AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

NEM Lack of Reserve Framework Report

30 January 2020

Reporting period 1 October 2019 to 31 December 2019

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 October 2019 to 31 December 2019 (Quarter 4 2019).

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VERSION CONTROL

Version	Release date	Changes
1	30 January 2020	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 October 2019 to 31 December 2019 (Quarter 4 2019), AEMO declared 14 Lack of Reserve (LOR) conditions[1].

- There were five forecast LOR1 conditions.
- There were four forecast LOR2 conditions.
- There were four actual LOR1 conditions.
- There was one actual LOR2 condition.

This compares with 17 LOR declarations in the previous reporting period (Quarter 3 2019), and nine LOR declarations for the same period last year (Quarter 4 2018)[2].

Quarter 4 2019 covered the later spring months and first month of summer. Conditions warmed through this period, peaking in December, which saw significant heatwaves in most regions of the National Electricity Market (NEM). In addition to high heat, this period also saw widespread bushfire activity impact the NEM. In some cases, the threat or direct impact of bushfires on the transmission network constrained generation and net imports, which consequently reduced reserves below LOR thresholds.

Of the 14 LOR declarations in Quarter 4 2019:

- For 11 conditions, the reserve requirement was set by the Largest Credible Risk (LCR, for LOR2 conditions) or the sum of the two Largest Credible Risks (LCR2, for LOR1 thresholds), while there were three conditions where the reserve requirement was set by the Forecast Uncertainty Measurement (FUM)[3].
- This means 21% of LOR conditions were declared when the reserve requirement was being set by the FUM.
  - For comparison, in Quarter 3 2019, five of the 17 LOR conditions (29%) were set by the FUM, and in Quarter 4 2018, six of the nine LOR conditions (67%) were set by the FUM.

The next report on the NEM Lack of Reserve Framework will be published by 30 April 2020, for the reporting period 1 January 2020 to 31 March 2020.

[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] Previously published reports are available at https://aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Power-system-operation/NEM-Lack-of-Reserve-Framework-Quarterly-Reports.

[3] LCR and FUM are also explained in detail in the Reserve Level Declaration Guidelines.

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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 2019 to 31 December 2019 (Quarter 4 2019).

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), including an indication of the required reserve level and if the requirement was set by the Forecast Uncertainty Measure (FUM) or the largest credible risk/s (LCR) in the region. The FUM value for the respective 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 will be published by 30 April 2020, for the reporting period 1 January 2020 to 31 March 2020 (Quarter 1 2020)

2. Reserve Level Declaration Guidelines

2.1 Changes in the reporting period

During the reporting period, there were no changes to the Guidelines[4].

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 2020 to include data up to 31 December 2019. The retraining involves a three-stage process:

1. An Extract-Transform-Load (ETL) stage, to extract historical data up to 31 December 2019, perform data validation and cleansing, and compile the data into the structured format required to incorporate into the network.
2. An analysis and modelling stage, to update the network and compile the network nodes.
3. A 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 in February 2020, 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 2018 to September 2019 using the existing BBN and the retrained BBN. The results of this comparison indicate multiple changes to expected future FUM values. The results from the retrained BBN are:

- New South Wales – mean FUM values decreased by 6 MW for the two hours ahead forecast horizon, and increased for longer horizons up to a maximum of 31 MW at the 60 hours ahead horizon. Minimum FUM values increased slightly for all time horizons except the 60 hours ahead horizon, where a 36 MW decrease was observed. Maximum FUM values decreased (by up to 180 MW two hours ahead) at all forecast horizons except 24 hours ahead, where a 36 MW increase was observed.
- Queensland – for most forecast horizons there was no significant change in mean, minimum, or maximum FUM values. For the 12 and 24 hours ahead forecast horizons, 76 MW and 77 MW increases in maximum FUM values were observed respectively.
- South Australia – minor increases in mean, minimum, and maximum FUM values were observed across most time horizons. Notable exceptions were maximums 60 hours ahead (125 MW increase) and minimums 6 hours ahead (17 MW decrease).
- Tasmania – mean, minimum, and maximum FUM values were relatively unchanged, with the exception of the two hours ahead maximum, which decreased by 76 MW.
- Victoria – the mean and minimum FUM values did not appreciably change. Maximum FUM values decreased for the two and six hours ahead forecast horizons (by 56 MW and 97 MW respectively), and increased (by 97 MW) for the 12 hours ahead forecast horizon.

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

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 October 2019 to 31 December 2019. Table 2 also identifies the market notices that communicated updates to, and cancellation of, either forecast or actual LOR conditions.

Declaration count principles

For each reporting period, AEMO determines 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 are counted once. In Table 1, 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 is 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.

Included in Table 1 and Table 2 is an actual LOR2 event on 20 December 2019 in Victoria. This was declared due to suspect wind generation availability in the Pre Dispatch Projected Assessment of System Adequacy (PD PASA). Further details on this event are provided in section 4.5 of this report.

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

Effective date*	Region	LOR1		LOR2		LOR3		Cause
		Actual	Forecast	Actual	Forecast	Actual	Forecast	
30/10/2019	NSW		2		1			Two separate forecast LOR1 events were declared on the effective date. The forecast effective periods for these events were on different times on the effective date (approximately 08:00-12:30 and 15:00-18:00). The reserve conditions for both events were mainly due to reduced generation availability and reduced net import. A forecast LOR2 was declared with an approximate effective period 14:30-16:00. The reserve condition was due to reduced generation availability and net import.

Effective date*	Region	LOR1		LOR2		LOR3		Cause
		Actual	Forecast	Actual	Forecast	Actual	Forecast	
31/10/2019	NSW	1			1			A forecast LOR1 was initially declared with an effective time 14:30-18:30. This reserve condition was mainly due to reduced non-energy limited generation availability. Reserve conditions worsened to a forecast LOR2 with an effective time 17:00-17:30, due to a further decrease in generation availability. Initial forecast LOR1 and LOR2 were later cancelled; the forecast LOR2 was cancelled due to decreased FUM, and the forecast LOR1 was cancelled due to increased generation availability. A forecast LOR1 was then re-issued with an effective period 14:30-16:00, mainly due to reduced generation availability and reduced net import. An actual LOR1 was later declared. Actual conditions existed from 14:30-18:00.
06/12/2019	QLD	1						A forecast LOR1 was declared with an effective period 16:30-19:00. The reserve condition was mainly due to a very high demand forecast, reduced generator availability, and reduced net import. Updates were issued for improved reserves while in forecast LOR1. An actual LOR1 was later declared. Actual conditions existed from 17:00-18:00.
07/12/2019	QLD		1					A forecast LOR1 was declared with an effective period 17:00-17:30. The reserve condition was mainly due to high demand, reduced generation availability, and reduced net import. The forecast LOR1 was cancelled mainly due to increased semi-scheduled generation availability.
27/12/2019	SA	1						An actual LOR1 was declared. Prior to this event, a forecast LOR1 declaration had not been issued. The available reserve level materially decreased in this trading interval due to an increased demand forecast and decreased net import. Actual conditions existed from 19:00-19:30.
18/12/2019	VIC		1		1			A forecast LOR1 and LOR2 were declared on this effective date. Reserve conditions were across the effective period 15:30-19:30. Both reserve conditions were due to a very high demand forecast, and partly due to reduced generation availability and reduced net import. The forecast LOR2 condition was cancelled mainly due to increased generation availability and a decreased required reserve level set by the FUM. The forecast LOR1 condition was cancelled due to a significantly decreased demand forecast.

Effective date*	Region	LOR1		LOR2		LOR3		Cause
		Actual	Forecast	Actual	Forecast	Actual	Forecast	
20/12/2019	VIC		1	1				A forecast LOR1 was declared with an effective period 17:00-18:00. This reserve condition was mainly due to a very high demand forecast. An actual LOR2 was declared. The actual reserve condition was not forecast in PDPASA. The actual LOR2 was declared due to a large difference between wind generation availability in pre-dispatch and actual wind generation in Victoria. Actual LOR2 conditions were declared for 17:15-18:30. *More information on this event is provided in Section 4.5 of this report.*
30/12/2019	VIC	1			1			A forecast LOR1 and LOR2 were declared on this effective date. Reserve conditions were across the effective period 15:30-19:00. Reserve conditions were due to network constraints associated with unplanned transmission outages caused by bushfires. The forecast LOR2 was cancelled due to increased net import and demand offset by activation of Reliability and Emergency Reserve Trader (RERT). An actual LOR1 was declared for 16:00-17:00.
Total		**4**	**5**	**1**	**4**	**0**	**0**	

* 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 October 2019 and 31 December 2019

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									
30/10/2019 15:30-16:00	70773	29/10/2019 11:03	LOR2	Forecast	Forecast LOR2 due to reduced generation availability and reduced net import.	973	968	973	FUM
30/10/2019 13:30-16:00	70774	29/10/2019 12:58	LOR1	Forecast	Forecast LOR1 due to reduced generation availability and reduced net import.	1,320	947	907	LCR2
30/10/2019 14:30-16:00	70775	29/10/2019 13:28	LOR2	Forecast	Forecast LOR2 declared when condition forecast in MN 70773 entered the pre-dispatch time frame. Forecast LOR2 due to reduced generation availability and net import.	878	680	878	FUM
30/10/2019	70779	29/10/2019 14:42	LOR2	Cancelled	This cancelled MN 70773. Forecast LOR2 cancelled mainly due to increased generation availability and increased net import. In addition, the demand forecast and FUM decreased.	887	1,421	887	FUM
30/10/2019	70776	29/10/2019 13:42	LOR2	Cancelled	This cancelled MN 70775. Forecast LOR2 cancelled mainly due to increased generation availability and increased net import. In addition, the demand forecast and FUM decreased.	887	1,421	887	FUM
30/10/2019 11:00-12:30	70777	29/10/2019 13:51	LOR1	Update	Update to MN 70774. Available reserve level increased mainly due to increased generation availability and increased net import. The number of trading intervals in forecast LOR1 increased. Forecast LOR1 split into two periods on the effective date which were then considered separate events.	1,320	1,137	977	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		
30/10/2019 16:00-17:00	70777	29/10/2019 13:51	LOR1	Update	Update to MN 70774. Available reserve level increased mainly due to increased generation availability and increased net import. The number of trading intervals in forecast LOR1 increased. Forecast LOR1 split into two periods on the effective date which were then considered separate events.	1,522	1,421	887	LCR2
31/10/2019 14:30-18:30	70780	29/10/2019 14:43	LOR1	Forecast	Forecast LOR1 due to reduced non energy limited generation availability.	1,432	1,137	1,136	LCR2
30/10/2019 08:00-12:30	70781	29/10/2019 14:46	LOR1	Update	Update to MN 70777. Available reserve level increased slightly due to increased generation availability. The number of trading intervals in forecast LOR1 materially increased for this effective period.	1,320	1,199	901	LCR2
30/10/2019 15:00-18:00	70781	29/10/2019 14:46	LOR1	Update	Update to MN 70777. Available reserve level decreased due to decreased generation availability. The number of trading intervals in forecast LOR1 materially increased for this effective period.	1,538	1,243	849	LCR2
31/10/2019 17:00-17:30	70784	29/10/2019 16:56	LOR2	Forecast	Forecast LOR2 due to reduced generation availability.	1,126	1,120	1,126	FUM
31/10/2019	70788	30/10/2019 00:34	LOR2	Cancelled	This cancelled MN 70784. Forecast LOR2 cancelled mainly due to a decrease in the required reserve set by the FUM.	1,038	1,114	1,038	FUM
30/10/2019 09:00-12:30	70789	30/10/2019 00:43	LOR1	Update	Update to MN 70781. Available reserve level materially decreased due to decreased generation availability and decreased net import. The number of trading intervals in forecast LOR1 decreased for this effective period.	1,320	813	620	LCR2
30/10/2019 15:30-18:00	70789	30/10/2019 00:43	LOR1	Update	Update to MN 70781. Available reserve level increased due to increased generation availability. The number of trading intervals in forecast LOR1 decreased for this effective period.	1,536	1,421	651	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		
30/10/2019 11:30-12:00	70790	30/10/2019 07:43	LOR1	Update	Update MN 70789. Available reserve level materially increased due to increased generation availability. The effective period reduced to one trading interval.	1,320	1,225	633	LCR2
30/10/2019	70791	30/10/2019 08:12	LOR1	Cancelled	This cancelled MN 70790. Forecast LOR1 cancelled mainly due to decrease in demand forecast.	1,320	1,368	625	LCR2
30/10/2019 16:30-18:00	70792	30/10/2019 10:16	LOR1	Forecast	Forecast LOR1 due to reduced net import and reduced semi-scheduled generation availability.	1,554	1,506	657	LCR2
30/10/2019	70796	30/10/2019 11:07	LOR1	Cancelled	This cancelled MN 70792. Forecast LOR1 cancelled due to increased net import and decreased demand forecast.	1,564	1,631	640	LCR2
31/10/2019	70797	30/10/2019 14:55	LOR1	Cancelled	This cancelled MN 70780. Forecast LOR1 cancelled mainly due to significantly increased generation availability and partly due to decreased demand forecast.	1,499	1,769	980	LCR2
31/10/2019 14:30-16:00	70801	30/10/2019 21:55	LOR1	Forecast	Forecast LOR1 split across three periods on the effective date. Due to reduced generation availability and reduced net import for this effective period.	1,488	1,206	646	LCR2
31/10/2019 17:00-17:30	70801	30/10/2019 21:55	LOR1	Forecast	Forecast LOR1 split across three periods on the effective date. Due to reduced net import for this effective period.	1,474	1,457	648	LCR2
31/10/2019 18:00-18:30	70801	30/10/2019 21:55	LOR1	Forecast	Forecast LOR1 split across three periods on the effective date. Due to reduced generation availability for this effective period.	1,443	1,323	658	LCR2
31/10/2019 14:30-18:30	70804	30/10/2019 22:13	LOR1	Update	Update MN 70801. Forecast LOR1 converged to one effective period. Available reserve level decreased mainly due to decreased generation availability and decreased net import, and partly due to decreased semi-scheduled generation availability. The number of trading intervals in forecast LOR1 increased.	1,501	1,195	645	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		
31/10/2019 15:30-16:00	70828	31/10/2019 08:19	LOR1	Update	Update to MN 70804. Available reserve level materially increased due to increased generation availability. The effective period reduced to one trading interval.	1,510	1,417	694	LCR2
31/10/2019	70833	31/10/2019 09:21	LOR1	Cancelled	This cancelled MN 70828. Forecast LOR1 cancelled mainly due to increased generation availability and partly due to decreased demand forecast.	1,512	1,587	669	LCR2
31/10/2019 14:30-16:00	70838	31/10/2019 12:24	LOR1	Forecast	Forecast LOR1 due to reduced generation availability and increased demand forecast.	1,547	1,404	575	LCR2
31/10/2019 15:00-16:00	70842	31/10/2019 14:15	LOR1	Update	Update to MN 70838. Available reserve level decreased mainly due to increased demand forecast. The number of trading intervals in forecast LOR1 decreased.	1,565	1,376	538	LCR2
31/10/2019 14:30-16:00	70843	31/10/2019 14:43	LOR1	Actual	Actual LOR1 declared.	1,520	1,430	343	LCR2
31/10/2019 14:30-18:00	70846	31/10/2019 17:04	LOR1	Update	Update to MN 70843. Available reserve level materially decreased due to decreased generation availability. The number of trading intervals in actual LOR1 increased.	1,547	1,220	332	LCR2
31/10/2019	70860	31/10/2019 19:22	LOR1	Cancelled	This cancelled MN 70846. Actual LOR1 cancelled at 19:30 due to increasing generation availability and increasing net import after the event. Actual LOR1 effective period 14:30 to 18:00.	1,463	1,529	332	LCR2
Queensland region									
06/12/2019 16:30-18:00	71664	05/12/2019 22:23	LOR1	Forecast	Forecast LOR1 due to very high demand forecast and reduced generation availability and reduced net import.	886	798	463	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		
06/12/2019 16:30-18:30	71667	06/12/2019 09:42	LOR1	Update	Update to MN 71664. Available reserve level decreased due to increased generation availability. The number of trading intervals in forecast LOR1 increased by one.	886	711	390	LCR2
06/12/2019 16:30-19:00	71671	06/12/2019 14:23	LOR1	Update	Update to MN 71667. Required reserve level materially increased, and available reserve level increased due to increased generation availability and increased semi-scheduled generation availability. The number of trading intervals in forecast LOR1 increased by one.	1,035	730	376	LCR2
06/12/2019 17:30-18:00	71674	06/12/2019 16:15	LOR1	Update	Update to MN 71671. Available reserve level materially increased due to decreased demand forecast and increased generation availability. The number of trading intervals in forecast LOR1 decreased.	1,065	996	348	LCR2
06/12/2019 17:00-18:00	71679	06/12/2019 17:16	LOR1	Actual	Actual LOR1 declared.	1,053	981	168	LCR2
06/12/2019	71686	06/12/2019 18:17	LOR1	Cancelled	This cancelled MN 71679. Actual LOR1 cancelled at 18:30 due to decreasing demand forecast after event. Actual LOR1 effective period 17:00 to 18:00.	1,040	1,041	160	LCR2
07/12/2019 17:00-17:30	71685	06/12/2019 17:58	LOR1	Forecast	Forecast LOR1 due to high demand, reduced generation availability and reduced net import.	1,025	1,017	566	LCR2
07/12/2019	71695	06/12/2019 21:33	LOR1	Cancelled	This cancelled MN 71685. Forecast LOR1 cancelled mainly due to increased semi-scheduled generation availability.	1,012	1,057	479	LCR2
South Australia region									
27/12/2019 19:00-19:30	72102	27/12/2019 19:17	LOR1	Actual	Actual LOR1 declared. There was no forecast LOR1 prior to this event. Available reserve level decreased quickly in this effective period due to increased demand forecast and decreased net import.	600	546	85	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		
27/12/2019	72103	27/12/2019 19:41	LOR1	Cancelled	This cancelled MN 72102. Actual LOR1 cancelled at 20:00 due to decreasing generation availability and decreasing demand forecast after the event. Actual LOR1 effective period 19:00 to 19:30.	600	618	101	LCR2
Tasmania region									
Nil									
Victoria region									
18/12/2019 15:00-17:00	71819	14/12/2019 15:21	LOR1	Forecast	Forecast LOR1 mainly due to very high demand forecast and partly due to reduced generation availability.	1,140	933	n/a – forecast > 72 hrs ahead	LCR2
18/12/2019	71837	15/12/2019 14:17	LOR1	Cancelled	This cancelled MN 71819. Forecast LOR1 cancelled due to decreased demand forecast, increased generation availability, and increased semi-scheduled generation availability.	1,140	1,358	n/a – forecast > 72 hrs ahead	LCR2
18/12/2019 16:30-18:00	71855	16/12/2019 12:52	LOR2	Forecast	Forecast LOR2 mainly due to reduced generation availability and reduced net import.	1,015	936	1,015	FUM
18/12/2019 16:00-16:30	71856	16/12/2019 14:34	LOR1	Forecast	Forecast LOR1 mainly due to very high demand forecast and reduced generation availability.	1,140	1,027	964	LCR2
18/12/2019 16:30-18:30	71857	16/12/2019 17:01	LOR2	Update	Update to MN 71855. Available reserve level materially decreased due to increased demand forecast and decreased net import. The number of trading intervals in forecast LOR2 increased by one.	998	767	998	FUM
18/12/2019 15:30-18:30	71861	17/12/2019 07:17	LOR2	Update	Update to MN 71857. Available reserve level materially decreased mainly due to decreased generation availability and partially due to decreased semi-scheduled generation availability. The number of trading intervals in forecast LOR2 increased.	957	580	957	FUM

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		
18/12/2019 18:30-19:00	71860	17/12/2019 07:17	LOR1	Update	Update to MN 71856. Effective period in forecast LOR1 changed. Available reserve decreased slightly and number of trading intervals in forecast LOR1 remained the same.	1,140	1,002	960	LCR2
18/12/2019 18:30-19:00	71862	17/12/2019 07:17	LOR1	Correction	Correction to MN 71860. No change to updated conditions.	1,140	1,002	960	LCR2
18/12/2019 16:00-18:30	71865	17/12/2019 13:02	LOR2	Forecast	Forecast LOR2 declared when condition originally forecast in MN 71855 (and subsequently updated in MN 71857 and MN 71861) entered the pre-dispatch time frame.	914	643	914	FUM
18/12/2019 15:30-16:00	71866	17/12/2019 13:02	LOR1	Forecast	Forecast LOR1 declared when condition originally forecast in MN 71856 (and subsequently updated in MN 71860) entered the pre-dispatch time frame. Forecast LOR1 split into two periods on the effective date.	1,140	1,033	916	LCR2
18/12/2019 18:30-19:00	71866	17/12/2019 13:02	LOR1	Forecast	Forecast LOR1 declared when condition originally forecast in MN 71856 (and subsequently updated in MN 71860) entered the pre-dispatch time frame. Forecast LOR1 split into two periods on the effective date.	1,140	1,014	907	LCR2
18/12/2019 16:30-18:30	71870	17/12/2019 20:23	LOR2	Update	Update to MN 71865. Required reserve decreased due to decreased FUM. Available reserve level materially decreased due to decreased net import and generation availability. The number of trading intervals in forecast LOR2 decreased by one.	783	460	783	FUM
18/12/2019 15:30-16:30	71871	17/12/2019 20:23	LOR1	Update	Update to MN 71866. Available reserve level materially decreased due increased demand forecast and decreased net import. The number of trading intervals in forecast LOR1 increased by one for this effective period.	1,127	870	742	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		
18/12/2019 18:30-19:30	71871	17/12/2019 20:23	LOR1	Update	Update to MN 71866. Available reserve level materially decreased mainly due to decreased net import and partly due to increased demand forecast. The number of trading intervals in forecast LOR1 increased by one for this effective period.	1,127	811	793	LCR2
18/12/2019	71872	17/12/2019 22:50	LOR2	Cancelled	This cancelled MN 71870. Forecast LOR2 cancelled due to increased generation availability and decreased required reserve level set by the FUM.	661	710	661	FUM
18/12/2019 16:00-18:30	71873	17/12/2019 22:51	LOR1	Update	Update to MN 71871. Forecast LOR1 converged to one effective period when forecast LOR2 was cancelled. Available reserve level decreased and number of trading intervals in forecast LOR1 increased.	1,127	710	661	LCR2
18/12/2019 17:00-18:00	71886	18/12/2019 15:46	LOR1	Update	Update to MN 71873. Available reserve materially increased due to decreased demand forecast and increased net import. The number of trading intervals in forecast LOR1 materially decreased.	1,128	1,052	331	LCR2
18/12/2019	71899	18/12/2019 16:40	LOR1	Cancelled	This cancelled MN 71886. Forecast LOR1 cancelled due to significantly decreased demand forecast.	1,128	1,270	281	LCR2
20/12/2019 17:30-18:00	71921	20/12/2019 15:21	LOR1	Forecast	Forecast LOR1 due to very high demand forecast.	1,131	1,091	508	LCR2
20/12/2019 17:00-18:00	71932	20/12/2019 16:15	LOR1	Update	Update to MN 71921. No significant change in available reserve, increased demand forecast was met with increased generation availability. The number of trading intervals in forecast LOR1 increased by one.	1,131	1,053	410	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		
20/12/2019 17:15-18:30	71935	20/12/2019 17:19	LOR2	Actual[C]	Actual LOR2 declared. Due to a large difference between wind generation availability in pre-dispatch and actual wind generation in Victoria. AEMO issued an Actual LOR2 for this effective period. The actual LOR2 was not forecast in pre-dispatch during this event.	570	448	N/A	LCR
20/12/2019	71951	20/12/2019 19:09	LOR2	Cancelled	This cancelled MN 71935. Actual LOR2 cancelled at 19:10 due to decreasing demand forecast after the event. Actual LOR2 effective period 17:15 to 18:30.	571	615	N/A	LCR
30/12/2019 15:30-18:30	72143	30/12/2019 15:16	LOR2	Forecast	Forecast LOR2 due to network constraints associated with unplanned transmission outages caused by bushfires.	569	223	532	LCR
30/12/2019 15:30-19:00	72142	30/12/2019 15:16	LOR1	Forecast	Forecast LOR2 due to network constraints associated with unplanned transmission outages caused by bushfires.	1,129	611	360	LCR2
30/12/2019 16:00-19:00	72169	30/12/2019 16:29	LOR1	Actual	Actual LOR1 declared.	1,129	617	263	LCR2
30/12/2019	72188	30/12/2019 17:11	LOR2	Cancelled	This cancelled MN 72143. Forecast LOR2 cancelled mainly due to demand forecast offset through activation and dispatch of Reliability and Emergency Reserve Trader (RERT).	569	960	253	LCR
30/12/2019	72189	30/12/2019 17:13	LOR1	Cancelled	This cancelled MN 72169. Actual LOR1 cancelled at 17:30 due to decreasing demand forecast after the event. Actual LOR1 effective period 16:00 to 17:00.	1,129	1,140	180	LCR2

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).
C. Refer to Section 4.5 of this report, *Suspect LOR events*, for more information.

4. Review of performance

4.1 Forecast Uncertainty Measure values

This section compares the average, minimum, and maximum FUM values for this reporting period to those for Quarter 4 2018 through Quarter 4 2019 (see Figures 1 through 5 below).

Changes in FUM values relative to Quarter 3 2019 are summarised below. For forecast horizons not mentioned below, the changes relative to Quarter 3 2019 are minor:

- New South Wales – changes to average FUM values were minor across all forecast horizons. Maximum and minimum FUM values generally increased.
- Queensland – average FUM values decreased for the 24 and 48 hours ahead forecast horizons. Maximum FUM values decreased for the 12 and 24 hour ahead forecast horizons. The decrease in the maximum FUM for the 24 hours ahead forecast horizon was approximately 100 MW, which was the largest change in average, maximum, or minimum FUM values for a NEM region between Quarter 3 2019 and Quarter 4 2019. Minimum FUM values increased for the 12 hours ahead forecast horizon and decreased for the 48 hours ahead forecast horizon.
- South Australia – average FUM values increased for the 24 hours ahead time horizon and decreased for the 60 hours ahead time horizon. Maximum FUM values increased for the two and 12 hours ahead forecast horizons, and decreased for the 24 and 60 hours ahead forecast horizons.
- Tasmania – average FUM values decreased for all forecast horizons, and maximum FUM values decreased for all forecast horizons except 24 hours ahead, where the change was minor. Minor changes were observed for minimum FUM values across all forecast horizons.
- Victoria – changes in average FUM values were minor across all forecast horizons except 24 hours ahead, which saw an increase. Maximum FUM values increased for forecast horizons up to 24 hours and decreased for the 48 and 60 hour forecast horizons. Changes in minimum FUM values were minor across all forecast horizons except 60 hours ahead, which saw an increase.

The large changes to FUM values for this reporting period relative to the corresponding period in 2018 are consistent with the expected changes published in the 2018 consultation on changes to the Reserve Level Declaration Guidelines[5].

[5] Refer to the Update Paper published during the Consultation, at http://aemo.com.au/Stakeholder-Consultation/Consultations/Changes-to-Reserve-Level-Declaration-Guidelines?Convenor=AEMO%20NEM. The updated Guidelines are effective 10 December 2018.

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

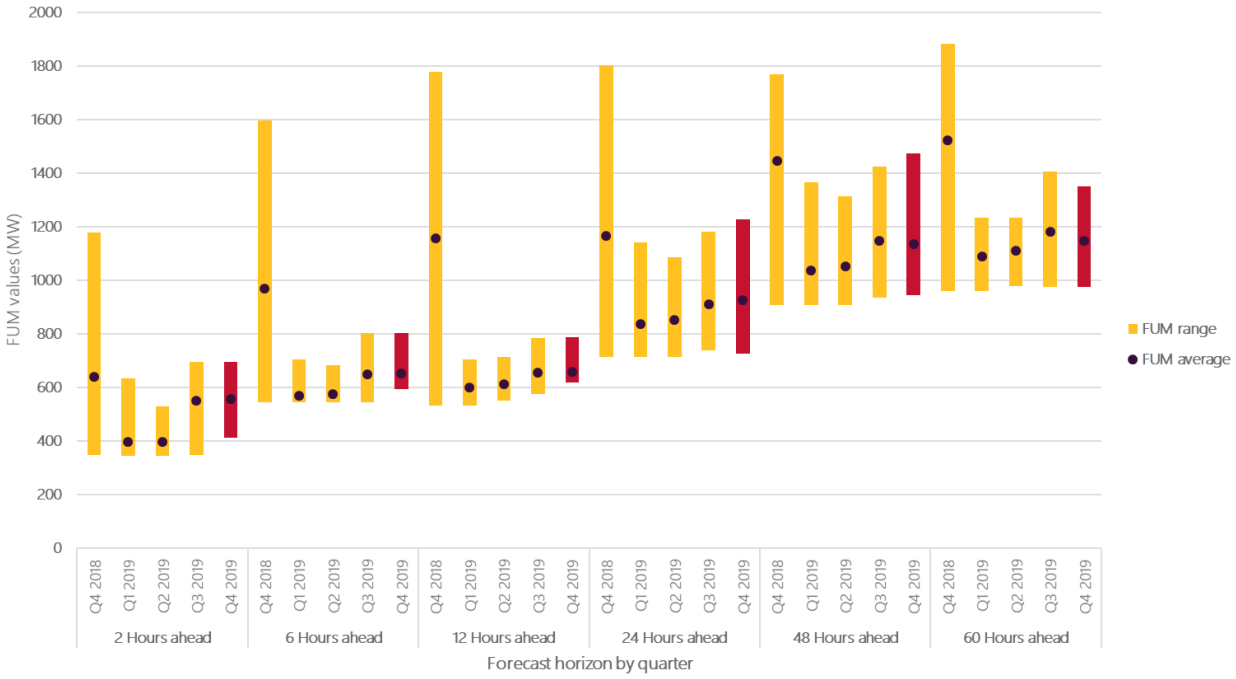


Figure 2 Queensland region: maximum, minimum, and average FUM values for the reporting period, and compared to previous four quarters

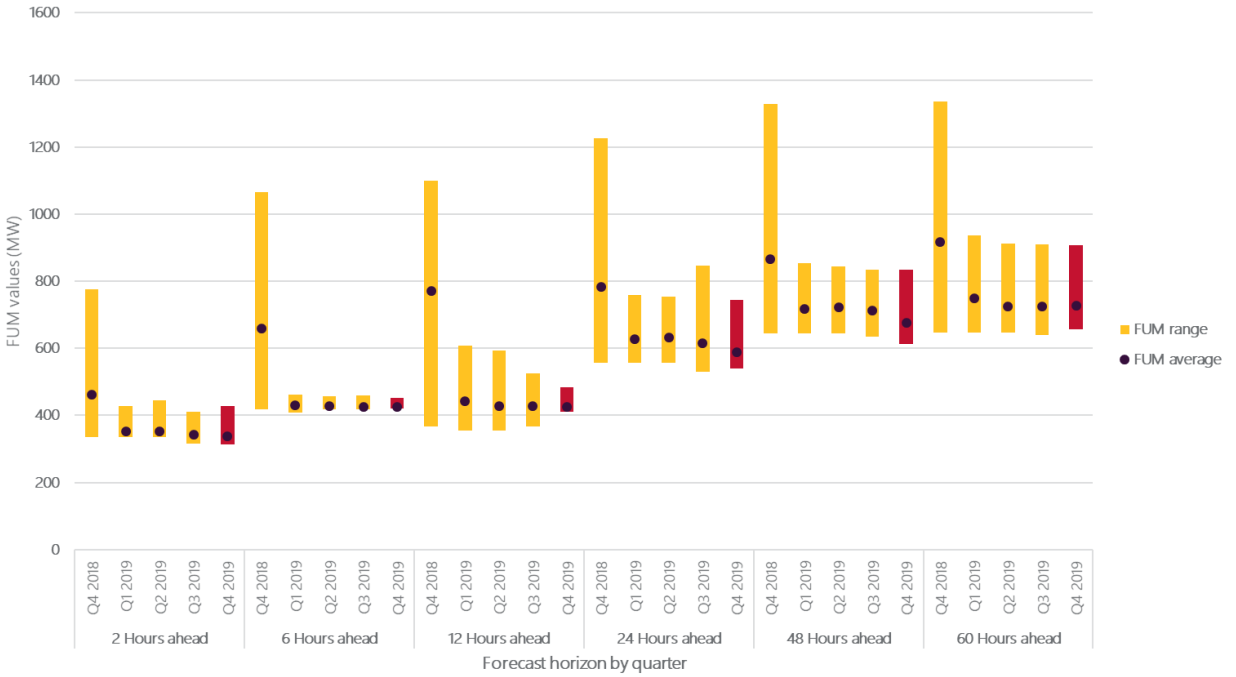


Figure 3 South Australia region: maximum, minimum, and average FUM values for the reporting period, and compared to previous four quarters

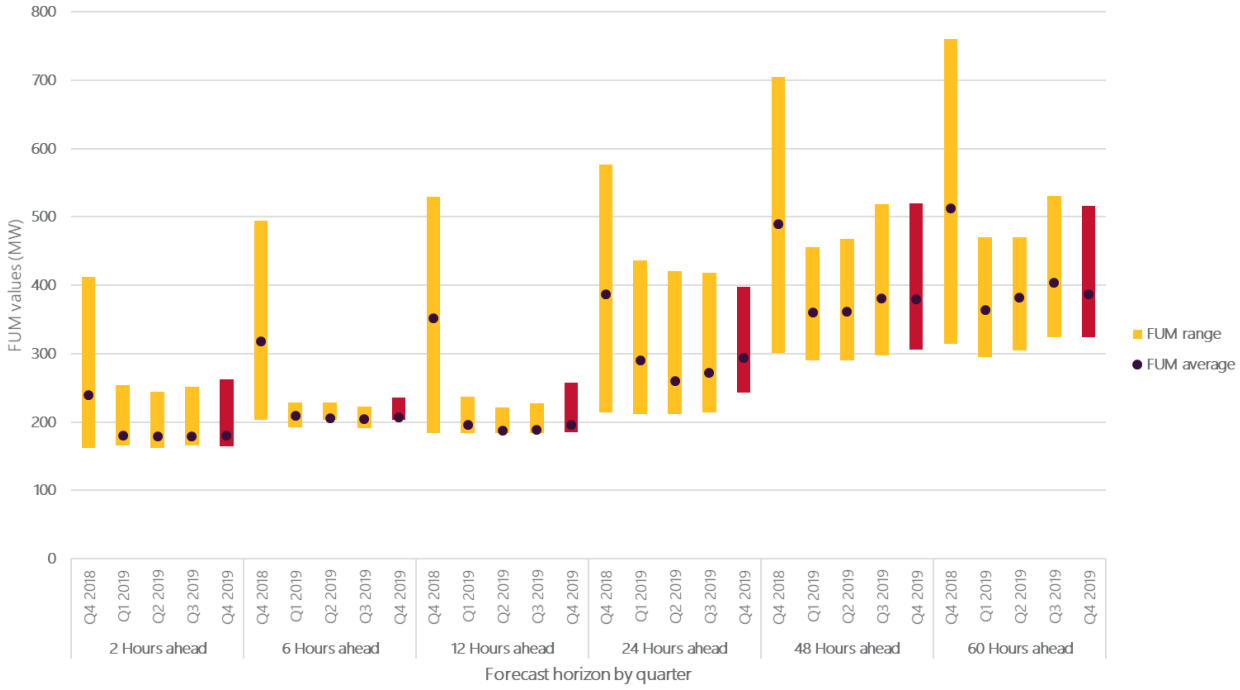


Figure 4 Tasmania region: maximum, minimum, and average FUM values for the reporting period, and compared to previous four quarters

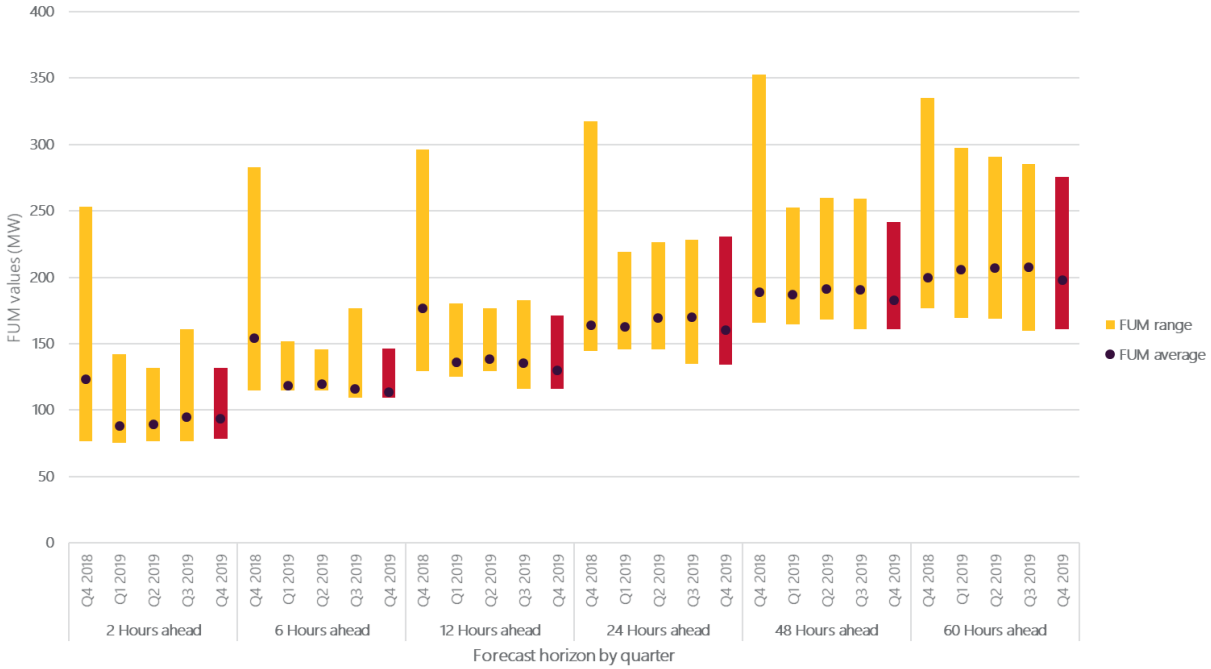
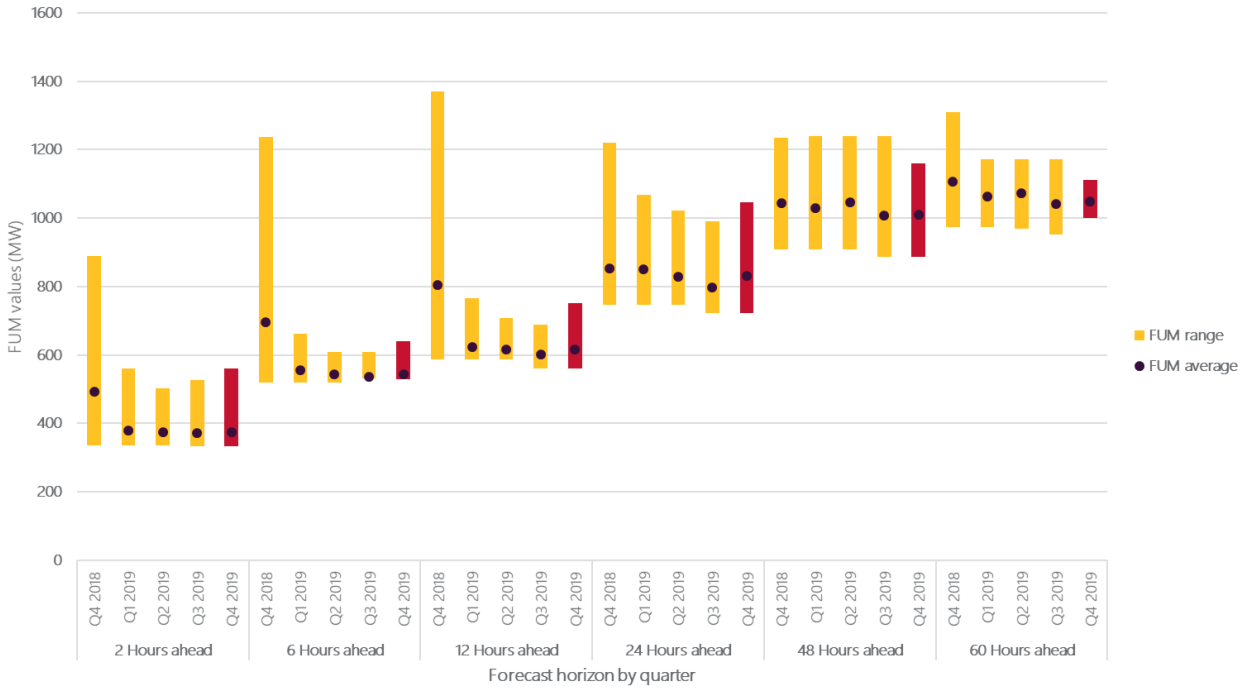


Figure 5 Victoria region: maximum, minimum, and average FUM values for the reporting period, and compared to previous four quarters



4.2 Forecast and actual LOR declarations

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

During the reporting period 1 October 2019 to 31 December 2019, there were 14 LOR declarations. Of these declarations, nine were forecast LOR declarations – five forecast LOR1 and four forecast LOR2 declarations. These do not include forecast LOR events that were later declared as actual LOR events, however do include forecast LOR1 events that were later updated to forecast LOR2 events, and LOR2 events that were later downgraded to LOR1 events.

On two effective dates, the forecast LOR1 conditions were subsequently updated to forecast LOR2 before later clearing. On one effective date, an event was first declared a forecast LOR2 before later being downgraded to a forecast LOR1, which was then declared as an actual LOR1 condition (refer MN 72188).

A total of five actual LOR events were declared in this reporting period. This included four actual LOR1 declarations and one actual LOR2 declaration. On 27 December 2019, an actual LOR1 was declared in South Australia without a prior declaration of forecast LOR1 or LOR2. This event occurred due to a sudden increase in forecast demand and decrease in net import just prior to the effective period. For all other actual LOR1 declarations, either a forecast LOR1 or LOR2 was declared prior to the event.

One actual LOR2 condition was declared in this reporting period. This declaration was made due to suspect inputs into PD PASA calculations. For more information on this event, see Section 4.5 of this report.

By comparison, zero actual LOR declarations were made in Quarter 3 2019, and one actual LOR declaration was made in Quarter 4 2018.

In addition, on 30 December 2019, AEMO activated additional capacity using Reliability and Emergency Trader (RERT), which assisted in clearing an existing forecast LOR2[6].

[6] The forecast LOR2 was initially declared in market notice 72143. An actual LOR2 condition existed in the 16:00 PD PASA run which was not declared via market notice due to rapidly changing conditions. The actual LOR2 cleared in the 16:30 PD PASA run and when reasonably practicable AEMO issued market notice 72169 declaring an actual LOR1 in Victoria.

4.3 LOR declaration of reserve requirement

The dates which contained LOR declarations, and the type of contingencies which set the reserve requirements for these declarations, are provided in Table 3.

Of the 14 LOR declarations in Quarter 4 2019:

- There were three conditions where the reserve requirement was set by the FUM (21%).
  - Three of the LOR2 declarations occurred when the FUM was setting the reserve requirement. These declarations were all issued within two days before their respective effective dates. For all three events, a contributing factor to their cancellation was a decrease in the FUM value as forecast horizon decreased.
  - The remaining two LOR2 conditions were declared on short notice, either due to suspect LOR events or due to unplanned transmission outages, therefore the FUM was either lower than the LCR or not applicable.
  - For comparison, in Quarter 3 2019, five of the 17 (29%) LOR conditions were set by the FUM, and in Quarter 4 2018, six of the 9 (67%) of LOR conditions were set by the FUM.
- For the remaining 11 conditions, the reserve requirement was set by either the LCR (for LOR2 conditions) or LCR2 (for LOR1 conditions).
  - All nine of the LOR1 declarations occurred when the reserve requirement was being set by the LCR2. One of these events was initially forecast when the FUM did not apply because the forecast horizon was greater than 72 hours[7].

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

Effective date	LOR1	LOR2	LOR3
New South Wales (NSW)			
30/10/2019	Forecast (two separate events)	Forecast	
31/10/2019	Forecast then Actual	Forecast	
Queensland (QLD)			
06/12/2019	Forecast then Actual		
07/12/2019	Forecast		
South Australia (SA)			
27/12/2019	Actual		
Victoria (VIC)			
18/12/2019	Forecast	Forecast	
20/12/2019	Forecast	Actual	
30/12/2019	Actual	Forecast	

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

[7] Refer to Market Notices 71819 and 71837.

4.4 Number and cause of LOR declarations

A total of 14 LOR conditions were declared during Quarter 4 2019. This is a decrease from Quarter 3 2019, where 17 LOR conditions were declared. While fewer LOR conditions were declared, this period saw five actual events occur, while last period saw none.

Quarter 4 2019 covered the later spring months and first month of summer. Conditions warmed through this period peaking in December which saw significant heatwaves across the National Electricity Market (NEM) and was among the 10 warmest Decembers on record[8]. In addition to high heat, this period also saw widespread bushfire activity impact the NEM. In some cases, the threat or direct impact of bushfires on the transmission network constrained generation and net imports, which consequently reduced reserves below LOR thresholds.

A total of 60 market notices related to LOR conditions were issued through this reporting period. Of these, 25 market notices were issued updating previously declared forecast or actual LOR conditions, reflecting the constantly changing conditions observed throughout the reporting period.

- New South Wales – five LOR declarations were made this reporting period, including one actual LOR1 event. These declarations were made earlier in the period (late October 2019) and were issued for effective periods when demand forecast was moderate. These events were mainly due to reduced generation availability and reduced net import into the region.
- South Australia – one actual LOR1 declaration was made this reporting period, which occurred without being forecast prior to the event. This was due to rapidly changing conditions just prior to the effective period which materially decreased reserve levels. These changes included an increase to the demand forecast and a decrease in net import. The effective period of the actual condition was one trading interval.
- Queensland – two LOR declarations were made this reporting period, including one actual LOR1 event. Both declarations were made in December for effective periods with very high forecast demand and reduced generation availability and net import.
- Victoria – six LOR declarations were made this reporting period, including one actual LOR1 and one actual LOR2 event. All declarations were made in December, and were influenced by extreme temperatures and bushfire activity impacting the network. The actual LOR2 declaration made on 20 December 2019 was due to a large difference between wind generation availability in PD PASA and actual wind generation (see Section 4.5). The actual LOR1 declaration made on 30 December 2019 was due to network constraints associated with unplanned transmission outages caused by bushfires.

Where forecast LOR conditions did not result in an actual LOR declaration, the main causes of the cancellations were increased generation availability and increased net import, and in some cases a reduction in forecast demand and reduction in FUM value.

4.5 Suspect LOR events

On 20 December 2019, an actual LOR2 condition was declared for Victoria without the event first being forecast in PD PASA[9].

On this day, extreme temperatures of up to 43°C were forecast in Melbourne, and temperatures exceeding 45°C were forecast for Northwest Victoria. Until 15:00 on the effective date, there were no LOR conditions forecast in PD PASA, and very high wind generation availability was expected across the peak demand period.

[8] Refer to the Bureau of Meteorology Annual Climate Statement for 2019: http://www.bom.gov.au/climate/current/annual/aus/#tabs=Overview

[9] Refer to Market Notice 71935 for declaration of actual LOR2 condition and Market Notice 71951 for cancellation of actual LOR2 condition.

From approximately 10:00, aggregate wind farm availability in PD PASA[10] and actual wind generation in Victoria[11] diverged, and actual generation was much lower than forecast availability. The difference between Pre Dispatch forecasts (30 minutes ahead) and actual generation was approximately 667 MW during the peak demand period.

This divergence was principally due to wind farm availability, submitted by market participants, not reflecting the observed high-temperature derating and cut out, and thus this unavailability was not reflected in AEMO's Pre Dispatch forecasts[12].

AEMO determined that the semi-scheduled availability input in PD PASA calculations was incorrect, resulting in suspect reserve conditions being forecast in PD PASA. As a result, AEMO used additional information to determine and declare an actual LOR2 for the effective period 17:15 to 18:30.

[10] Intermittent generator availability is submitted by market participants to the Intermittent Generation Availability section of AEMO's EMMS Participants Portal and is used to produce availability forecasts.

[11] Intermittent generator availability is used to determine Pre Dispatch forecasts for semi-scheduled generators. These forecasts may be less than generation availability, due to network constraints or market outcomes. In this event however, the principal difference between availability and actual generator output was not due to these factors but was due to high-temperature derating and cut out that was not communicated to AEMO.

[12] AEMO subsequently issued Market Notice 72015 reminding intermittent generators of their obligations under NER3.7B(b) to inform AEMO of their plant availability. AEMO is working with the Australian Energy Regulator (AER) to ensure intermittent generators comply with obligations.

Glossary

This document uses many terms that have meanings defined in the National Electricity Rules (NER). The NER meanings are adopted unless otherwise specified.

For each of the terms below, refer to the Guidelines for further information.

Term	Definition
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.
PD PASA	Pre-Dispatch Projected Assessment of System Adequacy