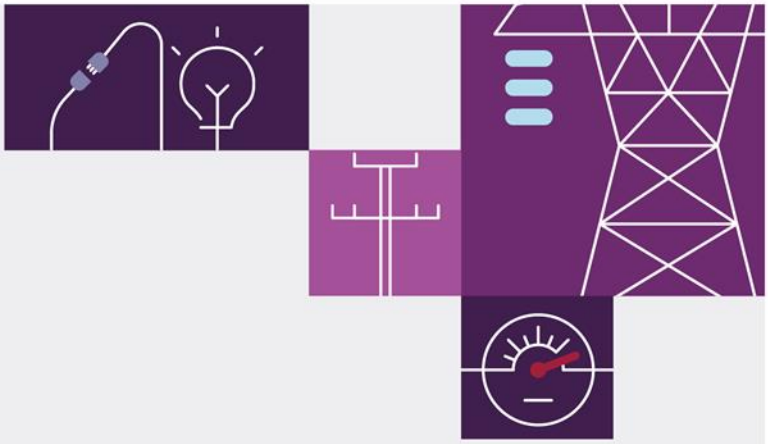
AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Ancillary Services Report for the WEM

June 2023



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 1 May 2023. 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	23 May 2023	Submission to the ERA
2	31 May 2023	Correction of values in Table 8 and Figure 4.

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 in the WEM Rules 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.

This report focuses on the performance of the existing Ancillary Services and the plan to meet the requirements of the current Ancillary Services up until the New WEM Commencement Day (NWCD) on 1 October 2023. Once the new WEM has commenced, the existing suite of Ancillary Services will be replaced by Essential System Services (ESS) as part of the WEM’s transition to Security-Constrained Economic Dispatch (SCED), designed to better value the services required to manage the power system in coming years. For the purpose of this report, the Ancillary Services requirements and plan for 2023-24 will apply from the start of the 2023-24 financial year until the NWCD in October 2023.

1.2 Frequency performance for 2022-23

The Ancillary Service Standards are intended to enable AEMO to operate the SWIS within the normal operating frequency bands of the SWIS Operating Standards and to restore the SWIS to the normal operating 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 Ancillary 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 and demand, respectively.
  - 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 WEM as defined in Appendix 13 of WEM Rules.

Table 1 Frequency Operating Standards for the WEM

Condition	Contain Band (Hz)	Stabilise (Hz)	Recover (Hz)
Normal Operating Frequency Band	49.8 to 50.2 Hz (99% of the time over any rolling 30-day period)	N/A	N/A
Normal Operating Frequency Excursion Band	49.7 to 50.3 Hz	49.8 to 50.2 Hz within 5 minutes	N/A
Credible Contingency Event Frequency Band	48.75 to 51 Hz	For over-frequency events: below 50.5 Hz within 2 minutes	49.8 to 50.2 Hz within 15 minutes
Island Separation Frequency Band	48.75 to 51 Hz	For over-frequency events: below 50.5 Hz within 2 minutes	49.8 to 50.2 Hz within 15 minutes
Extreme Frequency Tolerance Band	47 to 52 Hz (reasonable endeavours)	48.0 to 50.5 Hz within 5 minutes (reasonable endeavours) and: For under-frequency events: above 47.5 Hz within 10	49.8 to 50.2 Hz within 15 minutes (reasonable endeavours)

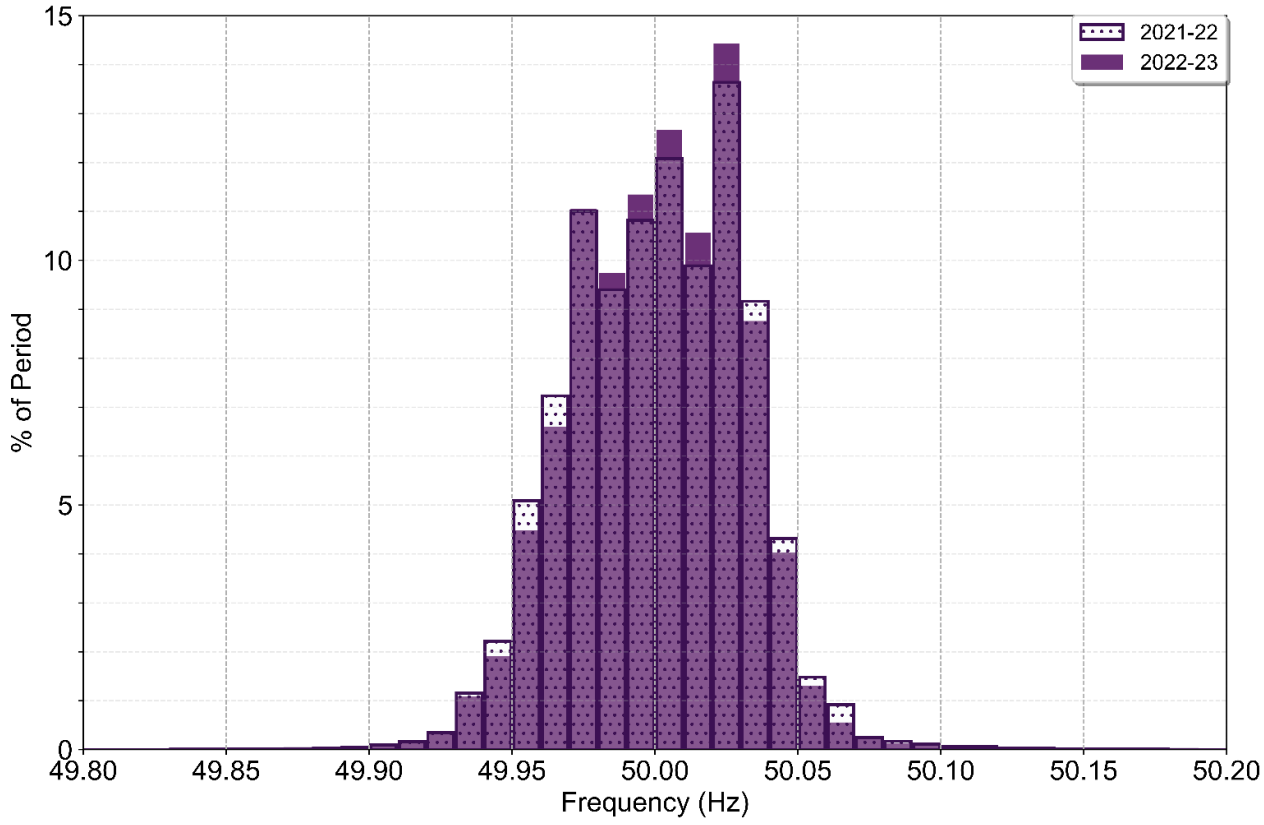
[1] Depending on the size of the contingency, rebalancing may be required to restore frequency to 50 Hz. Depending on the shortfall, additional generation may be required. This additional generation might be in or out of merit depending on the timeframe of response required.

Condition	Contain Band (Hz)	Stabilise (Hz)	Recover (Hz)
		seconds (reasonable endeavours). For over-frequency events: below 51.5 Hz within 1 minute; and below 51 Hz within 2 minutes (reasonable endeavours)	
Rate of Change of Frequency Safe Limit	0.25 Hz over any 500 millisecond period	N/A	N/A

Figure 1 shows the frequency performance of the SWIS for the period under review (May 2022 to April 2023) with a comparison against the previous Ancillary Services reporting period (May 2021 to April 2022). As can be seen in the figure, the frequency performance improved during the more recent period, with a higher percentage of the time where frequency was closer to 50.0 Hz. This is in part due to higher Spinning Reserve quantities than previous years, and the increased percentage assigned to the 50.02 – 50.03 Hz band is attributed to the over-frequency droop responses of intermittent generation facilities. 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[2].

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 2022 to April 2023



[2] The analysis of LFAS quantities in Appendix A1 of this report illustrates the alignment between frequency keeping mechanisms used 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 2022 to April 2023.

2.1 Overview

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

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

2.2 Load Following Ancillary Service

The approved LFAS requirement for 2022-2023 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.

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, or 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[3]. 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.

AEMO transitioned to the updated LFAS quantities Upward and Downward of 110 MW during peak, from 6 July 2022 following the publishing of the 2022-23 Ancillary Services report. The average quantity of LFAS Upwards and LFAS Downwards enabled by all providers in the reporting period is shown in Table 2.

[3] 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.

Backup LFAS of up to 80 MW was utilised across 23 intervals[4,5,6] 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 2022 to April 2023

	Requirement	LFAS Upwards	LFAS Downwards
Average quantity enabled[A] between 5:30 AM to 8:30 PM from 1 May 2022 up to 8:00 AM 6 July 2022	100 MW	125 MW	133 MW
Average quantity enabled[A] between 8:30 PM and 5:30 AM from 1 May 2022 up to 8:00 AM 6 July 2022	65 MW	94 MW	96 MW
Average quantity enabled[A] between 5:30 AM to 8:30 PM from 8:00 AM 6 July 2022 up to 1 May 2023	110 MW	130 MW	135 MW
Average quantity enabled[A] between 8:30 PM and 5:30 AM from 8:00 AM 6 July 2022 up to 1 May 2023	65 MW	98 MW	101 MW
% of time requirement met[B]		99.89%	99.90%
Average number of minutes per day requirement not met		1.56 minutes	1.48 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 2022-23, 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 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

[4] Compared to 92 intervals in 2022 Ancillary Services report.

[5] There were a further 56 intervals (compared to 24 intervals in 2022 Ancillary Services report) where Backup LFAS was utilised when LFAS providers were unable to provide LFAS, however these are not indicative of a shortfall in LFAS requirements.

[6] 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.

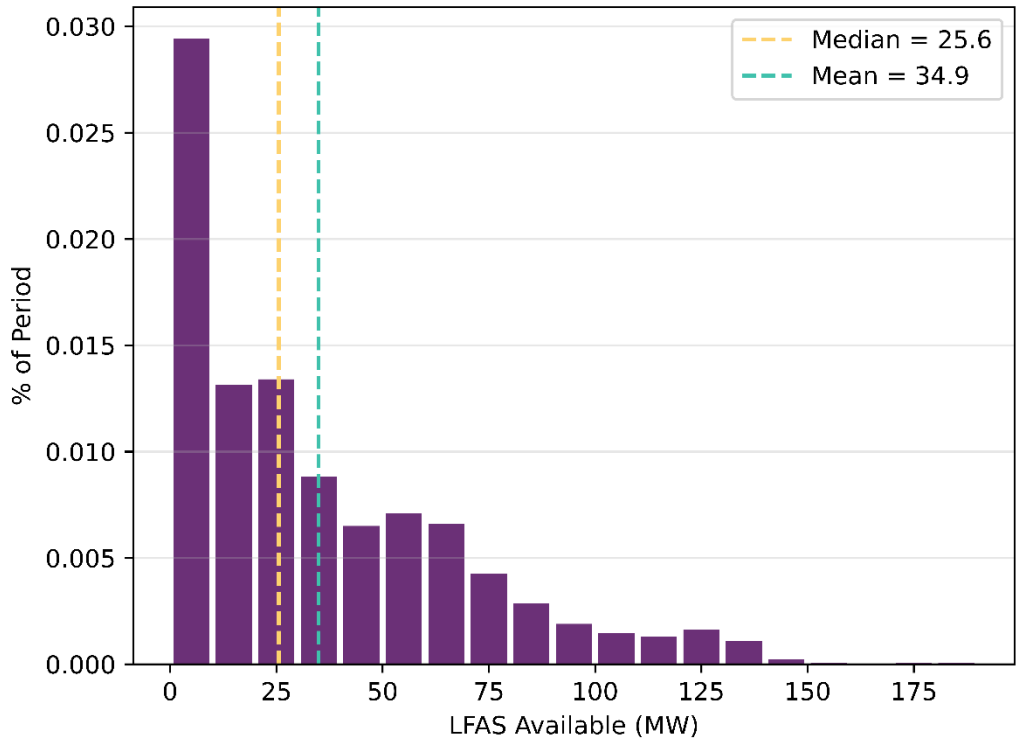
technical criteria and operate within a specific range. There was 62 MW provided under the two Ancillary Service Contracts. The SRAS requirement approved for 2022-23 was at least the maximum of:

- 70% of the largest generating unit; and
- 70% of the largest contingency event[7] 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[8]. 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 99.81% (up 0.085%) of the time with an average shortfall of the requirement of 47 MW during the 0.19% unavailability period.

AEMO's analysis of data for 2022-23 indicates a strong correlation between shortfalls of SRAS and lower LFAS Upwards availability[9], as shown in Figure 2. In practice, usage of SRAS can result in use of LFAS Upwards reserves, or likewise, usage of LFAS Upwards can result in shortfalls of SRAS. Figure 2 excludes periods where the system frequency was less than 49.8 Hz to exclude periods where SRAS is expected to be used. The inclusion of LFAS in SRAS means that 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.

Figure 2 Histogram of LFAS Upwards reserves during SRAS availability shortfalls



[7] 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.

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

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

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

Table 3 SRAS availability May 2022 to April 2023

	Quantity
Highest minimum requirement[A]	343 MW
% of time requirement met[B]	99.81%
Average minutes per day requirement not met	2.8 minutes
Events resulting in a frequency excursion below 48.75 Hz[C]	0

A. For the 2021-22 and 2022-23 financial years, the largest theoretical contingency in the SWIS was either the largest generator or network disturbance resulting in a loss of generation, 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[10], 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[11]. In the meantime, the Real-Time Frequency Stability tool[12] has been developed for AEMO's control room to assist in decision-making during these infrequent circumstances.

During the reporting period, eight generation contingencies[13] resulted in High-Risk Operating States due to frequency dropping below 49.68 Hz, with no Emergency Operating States identified as a result of a generation contingency. 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[14], including setting the upper limit of the LRR requirement, is based on the largest credible contingency in real time:

- allowing for the corresponding change in load because of an increase in frequency, known as load relief;
- allowing for the over-frequency response of online generating facilities;

[10] Wholesale market reforms to deliver the new Security Constrained Economic Dispatch, ESS and related functions being delivered under the WA Government's Energy Transformation Strategy.

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

[12] 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", IEEE, 2021, 10.1109/AUPEC52110.2021.9597823.

[13] Event resulting in a net loss of generation. Examples may include generator trips and network disturbances resulting in loss of rooftop PV.

[14] Refer to Section 4.3 of the 2022 Ancillary Services report for an updated description of the dynamic LRR, at https://aemo.com.au/-/media/files/electricity/wem/data/system-management-reports/2022-ancillary-services-report.pdf?la=en.

- allowing for the over-frequency response of a portion of residential inverters connected to rooftop solar (expected response defined in AS/NZS 4777); 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 planning requirement approved for 2022-23 was up to a maximum of 97 MW[15]. During the year, AEMO planned for 97 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. In particular the response from rooftop solar is being monitored.

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 1.79% of the time[16]). AEMO's analysis of data for 2022-23 indicates that more than half of the time when there was a shortfall in LRR, it was because of LFAS Downwards being utilised by facilities enabled to provide both services.

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

Table 4 Load Rejection Reserve availability May 2022 to April 2023

	Quantity
Approved LRR requirement	Up to 97 MW
LRR requirement in planning horizon	97 MW
Real time LRR requirement	Dynamic LRR
% of time dynamic LRR requirement met	98.21%
% of time less than dynamic requirement was provided[A]	1.79%
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.

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 2022-23 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 2022-23 for three Facilities.

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

[15] This is a dynamic requirement in response to a sudden drop of up to 150 MW load. Analysis is presented in Appendix A3 of the 2022 Ancillary Services report at https://aemo.com.au/-/media/files/electricity/wem/data/system-management-reports/2022-ancillary-services-report.pdf?la=en.

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

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 that 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 2022 to March 2023[17].

The costs of Ancillary Services as calculated by AEMO for the period from 1 April 2022 to 31 March 2023 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 2021 – 31 March 2022 and 1 April 2022 – 31 March 2023, are referred to as 2021-22 and 2022-23 respectively.

Table 6 Ancillary Service costs for 2021-22 and 2022-23

Ancillary Service	WEM Rule	2021-22		2022-23		Difference in Cost ($)
		Quantities	Cost ($)	Quantities	Cost ($)	
LFAS total			66,792,637		38,426,262	-28,366,375
LFAS capacity	9.9.2(q)	95 MW Peak; 70 MW Off-Peak[A] 100 MW Peak; 65 MW Off-Peak[B]	8,323,075	100 MW Peak; 65 MW Off-Peak[C] 110 MW Peak; 65 MW Off-Peak[D]	7,504,641	-818,434
LFAS Upwards	9.9.2(a)	95 MW Peak; 70 MW Off-Peak[A] 100 MW Peak; 65 MW Off-Peak[B]	24,804,470	100 MW Peak; 65 MW Off-Peak[C] 110 MW Peak; 65 MW Off-Peak[D]	14,434,512	-10,369,959
LFAS Downwards	9.9.2(b)	95 MW Peak; 70 MW Off-Peak[A] 100 MW Peak; 65 MW Off-Peak[B]	33,665,092	100 MW Peak; 65 MW Off-Peak[C] 110 MW Peak; 65 MW Off-Peak[D]	16,487,109	-17,177,983

A. Quantities valid 1 April 2021 to 14 July 2021. Peak & off-peak: 5:30am-7:30pm & 7:30pm-5:30am
B. Quantities valid: 15 July 2021 to 31 March 2022. Peak & off-peak: 5:30am-8:30pm & 8:30pm-5:30am
C. Quantities valid: 1 April 2022 to 6 July 2022. Peak & off-peak: 5:30am-7:30pm & 7:30pm-5:30am
D. Quantities valid: 6 July 2022 to 31 March 2023. Peak & off-peak: 5:30am-8:30pm & 8:30pm-5:30am

Ancillary Service	WEM Rule	2021-22		2022-23		Difference in Cost ($)
		Quantities	Cost ($)	Quantities	Cost ($)	
Spinning Reserve Ancillary Service (SRAS peak & SRAS off-peak)	9.9.2(f)	SRAS peak 252.03 MW[A] 240 MW[B] SRAS off-peak 252.03 MW[A] 241 MW[B]	12,133,507	SRAS peak 240 MW[C] 240 MW[D] SRAS off-peak 241 MW[C] 241 MW[D]	10,772,950	-1,360,557
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.	-	-
Load Rejection Reserve (LRR)	9.9.1	Up to 90 MW	5,697,349	Up to 97 MW	5,375,526	-321,824

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

Ancillary Service	WEM Rule	2021-22		2022-23		Difference in Cost ($)
		Quantities	Cost ($)	Quantities	Cost ($)	
Contract System Restart Service	9.9.4(a)	3 facilities	3,251,860	3 facilities	3,375,090	123,230
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.	126,237	Default payment for the System Restart Service component via the Synergy AS Payment.	109,765	-16,472
Total			88,001,590		58,059,593	-29,941,997

A. Quantities valid: 1 April 2021 to 30 June 2021
B. Quantities valid: 1 July 2021 to 31 March 2022
C. Quantities valid: 1 April 2022 to 30 June 2022
D. Quantities valid: 1 July 2022 to 31 March 2023
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

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.

The LFAS requirements for LFAS Up and LFAS Down services applicable for the 2021-22 and 2022-23 periods are shown in Table 7.

Table 7 LFAS Requirements for 2021-22 and 2022-23

			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**
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
2022-23	1/04/2022	05/07/2022	65 MW	100 MW	65 MW	100 MW
	06/07/2022	31/03/2023	65 MW	110 MW	65 MW	110 MW

In 2022-23, despite an increase in the average LFAS requirement, there was a net reduction in total LFAS enablement costs of $28.4 million compared to 2021-22. This was driven by significant decreases in average LFAS Up and LFAS Down Prices between 2021-22 and 2022-23 (Table 8), across all Trading Intervals (Figure 3), resulting from a significant increase in LFAS Up and LFAS Down quantities being offered at low prices, particularly in the $0/MW to $5/MW range (Figure 4).

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

LFAS Market	Period	Unit	2021-22	2022-23	Change
LFAS Down	Off-Peak	$/MW	22.02	8.43	-13.59
LFAS Down	Peak	$/MW	21.94	10.88	-11.06
LFAS Up	Off-Peak	$/MW	15.78	9.35	-6.43
LFAS Up	Peak	$/MW	16.53	8.03	-8.5

Figure 3 LFAS Up/Down Prices by time of day

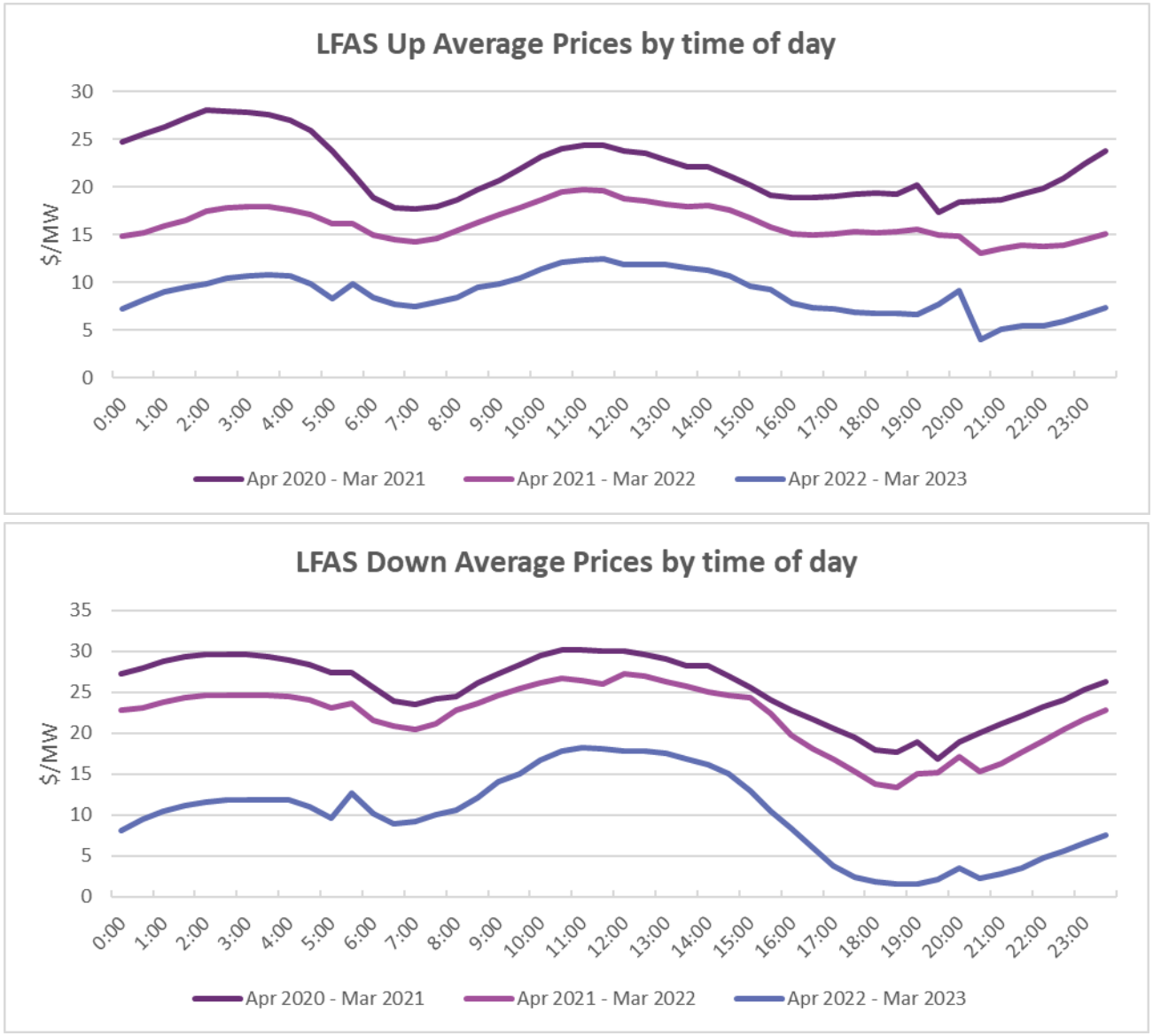
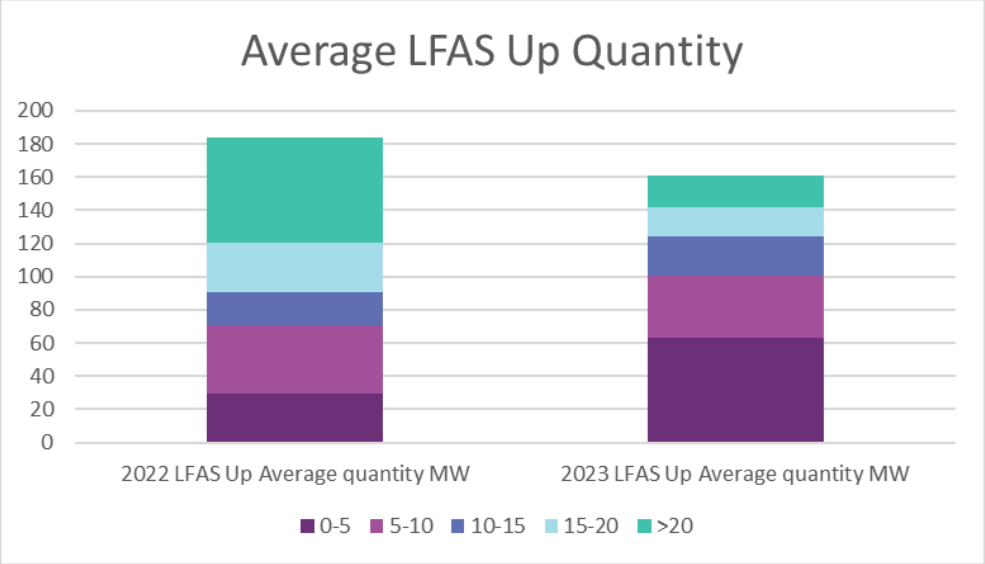
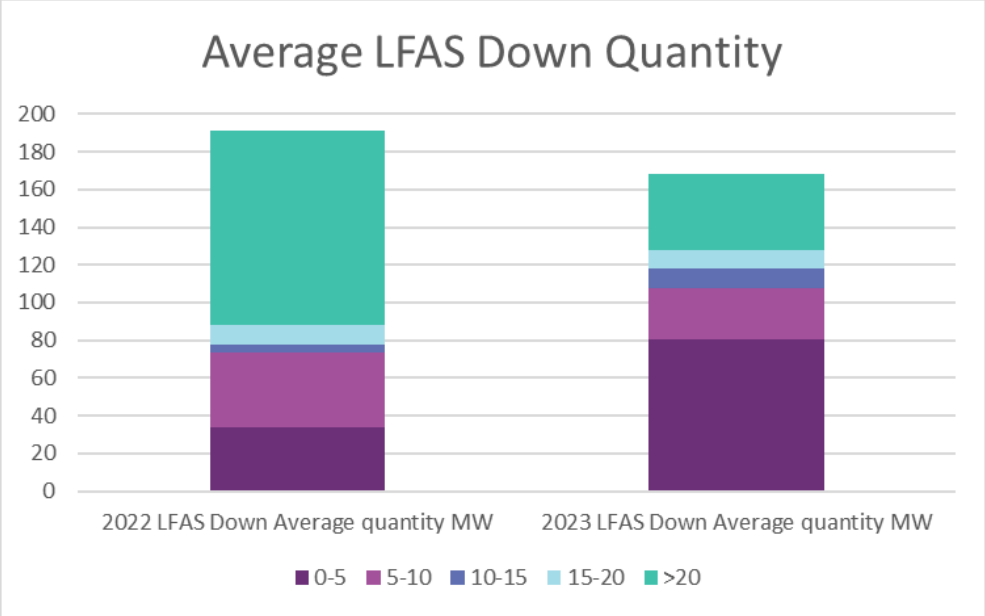


Figure 4 Average Total LFAS Offer Quantities by Price Band



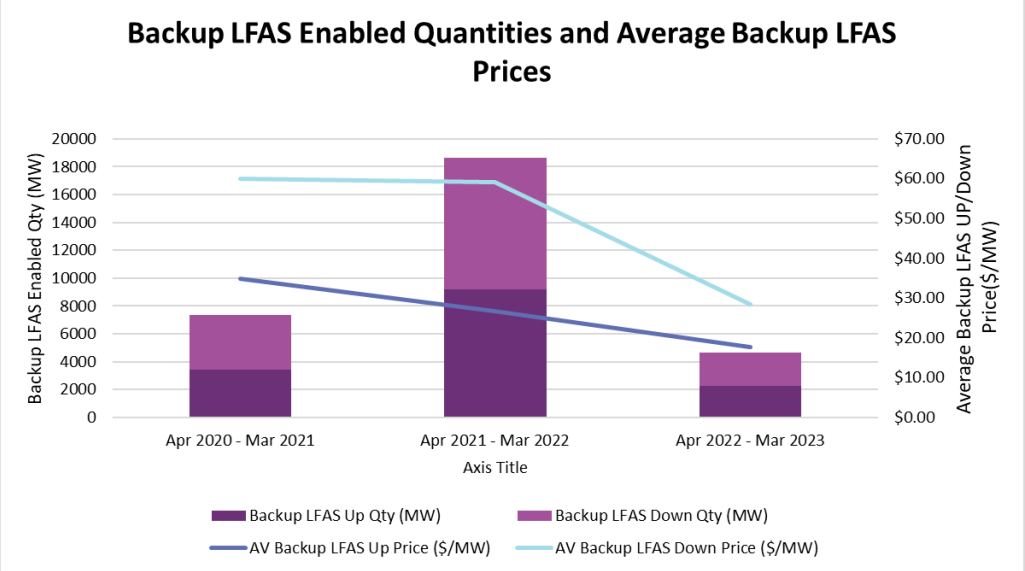


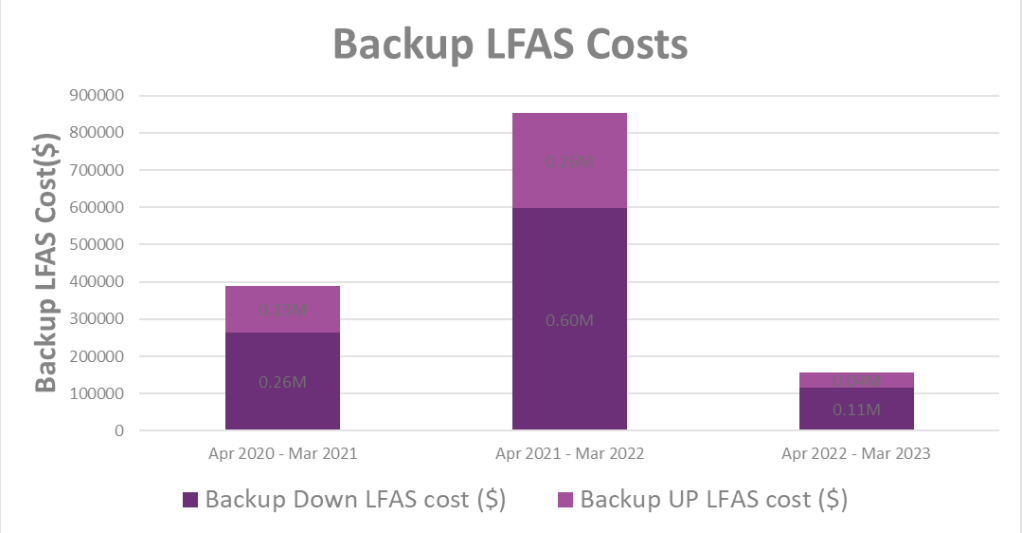
Backup LFAS may be used by AEMO from time to time when additional or replacement LFAS is required. Backup LFAS is provided by Synergy at a price nominated in its LFAS Submissions[18]. Backup LFAS enablement costs[19] decreased by $696,418 from 2021-22 to 2022-23 reporting years, which was driven by the reduced need to enable Backup LFAS quantities in this reporting year compared to last and a significant reduction in average backup LFAS prices (Figure 5).

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

[19] Backup LFAS costs have been included in the reported LFAS Upwards and LFAS Downwards costs for 2021-22 and 2022-23.

Figure 5 Backup LFAS enabled and costs 2020-21, 2021-22 and 2022-23





The LFAS capacity cost is calculated by multiplying the LFAS Up capacity requirement by the administered Reserve Capacity Price[20]. Despite an increase in the total quantity of ex-post LFAS Upwards Enablement quantities and Backup LFAS Upwards LFAS Enablement quantities, LFAS capacity costs decreased by $818,434 in 2022-23, driven by lower Reserve Capacity Prices for the 2021 and 2022 Capacity Years, which applied from October 2021 and 2022 respectively[21].

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.

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

[21] The administered Reserve Capacity Price ($/MW per year) for Capacity Year was: $85,294.19 (2022-2023); $78,573.33 (2021-22) and $114,134.15 (2020-21).

SRAS costs are driven predominantly by the Margin Values[22], which are determined by the ERA[23]. 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 a Trading Interval is calculated as the average SRAS requirement from Margin Values modelling and adjusted to subtract any available contracted SRAS quantity and any enabled LFAS Up quantity.

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[24].

The Margin Values and SRAS requirement determined by the ERA[25] 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
2022-23	1/04/2022	30/06/2022	0.126	0.232	240	241
	1/07/2022	31/03/2023	0.1144	0.0657	284	235
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 $1.36 million for 2022-23 compared with 2021-22 (Table 10):

- SRAS peak costs increased by $0.24 million for reporting year 2022-23 compared with 2021-22. This was predominantly driven by the increase in the time-weighted average SR Requirement across Peak Trading Intervals[26] by 30 MW compared to the previous year. The increase was moderated by a decrease in time-weighted Margin_Peak values from 0.1581 to 0.1173 (Table 10).
- Conversely, SRAS off-peak costs decreased by $1.7 million for 2022-2023 compared with 2021-22, mainly driven by the decrease in the time-weighted average Margin_Off-Peak value from 0.2276 to 0.1073. A small decrease in time-weighted average SRAS requirement quantities also contributed to the change (Table 10).

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 2021-22[27] and 2022-23[28] respectively.

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

[23] 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.

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

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

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

[27] 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.

[28] 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-202223.

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						
2022-23	1/04/2022	31/03/2023	6,743,567	0.12	273	70.04
2021-22	1/04/2021	31/03/2022	6,501,822	0.16	243	55.75
Change from previous year			241,745	-0.04	30	14.29
Off-Peak						
2022-23	1/04/2022	31/03/2023	3,927,470	0.11	237	68.93
2021-22	1/04/2021	31/03/2022	5,631,685	0.23	241	46.91
Change from previous year			-1,704,215	-0.12	-4	22.02

3.3 System Restart Service and Load Rejection Reserve Service Costs

SRS costs increased by $106,758 in 2022-23 compared to 2021-22 (Table 11), with contracted SRS payments increasing by $123,230. The increase in contracted SRS payments in 2022-23 was driven by increased availability of SRS against the contracts when compared to 2021-22.

Synergy receives payments for SRS through its role as the default Ancillary Services provider, which are calculated using the Synergy AS Provider Payment[29]. 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 2022-23, SRS payments via the Synergy AS Provider Payment was $109,765, a decrease of from 2021-22 $16,472. This decrease is driven by the increase in contracted SRS costs (Table 11).

The LRR cost is calculated relative to the Cost_LR parameter less any payments for LRR contracts and SRS contracts[30]. AEMO did not enter into any LRR contracts for either 2021-22 or 2022-23. 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 SRS costs. For a Trading Month, if the contracted SRS costs exceed the 'R' component in the Cost_LR parameter determined by the ERA[31], 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 decreased by $321,824 in 2022-23 compared to 2021-22 (Table 11) mainly due to a reduction in the 'L' component of the Cost_LR parameter determined by the ERA. The value of the monthly net adjustment applied to LRR payments decreased from -$133,901 in 2021-22 to -$78,474 in 2022-23. This decrease was mainly driven by higher contracted SRS payments in the October 2021 Trading Month as a result of SRS testing.

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

[30] 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.

[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 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]
2021-22 [C]	$9,075,447	$3,244,197	$5,831,250	$3,251,860	$126,327	-$133,901	$5,697,349
2022-23[D]	$8,860,382	$3,406,382	$5,454,000	$3,375,090	$109,765	-$78,474	$5,375,526
Change from previous year	-$215,065	$162,185	-$377,250	$123,230	-$16,472	-$55,426	-$321,824

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 2022-23 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 2021-22 and 2022-23 financial years.

4 Ancillary Services Requirements for 2023-24

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 2023-24 be maintained from 1 July 2023 until NWCD.

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 2023-24. 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 intermittent generation facilities have been commissioned since the start of 2021, increasing rooftop DPV connections[32] have continued to cause increased volatility, and this trend is expected to continue.

Assessment shows that the requirement for LFAS at peak may remain at up to 110 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. However, as the FKM only increased by 10 MW over peak (in line with the increase in LFAS requirement from July 2022) and frequency performance remains above required, it is expected that maintaining the peak LFAS requirement at 110 MW from July 2023 until NWCD will continue to allow frequency standards to be maintained.

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 up to 65 MW.

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

[32] Approximately 0.3 GW of rooftop distributed PV was installed in 2022, sourced at http://www.cleanenergyregulator.gov.au/RET/Forms-and-resources/Postcode-data-for-small-scale-installations/historical-postcode-data-for-small-scale-installations.

The following LFAS requirement is proposed for 2023-24:

1. LFAS Upwards up to 110 MW between 5:30 AM and 8:30 PM, up to 65 MW between 8:30 PM and 5:30 AM.
2. LFAS Downwards up to 110 MW between 5:30 AM and 8:30 PM, up to 65 MW between 8:30 PM and 5:30 AM.

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 2022 Ancillary Services report continued to use an updated methodology to determine the largest contingency by combining the largest generation output with the net DPV[33] 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. The estimate of DPV tripping due to contingencies is regularly refined by AEMO with input from Western Power.

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 DPV cloud cover event, was 412 MW (up by 113 MW from previous period), where the SRAS available prior to the ramp was higher than this. 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 2023-24 is 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[34].

[33] 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.

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

4.3 Load Rejection Reserve Service

The LRR requirement must meet the SWIS Operating Standards and the Ancillary Service Standards. The SWIS Operating Standards[35] 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.

The revision considered in the 2022 Ancillary Services report to include droop responses from online units, adjustments to the largest load contingency and underlying load relief have been continued to be used in the dynamic LRR calculation. In addition to these changes, the contribution of DPV response to over-frequency events has been included in the dynamic calculation. The contribution of DPV inverters is conservatively limited by a fixed cap and includes a large deadband prior to response in the dynamic equation to account for those inverters that might not be compliant against the AS/NZS 4777:2:2020 Standard, hence not responding to over-frequency events. This factor in the dynamic calculation will be further monitored closely in future load rejection events to ensure ongoing confidence. Details on the effect of the contribution of DPV are provided in Appendix A3.

As the contribution of DPV is only available during daytime when sunny, the proposed maximum LRR requirement remains as a fixed number across all periods with the dynamic calculation allowing operational LRR to be lower.

The proposed planning LRR requirement for 2023-24 is to remain at 97 MW[36].

4.4 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 SRS requirement for 2023-24 remains three Facilities with system restart capability.

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

[36] The dynamic requirement is expected to be within the planning requirement for at least 95% of the time. Analysis is presented in Appendix A3.

5 Ancillary Services Plan for 2023-24

5.1 Load Following Service

To meet the requirements for 2023-24, LFAS will be sourced through the LFAS Market up to the values shown in Section 4.1 of this report. AEMO will maintain the existing approach.

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 procured for the Trading Interval.

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

5.2 Spinning Reserve Service

For 2023-24, 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 sourced[37] 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.

5.3 Load Rejection Reserve Service

A planning requirement of 97 MW of LRR will be provided by the Balancing Portfolio. AEMO will use a dynamic LRR requirement in real time[38].

5.4 System Restart Service

The existing three System Restart contracts will continue to apply until contracts expire. 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 2023-24

Table 12 Summary of Ancillary Services requirements and plan to procure for 2023-24

	Requirement	Compared to previous year	Method to procure	Cost
LFAS Upwards	Up to 110 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 • No change to LFAS requirement during peak time • No change to LFAS requirement during off-peak time	LFAS Market	LFAS Market clearing price

[37] The commercial process is underway to source a short-term Spinning Reserve contract for 2023-24.

[38] The administrative payment to provide this service for FY24 has been determined through Cost_LR.

	Requirement	Compared to previous year	Method to procure	Cost
LFAS Downwards	Up to 110 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 • No change to LFAS requirement during peak time • No change to LFAS requirement during off-peak time	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 MW[A]	No change in the maximum dynamic LRR requirement	LRR is expected to be provided by the Balancing Portfolio	Annual price paid based on the ERA's Cost_LR determination for 2023-24
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.

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[39], 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 has utilised a methodology to calculate generator response required to maintain frequency, to determine the increased requirements during 2020-21 and 2021-22, which was approved by the ERA.

The calculated generator response, referred to as FKM, 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. It should be noted that this methodology only considers actual responses, rather than a required response to meet a frequency performance standard.

A similar analysis as presented in the 2022 Ancillary Services Report[40] 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. In the 2021-22 Ancillary Services period, there were challenges in obtaining a consistent data source for the entire 12-month period. Therefore, data was compared for the periods it was available when considering changes between years. This shorter period is during summer, and the magnitude of FKM used due to DPV volatility and variability of Non-Scheduled Generation is expected to be lower due to typically clearer and less volatile weather. In some cases, clear weather may require significant FKM to compensate for the current non-linear dispatch. In the future market, linear dispatch will reduce the need for compensation due to ramping at the start of intervals.

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 2022 values during off-peak times.

The outcome is presented in Table 13, which contains the FKM quantities (Upwards and Downwards) required to be procured to ensure that the FKM used was paid for 98% of the time. The table shows that the FKM used to keep the frequency stable 98% of the time for 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

[39] 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.

[40] Refer to Appendix A1 at https://www.aemo.com.au/-/media/files/electricity/wem/data/system-management-reports/2022-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
Oct 2022 to Feb 2023	138 MW	10 MW	70 MW	- 5 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 2023 summer period[41], it was found that an average increase of 10 MW of FKM was required to manage system frequency during the peak periods, which is in part made possible by the 10 MW increase to the LFAS Upwards and Downwards requirement since July 2022. 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 utilising 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.

While the data analysed above indicates an increasing requirement for LFAS during peak times due to continued connection of new DPV, frequency performance metrics over the Ancillary Service period indicate a much higher standard of frequency regulation than is required. Therefore, for the remaining period between July 2023 and NWCD, it is recommended that the LFAS requirements for both peak and off-peak remain at 110 and 65 MW respectively.

[41] 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

In the 2022 Ancillary Services Report, AEMO revised the calculation of Spinning Reserve requirement in real-time so that it was more reflective of the wider system response to a contingency. This includes, both DPV and underlying load tripping. The 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. This methodology has continued to be used.

A3. Load Rejection Reserve requirement calculation

The LRR requirement is based on the largest credible load contingency, less any load relief, specific facility protection systems and other known facility responses. More recently, an operational change in November 2022 considered a conservative representation of over-frequency response from DPV inverters to further reduce the LRR requirement during sun hours. The changes to the LRR requirement over several years have resulted in a reduction of the planned and dynamic requirements and consequently, a better reliability of LRR against the requirement while maintaining power system security.

Since 2022, the Eastern Goldfields (EGF) transfer limit has increased[42], resulting in a larger power transfer capability. This change resulted in an increase to the average load contingency and likewise, the LRR requirement. In the past year, this has not shifted significantly, but rather, the available response from other facilities has reduced due to changes in dispatch patterns. Despite increases in the estimated DPV response to an over-frequency event, the LRR requirement has shown an increase over most periods (when comparing with the same dynamic calculation), while remaining below the previous planning requirement of 97 MW for 98.4% of the time.

It is expected that for the remaining period between July 2023 and NWCD, changes in dispatch patterns due to low load may continue to reduce the component assumed from facility responses as they operate at lower outputs. The dynamic requirement is expected to remain below 97 MW for at least 95% of the period from July 2023 to NWCD. Energy market outcomes together with the increase in power transfer capability have resulted in an increase in EGF import due to local generators not being dispatched over low load periods. It is expected that this will continue to increase the frequency of larger load contingencies. However, since the changes in load contingency are expected to be driven by market outcomes over low load periods, the DPV response is expected to improve as new installations continue and therefore may assist in lowering the requirement for these periods. Therefore, AEMO intends to continue using the dynamic LRR requirement calculation. AEMO proposes that the planning LRR requirement remains at 97 MW until NWCD.

[42] Estimated power transfer of up to 160 MW into EGF.