AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

NEM Lack of Reserve Framework Report – reporting period 1 January 2021 to 31 March 2021

April 2021

A report for the National Electricity Market on the operation of the Lack of Reserve Framework

Important notice

PURPOSE

AEMO has prepared this document under clause 4.8.4B of the National Electricity Rules to report on the operation of the NEM Lack of Reserve Framework for the period 1 January 2021 to 31 March 2021.

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VERSION CONTROL

Version	Release date	Changes
1	28 April 2021	Initial version

Executive summary

This report has been published in accordance with clause 4.8.4B of the National Electricity Rules (NER).

In the reporting period 1 January 2021 to 31 March 2021 (Quarter 1 2021), AEMO declared seven Lack of Reserve (LOR) conditions in the National Electricity Market (NEM)[1]:

- There were two forecast LOR1 conditions.
- There were zero forecast LOR2 conditions.
- There were three actual LOR1 conditions.
- There were two actual LOR2 conditions.

This compares with 39 LOR conditions declared in the previous reporting period (Quarter 4 2020), and 19 LOR conditions declared for the same period last year (Quarter 1 2020)[2].

Quarter 1 2021 covered the later summer months and first month of autumn. The LOR declarations in this quarter are mainly due to short notice outages and unplanned power system events.

Multiple unplanned transmission outages and sudden loss of generation availability occurred during the reporting period which significantly impacted available reserves.

Bushfire activity in South Australia impacted the power system, particularly at the beginning of the quarter, when multiple transmission assets tripped due to bushfires. South Australia was at risk of separation on the next contingency, and import into South Australia needed to be constrained, which resulted in LOR conditions.

The majority of actual LOR conditions were unanticipated, occurring with no prior forecast as they were due to power system incidents and unplanned network or forced generator outages.

Of the seven LOR declarations in Quarter 1 2021:

- For five declarations, the reserve requirement was set by the sum of the two Largest Credible Risks (LCR2, for LOR1 thresholds). There were two declarations where the reserve requirement was set by the Largest Credible Risk (LCR, for LOR2 thresholds). There were no declarations where the reserve requirement was set by the Forecast Uncertainty Measurement (FUM).
- This means 0% of LOR conditions were declared when the reserve requirement was being set by the FUM. For comparison, in Quarter 4 2020, seven of the 39 LOR declarations were set by FUM (18%), and in Quarter 1 2020, two of the 19 LOR conditions (11%) were set by the FUM.

The next report on the NEM Lack of Reserve Framework, for the reporting period 1 April 2021 to 30 June 2021, will be published by 31 July 2021.

[1] Forecast or actual LOR1, LOR2, or LOR3. LOR is described in clause 4.8.4 of the NER. AEMO's considerations and methodology, and the LOR levels, are outlined in AEMO's Reserve Level Declaration Guidelines, at https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Power-system-operation.

[2] In Quarter 4 2020, the declared LOR conditions were 15 forecast LOR1 conditions, ten forecast LOR2 conditions, 13 actual LOR1 conditions and one actual LOR2 condition; in Quarter 1 2020 the declared LOR conditions were seven forecast LOR1 conditions, five actual LOR1 conditions and seven actual LOR2 conditions. Previous quarterly reports are on AEMO's website at https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/power-system-operation/nem-lack-of-reserve-framework-quarterly-reports.

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1. Introduction

This report has been published in accordance with clause 4.8.4B of the National Electricity Rules (NER), to provide a high-level analysis of how the Lack of Reserve (LOR) framework is operating. This report covers the period from 1 January 2021 to 31 March 2021 (Quarter 1 2021).

Unless otherwise noted, all times in this report are National Electricity Market (NEM) time (Australian Eastern Standard Time [AEST]).

The report is divided into three sections:

- **Reserve Level Declaration Guidelines** – a summary of changes to the Guidelines over the past quarter, and the retraining of the Bayesian Belief Network (BBN).
- **LOR conditions declared** – details of all LOR conditions declared or revised during the past quarter (based on market notices). For each condition declared, the report indicates the required reserve level and whether the requirement was set by the Forecast Uncertainty Measure (FUM), or the largest credible risk/s (LCR) in the region. The reserve requirement can be set by the largest credible risk (LCR, for LOR2 conditions) or the sum of the two largest credible risks (LCR2, for LOR1 thresholds). The FUM value for each relevant period is also provided.
- **Review of performance** – a review of the performance of the LOR framework and any observed trends, providing an assessment of FUM values compared to previous quarters, determinants of reserve level requirements, number of LOR declarations, and leading factors or causes of LOR declarations.

Please direct all LOR inquiries to www.aemo.com.au/Contact-us. In the inquiry form field '*What is your enquiry regarding?*', write "**LOR Framework Report**".

The next report on the NEM Lack of Reserve Framework, for the reporting period 1 April 2021 to 30 June 2021, will be published by 31 July 2021.

2. Reserve Level Declaration Guidelines

2.1 Changes in the reporting period

During the reporting period, there were no changes to the Guidelines[3].

2.2 Retraining of the Bayesian Belief Network

The BBN is the algorithm which determines the FUM, which in turn can determine LOR levels. This process is summarised in the Guidelines. The intention of retraining the BBN is to update the network to include recent historical data since the last retraining. AEMO commenced the retraining in April 2021 to include data up to 31 March 2021. The retraining involves a three-stage process:

1. Extract-Transform-Load (ETL) stage, to extract historical data up to 31 March 2021, perform data validation and cleansing, and compile the data into the structured format required to incorporate into the network.
2. Analysis and modelling stage, to update the network and compile the network nodes.
3. Test and verification stage, to ensure the retrained network is suitable for production implementation.

AEMO is in the final stage of retraining, and plans to implement the retrained BBN into production around the end of April 2021, pending final verification and readiness checks in the pre-production environment.

2.2.1 Results from retraining

To verify the retraining, AEMO completed a backcast of all forecast intervals from January 2020 to December 2020 inclusive using the existing BBN and the retrained BBN. The intention of the backcast is to provide an indication of the magnitude of changes to future maximum, minimum and mean FUM values.

Changes in maximum and minimum FUM values between the existing and retrained BBN backcasts are common, as these are sensitive to single events during the retraining quarter. These changes are listed below. Large differences in mean FUM values indicate a sustained change in uncertainty for a particular forecast horizon. Where material changes in the mean FUM have been identified, these have been investigated and investigation results summarised below. Minor changes were identified for some other forecast horizons and distribution statistics but are not listed here.

- New South Wales – maximum FUM values decreased by 54 and 96 megawatts (MW) for the 6 and 60 hours ahead forecast horizons. Mean and minimum FUM values were relatively unchanged.
- Queensland – maximum FUM values increased by 116 MW for the 12 hours ahead forecast horizon and decreased by 104 MW for the 60 hours ahead forecast horizon. Mean and minimum FUM values were relatively unchanged.
- South Australia – maximum FUM values decreased for the 2, 6 and 12 hours ahead forecast horizons by 199 MW, 63 MW and 44 MW respectively. Minimum FUM values increased by 30 MW for the 6 hours ahead forecast horizon. Mean FUM values were relatively unchanged.

[3] The Guidelines are at http://aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Power-system-operation.

- Tasmania – maximum FUM values decreased by 20 MW for the 6 hours ahead, by 14 MW for the 24 hours ahead, and by 86 MW for the 60 hours ahead forecast horizons. Mean and minimum FUM values were relatively unchanged.
- Victoria – maximum FUM values increased by 88 MW and 517 MW for the 12 and 24 hours ahead forecast horizon. Mean and minimum FUM values were relatively unchanged.

3. Lack of Reserve conditions declared

Table 1 provides a high-level summary of the count of forecast and actual LOR conditions based on the declaration count principles.

Table 2 lists all market notice declarations of forecast and actual LOR conditions over the reporting period 1 January 2021 to 31 March 2021. Table 2 also identifies the market notices that communicated updates to, and cancellation of, either forecast or actual LOR conditions.

Declaration count principles

For the reporting period, AEMO determined the total count for LOR conditions based on the following principles:

- All market notices making the initial declaration of a forecast or actual LOR condition with an effective date during the reporting period were counted.
- Any market notices which updated previously issued forecast or actual LORs for a given effective date (in relation to the reserve requirement, reserve capacity available, or effective period) were not counted, to prevent double-counting of a continuing condition.
- In cases where forecast LORs were cancelled but subsequently re-issued with approximately the same effective period, re-issues were not counted, to prevent double-counting of effective periods.
- Updates to existing LOR conditions where the LOR level changed were counted as separate LOR conditions.
- Any forecast LORs which were subsequently declared as actual LORs at the same LOR level were counted once. In Table 2, these are shown as actual conditions only. For example, where a forecast LOR1 was issued and later an actual LOR1 was declared for a similar period, only the actual LOR1 was counted. But if the initial forecast was for a forecast LOR2 condition and this was later declared as an actual LOR1, this would be counted as two LOR conditions, due to the differing LOR levels.

Table 1 Summary of forecast and actual LOR conditions, with causing factors

Effective date[A]	Region	LOR1		LOR2		LOR3		Cause and resolution
		Actual	Forecast	Actual	Forecast	Actual	Forecast	
14/01/2021	NSW	1						An actual LOR1 condition was declared with an effective period of 16:30-17:30 due to a decrease in generation availability, decrease in net import and increase in demand. Prior to this event, no prior forecast LOR1 declaration had been issued for this effective period. Actual condition existed from 16:30-17:30.
9/03/2021	QLD		1					A forecast LOR1 condition was declared with an effective period of 18:30-19:00 (13 hour lead time). The reserve condition was due to decreased generation availability. The forecast LOR1 was cancelled due to increased generation availability.
24/01/2021	SA	1		1				An actual LOR1 condition was declared with an effective period of 17:30-20:00 due to a significant decrease in net import due to bushfire tripping multiple lines and slight increase in demand. (Multiple transmission assets tripped due to bushfires. South Australia was at risk of separation on the next contingency, import into South Australia needed to be constrained, and import into South Australia was reduced.) An actual LOR2 condition declared with an effective period of 18:30-19:00 due to a further decrease in generation availability on top of existing conditions. Prior to this event, no prior forecast LOR1 or LOR2 declarations had been issued for this effective period. The actual LOR conditions existed from 17:30-20:00. The actual LOR2 condition existed from 18:30-19:00.
12/03/2021	SA	1		1				A forecast LOR1 condition was declared with an effective period of 19:00-19:30 (21 minute lead time) due to a decrease in generation availability. An actual LOR1 condition was then declared with an effective period of 18:30-19:30 due to a decrease in generation availability. Two updates were issued for the actual LOR1 condition with an extended effective period of 18:30-21:00 due to a further decrease in generation availability. An actual LOR2 condition was declared with an effective period of 19:30-20:30 due to a sudden decrease in generation availability. The actual LOR conditions existed from 18:30-21:00. The actual LOR2 condition existed from 19:30-20:30.
11/02/2021	TAS		1					A suspect LOR1 condition was declared with an effective period 16:00-17:00 (11 hour lead time) due to reduced net import that was related to an ongoing planned outage in Victoria. The suspect LOR1 condition was cancelled as the planned outage was returned to service.
Total		**3**	**2**	**2**	**0**	**0**	**0**	

A. Effective date is the date on which the condition occurred or was expected to occur, and may differ from the date on which a market notice advising of the forecast or actual condition was issued.

Table 2 LOR notices declared during the reporting period 1 January to 31 March 2021

Effective date and time	Market Notice ID	Issue date and time	Level	Actual, forecast, update or cancel	Comments	Reserve requirement (MW)[A]		FUM value (MW)[B]	Reserve requirement set by
						Required	Available		
New South Wales region									
14/01/2021 16:30 - 17:30	82158	14/01/2021 16:50	LOR1	Actual	Actual LOR1 declared. Decrease in generation availability, reduced net import and slight increase in demand caused an actual LOR1 condition.	1,320	1,177	242	LCR2
14/01/2021	82159	14/01/2021 18:23	LOR1	Cancelled	This cancelled MN 82158. Actual LOR1 cancelled as condition cleared after effective period.	1,320	1,713	222	LCR2
Queensland region									
09/03/2021 18:30 - 19:00	83186	09/03/2021 05:23	LOR1	Forecast	Forecast LOR1 declared due to decreased generation availability.	969	953	439	LCR2
09/03/2021	83190	09/03/2021 08:36	LOR1	Cancelled	This cancelled MN 83186. Forecast LOR1 cancelled due to increased generation availability.	954	1,130	417	LCR2
South Australia region									
24/01/2021 17:30 - 20:00	82347	24/01/2021 17:44	LOR1	Actual	Actual LOR1 declared. Significant decrease in net import due to bushfire tripping multiple lines and slight increase in demand caused an actual LOR1 condition.	420	240	163	LCR2
24/01/2021 18:30 - 19:00	82349	24/01/2021 18:44	LOR2	Actual	Actual LOR2 declared. Further decrease of generation availability on top of existing significant decrease in net import due to bushfire tripping multiple lines resulted in an actual LOR2 condition.	222	213	86	LCR
24/01/2021	82351	24/01/2021 19:14	LOR2	Cancelled	This cancelled MN 82349. Actual LOR2 cancelled as condition cleared after effective period.	222	268	103	LCR

Effective date and time	Market Notice ID	Issue date and time	Level	Actual, forecast, update or cancel	Comments	Reserve requirement (MW)[A]		FUM value (MW)[B]	Reserve requirement set by
						Required	Available		
24/01/2021	82354	24/01/2021 20:16	LOR1	Cancelled	This cancelled MN 82347. Actual LOR1 cancelled as condition cleared after effective period.	422	587	103	LCR2
12/03/2021 19:00 - 19:30	83254	12/03/2021 18:39	LOR1	Forecast	Forecast LOR1 declared due to decreased generation availability.	439	433	143	LCR2
12/03/2021 18:30 - 19:30	83255	12/03/2021 18:45	LOR1	Actual	Actual LOR1 declared. Decreased generation availability caused an actual LOR1 condition.	439	432	149	LCR2
12/03/2021 18:30 - 20:30	83258	12/03/2021 19:25	LOR1	Update	Update to MN 83255 due to change in effective period. Actual LOR1 condition effective period extended due to further decreased generation availability.	420	296	101	LCR2
12/03/2021 19:30 - 20:30	83263	12/03/2021 19:47	LOR2	Actual	Actual LOR2 declared. Decreased generation availability caused an actual LOR2 condition.	228	97	87	LCR
12/03/2021 18:30 - 21:00	83265	12/03/2021 20:04	LOR1	Update	Update to MN 83258 due to change in effective period. Actual LOR1 condition effective period extended due to further decreased generation availability.	420	247	143	LCR2
12/03/2021	83268	12/03/2021 20:33	LOR2	Cancelled	This cancelled MN 83263. Actual LOR2 cancelled due to increased generation availability and condition cleared after effective period.	192	283	80	LCR
12/03/2021 18:30 - 21:00	83269	12/03/2021 20:42	LOR1	Update	Update to MN 83265. Actual LOR1 condition improved due to increased generation availability.	420	380	80	LCR2
12/03/2021	83273	12/03/2021 21:10	LOR1	Cancelled	This cancelled MN 83269. Actual LOR1 cancelled due to increased generation availability and condition cleared after effective period.	425	500	135	LCR2

Effective date and time	Market Notice ID	Issue date and time	Level	Actual, forecast, update or cancel	Comments	Reserve requirement (MW)[A]		FUM value (MW)[B]	Reserve requirement set by
						Required	Available		
Tasmania region									
11/02/2021 16:00 - 17:00	82821	11/02/2021 5:20	LOR1	Suspect	Suspect LOR1 declared due to reduced net import which was related to an ongoing outage in Victoria forcing Basslink to export to Victoria.	248	236	136	LCR2
11/02/2021	82822	11/02/2021 10:11	LOR1	Cancelled	This cancelled MN 82821. Suspect LOR1 cancelled as the planned outage in Victoria was returned to service.	733	1,301	139	LCR2
Victoria region									
Nil									

A. Reserve Required and Reserve Available are the values that correspond to the trading interval in the effective period with the lowest reserve available.
B. The value in this field represents the FUM value for the trading interval during which the minimum available reserve occurred (see Reserve Requirement (MW) – Available field).

4. Review of performance

4.1 Forecast Uncertainty Measure values

This section compares the mean, minimum, and maximum FUM values for this reporting period to those for each quarter from Quarter 1 2020 to Quarter 1 2021 (see Figure 1 through Figure 5 below).

The most material changes in FUM values between Quarter 4 2020 and Quarter 1 2021 are summarised below. For forecast horizons not mentioned below, the changes from Quarter 4 2020 were minor:

- New South Wales – the mean and maximum FUM values increased for the 12, 24, 48 and 60 hours ahead forecast horizons. The maximum FUM values increases are in line with the increases seen in the last quarters training and are the result of a reduction in generation availability in Quarter 4 2020.
- Queensland – the maximum FUM values increased for the 6, 24 and 60 hours ahead forecast horizons, and decreased for the 2, 4 and 48 hours ahead forecast horizons. The mean FUM values for all horizons had very small changes.
- South Australia – the mean FUM values decreased for all except the 2 and 24 hour ahead forecast horizons. The maximum FUM values decreased for all except the 6 hour ahead forecast horizon.
- Tasmania – the mean FUM values decreased for the 12, 24, 48 and 60 hours ahead, and increased for the 2 and 6 hours ahead forecast horizons. The maximum FUM values decreased for all forecast horizons. The minimum FUM values remained steady.
- Victoria – the maximum FUM values decreased for the 2, 6, 12 and 48 hours ahead forecast horizons and increased for the 24 and 60 hours ahead forecast horizons. The minimum FUM values decreased for the 60 hour ahead forecast horizon.

Figure 1 New South Wales region: maximum, minimum, and mean FUM values for the reporting period, and compared to previous four quarters

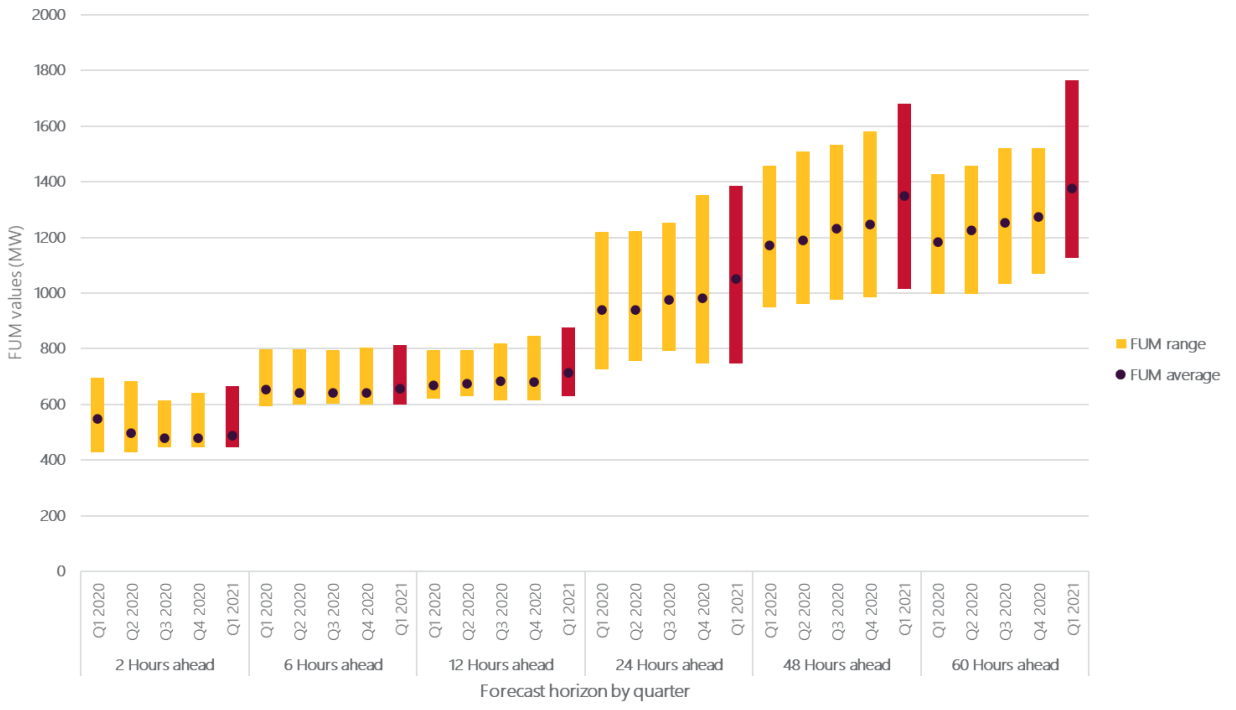


Figure 2 Queensland region: maximum, minimum, and mean FUM values for the reporting period, and compared to previous four quarters

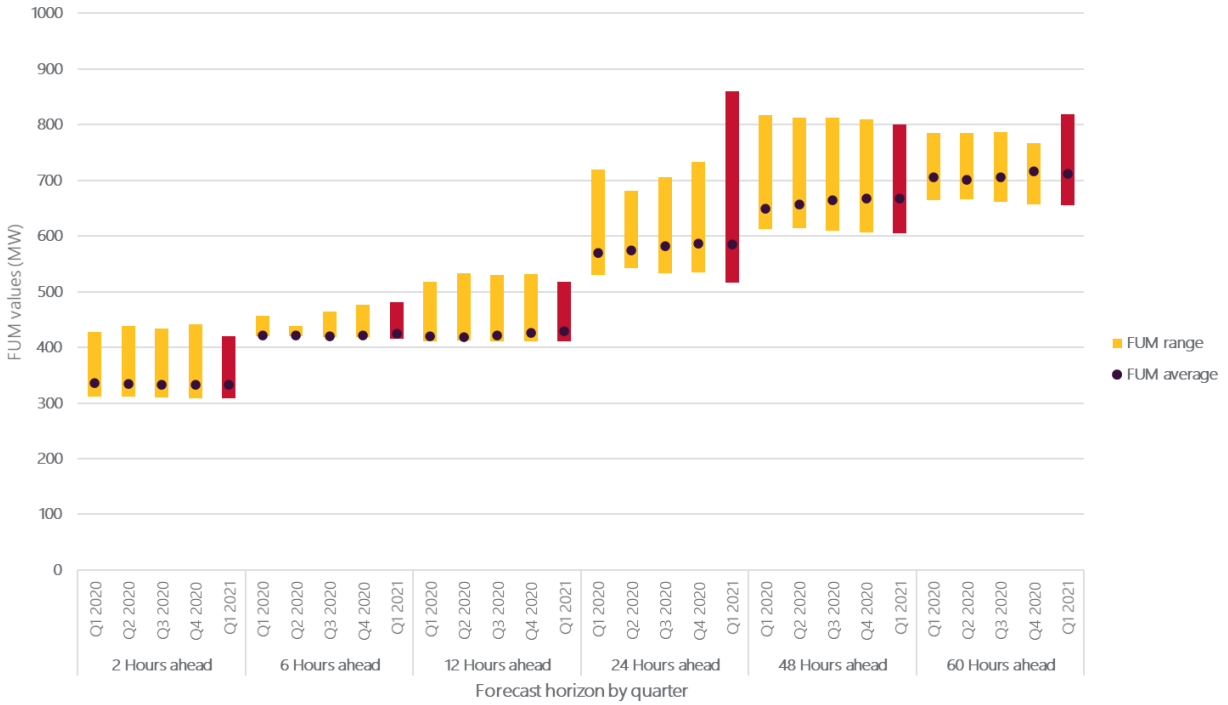


Figure 3 South Australia region: maximum, minimum, and mean FUM values for the reporting period, and compared to previous four quarters

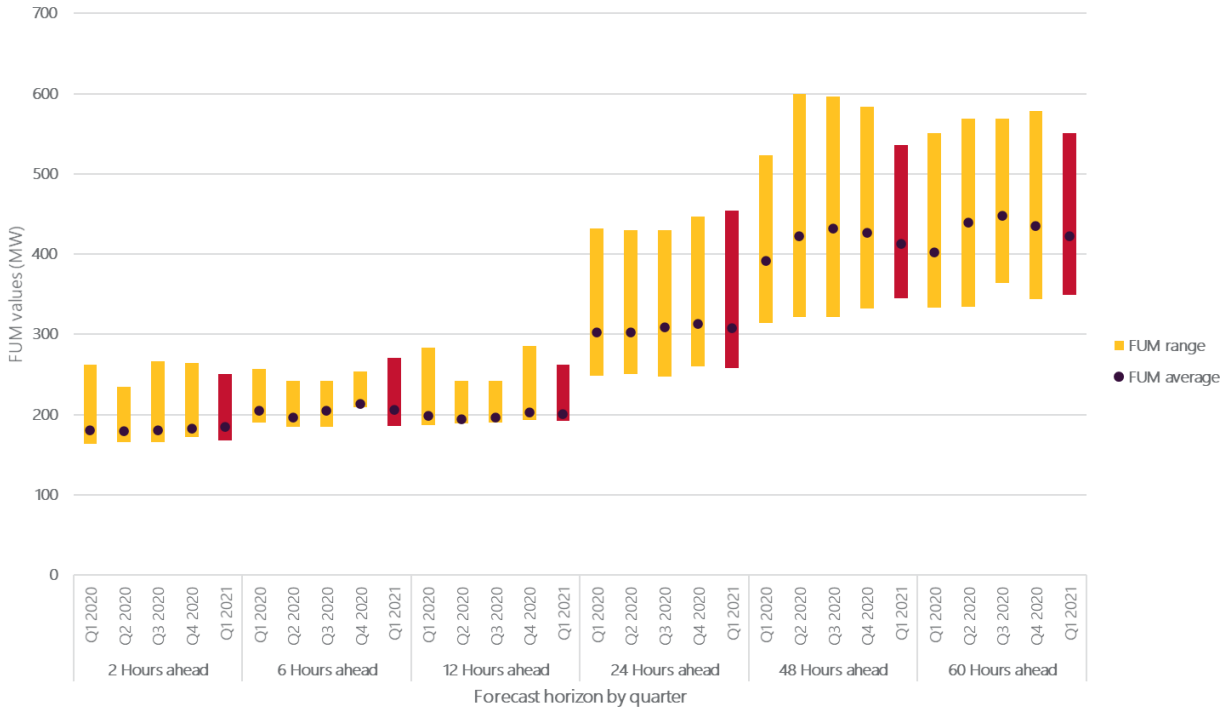


Figure 4 Tasmania region: maximum, minimum, and mean FUM values for the reporting period, and compared to previous four quarters

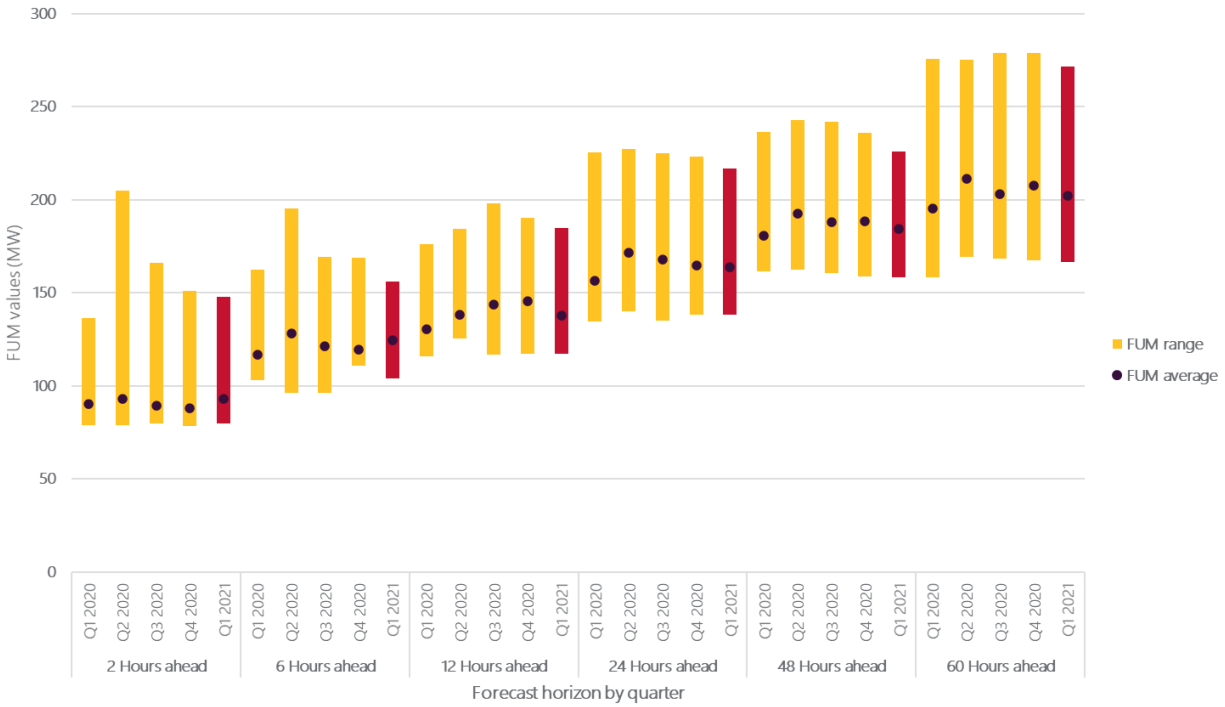
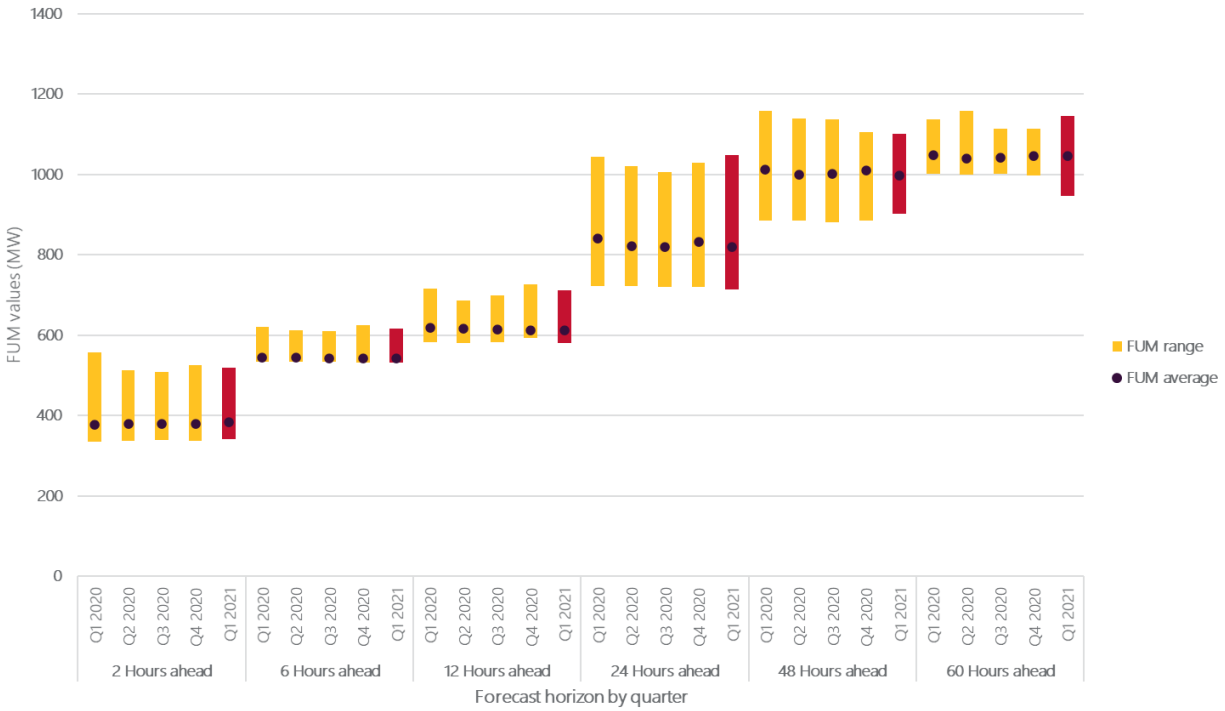


Figure 5 Victoria region: maximum, minimum, and mean FUM values for the reporting period, and compared to previous four quarters



4.2 Forecast and actual LOR declarations

A summary of the count and causes of declared forecast and actual LOR conditions can be found in Table 1 in Section 3 of this report.

During the reporting period 1 January 2021 to 31 March 2021, there were seven LOR declarations. Of these declarations, two were for forecast LOR conditions:

- Two forecast LOR1 conditions were declared.
- Zero forecast LOR2 conditions were declared.
- Zero forecast LOR2 conditions were set by FUM.

A total of three actual LOR1 conditions were declared during the reporting period:

- One was observed as forecast LOR1 prior to being declared as actual, therefore not counted as a forecast declaration based on the declaration count principles outlined in Section 3.
- No actual LOR1 conditions were forecast in the Short Term Projected Assessment of System Adequacy (ST PASA). One was only forecast in the Pre-Dispatch Projected Assessment of System Adequacy (PD PASA) shortly before the actual declaration.

A total of two actual LOR2 conditions were declared during the reporting period. They were not observed as forecast LOR2 conditions prior to being declared as actual.

By comparison, 39 LOR declarations were made in Quarter 4 2020 (25 forecast LOR events and 14 actual LOR events) and 19 LOR declarations were made in Quarter 1 2020 (seven forecast LOR events and 12 actual LOR events).

As no LOR declarations in the reporting period were set by the FUM, the percentage of LOR conditions where the FUM set the reserve requirement was 0%. In Quarter 4 2020 the percentage was 18%, and it was 11% in Quarter 1 2020.

There were two actual LOR2 conditions and no forecast or actual LOR3 conditions during the current reporting period. This outcome indicates that there was sufficient supply to meet demand during Quarter 1 2021.

Table 3 LORs declared during the reporting period by trigger (FUM or LCR)

Effective period	LOR1	LOR2	LOR3
New South Wales (NSW)			
14/01/2021	Actual		
Queensland (QLD)			
09/03/2021	Forecast		
South Australia (SA)			
24/01/2021	Actual	Actual	
12/03/2021	Forecast then Actual	Actual	
Tasmania (TAS)			
11/02/2021	Forecast		
Victoria (VIC)			
Nil			

Note. Yellow shading indicates the requirement was set by the LCR or LCR2, and orange indicates the requirement was set by the FUM.

4.3 LOR declaration of reserve requirement

No forecast or actual LOR3 conditions were declared.

No forecast LOR2 conditions were declared.

There were three forecast LOR1 conditions declared; of these, one resulted in an actual LOR1 condition. This is counted as an actual LOR1 condition based on the declaration count principles outlined in Section 3.

There were two forecast LOR1 conditions that did not develop into actual LOR1 conditions, due to either changes to the net import or market response following the issue of the forecast market notice. The market response generally took the form of increased available generation.

4.4 Number and cause of LOR declarations

As summarised in Table 1, a total of seven LOR conditions were declared during the current reporting period: two forecast and five actual LOR conditions.

This is significantly lower than the 39 LOR declarations recorded in the previous reporting period (1 October to 31 December 2020).

Quarter 1 2021 covered the later summer months and first month of autumn. The LOR declarations in this quarter are mainly driven by unplanned transmission, forced generator outages and power system incidents.

Multiple unplanned transmission outages and sudden loss of generation availability occurred during the reporting period and significantly impacted available reserves. Most actual LOR conditions occurred with no prior forecast were due to sudden changes in the power system.

Bushfire activity in South Australia impacted the electricity network, particularly at the beginning of the quarter, which resulted in LOR conditions.

Glossary

This document uses many terms that have meanings defined in the NER. The NER meanings are adopted unless otherwise specified.

For each of the terms below, refer to the Reserve Level Declaration Guidelines[4] for further information.

Term	Definition
BBN	Bayesian Belief Network[5]
FUM	Forecast Uncertainty Measure (the number of MW representing the level of forecasting uncertainty)
Guidelines	The Reserve Level Declaration Guidelines published by AEMO under clause 4.8.4A of the NER
LCR	Largest Credible Risk – the single largest credible risk in the region
LCR2	Largest Credible Risk 2 – the sum of the two largest credible risks in the region
LOR1	Lack of Reserve level 1. The threshold for an LOR1 is determined by the larger value of either the FUM or the sum of the two largest credible risks in the region (LCR2).
LOR2	Lack of Reserve level 2. The threshold for an LOR2 is determined by the larger value of either the FUM or the largest credible risk in the region (LCR).
LOR3	Lack of Reserve level 3. The threshold for an LOR3 condition is when the forecast reserve for a region is at or below zero.
PASA	Projected Assessment of System Adequacy[6]

[4] See AEMO's reserve level declaration guidelines, at https://www.aemo.com.au/-/media/files/electricity/nem/security_and_reliability/power_system_ops/reserve-level-declaration-guidelines.pdf.

[5] More detail regarding Bayesian Belief Networks is available in the Appendix of AEMO's reserve level declaration guidelines document in the link above.

[6] See AEMO's Projected Assessment of System Adequacy (PASA) principles, at https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-reliability/projected-assessment-of-system-adequacy.