NEM Lack of Reserve Framework Report 1 October to 31 December 2022

January 2023

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 from 1 October to 31 December 2022.

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Version control

Version	Release date	Changes
1	27/1/2023	Initial release

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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 October to 31 December (Quarter 4 2022), AEMO declared 69 individual Lack of Reserve (LOR) conditions in total in the National Electricity Market (NEM)[1].

Table 1 shows the number and type of LOR conditions declared in Quarter 4 2022.

Table 1 LOR conditions declared in Quarter 4 2022

LOR declarations		Total
LOR1	**Actual**	3
	Forecast	45
LOR2	**Actual**	0
	Forecast	21
LOR3	**Actual**	0
	Forecast	0
Total		**69**

This compares with 253 LOR conditions declared in the previous reporting period (Quarter 3 2022), and 55 LOR conditions declared for the same period last year (Quarter 4 2021)[2].

Quarter 4 2022 covered the mid spring months and the first month of summer:

- Across the NEM, most of the LOR declarations in this quarter were due to decreased generation availability (including energy limitations). Some of the LOR declarations in this quarter were due to reduced net import and increased forecast operational demand.
- Many of the forecast LOR conditions did not eventuate into actual LOR conditions, mainly because additional generation was made available either locally or through increased net import, or revised forecast demand meant the actual demand was not as high as previously forecast. Some of the forecast LOR conditions were cancelled when the forecast uncertainty measure (FUM) value decreased.
- The LOR conditions in Queensland and New South Wales were mainly driven by decreased generation availability and increased forecast demand.
- The LOR conditions in South Australia and Tasmania were mainly driven by decreased generation availability and decreased net import.

Of the 69 LOR declarations in Quarter 4 2022:

- For all 48 LOR1 declarations, the reserve requirement was set by the sum of the two largest credible risks (LCR2).

[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.

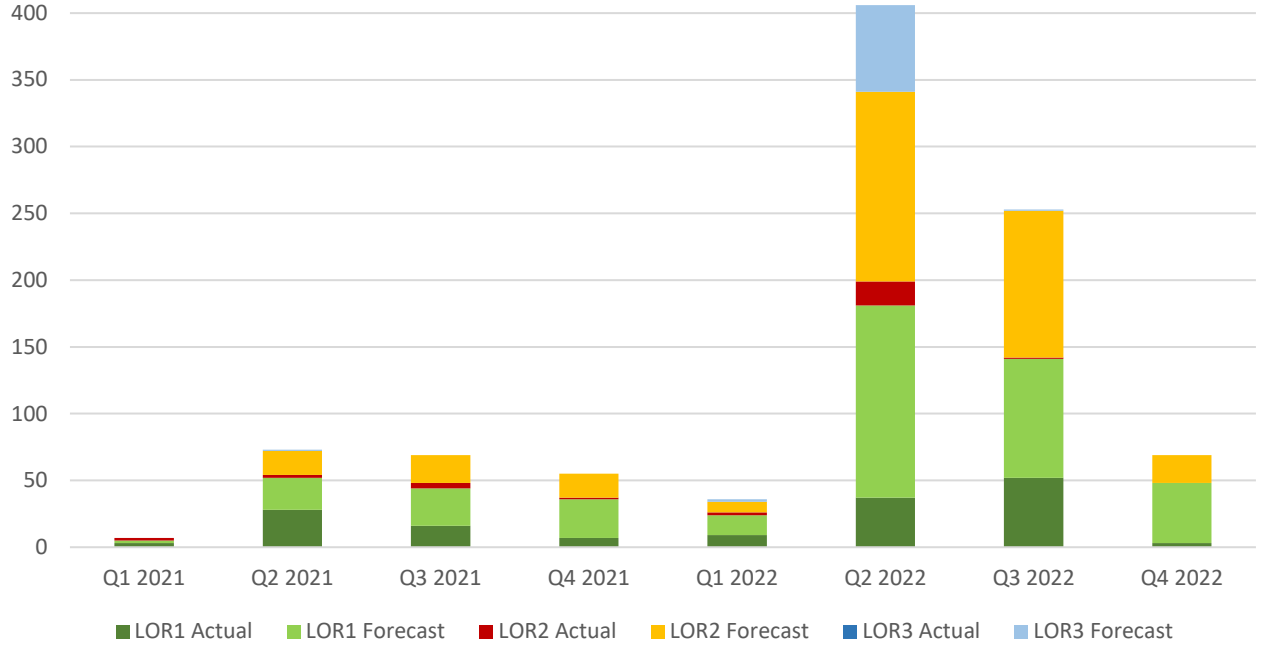
[2] Previous quarterly reports are on AEMO's website at https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/power-system-operation/nem-lack-of-reserve-framework-quarterly-reports.

- There were six LOR2 declarations where the reserve requirement was set by the largest credible risk (LCR). There were 15 LOR2 declarations where the reserve requirement was set by the FUM.

For comparison, in Quarter 3 2022, 91 of the 253 LOR declarations were set by the FUM (36%), and in Quarter 4 2021, nine of the 55 LOR declarations were set by the FUM (16%).

The graph below shows the historical trend of actual and forecast LOR conditions in past quarters from Quarter 1 2021 compared to the current quarter. The total number of LOR declarations in this reporting period decreased significantly compared to the last quarter.

Figure 1 Quarterly comparison of actual and forecast LOR conditions, Q1 2021 to Q4 2022



The next report on the NEM Lack of Reserve Framework, for the reporting period 1 January 2023 to 31 March 2023, will be published by 30 April 2023.

Contents

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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 October to 31 December 2022 (Quarter 4 2022).

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 January 2023 to 31 March 2023, will be published by 30 April 2023.

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 January 2023 to include data up to 31 December 2022. The retraining involves a three-stage process:

1. Extract-Transform-Load (ETL) stage, to extract historical data up to 31 December 2022, 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 shortly, 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 October 2021 to December 2022, 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 FUM values.

Changes in 90th, 50th (median) and 10th percentiles FUM values between the existing and retrained BBN backcasts are listed below. Minor changes were identified for some other forecast horizons and distribution statistics but are not listed here. Maximum, mean, and minimum values are to still be included in visuals for review of actual FUM values in Section 4.1 of this report.

- New South Wales – 90th percentile FUM values decreased by 41 megawatts (MW) for the 6 hours ahead forecast horizon. Median percentile FUM values decreased by 41 MW for the 24 hours ahead forecast horizon. 90th, median, and 10th percentile FUM values for all other forecast horizons were relatively unchanged.
- Queensland – 90th percentile FUM values increased by 30 MW for the 24 hours ahead forecast horizon. 10th percentile FUM values increased by 44 MW for the 60 hours ahead forecast horizon. 90th, median, and 10th percentile FUM values for all other forecast horizons remained relatively unchanged.

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

- South Australia – 90th percentile FUM values decreased by 35 MW for the 60 hours ahead forecast horizon. Median percentile FUM values increased by 12 MW for the 12 hours ahead forecast horizon. 90th, median and 10th percentile FUM values for all other forecast horizons remained relatively unchanged.
- Tasmania – 90th percentile FUM values decreased by 22 MW for the 12 hours ahead forecast horizon and increased by 14 MW and 13 MW for the two hours ahead and 60 hours ahead forecast horizons respectively. 10th percentile FUM values decreased by 11 MW for the two hours ahead forecast horizon. 90th, median, and 10th percentile FUM values for all other forecast horizons remained relatively unchanged.
- Victoria – 90th percentile FUM values decreased by 40 MW for the 60 hours ahead forecast horizon. Median percentile FUM values decreased by 36 MW for the 60 hours ahead forecast horizon. 90th, median, and 10th percentile FUM values for all other forecast horizons remained relatively unchanged.

3 Lack of Reserve conditions declared

Table 2 provides a high-level summary of the counts of forecast and actual LOR conditions for the reporting period (Quarter 4 2022) based on the declaration count principles.

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 at the same level 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.
  - 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.
- Continuous LOR conditions which spanned multiple periods throughout a day are counted as individual LOR declarations for each period covered. For this purpose, a NEM trading day is split into four 6-hour periods: morning peak covers 0400 hrs to 1000 hrs, mid-day covers 1000 hrs to 1600 hrs, evening peak covers 1600 hrs to 2200 hrs, and overnight covers 2200 hrs to 0400 hrs on the next day[4]. The maximum count allocated to each trading day is four.

[4] This is due to trading day rather than calendar day to prevent double-counting of a continuous condition.

Table 2 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	
05/10/2022	NSW	1	1					**Morning Peak** • An actual LOR1 condition was present between 09:30 – 10:00 due to decreased generation availability and increased operational demand (MN 102067). • The actual LOR1 was cancelled when the effective period elapsed (MN 102069). **Evening Peak** • A forecast LOR1 was declared with effective period 17:00 – 19:30 (8 hour lead time) due to decreased generation availability (MN 102066). • The forecast LOR1 condition was updated to effective period 16:00 – 20:00 and later cancelled due to increased net import (MN 102068, MN 102101).
06/10/2022	NSW		3		3			**Morning Peak:** • A forecast LOR2 was declared with effective period 08:30 – 10:00 (21 hour lead time) due to decreased generation availability (MN 102070). • A forecast LOR1 was declared with effective period 06:00 – 10:00 (17 hour lead time) due to decreased generation availability and increased forecast operational demand (MN 102073). • The forecast LOR1 and LOR2 conditions were cancelled due to increased generation availability and net imports. **Midday:** • A forecast LOR2 was declared with effective period 14:30 – 16:00 (27 hour lead time) due to decreased generation availability (MN 102070). • A forecast LOR1 was declared with effective period 10:00 – 15:30 (17 hour lead time) due to decreased generation availability and increased forecast operational demand (MN 102073). • The forecast LOR1 and LOR2 conditions were cancelled due to increased generation availability. **Evening Peak:** • A forecast LOR2 was declared with effective period 16:00 – 21:30 (28 hour lead time) due to decreased generation availability and increased forecast operational demand (MN 102070). • A forecast LOR1 was declared with effective period 21:30 – 22:30 (32 hour lead time) due to decreased generation availability and increased forecast operational demand (MN 102073). • The forecast LOR2 condition was updated and declared to effective period 16:00 – 21:30 and later cancelled due to increased net import and generation availability (MN 102071,

Effective date[A]	Region	LOR1		LOR2		LOR3		Cause and resolution
		Actual	Forecast	Actual	Forecast	Actual	Forecast	
								MN 102072, MN 102102). • The forecast LOR1 condition was cancelled due to increased net import and generation availability (MN 102104).
08/10/2022	NSW							Suspect forecast LOR3 condition issued (MN 102136). Investigation found suspect LOR3 condition invalid due to input errors. AEMO considers this forecast LOR3 condition invalid. (MN 102137)
14/11/2022	NSW		1		1			• A forecast LOR2 was declared and cancelled twice with effective period 18:00 – 19:30 (52 and 29 hour lead time) due to changed generation availability and net import (MN 103045, MN 103062, MN 103092, MN 103095). • A forecast LOR1 was declared with effective period 18:00 – 19:00 (28 hour lead time) due to decreased net import (MN 103097). • The forecast LOR1 condition was cancelled due to decreased forecast operational demand and increased net import (MN 103149).
05/12/2022	NSW	1						• A forecast LOR1 was declared with effective period 17:00 – 18:30 (1 hour lead time) due to decreased generation availability and decreased net import (MN 104218). Later the forecast LOR1 condition was cancelled due to increased generation availability (MN 104220). • An actual LOR1 condition was present between 17:15 – 17:45 due to decreased generation availability and increased operational demand (MN 104222). • The actual LOR1 condition was cancelled due to increased generation availability and net import (MN 104224).
07/12/2022	NSW		1		1			• A forecast LOR1 was declared with effective period 18:00 – 19:30 (3 day lead time) due to decreased generation availability and decreased net import (MN 104165) and later cancelled due to change in generation availability (MN 104204). • A forecast LOR2 was declared and updated twice with effective period ranged 18:00- 19:30 (56-59 hour lead time) due to decreased generation availability and decreased net import (MN 104183, MN 104193, MN 104194, MN 104198) and were cancelled due to increased generation availability (MN 104189, MN 104201).

Effective date[A]	Region	LOR1		LOR2		LOR3		Cause and resolution
		Actual	Forecast	Actual	Forecast	Actual	Forecast	
14/11/2022	QLD		1					• A forecast LOR1 was declared with effective period 18:00 – 19:00 (29 hour lead time) due to decreased generation availability and increased forecast operational demand (MN 103093). • The forecast LOR1 condition was cancelled due to increased generation availability (MN 103119). • A forecast LOR1 was redeclared with effective period 18:30 – 19:00 (13 hour lead time) due to decreased generation availability and increased forecast demand (MN 103122). • The forecast LOR1 condition was cancelled due to increased generation availability (MN 103148).
21/11/2022	QLD	1						• A forecast LOR1 was declared with effective period 18:30 – 19:00 due to decreased generation availability (MN 103788). • The forecast LOR1 condition was cancelled due to increased generation availability (MN 103792). • An actual LOR1 was declared with effective period 18:20 – 19:00 due to decreased generation availability (MN 103859). • The actual LOR1 condition was cancelled when the effective period elapsed (MN 103861).
28/11/2022	QLD		1					• A forecast LOR1 was declared with effective period 18:00 – 19:00 due to increased forecast operational demand (MN 103914). • The forecast LOR1 condition was cancelled due to decreased forecast operational demand (MN 103953).
29/11/2022	QLD		1					• A forecast LOR1 was declared with effective period 19:00 – 19:30 due to decreased generator availability (MN 104073). • The forecast LOR1 condition was cancelled due to increased generator availability (MN 104074).
06/12/2022	QLD		1		1			• With a 3 day lead time, forecast LOR1 and LOR2 conditions were declared, updated, and cancelled several times, due to changing effective period and forecast reserve level. The effective period ranged 18:00 – 20:30. The forecast LOR conditions worsened or improved due to changes in generation availability and forecast operational demand. • (MN 104149, MN 104150, MN 104151, MN 104154, MN 104158, MN 104166, MN 104175, MN 104177, MN 104182, MN 104191, MN 104196, MN 104219)
07/12/2022	QLD		1		1			• With a 6 day lead time, forecast LOR1 and LOR2 conditions were declared, updated, and cancelled several times, due to changing effective period and forecast reserve level. The effective period ranged 18:00 – 20:30. The forecast LOR conditions worsened or improved due to changes in generation availability and forecast operational demand. • (MN 104114, MN 104118, MN 104127, MN 104135, MN 104152, MN 104178, MN 104187,

Effective date[A]	Region	LOR1		LOR2		LOR3		Cause and resolution
		Actual	Forecast	Actual	Forecast	Actual	Forecast	
								MN 104192, MN 104195, MN 104202, MN 104203, MN 104236)
13/12/2022	QLD		2		1			• With a 6 day lead time, forecast LOR1 and LOR2 conditions were declared, updated, and cancelled several times, due to changing effective period and forecast reserve level. The effective period ranged 12:30 – 19:30. The forecast LOR conditions worsened or improved due to changes in forecast operational demand and generation availability. • (MN 104245, MN 104247, MN 104248, MN 104251, MN 104276, MN 104277, MN 104287, MN 104295, MN 104309, MN 104310, MN 104311, MN 104329)
12/10/2022	SA		1					• A forecast LOR1 was declared with effective period 18:30 – 20:30 (52 hour lead time) due to decreased generation availability (MN 102167). • The forecast LOR1 condition was updated to effective period 18:00 – 20:30 and later cancelled due to increased generation availability (MN 102179, MN 102180).
17/10/2022	SA		2		1			**Evening peak:** • With a 7 day lead time, forecast LOR1 and LOR2 conditions were declared, updated, and cancelled several times, due to changing effective period and forecast reserve level. The effective period ranged 17:30 – 21:00. The forecast LOR conditions worsened or improved due to changes in generation availability and net import. • (MN 102165, MN 102168, MN 102173, MN 102174, MN 102177, MN 102181, MN 102187, MN 102192) **Overnight:** • A forecast LOR1 was declared with effective period 00:00 – 01:00 (18th) (6 day lead time) due to decreased generation availability (MN 102182). This was later cancelled due to increased generation availability (MN 102193).
18/10/2022	SA		3					**Morning Peak:** • A forecast LOR1 was declared with effective period 05:30 – 07:30 (7 day lead time) due to decreased generation availability (MN 102182). **Evening Peak:** • A forecast LOR1 was declared with effective period 18:30 – 22:00 (7 day lead time) due to decreased generation availability (MN 102182). **Overnight:** • A forecast LOR1 was declared with effective period 22:00 – 04:00 (19th) (7 day lead time) due to decreased generation availability (MN 102182). • The forecast LOR1 conditions were all cancelled due to increased generation availability (MN 102193).
20/10/2022	SA		2					**Morning Peak:** • A forecast LOR1 was declared with effective period 06:00 – 08:00 (5 day lead time) due to

Effective date[A]	Region	LOR1		LOR2		LOR3		Cause and resolution
		Actual	Forecast	Actual	Forecast	Actual	Forecast	
								decreased generation availability and increased forecast operational demand (MN 102295). • The forecast LOR1 condition was updated to effective period 06:00 – 09:00 and later cancelled due to increased generation availability (MN 102304, MN 102328). **Evening Peak:** • A forecast LOR1 was declared with effective period 18:30 – 21:00 (7 day lead time) due to decreased generation availability (MN 102206). • Several updates to the forecast LOR1 condition were issued due to change in effective period and forecast reserve level. The effective period ranged 18:00 – 21:00. The forecast LOR condition improved due to increased generation availability and net import (MN 102328, MN 102337). • The forecast LOR1 condition was cancelled due to increased generation availability and net import (MN 102357).
21/10/2022	SA		1		2			**Morning Peak:** • With a 7 day lead time, forecast LOR1 and LOR2 conditions were declared, updated, and cancelled several times, due to changing effective period and forecast reserve level. The effective period ranged 04:00 – 08:00. The forecast LOR conditions worsened or improved due to changes in generation availability and net import. • (MN 102296, MN 102305, MN 102324, MN 102327, MN 102329, MN 102331, MN 102335, MN 102338, MN 102354, MN 102358, MN 102369, MN 102370, MN 102376, MN 102378, MN 102385) **Evening Peak:** • A forecast LOR2 was declared with effective period 18:30 – 20:30 (4 day lead time) due to decreased net import (MN 102331). • The forecast LOR2 condition was cancelled due to increased net import (MN 102335).
22/10/2022	SA		1		2			**Overnight:** • A forecast LOR2 was declared with effective period 00:30 – 01:30 (4 day lead time) due to decreased net import (MN 102332). • The forecast LOR2 condition was cancelled due to increased net import (MN 102336). **Morning Peak:** • With a 4 day lead time, forecast LOR1 and LOR2 conditions were declared, updated, and cancelled several times, due to changing effective period and forecast reserve level. The effective period ranged 05:00 – 07:00. The forecast LOR conditions worsened or improved due to changes in generation availability and net import. • (MN 102359, MN 102377, MN 102393, MN 102401, MN 102405, MN 102408, MN 102411, MN 102412, MN 102419)

Effective date[A]	Region	LOR1		LOR2		LOR3		Cause and resolution
		Actual	Forecast	Actual	Forecast	Actual	Forecast	
08/11/2022	SA				1			• A forecast LOR2 was declared with effective period 14:00 – 14:30 (31 hour lead time) due to decreased generation availability and increased FUM level (MN 102935). • The forecast LOR2 condition was cancelled due to increased generation availability and net import (MN 102936).
15/11/2022	SA		1		2			**Evening Peak:** • A forecast LOR1 was declared with effective period 17:30 – 18:30 (27 hour lead time) due to decreased generation availability and decreased net import (MN 103170). • A forecast LOR2 was declared with effective period 18:30 – 22:00 (28 hour lead time) due to decreased generation availability and decreased net import (MN 103169). **Overnight:** • A forecast LOR2 was declared with effective period 22:00 – 01:30 (16th) (32 hour lead time) due to decreased generation availability and decreased net import (MN 103169). • The LOR1 and LOR2 conditions were cancelled due to increased generation availability (MN 103173, MN 103174).
17/11/2022	SA		1					• A forecast LOR1 was declared with effective period 18:30 – 19:00 (7 hour lead time) due to decreased generation availability and decreased net import (MN 103394). • The forecast LOR1 condition was cancelled due to decreased forecast operational demand and increased generation availability (MN 103475).
19/11/2022	SA				1			• A forecast LOR2 was declared with effective period 06:30 – 07:00 (43 hour lead time) due to decreased generation availability, decreased net import, and increased FUM level (MN 103396). • The forecast LOR2 condition was cancelled due to increased generation availability (MN 103408).
22/11/2022	SA		1					• A forecast LOR1 was declared with effective period 21:00 – 21:30 due to decreased net import (MN 103868) • The forecast LOR1 condition was cancelled and re-issued due to changes in generation availability (MN 103869, 103871). • The forecast LOR1 condition was cancelled due to increased generation availability (MN 103878).
23/11/2022	SA		1		1			• A forecast LOR2 was declared with effective period 05:30 – 06:30 due to decreased net import (MN 103761) • The forecast LOR2 was cancelled, re-issued and updated several times due to change in forecast reserve level. The forecast LOR2 condition worsened due to reduced net import (MNs 103777, 103786, 103790, 103804, 103838). • The forecast LOR2 condition was cancelled due to increased generation availability (MN

Effective date[A]	Region	LOR1		LOR2		LOR3		Cause and resolution
		Actual	Forecast	Actual	Forecast	Actual	Forecast	
								103843). • A forecast LOR1 was declared with effective period 05:30 – 07:00 due to decreased net import (MN 103761) and updated (MN 103847) following the cancellation of forecast LOR2 condition. • The forecast LOR1 condition was cancelled due to increased generation availability (MN 103875).
27/12/2022	SA				1			• A forecast LOR2 was declared with effective period 18:30 – 19:00 (55 hour lead time) due to decreased generation availability (MN 104684). • The forecast LOR2 condition was cancelled due to increased generation availability (MN 104691).
17/10/2022	TAS		1					• A forecast LOR1 was declared with effective period 06:30 – 08:00 (63 hour lead time) due to decreased generation availability (MN 102285). The LOR condition was later cancelled due to increased generation availability (MN 102297). • A forecast LOR1 was redeclared with a similar effective period 07:30 – 08:30 (6 hour lead time) due to decreased generation availability and later cancelled due to increased generation availability (MN 102325, MN 102326).
18/10/2022	TAS		1					• A forecast LOR1 was declared with effective period 07:00 – 07:30 (6 day lead time) due to decreased generation availability (MN 102194). • The forecast LOR condition was cancelled due to increased generation availability (MN 102205). • A forecast LOR1 was declared with effective period 07:30 – 08:30 (6 hour lead time) and later cancelled due to change in generation availability (MN 102352, MN 102353).
19/10/2022	TAS		1					• A forecast LOR1 was declared with effective period 06:30 – 07:30 (15 hour lead time) due to decreased generation availability (MN 102362). • The forecast LOR condition was cancelled due to increased generation availability (MN 102364). • A forecast LOR1 was declared and cancelled twice with effective period ranged 07:00 – 08:00 (4-6 hour lead time) due to change in generation availability and forecast operational demand (MN 102371, MN 102372, MN 102373, MN 102374).
27/10/2022	TAS		2					**Morning Peak:** • A forecast LOR1 was declared with effective period 08:00 – 09:30 (19 hour lead time) due to decreased net import (MN 102583). • A forecast LOR1 was declared with effective period 08:00 – 08:30 (5 hour lead time) due to decreased generation availability and decreased net import (MN 102598). • The forecast LOR condition improved due to increased generation availability and net

Effective date[A]	Region	LOR1		LOR2		LOR3		Cause and resolution
		Actual	Forecast	Actual	Forecast	Actual	Forecast	
								import. (MN 102590, MN 102602) **Midday:** • A forecast LOR1 was declared with effective period ranged 10:30 - 14:30 (15-19 hour lead time) due to decreased generation availability and decreased net import (MN 102583, MN 102595). • A forecast LOR1 was declared and updated with effective period ranged 13:00 – 15:00 (1-15 hour lead time) due to decreased generation availability (MN 102595, MN 102613, MN 102615). • The forecast LOR condition improved due to increased generation availability and net import. (MN 102590, MN 102597, MN 102602, MN 102616)
8/11/2022	TAS		1					• A forecast LOR1 was declared with effective period 07:00 – 07:30 (7 hour lead time) due to decreased generation availability (MN 102961). • The forecast LOR condition was cancelled due to increased generation availability (MN 102962).
9/11/2022	TAS		1					• A forecast LOR1 was declared with effective period 07:00 – 08:00 (15 hour lead time) due to decreased net import (MN 102979). • The forecast LOR1 condition was cancelled due to increased net import and decreased forecast operational demand (MN 102980). • A forecast LOR1 was declared with effective period 08:30 – 09:00 (4 hour lead time) and later cancelled due to decreased forecast operational demand (MN 102985, MN 102986).
11/11/2022	TAS		2					**Morning Peak:** • A forecast LOR1 was declared with effective period 06:30 – 10:00 (7 day lead time) due to decreased generation availability (MN 102879). • The forecast LOR1 condition was cancelled due to increased generation availability (MN 102943). • A forecast LOR1 was redeclared with effective period 06:00 – 08:00 (63 hour lead time) due to decreased generation availability (MN 102972). • The forecast LOR1 condition was updated to effective period 06:30 – 07:30 and later cancelled due to increased generation availability (MN 102992, MN 103018, MN 103019). **Midday:** • A forecast LOR1 was declared with effective period 10:00 – 11:00 (7 day lead time) due to decreased generation availability (MN 102879). • A forecast LOR1 was declared with effective period 13:00 – 15:30 (7 day lead time) due to decreased generation availability (MN 102879). • The forecast LOR1 condition was cancelled due to increased generation availability

Effective date[A]	Region	LOR1		LOR2		LOR3		Cause and resolution
		Actual	Forecast	Actual	Forecast	Actual	Forecast	
								(MN 102943).
14/11/2022	TAS		1					• A forecast LOR1 was declared with effective period 06:30 – 07:00 (4 hour lead time) due to decreased generation availability and decreased net import (MN 103118). • The forecast LOR1 condition was cancelled due to increased generation availability (MN 103123).
15/11/2022	TAS		2		1			**Morning Peak:** • A forecast LOR1 was declared with effective period 06:30 – 10:00 (7 day lead time) due to decreased generation availability (MN 102974). • A forecast LOR2 was declared with effective period 08:00 – 08:30 (6 day lead time) due to decreased generation availability (MN 102987). • The forecast LOR2 condition was cancelled due to increased generation availability (MN 102988). • The forecast LOR1 condition was updated twice with effective period 07:00 – 10:00 due to decreased net import (MN 102994, MN 103013). • The forecast LOR1 condition was cancelled due to increased generation availability (MN 103031). **Midday:** • A forecast LOR1 was declared with effective period 10:00 – 12:00 (5 day lead time) due to decreased generation availability (MN 102974). • A forecast LOR1 was declared with effective period 14:00 – 15:00 (5 day lead time) due to decreased generation availability (MN 102974). • The forecast LOR1 condition was updated twice with effective period ranged 10:00 – 15:00. The reserve condition changed with change in net import, forecast operational demand, and generation availability (MN 102994, MN 103013). • The forecast LOR1 condition was cancelled due to increased generation availability (MN 103031).
16/11/2022	TAS		1		1			• A forecast LOR2 was declared with effective period 09:00 – 11:00 (6 day lead time) due to decreased generation availability (MN 103008). • The forecast LOR2 condition was cancelled due to increased generation availability (MN 103191). • A forecast LOR1 was declared with effective period 06:30 – 07:00 (7 hour lead time) due to decreased generation availability (MN 103264). • The forecast LOR1 condition was cancelled due to increased generation availability.
17/11/2022	TAS		1					• With a 6 day lead time, a forecast LOR1 condition was declared, updated, and cancelled several times, due to changing effective period and forecast reserve level. The effective

Effective date[A]	Region	LOR1		LOR2		LOR3		Cause and resolution
		Actual	Forecast	Actual	Forecast	Actual	Forecast	
								period ranged 07:00 – 10:30. The forecast LOR condition worsened or improved due to changes in generation availability (MN 103032, MN 103050, MN 103101, MN 103167, MN 103247, MN 103346, MN 103356, MN103357).
18/11/2022	TAS		1					• A forecast LOR1 was declared with effective period 06:30 – 07:30 (39 hour lead time) due to decreased generation availability (MN 103332). • The forecast LOR1 condition was updated and cancelled due to increased generation availability (MN 103492, MN 103494).
19/11/2022	TAS		1					• A forecast LOR1 was declared with effective period 09:00 – 10:00 (4 day lead time) and later cancelled due to change in generation availability (MN 103249, MN 103331).
01/12/2022	TAS		1					• A forecast LOR1 was declared with effective period 07:00 – 07:30 due to decreased generation availability (MN 103996) and updated (MN 104011) the following day. • A forecast LOR1 was declared with effective period 08:30 – 09:00 due to decreased generation availability (MN 103996) and updated (MN 104011) the following day. • The forecast LOR1 condition was cancelled due to increased net import (MN 104079) • The forecast LOR1 was re-declared for the effective period 07:00 – 09:30 due to increased forecast operational demand and decreased net import (MN 104080) • The forecast LOR1 condition was cancelled due to increased net import (MN 104101)
02/12/2022	TAS		1					• A forecast LOR1 was declared with effective period 07:00 – 09:30 (64 hour lead time) due to decreased generation availability (MN 104080) and was later cancelled due to increased generation availability (MN 104101). • A forecast LOR1 was redeclared with a similar effective period 06:30 – 07:00 (6 hour lead time) due to decreased generation availability (MN 104120) and shortly cancelled due to decreased forecast operational demand (MN 104122).
Total		**3**	**45**	**0**	**21**	**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.

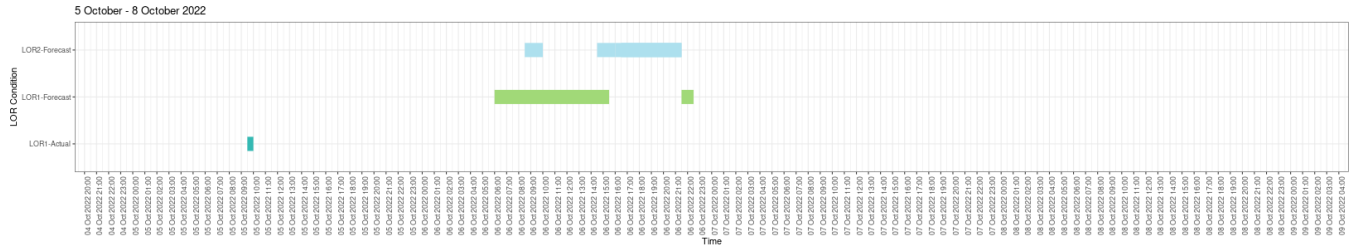
3.1 LOR declarations during the reporting period – Gantt chart

This section shows the LOR declarations during the reporting period 1 October – 31 December 2022 for each region using Gantt charts. Each Gantt chart covers a four-day period. Periods with no LOR declarations were omitted and not graphed.

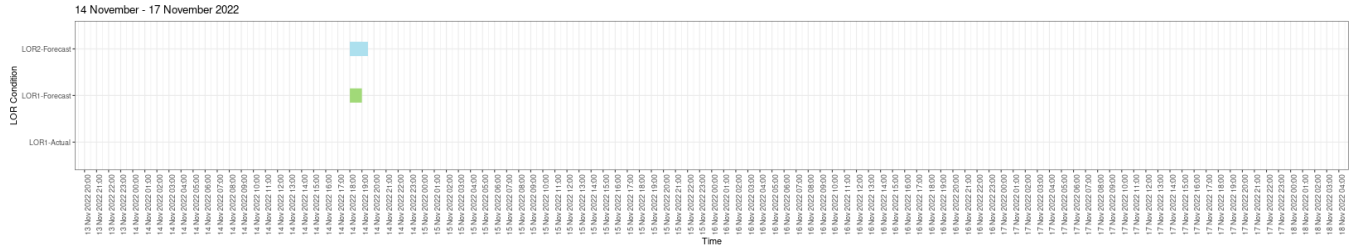
Forecast and actual LOR1, LOR2 and LOR3 conditions including updates are shaded according to the legend at the bottom of each page for the corresponding effective periods based on the market notices.

3.1.1 New South Wales

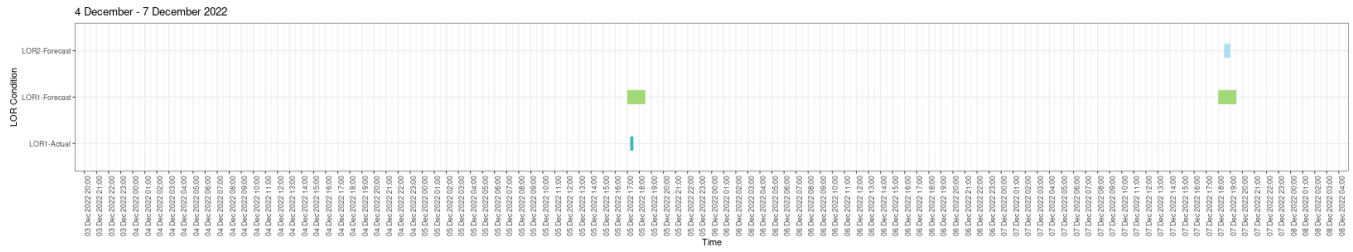
There were no LOR declarations in the period from 1 October to 4 October 2022.



There were no LOR declarations in the period from 9 October to 13 November 2022.



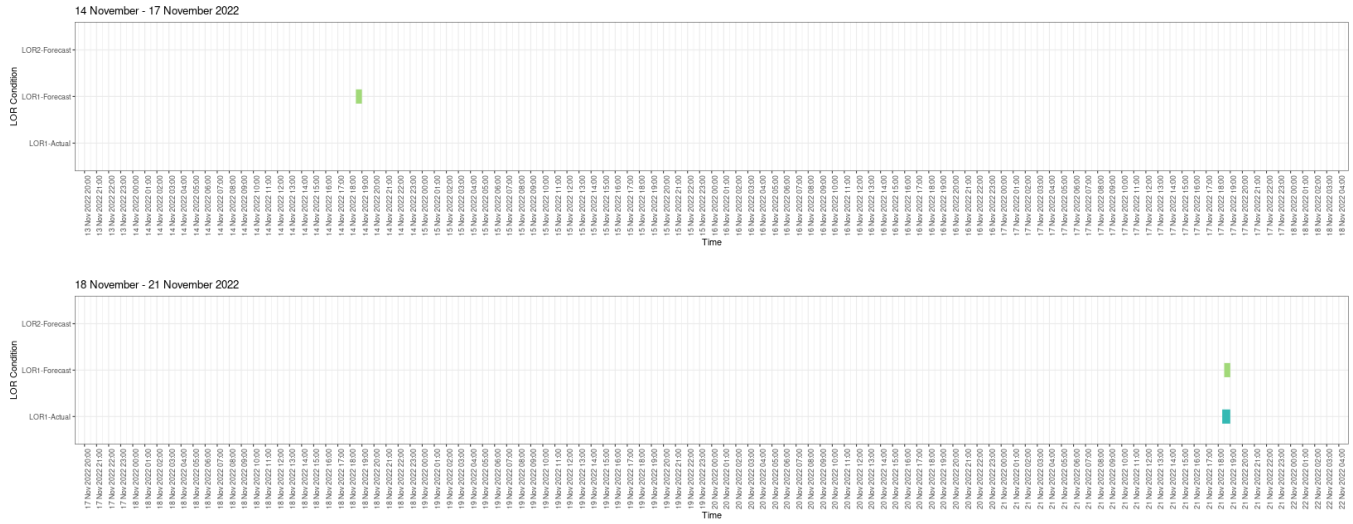
There were no LOR declarations in the period from 18 November to 3 December 2022.



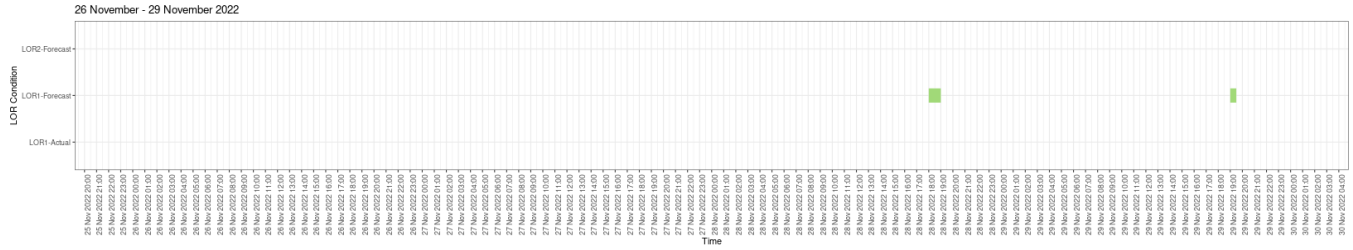
There were no LOR declarations in the period from 8 December to 31 December 2022.

3.1.2 Queensland

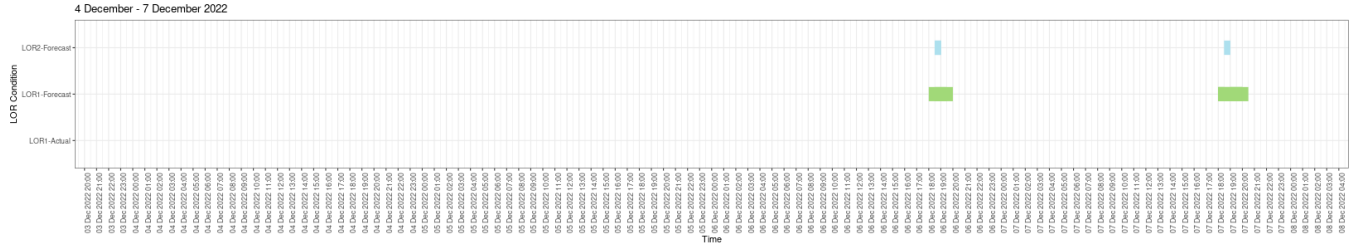
There were no LOR declarations in the period from 1 October to 13 November 2022.



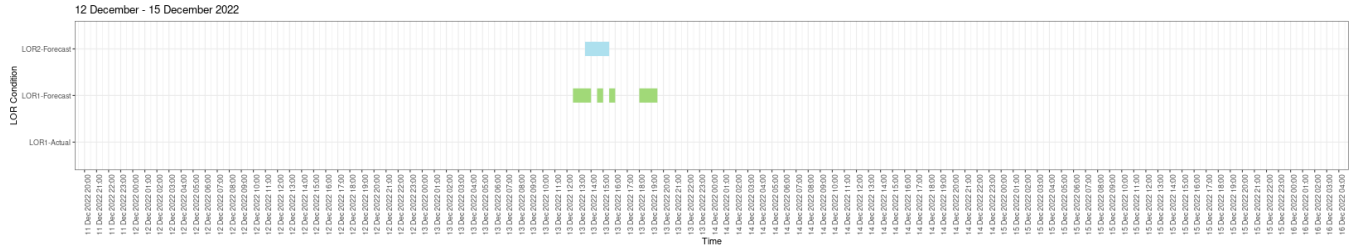
There were no LOR declarations in the period from 22 November to 25 November 2022.



There were no LOR declarations in the period from 30 November to 3 December 2022.



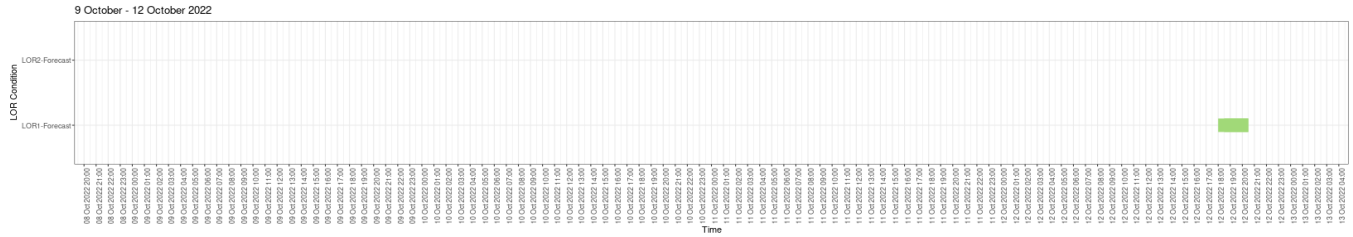
There were no LOR declarations in the period from 8 December to 11 December 2022.



There were no LOR declarations in the period from 16 December to 31 December 2022.

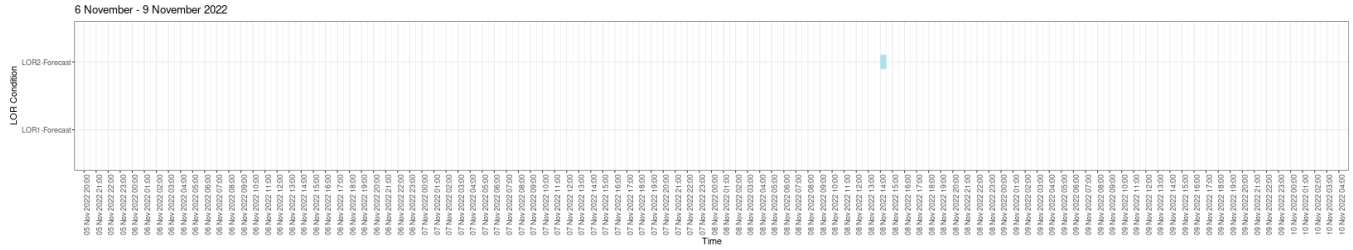
3.1.3 South Australia

There were no LOR declarations in the period from 1 October to 8 October 2022.

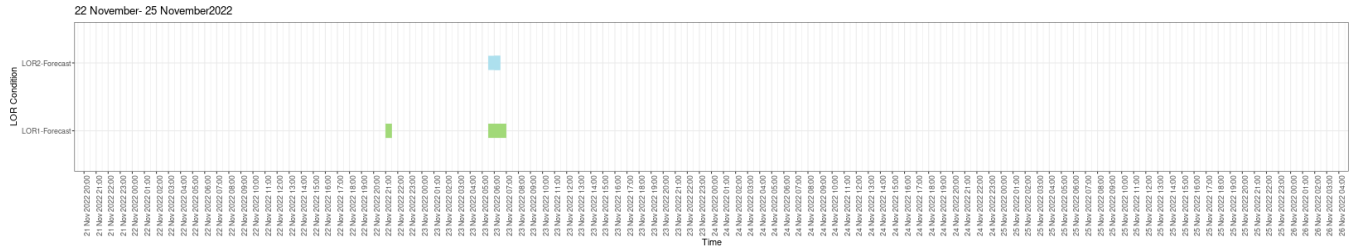


There were no LOR declarations in the period from 13 October to 16 October 2022.

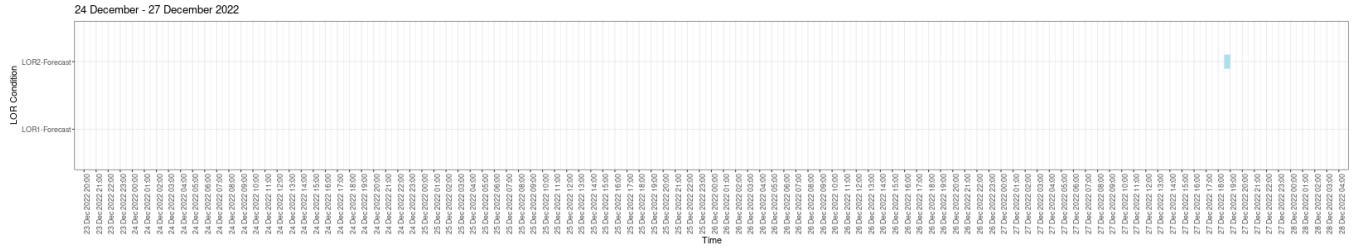
There were no LOR declarations in the period from 25 October to 5 November 2022.



There were no LOR declarations in the period from 10 November to 13 November 2022.



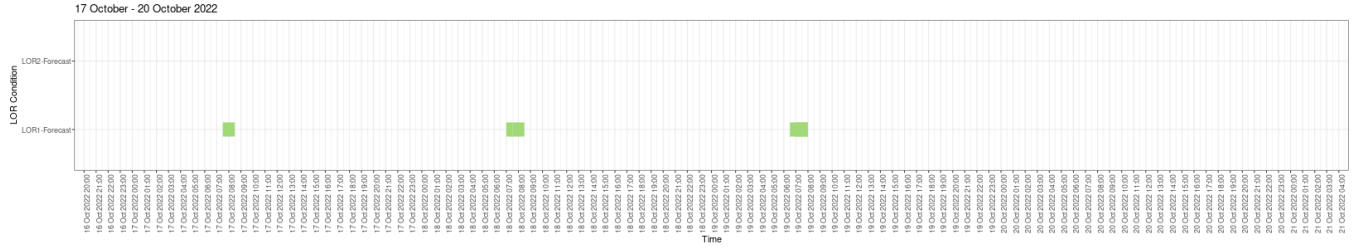
There were no LOR declarations in the period from 26 November to 23 December 2022.



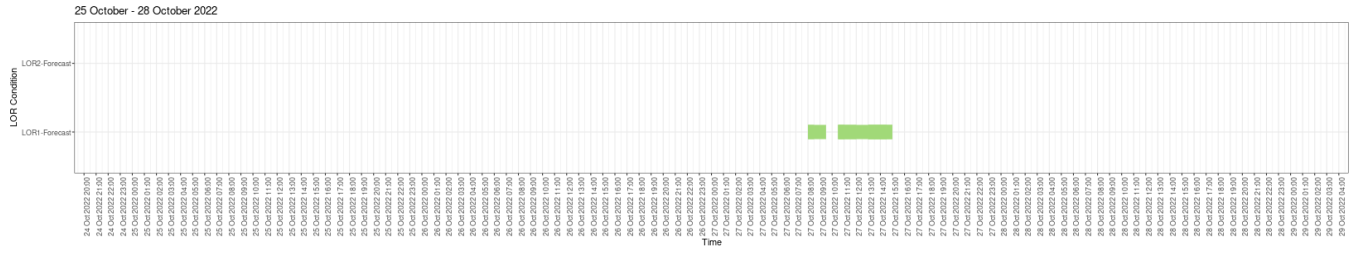
There were no LOR declarations in the period from 28 December to 31 December 2022.

3.1.4 Tasmania

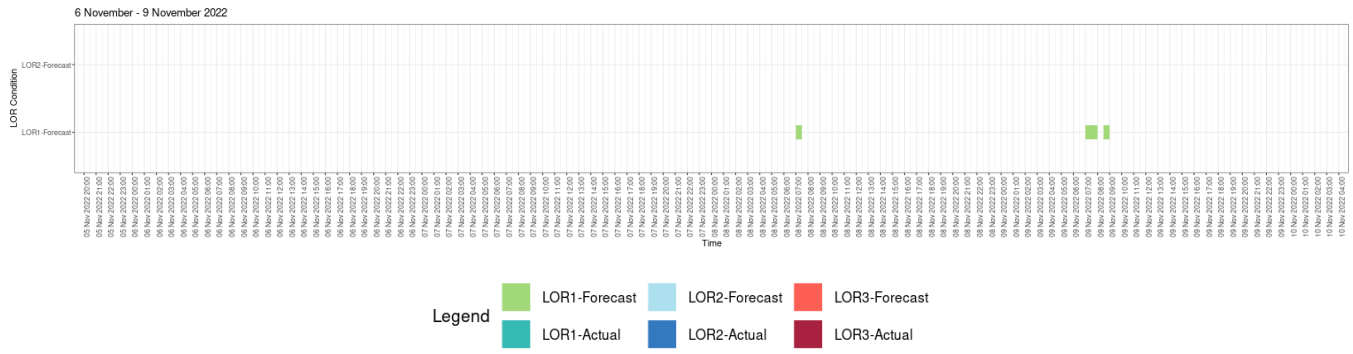
There were no LOR declarations in the period from 1 October to 16 October 2022.

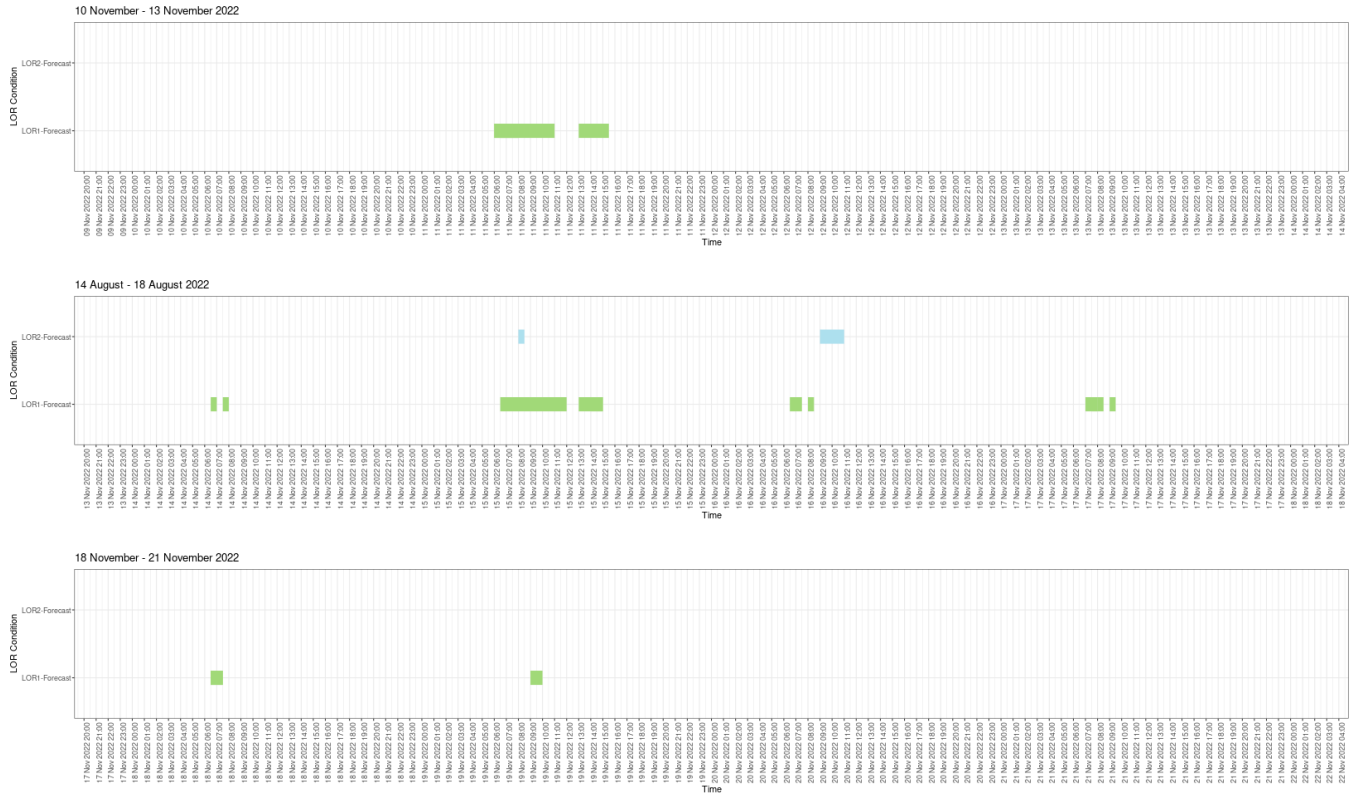


There were no LOR declarations in the period from 21 October to 24 October 2022.

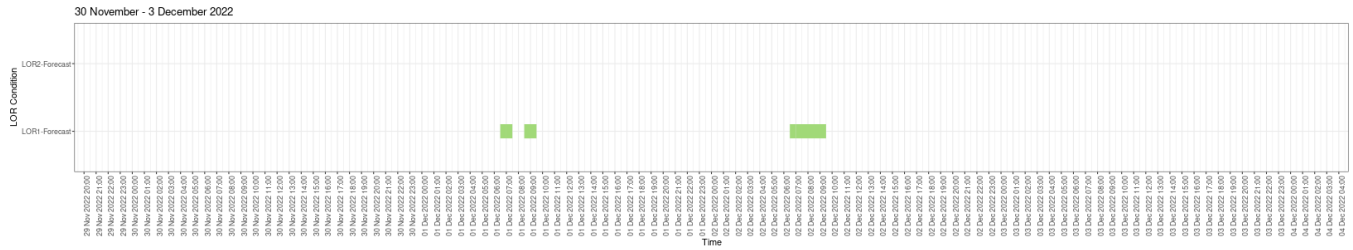


There were no LOR declarations in the period from 29 October to 5 November 2022.





There were no LOR declarations in the period from 22 November to 29 November 2022.



There were no LOR declarations in the period from 3 December to 31 November 2022.

3.1.5 Victoria

There were no LOR declarations in the period from 1 October to 31 December 2022.

4 Review of performance

4.1 Forecast Uncertainty Measure values

As in Section 2.1, this section will compare the 10th, 50th (median) and 90th percentile FUM values for this reporting period to those for each quarter from Quarter 4 2021 to Quarter 4 2022 (Figure 2 to Figure 6). FUM values decreasing is indicative of the distribution tightening with decreasing forecast uncertainty.

Values from 4/9/2022 to 5/9/2022 have been removed from the visualisations due to an outage impacting data delivered to the BBN which impacted the FUM.

The most material changes in FUM values between Quarter 3 2022 and Quarter 4 2022 are summarised in this section. For forecast horizons not mentioned in this section, the changes from Quarter 3 2022 were minor:

- New South Wales – 10th percentile FUM values increased for the 12, 24 and 60 hours ahead forecast horizons, and decreased for the 48 hours ahead forecast horizon. Median FUM values increased for the 6, 12, 24 and 60 hours ahead forecast horizons, and decreased for the 48 hours ahead forecast horizon. 90th percentile FUM values increased for the 12, 24, and 48 hours ahead forecast horizons.
- Queensland – 10th percentile FUM values increased for the 60 hours ahead forecast horizon. The median FUM values increased for the 24 hours ahead forecast horizon. 90th percentile FUM values increased for the 24 hours ahead forecast horizon and decreased for the 12 hours ahead forecast horizon.
- South Australia – Median FUM values decreased for the 48 hours ahead forecast horizon. 90th percentile FUM values decreased for the 48 and 60 hours ahead forecast horizon.
- Tasmania – 10th percentile FUM values increased for the two hours ahead forecast horizon and decreased for the 24 and 48 hours ahead forecast horizons. The median FUM values decreased for all the forecast horizons except the two hours ahead horizon. 90th percentile FUM values decreased for the two, 24, 48 and 60 hours ahead forecast horizons.
- Victoria – 10th, median and 90th percentile FUM values were relatively unchanged.

Figure 2 New South Wales region: FUM values for the reporting period, and compared to previous four quarters

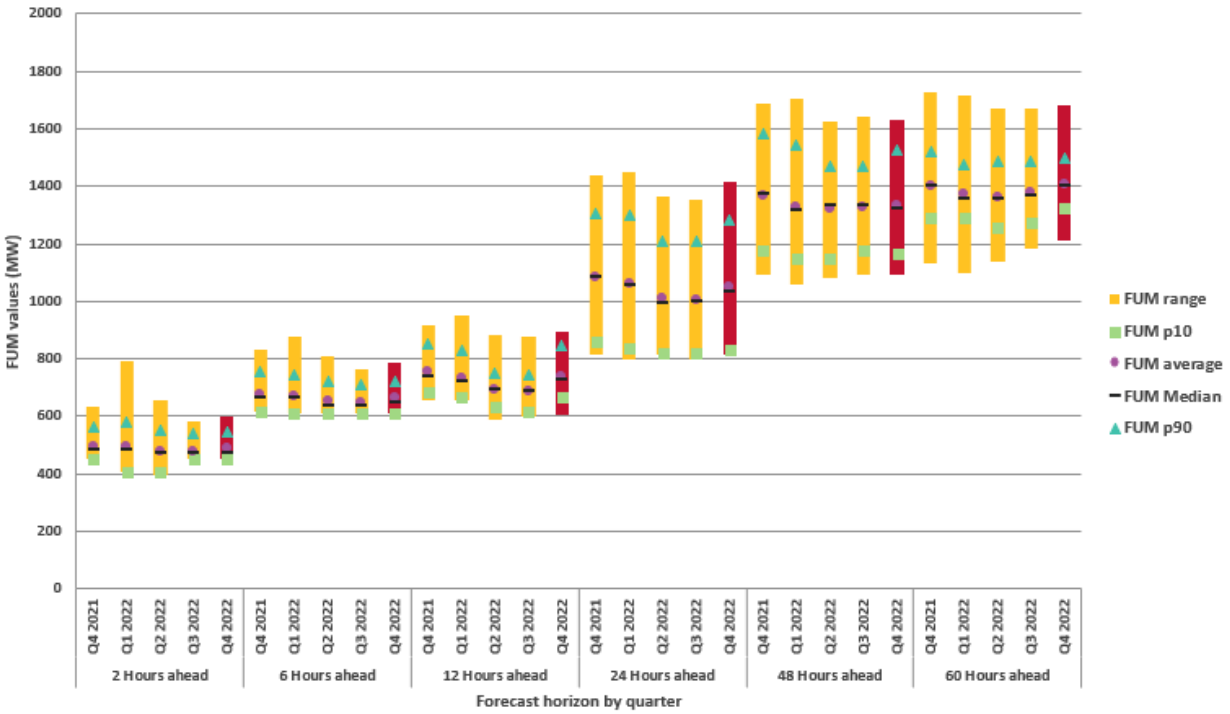


Figure 3 Queensland region: FUM values for the reporting period, and compared to previous four quarters

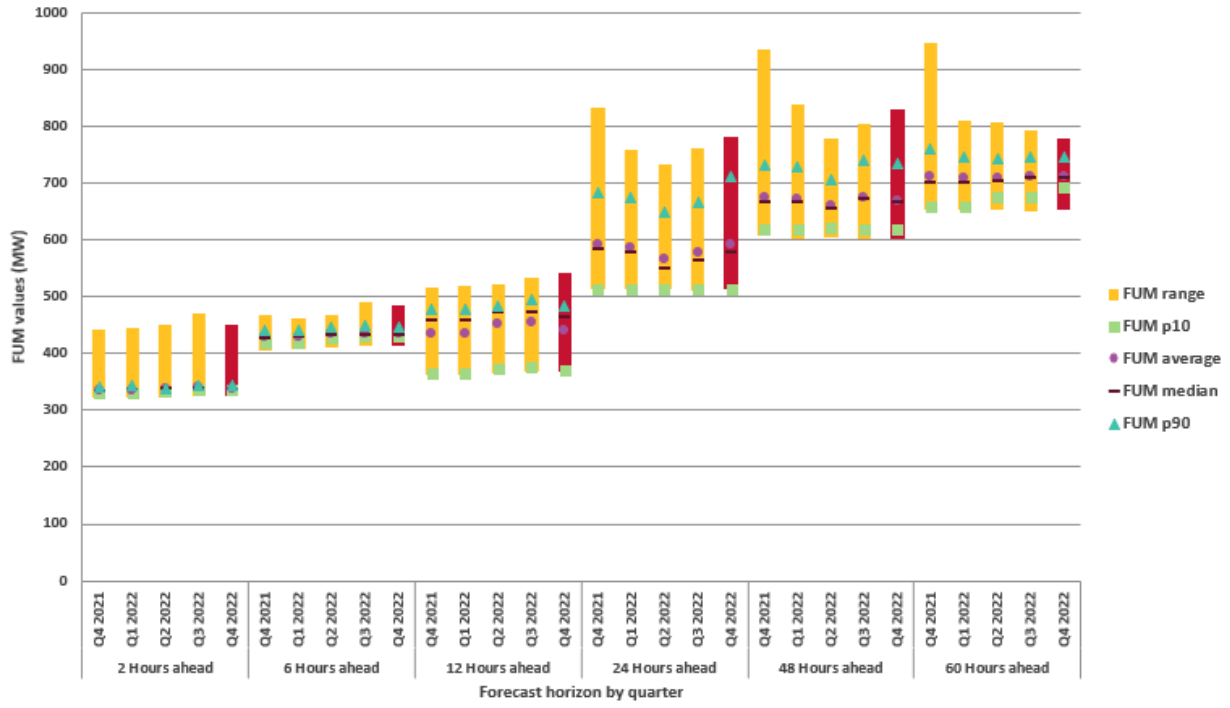


Figure 4 South Australia region: FUM values for the reporting period, and compared to previous four quarters

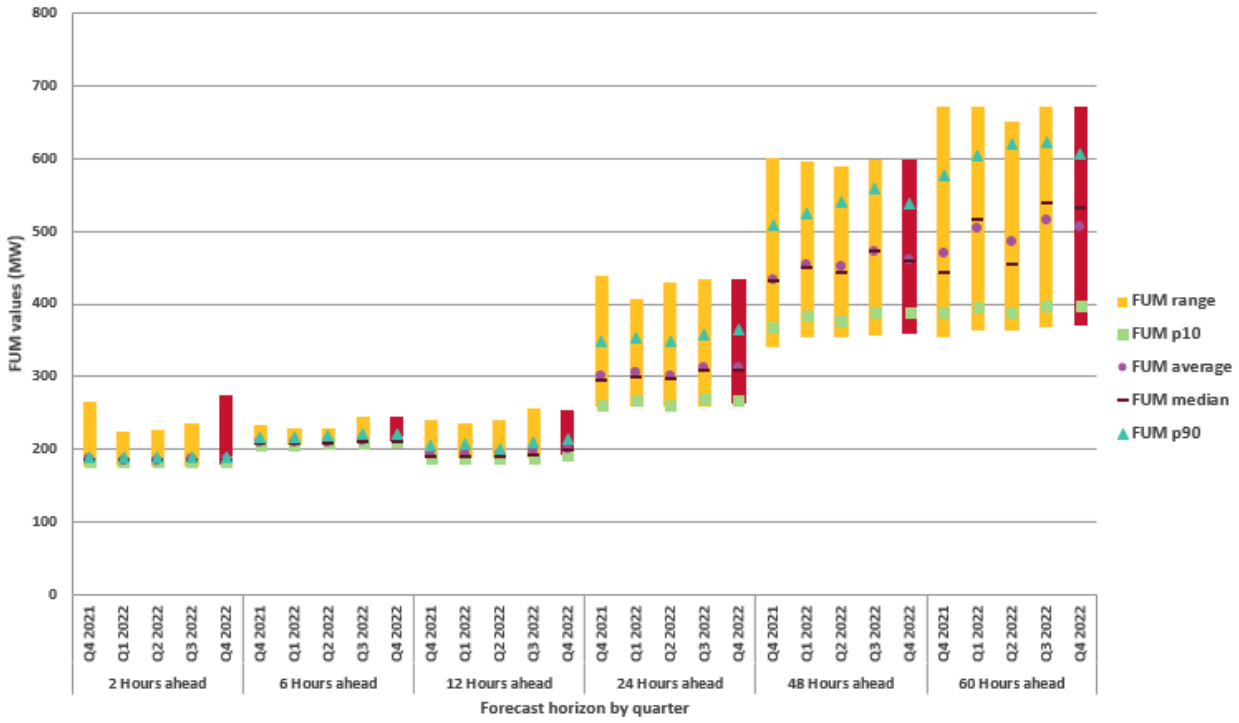


Figure 5 Tasmania region: FUM values for the reporting period, and compared to previous four quarters

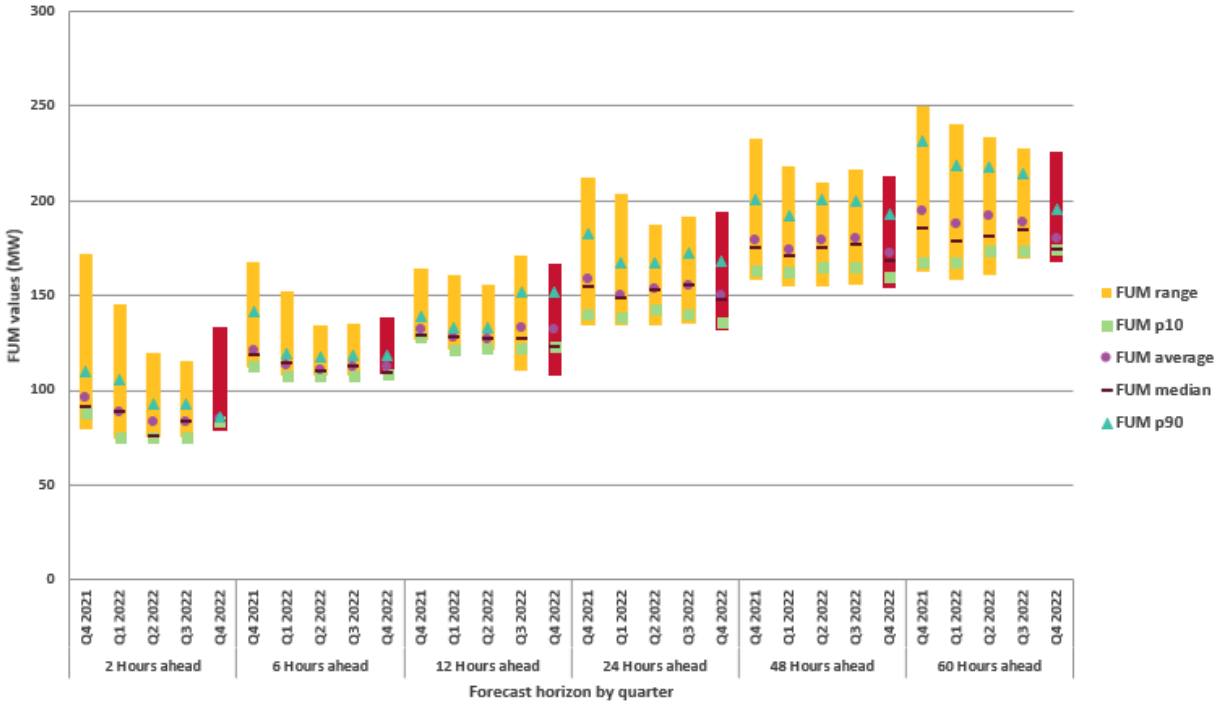
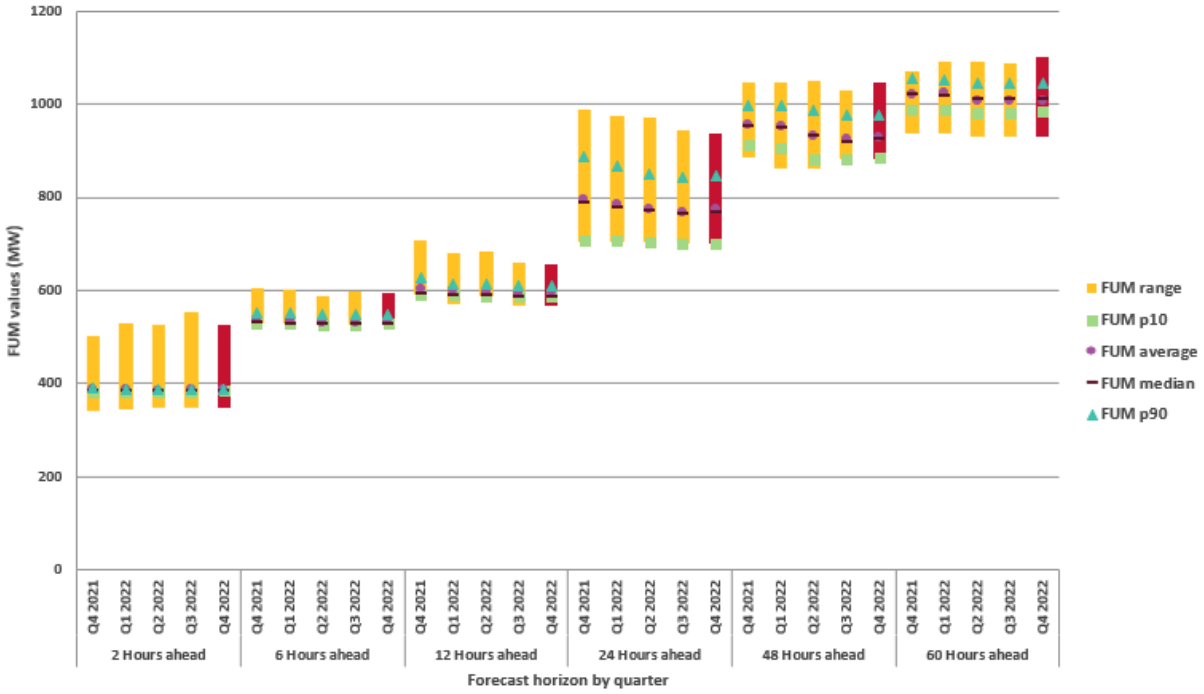


Figure 6 Victoria region: FUM values for the reporting period, and compared to previous four quarters



4.2 Forecast and actual LOR declarations

Of the 69 LOR declarations in the reporting period, 66 were for forecast LOR conditions:

- 45 forecast LOR1 conditions were declared.
- 21 forecast LOR2 conditions were declared.
- No forecast LOR3 conditions were declared[5].
- There was a transient LOR3 condition in Queensland on 13 December 2022, which was cleared in the subsequent Projected Assessment of System Adequacy (PASA) run and therefore was not declared.
- Of the 69 LOR declarations in the reporting period, three were for actual LOR1 conditions. Of these, two were observed as forecast LOR1 prior to being declared as an actual, therefore not counted as a forecast declaration based on the declaration count principles outlined in Section 3. There were zero actual LOR2 or LOR3 conditions in this reporting period.

[5] There was one suspect LOR3 condition issued for New South Wales. The investigation found that the suspect LOR3 condition was invalid due to input errors.

Table 3 Summary of LOR conditions during reporting period, 1 October to 31 December 2022

Region	LOR1		LOR2		LOR3	
	Actual	Forecast	Actual	Forecast	Actual	Forecast
NSW	2	6	0	5	0	0
QLD	1	7	0	3	0	0
SA	0	14	0	11	0	0
TAS	0	18	0	2	0	0
VIC	0	0	0	0	0	0
Total	**3**	**45**	**0**	**21**	**0**	**0**

Table 4 LORs declared during the reporting period by trigger (FUM or LCR)

Effective period	LOR1	LOR2	LOR3
New South Wales (NSW)			
05/10/2022	Actual		
	Forecast		
06/10/2022	Forecast	Forecast	
	Forecast	Forecast	
	Forecast	Forecast	
14/11/2022	Forecast	Forecast	
05/12/2022	Forecast then Actual		
07/12/2022	Forecast	Forecast	
Queensland (QLD)			
14/11/2022	Forecast		
21/11/2022	Forecast then Actual		
28/11/2022	Forecast		
29/11/2022	Forecast		
06/12/2022	Forecast	Forecast	
07/12/2022	Forecast	Forecast	
13/12/2022	Forecast	Forecast	
	Forecast		
South Australia (SA)			
12/10/2022	Forecast		
17/10/2022	Forecast	Forecast	
	Forecast		
18/10/2022	Forecast		
	Forecast		
	Forecast		
20/10/2022	Forecast		
	Forecast		
21/10/2022	Forecast	Forecast	

Effective period	LOR1	LOR2	LOR3
		Forecast	
22/10/2022	Forecast	Forecast	
		Forecast	
08/11/2022		Forecast	
15/11/2022	Forecast	Forecast	
		Forecast	
17/11/2022	Forecast		
19/11/2022		Forecast	
22/11/2022	Forecast		
23/11/2022	Forecast	Forecast	
27/11/2022		Forecast	
Tasmania (TAS)			
17/10/2022	Forecast		
18/10/2022	Forecast		
19/10/2022	Forecast		
27/10/2022	Forecast		
	Forecast		
08/11/2022	Forecast		
09/11/2022	Forecast		
11/11/2022	Forecast		
	Forecast		
14/11/2022	Forecast		
15/11/2022	Forecast	Forecast	
	Forecast		
16/11/2022	Forecast	Forecast	
17/11/2022	Forecast		
18/11/2022	Forecast		
19/11/2022	Forecast		
01/12/2022	Forecast		
02/12/2022	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.

4.2.1 Reliability and Emergency Reserve Trader (RERT) activations

During the reporting period, no RERT services were activated.

4.3 Causes of LOR declarations

As summarised in Table 2, a total of 69 LOR conditions were declared during the reporting period: 66 forecast and three actual LOR conditions:

- The three actual LOR1 conditions were caused by decreased generation availability and increased operational demand. Of the 68 forecast LOR conditions declared, only two developed into actual LOR1 conditions.
- The LOR conditions in Queensland were mainly driven by decreased generation availability and increased forecast demand.
- The LOR conditions in South Australia and Tasmania were mainly driven by decreased generation availability and decreased net import.

In Tasmania, on 14 October 2022, both Liapootah – Waddamana – Palmerston 220 kilovolts (kV) lines tripped. Following the trip of these circuits, North and South Tasmania remained connected only by the remaining in-service Waddamana – Palmerston 110 kV line. To maintain power system security, while TasNetworks worked to restore the 220 kV lines, AEMO constrained the power flow on the Palmerston – Waddamana 110 kV line below 15 MW. Both of the Liapootah – Waddamana – Palmerston 220 kV lines were returned to service on 2 December 2022[6]. During this outage, the LOR declarations represented the reserves in Northern Tasmania, where the Regional Reference Node is located. During Q4 2022, a total of 14 LOR1 declarations and 2 LOR2 declarations were issued, all of which occurred during this period. AEMO closely monitored the reserve situation in both Tasmanian sub-regions.

In South Australia, on 12 November 2022, both South East – Tailem Bend 275 kV lines and the Keith – Tailem Bend 132 kV line tripped. This caused the synchronous separation of a major part of the South Australian power system from the rest of the NEM. By 23 November 2022, all three lines were returned to service[7]. A total of 14 LOR1 declarations were made for South Australia in Q4 2022, of which four occurred during the synchronous separation event. This represents 29% of the LOR declarations occurring in 12% of the quarter. A total of 11 LOR2 declarations were made for South Australia in Q4 2022, of which four occurred during the synchronous separation event. This represents 36% of the LOR declarations occurring in 12% of the quarter. During the synchronous separation, the major contributors to LOR declarations were decreased generation availability and net imports.

There were 45 forecast LOR1 conditions in the NEM that did not develop into actual LOR1 conditions, and none of the 21 forecast LOR2 conditions developed into actual LOR2 conditions. The reason was the market response following the issue of the forecast market notice, or changes in forecast demand. The market response took the form of increased available generation or transmission network service providers (TNSPs) rescheduling planned transmission outages.

4.4 Number of LOR declarations compared to previous quarters

Quarter 4 2022 covered the mid spring months and the first month of summer.

A total of 69 LOR conditions were declared during Quarter 4 2022: 66 forecast and 3 actual LOR conditions. This is significantly lower than the 253 LOR declarations recorded in the previous reporting period (1 July 2022 to

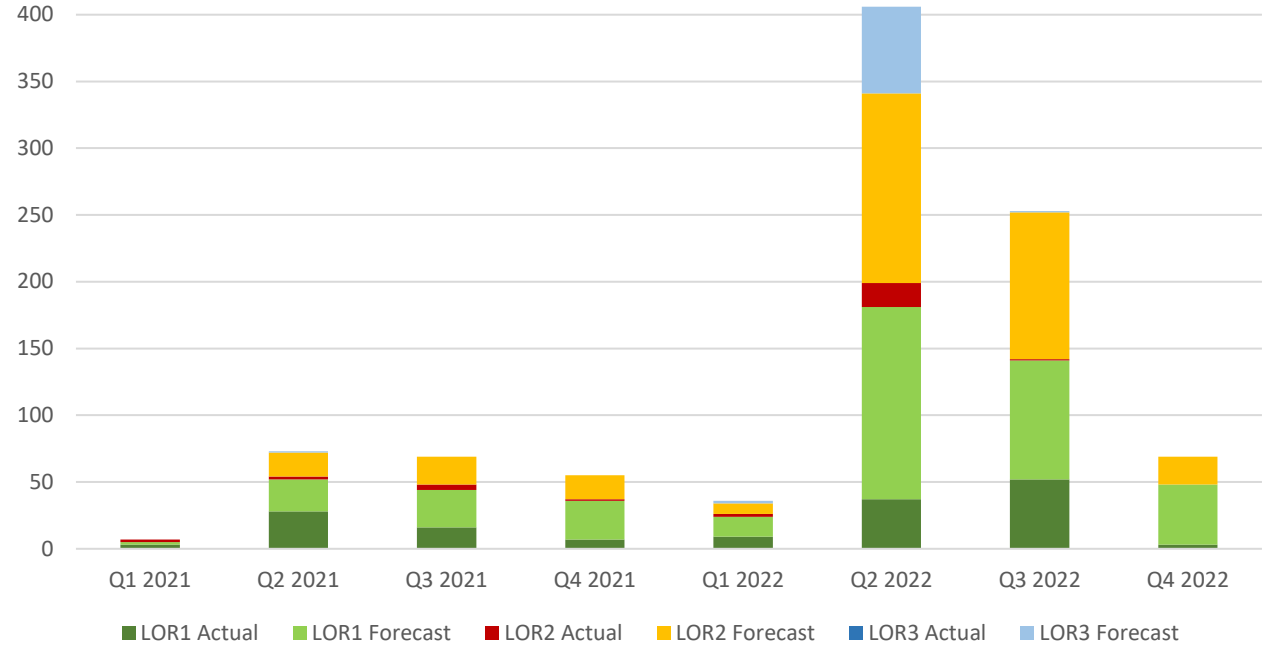
[6] The Preliminary Power System Operating Incident Report for this incident is available at https://aemo.com.au/-/media/files/electricity/nem/market_notices_and_events/market_event_reports/2022/preliminary-report-trip-of-liapootah-palmerston-lines.pdf?la=en

[7] The Preliminary Power System Operating Incident Report for this incident is available at https://aemo.com.au/-/media/files/electricity/nem/market_notices_and_events/power_system_incident_reports/2022/preliminary-report--trip-of-south-east-tailem-bend.pdf?la=en

30 September 2022), but slightly higher than the 55 LOR conditions declared for the same period last year (Quarter 4 2021).

Figure 7 shows the historical trend of actual and forecast LOR conditions in past quarters from Quarter 1 2021 compared to the Quarter 4 2022.

Figure 7 Quarterly comparison of actual and forecast LOR conditions, Q1 2021 to Q4 2022



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[8] for further information.

Term	Definition
AEST	Australian Eastern Standard Time
BBN	Bayesian Belief Network[9]
ETL	Extract-Transform-Load
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[10]
RERT	Reliability and Emergency Reserve Trader[11]
TNSP	Transmission network service provider

[8] 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

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

[10] See AEMO's 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

[11] See AEMO's RERT guidelines, at https://aemo.com.au/en/energy-systems/electricity/emergency-management/reliability-and-emergency-reserve-trader-rert