

# Changes to Reserve Level Declaration Guidelines

Final Report – Expedited consultation  
for the National Electricity Market

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New South Wales | Queensland | South Australia | Victoria | Australian Capital Territory | Tasmania | Western Australia  
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## Executive summary

The publication of this final report concludes the expedited consultation procedure conducted by AEMO to change the Reserve Level Declaration Guidelines (**Guidelines**) (the **proposal**) under the National Electricity Rules (**NER**).

AEMO thanks all stakeholders for their feedback on the proposal, which was undertaken as required by NER 4.8.4A(e), following the procedure in NER 8.9.3.

In February 2024, AEMO published a draft report and proposal which provided stakeholders a summary of AEMO's intended changes to the Guidelines. The proposed changes included:

- replacing the current Bayesian Belief Network (**BBN**) model with an alternative in-house Machine Learning (**ML**) model using Quantile Regression (**QR**) to calculate the Forecast Uncertainty Measure (**FUM**); and
- adding a single input variable (time-of-day) to calculate the FUM; and
- minor drafting updates for consistency and accuracy (such as terminology and references), and to reflect changes resulting from Five-Minute Settlement (**5MS**) and Semi-Scheduled Generator's available capacity.

The intent of the consultation was to propose changes to improve resiliency and reduce operational risks related to externally provided software applications. By adopting a new QR model that operates in-house on AEMO's systems, AEMO reduces the associated operational risks with which the current BBN FUM model operates on. The addition of time-of-day as an input variable to the new QR model was a simple yet effective addition to the existing data set used to calculate the FUM. This better captures the uncertainty effects of solar generation in all periods throughout the year and in turn, has yielded slightly improved FUM output results.

AEMO received three submissions in response to the draft report. These submissions were generally supportive of the proposed changes, but also requested further information and clarification on the impact of seasonality on the FUM calculation, and recommended AEMO change the current confidence level of 95% to 50%. In addition, two of these submissions sought further clarification regarding the August 2023 review of the Guidelines.

AEMO has clarified that the time-of-day input variable considers all periods throughout the year (including seasons) and is not just limited to the time within a day when calculating the FUM. After considering the submissions received, AEMO has renamed the 'time-of-day' input variable stated in the draft proposal to 'Timestamp' and included this in the final determination.

AEMO has confirmed its intention not to make changes to the confidence level as part of this consultation and will instead invite stakeholders to make submissions on confidence levels and uncertainty margins in the consultation on the Guidelines that is planned to occur as part of the ST PASA Replacement project<sup>1</sup>.

AEMO has also clarified that the August 2023 review of the Guidelines was an internal review conducted by AEMO, and information about the review was published on the AEMO website<sup>2</sup>.

<sup>1</sup> Found at <https://aemo.com.au/initiatives/trials-and-initiatives/st-pasa-replacement-project>

<sup>2</sup> Found at <https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/system-operations/power-system-operation>

Finally, AEMO has updated the Guidelines to incorporate terminology updates related to the National Electricity Amendment (Integrating energy storage systems into the NEM) Rule 2021 No.13<sup>3</sup> and National Electricity Amendment (Implementing integrated energy storage systems) Rule 2023 No.2<sup>4</sup>, including incorporating references to bidirectional units.

AEMO's final determination on the proposal is to amend the Guidelines in the form published with this final report, and intends to make the amended version of the Guidelines effective on 26 June 2024.

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<sup>3</sup> Found at [https://www.aemc.gov.au/sites/default/files/2021-12/3.\\_final\\_amending\\_rule\\_-\\_integrating\\_energy\\_storage\\_systems\\_into\\_the\\_nem.pdf](https://www.aemc.gov.au/sites/default/files/2021-12/3._final_amending_rule_-_integrating_energy_storage_systems_into_the_nem.pdf)

<sup>4</sup> Found at <https://www.aemc.gov.au/sites/default/files/2023-05/National%20Electricity%20Amendment%20%28Implementing%20integrated%20energy%20storage%20systems%29%20Rule%202023%20No.%202.pdf>

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## 1. Stakeholder consultation process

As required by National Electricity Rules (**NER**) 4.8.4A(e), AEMO has consulted on changes to the Reserve Level Declaration Guidelines (**Guidelines**) (the **proposal**) in accordance with the expedited rules consultation procedure in NER 8.9.3.

Note that this document uses terms defined in the NER, which are intended to have the same meanings. There is a glossary of additional terms and abbreviations in Appendix A.

AEMO's process and timeline for this consultation are outlined below.

**Table 1 Consultation process and timeline**

| Consultation steps   | Dates                   |
|--|-------------------------|
| Draft report published   | <b>20 February 2024</b> |
| Presented at the NEM Reform Electricity Wholesale Consultative Forum (meeting #13) | <b>20 February 2024</b> |
| Presented at the NEM Reform Electricity Wholesale Consultative Forum (meeting #14) | <b>19 March 2024</b>    |
| Submissions closed on draft report   | <b>19 March 2024</b>    |
| Final report published   | <b>2 May 2024</b>       |

AEMO's consultation webpage for the proposal is at <https://www.aemo.com.au/consultations/current-and-closed-consultations/2024-Consultation-on-changes-to-Reserve-Level-Declaration-Guidelines>, containing all published papers and reports, written submissions, and other consultation documents or reference material.

In response to its draft report, AEMO received two written submissions including one late submission (which AEMO has considered), and held two sessions regarding this consultation at the NEM Reform Electricity Wholesale Consultative Forum (**EWCF**) on 20 February 2024 and 19 March 2024.

AEMO thanks all stakeholders for their feedback on the draft report, which has been considered in preparing this final report.

## 2. Background

### 2.1. Context for this consultation

The initial version of the Guidelines was developed through a consultation process in late 2017 and was subsequently published in December 2017, taking effect from 16 February 2018<sup>5</sup>. A subsequent consultation was undertaken in July 2018 regarding changes to the definition of Regional Excess Supply (**RXS**), the inputs used to determine prevailing conditions, and the confidence levels used to determine the FUM. This resulted in the second version of the Guidelines being published with effect from 12 December 2018<sup>6</sup>.

Most recently, AEMO undertook a review of the Guidelines in August 2023. This review found no material issues with the interpretation or application of the current Guidelines. However, in 2021-22, AEMO had also identified the need to amend the Guidelines and several other AEMO instruments to implement the ST PASA Replacement Project<sup>7</sup>. A rule change was made in 2022 to facilitate this project, effective from 31 July 2025<sup>8</sup>. AEMO intends to conduct a further review of all aspects of the Guidelines within the scope of that consultation.

This proposal, however, is separate and seeks to update the Guidelines to reflect a different modelling engine used and single additional input variable to calculate the FUM. The purpose of this is to reduce external-vendor risk that the BBN application runs on by AEMO building its own in-house QR model to calculate the FUM.

At the same time, AEMO proposes to make minor and administrative updates to the Guidelines identified in the August 2023 review and subsequently, including during this consultation. These include updates to incorporate terminology that will be introduced into the NER by the National Electricity Amendment (Integrating energy storage systems into the NEM) Rule 2021 No.13 and National Electricity Amendment (Implementing integrated energy storage systems) Rule 2023 No.2.

A summary of the initial proposal is provided in Section 3 of the draft report.

### 2.2. NER requirements

Clause 4.8.4A of the NER requires AEMO to “make and publish guidelines (reserve level declaration guidelines) that set out how AEMO will determine a lack of reserve condition”.

The Guidelines are required to:

1. describe how AEMO continually assesses the probability of capacity reserves being insufficient to avoid load shedding (other than the reduction or disconnection of interruptible load) given reasonably foreseeable conditions and events (probability assessment);
2. describe how the probability assessment applies in relation to different periods of time;

<sup>5</sup> Found at <https://aemo.com.au/en/consultations/current-and-closed-consultations/consultation-on-initial-version-of-reserve-level-declaration-guidelines>

<sup>6</sup> Found at <https://aemo.com.au/en/consultations/current-and-closed-consultations/changes-to-reserve-level-declaration-guidelines>

<sup>7</sup> Found at <https://aemo.com.au/initiatives/trials-and-initiatives/st-pasa-replacement-project>

<sup>8</sup> Found at <https://www.aemc.gov.au/rule-changes/updates/short-term-pasa>

3. specify at least three probability levels at which AEMO will declare a corresponding lack of reserve condition in relation to a specified period of time, indicating an increasing probability of load shedding (other than the reduction or disconnection of interruptible load).

NER 4.8.4A(b)(4) requires the Guidelines to be reviewed by AEMO at least once every four years. The process by which the Guidelines are to be amended is set out in NER 4.8.4A(d) and (e) and in accordance with the expedited rules consultation procedure provisions in NER 8.9.3.

## 2.3. The national electricity objective

Within the specific requirements of the NER applicable to this proposal, AEMO has sought to make a determination that is consistent with the national electricity objective (**NEO**) and, where relevant, to select the option best aligned with the NEO.

The NEO is expressed in section 7 of the National Electricity Law as:

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

- (a) price, quality, safety, reliability and security of supply of electricity; and
- (b) the reliability, safety and security of the national electricity system; and
- (c) the achievement of targets set by a participating jurisdiction—
  - (i) for reducing Australia’s greenhouse gas emissions; or
  - (ii) that are likely to contribute to reducing Australia’s greenhouse gas emissions.



### 3. List of material issues

The issues raised in submissions to the draft report are listed in Table 2 in summary form.

AEMO received a total of three written submissions: Shell Energy, Clean Energy Council (CEC), and a late submission from Energy Users Association of Australia (EUAA). All three submissions had two common issues raised (No. 2 and 3 in the table below) which are discussed in Section 4.2 **Error! Reference source not found.** and 4.3. A total of three issues were raised in the submissions.

**Table 2 List of material issues**

| No. | Issue   | Raised by               |
|-----|---|-------------------------|
| 1.  | Replacing the current BBN model with an alternative in-house ML model using QR to calculate the FUM | Shell Energy            |
| 2.  | Adding a single input variable to calculate the FUM   | Shell Energy, CEC, EUAA |
| 3.  | Changes to the confidence level   | Shell Energy, CEC, EUAA |

Questions and responses relating to the proposal and raised in the February and March 2024 meetings of the NEM Reform ECWF are published on the ECWF webpage<sup>9</sup>.

Each of the material issues in Table 2 is discussed in Section 4.

<sup>9</sup> Found at <https://aemo.com.au/en/consultations/industry-forums-and-working-groups/list-of-industry-forums-and-working-groups/electricity-wholesale-consultative-forum>

## 4. Discussion of material issues

### 4.1. Replacing the current BBN model with an alternative in-house ML model using QR to calculate the FUM

#### 4.1.1. Issue summary and submissions

The FUM is currently produced using a probabilistic model called the BBN which operates on an application provided by an external vendor. To improve the resiliency and reliability of producing the FUM, and reduce operational risks related to externally provided software applications, AEMO proposes to update the BBN model with an alternative ML solution using QR that will be run and hosted on AEMO's systems.

Shell Energy's submission to the draft report supported the efforts being made by AEMO to produce more reliable forecasts of the timing and magnitude of low reserve conditions. No objections were made to AEMO's proposal to replace the FUM model.

#### 4.1.2. AEMO's assessment

AEMO has developed a QR model which has been trained with the same data set used to train the current BBN model (using data dated as far back as 2012) with the addition of timestamp (referred to as 'time-of-day' in the draft report) as an input variable.

#### 4.1.3. AEMO's conclusion

AEMO will proceed with replacing the current BBN model with the in-house QR model to calculate the FUM.

This requires changes to Appendix A of the current Guidelines.

### 4.2. Adding a single input variable to calculate the FUM

#### 4.2.1. Issue summary and submissions

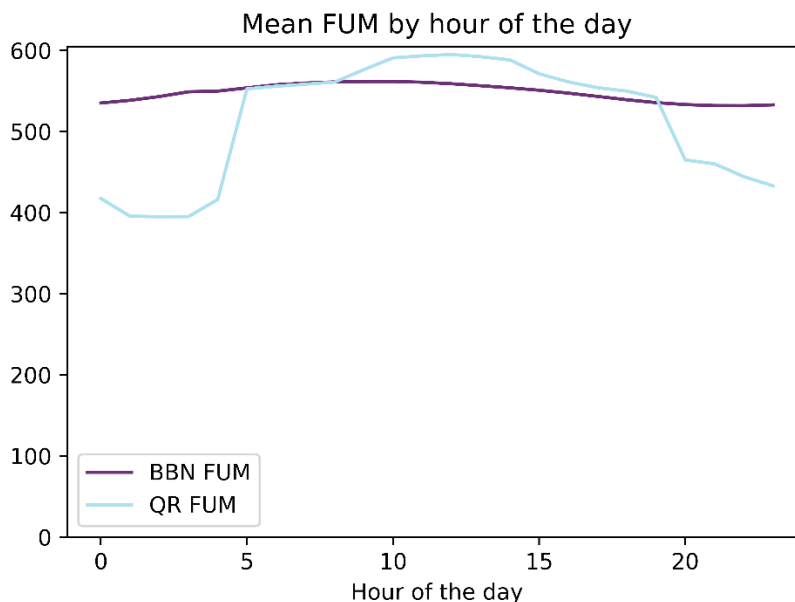
The current input variables used by the BBN model to produce the FUM are variables (a) through (e) below, using data dating back to 2012. The QR model also utilises these input variables with the addition of variable (f) 'Timestamp' (referred to as 'time-of-day' in the draft report and proposal):

- a) Forecast of dry bulb temperature
- b) Solar irradiance forecast
- c) Forecast output of semi-scheduled generating units
- d) Current demand forecast error
- e) Current supply mix for coal, gas and hydro
- f) Timestamp

The addition of the timestamp input variable leads to lower average FUM values during the night compared to during the day (shown in Figure 1 of the draft report and below). This better

captures the uncertainty in predictions of solar generation from semi-scheduled generators and residential rooftop PV systems.

**Figure 1 Mean FUM value (in MW) across all NEM regions by hour of the day in 2023**



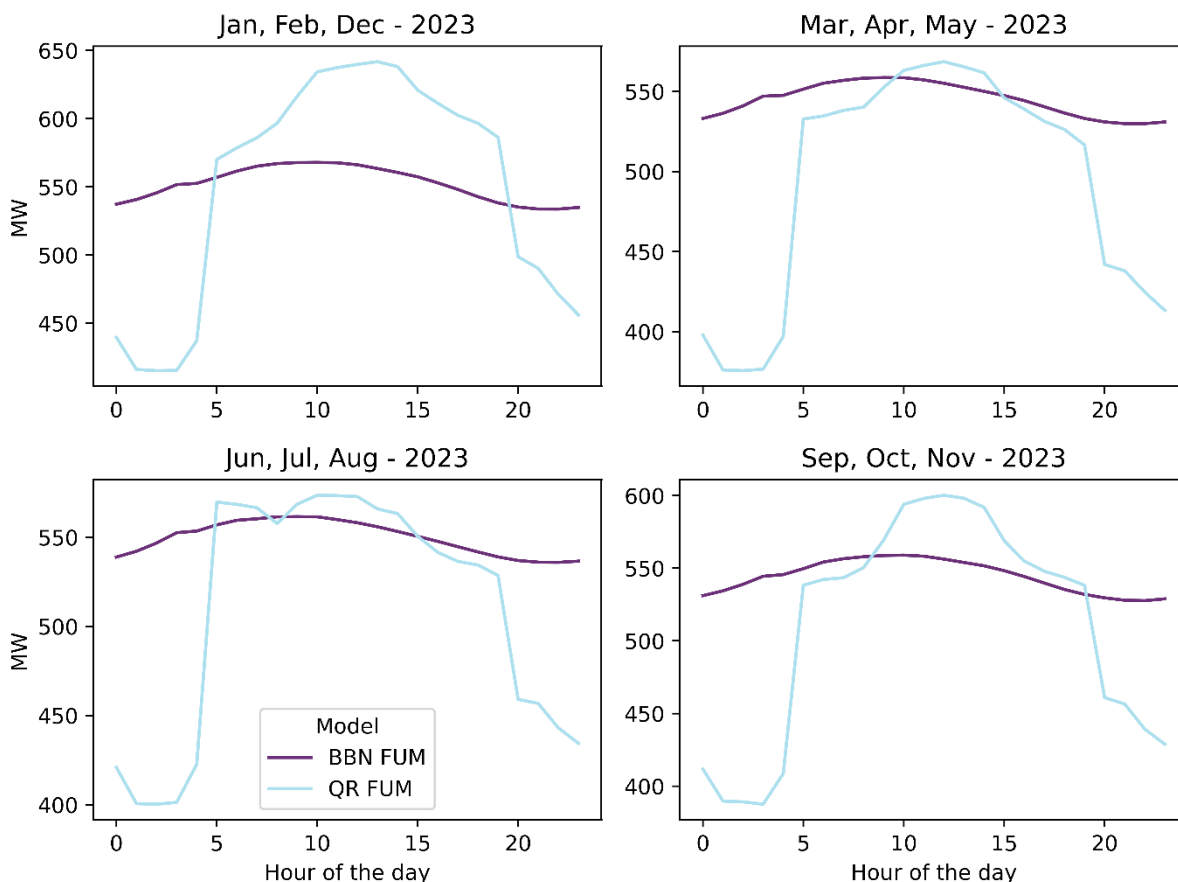
Shell Energy, CEC, and EUAA’s submissions all supported the addition of time-of-day as an input variable but each further suggested that in addition to time-of-day, the FUM calculation should also capture seasonal impacts to account for the seasonal variation in variable renewable energy generation, predominantly solar. Therefore, the submissions requested AEMO produce a new version of Figure 1 for each season of the year.

#### 4.2.2. AEMO’s assessment

AEMO would like to clarify that seasonality and other temporal features are already incorporated with the inclusion of the proposed timestamp variable (referred to as ‘time-of-day’ input variable in the draft report). This variable therefore considers all periods throughout the year (including seasons, weeks etc.) and is not just limited to the time within a day when calculating the FUM.

AEMO has produced a figure for each season to show the seasonality effect of the FUM value for the QR model – see Figure 2 below. This emphasises that the uncertainty of solar generation during the middle of the day is greater in the summer period than the winter period, which is expected as there’s less solar generation during the winter months.

**Figure 2 Mean FUM value across all NEM regions for each season by hour of the day in 2023**



AEMO acknowledges the ‘time-of-day’ variable name could have been better chosen to reflect the fact that this is a timestamp variable which includes other temporal features.

### 4.2.3. AEMO’s conclusion

AEMO has clarified that the time-of-day (now ‘Timestamp’) input variable captures seasonality effects as well as other periods throughout the year, such as time of week and time of day, and thus, is reflected in the resulting FUM value.

This requires a change to Section 3.2 and Appendix A of the current Guidelines by including ‘Timestamp’ as an input variable to the FUM calculation and clarifying that this variable inherently incorporates a seasonality component when calculating the FUM.

## 4.3. Changes to the confidence level

### 4.3.1. Issue summary and submissions

Shell Energy, CEC, and EUAA’s submissions recommended AEMO change the current confidence level of 95% to 50%, based on the following reasoning:

- The 95% confidence level is too conservative leading to a higher likelihood of false-positive LOR declarations, potentially requiring RERT or IRR contacts to be pre-activated or activated.
- Ensures consistency with other market processes utilising a 50% POE value, such as PASA, which ensures under and over forecasts are weighted equally.

CEC's submission recognised these issues may fall outside of scope of this review, however it expressed an intent to get them into the public record to be addressed in the near term.

#### 4.3.2. AEMO's assessment

As outlined in the draft report, the intent of this consultation is to urgently reduce vendor provided software application risk. By adopting a new QR model that operates in-house on AEMO's systems, AEMO reduces the associated operational risks under which the current BBN FUM model operates. The addition of time-of-day ('Timestamp') as an input variable to the new QR model was seen as a simple yet effective addition to the existing data set used to calculate the FUM which would yield slightly improved FUM output results.

AEMO acknowledges the submissions on review of the confidence level. AEMO is also conscious of the upcoming need to review the Guidelines, alongside several other AEMO guidelines and procedures, to implement the major ST PASA Replacement project<sup>10</sup>. It is AEMO's intent to conduct a further review and consultation on all aspects of the Guidelines – including the confidence level - within the scope of that broader project.

#### 4.3.3. AEMO's conclusion

AEMO will invite stakeholders to contribute feedback on the appropriateness of confidence levels and uncertainty margins in the consultation on the Guidelines that is planned to occur as part of the ST PASA Replacement project, as this is intended to cover model refinement improvements in calculating uncertainty.

In the interim, AEMO has not made changes to the Guidelines and will continue to apply a 95% confidence level in the FUM calculation.

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<sup>10</sup> Found at <https://aemo.com.au/en/initiatives/trials-and-initiatives/st-pasa-replacement-project>

## 5. Other matters

### 5.1. August 2023 review of the Guidelines

#### 5.1.1. Issue summary and submissions

In EUAA's submission, it said that it was unable to find the August 2023 review of the Guidelines on AEMO's website. EUAA stated it made it difficult to know whether the recommendations in the draft report were the full extent or whether further changes were needed to the Guidelines in addition to the changes in the FUM calculation. Further, EUAA commented that it expected that these types of documents are readily available, particularly when they are quoted references in the subsequent reports (as the August 2023 review was referenced in the draft report).

CEC's submission observed that the Guidelines must be reviewed by AEMO at least once every four years (as per NER 4.8.4A(b)(4)) and that the FUM calculation methodology has remained basically unchanged since December 2018. CEC acknowledged the August 2023 review however it also suggested that further consideration is necessary due to certain recent developments regarding use of the FUM and reserve level declarations.

#### 5.1.2. AEMO's response

In the August 2023 review, AEMO found no material issues with the interpretation or application of the current Guidelines, only minor and administrative updates that have been subsequently included in this consultation. Information on the outcome of the review was published on the AEMO website<sup>11</sup> and no formal external consultation process or reporting was undertaken.

AEMO acknowledges CEC's comment that the Guidelines have (at least until this proposal) remained unchanged since December 2018 and agrees that further consideration of the FUM calculation methodology is warranted.

From the time of the August 2023 review, AEMO has been aware of the upcoming need to amend the Guidelines, alongside several other AEMO guidelines and procedures, to implement the major ST PASA Replacement project. It is AEMO's intent to conduct a further review and consultation on all aspects of the Guidelines within the scope of that broader project.

Whilst AEMO agrees with CEC's comment, there is a critical need to reduce the immediate operational risk associated with the BBN model operating on an externally provided software application. The intent of the current consultation is focused on urgently reducing these operational risks related to externally provided software, and AEMO's approach to conducting this consultation under the expedited rules consultation procedure has reflected this aim.

AEMO will invite feedback from stakeholders regarding confidence levels and uncertainty margins in the consultation on the Guidelines that will occur as part of the ST PASA Replacement project.

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<sup>11</sup> Found at <https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/system-operations/power-system-operation>

## 5.2. Other changes

AEMO has updated the Guidelines to incorporate terminology updates related to the National Electricity Amendment (Integrating energy storage systems into the NEM) Rule 2021 No.13 and National Electricity Amendment (Implementing integrated energy storage systems) Rule 2023 No.2 including incorporating references to Integrated Resource Providers and bidirectional units.

## 6. Final determination on proposal

Having considered the matters raised in submissions to the draft report and at consultation forum meetings, AEMO's final determination is to amend the Reserve Level Declaration Guidelines in the form published with this final report, in accordance with NER 4.8.4A and NER 8.9.

The final amendments to the Reserve Level Declaration Guidelines differ from the draft determination in the following material respects, for the reasons discussed in section 4 and 5 of this final report:

- Renaming the 'time-of-day' input variable to 'Timestamp'.
- Updating the effective date to 26 June 2024.

Updates specifically related to the incorporation of terminology related to the IESS Rule Changes effective 3 June 2024 are highlighted in yellow for ease of reference.

By consulting on proposed changes to the Guidelines, AEMO has fulfilled its obligations under NER 4.8.4A(e). The proposed changes promote the continued efficient operation of the power system and reliability of the national electricity system.

### **Effective date**

AEMO intends to make the amended version of the Guidelines effective on 26 June 2024.



## Appendix A. Glossary

| Term or acronym | Meaning  |
|-----------------|--|
| 5MS             | Five-Minute Settlement                             |
| AEMO            | Australian Energy Market Operator Limited          |
| BBN             | Bayesian Belief Network                            |
| FUM             | Forecast Uncertainty Measure                       |
| Guidelines      | Reserve Level Declaration Guidelines               |
| IESS            | Integrating Energy Storage Systems                 |
| IRR             | Interim Reliability Reserve                        |
| LOR             | Lack of Reserve                                    |
| ML              | Machine Learning                                   |
| MW              | Megawatts  |
| NEO             | National Electricity Objective                     |
| NEM             | National Electricity Market                        |
| NER             | National Electricity Rules                         |
| PD              | Pre-dispatch                                       |
| POE             | Probability of Exceedance                          |
| PV              | Photovoltaic                                       |
| QR              | Quantile Regression                                |
| RERT            | Reliability and Emergency Reserve Trader           |
| RXS             | Regional Excess Supply                             |
| ST PASA         | Short-Term Projected Assessment of System Adequacy |