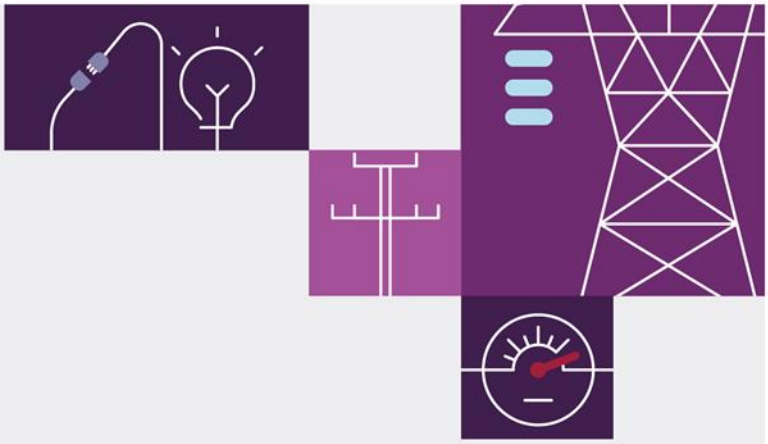
AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Ancillary Services Report for the WEM

June 2022



Important notice

Purpose

AEMO publishes the Wholesale Electricity Market Ancillary Services report under clause 3.11.13 of the Wholesale Electricity Market Rules (WEM Rules).

This publication has been prepared by AEMO using information available as at 25 May 2022. Information made available after this date may be included in this publication where practicable.

Disclaimer

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Version control

Version	Release date	Changes
1	31 May 2022	Submission to the ERA

AEMO acknowledges the Traditional Owners of country throughout Australia and recognises their continuing connection to land, waters and culture. We pay respect to Elders past, present and emerging.

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1 Introduction

Each year AEMO is required to publish an Ancillary Services report for the Wholesale Electricity Market (WEM), including the Ancillary Service Requirements for the next year and an Ancillary Services plan to meet those requirements.

1.1 Purpose

Clause 3.11.2 of the Wholesale Electricity Market Rules (WEM Rules) requires AEMO to update Ancillary Service Requirements on an annual basis. The Ancillary Service Requirements must be set based on the Facilities and configuration expected for the South-West Interconnected System (SWIS) in the coming year.

Clause 3.11.6 of the WEM Rules requires AEMO to submit the Ancillary Service Requirements to the Economic Regulation Authority (ERA) for approval.

Clause 3.11.11 of the WEM Rules states:

> *By 1 June each year, AEMO must submit to the Economic Regulation Authority a report containing information on:*
>
> *(a) the quantities of each of the Ancillary Services provided in the preceding year, including Ancillary Services provided under Ancillary Service Contracts, and the adequacy of these quantities;*
>
> *(b) the total cost of each of the categories of Ancillary Services provided, including Ancillary Services provided under Ancillary Service Contracts, in the preceding year; and*
>
> *(c) the Ancillary Service Requirements for the coming year and the Ancillary Services plan to meet these requirements.*

Clause 3.11.12 of the WEM Rules requires the ERA to audit the Ancillary Services plan.

Clause 3.11.13 of the WEM Rules requires AEMO to publish the Ancillary Services report (including the Ancillary Services Plan).

Clause 3.11.1 of the WEM Rules requires AEMO to determine all Ancillary Service Requirements in accordance with the SWIS Operating Standards and the Ancillary Service Standards.

The SWIS Operating Standards are defined as “the standards for the operation of the SWIS including the frequency and time error standards and voltage standards set out in clause 3.1”. Clause 3.1 of the WEM Rules states that the frequency, time error standards and voltage standards for a Network in the SWIS are as defined in the Technical Rules that apply to that Network.

While this report focuses on the requirements for 2022-23 and the plan to meet these requirements, it should be noted that as part of the government’s Energy Transformation Strategy, a key focus will be a move to co-optimised energy and Essential System Services. This will result in a clearer definition of services, improving the ability to determine requirements more accurately. It is also worth noting that the current requirement setting and approval process, including this report, will not be required in the new WEM.

1.2 Frequency performance for 2021-22

The Ancillary Service Standards are intended to enable AEMO to ensure the SWIS operates within normal frequency bands and to restore the SWIS to the normal frequency bands within the target recovery time following a contingency event.

There are different categories of frequency control Ancillary Services in the SWIS:

- The Load Following Service (LFAS) is used to continuously balance supply and demand.
  - While contingency reserves arrest the frequency change following a contingency event, LFAS will restore the frequency to 50 hertz (Hz)[1].
  - LFAS is dispatched using Automatic Generation Control (AGC).
  - Clause 3.10.1(a) of the WEM Rules sets the standard for LFAS as a level that is the greater of 30 megawatts (MW) and the capacity sufficient to cover 99.9% of the short-term fluctuations in load and output of Non-Scheduled Generators and uninstructed output fluctuations from Scheduled Generators.
  - While LFAS is provided by specific generators cleared in the LFAS Market for provision of this service, the above standard is also partially met by the governor droop response of all other synchronous generators.
- Spinning Reserve (SRAS) and Load Rejection Reserve (LRR) are relied on as contingency reserves to arrest a frequency change following the unplanned loss of generation or demand.
  - While some SRAS is provided by Interruptible Loads, SRAS and LRR are mostly provided using the governor droop response on specific synchronous generators able to maintain the response for the period of service.

Table 1 summarises the frequency operating standards for the SWIS as defined in the Technical Rules[2]. AEMO uses these frequency operating standards to assess SWIS frequency performance. The Normal Operating Frequency Band and the Credible Contingency Event Frequency Band of the Frequency Operating Standards in Appendix 13 of the WEM Rules, introduced from 1 February 2021, are aligned with these requirements.

Table 1 Frequency operating standards for the South-West Interconnected Network

Condition	Frequency band	Target recovery time
Normal range: South-West	49.8 to 50.2 Hz for 99% of the time	
Single Contingency Event	48.75 to 51 Hz	Normal range: within 15 minutes For over-frequency events: below 50.5 Hz within 2 minutes

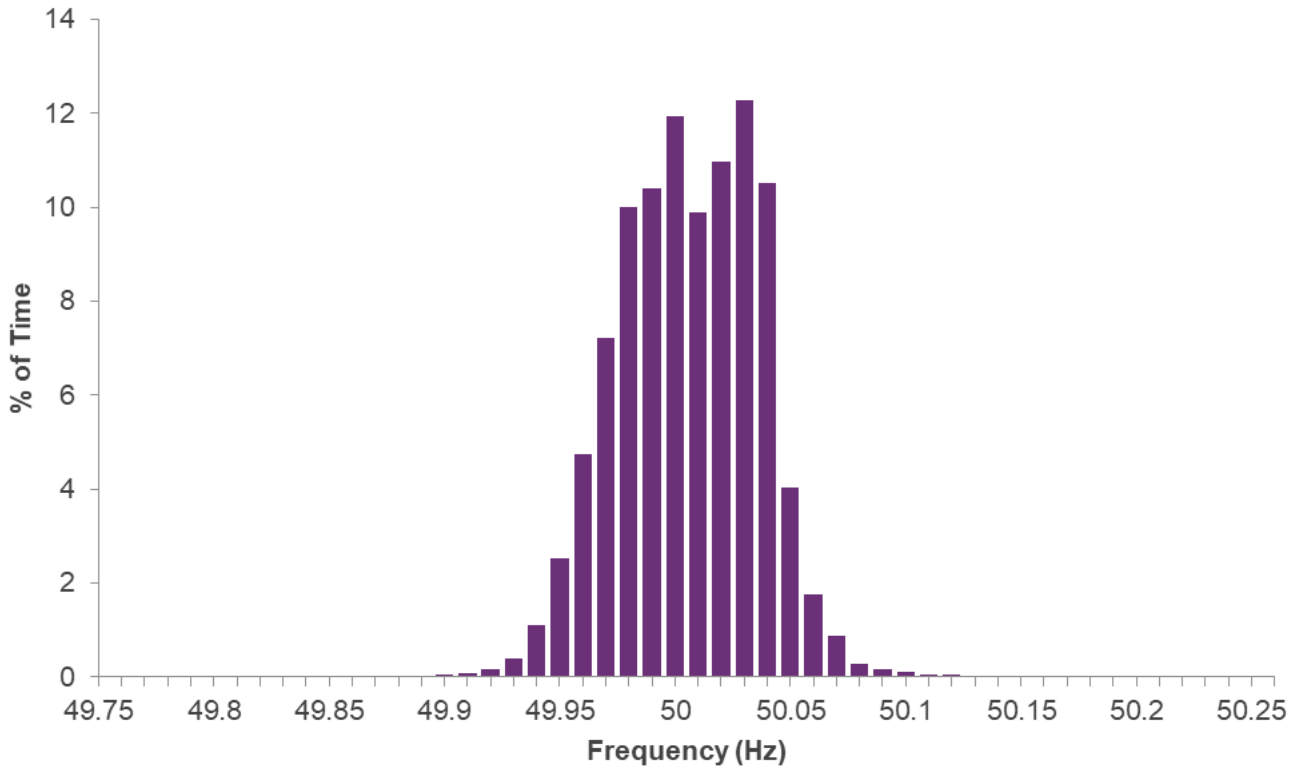
[1] Depending on the size of the contingency, rebalancing may be required to restore frequency to 50 Hz. Depending on the shortfall additional generation may be required. This additional generation might be in or out of merit depending on the timeframe of response required.

[2] Table 2.1 of the Technical Rules.

Figure 1 shows the frequency performance of the SWIS for the period under review (May 2021 to April 2022). The frequency remained in the normal operating band for 99.98% of the time. This meets the frequency operating standards specified in the WEM Rules and Technical Rules[3].

This performance was a product of the combination of active frequency control of the LFAS generators via AGC and the governor responses from all online generators.

Figure 1 Frequency performance of the SWIS from May 2021 to April 2022



[3] The analysis of LFAS quantities in Appendix A1 of this report illustrates the alignment between frequency keeping mechanisms use and LFAS requirements.

2 Ancillary Service Quantities

This section describes the quantity of each Ancillary Service provided in the preceding year and the adequacy of those quantities. The period of reporting is May 2021 to April 2022.

2.1 Overview

Clause 3.9 of the WEM Rules defines the following Ancillary Services:

- Load Following Service (LFAS);
- Spinning Reserve Service (SRAS);
- Load Rejection Reserve Service (LRR); and
- System Restart Service.

2.2 Load Following Service

The LFAS requirement approved for 2021-22 to be enabled for each Trading Interval was 110 MW LFAS Upwards and Downwards between 5:30 AM and 8:30 PM, and 65 MW LFAS Upwards and Downwards between 8:30 PM and 5:30 AM. This LFAS requirement was proposed by AEMO and approved by the ERA[4], subject to ongoing monitoring and assessment of adequacy of LFAS requirements.

In the WEM there are seven certified LFAS Resources from four Market Participants, in addition to the Balancing Portfolio.

AEMO enables specific Facilities to provide LFAS based on LFAS Market outcomes. A Facility may provide LFAS Upwards, LFAS Downwards, for both. If a non-Balancing Portfolio Facility is cleared in the LFAS Market, it is automatically enabled via AGC to provide LFAS Upwards or LFAS Downwards, or both, for the cleared quantity. It is therefore possible to specify the exact quantity of LFAS that is enabled from a non-Balancing Portfolio Facility.

The dispatch of the Balancing Portfolio, however, requires AEMO to manually select the Facilities. Balancing Portfolio Facilities enabled via AGC provide a combination of services, including LFAS and energy balancing services for the Balancing Portfolio. Therefore, each Facility in the Balancing Portfolio is enabled for its entire operating range, providing LFAS Upwards and LFAS Downwards depending on the output at the time[5]. Consequently, the LFAS contribution from individual generators in the Balancing Portfolio is not limited to a defined range, and the quantity of LFAS enabled may exceed the requirement.

[4] Refer to page 4 of the 2021 ERA decision for AEMO's Ancillary Services, at https://www.erawa.com.au/cproot/22038/2/202122-Ancillary-Service-audit-and-approval-report.PDF.

[5] See Appendix A1.1 of the 2019 Ancillary Services Report for further details, at https://www.aemo.com.au/-/media/files/electricity/wem/data/system-management-reports/2019-ancillary-services-report.pdf?la=en.

AEMO initially implemented LFAS quantities Upward and Downward of 100 MW during peak, with the view of moving to maximum peak requirement of 110MW through the approval period if the lower quantities were insufficient to manage short term fluctuations. The average quantity of LFAS Upwards and LFAS Downwards enabled by all providers in the reporting period is shown in Table 2.

Backup LFAS of up to 80 MW was utilised across 92 intervals[6,7] due to volatility in non-scheduled generation and rooftop distributed photovoltaic (DPV).

Based on the observed frequency performance, the quantity of LFAS provided during the reporting period was adequate.

Table 2 LFAS quantities from May 2021 to April 2022

	Requirement	LFAS Upwards	LFAS Downwards
Average quantity enabled[A] between 5:30 AM to 8:30 PM from 1 May 2021 up to 8:00 AM 15 July 2021	95 MW	113 MW	123 MW
Average quantity enabled between 8:30 PM and 5:30 AM from 1 May 2021 up to 8:00 AM 15 July 2021	70 MW	94 MW	98 MW
Average quantity enabled[A] between 5:30 AM to 8:30 PM from 8:00 AM 15 July 2021 up to 1 May 2022	100 MW[8]	110 MW	115 MW
Average quantity enabled between 8:30 PM and 5:30 AM from 8:00 AM 15 July 2021 up to 1 May 2022	65 MW	85 MW	89 MW
% of time requirement met[B]		99.41%	99.46%
Average number of minutes per day requirement not met		8.47 minutes	7.81 minutes
Frequency within normal operating range for > 99% of the time[C]	Met		

A. For non-Synergy providers, the quantity enabled is the LFAS Market cleared volume, while for Balancing Portfolio Facilities, it is the entire operating range of Synergy's Facilities enabled for LFAS. As such, the average quantities provided will likely equal or exceed the requirement. For this analysis, half of the quantity enabled for Balancing Portfolio Facilities is assumed to be LFAS Upwards and the other half is assumed to be LFAS Downwards.
B. While AEMO endeavours through its operational planning to have the required level of LFAS available at all times, real-time events result in less than 100% of this target being achieved.
C. Clause 3.1.1 of the WEM Rules states that the frequency and time error standards for a network in the SWIS are as defined in the Technical Rules that apply to that network. According to the Technical Rules, frequency should be within the normal band (49.8 Hz and 50.2 Hz) for 99% of the time.

2.3 Spinning Reserve Service

Clause 3.10.2(a) of the WEM Rules requires the standard for SRAS to be a level that is sufficient to cover the greater of:

1. 70% of the total output, including Parasitic Load, of the generation unit synchronised to the SWIS with the highest total output at the time; and
2. the maximum load ramp expected over a period of 15 minutes.

For 2021-22, SRAS was provided by Balancing Portfolio Facilities and by Interruptible Loads under two Ancillary Service Contracts. Generation Facilities in the Balancing Portfolio are not specifically enabled to provide SRAS. The available quantity from Balancing Portfolio Facilities is based on the spare capacity of

[6] There were a further 24 occasions where Backup LFAS was utilised when LFAS providers were unable to provide LFAS, however these are not indicative of a shortfall in LFAS requirements.

[7] The magnitude of Backup LFAS required to respond to specific events of volatility in non-scheduled generation and rooftop distributed photovoltaic (DPV) was significantly greater than the increase in LFAS requirements implemented.

[8] Operationally, the requirement remained at 100 MW as the approved 110 MW was not required to be enabled.

SRAS-capable Balancing Portfolio Facilities operating. The available quantity from a non-Balancing Portfolio Facility is based on the Ancillary Service Contract, which requires the non-Balancing Portfolio Facility to satisfy technical criteria and operate within a specific range. There was 62 MW provided under the two Ancillary Service Contracts. The SRAS requirement approved for 2021-22 was at least the maximum of:

- 70% of the largest generating unit; and
- 70% of the largest contingency event9 that would result in generation loss.

AEMO may relax the SRAS requirement by up to 12% where it expects a shortfall will be for a period of less than 30 minutes[10]. In the case of a shortfall of up to 12% for a period of less than 30 minutes, the availability of SRAS was compliant for 99.72% of the time with an average shortfall of 28.6 MW, which AEMO considers to be adequate.

AEMO's analysis of data for 2021-22 indicates that more than half the time when there was a shortfall in SRAS, it was because of LFAS Upwards being utilised[11]. The inclusion of LFAS in SRAS means it is likely there will be times when the available SRAS is less than the requirement, as some of the LFAS Upwards is utilised. In such situations, AEMO will assess the risk and, where necessary, take appropriate measures to minimise the risk to power system security.

The Spinning Reserve requirements and availability is shown in Table 3.

Table 3 SRAS availability May 2021 to April 2022

	Quantity
Highest minimum requirement (including the MARNET Contingency)[A]	300 MW
% of time requirement met[B]	99.72%
Average minutes per day requirement not met	4.10 minutes
Events resulting in a frequency excursion below 48.75 Hz[C]	0

A. For the 2021-22 financial year, the largest theoretical contingency in the SWIS was either the largest generator or MARNET Contingency, simultaneous with DPV tripping. It is anticipated that the highest minimum requirement will not increase materially from previous years and is regularly monitored for change.
B. While AEMO endeavours through its operational planning to have the required level of SRAS available, real-time events result in less than 100% of this target being achieved.
C. Clause 3.9.2 of the WEM Rules defines the purpose of SRAS as, among other things, to retard frequency drops following the failure of one or more generating works or transmission equipment. Table 2.1 of the Technical Rules sets the minimum frequency operating standard for a single contingency event as 48.75 Hz.

It is possible that if the largest contingency occurred when there was inadequate SRAS and there was no other available response from other generators on the system, under-frequency load shedding could occur. After WEM reform[12], the requirements for Contingency Raise (the current Spinning Reserve) will be separated from Regulation (the current LFAS Up). This will minimise the risk of this scenario occurring[13]. In the meantime, the

[9] Clause 3.11.1 of the WEM Rules requires AEMO to ensure that the Ancillary Service Standards meet the requirements of the SWIS Operating Standards. The WEM Rules definition of "SWIS Operating Standards" cross-refers to clause 3.1. Clause 3.1.1 states that the frequency and time error standards for a Network in the SWIS are as defined in the Technical Rules that apply to that Network. Clause 2.2.1(d) of the Technical Rules for Western Power's Network requires that the frequency operating standards must be satisfied, provided that there is no shortage of SRAS in accordance with clause 3.10.2 of the WEM Rules, without the use of load shedding under credible contingency events.

[10] Clause 3.10.2(c) of the WEM Rules.

[11] This relates to LFAS provided by generators that is counted towards SRAS under the WEM Rules.

[12] Wholesale market reforms being delivered under the WA Government's Energy Transformation Strategy.

[13] See http://www.wa.gov.au/sites/default/files/2019-12/Information%20Paper%20-%20ESS%20Scheduling%20and%20Dispatch%20_final.pdf.

Real-Time Frequency Stability tool[14] has been developed for AEMO's control room to assist in decision-making during these infrequent circumstances.

During the reporting period, 8 generator contingencies resulted in High-Risk Operating States or Emergency Operating States. No under-frequency load shedding events occurred during the reporting period.

Overall, the quantity of SRAS provided during the reporting period was adequate.

2.4 Load Rejection Reserve Service

LRR was provided by generation Facilities in the Balancing Portfolio that were capable of doing so. These generators are not specifically enabled to provide LRR. A generator can provide LRR when it is online, and its output is in the correct range. The quantity of the available reserve is determined by the generator's output and its ability to respond when the frequency increases.

AEMO's dynamic LRR[15], including setting the upper limit of the LRR requirement, is based on the largest credible contingency in real time[16]:

- allowing for the corresponding change in load because of an increase in frequency, known as load relief; and
- where required by the Network Operator as a requirement of connection to the SWIS, allowing for the operation of Facility protection systems in response to frequency increases.

The LRR requirement approved for 2021-22 was up to a maximum of 90 MW[17]. During the year, AEMO planned for 90 MW LRR in the planning horizon while operating with a dynamic requirement in real time. AEMO continues to consider additional interaction between dynamic LRR and frequency response to refine the dynamic LRR approach, as presented in Appendix A3.

The adequacy of LRR is described by the percentage of time that the quantity of LRR provided at each point in time was in the dynamic range in real time. Although adequate LRR was planned for and made available pre-dispatch, there were periods when the minimum requirement for LRR was not met in real time (approximately 2.72% of the time[18]). AEMO's analysis of data for 2021-22 indicates that more than half of the time when there was a shortfall in LRR, it was because of LFAS Downwards being utilised. This was a consequence of changes in power system conditions, particularly where variability in non-scheduled generation and load affected the availability of LFAS Downwards (which is considered as providing part of LRR).

The Load Rejection requirements and availability is shown in Table 4.

[14] A. Fereidouni, J. Susanto, P. Mancarella, N. Hong, T. Smit and D. Sharafi, "Online Security Assessment of Low-Inertia Power Systems: A Real-Time Frequency Stability Tool for the Australian South-West Interconnected System", ArXiV Preprint-, 2020, at https://arxiv.org/abs/2010.14016.

[15] Refer to Section 2.4 of the 2020 Ancillary Services report for a description of the dynamic LRR, at https://www.aemo.com.au/-/media/files/electricity/wem/data/system-management-reports/2020-ancillary-services-report.pdf?la=en.

[16] This has been set to a maximum of 120 MW.

[17] This is a dynamic requirement in response to a sudden drop of up to 120 MW load less a minimum of 30 MW load relief.

[18] This is an operational value calculated using 1 minute granularity.

Table 4 Load Rejection Reserve availability

	Quantity
Approved LRR requirement	Up to 90 MW
LRR requirement in planning horizon	90 MW
Real time LRR requirement	Dynamic LRR
% of time dynamic LRR requirement met	97.28%
% of time less than dynamic requirement was provided[A]	2.72%
Frequency excursions above 51 Hz[B]	0

A. While AEMO endeavours through its operational planning to have the required level of LRR available, real-time events result in less than 100% of this target being achieved.
B. Clause 3.10.4(a) of the WEM Rules requires the LRR standard to be a level sufficient to keep over-frequency below 51 Hz for all credible load rejection events.

Based on experience of past events and power system analysis, even when the quantity of LRR available was lower than the requirement the standard for LRR service was still met, as the frequency would not have exceeded 51 Hz for credible load rejection events.

During the reporting period there were no frequency excursions greater than 51 Hz. Overall, the quantity of LRR provided during the reporting period was adequate.

2.5 System Restart Service

The System Restart Service requirement for 2021-22 was three Facilities with system restart capability, to allow for one Planned Outage and one Forced Outage. There were three System Restart Ancillary Service Contracts in place during 2021-22 for three Facilities.

At least two services were always available during the reporting period.

No events occurred during the reporting period that required a system restart.

The System Restart availability has been shown in Table 5.

Table 5 System Restart Service availability

Services	Availability requirement[A]
Three Facilities with system restart capability	Met
At least two System Restart services planned to be available at all times[A]	Met

A. AEMO plans to ensure there are always at least two System Restart Services available to cater for a Forced Outage of one service.

3 Cost of Ancillary Services provided

Clause 3.11.11(b) of the WEM Rules requires this report to include the total cost of each Ancillary Service category provided in the preceding year. The period of reporting is April 2021 to March 2022[19].

The costs of Ancillary Services as calculated by AEMO for the period from 1 April 2021 to 31 March 2022 are set out in Table 6. This period reflects the most recently available settlement data, and costs are determined in accordance with the calculations specified in the WEM Rules. For comparative purposes, the costs of the previous reporting year are also provided.

In this Section 3, the reporting periods for 1 April 2020 – 31 March 2021 and 1 April 2021 – 31 March 2022, are referred to as 2020-21 and 2021-22 respectively.

Table 6 Ancillary Service costs for 2020-21 and 2021-22

Ancillary Service	WEM Rule	2020-21		2021-22		Difference in Cost ($)
		Quantities	Cost ($)	Quantities	Cost ($)	
LFAS total			73,545,446		66,792,637	-6,752,809
LFAS capacity	9.9.2(q)	85 MW Peak; 50 MW Off-Peak[A] 95 MW Peak; 70 MW Off-Peak[B]	9,323,182	95 MW Peak; 70 MW Off-Peak[C] 100 MW Peak; 65 MW Off-Peak[D]	8,323,075	-1,000,107
LFAS Upwards	9.9.2(a)	85 MW Peak; 50 MW Off-Peak[A] 95 MW Peak; 70 MW Off-Peak[B]	29,304,497	95 MW Peak; 70 MW Off-Peak[C] 100 MW Peak; 65 MW Off-Peak[D]	24,804,470	-4,500,027
LFAS Downwards	9.9.2(b)	85 MW Peak; 50 MW Off-Peak[A] 95 MW Peak; 70 MW Off-Peak[B]	34,917,767	95 MW Peak; 70 MW Off-Peak[C] 100 MW Peak; 65 MW Off-Peak[D]	33,665,092	-1,252,675

A. Quantities valid: 1 April 2020 to 24 September 2020. Peak & off-peak: 5:30am-7:30pm & 7:30pm-5:30am
B. Quantities valid: 25 September 2020 to 31 March 2021. Peak & off-peak: 5:30am-7:30pm & 7:30pm-5:30am
C. Quantities valid: 1 April 2021 to 14 July 2021. Peak & off-peak: 5:30am-7:30pm & 7:30pm-5:30am
D. Quantities valid: 15 July 2021 to 31 March 2022. Peak & off-peak: 5:30am-8:30pm & 8:30pm-5:30am

Ancillary Service	WEM Rule	2020-21		2021-22		Difference in Cost ($)
		Quantities	Cost ($)	Quantities	Cost ($)	
Spinning Reserve Ancillary Service (SRAS peak & SRAS off-peak)	9.9.2(f)	SRAS peak 235.40 MW[A] 252.03 MW[B] SRAS off-peak 236.40 MW[A] 240.66 MW[B]	14,105,743	SRAS peak 252.03 MW[C] 240 MW[D] SRAS off-peak 252.03 MW[C] 241 MW[D]	12,133,507	- 1,972,237
Contract Load Rejection Reserve (LRR)	9.9.4(a)	AEMO did not enter into any LRR Ancillary Service contracts.	-	AEMO did not enter into any LRR Ancillary Service contracts.	-	-

[19] The period is one month earlier than that used in Section 2. This reflects the most recently available settlement data.

Ancillary Service	WEM Rule	2020-21		2021-22		Difference in Cost ($)
		Quantities	Cost ($)	Quantities	Cost ($)	
Load Rejection Reserve (LRR)	9.9.1	Up to 90 MW	1,153,381	Up to 90 MW	5,697,349	4,543,968
Contract System Restart Service	9.9.4(a)	3 facilities	2,954,283	3 facilities	3,296,097	341,814
System Restart Service paid via Synergy AS Payment[E]	9.9.1	Default payment for the System Restart Service component via the Synergy AS Payment.	-	Default payment for the System Restart Service component via the Synergy AS Payment.	82,001	82,001
Total			91,758,854		88,001,590	-3,757,263

A. Quantities valid: 1 April 2020 to 30 June 2020
B. Quantities valid: 1 July 2020 to 31 March 2021
C. Quantities valid: 1 April 2021 to 30 June 2021
D. Quantities valid: 1 July 2021 to 31 March 2022
E. Default payment to Synergy for the System Restart Service component via the Synergy AS Provider Payment in accordance with clause 9.9.1 of the WEM Rules.

3.1 Load Following Service Costs

Load Following Ancillary Service (LFAS) is provided through a market mechanism, and LFAS availability costs are driven by the combination of prices offered by Market Participants and quantities cleared in the LFAS Market. The quantities cleared in the LFAS Market in each Trading Interval will be equal to the LFAS Requirement set by AEMO.

During the 2021-22 reporting year, LFAS Peak and LFAS Off-Peak timings were revised to include an additional hour of LFAS Peak requirement period in the evening; the transition from LFAS Peak to LFAS Off-Peak moved from 7:30pm to 8:30pm effective from 15 July 2021. On this day, LFAS Requirement quantities were also adjusted, increasing by 5 MW in the LFAS Peak period and reducing by 5 MW during LFAS Off-Peak period. These changes to LFAS requirements, along with the increased requirement quantities introduced in September 2020, meant the average LFAS requirement across both markets increased this reporting year compared to last, from 78 MW to 86 MW on average across all Trading Intervals.

The LFAS requirements for LFAS Up and LFAS Down services applicable for the 2020-21 and 2021-22 periods are shown in Table 7.

Table 7 LFAS Requirements for 2020-21 and 2021-22

			LFAS Up Quantities		LFAS Down Quantities	
Reporting Year	**Reporting Dates Impacted from**	**Reporting Dates Impacted to**	**LFAS Off-Peak**	**LFAS Peak**	**LFAS Off-Peak**	**LFAS Peak**
2020-21	1/04/2020	24/09/2020	50 MW	85 MW	50 MW	85 MW
	25/09/2020	30/06/2021	70 MW	95 MW	70 MW	95 MW
2021-22	1/04/2021	14/07/2021	70 MW	95 MW	70 MW	95 MW
	15/07/2021	31/03/2022	65 MW	100 MW	65 MW	100 MW

Note: Since the introduction of sculpted LFAS requirements in August 2019, LFAS Off-Peak was 7:30 PM to 5:30 AM, and LFAS Peak was 5:30 AM to 7:30 PM. On 15 July 2021, the evening transition time from LFAS Peak to LFAS Off-Peak shifted by one hour from 7:30PM to 8:30PM. From this date, LFAS Off-Peak is 8:30 PM to 5:30 AM and LFAS Peak is 5:30 AM to 8:30 PM.

In 2021-22, despite an increase in the average LFAS requirement, there was an overall net reduction in total LFAS enablement costs of $5.8 million compared to 2020-21. The key drivers for the reduction in total LFAS enablement costs were:

- LFAS Up costs decreased by $4.54 million in 2021-22 compared to 2020-21, due to decreases in the LFAS Up Prices during LFAS Off-Peak and LFAS Peak periods (Table 8). The average LFAS Up Price was consistently lower across all Trading Intervals in the Trading Day in 2021-22 compared to 2020-21 (Figure 2). The largest change in average weighted LFAS Up prices was observed during the LFAS Off-Peak period, decreasing by $7.22/MW.
- LFAS Down costs decreased by $1.25 million in 2021-22 compared to 2020-21, due to decreases in the LFAS Down Prices during the LFAS Off-Peak and LFAS Peak periods (Table 8).

Figure 2 LFAS Up/Down Prices by time of day

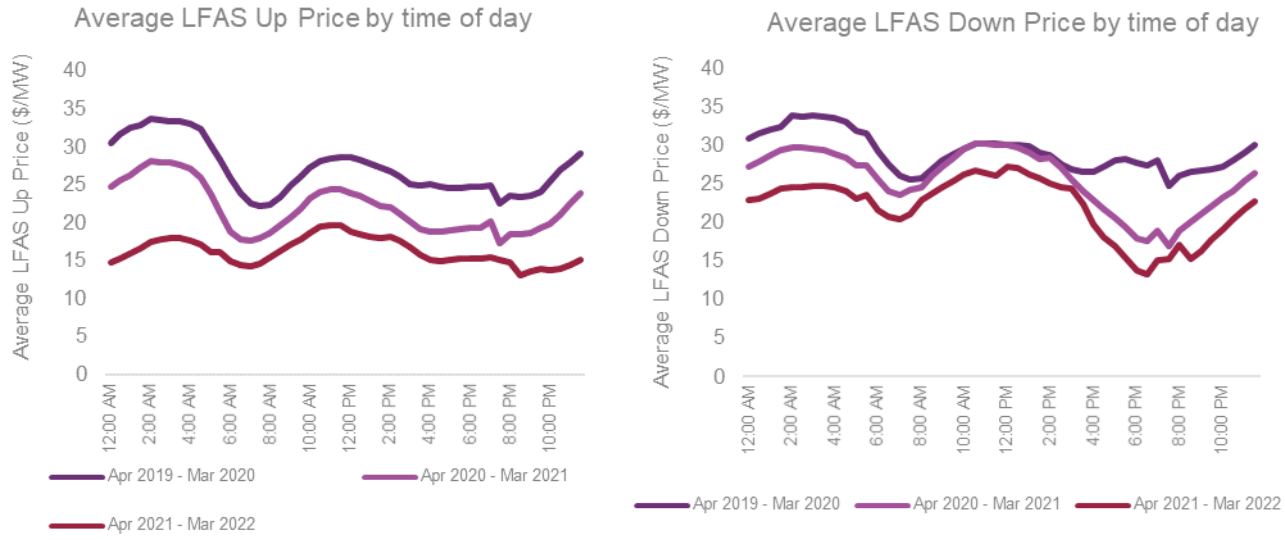


Table 8 Weighted Average LFAS Up/Down price ($/MW) during LFAS Peak and LFAS Off-Peak Periods

LFAS Market	Period	Unit	2020-21	2021-22	Change
LFAS Down	Off-Peak	$/MW	25.54	22.02	-3.52
LFAS Down	Peak	$/MW	25.53	21.94	-3.59
LFAS Up	Off-Peak	$/MW	23.00	15.78	-7.22
LFAS Up	Peak	$/MW	20.77	16.53	-4.24

Given that the average LFAS requirement increased compared to 2020-21, the key driver for lower LFAS cost were changes in prices offered by Market Participants. Figure 3 shows that the Synergy Balancing Portfolio remained the price setter in both LFAS Up and Down for the vast majority of Trading Intervals, however, the percentage of time the Balancing Portfolio set the price reduced from 97% to 93% and from 96% to 92% in LFAS Up and LFAS Down markets respectively.

Figure 3 LFAS Price Setting Facility

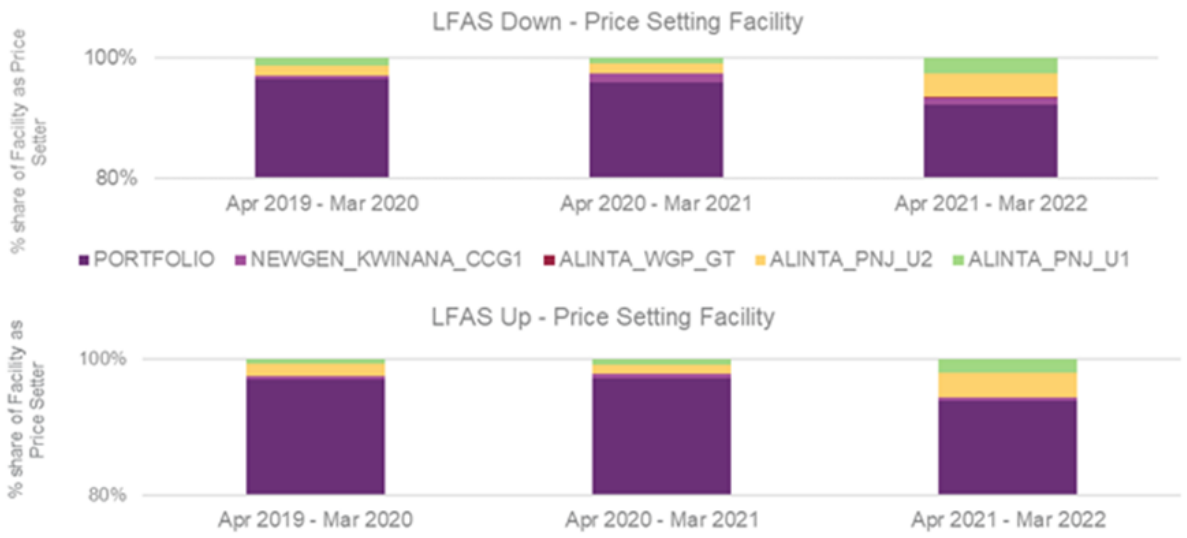
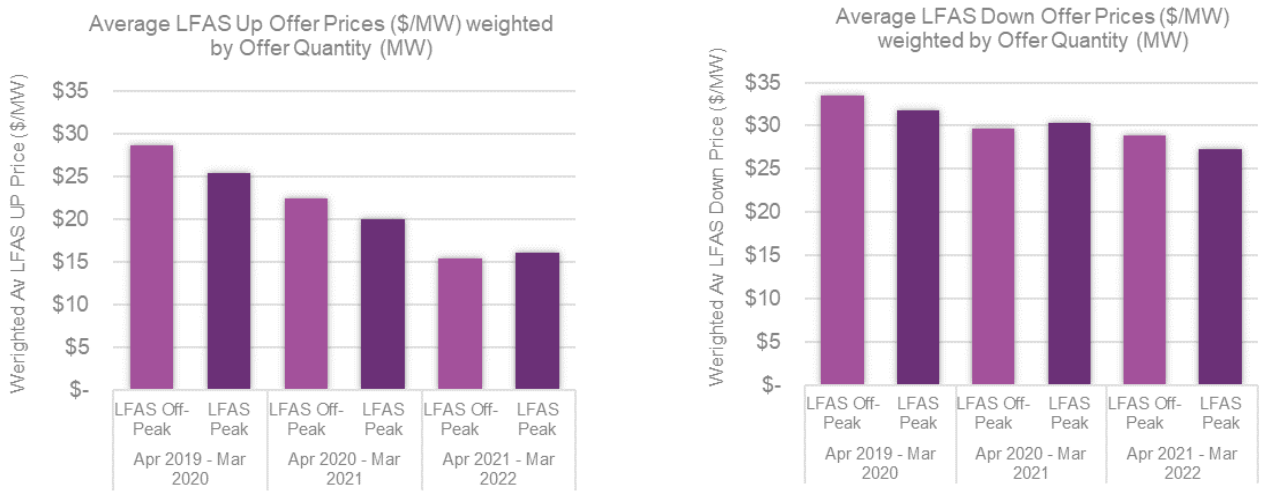


Figure 4 shows how the average LFAS offer prices[20] for both LFAS Up and LFAS Down has progressively decreased across LFAS Peak and Off-Peak times, since 2019-20. Lower average LFAS offer prices are resulting in lower LFAS Prices.

Figure 4 Average LFAS Offer Prices weighted by LFAS Offer Quantities



Backup LFAS may be used by AEMO from time to time when additional or replacement LFAS is required. Backup LFAS is provided by Synergy at a price nominated in its LFAS Submissions[21]. Backup LFAS enablement costs[22] increased by $465,678, from 2020-21 to 2021-22 reporting years, which was driven by the need to enable increased Backup LFAS quantities in this reporting year compared to last (Figure 5).

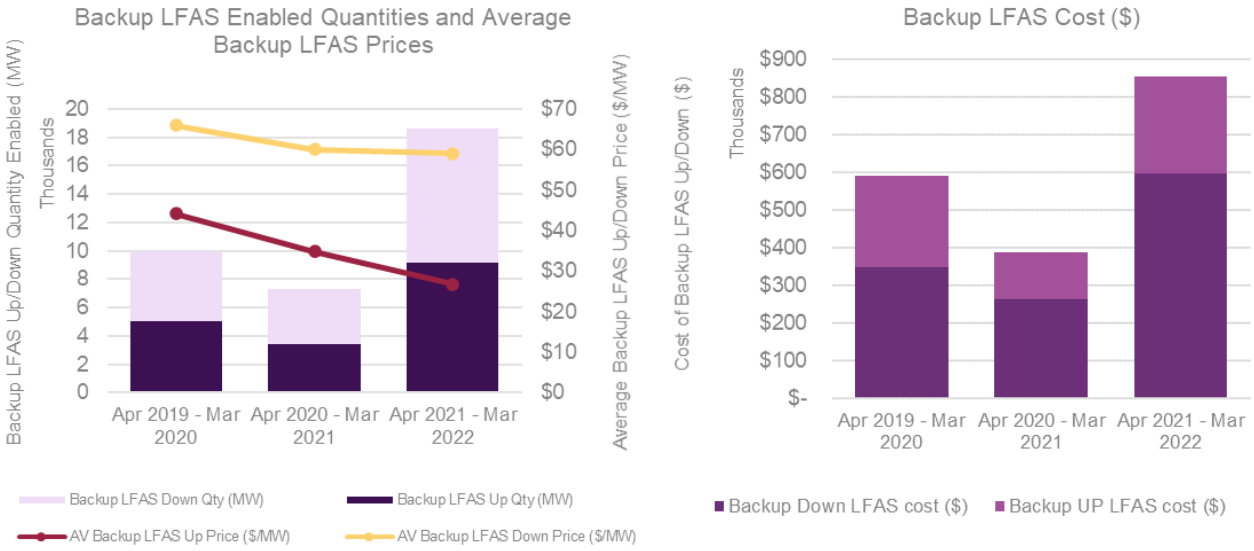
[20] Average LFAS offer prices included in Figure 4 are calculated using all LFAS Submissions, including those which did not clear in the respective Load Following Merit Order. These average LFAS Prices have been weighted by the offer quantity (MW).

[21] In accordance with clause 7B.2.6 of the WEM Rules.

[22] Backup LFAS costs have been included in the reported LFAS Upwards and LFAS Downwards costs for 2020-21 and 2021-22.

The increase in Backup LFAS costs had minimal impact on the overall decrease to LFAS costs, as Backup LFAS only comprised 1.0% of LFAS Up availability cost and 1.8% of LFAS Down availability costs in this reporting year.

Figure 5 Backup LFAS enabled and costs



The LFAS capacity cost is calculated by multiplying the LFAS Up capacity requirement by the administered Reserve Capacity Price[23]. In 2021-22, the decrease in LFAS capacity costs of $1,000,107 was due to the lower Reserve Capacity Price for the 2021 Capacity Year, which applied from October 2021[24].

3.2 Spinning Reserve Service Costs

SRAS costs include services provided by Synergy, as the default provider, and those provided under Ancillary Service Contracts. As the default provider of SRAS under the WEM Rules, Synergy receives an administered payment.

SRAS costs are driven predominantly by the Margin Values[25], which are determined by the ERA[26]. These set Margin Values are then applied to the Balancing Price for each Trading Interval. In accordance with the WEM Rules at the time of settlement, AEMO must apply the Margin Values and Balancing Price to the average SRAS requirement for peak periods and off-peak Trading Intervals assumed in the modelling performed for the Margin Values determination. The SRAS quantity attributed to Synergy for settlement of Trading Interval is calculated as the average SRAS requirement from Margin Values modelling and adjusted to subtract any available contracted SRAS quantity and subtract any LFAS Up quantity.

[23] In accordance with clause 9.9.2 of the WEM Rules.

[24] The administered Reserve Capacity Price ($/MW per year) for Capacity Year was: $78,573.33 (2021-22); $114,134.15 (2020-21), and $126,683.47 (2019-20).

[25] Margin_Peak, Margin_Off-Peak, SR_Capacity_peak and SR_Capacity_Off-peak.

[26] The Margin Values process is outlined in clause 3.13.3A of the WEM Rules. Further information on how SRAS costs are calculated is set out in clause 9.9.1 of the WEM Rules.

The SRAS quantity paid to other Market Participants is based on their negotiated SRAS contracts. Payment for these is also subject to the availability of the SRAS service and must be based on a contract price that is lower than Synergy's administered payment[27].

The Margin Values and SRAS requirement determined by the ERA[28] are set out in Table 9.

Table 9 Margin Values and SRAS Requirements determined by the ERA

Reporting Year	Reporting Dates Impacted from	Reporting Dates Impacted to	Margin Value % – Peak	Margin Value % - Off Peak	SR Requirement Peak MW	SR Requirement Off-Peak MW
2020-21	1/04/2020	30/06/2020	0.1732	0.1292	235.40	236.40
	1/07/2020	31/03/2021	0.2546	0.2142	252.03	240.66
2021-22	1/04/2021	30/06/2021	0.2546	0.2142	252.03	240.66
	1/07/2021	31/03/2022	0.126	0.232	240	241

SRAS costs decreased by $1.97 million for 2021-22 compared with 2020-21 (Table 10):

- SRAS peak costs decreased by $2.57 million for reporting year 2021-22 compared with 2020-21. This was predominately driven by the decrease in Margin_Peak values, with the time-weighted average Margin_Peak value decreasing from 0.2343 to 0.1581. Other factors impacting the decrease in SRAS peak costs were the time-weighted average SR Requirement across Peak Trading Intervals[29] decreasing by 4.88 MW in this reporting year compared to last year (Table 10) and the increased LFAS Up enabled quantities during LFAS Peak times in this reporting year. The LFAS Up and Backup LFAS Up enabled quantities are netted off from the SRAS requirement quantity when calculating the administered SRAS payment to Synergy.
- Conversely, SRAS off-peak costs increased by $595,767 for 2021-2022 compared with 2020-21. This increase was driven by the increase in the time-weighted average Margin_Off-Peak value, increasing from 0.193 to 0.2276 and increased SRAS requirement quantities in this reporting year (Table 10). Higher average Balancing Prices over the off-peak period (+$4.39/MWh) would have also placed upwards pressure on SRAS off-peak costs.

Further information on the drivers for changes in Spinning Reserve and Margin Values can be found in the ERA's determination of the Margin Values for Financial Year 2020-21[30] and 2021-22[31] respectively.

[27] In accordance with clause 3.11.8 of the WEM Rules.

[28] See https://www.erawa.com.au/electricity/wholesale-electricity-market/ancillary-services-parameters.

[29] Peak Trading Intervals occur between 8 AM and 10 PM and Off-Peak Trading Interval occur between 10 PM and 8 AM.

[30] See https://www.erawa.com.au/electricity/wholesale-electricity-market/ancillary-services-parameters/spinning-reserve-margin-peak-and-off-peak-load-rejection-reserve-and-system-restart-cost_lr/margin-peak-and-margin-off-peak-parameters-for-202021.

[31] See https://www.erawa.com.au/electricity/wholesale-electricity-market/ancillary-services-parameters/spinning-reserve-margin-peak-and-off-peak-load-rejection-reserve-and-system-restart-cost_lr/margin-peak-and-margin-off-peak-parameters-and-load-rejection-cost_lr-for-202122.

Table 10 Summary of Total SRAS Costs (contracted and uncontracted) and Input Variables from Settlements

Reporting Year	Reporting Dates Impacted from	Reporting Dates Impacted to	Total SRAS Costs for Market ($)	Time-weighted Average Margin Value %	Time-weighted Average SR Requirement (MW)	Average Balancing Price ($/MWh)
Peak						
2020-21	1/04/2020	31/03/2021	9,069,826	0.2343	247.88	50.03
2021-22	1/04/2021	31/03/2022	6,501,822	0.1581	243.00	55.75
Change from previous year			-2,568,005	-0.0762	-4.88	+5.72
Off-Peak						
2020-21	1/04/2020	31/03/2021	5,035,918	0.193	239.60	42.52
2021-22	1/04/2021	31/03/2022	5,631,685	0.2276	240.92	46.91
Change from previous year			+595,767	+0.346	+1.32	+4.39

3.3 System Restart Service and Load Rejection Reserve Service Costs

System Restart Service (SRS) costs increased by $423,815 in 2021-22 compared to 2020-21 (Table 11), with contracted SRS payments increasing by $341,814. The increase in contracted SRS payments in 2021-22 was driven by increased availability of SRS against the contracts when compared to 2020-21.

Synergy receives payments for System Restart Service through its role as the default Ancillary Services provider, which are calculated using the Synergy AS Provider Payment[32]. For a Trading Month, the SRS payment to Synergy through this mechanism is equal to the greater of zero or the net of the 'R' component in the Cost_LR parameter and the contracted SRS payments. In 2021-22, SRS payments via the Synergy AS Provider Payment increased by $82,001, up from $0 in the last reporting year. This increase is attributed to the increased value of the 'R' component of the ERA-determined COST_LR parameter (Table 11).

The Load Rejection Reserve (LRR) cost is calculated relative to the Cost_LR parameter less any payments for LRR contracts and SRS contracts[33]. AEMO did not enter into any LRR contracts for either 2020-2021 or 2021-2022. Instead, all LRR costs were paid to Synergy as the default provider and settled through the Synergy AS Provider Payment. Under clauses 9.9.1 and 9.9.3A of the WEM Rules, the LRR costs are relative to the Cost_LR parameter determined by the ERA and the contract System Restart Service costs. For a Trading Month, if the contracted System Restart Services costs exceed the 'R' component in the Cost_LR parameter determined by the ERA[34], it will result in a decrease in the LRR cost which is paid to compensate to Synergy as the default of LRR provider.

The LRR cost increased by $4,543,968 in 2021-22 compared to 2021-22 (Table 11) in line with the changes to the Cost_LR value and settlement equations. The LRR Payments to Synergy increased in 2021-22 due to the increase in both the 'L' and 'R' parameters in Cost_LR determined by the ERA. The value of the monthly net adjustment applied to LRR payments increased from -$71,869 in 2020-21 to -$133,901 in 2021-22. This

[32] In accordance with clause 9.9.1 of the WEM Rules.

[33] In accordance with clause 9.9.3A of the WEM Rules, any decrease to LRR costs which is caused by excess contract System Restart Service costs must be capped to monthly amount attributed to "L" component of the Cost_LR parameter.

[34] See https://www.erawa.com.au/electricity/wholesale-electricity-market/ancillary-services-parameters/spinning-reserve-margin-peak-and-off-peak-load-rejection-reserve-and-system-restart-cost_lr/margin-peak-and-margin-off-peak-parameters-and-load-rejection-cost_lr-for-202122.

increase was driven by higher contracted SRS payments in the October 2021 Trading Month, relative to the 'R' component of the Cost_LR parameter and to the rest of the reporting year.

Table 11 COST_LR Parameters, SRS and LRR Payments

Reporting Year	Cost_LR	'R' Component of Cost_LR	'L' Component of Cost_LR	Contracted SRS Payments	System Restart Service paid via Synergy AS Payment	Net adjustment applied to LRR payments[A]	LRR Payments[B]
2020-21[C]	$4,107,664	$2,882,414	$1,225,250	$2,954,283	$0.00	-$71,869	$1,153,381
2021-22 [D]	$9,075,447	$3,244,197	$5,831,250	$3,296,097	$82,001	-$133,901	$5,697,349
Change from previous year	$4,967,783	$361,783	$4,606,000	$341,814	$82,001	-$62,032	$4,543,968

A. Monthly net adjustment downwards made to LRR payments = min(0, ('R' Component of Cost_LR/12 months) – Monthly Contracted System Restart Service Costs).
B. LRR Payments is the sum of all Monthly LRR Costs, where Monthly LRR Costs = Max[0, min(0, ('R' Component of Cost_LR/12 months) – Monthly Contracted System Restart Service Costs) + ('L' Component of Cost_LR/12)]
C. The 2020-21 reporting year includes relevant monthly values from the ERA-approved Cost_LR, 'R' Component of Cost_LR and 'L' Component of Cost_LR from the 2019-20 and 2020-21 financial years.
D. The 2021-22 reporting year includes relevant monthly values from the ERA-approved Cost_LR, 'R' Component of Cost_LR and 'L' Component of Cost_LR from the 2020-21 and 2021-22 financial years.

3.4 Dispatch Support Service Costs

AEMO did not incur costs for Dispatch Support Service in 2021-22, as there were no Dispatch Support Service contracts. From 1 February 2022, clause 3.9.9 of the WEM Rules (which previously related to Dispatch Support Service) was repealed.

4 Ancillary Services Requirements for 2022-23

Clause 3.11.11(c) of the WEM Rules requires this report to include the Ancillary Services Requirements for the coming year, and the Ancillary Services plan to meet those requirements. Clause 3.11.12 of the WEM Rules requires the ERA to audit this plan.

Clause 3.10 of the WEM Rules defines the Ancillary Services Standards. Clause 3.11.1 of the WEM Rules requires that AEMO determine all Ancillary Service Requirements in accordance with the SWIS Operating Standards (defined in clause 3.1 of the WEM Rules) and the Ancillary Services Standards.

AEMO proposes that the requirements considered for 2022-23 be maintained from 1 July 2023 – 30 September 2023, before the commencement of the new market. AEMO will engage with the ERA on the appropriate mechanism to finalise requirements for this three-month period.

4.1 Load Following Service

As indicated in Section 2.2 of this report, from a power system security perspective, the provision of LFAS for the previous year has been adequate for frequency control. The response from generators providing LFAS has increased, attributed predominantly due to increasing rooftop DPV penetration on the SWIS. This trend is expected to continue through 2022-23. Although not currently actively procured, additional sources of frequency response, like droop, contribute to the ability to manage frequency within the normal operating band. Although the volatility of rooftop DPV generation and wind generation has increased, Power System Security continues to be maintained.

While no new facilities have been commissioned since the start of 2021, new intermittent generation and increasing rooftop DPV connections[35] have caused increased volatility in recent years, and this trend is expected to continue. AEMO's analysis of LFAS utilisation during the year[36] and operational experience from 2021-22, indicated an increasing trend in complete utilisation, particularly of LFAS Down (also contributing to increased periods of small shortfalls in LRR). In the 2021 Ancillary Report, AEMO determined that volatility uncertainty may result in a need for a further 10 MW of LFAS as a contingency buffer. As conditions unfolded, AEMO was not required to utilise this buffer.

Assessment shows that the minimum requirement for LFAS at peak is 120 MW (Appendix A1). As per the analysis presented in Appendix A1, the baseline Frequency Keeping Mechanism (FKM) continues to rise because of increasing underlying volatility. Although the FKM enables adequate frequency performance to be maintained, increasing duration of frequency away from 50 Hz increases the probability that a contingency will result a frequency exceedance.

[35] Approximately 334 MW of rooftop distributed PV was installed in 2021, sourced at http://www.cleanenergyregulator.gov.au/RET/Forms-and-resources/Postcode-data-for-small-scale-installations/historical-postcode-data-for-small-scale-installations.

[36] See Appendix A1 of this report

As a result, the proposed new requirements are an increase in 10 MW during peak periods, up to 120 MW Upwards/Downwards between 5:30 AM and 8:30 PM. A staged approach is again proposed to reduce the initial impact but enable necessary quantities to be procured if required. As such 110 MW will initially be implemented with an increase to 120 MW if assessment indicates it is necessary.

It was also evident in this analysis that there has been no substantial change in LFAS requirements between 8:30 PM and 5:30 AM, and this can be maintained at 65 MW.

Appendix A1 of this report contains further supporting information related to the calculation of the LFAS requirement.

The following LFAS requirement is proposed for 2022-23:

1. LFAS Upwards up to 120 MW between 5:30 AM and 8:30 PM, 65 MW between 8:30 PM and 5:30 AM.
2. LFAS Downwards up to 120 MW between 5:30 AM and 8:30 PM, 65 MW between 8:30 PM and 5:30 AM.

The new requirement will be implemented in a staged approach, with 110 MW initially implemented between 5:30 AM and 8:30 PM for both LFAS Upwards and LFAS Downwards. AEMO will monitor the adequacy of current LFAS requirements and assess whether further adjustments are required.

4.2 Spinning Reserve Service

The SRAS requirement must meet the SWIS Operating Standards and the Ancillary Service Standards. The SWIS Operating Standards require that the frequency remains within the band of 48.75-51 Hz for a single contingency event. Clause 3.10.2(a) of the WEM Rules requires the standard for SRAS to be a level that is sufficient to cover the greater of:

1. 70% of the total output, including Parasitic Load, of the generation unit synchronised to the SWIS with the highest total output at the time; and
2. the maximum load ramp expected over a period of 15 minutes.

The 2021 Ancillary Services Report considered the Spinning Reserve requirement as either the largest generator lost, or MARNET contingency combined with 10% DPV tripping. AEMO continues to re-evaluate contributing factors. Consequently, the largest contingency consideration has been revised for the 2022-23 period.

In determining Spinning Reserve quantities, the new methodology determines the largest contingency by combining the largest generation output with the net DPV[37] tripped. The largest contingency event that would result in generation loss may be the net DPV tripped during a voltage disturbance or the loss of generation simultaneous with the net DPV tripped during the fault. Further analysis conducted across the year resulted in better estimates of both DPV and load tripping, for various fault types[38]. The estimate of DPV tripping due to contingencies is regularly refined by AEMO with input from Western Power.

[37] The net DPV is the difference between DPV tripping and underlying load that is expected to be tripped for a given fault type at that location.

[38] Review of net DPV contribution is presented in Appendix A1 of this report.

AEMO continues to investigate the impact of rooftop DPV disconnection and will continue to manage SRAS to match the operational conditions for power system security.

The maximum load ramp over a 15-minute period during the last year, during a rooftop distributed PV cloud cover event, was 299 MW. This is a 50 MW increase from the 249 MW maximum load ramp over a 15-minute period reported in the 2021 Ancillary Services Report. The magnitude and timing of these cloud cover events is difficult to forecast accurately and is managed in real-time by the Control Room. For SRAS planning, AEMO will consider the forecast maximum load ramp and if greater than the expected spinning reserve quantity, will adjust the spinning reserve quantity accordingly.

The SRAS requirement proposed for 2022-23 is at least the maximum of:

1. 70% of the largest generating unit;
2. 70% of the largest contingency event that would result in generation loss; and
3. The maximum load ramp expected over a period of 15 minutes[39].

4.3 Load Rejection Reserve Service

The LRR Requirement must meet the SWIS Operating Standards and the Ancillary Service Standards. The SWIS Operating Standards[40] require that frequency be maintained below 51 Hz and be restored below 50.5 Hz within two minutes following a single contingency event. Clause 3.10.4(a) of the WEM Rules requires the standard for LRR to be the level sufficient to keep over-frequency below 51 Hz for all credible load rejection events (this requirement may be relaxed by up to 25% if AEMO considers that the probability of transmission faults is low).

LRR provides a power system response to a sudden drop in load. The mandatory generator governor droop response capability required by the Technical Rules for all generators operating above their minimum stable load will also act to mitigate the loss of load as the frequency initially increases.

While the largest credible load contingency has previously been 120 MW, operational experience has seen network expansions and increased load in the Eastern Goldfields region. Under specific operating conditions the largest credible load rejection event has increased up to approximately 150 MW. This is the loss of a bulk transmission line feeding the Eastern Goldfields region.

AEMO continues to utilise a dynamic LRR requirement. This dynamic LRR calculation previously incorporated elements of load relief (change in load because of increase in frequency) and Facility protection systems. Additional analysis suggests this calculation can be further revised to consider the demonstrated over-frequency responses of online generating facilities that have shown a consistent response to high frequency events as well as droop response from online Non-Scheduled Generators, which provides further relief. Thus, the proposed LRR is to consider the actual largest credible load contingency and incorporate elements of load relief, Facility protection schemes, and demonstrated response from generators to over-frequencies.

Considering the likely largest contingency, the underlying load relief combined with the known response of selected generating facilities which will respond to the largest contingency, the dynamic requirement is

[39] Maximum load contingency catered for will be based on the expected load ramp on a day-ahead basis.

[40] See clause 2.2.1 and Table 2.1 of the Technical Rules, and Chapter 3B of the WEM Rules.

expected to be a similar magnitude of LRR quantity as was required in previous years, as shown in Appendix A3.

Other factors that may justify a lower LRR requirement, such as the contribution of DPV response, are currently being investigated and may be considered during the year if it is possible to sufficiently validate the impact on the dynamic LRR quantity.

The proposed LRR requirement for 2022-23 is a maximum of 97 MW[41].

4.4 Dispatch Support Service

From 1 February 2022, clause 3.9.9 of the WEM Rules (which previously related to Dispatch Support Service) was repealed. Therefore, Dispatch Support Service will not feature in future reports.

4.5 System Restart Service

AEMO requires three System Restart Facilities, to ensure service provision following a failure of one Facility while another is undergoing a Planned Outage. The three system restart facilities should not be in the same location, to mitigate the risk of common failure in the same geographic or electrical area.

The proposed System Restart Service requirement for 2022-23 remains three Facilities with system restart capability.

[41] This is a dynamic requirement in response to a sudden drop of up to 150 MW load. Analysis is presented in Appendix A3.

5 Ancillary Services Plan for 2022-23

5.1 Load Following Service

To meet the requirements for 2022-23, LFAS will be sourced through the LFAS Market up to the values shown in Section 4.1 of this report. AEMO will implement process changes to implement the new LFAS thresholds as follows:

1. Maintain existing approach and quantities until step 2 below is implemented;
2. Implement the first phase of the new LFAS requirements as soon as practicable; and
3. Increase the requirements up to the approved quantities if deemed necessary.

As considered under clause 7B.4.1 of the WEM Rules, AEMO will continue to utilise Backup LFAS when the requirements introduced through DPV or Non-Scheduled Generation volatility result in the LFAS requirements being greater than the quantity for the Trading Interval.

The cost of LFAS will depend on the clearing price in the LFAS Market.

5.2 Spinning Reserve Service

For 2022-23, SRAS will be sourced as follows:

1. 42 MW will be sourced from a long-term Interruptible Load contract.
2. An additional quantity is expected to be sourced42 from a short-term Spinning Reserve contract at a discount to the Synergy administered price.
3. The remainder of the real-time requirements will be provided by the Balancing Portfolio, including a possible component from the Kwinana Battery Energy Storage System.

There is an emerging risk due to increased penetration of DPV, which contributes significantly to contingency sizes when tripping in consequence of credible contingencies involving network or generator faults occurs. The impact of DPV tripping in response to power system disturbances may not be fully mitigated through existing mechanisms under the WEM Rules (specifically Spinning Reserve and intervention in dispatch outcomes). AEMO's analysis indicates that there is a risk that AEMO will be unable to operate the power system securely under certain operating conditions, and that, in the event of a contingency, involuntary load shedding may occur. AEMO's assessment of this emergent risk identified a trigger condition under clause 3.11A.2A(a) of the WEM Rules.

AEMO submitted a trigger request to the Coordinator of Energy in accordance with 3.11A.3 of the WEM Rules proposing to procure 100 MW of Fast Frequency Response (FFR) to mitigate this risk until October 2023. The Coordinator of Energy, in response to AEMO's request, triggered the NCESS procurement in accordance with 3.11A.4 of the WEM Rules on 28 April 2022. The need for Spinning Reserve is not varied by procuring FFR service, as FFR will only be enabled for specific intervals in addition to the expected available Spinning Reserve at the time.

[42] The commercial process is underway to source a short-term Spinning Reserve contract for 2022-23.

5.3 Load Rejection Reserve Service

A maximum of 97 MW of LRR will be provided by the Balancing Portfolio. AEMO will use a dynamic LRR requirement in real time[43].

5.4 System Restart Service

The existing three System Restart contracts will continue to apply for 2022-23. The North Metro and South Metro contracts expire in June 2026, and the South Country contract expires in October 2028.

5.5 Summary of Ancillary Services plan for 2022-23

Table 12 Summary of Ancillary Services requirements and plan to procure for 2022-23

	Requirement	Compared to previous year	Method to procure	Cost
LFAS Upwards	Up to 120 MW between 5:30 AM and 8:30 PM 65 MW between 8:30 PM and 5:30 AM	• No change to peak and off-peak timing definitions. • Additional 10 MW LFAS requirement during peak time to address increasing volatility due to increasing rooftop PV penetration. • No change to LFAS requirement during off-peak time as volatility is expected to be consistent with the experience this year.	LFAS Market	LFAS Market clearing price
LFAS Downwards	Up to 120 MW between 5:30 AM and 8:30 PM 65 MW between 8:30 PM and 5:30 AM	• No change to peak and off-peak timing definitions. • Additional 10 MW LFAS requirement during peak time to address increasing volatility due to increasing rooftop PV penetration. • No change to LFAS requirement during off-peak time as volatility is Expected to be consistent with the experience this year.	LFAS Market	LFAS Market clearing price
SRAS	At least the maximum of • 70% of largest generating unit and • 70% of largest contingency event that would result in generation loss. • the load ramp expected over a period of 15 minutes	Consideration of largest contingency event that would result in generation loss has been refined with increased information related to the net DPV tripping during a fault. Large load ramps will continue to be monitored day ahead but managed in real-time by the Control Room.	42 MW from long-term interruptible load contract	Contract price
			Quantity from short-term contracts currently being finalised	Contract price as discount of Synergy administered price
			Remainder provided by Balancing Portfolio	Administered price to be paid based on the ERA's Margin Values determination.
LRR	Up to 97 MWA	Increase in the maximum dynamic LRR requirement	A maximum of 97 MW of LRR is expected to be provided by the Balancing Portfolio.	Annual price paid based on the ERA's Cost_LR determination for 2022-23
System Restart Service	Three Facilities	Unchanged	Contracts with three providers	Contract price

A. AEMO will plan for 97 MW but use a dynamic LRR requirement in real time.
B. Based on day ahead forecast values.

[43] The administrative payment to provide this service for FY22 has been determined through Cost_LR.

A1. LFAS requirement calculation

Clause 3.11.1 of the WEM Rules requires AEMO to determine all Ancillary Service Requirements in accordance with the SWIS Operating Standards (defined in clause 3.1 of the WEM Rules) and the Ancillary Services Standards. The standard for LFAS is defined in clause 3.10.1 of the WEM Rules as the level sufficient to provide Minimum Frequency Keeping Capacity, where the Minimum Frequency Keeping Capacity is the greater of:

- 30 MW; and
- the capacity sufficient to cover 99.9% of the short-term fluctuations in load and output of Non-Scheduled Generators and uninstructed output fluctuations from Scheduled Generators, measured as the variance of 1 minute average readings around a 30-minute rolling average.

Consistent with the discussion in previous Ancillary Services Reports[44], AEMO considers the results of the methodology in clause 3.10.1(a)(ii) of the WEM Rules to be inefficient and not accurately represent current operational practices, including the 10-minute dispatch cycle. As a result, in previous years AEMO utilised the approach taken for the new WEM[45] to determine the LFAS requirements. This approach is also aligned with the methodology AEMO utilised to determine the increased requirements during 2020-21 and 2021-22, which was approved by the ERA.

The methodology calculates the generator response, referred to as Frequency Keeping Mechanism (FKM), to maintain frequency. This is a combination of response from the Balancing Portfolio and generator providing LFAS. Through calculation of the underlying FKM, AEMO determines the real system response to frequency deviations, not just LFAS enabled services.

A similar analysis as presented in the 2021 Ancillary Services Report[46] was performed to assess the LFAS quantities utilising the sculpted methodology. Data was separated into peak/off-peak periods and the quantities of FKM being utilised in each interval was observed. Due to challenges in obtaining a consistent data source for the entire 12-month period, data was compared for the period it was available. This shorter period is during summer, and the magnitude of FKM use due to DPV volatility and variability of Non-Scheduled Generation will err on the lower side due to typically clearer and less volatile weather.

AEMO's analysis indicated that, as expected, there is an increasing trend of FKM utilisation during peak times and a relatively consistent amount compared to 2021 values during off-peak times. This is an uplift in the baseline requirement during peaks and is necessary together with the use of Backup LFAS to respond to specific events of increased volatility.

The outcome is presented in Table 13, which contains the average FKM quantities (Upwards and Downwards). The table shows that the average FKM used each year is increasing overall. There was a considerable increase in the requirement for FKM from October 2020 onwards (both peak and off-peak) which can be

[44] Refer to Appendix A3.1, at https://www.aemo.com.au/-/media/files/electricity/wem/data/system-management-reports/2019-ancillary-services-report.pdf?la=en.

[45] Refer to the Frequency Control Technical Arrangements Information paper, at https://www.wa.gov.au/sites/default/files/2019-08/Information-paper-Frequency-Control-Technical-Arrangements.pdf.

[46] Refer to Appendix A1 at https://www.aemo.com.au/-/media/files/electricity/wem/data/system-management-reports/2021-ancillary-services-report.pdf?la=en.

attributed to the connection of new wind and solar facilities in that period. The continued increase in underlying requirement for FKM use during peak periods is due to ongoing connection of new DPV.

Table 13 Sculpted frequency keeping mechanism requirements

Analysis periods	Peak (5:30 AM to 8:30 PM)[A]	Change in Peak	Off-peak (8:30 PM to 5:30 AM)	Change in off-peak
Oct 2018 to Feb 2019	81 MW		56 MW	
Oct 2019 to Feb 2020	97 MW	16 MW	61 MW	6 MW
Oct 2020 to Feb 2021	122 MW	26 MW	78 MW	17 MW
Oct 2021 to Feb 2022	128 MW	6 MW	75 MW	-3 MW

A. Prior to 15 July 2021, the evening transition from peak to off-peak was 7.30pm for LFAS sculpting purposes.

The historical analysis in Table 13 indicates the increased requirements to respond to increasing volatility. During the 2022 summer period[47], it was found that an average increase of 6MW of FKM was required to manage system frequency during the peak periods, which is an increase in the baseline level of LFAS required. It is noted that the dataset analysed took place over the summer period, where there is less volatility, while more volatility is expected across the year requiring more FKM for frequency regulation. The data from this analysis (together with annual analysis for previous periods) and operational experience related to the contribution of droop response to frequency control, is used to develop the LFAS requirements.

Based on the data analysed above, it is recommended to increase the peak LFAS quantity by 10 MW to 120 MW. Due to the negligible change in off-peak average use, and noting minimal system changes impacting off-peak operations, the off-peak quantity is recommended to remain at 65 MW.

[47] Due to the migration of AEMO's Energy Management System in October 2021, data is not easily available for comparison in the March to September periods. The available subset was used for analysis purposes and presented in this Appendix.

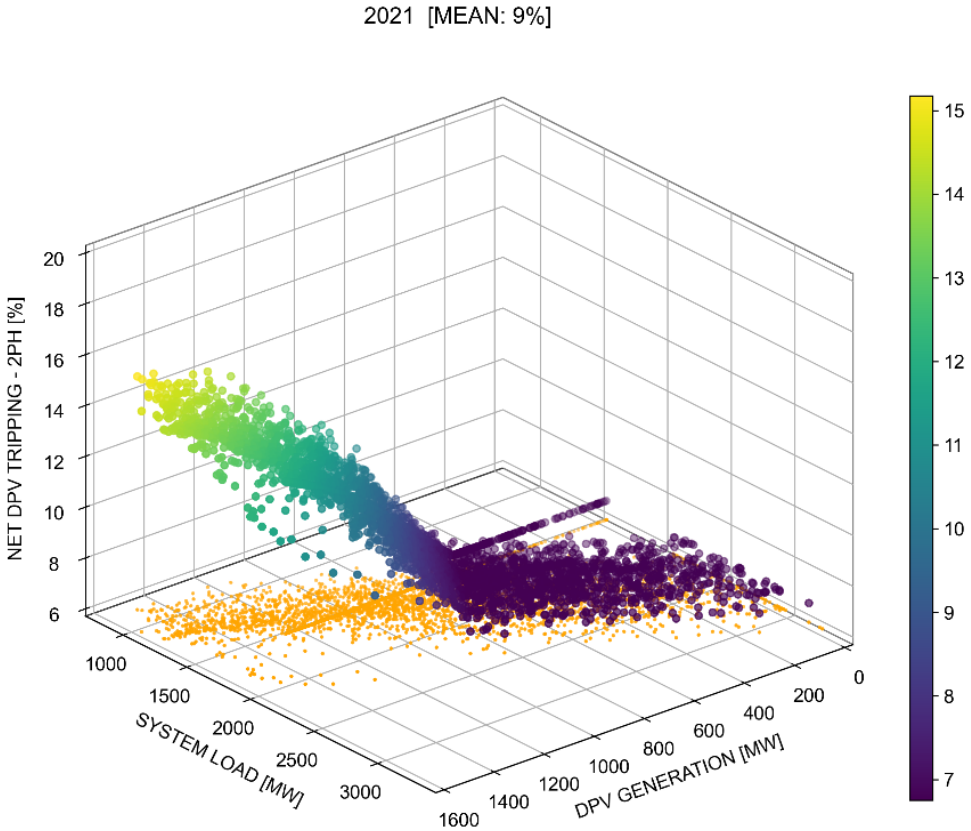
A2. Spinning Reserve requirement calculation

The requirement of Spinning Reserve in real-time as presented in previous Ancillary Service Reports was either to respond to the largest generation lost, or the MARNET Contingency simultaneous with 10% DPV tripping. This calculation has been reviewed for the 2022-23 period to reflect the increasing impact of DPV on system security following a credible contingency.

AEMO has revised the calculation of Spinning Reserve requirement in real-time so that it is more reflective of the wider system response to a contingency, which includes both DPV and underlying load tripping. The new calculation considers the net contribution of DPV by also subtracting underlying load that trips. The net DPV is then combined with the largest generation output lost in real-time to determine the total Spinning Reserve requirement.

Figure 6 represents the new (net DPV) calculation method which dynamically calculates the DPV tripped based on system load and DPV generating. At lower underlying system loads with high DPV, the additional Spinning Reserve required to accommodate net DPV lost during a contingency is higher. Conversely, at higher system loads, which also implies lower DPV, the Spinning Reserve requirement is lowered. On average, the historical analysis across 2021 yielded an average net DPV loss of 9%.

Figure 6 Contribution of DPV tripping relative to system load

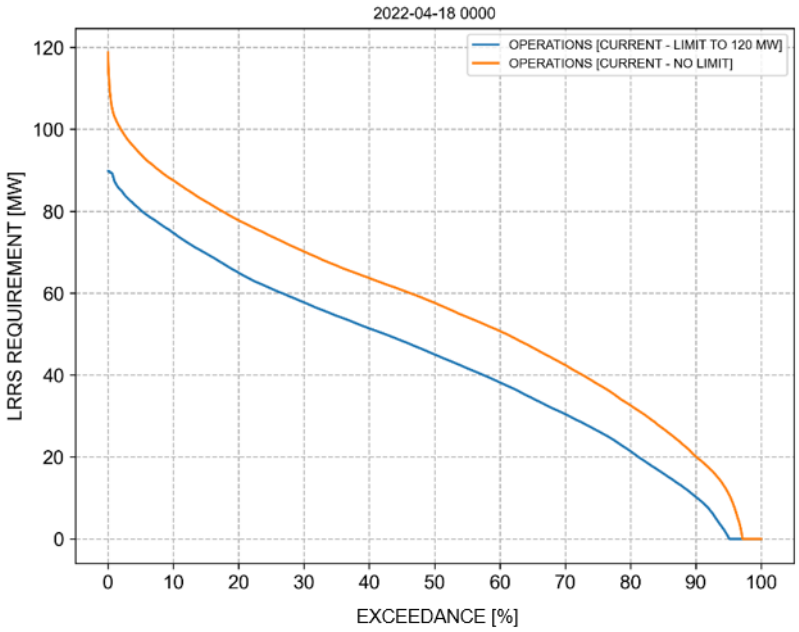


Note: the orange dots at the base are not data points. It represents the 'shadow' of the 3D points above, for visibility purposes.

A3. Load Rejection Reserve requirement calculation

Load Rejection Reserve requirements have historically been based on the largest credible load contingency, less any load relief and specific Facility protection systems. In 2022, the Eastern Goldfields (EGF) transfer limit was increased[48], resulting in a larger power transfer capability and consequently the possibility of larger load rejection requirements. Figure 7 shows the duration curve of Load Rejection Reserve requirements since January 2022 that considers the actual load transfer to the EGF and compares the previous LRR requirements, less load relief/protection systems.

Figure 7 Duration curve of LRR requirement



As seen in Figure 7, the increased EGF power transfer resulted in a higher maximum dynamic LRR requirement. When comparing the dynamic LRR requirements before and after the increase, the new requirement was within 90MW for 93% of the time of the analysis period.

In addition to load relief, further analysis has yielded that response from Generation with proven over-frequency response can be considered in the determination of the dynamic LRR requirements. Based on operational experience and historical dispatch, AEMO expects the reduction in LRR requirements to be at least 22.9 MW through known facilities' droop response.

By incorporating the known factors, it is expected that the LRR requirement will be a maximum of 97 MW, which will continue to be calculated dynamically in real-time.

[48] Estimated power transfer of up to 150 MW into EGF. Data analysis presented in Figure 7 represents approximately 3 months of data since the increase in January 2022.