions from stakeholders. AEMO appreciates the submissions and other engagement throughout the process, which have helped refine the approach AEMO will use in preparing any reliability instrument request.

Substantial changes include:

- Adopting a threshold of 10% probability of lost load, for both the T-3 and T-1 years, day types and likely trading intervals.
- Assuming network reliability demand side participation programs are 100% available.
- Tightening of the definition of the Com* generator status and decision to include all Com* projects as fully committed from the end of the T-1 window onwards.

AEMO's final determination is the amended *2019* ***Reliability Forecasting Methodology Paper*** in the form published with this Final Report.

[1] For a copy of the Issues Paper, submission, and other related information, see http://aemo.com.au/Stakeholder-Consultation/Consultations/Reliability-Forecasting-Methodology-Issues-Paper.

Contents

Tables

1. Stakeholder consultation process

AEMO has been consulting on its Reliability Forecasting Methodology for use in the 2019 Electricity Statement of Opportunities (ESOO) for the National Electricity Market (NEM).

The table below outlines the consultation steps AEMO has undertaken.

Table 1 Consultation timeline

Consultation steps	Dates
Issues Paper published	Wednesday 17 April 2019
Industry Workshop	Thursday 9 May 2019
Submissions due on Issues Paper	Wednesday 22 May 2019 (late submission 17 June 2019)
Industry briefing	Friday 21 June 2019
AEMO Final Report and Methodology Paper	Friday 12 July 2019

All written submissions to AEMO's Issues Paper have been published on AEMO's website with this Final Report[2].

The publication of this Final Report marks the completion of the consultation and presents AEMO's response to the feedback received.

[2] See http://aemo.com.au/Stakeholder-Consultation/Consultations/Reliability-Forecasting-Methodology-Issues-Paper.

2. Background

The implementation of the Retailer Reliability Obligation (RRO) was agreed at the Council of Australian Governments (COAG) Energy Council meeting on 26 October 2018. The necessary legislative and National Electricity Rules (NER) changes took effect on 1 July 2019.

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

2.1 Reliability gap

These are key definitions of importance under the RRO. Forecast reliability gaps will be assessed for each NEM region individually and by financial year, consistent with the reliability standard[3].

Material forecast reliability gap

A material forecast reliability gap for a NEM region exists if the forecast expected unserved energy (USE) exceeds the reliability standard defined in the NER.

Reliability gap size

If a material forecast reliability gap is identified, AEMO is required to report the expected USE and the size of the forecast reliability gap in megawatts. AEMO proposes defining the size of the forecast reliability gap as the additional quantity of dispatchable[4] capacity or equivalent, that AEMO projects is needed during the reliability gap period to reduce the expected USE to the level that meets the reliability standard.

T-3 reliability gap

A T-3 reliability gap occurs if the third year of the reliability forecast identifies a reliability gap in a region. In the 2019 reliability forecast, this could occur in financial year 2022-23.

T-1 reliability gap

A T-1 reliability gap occurs if the first year of the reliability forecast identifies a reliability gap in a region and a T-3 reliability instrument exists for that same period. In the 2019 reliability forecast this could occur in financial year 2020-21 in South Australia only.

Reliability gap period

A reliability instrument request must include a defined reliability gap period, which specifies the start and end of the period(s) within the financial year where a material reliability gap is likely to occur.

Gap trading intervals

A reliability instrument must also specify the trading intervals within the reliability gap period where the supply shortfall is expected to occur. The contracting obligations under the RRO will only apply for the reliability gap period and the trading intervals listed in the T-1 reliability instrument.

---

[3] The reliability standard is defined in NER clause 3.9.3C and specifies that expected unserved energy (USE) should not exceed 0.002% of total energy consumption in any region in any financial year.

[4] The dispatchability of an energy resource can be considered as the extent to which its output can be relied on to 'follow a target', and incorporates how controllable the resources are, how much they can be relied upon, and how flexible they are. For more information, see AEMO's Power System Technical Requirements, March 2018, available at http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability.

Reliability instrument

If a material forecast reliability gap is identified at either T-3 or T-1, AEMO must make a request to the AER for a reliability instrument to be issued. If approved by the AER, the reliability instrument triggers a number of compliance obligations for liable entities under the RRO.

Under the South Australian application legislation[5], the Minister will also have powers to request the AER to make a T-3 reliability instrument for that region only 15 months in advance.

One-in-two year peak demand

For the period of any reliability gap identified in the reliability instrument, the RRO specifies a requirement for liable entities to have sufficient qualifying contracts in place to cover their share of a one-in-two year peak demand. Compliance will only be assessed if the actual demand for a trading interval exceeds the forecast one-in-two year peak demand within the reliability gap period and trading intervals defined in the T-1 reliability instrument.

2.2 Purpose of AEMO's consultation

The reliability forecast is a critical input to triggering obligations under the RRO. Therefore, AEMO has been consulting with all interested stakeholders on the methodology and input assumptions so as to maximise forecast accuracy and transparency, and engagement by applying the guiding principles set out in clause 4A.B.5 of the NER:

- Forecasts should be as accurate as possible, based on comprehensive information and prepared in an unbiased manner.
- The basic inputs, assumptions, and methodology that underpin forecasts should be disclosed.
- Stakeholders should have as much opportunity to engage as is practicable, through effective consultation and access to documents and information.

After the 2019 ESOO, AEMO will be required to produce reliability forecasts in accordance with Forecasting Best Practice Guidelines to be developed by the AER, and Reliability Forecast Guidelines to be established subsequently by AEMO. Interim versions of both Guidelines are to be made by the end of 2019, and final Guidelines in 2020-21.

On 17 April 2019, AEMO published the Reliability Forecasting Methodology Issues Paper[6] to explain the inputs, assumptions, and methodologies used to develop AEMO's reliability forecast. In particular, it set out the proposed methodology to be followed to determine the content of a reliability instrument request, including the forecast reliability gap, reliability gap period, and trading intervals subject to compliance.

AEMO subsequently held an Industry Workshop on 9 May 2019 to allow industry to ask questions about the issues raised to improve their understanding ahead of the submission deadline. The Issues Paper invited stakeholder submissions to respond to the following questions:

1. Transparency

1.1. Is the level of detail provided in this issues paper and referred methodology papers sufficient to allow you to constructively critique and provide feedback on the appropriateness of the methodology? If not, what additional information/explanations are required?

2. Open processes

2.1. In addition to this consultation and associated workshop, what other means of engagement could be considered for this year's ESOO, taking into account the time available and balancing timeliness and relevancy of information with need for consultation?

---

[5] *National Electricity (South Australia) (Local Provisions) Regulations 2019*

[6] See https://www.aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/Reliability-Forecasting-Methodology-Issues-Paper.pdf.

3. Accuracy and lack of bias

3.1. Are the proposed assumptions and methodologies for calculating supply and transmission inputs to the Reliability Forecast (e.g. forced outage rates and auxiliary loads) reasonable for the purpose of assessing unserved energy? If not, what refinements should be considered?

4. Reliability Forecast and reliability instrument methodologies

4.1. Are the outlined assumptions and approaches to calculate the reliability gap size, reliability gap period, and likely trading intervals reasonable?

4.2. Is the proposed demand definition to be used for the 1-in-2 year peak demand forecast reasonable? If not, what alternative definition should be considered and why?

4.3. Does the set of result visualisations provided in the conceptual example provide information that assists participants in responding to any reliability instrument? What additional information would support decision-making in response to any reliability instrument?

3. Summary of material issues

AEMO received feedback on a wide range of topics. At a high level, they can be grouped as feedback about:

- Method to establish reliability gap period and size.
- Assumptions and inputs.
- Other issues.

AEMO received feedback from 15 stakeholders (see Table 2) in the form of written submissions[7], and additional feedback through the workshops and one-on-one discussions. AEMO would like to thank all who provided feedback throughout this process.

Table 2 List of stakeholders providing feedback

Organisation	
Australian Energy Council (AEC)	Flow Power
AGL	Meridian Energy Australia (MEA) / Powershop
Energy Queensland (EQ)	Major Energy Users (MEU)
Energy Australia	Public Interest Advocacy Centre (PIAC)
Energy Consumers Australia (ECA)	Queensland Electricity Users Network (QEUN)
Energy Users' Association of Australia (EUAA)	Sliger & Associates
ENGIE	Snowy Hydro
ERM Power	

A detailed summary of issues raised in submissions and at meetings/forums, together with AEMO's responses, is contained in Sections 3 and 4.

The final methodology is documented separately in the *2019* ***Reliability Forecasting Methodology Paper***[8].

[7] The submissions are available on AEMO's consultation website: https://www.aemo.com.au/Stakeholder-Consultation/Consultations/Reliability-Forecasting-Methodology-Issues-Paper

[8] See http://aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/2019-Reliability-Forecasting-Methodology-Paper.pdf

4. Discussion of reliability forecasting issues

This section discusses the material issues raised in relation to the reliability forecast methodology proposed by AEMO for the 2019 ESOO, and key parameters that must be contained in any reliability instrument request.

4.1 Determining a material reliability gap

4.1.1 Issue summary and submissions

Under the RRO, if AEMO identifies a material forecast reliability gap, it must submit a reliability instrument request to the AER. The materiality of a forecast reliability gap is defined in clause 4A.A.2 of the NER.

> 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.

In the published Issues Paper, AEMO emphasised that the determination of a material forecast reliability gap requires assessment of expected USE against the reliability standard. The RRO requires this assessment of USE to be consistent with the approach outlined in the Reliability Standard Implementation Guidelines (RSIG)[9].

Several submissions (ERM Power, MEU) questioned the use of 10% Probability of Exceedance (POE) demand in the forecast of expected USE and whether this was consistent with the intent of the RRO which requires contracting to the one-in-two year peak demand level only.

AGL highlighted the risk that a small breach of the reliability standard may result in broad contracting obligations, and that there may be more efficient ways for resolving small breaches of the reliability standard.

4.1.2 AEMO's assessment

AEMO notes that use of 10% POE, 50% POE, and 90% POE maximum demand forecasts to form a view of expected USE is consistent with the RSIG as currently published, and this calculation was never intended to be revised as part of the RRO. AEMO has concerns that even the expected USE as calculated consistent with the RSIG, may leave consumers exposed to significant 'tail risk' under one-in-ten year peak demand conditions[10]. Using only the 50% POE demand forecast would be an inappropriate measure for reliability forecasting.

The issue of materiality was extensively consulted on by the Energy Security Board (ESB) during the design of the RRO mechanism. The RRO as designed, is based on a binary trigger. Any reliability forecasting

[9] See https://www.aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/Electricity_Consultations/2018/RSIG-Final/Reliability-Standard-Implementation-Guidelines-June-2018.pdf.

[10] See https://www.aemc.gov.au/sites/default/files/2018-11/Additional%20information%20from%20AEMO%20to%20support%20its%20Enhanced%20RERT%20rule%20change%20proposal.pdf

methodology proposed must necessarily reflect this feature and therefore the existence of a possible small breach is unavoidable. AEMO notes that if the size of a breach in the standard identified at T-3 is very small, participants will be able to address this through other means such that a gap would no longer exist at T-1. Some of these actions would be visible in the update to the forecast that would be provided at the T-2 point.

As required by the NER, AEMO will publish the size of any reliability gap in megawatts. Industry participants can then form their own view of the appropriate level of action to take, but AEMO would also highlight that even if the gap remains by T-1, retailers need only ensure they are contracted up their actual share of the 50% POE demand to eliminate any liabilities that could be incurred under the RRO.

4.1.3 AEMO's conclusion

AEMO will, and indeed must, continue to forecast expected USE in accordance with the methodologies set out in the RSIG in effect at the time of the forecast. A material reliability gap will be determined to exist if the expected USE exceeds the reliability standard, in accordance with the RRO provisions in the NER.

As envisioned in the Australian Energy Market Commission's final determination on the enhanced reliability and emergency reserve trader[11], AEMO will undertake a review of the ongoing appropriateness of its approach to operationalising the reliability standard described in the RSIG.

4.2 Calculating the reliability gap period

4.2.1 Issue summary and submissions

Where a material reliability gap is forecast for either T-3 or T-1, AEMO must ask the AER to consider making a reliability instrument.

AEMO's request for a reliability instrument must include, as a minimum, the information required under section 14I(4) of the National Electricity Law (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.

[11] See https://www.aemc.gov.au/sites/default/files/2019-05/Final%20Determination.pdf

AEMO's Issues Paper set out a proposal to use 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 were proposed 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 was forecast to exceed the reliability standard. The methodology was not intended to, and does not, represent a tightening of the reliability standard in any way.

These thresholds were proposed to be applied at a monthly level, for day type (working days or weekends), and at a time-of-day level, with a tighter threshold applied at T-1 than at T-3 in recognition of greater uncertainty the further into the future AEMO forecasts. AEMO issued an addendum to the Issues Paper[12] that laid out the reasoning for the proposed methodology and thresholds and provided a number of real examples based on outcomes of the 2018 ESOO.

A number of submissions, and discussions at workshops and forums, questioned the rationale behind this proposed approach, with many stakeholders seeking a statistical or economic analysis to support the use of probability of lost load choice of thresholds:

- ENGIE urged a statistical analysis to support the selection of thresholds.
- ERM Power (supported by MEU and QEUN) proposed an alternative solution which identified thresholds based on the probability of lost load that would be achieved in a market that exactly met the reliability standard.
- ENGIE, Flow Power, and MEU requested further detail on the reasoning behind the selection of probability of lost load thresholds and the level of the thresholds.
- AEC, Energy Australia, MEU, ERM Power, and ECA requested justification for using different thresholds at T-3 and T-1.
- The MEA and AGL submissions questioned whether the use of probability of lost load was inconsistent with the NER, the intention of the RRO, and AEMO's NEL obligations to identify a period in which the forecast unserved energy observed during the forecast reliability gap is likely to occur.
- AEC acknowledged in its submission that the technique requires judgement and that the proposed approach yields a period which they would expect a prudent retailer to be well contracted (although saying the threshold could be higher).
- Snowy Hydro and EUAA questioned the economic rationale for the threshold approach.

The main concern expressed through many of these submissions was that if the threshold is too low, then the reliability gap period and trading intervals may be too broad, ultimately leading to over-contracting and higher costs to consumers.

4.2.2 AEMO's assessment

AEMO is of the view that use of the probability of lost load thresholds is consistent with the NEL, as the threshold serves to filter out from the simulations trading intervals where supply shortfalls are less likely to occur. The existence of the gap remains tied to the reliability standard, and the choice of threshold has no bearing on the initial assessment of whether a material reliability gap exists. There is no way to specify which periods are above the reliability standard, because the standard is based on annual outcomes.

AEMO has acknowledged, both in the Issues Paper and in the forum, that no economic cost-benefit analysis has been conducted in designing this methodology or determining the appropriate thresholds. The costs of over- or under-estimating the reliability gap period and likely trading intervals where shortfall may occur are unknown. If overly broad, the market may over-contract. If too narrow, there may be insufficient market response, leading to greater reliance on Reliability and Emergency Reserve Trader (RERT). Without visibility of

[12] See https://www.aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/Reliability-Forecasting-Metholodology-Issues-Paper-addendum.pdf.

these cost trade-offs, it is not possible to justify the choice of reliability gap period and likely trading intervals based on an economic cost-benefit assessment.

The exact thresholds have been selected by assessing different levels against historical USE outcomes to find a level that would include most, but not all, forecast USE. Based on feedback from submissions, and subsequent analysis of a number of forecast years from the 2018 ESOO, AEMO analysis suggests a 5% threshold (as proposed in the Issues Paper for both monthly, day type, and time of day trigger at T-1) will capture at least 90% of forecast expected USE in any year. A 10% threshold would capture up to 90%, but in certain cases less than 70%. An even higher threshold would risk capturing less than half the USE on occasions.

Following discussions with ERM, AEMO has analysed their methodology further. It was based on determining thresholds (probability of lost load in a particular half-hour) based on a market with just sufficient capacity to meet the reliability standard. When compared with the USE in a system that breaches the standard, all periods would exceed this dynamically calculated threshold and result in a reliability gap period that covers any period where USE occurred in the simulations. This would be wider and more conservative than the 5% and 2% thresholds originally proposed by AEMO and be essentially the same as not applying any threshold at all.

While this particular proposal proved to be unworkable, AEMO is interested in further exploring other alternatives as part of its consultation on the Interim Reliability Forecasting guidelines later in 2019.

4.2.3 AEMO's conclusion

On balance, AEMO considers that a threshold of 10% probability of lost load, for both the T-3 and T-1 years, helps to address some stakeholder concerns while still covering the majority of supply scarcity risks identified in the simulations.

4.3 Multiple reliability instrument requests, start and end dates

4.3.1 Issue summary and submissions

In AEMO's original proposed methodology, the reliability gap period specified may contain months which do not meet the probability of lost load thresholds described above. In the Issues Paper, AEMO proposed to apply the following rules with regards to issuing a Reliability Instrument Request in those circumstances:

- Where there is no consecutive two-month period that does not meet the threshold (for example, November, January, and March are above the probability of lost load threshold but December and February are not), a single instrument request will be 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 will be submitted with different reliability gap period specifications. For the purpose of calculating the megawatt size of the reliability gap, the two reliability gap periods will be considered together, due to the need to assess the additional megawatts required to meet the annual reliability standard.

Flow Power's submission commented in detail on the calculation of the reliability gap periods. Flow Power questioned why the number of reliability instrument requests is limited to two, and provided an alternative suggestion to request multiple reliability instruments in any given year where a material reliability gap has been identified. Flow Power provided examples indicating that AEMO's approach would result in many instances where months that do not exceed the probability of lost load threshold are included in the gap period.

The MEA submission expressed the concern that the use of months in defining the reliability gap period might result in the reliability gap period being unnecessarily and excessively extended, and that applying a 'sense test' could address this issue.

4.3.2 AEMO's assessment

AEMO would like to clarify that it only proposes to split the reliability gap into multiple reliability instruments if there are two consecutive months within the reliability gap period with low risk of supply shortfall. There is no restriction on the number of reliability instrument requests that can be made in each year.

With respect to Flow Power's concern around having a single reliability gap period with multiple months of little to no scarcity risk, AEMO notes that while this may be possible if all months were equally likely to exceed the threshold, in reality the risk of USE is highest in January and February and generally declines for months that are further from the central summer months. Therefore, the likelihood of having a single reliability gap period spanning multiple non-contiguous months of supply shortfall risk is low.

AEMO takes on board the potential negative impacts of including months which do not meet the threshold in the reliability gap. This needs to be balanced against the risk of confusion and administrative burden if multiple reliability instrument requests are requested in the same financial year.

AEMO has adjusted its approach to address both concerns. The approach to splitting the reliability gap period will be unchanged, that is, a reliability gap will only be split if there are two consecutive months that do not meet the threshold for the probability of lost load. However, 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 will be excluded explicitly from 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.

AEMO also accepts MEA's proposition, and has adjusted its approach to allow AEMO to subjectively tighten the gap period (there will be no ability to subjectively extend the period). For example, if all the risk in the simulations (across all reference years) occurs in the first week of March, and March is above the probability of lost load threshold, the end date of the gap period could be set for end of the first week in March.

4.3.3 AEMO's conclusion

When a material forecast reliability gap has been determined, AEMO will calculate the reliability gap period and trading intervals where supply shortfalls are likely to occur as follows:

- **A probability of lost load threshold of 10% will be used for both T-1 and T-3 to determine months to include within the reliability gap period. AEMO will apply a 'sense test' that could tighten the start-dates and end-dates of the reliability gap periods:**
  - **Any two-month gap between months where the threshold is exceeded will trigger a separate instrument request.**
- **Within each gap period, the probability of lost load will be calculated for each time-of-day and for weekends and weekdays. The set of likely trading intervals will be assessed separately within each reliability gap period based on a 10% probability of lost load threshold.**
  - **Where a single month within the gap period does not exceed the threshold, AEMO will consider the results and may exclude this month from the likely trading intervals if the risks of load shedding are low.**
  - **AEMO will also consider exclusions within the gap period for other reasons if a defined period exists where the risk of load shedding is low, for example the Christmas-New Year period.**

AEMO considers that the above approach should address many of the concerns raised by stakeholder around the level of conservatism, the difference between T-3 and T-1 thresholds, and reliability gap periods that are extended over periods where risks are low, while still identifying the periods most at risk of supply shortfalls.

4.4 Determining the size of the gap

4.4.1 Issue summary and submissions

AEMO proposed to determine the size of the gap by using the interval level USE simulation data from the reliability forecast. The gap will be determined by assessing the additional megawatts of capacity required to reduce USE to be at the reliability standard, when applied to periods within the reliability gap period. The capacity is assumed to be fully firm and reliable over these periods only.

ERM Power argued that only assuming the additional capacity is available within the reliability gap period would artificially increase the size of the gap, as it implies that the additional reserves would not be available to reduce USE more generally. ERM Power also expressed concern that any inflated reliability gap (expressed in megawatts) could result in government intervention or unfounded alarm if market response is lower than this megawatt gap level, even if the market response is forecast to successfully address supply scarcity risks.

AGL raised concerns regarding the proposed approach not considering reserve sharing, as this would not account for the benefits from interregional generation when calculating the size of the gap.

4.4.2 AEMO's assessment

AEMO does not consider that limiting the reliability gap calculation (in megawatts) to trading intervals identified within the reliability gap period would artificially inflate the assessment, as ERM Power suggests, because the intention of the RRO is to encourage sufficient contracting within the period where compliance is enforced. To assume that any additional megawatts procured to fill the gap are available at all times would be to assume a certain response, for example the entry of new generation. This is not the intention of the RRO, and would not be a technology-neutral approach, because it precludes other means of addressing the reliability gap such as demand response or virtual power plants (VPPs).

However, to provide more information to market to support decision making, AEMO will also report an equivalent reliability gap (expressed in megawatts) assuming capacity was available at all times of the year in any reliability instrument request. In the event of a compliance trigger, the reliability gap (expressed in megawatts) on which the Procurer of Last Resort (POLR) costs are apportioned will still be based on assumed availability during the reliability gap period and trading intervals only.

On the issue of reserves sharing, this was considered by ESB as part of the design process and decided that it was a complication that was not warranted given that the size of the gap is used for POLR cost allocation only. AEMO notes the proposed methodology is expected to provide the appropriate incentives in this context and that AEMO will account for potential reserves sharing during the POLR process instead, so the magnitude of RERT purchased will be lower should interregional generation be deemed available.

4.4.3 AEMO's conclusion

AEMO will continue to calculate the size of the reliability gap (in megawatts) required to reduce the annual expected USE to the reliability standard, based on the assumption that the additional megawatts are 100% available during all identified trading intervals within the reliability gap period only.

For information purposes only, AEMO will also report the size of any reliability gap assuming availability at all times of the year.

AEMO will make no adjustment for reserve sharing.

4.5 Definition of one-in-two year peak demand forecast

4.5.1 Issue summary and submissions

The one-in-two year peak demand forecast is defined in NER 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.

AEMO proposes to use its 50% POE operational 'as generated' forecast for the season within which the reliability gap period falls as the one-in-two year peak demand forecast. The use of 'as generated' for the one-in-two year peak demand forecast will allow stakeholders to readily compare against demand in real time, because actual historical demand is reported ongoing by AEMO using this point of measurement[13].

Energy Queensland requested the one-in-two year demand forecast be reported at the regional reference node (RRN) in addition to "as-generated" and "sent out", because retailers settle purchases as "Generation at the [regional reference node (RRN)]" and this definition would be more suitable for them.

4.5.2 AEMO's assessment

AEMO understands that retailers may intend use of the one-in-two year demand forecast to help determine how much dispatched load must be purchased at the RRN. It is considered that the use of a forecast expressed at the RRN would still require further translation to convert it to a single retailer's portion of the total. Furthermore, the demand forecast is a probabilistic forecast and not specific to any one single day or period. In reality, the relative portions of total demand required to be backed by qualifying contracts by each retailer may change throughout the different time bands of the gap period(s), leading to uncertainty in any translation results.

A second consideration is that USE and the gap periods will be determined on an as-generated basis and reported in near-real-time on this basis, therefore other demand reporting measurement points are less relevant.

4.5.3 AEMO's conclusion

The one-in-two year peak demand forecast will be the 50% POE operational 'as generated' forecast for the season within which the reliability gap period falls.

4.6 Treatment of demand side participation and virtual power plants

4.6.1 Issue summary and submissions

There is some confusion around how demand side participation (DSP) and VPPs that are included in qualifying contracts should impact either the one-in-two year peak demand forecasts or the reliability forecast more generally.

ERM Power believed that AEMO was intending to apply an assumption that DSP will be comprehensively included in qualifying contracts under the RRO, and consequently had not included DSP against its

[13] See https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Data-dashboard#operational-demand.

one-in-two year peak demand forecast. ERM questioned this assumption and considered it should only be used if evidence was provided that supports the assumption.

MEA highlighted that some of the assumptions around one-in-two-year peak demand forecast, for example "the assumption that all (VPPs) are to be included in qualifying contracts" should be tested and continuously monitored. They also suggested a VPP participation factor be included in the process (that is, to set out what percentage of VPPs is included in base demand) and adjust it each year based on prior experience.

4.6.2 AEMO's assessment

AEMO's demand forecasts always assume no response of DSP. Instead, DSP is assumed as a supply option that can help meet demand above certain price thresholds.

From a supply adequacy perspective, whether demand response is registered as a qualifying contract or not has no impact on its effectiveness in addressing supply scarcity risks. Most of the time the power system would have sufficient reserves and prices would be sufficiently low to not trigger any significant DSP response. Lowering the forecast (by assuming DSP is always activated) could increase the number of periods actual demand would exceed the threshold and thus the periods in which liable entities would be checked for compliance.

AEMO is monitoring progress in VPPs closely and agrees that it is appropriate to adjust the level of VPPs included in the simulations over time, based on market changes. However, as with DSP, whether or not to treat VPP as qualifying contracts should not impact its ability to help alleviate supply scarcity risks and therefore the calculation of USE, or the one-in-two year demand forecast.

4.6.3 AEMO's conclusion

Irrespective of whether DSP and VPPs are submitted as qualifying contracts or not, AEMO's demand forecast will assume no response from either source, and instead will allow the DSP and VPPs to respond to price (or supply scarcity) in the modelling simulations. The potential contribution of DSP and VPP to reducing risk of load shedding will therefore be captured in the reliability forecast.

5. Discussion of assumptions and inputs

In addition to the specific comments related to the reliability gap period and size, stakeholders raised a number of broader issues raised around inputs and methodology used to assess USE. While the approach to developing specific inputs for use each year in assessing reliability forecasts will necessarily be operationalised, following consultation, any material changes to the approach that impacts the implementation of the reliability standard will need to be consulted on formally and changed within the RSIG. Points of clarification and/or minor adjustments are discussed below.

5.1 Demand forecasts

5.1.1 Issue summary and submissions

AEMO's demand forecast methodology and supplementary materials are published on its website and updated periodically as information changes[14]. The forecasting approaches, inputs, and assumptions are also extensively consulted on through AEMO's monthly Forecasting Reference Group and specialist workshops. Key inputs that may materially impact the USE calculations were also highlighted in AEMO's Issues Paper.

A number of questions of clarification around methodology and inputs were raised in the submissions, with many stakeholders expressing concerns that AEMO's proposed assumptions were overly conservative for use in the RRO:

- ERM Power, MEU, and AEC questioned the scaling of reference year demand to meet 10% POE targets and whether distortions would occur as a result of this approach. Several alternative approaches were proposed.
- AEC suggested AEMO adopts economic advice to guide decisions on the likelihood of industrial closures and subsequent inclusion in the forecast, rather than adopt only what is formally announced.
- Two suggestions were received requesting further information and clarification around the expected performance of energy efficiency in extreme weather and how AEMO has identified and addressed this in the forecasts.
- ERM and MEU questioned the use of the 50th percentile of historical responses for DSP, suggesting this would be a conservative estimate and asking if the estimate can be verified from key historical events.
- A number of submissions (QEUN, ERM, and MEU) noted the level of DSP is likely to increase over time driven by a number of initiatives, such as market rules changes to promote growth in DSP as a resource.
- AEC rejected AEMO's proposal to apply a 50% availability factor on the contribution of network reliability programs (see below for context).

AEMO's DSP forecast is based on two components:

1. Market-driven DSP (responding to prices), and
2. Network reliability programs (called on a very limited number of high demand days per season).

In the Issues Paper, AEMO set out a proposal to apply a 50% availability factor on the contribution of network reliability programs. This proposal was based on the understanding that the number of times these programs

[14] Updates will be published on AEMO's NEM Electricity Demand Forecasts webpage, at https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/NEM-Electricity-Demand-Forecasts.

can be called within a year is limited and therefore they may not always be available at times when needed by the system, for example in Victoria on 25 January 2019.

AEC rejected this proposal in its submission, and argued that in other areas, such as generator maintenance and hydro management, AEMO does not consider operational ineffectiveness. Instead, perfect foresight is assumed, with supply (or demand response) able to optimally manage its limited availability to target the periods where it is most needed.

5.1.2 AEMO's response

Scaling of traces

AEMO thanks stakeholders for their suggestions on the issue of scaling historical demand traces to match future expectations of maximum demand and consumption, and has previously recognised this issue as needing further review.

AEMO has undertaken some historical analysis and found that there may be minor issues associated with the scaling of benign reference years, but the scaling does not necessarily result in patterns of demand that have not been seen in more extreme summers historically. AEMO currently scales the top 10 days of demand to meet peak demand targets, although not all of these days are scaled to meet the peak demand target; rather they are scaled to preserve the relativity between the 10 days historically. This means that in a benign year where no one day was exceptionally peaky, it may be more likely for there to be a high number of days in the future scaled trace that are near to the target peak.

Based on this review, AEMO is proposing to revise the approach to scaling to reduce the number of days which are subject to scaling to reflect 10% POE conditions, from 10 days down to four. This is broadly consistent with the number of days near to extreme peaks that have been observed historically in New South Wales (2016-17), Victoria (2013-14), South Australia (2013-14), and Queensland (2017-18).

Large load closures

AEMO agrees that information on the likelihood of large load closures would ideally be available to AEMO, and AEMO should retain its discretion to assume a future closure on a case by case basis. AEMO acknowledges that including closures only when announced may result in demand being over-forecast under a small set of circumstances, however it also prevents under-forecasting due to inclusion of closures that do not eventuate. The approach is viewed as being neutral and not conservative, because it does not assume improvements in future supply adequacy (due to demand reductions) without some level of certainty.

Energy efficiency assumptions

AEMO engaged Energy Efficient Strategies to undertake thermal modelling of a range of building types, air-conditioning appliance efficiencies, and climate conditions. The consultant's analysis found improved building insulation had less impact on cooling needs on extreme days than average days.

The effect from existing building stock is already captured in the existing maximum demand forecast, so no adjustments are made in the initial year. However, based on building stock changes out to 2040, AEMO has calculated 3.4% reduction in cooling efficiency on extreme days, and AEMO's model will gradually reach this level.

Demand side participation forecasts

AEMO accepts AEC's logic with respect to perfect foresight for network reliability programs and will continue to assume these programs are fully available at times of extreme peak demand.

For market-driven DSP, AEMO first wants to clarify that its approach is not to assume 50% of the historically observed response. Rather, it sees the 50th percentile of historical response as the best estimate of expected DSP (half the time response will be higher, half the time it will be lower). In AEMO's view this is not conservative, noting that DSP, like other supply options, is not 100% reliable at all times.

AEMO has looked at DSP response during key historical events and found that while events with actual Low Operating Reserve (LOR) 2 and LOR 3 conditions are rare[15], the observed DSP response at these times generally aligns with the DSP forecast, noting the very small sample size. AEMO briefly discussed DSP in its Summer 2019 Forecast Accuracy Update[16], and will expand on it in future Forecast Accuracy Reports.

However, as market changes facilitate growth in DSP, using historical data to estimate future capability will become less appropriate. As experience is gained in reporting, understanding and validating future DSP opportunities, future growth may be forecast. For the 2019 ESOO, AEMO will maintain a current estimated level of DSP, consistent with other supply options, which are only included if committed. For future ESOOs, AEMO will consider adding future growth once communicated as a qualifying contract through its DSP Information Portal.

5.1.3 AEMO's conclusion

AEMO's demand forecasting methodology for 2019 will be updated to include clarification on the above topics. In summary:

- **Scaling of historical demand traces to meet target maximum demand forecasts will be limited to the four peakiest days in the historical trace, rather than the 10 days previously assumed.**
- **AEMO will retain discretion to assume future large load closures before they are publicly announced, based on the best information it has available to it.**
- **Trends in energy efficiency effectiveness at time of maximum demand will be applied based on consultant's advice, equivalent to a 3.4% reduction in cooling efficiency impact by 2040.**
- **All DSP from network reliability programs will be assumed to be available in the reliability forecasts.**
- **For market-driven DSP, the 50th percentile of historical response will continue to be assumed.**
- **In future, if growth in DSP qualifying contracts is indicated through AEMO's DSP portal, and can be verified, this will be included within the forecasts.**

5.2 Distributed energy resources

5.2.1 Issue summary and submissions

Distributed energy resources (DER) are rapidly changing the supply-demand balance in the NEM, and AEMO is closely following developments and adapting its forecasts and approaches when appropriate. In particular, AEMO is actively working with the Energy Networks Australia (ENA) on a body of work to enable DER integration and optimisation, which is expected to accelerate and facilitate DER (and DSP) uptake.

A number of questions were raised regarding AEMO's intended approach to forecasting DER and VPPs.

EQ recommended AEMO improve its collection of data of DER systems. ERM requested clarification regarding:

- How AEMO would use two differing DER forecasts from consultants to form a view on future DER for use in its demand forecasts.
- AEMO's methodology for assessing large commercial- and industrial-based photovoltaic (PV) systems (100 kilowatts [kW] to 5 MW).
- AEMO's methodology used for distributed storage, specifically battery discharge capacity and storage capability on high demand days.

[15] Lack of Reserve notices are issued when there are insufficient reserves to meet largest contingency (LOR2) or insufficient capacity to meet demand (LOR3). See National Electricity Rules, rule 4.8.4 for definitions.

[16] See https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/Accuracy-Report/2019-Summer-Forecast-Accuracy-update.pdf .

5.2.2 AEMO's assessment

AEMO is actively working to improve the quality of the available historical DER data, including:

- Obtaining more data from the Clean Energy Regulator (CER) including Energy Storage Systems (ESS) and non-scheduled PV generators. Previously AEMO only received information about rooftop PV installations from the CER.
- Improving data collection with the establishment of the DER register at the end of 2019.
- Seeking electric vehicle data as part of wider collaboration efforts across industries.

For large commercial- and industrial-based PV systems, AEMO uses installation data provided by the CER along with installation data sourced from the Australian PV Institute. Checks are also performed against AEMO's Generation Information webpage[17] to ensure the forecasts are made for non-scheduled systems only.

In recognition of the materiality and uncertainty in future DER, AEMO has sought two independent assessments of future DER uptake to inform this year's ESOO. AEMO acknowledges that the two consultants provided significantly different outlooks, particularly for ESS, and this reflects the large uncertainty associated with future uptake of emerging technologies. AEMO has reviewed the different consultant forecasts, discussed them with industry at numerous workshops and on a scenario-by-scenario basis selected the projections that align best with the scenario narratives. Only the Central scenario projections are relevant for the RRO. These assumptions are presented in AEMO's latest Inputs and Assumptions workbook[18].

The consultants also provided half-hourly charge and discharge battery profiles that are linked to 15+ years of historical PV generation traces. The operation of the battery installations is then linked to PV generation, so it is based on available solar insolation and how this is best utilised on the day for the customer (taking into account available network tariffs). These battery storage traces and associated PV generation traces are inputs into the Maximum Demand model to ensure the weather-sensitive load components (which are a driver of high demand days) are forecast on a consistent basis with the solar generation and battery use. AEMO intends to release indicative half-hourly battery traces as part of the 2019 ESOO data pack.

5.2.3 AEMO's conclusion

The consultants' methodologies for forecasting future DER are now available on AEMO's website[19]. Updates to the demand forecasting methodology document in 2019 will also include clarification on how AEMO incorporates these consultant forecasts into its models.

5.3 New entrant generation

5.3.1 Issue summary and submissions

The Issues Paper set out AEMO's proposal to exclude Com* projects in the 2019 Reliability Forecasts. Com* projects were a new category introduced by AEMO in 2018 to represent projects under construction and thereby having made a formal commitment to construct (clause 3.13.3 of the Rules), but not yet satisfying all of AEMO's commitment criteria[20].

Several submissions (AEC, Snowy Hydro, ERM, Energy Australia, MEA, Flow Power, and ECA) either rejected this proposal or sought further clarity on this issue. Both ERM and MEA proposed similar alternatives to this approach. MEA proposed to that, for at least T-3, it would be preferable to use a proportion of Com* projects

[17] See http://aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Generation-information.

[18] See https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/Inputs-Assumptions-Methodologies/2019/2019-Input-and-Assumptions-workbook.xlsx

[19] See https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/Inputs-Assumptions-Methodologies/2019/2019-Projections-for-Small-Scale-Embedded-Technologies-Report-by-CSIRO.pdf and https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/Inputs-Assumptions-Methodologies/2019/Distributed-Energy-Resources-and-Electric-Vehicle-Forecasts---Report-by-Energeia.pdf.

[20] AEMO's five commitment criteria relate to decisions about site, major equipment/plant components, planning and approvals, finance, and operations commencement time. They are detailed under the Background Information tab on each regional spreadsheet at AEMO's Generation Information webpage, at https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Generation-information.

and provide AEMO with the flexibility to adjust this proportion over time based on historical evidence. ERM Power proposed an alternative whereby projects under construction (Com*) would be included in the T-3 forecast, subject to additional commitment criteria having been met.

5.3.2 AEMO's assessment

AEMO has taken this feedback into account and has revised its approach:

- AEMO will tighten the Com* criteria such that projects that have "started construction" must have met all AEMO's commitment criteria other than either the planning or components criteria.
- AEMO will include all Com* projects from the end of the T-1 window onwards.
- Any Com* project that is intended to be completed within the T-1 window will be postponed until the end of the T-1 window, on the basis that there is little time remaining to get these projects committed.

AEMO believes this strikes an appropriate balance, by including projects that are likely to proceed without incorporating projects with a higher probability of not proceeding or being delayed beyond their announced completion date.

AEMO's Summer 2019 Forecast Accuracy Update[21] found that in the 2018 ESOO AEMO had over-forecast new supply, compared to what eventuated. This was the first such assessment, and AEMO will continue to review forecast accuracy and potentially adjust its supply forecasting methodology based on these observations. In that event, AEMO would propose appropriate revisions to the RSIG which would be subject to formal consultation.

5.3.3 AEMO's conclusion

For the 2019 ESOO, AEMO will tighten the Com* category to include projects that have both:

- **Commenced construction.**
- **Met all but one of AEMO's commitment criteria (with only the planning or components criteria yet to be satisfied).**

Commercial use date assumed for all Com* projects will be the later of:

- **The first day after the T-1 reliability gap financial year end.**
- **The actual commercial use date submitted by the proponent.**

5.4 Dispatchable generation summer deratings

5.4.1 Issue summary and submissions

AEMO has previously acknowledged that the use of a single summer capacity for the duration of the summer period could at times underestimate capacity availability in the reliability forecasts. However, previous discussions with generation owners have shown that issues around temperature derating are complex and that more accurate methods could be very difficult to derive and implement given variability in factors such as temperature response due to plant characteristics, or lagged temperature effects.

A number of submissions (AEC, MEA, and ERM) reiterated this concern and suggested that it would be more prudent to assume that the summer capacity associated with the reference temperature is only applied for a subset of the summer period. AEC noted that as the share of intermittent generation increases, it may be that periods of tight supply-demand balance are less tied to extreme temperatures, which makes it increasingly important to capture supply capability across the spectrum of possible temperatures at times of supply scarcity risk.

[21] See https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/Accuracy-Report/2019-Summer-Forecast-Accuracy-update.pdf.

The MEA submissions proposed an alternative to AEMO's current approach, whereby the modelling would use a standard capacity value for 'average' summer temperatures, and only use the current summer capacity (defined based on the regional reference temperature under 10POE demand conditions) on days where the temperature is high (for example, within 10% of the reference temperature), or where this condition occurred in the two days prior or the succeeding day.

ERM Power and AEC expressed concern based on a belief that AEMO had proposed amending the summer reference temperatures in its assessment of generator bids and forced outage rates, which had the potential to result in modelled outcomes where normal temperature derating is deemed to be a forced outage.

5.4.2 AEMO's assessment

AEMO has taken on board this feedback, and in particular considers MEA's suggested alternative could improve the accuracy of the reliability forecast. AEMO is proposing to develop a new approach based on historical analysis to determine what conditions would need to be met for the application of the summer reference temperature capacity, and appropriate assumptions to apply at other times.

AEMO is not able to apply this methodology in the 2019 reliability forecast because the approach will take some time to design, consult on, and implement. AEMO will also need to adjust its requests to generators to provide a capacity at the summer reference temperature and at some lower temperature (such as the temperature associated with average summer conditions), and adapt its generation survey portal to obtain this new information.

It should be noted that AEMO does not expect this to have a significant impact on the USE forecast in the short to medium term, because its analysis shows that the vast majority of USE still occurs in the top three demand days in the forecast, and it is likely that the summer reference temperature capacity would continue be applied to this period under the new methodology.

AEMO clarifies there is no proposal to change the treatment of temperature deratings and partial outages. The partial outages submitted by generators should not include deratings due to temperature and should therefore not influence the partial outage rates applied in the modelling.

5.4.3 AEMO's conclusion

AEMO intends to review use of generator deratings in the latter half of 2019 and consult on this approach through the Forecast Reference Group meetings and through a consultation on changes to the RSIG.

5.5 Generator forced outage rates

5.5.1 Issue summary and submissions

In the Issues Paper, AEMO set out its proposed methodology for modelling generator forced outages. This involved three key principles:

- For coal-fired generators, combined cycle gas turbines (CCGTs), gas-fired steam turbines, and large open cycle gas turbines (OCGTs), individual station rates would be applied instead of technology aggregations.
- The most recent three years of forced outage data would be used for all stations and aggregations.
- For each station and aggregation, three forced outage rates would be applied in the modelling based on the most recent three years of forced outage submissions, rather than a single average rate. This change was proposed to better represent the distribution of coincident outages observed historically.

The move towards station-specific rates was generally supported in submissions (for example, from Energy Queensland) with support expressed for this approach to be extended to Medium Term Projected Assessment of System Adequacy (MT PASA). Energy Queensland also expressed a desire for the station-specific information to be individually reported.

Several submissions (AEC, Energy Queensland, Snowy Hydro, Energy Australia, ERM Power, and ENGIE) opposed the decision to use the most recent three years of data rather than all historical data available, arguing that any observed trend was more likely the result of random variability rather than indicative of a new trend. ERM Power, in opposing the use of a more recent historical set, stated that this had the potential to overstate the impact of high impact low probability (HILP) events. AEC recommended that AEMO seek and publish expert international advice about how forced outage rates can change in middle-aged conventional plants. If, after these discussions, AEMO was unable to identify a rationale for a change to a new forced outage rate, AEC suggested AEMO should assume recent anomalies are due to statistical variation.

The same submissions also rejected the proposal to use rates sourced from individual years (rather than an average over multiple years) to represent the distribution of coincident outages. In general, the submissions (for example, from AEC) were of the view that any perceived lack of variability should be rectified using a statistical approach, and that it is the role of the simulation model to statistically recreate the variations in site availability (Energy Australia).

There were also a number of submissions related to what should, and should not, be included in the assessment of plant reliability:

- Energy Australia encouraged AEMO to ensure that the approach to partial deratings realistically captured the frequency and volume of partial outages.
- ERM emphasised that the inclusion of non-discretionary maintenance should not be considered.
- The QEUN noted that AEMO's forecast are highly reliant on generators remaining online until their announced closure and recommended that AEMO include in its forecast reduced availability or capacity due to the impact of renewable energy targets.

5.5.2 AEMO's assessment

AEMO's analysis of forced outage rates indicates that an ageing fleet of thermal generation in the NEM is increasing the risk of forced outages. In the Industry briefing on 21 June 2019, AEMO set out its reasoning for using more recent data by showing that there are statistically significant trends which would not be reflected in modelling if all historical data was used. This is particularly the case for brown coal power stations. AEMO has decided to extend the historical period from three to four years, given that there is no statistically significant difference in forced outage rate in the past four years. AEMO is also considering engaging a consultant to undertake an international review of reliability of ageing plant to performance benchmark the existing fleet. Due to data confidentiality, AEMO is not able to publish station-specific rates and will therefore continue to publish outage parameters at the technology aggregation level, while using station-specific rates in its analysis.

Asset owners have an opportunity to request an adjustment to future forced outage rate assumptions if they can establish that known issues in plant resulting in poor reliability have been addressed, or if they believe the condition of their assets is deteriorating. Evidence provided by asset owners in support of alternate outage rates may include an outline of recent or planned capital spend to maintain the assets. AEMO considers that this collaboration with generation asset owners should alleviate any concern of an overestimation of the impact of HILP events.

The analysis presented at the 21 June briefing[22] also provided evidence that the proposed approach of using individual years of reliability in its sampling to better represent the distribution of coincident outages, does not artificially overestimate the variability when compared to historical observations.

AEMO acknowledges that there may be an alternate approach to statistically replicate the observed variability, but in testing a number of options as reported in the 21 June briefing no other method was found to capture the variability that has been observed in recent years when looking at technology aggregations. An order of magnitude increase in sample size would likely be required to capture the distribution in forced

[22] See http://aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/Industry-Briefing---combined-slide-pack.pdf

outage rate variability adequately. AEMO thanks Energy Australia for their offer of assistance to develop an alternate statistical method and will aim to engage on this approach over the latter half of 2019.

Both full and partial outages are modelled with the two forms of outages based on different probabilities, time durations, and severity (100% for a full outage and an average deratings percentage for partial outages). Even though non-discretionary maintenance can increase the risk of USE, and did in fact do so in January 2019, AEMO is not proposing to include non-discretionary maintenance in the reliability forecast.

AEMO is reviewing whether the approach applied in the 2019 reliability forecast can also be applied in the MT PASA system, but in principle agrees that, where possible, the MT PASA, RRO, and ESOO assumptions should be aligned.

As with new entrant generation, AEMO will only include retirements that have a firm commitment rather than subjectively including any likely reductions in plant capability or reliability.

5.5.3 AEMO's conclusion

In assessing future reliability, the observed outage rates from the most recent four years will be sampled for each power station, unless compelling evidence has been provided by participants of reasons why a different forced outage rates should be used going forward.

5.6 Transmission outages

5.6.1 Issue summary and submissions

AEMO may include the impact of key unplanned transmission line outages or deratings which affect inter-regional transfer capability. AEMO assesses the probability of these outages using historical data to determine which outages will be included and the severity of the outage assumed.

ERM requested further information on the inputs used to determine the transmission outage rates and whether this included outages that could have been delayed.

5.6.2 AEMO's assessment

AEMO can confirm that where an outage was able to be delayed this has been considered a "Planned" outage and has not been included in determining the forced outage rates.

5.6.3 AEMO's conclusion

Only outages that occur with very short notice or with immediate effect are included in the calculation of transmission forced outage hours.

6. Other matters

In addition to the specific comments related to the reliability gap period and size and assumptions more generally, a number of broader issues were raised.

6.1 Perceived conservatism in forecast

Many submissions (AEC, QEUN, MEU, ERM, Snowy Hydro, Energy Australia, EUAA, MEA and ECA) expressed concerns about a perceived conservatism in assessing the existence, size, and period of the reliability gap. AEMO agrees that the reliability forecasts, and assumptions underpinning the reliability forecast, should be as accurate as reasonably possible, and believes the proposed methodology presented with this Final Report meets this objective.

6.1.1 Approach to the T-3 forecast

The Issues Paper set out an approach for determining the periods in the reliability gap for the T-3 period and the T-1 period. As the periods that comprise the T-1 gap period must be a subset of the previously specified T-3 gap period, and acknowledging that there is greater uncertainty four years out, AEMO proposed an approach that loosened the thresholds for the gap period calculation in the T-3 period. The rationale was that the increased uncertainty when forecasting more than three years into the future was greater than when forecasting one year ahead, and slight changes in assumptions could change the trading intervals identified as most at risk of supply shortfalls, and as such a looser threshold was justified.

A number of submissions (AEC, Energy Australia, MEU, ERM, and ECA) argued that the more conservative approach to determining the T-3 gap period, for example by setting a lower probability of lost load thresholds, was not in the interest of industry and consumers. Energy Australia noted that not identifying a gap in T-3 would not limit AEMO's powers to address reliability gaps that do arise in T-1, through RERT.

AEMO has taken on board this feedback, and on reflection considers it is more appropriate to address uncertainty further into the future through the choice of inputs (as discussed further below) rather than through variations in the T-3 and T-1 thresholds. The same threshold for T-3 and T-1 is now proposed.

6.1.2 Conservative input assumptions

Additional concerns raised about conservative assumptions included the level of DSP and what future generation units should be assumed committed. AEC suggested that AEMO was making assumptions of future deterioration in supply conditions.

AEMO does not consider that it is making assumptions of future deterioration with a particularly conservative bias. Rather, AEMO does not consider it appropriate to make assumptions around future improvements until it is clear those improvements will be delivered. AEMO has accommodated a number of suggested improvements to address reasonable concerns with elements of the proposed forecast approach assumptions where these are practically implementable and could be expected to improve forecasting accuracy.

As already noted, the RRO reliability forecast is intended to use a methodology that is consistent with the RSIG and ESOO. Given the purpose of the ESOO is to forecast potential development needs to assist in planning, it is not appropriate for the ESOO to anticipate further supply (including demand response and VPPs, for example) that has not reached a firm level of commitment. The ESOO provides an indication of supply, demand response, or transmission requirements required to maintain reliability but does not pass judgement on which future development options are most likely to proceed. Instead, AEMO publishes the pipeline of future supply that may help fill any reliability gap. When considering supply more than three years into the future, there is naturally less confidence that this supply will definitely proceed, but in AEMO's view not including this supply does not constitute a "conservative" approach for the purpose of the RRO.

6.2 Other issues raised

There were a number of issues raised on other subjects, such as transparency, communication, and timelines. See the table in Appendix A for a summary of these issues and AEMO's responses.

Finally, some of the submissions provided feedback which AEMO believes is related to the design of the RRO rather than the approach taken to determine the reliability forecast parameters. AEMO is not able to address these issues.

7. Final 2019 reliability forecast methodology

After considering the matters raised in the submissions, AEMO has decided to amend its assumptions and approach as listed in the responses above, when undertaking the reliability forecast for the 2019 ESOO.

The final methodology to be applied in 2019 for calculating any reliability gap (expressed in megawatts), reliability gap period, and the likely time of occurrence of the shortfall is as published in the 2019 Reliability Forecasting Methodology Paper on AEMO's website[23].

[23] See http://aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/NEM-Consultations/2019/Reliability-Forecasting-Methodology/2019-Reliability-Forecasting-Methodology-Paper.pdf

A1. Summary of other issues raised

Table 3 Continuous methodology improvement and other potential influential variables

Organisation(s)	Comment	AEMO Response
AEC	The actions which cannot be implemented in time for the start of the RRO, AEMO should take into account them in the future as it continuously improves its forecasting processes over time.	AEMO will publish updated action plans, including any planned future improvements, to its Forecasting Processes, at least annually as part of its Forecasting Accuracy report. This will include both demand and supply side improvements.
Sligar and Associates	It is suggested to consider factors such as community demand, demand management activity, likely weather effects with wind/solar, available dispatchable generation/storage; each one with a corresponding level of uncertainty. It is recommended to discuss how extensive are these uncertainties, and whether are they additive or complementary.	AEMO captures a range of risks and uncertainties in its modelling. Some, like weather and forced outages where the distribution of possible outcomes is known from historical analysis, is being captured though its probabilistic maximum demand forecasting (temperature) and Monte-Carlo simulations (forced outage rates). Uncertainties that cannot be described through distributions is generally captured through scenarios. AEMO will consider how it better can communicate uncertainties as part of its reporting, potentially through uncertainty bands.
MEA (Powershop)	MEA (Powershop) suggested to include a process to ensure that detailed assessment of the ESOO's accuracy and workability for the purpose of RRO be regularly undertaken.	AEMO will take onboard the suggestion for improvements to its Forecasting Accuracy Report.
PIAC	AEMO uses 'what if' methodologies to generate counterfactuals in other processes. Similar methods on a conceptual level could be used to compare predictions made in the reliability forecast with the actual values that eventuate. PIAC encouraged AEMO to explore this issue.	AEMO will consider if this can be done.
Energy Queensland	It should be recognized whether the following input refinements contribute additional rigour to the forecasting methodology: • Reactive demand and energy balances; • Network capacity; • Average and standard deviations of demand; • Trends in customer electricity consumption and behaviour; and • Trends in electricity price.	AEMO will take these suggestions on notice for its next improvement plan. AEMO does account for electricity price trends and trends on customer consumption and behaviour. Access to improved metering information allows AEMO to do analytics to better understand the impact of such changes and AEMO will enhance the forecast as it improves its understanding.
PIAC	PIAC suggested exploring methods for explicitly incorporating 'error correction' mechanisms into future iterations of the reliability forecast. PIAC also provided suggestions to improve data visualisation.	AEMO will take onboard this suggestion for consideration to improve future reliability forecasts and improve how concepts are presented in future publications.

Table 4 Transparency and communication

Organisation(s)	Comment	AEMO Response
Sligar and Associates	It is suggested to prepare a short video to cover a broader audience.	There will be insufficient time for a video ahead of the 2019 ESOO, but AEMO will consider it for future work, such as the development of the interim Reliability Forecasting Guidelines.
Snowy Hydro	Snowy Hydro noted that participants should be able to replicate the results of forecasts with forecasting expected to impact commercial outcomes and the cost on consumers.	AEMO will endeavour to provide all relevant forecasting input data (confidential data only in aggregated form though) and have well-documented methods to allow stakeholders to verify and replicate AEMO's forecasting outcomes.
Engie	AEMO is urged to make all the detailed modelling input and configuration data available to participants. This data must be thoroughly tested prior to its release to ensure that it is fit for purpose.	
PIAC	PIAC recommends that AEMO and other market bodies consider mechanisms to improve access to data as an input to forecasting.	As part of the 2019 ESOO and the following development of the interim Reliability Forecasting Guidelines, AEMO will identify any data and information gaps that currently exist and start discussion how best to get access, including through updates to market rules.
PIAC	PIAC queried if currently, generators and other market participants have adequate incentives to provide AEMO with sufficient data as an input to forecasts and what are the opportunities for improved data sharing between AEMO and other market bodies.	AEMO collects outage data for each previous year in preparation for the annual ESOO. This data is checked for quality and any unusual data is questioned. Participants are able to supply their own outage rates with evidence that AEMO is able to use if they believe these are a better representation of future outages. There is currently no incentive for generators to provide the best possible data.
PIAC	PIAC suggested AEMO develop explicit guidelines to ensure transparency with respect to the role of consultants in generating the reliability forecast.	AEMO will consider this suggestion when developing the interim Reliability Forecasting Guidelines.
PIAC	PIAC suggested bringing consultants and other entities into formal consultation procedures.	For the 2019 ESOO, AEMO has had most of its consultants to present at Forecasting Reference Group meetings ahead of their final deliveries. AEMO appreciate the suggestion and will see if it can improve this process further to allow wider feedback to the consultancies ahead of their delivery of final forecasts.
PIAC	PIAC requested AEMO to provide access to data enabling stakeholders to compare forecast values for market variables with actual historical values, along with any assumptions made in the application of input data.	AEMO is working on improved access to historical and forecast data as part of its new digital strategy. This includes better tools for stakeholders to assess forecast against history overall and for key drivers.
AGL	AEMO could provide a range of ways USE could be resolved as a part of its forecasting process. This range could then be assessed by another party, such as the AER, and a preferred option identified that best aligned with the intended design of the scheme and the long-term interest of customers.	AEMO will in its calculation of the reliability gap period and the size of the reliability gap make no assumptions about the technologies that may contribute to fill the gap. However, if a gap ultimately exists at T-1 and AEMO procures RERT, it will purchase the RERT based on a tendering process that ensures it is for the lowest cost to consumers.

Organisation(s)	Comment	AEMO Response
PIAC	PIAC recommends that AEMO explore methods of incorporating measures of confidence and uncertainty into its public communications with respect to reliability and other forecasts.	AEMO thanks for the feedback and will use this to improve how this concept is presented in future publications.
MEA (Powershop)	MEA encourages AEMO to ensure participants and relevant customers who will be significantly impacted (e.g. large users), are made aware of the consultation and how it may impact them and their power supply reliability and costs in the future. MEA suggested to use of AEMO marketing resources (e.g. Energy Live) and targeted media commentary and include a session at the annual Summer Readiness session on how the reliability gaps are identified and quantified may be necessary to ensure that all parties are aware of the need to consider and comment on these issues.	AEMO will take onboard this suggestion for how to ensure more stakeholders are aware of AEMO's processes supporting the RRO and what opportunities they have to provide feedback, e.g. for the Forecasting Reference Group and the upcoming consultation on the interim Reliability Forecasting Methodology Guidelines.
MEA (Powershop)	MEA requested AEMO to publish more granular data either a graphical or CSV format, showing an effective 1-in-2 trace, the forecast outcome with bands and the actual declared shortfalls.	AEMO thanks MEA for the suggestion and will aim to improve its descriptions of how the demand forecast and demand trace relates to the defined gap periods and unserved energy predictions. A single 1-in-2 year trace is not an output of the RRO reliability forecast therefore this suggestion may only aid in clarifying concepts, terms and definitions.

Table 5 Timeline

Organisation(s)	Comment	AEMO Response
ERM	ERM believes that AEMO's view that not all feedback will be able to be included in the 2019 ESOO does not align with the objective of effective consultation and recommends AEMO delay the issue of the reliability forecast component of the ESOO until matters raised have been considered.	AEMO will endeavour to address all material issues raised but is bound by the rules to produce the ESOO and Reliability Forecast component of it by the end of August.
AGL	AGL is concerned that the RRO could be triggered prior to participants and policy makers having a clear understanding of how the parameters of the Reliability Gap will be determined. The cost of compliance and potential liabilities associated with not meeting obligations are directly related to the size of the Reliability Gap. AGL requested that sufficient time should be allocated to assess how AEMO's methodology best serves to meet the intention of the scheme.	There are a number of parameters that will impact on the compliance cost for liable parties. While the size of the gap will guide any purchase of RERT, the duration of the reliability gap period and the 1-in-2 year peak demand forecast will more directly impact compliance costs. AEMO is aware of the impact to the liable parties and has adjusted its proposed approached for the reliability gap period based on the feedback received in this consultation.

Some of the submissions provided feedback which AEMO believes is related to the intention of the RRO rather than the approach taken to the reliability forecast. AEMO cannot address those issues.