CHANGES TO RESERVE LEVEL DECLARATION GUIDELINES

UPDATE ON PROPOSALS

Published: **October 2018**

EXECUTIVE SUMMARY

The publication of this Update on Proposals Paper (Update Paper) forms part of the Rules consultation process conducted by AEMO on proposed changes to the Reserve Level Declaration Guidelines (**Guidelines**) under the National Electricity Rules (NER). This consultation is being conducted in accordance with the special provisions in clause 4.8.4A(e).

AEMO outlined its consultation plan within the Issues Paper published on 16 July 2018. This plan included publishing an update on proposals to provide Interested Parties with further information that was not available at the time that the Issues Paper was published. It includes analysis and justification for each of the proposed changes discussed within the Issues Paper.

AEMO received two written responses during the consultation window specified for the Issues Paper. These submissions have both been published on the consultation webpage[1]. Both of these submissions requested further information and justification for the proposed changes.

This Update Paper provides clarity around each of the proposed changes. Several of the proposed changes require no updates to the Guidelines, however additional information and justification is provided in this paper to increase the transparency of how the FUM value is determined. For the proposed changes which require updates to the Guidelines, additional information and justification for the proposed changes is provided in this paper and a draft of the Guidelines with the required updates is attached. A summary of the proposed changes and the updates (if any) to the Guidelines is available in section 4.11.

AEMO invites stakeholders to suggest alternative options where they do not agree that AEMO's proposals would achieve the objectives and requirements for the Guidelines in NER clause 4.8.4A(b) and (c).

AEMO also asks stakeholders to identify any unintended adverse consequences of the proposed changes.

Stakeholders are invited to submit written responses on this Update Paper by 5.00 pm (Melbourne time) on Friday 19 October 2018.

[1] Consultation webpage link: http://aemo.com.au/Stakeholder-Consultation/Consultations/Changes-to-Reserve-Level-Declaration-Guidelines

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1. STAKEHOLDER CONSULTATION PROCESS

As required by the NER, AEMO is consulting on changes to the Reserve Level Declaration Guidelines in accordance with the amended Rules consultation procedure in clause 4.8.4A(e).

Note that there is a glossary of terms used in this Update Paper is in Section 2.

AEMO's indicative timeline for this consultation is outlined below. Dates may be adjusted depending on the number and complexity of issues raised in submissions and any meetings with stakeholders.

Deliverable	Indicative date
Issues Paper published	Monday 16 July
Submissions due on Issues Paper	Wednesday 22 August
Update on proposals (Update Paper) published	Friday 5 October
Stakeholder forum	Date to be advised[2]
Submissions due on updates to proposals	Friday 19 October
Final Report published	Friday 9 November

[2] Refer to the consultation webpage: http://aemo.com.au/Stakeholder-Consultation/Consultations/Changes-to-Reserve-Level-Declaration-Guidelines

2. GLOSSARY

Term or acronym	Meaning
AEMO	Australian Energy Market Operator Limited
Aggregate capacity of non-energy limited plant	Refer Section 4.7 of this paper
Aggregate capacity of energy limited plant	Refer Section 4.7 of this paper
Analysis	Refer Section 3.4 and Appendix A of this paper
BBN	Bayesian Belief Network
FUM	Forecast uncertainty measure
Guidelines	Reserve Level Declaration Guidelines
Interconnector support	Refer Section 4.7 of this paper
LCR	Largest credible risk as defined in the Guidelines
LCR2	Two largest credible risks as defined in the Guidelines
LCR/2	The largest credible risk or the two largest credible risks depending on the Lack of reserve level
LOR	Lack of reserve (may be followed by a number corresponding with a reserve level as defined in the Guidelines)
MW	Megawatts
MWh	Megawatt hours
NER	National Electricity Rules
PD	Pre-Dispatch
Scheduled Demand	Refer Section 4.7 of this paper
RXS	Regional excess supply
RXS error	The expected difference between forecast RXS and actual RXS (see clause 3.2 of the Guidelines)
Aggregate output of semi-scheduled generating units	Refer Section 4.7 of this paper
ST	Short - Term

3. BACKGROUND

3.1 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 intended 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;
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*);"

The process by which the Guidelines are to be amended is set out in rule 4.8.4A (e). This process is an abridged single stage version of the Rules Consultation procedures set out in rule 8.9.

3.2 Context for this consultation

The initial version of the Guidelines was developed through a consultation process in late 2017 with the initial version being published in December 2017[3].

The new process to determine the reserve levels became operational on 15 February 2018.

AEMO has published two Lack of Reserve Framework Reports describing the operation of this new process for the two quarters up to 30 June 2018[4]. AEMO is required to publish reports on the performance of the process within 1 calendar month of the end of the quarter.

AEMO is considering changes to the process and hence the Guidelines to improve performance of the process for summer 18-19 and to develop the process further.

The details of the proposed changes are set out in Section 4 below.

3.3 Performance review of the process

AEMO has completed a review of the performance of the Guidelines for the period 15 February 2018 to 30 June 2018, with the results summarised as follows:

- 32 total lack of reserve conditions were declared (this includes forecast or actual conditions and level one or level two lack of reserve conditions). Of the 32 total conditions:
    - 29, or approximately 91%, were declared with the largest credible risk (or two largest credible risks) setting the reserve trigger level; and
    - 3, or approximately 9%, were declared with the FUM setting the reserve trigger level.
- 20 of the 32 declarations were forecast lack of reserve conditions, of which 11 forecast conditions subsequently resulted in actual lack of reserve conditions. For the remaining 9 forecast lack of reserve conditions the actual lack of reserve condition did not eventuate due to a market response causing the reserve level shortfall to clear prior to the forecast period in each of the cases.

[3] Refer https://www.aemo.com.au/Stakeholder-Consultation/Consultations/Consultation-on-initial-version-of-Reserve-Level-Declaration-Guidelines

[4] Refer https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Power-system-operation/NEM-Lack-of-Reserve-Framework-Quarterly-Reports

- 12 of the 32 declarations were actual lack of reserve conditions, with the largest credible risk (or two largest credible risks) setting the reserve level in all 12 cases.
- Of the 32 lack of reserve conditions declared, AEMO did not intervene (through the Reliability and Emergency Reserve Trader mechanism, or through reliability directions) on any occasion.

3.4 Updates since publishing the Issues paper

AEMO has completed an assessment of the proposed changes (referred to in this paper as the Analysis*)* initially identified in the Issues paper. This assessment involved completing the following steps:

- Data extraction;
- Selection of input predictors; and
- Selection of confidence level.

Each of these steps is described in more detail below and the results are presented in Appendix A - Results from the analysis.

3.4.1 Data extraction

This step involved data Extraction, Transformation and Load (ETL) to obtain historic values for all data required to assess the changes proposed. The historic data was then used to create Bayesian Belief Network models for each region for 3hr, 24hr and 48hr ahead horizons. Each BBN models the proposed RXS definition (accounting for network limitations, interconnector support and energy limitations as detailed in section 4.7) and includes the following additional predictors: forecasts (at multiple horizons) and (current) observations of precipitation, humidity, wind speed, temperature and solar radiation; temperature forecast differential between different forecast providers at multiple horizons; current generation level across each generation type (coal/gas/hydro/solar/wind); forecasts of semi-scheduled generators at multiple horizons; forecasts of reserve levels at multiple horizons; and forecasts of interconnector flow at multiple horizons.

3.4.2 Selection of input predictors

A sensitivity analysis of each of the proposed additional predictors was completed to determine which inputs lead to the largest shifts in the distribution of RXS for each region. The results from the sensitivity analysis for each region were used to guide the selection of a consistent set of input predictors with consideration of the maximum number of nodes that can be compiled in a BBN (too many nodes and the network will fail to converge), and the current and expected future materiality and frequency of uncertainty that the input is intended to manage. For example, solar radiation forecast inputs indicate to the model the expected solar irradiance influencing rooftop PV generation and generation from large scale solar farms. This input is prioritised given the current penetration and continued growth of rooftop PV, and the predicted ramp up of large scale solar generation.

The final step in the selection of input predictors involved simulating the forecasting uncertainty measure at 3hr, 24hr and 48hr ahead horizons to assess the distribution of FUM values and ensure that the bin sizes of the input nodes do not lead to small sample size issues and hence “spiky” FUM values.

3.4.3 Selection of confidence level

An ex-ante historic backcast of every PASA run since 2012 was completed to simulate the estimated FUM value for all 144 trading intervals (the horizon that the FUM covers) of every run. The FUM values are compared to LCR and LCR2 to determine which criteria would set the LOR1 and LOR2 trigger levels, and then the trigger levels are compared to the historic reserve level for each trading interval for each run. This was completed at 94%, 95%, 96% and 98% confidence levels to obtain the following results:

- The expected number of LORs identified due to FUM based on the combination of the proposed RXS definition, input predictors and confidence levels for the financial year 2017/18. The number due to FUM was compared to the number due to LCR to assess if the ratio was appropriate.
- The average, minimum and maximum FUM values for each forecast horizon for 2018 quarter one and two were compared to the expected average, minimum and maximum values over the same period obtained from the historic backcast. This comparison was used to determine the expected changes to FUM values.

4. PROPOSED CHANGES

This section provides further information regarding each of the proposed changes to the design of the FUM determination process (specifically the BBN) which are under consideration.

In the Issues paper AEMO proposed two categories: changes proposed to improve performance; and changes proposed to continue development of the process. During the Analysis, it became apparent that assessment of the proposed changes on an individual or categorical basis was not appropriate, due to the interdependent relationship between proposed changes. For example, a change to the definition of RXS causes a change to the distribution of RXS errors, which requires a re-assessment of the input predictors to ensure the inputs are driving shifts in the error distribution. Similarly, the change to the definition of RXS also requires a re-assessment of the confidence levels to ensure that the values of FUM are appropriate and the number of LORs declared is not excessive.

Therefore, AEMO no longer considers it necessary to classify the changes under the two categories initially proposed; in fact, the changes need to be assessed holistically to ensure that the conclusions represent the expected nature of the changes together.

The following sections provide additional details on the set of initial changes proposed, as well as identifying and describing the rationale behind further proposed changes.

4.1 Reducing the number of models per region

In the Issues Paper AEMO proposed the following change to the number of models per region:

Together with the other changes proposed to improve performance, the number of models can potentially be reduced to three models per forecast region, with no adverse impact on forecast accuracy.

The current system has 9 BBN models per region, each model representing 8 hours of the forecast horizon. The output from the 9 BBN models is then appended to form a time-series of FUM values covering the first 72-hours of the forecast horizon. As each BBN model is trained independently of the other 8 BBN models for the given region, there is potential for the FUM values at the end of one BBN model to differ from the FUM values produced at the start of the next BBN model. This is only evident under certain input conditions and is usually only observed for a limited number of runs before the condition is no longer evident.

In the current system design there are 8 such boundaries for each region (9 BBN models leads to 8 boundaries between models) – these 8 boundaries are potential spots on the forecast horizon where discontinuities or inflexions in FUM values can occur.

An example of how this potential issue manifests is shown in Figure 1. This example shows a “sawtooth” pattern affecting the NSW FUM value for the PD PASA run on 20/08/2018 at 16:00. The “sawtooth” pattern is visible between approximately 04:00 on 21/08/2018 to 14:00 on 22/08/2018. The “teeth” correspond with the boundaries between BBN models. This pattern was evident in the NSW FUM value for the runs from 16:00 to approximately 20:00 on 20/08/2018, after which the pattern was no longer evident.

The Analysis has confirmed that the number of BBN models can be reduced from 9 per region to 3 per region. This change will reduce the number of potential inflexion points from 8 to 2. To manage the potential differences between FUM values at the remaining 2 boundary points, the input predictor spacing has been adjusted to allow a gradual transition of FUM values from the end of one BBN model to those at the start of the next BBN model.

Reducing the number of models per region also brings operational efficiencies related to model management with no adverse impact on forecast accuracy and will also streamline the model re-training and verification procedure, which is further documented in 4.8

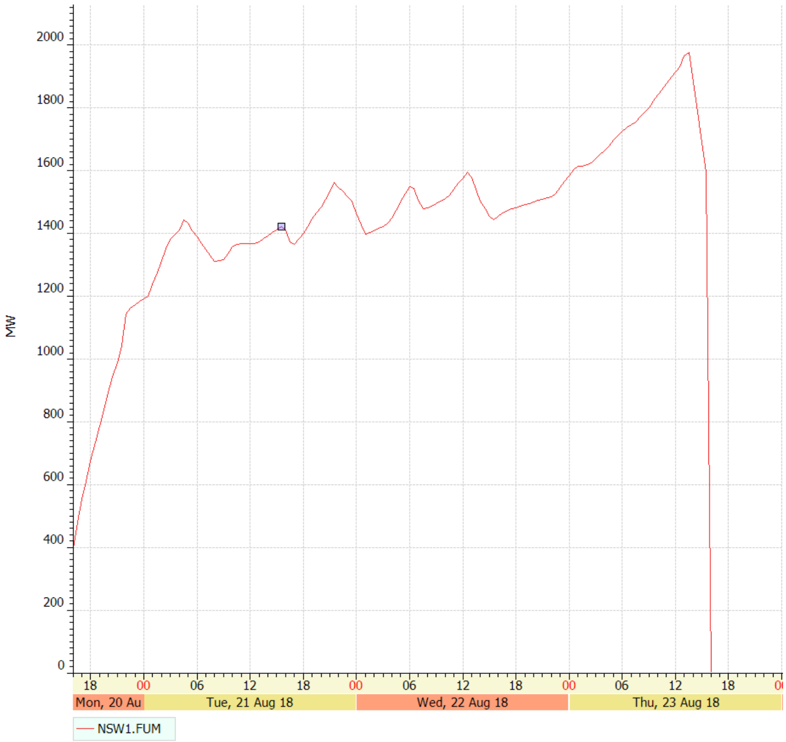

Figure 1 - sawtooth pattern of FUM for NSW

Reducing the number of models per region will not require any changes to the Guidelines.

4.2 Changing the output bin structure

The proposed changes to the definition of RXS and the confidence level requires changes to the output bin structure to ensure there are sufficient bins to allow the distribution of RXS error to have gradations, particularly under small sample size conditions.

The previous output bin structure had the smallest bin accounting for the values up to the 94th percentile of the RXS error distribution, and each subsequent bin was defined as an additional half of a percentile up to 100% of the distribution.

The proposed output bin structure has the smallest bin accounting for the values up to the 93rd percentile of the RXS error distribution, increasing in 1% bins till the 95th percentile, then increasing in 0.5% bins till the 98th percentile, then increasing in 0.25% bins up to 100% of the distribution.

The Analysis indicated that without this change there were instances of the FUM values becoming “spiky” due to insufficient bin gradations when small sample size conditions were evident.

Changing the output bin structure will not require any changes to the Guidelines.

4.3 Changing the temperature input bin structure

The proposed changes to include additional predictors requires changes to the temperature input bin structure to manage sample selection given the number of input predictors is increasing. These changes are required to ensure the temperature inputs continue to drive material shifts in the distribution of RXS error.

The previous temperature input bin structure had the smallest bin accounting for values up to the 43rd percentile of the distribution of temperatures, the 2nd bin accounting for values from the 43rd percentile up to the 98th percentile, and the final bin accounting for the remaining 2 percent of the distribution.

The proposed temperature input bin structure has the smallest bin accounting for values up to the 1.5% of the distribution of temperatures, the 2nd bin accounting for values from 1.5% to 98.5% of the distribution, and the final bin accounting for the remaining 1.5% of the distribution.

Changing the temperature input bin structure will not require any changes to the Guidelines.

4.4 Reducing the number of output nodes and interpolating in between

Following the Analysis, changes to the number of output nodes and changes to the interpolation between output values is no longer required.

4.5 Extending the BBN models to produce a dynamic FUM value for the 144th trading interval

AEMO proposes to extend the BBN models to produce a dynamic FUM value for the 144th trading interval to remove the need to use a static default starting FUM value for the 144th trading interval. The use of a default value for the 144th interval can result in occasions where this value differs from the dynamically calculated value for the 143rd (and prior) interval/s, resulting in a noticeable inflexion in the FUM values at this point in the horizon.

Extending the BBN models to produce a dynamic FUM value for the 144th trading interval will not require any changes to the Guidelines.

4.6 Changing the input predictors (input states) used in the BBN models

In the Issues paper AEMO proposed specifying a primary set of predictors in the Guidelines and introducing flexibility to include or remove secondary predictors using the process set out in Appendix A.2.1 of the Guidelines. AEMO no longer considers this proposal appropriate due to the interdependent relationship of the predictors to the other components of the system and the need for detailed holistic analysis when assessing changes to predictors.

AEMO instead proposes to expand and amend the existing set of input predictors, for the reasons given below:

- Scheduled demand forecast error for the most recent complete trading interval, comparing the forecast generated one interval prior to the trading interval to the actual. This captures recent demand forecast error and the sensitivity analysis indicates the importance of this input for the first 6 hrs of the horizon.
- Forecasts of semi-scheduled capacity at 6-hourly intervals. This input manages semi-scheduled intermittent generation at various timesteps to provide the BBN with expected generation from intermittent resources, and considers the impact of network constraints which were previously not considered.
- Forecasts of temperature at 6-hourly intervals. This input provides the BBN with expected temperature conditions and accounts for demand forecast uncertainty and plant de-rating/trips on extreme days.
- Forecasts of solar radiation at 6-hourly intervals. This input provides the BBN with expected solar irradiance conditions and accounts for rooftop PV and large scale solar forecast uncertainty.
- Current gas generation aggregated for the region. This input provides the BBN with an indication of the current generation mix and is particularly important in driving the distribution in the short-term horizon (first 6 hrs).

- Current coal generation aggregated for the region. This input provides the BBN with an indication of the current generation mix and is particularly important in driving the distribution in the short-term horizon (first 6 hrs). This input is not used in the South Australian or Tasmanian BBN models due to the lack of coal-based generation sources in these regions.
- Current hydro generation aggregated for the region. This input provides the BBN with an indication of the current generation mix and is particularly important in driving the distribution in the short-term horizon. This input is only used in the Tasmanian BBN models due to the predominance of hydro based generation in the Tasmanian region. For other regions, current hydro generation was not deemed a significant input by the sensitivity analysis.

The selection of the above input predictors was based on the Analysis outlined in section 3.4.2.

The revised input predictors will require the following changes to the Guidelines:

- Section 3.2 – the list of input states taken into account will be updated.
- Appendix A.1.4 (c) and A.2.1 will be updated to describe the process outlined in 3.4.2.

4.7 Revision of definition of Regional Excess Supply

The concept of Regional Excess Supply (RXS) is employed in the BBN process to estimate the reserve forecasting uncertainty from the forecasting uncertainty of the various contributing factors.

Currently the components of the RXS value are the forecast:

1. available capacity of scheduled generating units (A);
2. unconstrained intermittent generation forecast (B); and
3. Operational Demand (C) (includes the impact of smaller scale embedded generation).

The value of forecast RXS is determined by the formula:

A + B – C.

This definition captures the major factors that will always contribute to the reserve forecast uncertainty.

However, there are other forecasting uncertainties which contribute to the level of reserve forecasting uncertainty. AEMO has considered uncertainties relating to:

- Network limitations, both inter-regional and intra-regional.
- Supply-demand balance in neighbouring regions.
- Energy limitations on scheduled generating units.

The Analysis indicates that each of these factors can, at times, contribute to significant levels of uncertainty in the reserve forecasting process. Without accounting for them, the current RXS definition may be overly conservative.

For example, in circumstances where a generating unit in a region shares network capacity with an interconnector, an un-forecast reduction in the availability of the generating unit could result in an un-forecast increase in interconnector support. Under the current RXS definition this scenario is not considered and may result in an overly conservative distribution of RXS errors. Further detail is provided in Appendix B of this paper.

Therefore, AEMO proposes redefining the RXS for all mainland NEM regions using the following components:

- Aggregate capacity of scheduled generation in the region (C) calculated as:
  - Aggregate capacity of non-energy limited plant, plus
  - Aggregate capacity of energy limited plant, less
  - Aggregate output of semi-scheduled generating units.

- Interconnector Support (I).
- Aggregate output of semi-scheduled generating units (SS).
- 50 % POE scheduled demand (D).

To include all these components, the RXS formula would be revised to:

RXS = C + I +SS – D

Where each of these components would be defined as follows:

Aggregate capacity of non-energy limited plant is the total aggregate contribution to supply from scheduled and semi-scheduled generating units in the region for which no daily energy limit has been specified in ST and PD PASA bids. The value is determined by the PASA process taking into account

- forecast market availability as specified by Generators;
- network limitations as specified by AEMO through network constraint equations; and
- AEMO forecasts for output of semi-scheduled generating units.

This forecast value for each trading interval of each PASA run is reported in the PASA Solution files.

Aggregate capacity of energy limited plant is the total aggregate contribution to supply from scheduled generating units in the region for which a daily energy limit has been specified in ST and PD PASA bids. The value is determined by the PASA process taking into account:

- forecast market availability as specified by Generators;
- forecast daily energy limit as specified by Generators;
- optimisation of energy limited capacity through the PASA algorithm; and
- network limitations as specified by AEMO through network constraint equations.

This forecast value for each trading interval of each PASA run is reported in the PASA Solution files

Interconnector support is the maximum supply to the region available from adjacent regions after the supply demand balance is satisfied in adjacent regions. This value is determined by the PASA process taking into account:

- network limitations as specified by AEMO through network constraint equations; and
- supply demand balance in adjacent regions as determined by the PASA algorithm.

This forecast value for each trading interval of each PASA run is reported in the PASA Solution files.

Aggregate output of semi-scheduled generating units is the forecast output of semi-scheduled generating units in the region. This value is determined by PASA taking into account:

- unconstrained intermittent generation forecast determined by AEMO forecasting systems; and
- network limitations as specified by AEMO through network constraint equations.

This forecast value for each trading interval of each PASA run is reported in the PASA Solution files.

50 % POE scheduled demand is the expected value of regional electricity demand (excluding scheduled loads) which will need to be met by supply from scheduled and semi-scheduled generating units in the region or from other regions. This value is determined by AEMO forecasting systems taking into account expected:

- customer load;
- output of major non-scheduled generating units; and
- output of embedded generating units including rooftop solar generation.

This forecast value for each trading interval of each PASA run is reported in the PASA Solution files.

For the Tasmanian region, the redefinition of the RXS calculation was not feasible because it would result in excessively large FUM values and a subsequent increase in the number of LORs of the order of approximately 50 - 100 per year. This is considered unrealistic given the normal relatively high level of capacity reserves and the rarity of lack of reserve conditions in Tasmania. The very large FUM values seen for Tasmania arise for the following reasons:

- When an un-forecast intraregional network constraint forces Basslink to export from Tasmania to the mainland, it results in large errors in the interconnector support component of the RXS.
- The large interconnector support error is compounded by a subsequent large error in the aggregate capacity of non-energy limited plant, due to the required increase in generation within the region to support exports via Basslink.

Further detail is provided in Appendix B. For these reasons, AEMO proposes retaining the current definition of RXS for Tasmania only.

The revised definition of Regional Excess Supply will require changes to the following sections of the Guidelines:

- Section 3.1 to update the components of the RXS definition, provide for a separate definition for Tasmania and explain the difference.
- Appendix A section A.1 to update the sources of error and add subsections to describe each source.

4.8 Flexibility in determining the frequency of retraining

AEMO has streamlined the model retraining process by automating, as much as possible, the data extraction, model creation and retraining, and model verification steps. The changes proposed to reduce the number of models further simplifies the retraining and verification procedure. Due to the efficiencies achieved through implementing these changes AEMO no longer proposes to modify the Guidelines to introduce a flexible retraining schedule and will continue to retrain the BBN models on a quarterly basis.

4.9 Changes to the confidence level

The Guidelines set out the basis for selecting the confidence level, such that an appropriate balance is struck between:

- Reducing the chance of a situation where LOR Load Shedding arises due to lack of action by AEMO as a result of reserve forecasting error; and
- Increasing the likelihood of unnecessary declarations due to an overly conservative confidence level.

The Guidelines further require an annual review of the confidence levels to determine whether or not they are achieving the appropriate balance indicated above.

The current confidence level varies between 98% and 95% depending on the forecast horizon, as detailed in Appendix B of the Guidelines.

Due to the interdependent relationship between all of the proposed changes (described in Section 4), AEMO has completed a review of the confidence levels, and proposes to update the confidence level to 95% for the full forecast horizon.

The revisions to the confidence level will require changes to Appendix B of the Guidelines.

4.10 Other changes to the Guidelines

Section 3.5 of the Guidelines requires changes to include the delta raise and delta lower reasonability limits and their purpose. These limits were introduced prior to implementation of the Guidelines, to manage large transient movements in the output values for the same trading interval from successive runs of the BBN[5]. The delta raise and delta lower reasonability limits were not included in version 1 of the Guidelines due to identifying the need for this type of reasonability limit after version 1 of the Guidelines had been published.

For completeness, AEMO proposes to update Appendix A section A.1.4(f) to remove the statement that the first BBN retraining would occur after March 2018.

4.11 Summary of proposed changes

Proposed change	Changes required to the Guidelines
Reducing the number of models per region	N/A
Changing the output bin structure	N/A
Changing the temperature input bin structure	N/A
Extending the BBN models to produce a dynamic FUM value for the 144th trading interval	N/A
Changing the input predictors (input states) used in the BBN models	Section 3.2, Appendix A.1.4, Appendix A.2.1
Revision of definition of Regional Excess Supply	Section 3.1, Appendix A.1
Changes to the confidence level	Appendix B
Include delta reasonability limits in Guidelines	Section 3.5
Update date range of training data specified in Guidelines	Appendix A.1.4

[5] Refer to https://www.aemo.com.au/Stakeholder-Consultation/Consultations/Consultation-on-initial-version-of-Reserve-Level-Declaration-Guidelines

5. DRAFTING FOR PROPOSED CHANGES

The process by which the Guidelines are to be amended is set out in NER clause 4.8.4A(e). This process is an abridged single stage version of the Rules Consultation procedures set out in rule 8.9.

Having considered the matters raised in submissions, AEMO has developed a draft version of the Guidelines showing the changes that are currently intended. This draft is published on the consultation webpage http://aemo.com.au/Stakeholder-Consultation/Consultations/Changes-to-Reserve-Level-Declaration-Guidelines .

APPENDIX A - RESULTS FROM THE ANALYSIS

This section presents the results from the Analysis described in section 3.4 of this Update Paper.

A.1 Expected number of LORs

The results showing the expected number of LORs are based on an ex-ante historic backcast using BBN models after the application of the proposed changes detailed in this Update Paper (refer to 3.10 for the summary of the proposed changes). The number of LORs due to LCR are based on a static calculation of the largest credible risk in each region and thus are an approximation (PD PASA and ST PASA use a dynamic calculation of LCR).

The period of comparison is financial year 2017/18.

Region	LOR type	Confidence level	LORs due to FUM	LORs due to LCR/2[6]
NSW	LOR1	94	5	24 (1 instance identified earlier by FUM)
NSW	LOR1	95	6	24 (3 instances identified earlier by FUM)
NSW	LOR1	96	7	24 (4 instances identified earlier by FUM)
NSW	LOR1	98	14	24 (10 instances identified earlier by FUM)
NSW	LOR2	94	5	3 (1 instance identified earlier by FUM)
NSW	LOR2	95	6	3 (1 instance identified earlier by FUM)
NSW	LOR2	96	8	3 (1 instance identified earlier by FUM)
NSW	LOR2	98	14	3 (1 instance identified earlier by FUM)
QLD	LOR1	94	0	15
QLD	LOR1	95	0	15
QLD	LOR1	96	0	15
QLD	LOR1	98	0	15
QLD	LOR2	94	0	1
QLD	LOR2	95	0	1
QLD	LOR2	96	0	1
QLD	LOR2	98	4	1 (1 instance identified earlier by FUM)

[6] LORs due to LCR/2 is the number of LORs due to the Largest Credible Risk (LCR) in the case of LOR2s, and the number of LORs due to the two Largest Credible Risks (LCR2) in the case of LOR1s.

SA	LOR1	94	7	10 (4 instances identified earlier by FUM)
SA	LOR1	95	9	10 (4 instances identified earlier by FUM)
SA	LOR1	96	10	10 (4 instances identified earlier by FUM)
SA	LOR1	98	22	10 (5 instances identified earlier by FUM)
SA	LOR2	94	9	1 (1 instance identified earlier by FUM)
SA	LOR2	95	11	1 (1 instance identified earlier by FUM)
SA	LOR2	96	12	1 (1 instance identified earlier by FUM)
SA	LOR2	98	23	1 (1 instance identified earlier by FUM)
TAS	LOR1	94	0 (66)[7]	50
TAS	LOR1	95	0 (74)	50
TAS	LOR1	96	0 (85)	50
TAS	LOR1	98	0 (106)	50
TAS	LOR2	94	0 (66)	39
TAS	LOR2	95	0 (74)	39
TAS	LOR2	96	0 (85)	39
TAS	LOR2	98	1 (106)	39
VIC	LOR1	94	13	14 (7 instances identified earlier by FUM)
VIC	LOR1	95	14	14 (10 instances identified earlier by FUM)
VIC	LOR1	96	16	14 (10 instances identified earlier by FUM)
VIC	LOR1	98	41	14 (10 instances identified earlier by FUM)
VIC	LOR2	94	15	3 (3 instances identified earlier by FUM)
VIC	LOR2	95	15	3 (3 instances identified earlier by FUM)

[7] The number in parentheses is the number of LORs due to FUM with the new proposed definition of RXS. The number without the parentheses is the number of LORs due to FUM with the existing definition of RXS. As described in 4.7, AEMO proposes to retain the existing definition of RXS for Tasmania.

VIC	LOR2	96	16	3 (3 instances identified earlier by FUM)
VIC	LOR2	98	41	3 (3 instances identified earlier by FUM)

Note, the results for Tasmania LORs due to LCR/2 are based on static LCR and LCR2 values of 478 and 600MW respectively. During the outages of Basslink during financial year 2017/18 the LCR and LCR2 dynamic values used in PASA would fall below these static values. All of the LCR based declarations in the table above occurred during a Basslink outage and thus this explains the discrepancy between the number of LCR based declarations returned above when compared to the actual number of LOR declarations for Tasmania for financial year 2017/18.

Selection of confidence level

The Guidelines set out the basis for selecting the confidence level, such that an appropriate balance is struck between:

- Reducing the chance of a situation where LOR Load Shedding arises due to lack of action by AEMO as a result of reserve forecasting error; and
- Increasing the likelihood of unnecessary declarations due to an overly conservative confidence level.

The process used to select the confidence level is as follows, and is based on the results from the expected number of LORs analysis described above:

- For each region and each of the confidence levels specified, assess the number of LOR1s and LOR2s due to FUM and due to LCR/2
- For each of the LORs due to LCR/2 identify the number that are identified due to the FUM with an earlier lead time. For example an LOR for 15/03/2018 may have been identified due to FUM on the 12/03/2018 and may have subsequently been identified due to LCR/2 on 14/03/2018. Note each of these instances for each region and each of the confidence levels specified.
- Increase the confidence level such that, where possible, a larger proportion of the LORs identified due to LCR/2 are identified with an earlier lead time due to FUM.
- When increasing the confidence level, monitor the increase in LORs due to FUM to prevent selection of an over conservative confidence level which will result in an excessive increase in the number of LORs due to FUM.
- Where an increase of the confidence level does not result in a significant increase in the proportion of LORs due to LCR/2 being identified earlier due to FUM, select the lower of the confidence levels to prevent selection of an over conservative confidence level.

After applying the above criteria, the selected confidence level is 95%. Although increasing the confidence level to 96% satisfies the criteria for the level of LORs due to FUM for all regions, it fails to meet the criteria of increasing the proportion of LORs due to LCR/2 being identified earlier due to FUM for SA and VIC, as the proportion remains the same.

The confidence levels used in the current implementation differ by forecasting horizon, with higher confidence levels at the shorter forecasting horizons, monotonically decreasing as the forecast horizon becomes larger[8]. This results in regular occurrences of the FUM value for a given trading interval increasing as the trading interval moves closer to the current time, due to the confidence level used to select the FUM value increasing.

This is demonstrated in the Average FUM values of Appendix A.2 where the relative increase in average FUM values can be observed for the existing FUM values data set for the forecasting horizon 30 to 42 half-hours ahead (corresponding to 15 hrs to 21 hrs ahead where the current confidence level

[8] The confidence levels are specified in Appendix B of the Guidelines

increases from 95% to 98%). Based on this unintended behaviour AEMO proposes to set the selected confidence level of 95% for the entire forecast horizon.

A.2 Expected FUM values

The results showing the expected FUM values are based on an ex-ante historic backcast using BBN models after the application of the proposed changes detailed in this Update paper (refer to 4.11 for the summary of the proposed changes). The results are the best estimate of the FUM values likely to be obtained from the BBN models (with all the proposed changes applied) accounting for the given conditions, and using the input predictors available, at that time.

The results are compared against the existing FUM values archived from the production system runs. Note, the values compared are “raw” values before application of any min/max reasonability limits or delta raise/lower reasonability limits, to ensure a direct comparison of FUM values that would be obtained from the BBN models.

The period of comparison is 15 February 2018 (when the Guidelines were implemented) to 30 June 2018.

Average FUM values

Average FUM values have significantly decreased for NSW, QLD and SA across the full forecast horizon. For VIC the average FUM values have significantly decreased in the 0 to 20 hours ahead horizon and have slightly decreased in the 20 to 144 hours ahead horizon. Tasmanian average FUM values have decreased in the 0 to 19 hours ahead horizon and are generally similar in the 19 to 144 hours ahead horizon.

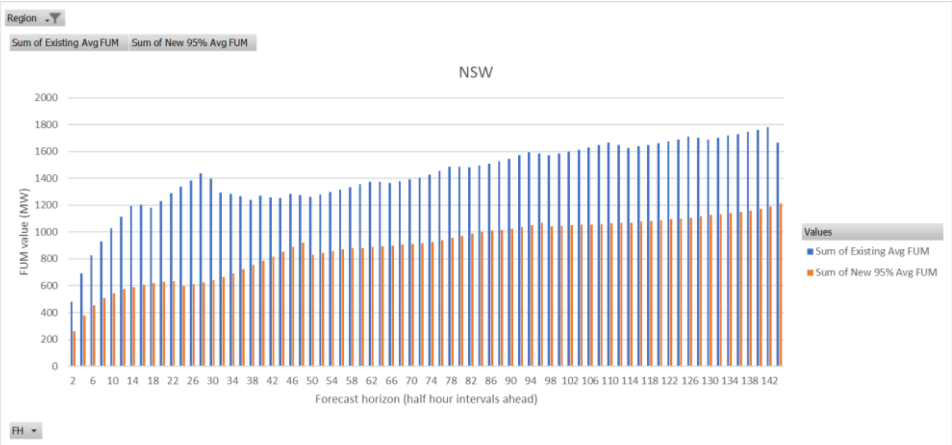

Figure 2 - average FUM values by forecast horizon for NSW

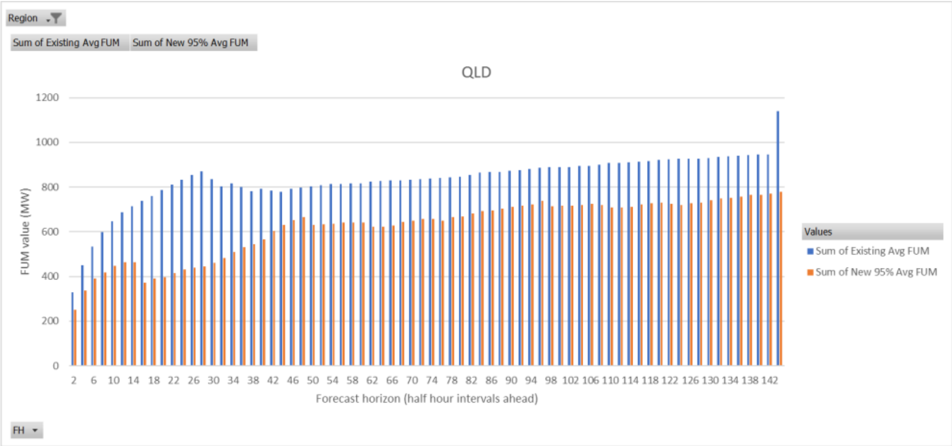

Figure 3 - average FUM values by forecast horizon for QLD

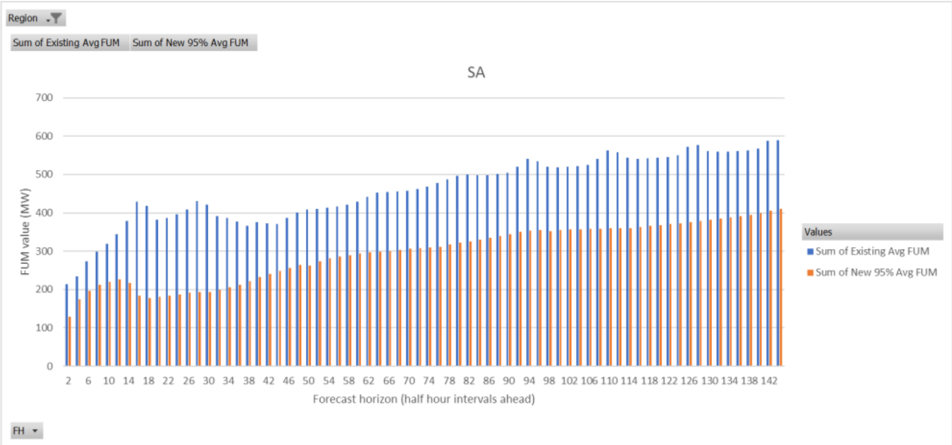

Figure 4 - average FUM values by forecast horizon for SA

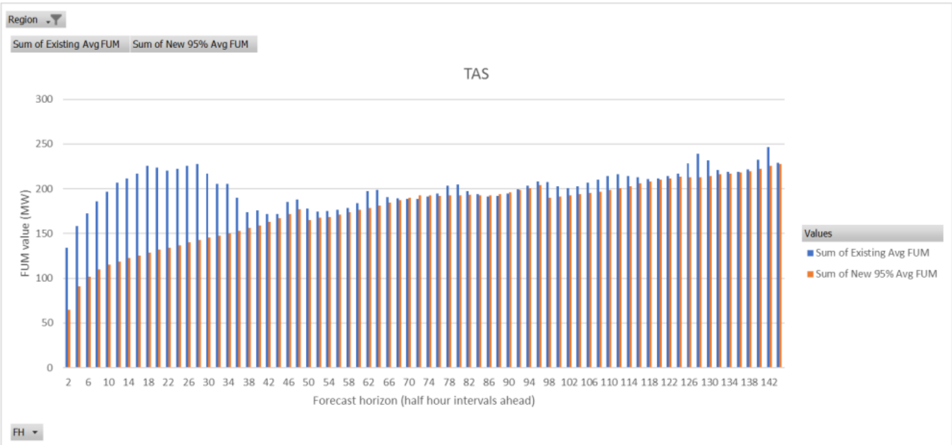

Figure 5 - average FUM values by forecast horizon for TAS

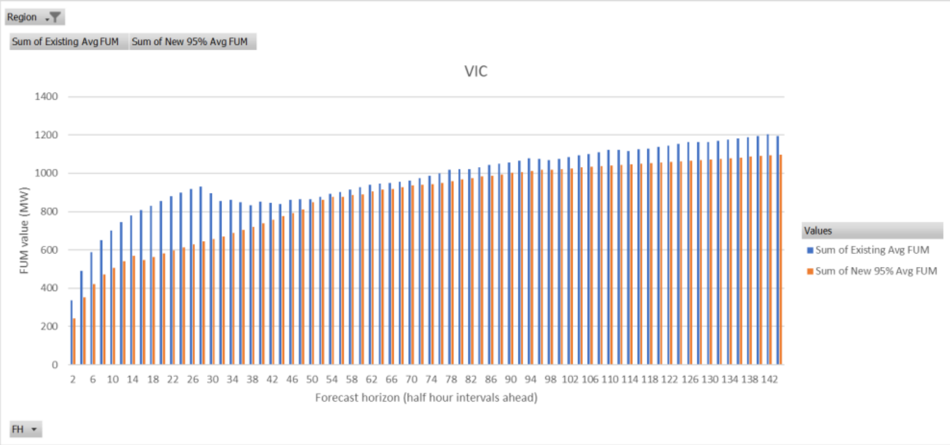

Figure 6 - average FUM values by forecast horizon for VIC

Maximum FUM values

Maximum FUM values have significantly decreased for NSW and SA. For QLD maximum FUM values have decreased in the 0 to 20 hours ahead horizon and are generally similar in the 20 to 144 hours ahead horizon. For VIC maximum FUM values have decreased in the 0 to 24 hours ahead horizon and are generally similar in the 24 to 144 hours ahead horizon. Tasmanian maximum FUM values have decreased across most of the horizon with the exception of a minor increase in the 50 to 74 hours ahead horizon.

In the figures below, the maximum reasonability limit is included as a line graph to indicate the level of the current maximum reasonability limit. The results indicate the proposed changes will significantly reduce the extent of maximum reasonability limit binding.

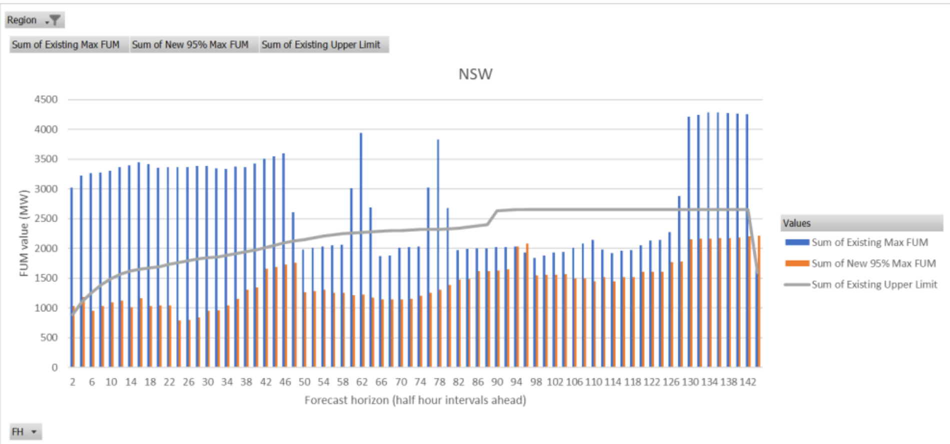

Figure 7 - maximum FUM values by forecast horizon for NSW

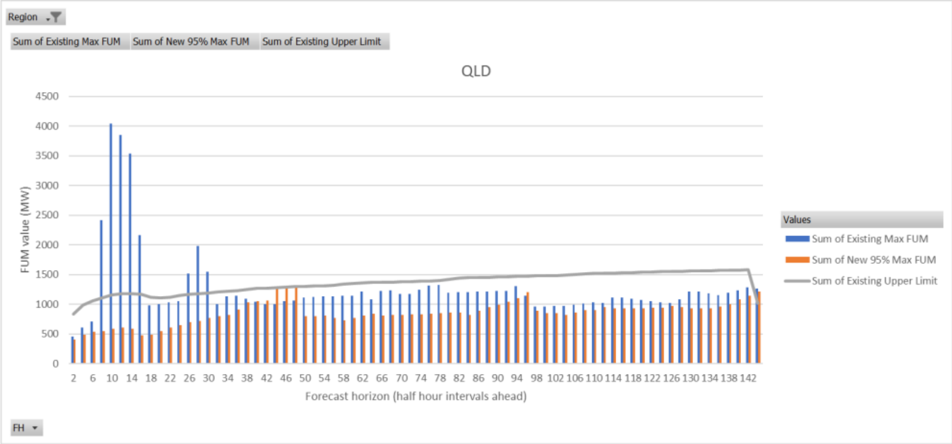

Figure 8 - maximum FUM values by forecast horizon for QLD

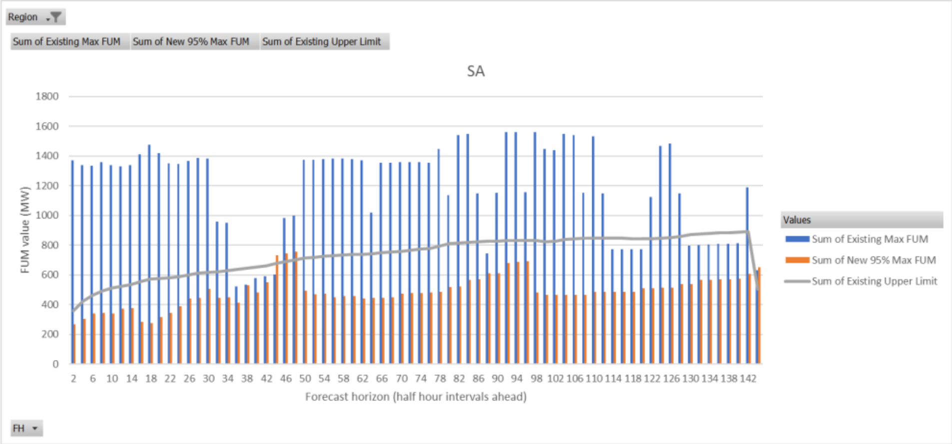

Figure 9 - maximum FUM values by forecast horizon for SA

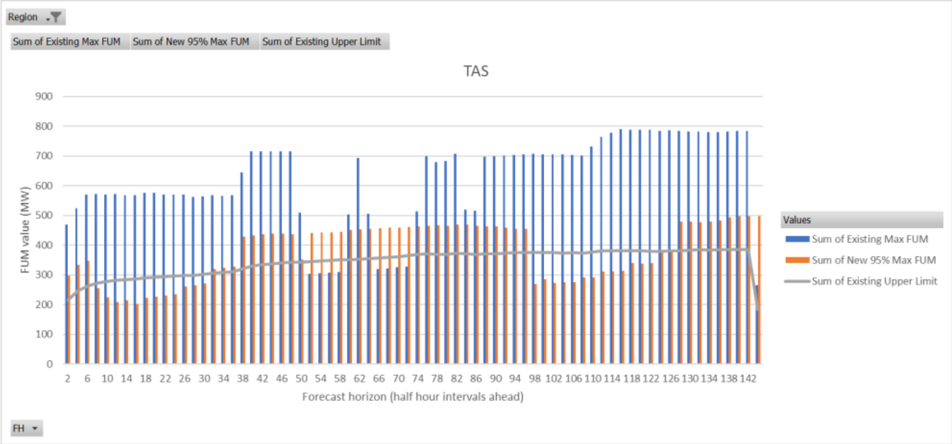

Figure 10 - maximum FUM values by forecast horizon for TAS

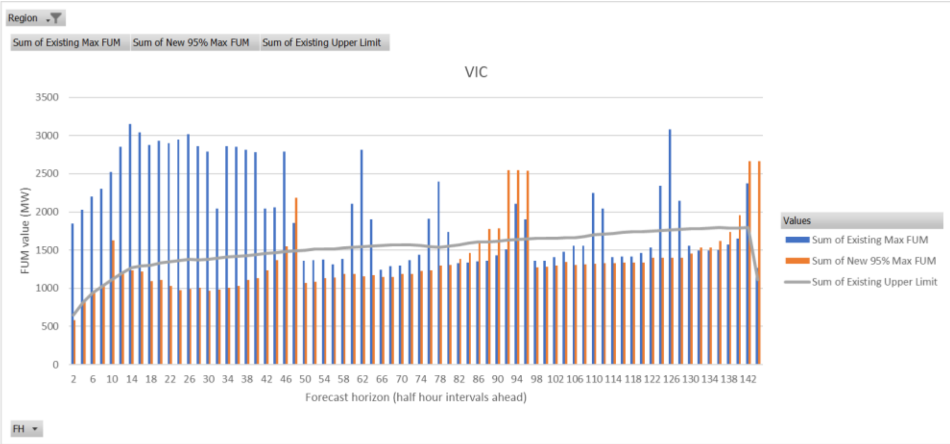

Figure 11 - maximum FUM values by forecast horizon for VIC

Minimum FUM values

Minimum FUM values have decreased for NSW, QLD, SA and VIC. Tasmanian minimum FUM values have generally decreased by a minor amount.

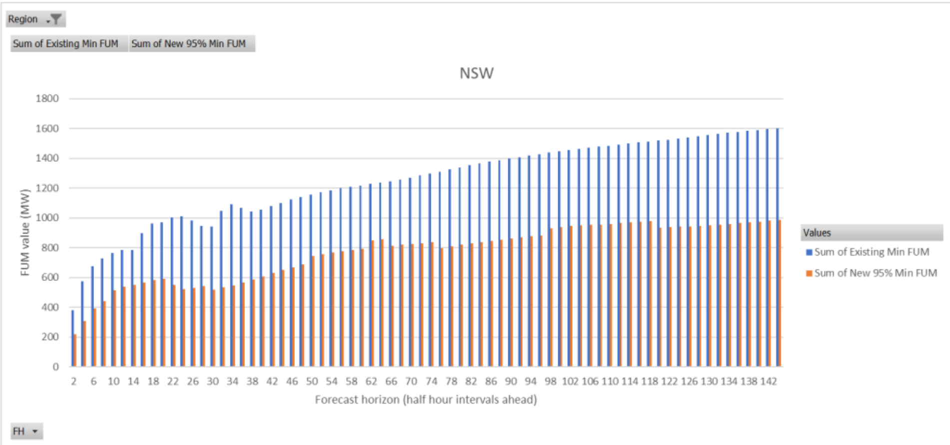

Figure 12 - minimum FUM values by forecast horizon for NSW

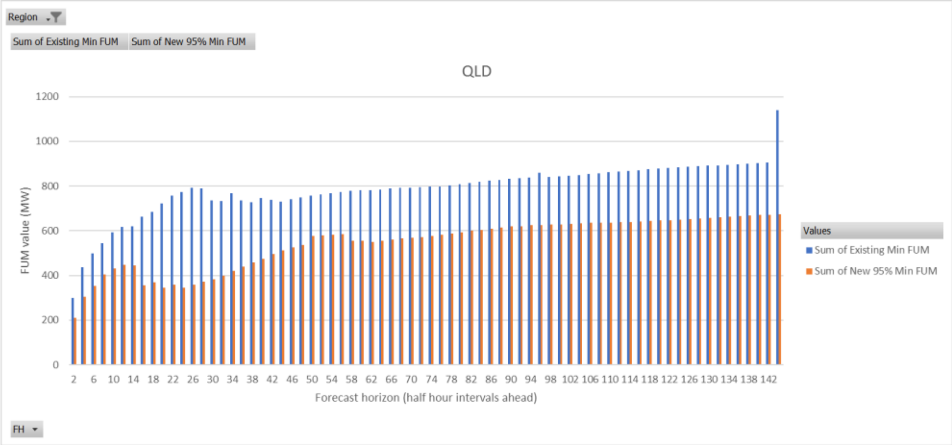

Figure 13 - minimum FUM values by forecast horizon for QLD

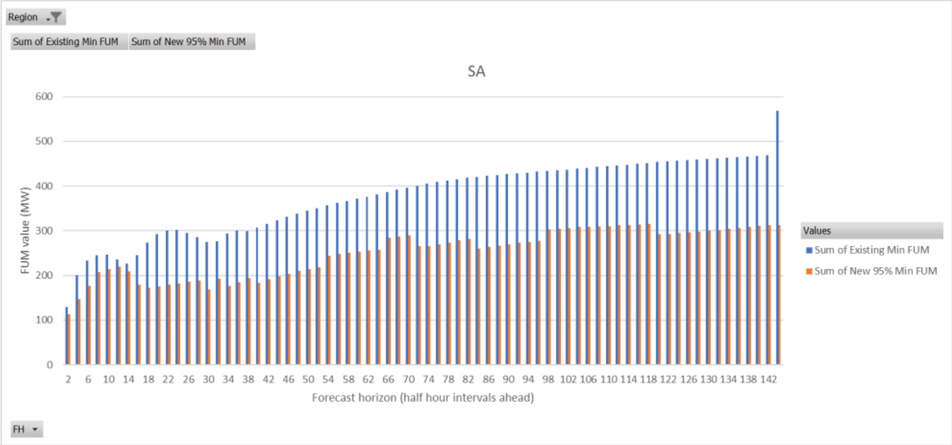

Figure 14 - minimum FUM values by forecast horizon for SA

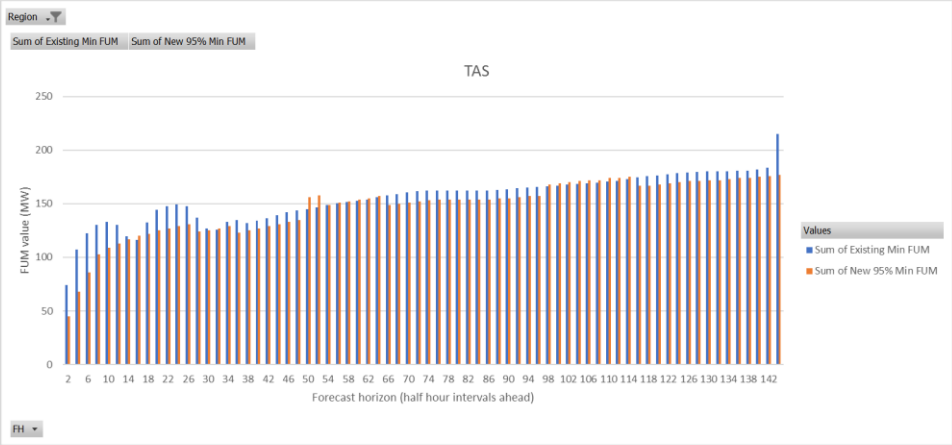

Figure 15 - minimum FUM values by forecast horizon for TAS

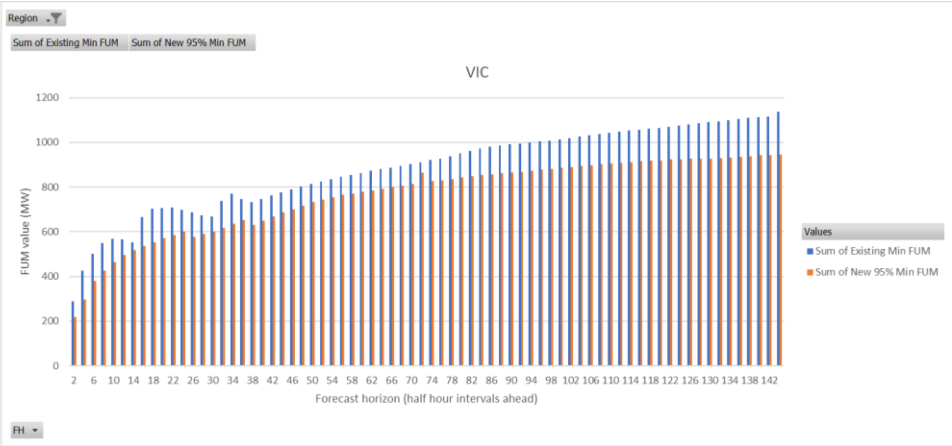

Figure 16 - minimum FUM values by forecast horizon for VIC

APPENDIX B. COMPONENTS OF RXS

This section provides a breakdown of the 24-hour ahead errors of each of the components of the proposed RXS definition on a regional basis.

The x-axis is time from 2012 to 30 June 2018 to provide an indication of how the error from these components has changed over time. The y-axis is divided into each component and displays the error value in MWs (note the scale differences between each component).

The mapping of the variables to the definitions in 4.7 are as follows:

- RXS = error of the RXS definition
- UNCON_GEN_ERROR = error of aggregate capacity of non-energy limited plant
- CON_GEN_ERROR = error of aggregate capacity of energy limited plant
- INTERCONNECTOR_ERROR = error of interconnector support
- DEMAND_ERROR = error of 50% POE scheduled demand
- SEMI_GEN_ERROR = error of aggregate output of semi-scheduled generating units

Where error is defined as forecast minus actual.

NSW

The scenario described in 4.7 where a generating unit shares network capacity with an interconnector and the un-forecast reduction in the availability of this generator unit could result in an un-forecast increase in interconnector support is clearly evident in the CON_GEN_ERROR and INTERCONNECTOR_ERROR components between 2012 and 2015 (refer to figure below). During this period there are several errors in these components of 2000 MWs however due to the counteracting nature of these errors, the RXS error remains generally up to 1500MW.

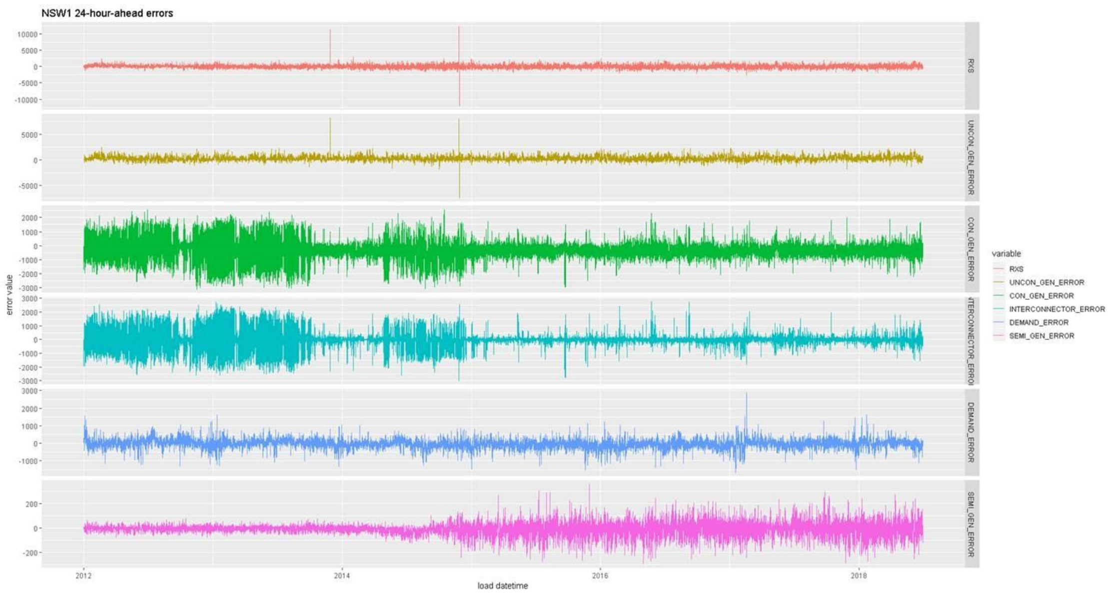

Figure 17 - 24-hour ahead error of components of RXS over time for NSW

QLD

Figure 18 shows the QLD region RXS has remained relatively stable over time.

Note the recent addition of SEMI_GEN_ERROR corresponding to the registration of the first semi-scheduled generators in the region.

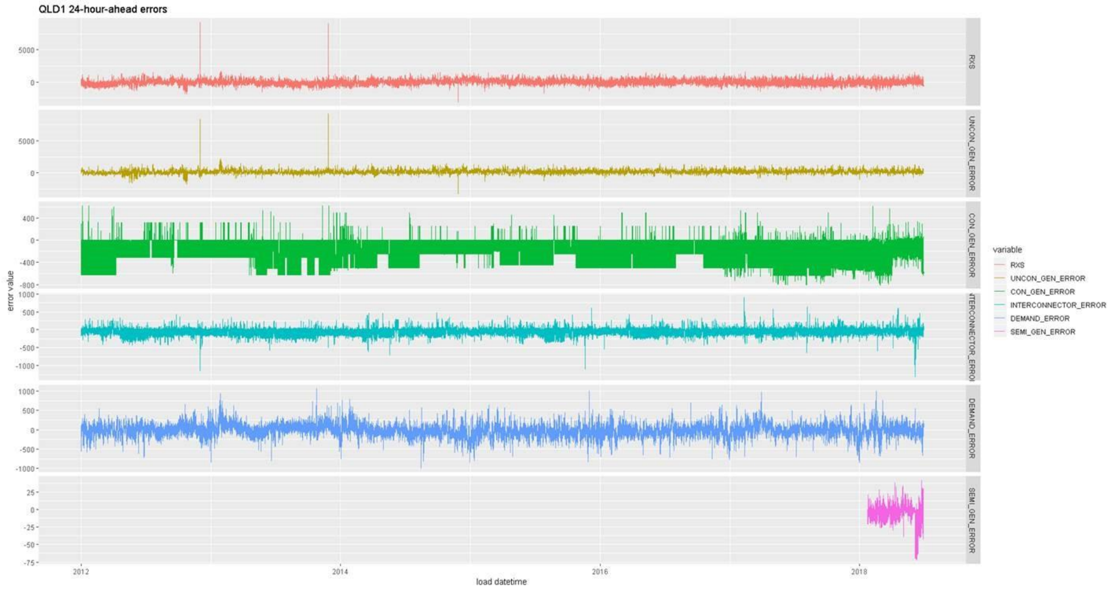

Figure 18 - 24-hour ahead error of components of RXS for QLD

SA

Figure 19 shows the SA region RXS over time. There is a slight increase in RXS since mid 2016 which appears consistent with an increase in the CON_GEN_ERROR component.

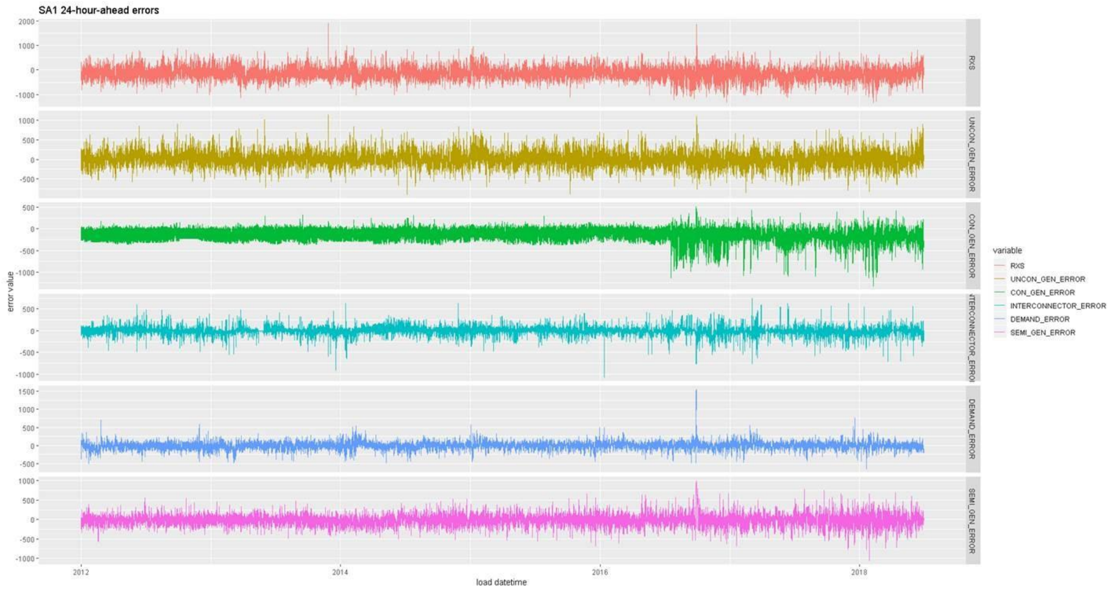

Figure 19 - 24-hour ahead error of components of RXS for SA

TAS

The scenario described in 4.7 where an un-forecast intraregional network constraint forces Basslink to export from Tasmania to the mainland resulting in large interconnector and non-energy limited plant errors is clearly evident in the UNCON_GEN_ERROR and INTERCONNECTOR_ERROR components (refer to figure below). During the Basslink outage of early 2016 the reduction in UNCON_GEN_ERROR and subsequent small RXS error is evident.

Due to the excessively large FUM values for Tasmania with the new proposed RXS definition AEMO is proposing to retain the existing RXS definition as described in 4.7.

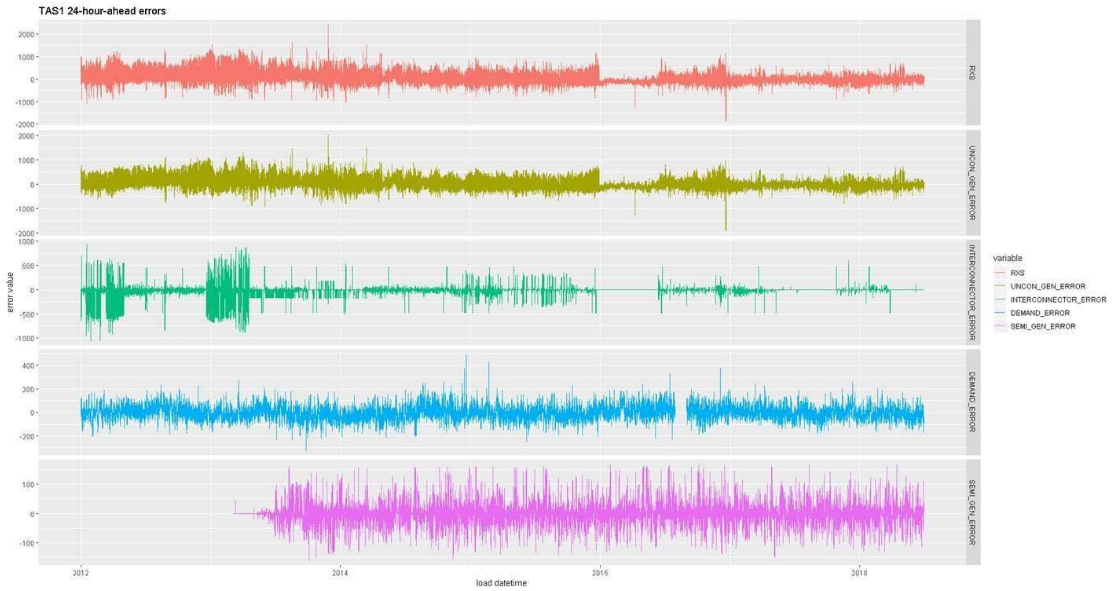

Figure 20 - 24-hour ahead error of components of RXS for TAS

VIC

Figure 21 shows the VIC region RXS over time.

Note the increase in SEMI_GEN_ERROR is consistent with the increase in installed capacity in late 2012.

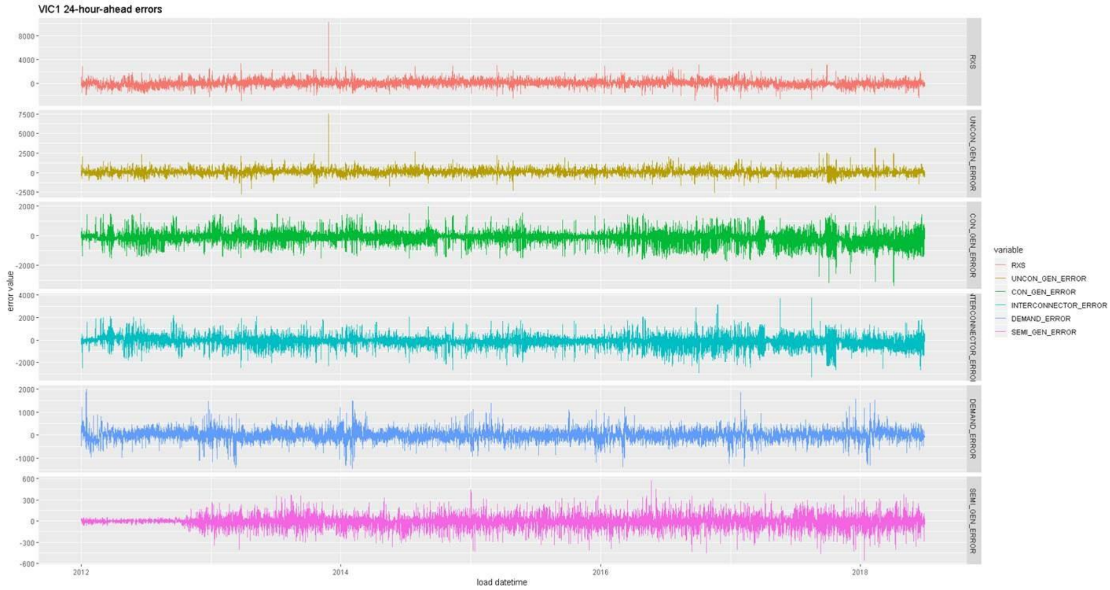

Figure 21 - 24-hour ahead error of components of RXS for VIC