AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Ancillary Service Report for the WEM 2018–19

June 2018

System Management

Important notice

PURPOSE

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

This publication has been prepared by AEMO using information available at 16 May 2018. Information made available after this date may have been included in this publication where practical.

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VERSION CONTROL

Version	Release date	Changes
1	31/5/2018	

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1 Introduction

Under the Wholesale Electricity Market (WEM) Rules, AEMO is required to provide an annual Ancillary Services report to the Economic Regulation Authority (ERA). This report serves to fulfil this obligation.

1.1 Purpose

Clause 3.11.11 of the WEM Rules provides that:

> By 1 June each year, System Management 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).

1.2 Frequency Operating Standards

Table 2.1 of the Technical Rules[1] specifies the Frequency Operating Standards for the South West Interconnected Network (which are applied in the South West Interconnected System (SWIS)). A relevant extract from Table 2.1 of the Technical Rules is set out in Table 1.

[1] The Technical Rules are available at: https://www.erawa.com.au/electricity/electricity-access/western-power-network/technical-rules/technical-rules.

Table 1 Extract of 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

AEMO uses Ancillary Services to ensure that the SWIS operates within the normal frequency bands and to restore the SWIS to the normal frequency bands within the target recovery time following a contingency event.

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 Hz. LFAS is dispatched through the use of Automatic Generation Control (AGC).

LFAS is also used to balance supply and demand during generator ramp up and down within Trading Intervals in accordance with their Dispatch Instructions.

In the SWIS, Spinning Reserve and Load Rejection Reserve are relied on as contingency reserves to arrest a frequency change following the unplanned loss of generation or demand. While some Spinning Reserve is provided by interruptible loads, Spinning Reserve and Load Rejection Reserve are also provided using the governor droop response on specific synchronous generators able to maintain the response for the period of service.

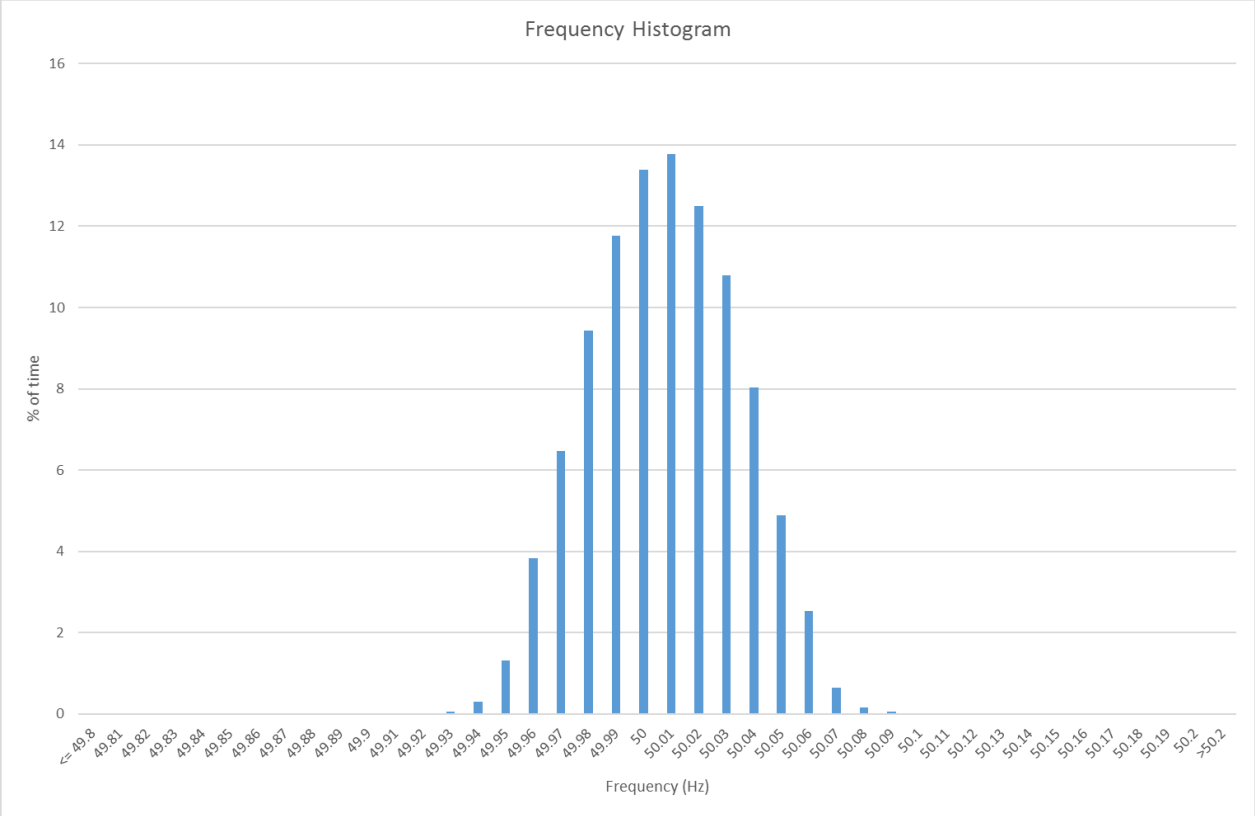
The capacity provided to meet the LFAS (raise) requirement is counted as providing part of the Spinning Reserve requirement. Similarly, the capacity provided to meet the LFAS (lower) requirement is counted as providing part of the Load Rejection Reserve.

Frequency regulation in the SWIS is achieved by a combination of AGC and governor action. The Technical Rules[2] require the dead band of a generator to be less than 0.05 Hz, therefore most generators will respond to changes in frequency, even within the normal frequency operating band. This includes generators specifically assigned to provide Spinning Reserve as well as all the other governor controlled generators[3] not running at maximum output. This governor control works together with AGC to ensure frequency remains within the normal operating band and contributes to the good frequency performance of the SWIS.

[2] Clause 3.3.4.4(d) of the Technical Rules states that "The dead band of a generating unit (the sum of increase and decrease in power system frequency before a measurable change in the generating unit's active power output occurs) must be less than 0.05 Hz".

[3] Dispatchable thermal generators are required to sustain this response for a minimum of 10 seconds.

Figure 1 Frequency performance of the SWIS from May 2017 to April 2018



The frequency performance of the SWIS for the period under review is provided in Figure 1. The frequency remained in the normal operating band for 99.996% of the time. This meets the Frequency Operating Standards specified in the Technical Rules. This performance was a product of the combination of active frequency control via AGC of the LFAS generators and the governor responses from all online generators.

2 Ancillary Services quantities

This section describes the quantity of each of the Ancillary Services provided and the adequacy of those quantities. The period of reporting is May 2017 to April 2018.

2.1 Overview

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

1. Load Following Service
2. Spinning Reserve Service
3. Load Rejection Reserve Service
4. Dispatch Support Service
5. System Restart Service.

2.2 Load Following Ancillary Service (LFAS)

For the 2017-18 reporting period, the approved requirement was 72 MW for LFAS raise and 72 MW for LFAS lower to be enabled for each Trading Interval.

The average quantity of LFAS raise and LFAS lower provided by all providers for each minute of the reporting period is provided in Table 2.

Table 2 LFAS quantities

	LFAS Raise	LFAS Lower
Average quantity enabled	110 MW	111 MW
Average number of minutes per day requirement not met	6.1 minutes	6.0 minutes
% of time requirement met	99.57%	99.59%
Frequency within normal operating range for > 99.9% of the time[A]	Yes	

A Clause 3.10.1(a)(ii) of the WEM Rules sets the standard for Load Following Service as a level that is 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.

LFAS is provided by enabling specific generators to provide the service. A generator may provide LFAS raise service, LFAS lower service, or both.

LFAS is provided through an LFAS market, in which providers submit offers for the service on a Trading Interval basis.

If a non-Balancing Portfolio Facility is cleared in the LFAS market, it is automatically enabled to provide either LFAS raise or LFAS lower, or both, for the quantity at which it was cleared. It is therefore possible to specify the exact amount of LFAS that is available from a non-Balancing Portfolio Facility.

The dispatch of the Balancing Portfolio is different, and requires AEMO to manually select the Facilities to be able to provide the remaining requirement. Each Facility is enabled for its entire operating range, providing both LFAS raise and LFAS lower services depending on the output at the time. The LFAS contribution from individual generators in the Balancing Portfolio is not limited to a defined range. For the purpose of reporting, it is assumed that the range of the generator to provide either LFAS raise or LFAS lower is half of the operating range. Hence the absolute value of LFAS is not limited to exactly 72MW. Further details are provided in Appendix A1.

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

2.3 Spinning Reserve Ancillary Services (SRAS)

Spinning Reserve was provided by specific generators in the Balancing Portfolio and through three other contracts during the reporting period. Generators in the Balancing Portfolio are not specifically enabled to provide Spinning Reserve but if they are online, their capability is considered to be available. While AEMO ensures there is sufficient Spinning Reserve online, the actual quantity of Spinning Reserve available is a consequence of the spare capacity of units online rather than an absolute quantity being provided.

Table 3 Spinning Reserve contracts

	Interruptible Load	Interruptible Load	Scheduled Generator
Contract quantity	42 MW	13 MW	13 MW
% of time contract met	100%	97%	76%

For the reporting period, the approved Spinning Reserve requirement was the level sufficient to cover 70% of the largest contingency. This may be relaxed by up to 12% where AEMO expects that the shortfall will be for a period of less than 30 minutes.

The requirement for each minute was compared to the available spinning reserve at the time. If the quantity was sufficient or insufficient by an amount of up to 12% for less than 30 consecutive minutes, it was considered adequate.

Table 4 Spinning Reserve availability

	Quantity
Highest minimum requirement (catering for 340 MW contingency)	238 MW
Average spinning reserve availability (peak periods)	290 MW
Average spinning reserve requirement on which payment based (peak)[A]	221.8 MW
Average spinning reserve availability (off peak periods)	257 MW
Average spinning reserve requirement on which payment based (off-peak)[B]	190.2 MW
Average minutes per day requirement not met	27 minutes
% of time requirement met	98.1%[C]
Frequency excursions below 48.75 Hz[D]	0

A This figure is the amount used in the modelling done for the Margin Value determination for the period July 2017 – June 2018. The value for May 2017 and June 2017 is 218.1 MW (peak).
B This figure is the amount used in the modelling done for the Margin Value determination for the period July 2017 – June 2018. The value for May 2017 and June 2017 is 191.9 MW (off-peak).
C The % availability refers to the amount of time that the actual available Spinning Reserve to respond to a frequency drop did not meet the requirement. As there were periods of time when this was due to the component of Spinning Reserve also enabled for LFAS raise having being utilised, the enabled Spinning Reserve capacity would indicate a higher availability.
D Clause 3.9.2 of the WEM Rules defines the purpose of the Spinning Reserve Service 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 set the minimum operating frequency standard for a single contingency event as 48.75 Hz.

There was adequate Spinning Reserve for about 98.1% of the time during the reporting period. The average shortfall (including that within the 12% allowable range) was 21 MW which represents less than 10% shortfall on the peak requirements for 1.9% of the year.

During the reporting period, there were 11 generator trips varying in output reduction from 139 MW to 318 MW. The lowest frequency recorded was 49.38 HZ following the loss of 318 MW. There were no under-frequency load shedding events recorded during the reporting period.

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

2.4 Load Rejection Reserve (LRR)

LRR was provided by Balancing Portfolio generators that were able to do so. These generators do not need to be enabled to provide this service. The service can be provided when the generator is online and its output is in the correct range. The quantity of the available reserve is determined by the actual output of the generator and its ability to respond when the frequency increases.

For the reporting period, the approved LRR requirement was 120 MW. This may be relaxed by up to 25% (or down to 90 MW) where the probability of a transmission fault is considered to be low. The adequacy of LRR is described by the percentage of time that the quantity of LRR provided was in each indicated interval. These values were determined for each one-minute period, and are not necessarily consecutive.

Table 5 Load Rejection Reserve availability

	Quantity
Load Rejection Reserve requirement	120 MW
Relaxed Load Rejection Reserve requirement[A]	90 MW
Average Load Rejection Reserve	167 MW
% of time 120 MW requirement met	78.6%
% of time 90 – 120 MW provided	14.9%
% of time less than 90 MW was provided	6.5%
Frequency excursions above 51 Hz[B]	0

A Clause 3.10.4(b) of the WEM Rules allows the Load Rejection Reserve standard to be relaxed by 25% to 90 MW where the probability of a transmission fault is considered to be low.
B Clause 3.10.4(a) of the WEM Rules requires the Load Rejection Reserve standard to be the level sufficient to keep over-frequency below 51 Hz for all credible load rejection events.

There were periods when the minimum requirement for LRR was not met (approximately 6.5% of the time). This was a consequence of generators providing LRR operating at low output during low system demand. Whilst there were periods of insufficient LRR to respond automatically in six seconds, a number of generators within the Balancing Portfolio acknowledged that if necessary they would trip their unit on AEMO instruction if the frequency could not be managed within the frequency operating standards. Therefor the risk of an over frequency condition was considered low during those time frames.

During the reporting period there were no frequency excursions greater than 50.25 Hz.

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

2.5 Dispatch Support Services (DSS)

The sole DSS contract compensates Synergy for energy provided from the Mungarra and West Kalgoorlie power stations. This is required to manage regional network reliability issues in these regions, which are significant enough to affect SWIS Power System Reliability. The energy provided under this DSS contract for the period under consideration is provided in Table 6 below.

Table 6 Energy provided under DSS contract

Dispatch Support Facility	Energy provided (MWh) 1/5/2017 – 30/4/2018	Energy provided (MWh) 1/5/2016 – 30/4/2017
Mungarra Power Station	5,270	4,279
West Kalgoorlie	564	0

Changes in the energy requirements under the DSS contract are due to additional network outages, requiring the use of generation from these facilities.

2.6 System Restart Services

For the reporting period, there were contracts with three facilities to provide System Restart Services. Successful restart tests were concluded for each of the three facilities during this period. Despite a number of planned and unplanned outages, there were always at least two facilities available simultaneously. No events occurred during the reporting period that required the System Restart facilities to operate.

Table 7 Availability of System Restart Facilities

Facility	Market Participant	% of days available[A]
Pinjar	Synergy	100%
Kwinana Donaldson	Perth Energy	73%
Kwinana	Synergy	96%

A. Availability calculations are based on the number of days that each facility was unavailable as a result of planned or unplanned outages.

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 2017 to March 2018[4].

The cost of Ancillary Services as calculated by AEMO for the period 1 April 2017 – 31 March 2018 is set out in Table 8 below. For comparative purposes, the costs of the previous year are also provided.

Table 8 Ancillary Services costs for 2016–17 and 2017–18

Ancillary Service	WEM Rule	Quantities	1 April 2017 – 31 March 2018 ($)	Quantities	1 April 2016 – 31 March 2017 ($)
LFAS Total			78,715,234		63,142,495
• LFAS Capacity	9.9.2(q)	72 MW	8,410,926	72 MW	8,714,122
• LFAS Raise	9.9.2(a)	72 MW	22,135,877	72 MW	18,227,331
• LFAS Lower	9.9.2(b)	72 MW	48,168,431	72 MW	36,201,042
Spinning Reserve peak Spinning Reserve off-peak	9.9.2(f)	221.8 MW 190.2 MW	22,206,622	218.1 MW 191.9 MW	16,915,505
Contract Load Rejection Reserve[A]	9.9.4(a)	–	–	–	–
Load Rejection Reserve[B]	9.9.1	120 MW	1,023,342	120 MW	716,324
Contract DSS[C]	9.9.4(a)	5,000 MWh	644,702	3,872 MWh	423,313
Contract System Restart	9.9.4(a)	3 facilities	934,908	3 facilities	877,972
Total			**103,544,808**		**82,075,608**

A. AEMO has not entered into any contracts for the provision of Load Rejection Reserve.
B. This component of payment refers to the residual costs paid to Synergy as the default provider of Ancillary Services. It is predominantly Load Rejection Reserve, but small amounts are related to residual System Restart payments.
C. The period of reporting for the Ancillary Services (this section 3) is April to March while that for quantities provided (section 2) is May to April. April to March is the most recently available settlement data

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

LFAS capacity quantities for 2017-18 were unchanged from 2016-17, but LFAS capacity costs have decreased due to a respective decrease in the Reserve Capacity Price.

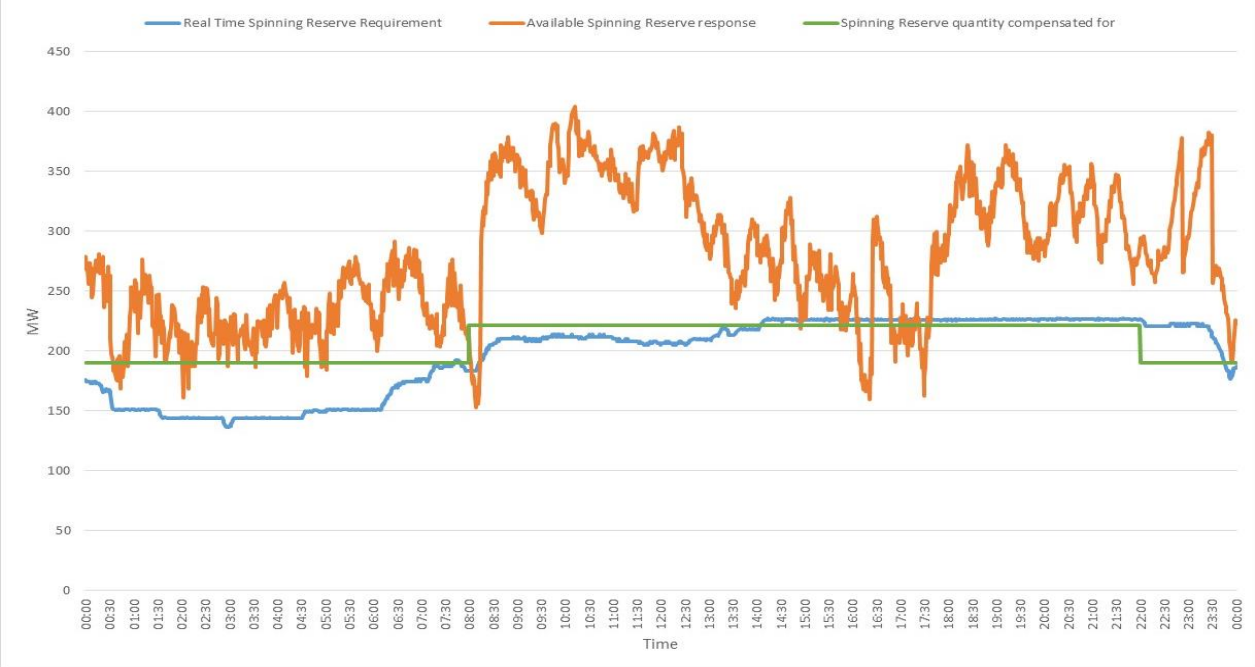
LFAS availability costs, for both raise and lower services, have increased despite the LFAS quantities remaining constant from the previous year. LFAS is provided through a market mechanism, and the availability costs are driven by the prices offered by Market Participants in the LFAS market.

Spinning Reserve costs include services provided by Synergy and those provided under Ancillary Service Contracts. They are driven predominantly by the margin values, determined annually by the ERA[5], and the Balancing Prices occurring during the year. Margin values increased from 24% and 35% in 2016-17 (peak and off-peak respectively) to 36% and 64% in 2017-18.

The quantity of Spinning Reserve that is paid for is the average requirement for peak and off-peak periods assumed in the modelling done for the margin value determination[6]. Synergy, the default provider of Spinning Reserve, receives an administered payment for the difference between the determined average quantity less any available contracted Spinning Reserve and less any component allocated to LFAS raise service. For contracted Spinning Reserve the quantity paid for is subject to the availability of the service, and is based on a contract price which is lower than Synergy's administered payment for Spinning Reserve.

Figure 2 indicates, for a typical day, the requirements for Spinning Reserve, the actual Spinning Reserve response and how much Spinning Reserve is compensated for.

Figure 2 Illustrative representation of Spinning Reserve requirements, availability and that compensated for



[5] https://www.erawa.com.au/cproot/17550/2/201718%20determination%20of%20Margin%20peak%20and%20Margin%20Off-Peak%20parameters.pdf

[6] Clauses 3.22.1(e) and (f) of the WEM Rules use the quantities assumed in the Margin Value determination process for settlement.

The orange line indicates the amount of capacity that was available on the system to respond to a reduction in frequency. Spinning Reserve payments are based on the green line regardless of how much actual Spinning Reserve is available (orange line).

The annual payment to the Synergy for Load Rejection Reserve is as determined by the ERA as part of the Cost_LR determination[7]. The costs for contracts for System Restart, DSS contracts and Load Rejection Reserve payments to Synergy have not changed substantially, as the contracts have remained the same and the Cost_LR determination covering the period of 2016 – 2019 still applies.

[7] https://www.erawa.com.au/cproot/14174/2/Cost%20L_R%20parameters%20-%20Determination%20paper%20(Redacted).PDF

4 Ancillary Services requirements for financial year 2018-19

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 requires the ERA to audit this plan.

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

4.1 Load Following Ancillary Service

In response to the ERA's feedback on the 2017 Ancillary Services report, AEMO engaged an independent consultant to review the LFAS requirements and investigation into the data availability to support the Ancillary Services reporting.

Based on the LFAS review findings, the proposed methodology determines an adequate capacity for LFAS by considering the level of uncertainty in the power system that must be managed to ensure that supply and demand are continuously balanced. The analysis measured:

1. Variations in demand from forecast
2. Variations in the output of non-scheduled generators from forecast.

In reviewing the opportunity to vary the LFAS requirements across different load levels, such as time of day or periods in the year, the level of uncertainty under different conditions was compared. No significant differences were noted in the level of uncertainty introduced by the forecast errors at different load levels or at different times of the day or year[8].

Table 9 summarises the combined level of uncertainty in the power system over the last three calendar years using different forecast time frames: 10 minute, 20 minute and 30-minute

[8] This will continue to be monitored, particularly as the level of non-scheduled generation and distributed energy resources continues to increase.

windows. The uncertainty in this context is the megawatt (MW) difference between the forecast and the actual demand and non-scheduled generation combined for any specific time frame.

Table 9 Historical levels of uncertainty in combined effect of wind and demand forecasts

Forecast period	2017		2016		2015	
Minutes ahead	Forecast error percentile (MW)					
	99.9th	99th	99.9th	99th	99.9th	99th
30	238	189	253	208	250	194
20	170	131	184	142	169	130
10	112	78	118	82	111	74

Forecast error percentile is the percentage of the year that the error (forecast vs actual) is below the number provided in the table. For example, during 2017, 99% of the time the forecast error for a 10-minute interval was less than 78MW.

In each 30-minute Trading Interval, AEMO re-dispatches generators at 10-minute intervals as the actual conditions change, thus responding to forecast errors.

Although there was a slightly higher level of uncertainty in 2016, the order of magnitude has remained relatively consistent over the last three calendar years. It is expected that as additional non-scheduled generation is added to the system and the level of distributed energy resources increases, there will be more periods when the short-term uncertainty is higher than these averages. While work is being done to improve the accuracy of demand forecasting, the benefit of this is likely to be offset to some extent by increasing levels of intermittent generation.

While LFAS is necessary to respond to the uncertainty introduced by variations from demand and intermittent generation forecasts, it is also required to respond to operational situations such as variations in energy being provided during commissioning tests and mismatches between balancing ramp rates.

Based on the LFAS review findings, it is recommended that the requirement for LFAS be maintained at 72 MW for the following reasons:

1. It is consistent with the 99th percentile[9] combined wind and demand forecast error achieved in the SWIS across 2015-2017;
2. AEMO re-dispatches at 10 minute intervals within a trading interval;
3. It is a quantity that aligns with the LFAS capacity blocks available from existing LFAS service providers;
4. It can be achieved with at least two service providers enabled at all times, which meets AEMO's operational requirements; and

[9] The 99th percentile refers to the fact that 99% of time the combined error in forecast and wind was less than this value.

5. Historical evidence suggests this will be sufficient to meet the requirements of clause 3.10.1(a)(ii) of the WEM Rules.

The following LFAS requirement is proposed for the 2018-19 period:

1. **LFAS (raise) 72 MW**
2. **LFAS (lower) 72 MW.**

While minimum quantities of LFAS are required throughout the year, AEMO may require additional LFAS to be provided in real time during short-term periods of high variability in non-scheduled generation or rapidly changing levels of output from rooftop PV systems. This is an emerging challenge. AEMO will monitor this trend and, where necessary, will take action to maintain frequency and power system security.

4.2 Spinning Reserve

The Spinning Reserve requirement must meet both the Ancillary Services Standards and the SWIS operating standards. Clause 3.10.2(a) of the WEM Rules requires the standard for Spinning Reserve to be a level that is sufficient to cover the greater of:

i. 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

ii. the maximum load ramp expected over a period of 15 minutes[10].

The SWIS Operating Standard requires that the frequency remain within the band of 48.75 – 51 Hz for a single contingency event.

The Spinning Reserve requirement proposed for 2018-19 is the maximum of:

1. **70% of the largest generating unit; and**
2. **70% of the largest contingency event that would result in generation loss[11].**

As shown in Figure 2, AEMO will adjust the available Spinning Reserve close to real time to match the operational conditions.

4.3 Load Rejection Reserve

The LRR Requirement must meet both the Ancillary Services Standards and the SWIS Operating Standards. Clause 3.10.4(a) of the WEM Rules requires that the standard for Load Rejection Reserve is 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). The SWIS Operating Standards[12] require the frequency to be maintained below 51 Hz for a single contingency event and require it to be restored below 50.5 Hz within 2 minutes of a single contingency event.

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[10] Analysis was done to review the load ramp over a 15-minute period during the last year. While there are no periods when the ramp rate in a 15-minute period exceeded 70% of the largest contingency, it is moving more towards this at particular times of the day and will be monitored going forward.

[11] AEMO's obligation to ensure Power System Security may require AEMO to dispatch to reduce the size of the largest contingency. This may occur more frequently, particularly at lower inertia levels.

[12] See clause 2.2.1 and Table 2.1 of the Technical Rules.

The largest credible load rejection event is approximately 120 MW, and is typically the loss of a transmission line. This may be a radial line feeding the Eastern Goldfields region under specific conditions, or a single line feeding a particular customer. Larger load rejection events may occur for a fault with associated voltage dip. As an example, an estimated 260 MW was lost as a result of a fault near the Perth metropolitan area during 2017. These are not explicitly catered for as credible load rejection events, but the additional downward response from generators not providing LRR assists in arresting the frequency increase.

LRR is one response of the power system to a sudden drop in load. The governor capability required by the Technical Rules for all generators will also act to mitigate the loss of load as the frequency initially increases. Some non-scheduled generators also automatically reduce output at specified frequencies.

The proposed LRR requirement for 2018-19 is a maximum of 120 MW (with a 25% allowance if AEMO considers that the probability of transmission faults is low).

4.4 Dispatch Support Services

The requirement for the current DSS contract is to ensure regional reliability to the Kalgoorlie and Geraldton areas is achieved, given the higher network reliability risks in those areas. The present DSS contract compensates Synergy for when the West Kalgoorlie and Mungarra generators are dispatched and the Balancing Price does not cover the unit operating costs.

Synergy has announced that the Mungarra and West Kalgoorlie generators will be retired on 30 September 2018. AEMO is currently in discussions with Synergy, Western Power and the Public Utilities Office regarding the appropriate approach for maintaining power system security and reliability in the Kalgoorlie and Geraldton regions after 30 September 2018.

4.5 System Restart

AEMO requires three system restart facilities with the capability to start up under black system conditions and energise the rest of the system. The three black start facilities should not be in the same location to mitigate the risk of common failure in the same geographic or electrical area. The requirement for three facilities is because one may be on a Planned Outage and one may experience a Forced Outage.

The proposed system restart requirement for 2018-19 is three facilities with system restart capability.

5 Ancillary Services Plan for financial year 2018-19

5.1 Load Following Ancillary Service

LFAS will be sourced through the LFAS market. A minimum of 72 MW will be required from Market Participants. The price paid for LFAS will depend on the clearing price within the LFAS Market.

5.2 Spinning Reserve

Spinning Reserve will be sourced as follows:

1. 42 MW from a long-term interruptible load contract
2. 26 MW from short-term contracts (currently being finalised, with contract prices to be at a discount to the Synergy administered price)
3. Remainder of the real-time requirements to be provided by the Balancing Portfolio. The quantities to be paid for are those assumed in the modelling done to support the margin value determination.

5.3 Load Rejection Reserve

Up to 120 MW of LRR will be provided by the Balancing Portfolio.

5.4 Dispatch Support Service

The existing DSS contract with Synergy will end on 30 September 2018. As noted in Section 4.4, AEMO is currently in discussions with Synergy, Western Power and the Public Utilities Office regarding the appropriate approach for maintaining power system security and reliability in the Kalgoorlie and Geraldton regions after 30 September 2018.

5.5 System Restart Service

The contract with Synergy for the System Restart Service at Kwinana ends on 30 June 2018.

The contract with Synergy for the System Restart Service at Pinjar on units 3 and 5 will continue to apply for the 2018–19 financial year[13]. This contract expires on 30 June 2021.

The contract with Perth Energy for the System Restart Service at Kwinana Donaldson will continue to apply for the 2018–19 financial year. This contract ends on 30 June 2021.

A new contract with Synergy has been signed for the System Restart Service at Kemerton Power Station. This facility is currently being constructed and is planned to be commissioned in November 2018. Once commissioned, this will achieve system restart capability in the North Metropolitan, South Metropolitan and South Country regions, which will then, in the event of a complete system shutdown, allow three separate islands to be established with both significant generation and load. This is in accordance with AEMO's system restart plans.

[13] This is a single contract covering both unit 3 and unit 5. Due to the potential common mode failure at a single generating location, these are not considered two individual system restart facilities.

Table 10 Summary of Ancillary Services requirements and plan to procure for financial year 2018–19

	Requirement	Method to procure	Cost
LFAS raise	72 MW	LFAS market	LFAS Market clearing price
LFAS lower	72 MW	LFAS market	LFAS Market clearing price
Spinning Reserve	70% of largest contingency	42 MW from long-term interruptible load contract	Contract price
		26 MW from short-term contracts currently being finalised	Contract price as discount of Synergy administered price
		Remainder provided by Balancing Portfolio	Quantities to be paid for are as per the modelling outcome done for the margin values determination. Administered price to be paid as per the ERA determination.
Load Rejection Reserve	Up to 120 MW	Up to 120 MW of LRR will be provided by the Balancing Portfolio.	Annual price paid as per ERA Cost_LR determination for period 2016–17 to 2018–19
DSS	AEMO will continue to dispatch facilities under current DSS contract. AEMO is in discussions with other parties regarding DSS after 30 September 2018.		Contract price. System requirements will determine the quantity.
System Restart	Three facilities	Contracts with three providers	Contract price

A1. LFAS Provision

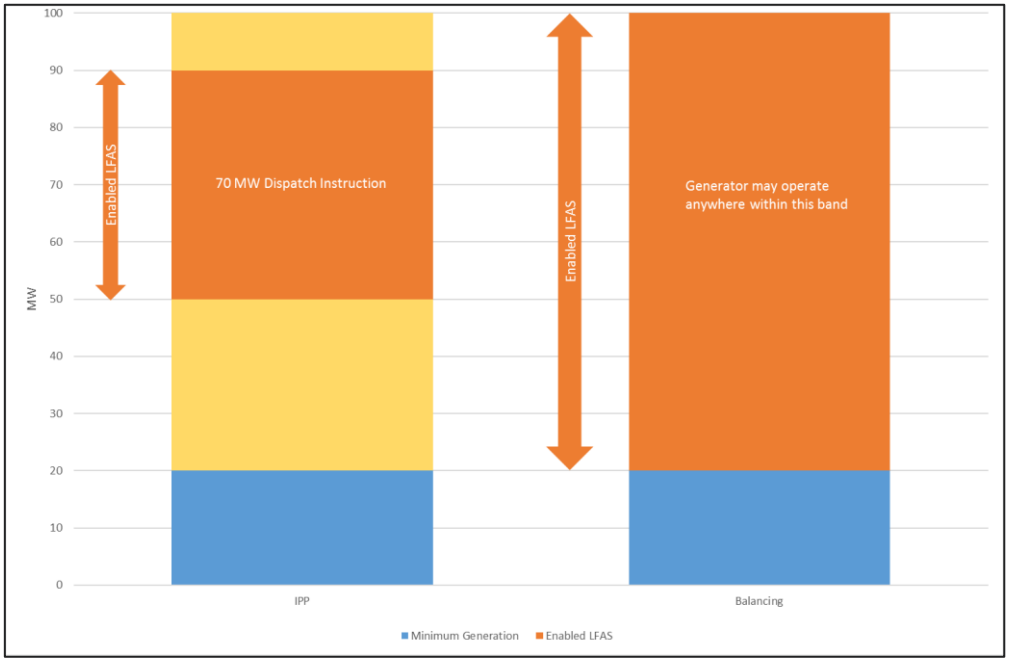
As presented in Section 2.1.1, the amount of LFAS enabled on average throughout the 2017–18 reporting period exceeded the target 72 MW quantity. There are a number of reasons for this. LFAS is used to respond to uncertainty in the power system and to generator or load movements that affect the balance between supply and demand within a trading interval. The uncertainty includes the volatile output of non-scheduled generators, as well as variations in actual demand from forecast demand. Large movements in the output of individual generators between trading intervals requires sufficiently fast movement of other generators to compensate for this.

A1.1 Enabling generators to provide LFAS

The LFAS Market determines which Market Participants provide LFAS. The practical implementation of LFAS provision is different for Synergy (Balancing Portfolio) generators and non-Synergy generators (independent power producers or IPPs). This difference is due to the manner in which the Balancing Portfolio is dispatched.
In the Balancing Market, IPPs are given a balancing base point, representing their Dispatch Instruction for a trading interval. For IPPs providing LFAS, this balancing base point is used as the target from which the LFAS limits are specified either up (LFAS raise), down (LFAS lower) or in both directions.

As the example in Figure 3 shows, if a 100 MW IPP were to receive a Dispatch Instruction of 70 MW for a particular trading interval and was cleared to provide 20 MW LFAS up and 20 MW LFAS down in the same trading interval, the low and high operating limits would be set to 50 MW and 90 MW respectively. In this way, the capability to provide exactly 20 MW LFAS raise and 20 MW LFAS lower has been provided.

Figure 3 Comparison of LFAS Enablement for IPPs and Balancing Portfolio



Balancing Portfolio Facilities do not receive Dispatch Instructions. AEMO dispatches Balancing Portfolio Facilities to the total levels determined through the market, for energy and ancillary services, according to dispatch guidelines provided by Synergy[14].

AEMO is able to remotely change the output of some generators and, for others, can issue telephone instructions regarding an output change. However, this output does not automatically become the balancing base point to be used in the AGC algorithm.

AEMO dispatches the Balancing Portfolio Facilities to compensate for variability within the portfolio. This includes variability from wind farms as well as other generators. AEMO reviews how much LFAS is being provided by IPPs and enables specific Balancing Portfolio Facilities to provide the balance. When a Balancing Portfolio Facility is enabled to provide LFAS, it does not have a set balancing base point like IPP Facilities do. Therefore, a Balancing Portfolio Facility's *full range* of output can be used to provide LFAS, and is used to calculate the enablement quantity.

As per the example in Figure 3, if a 100 MW generator, with a minimum capability of 20 MW was enabled for LFAS, it could move anywhere between 20 MW and 100 MW. It is considered to be enabled for 80 MW of LFAS, 40 MW for LFAS raise and 40 MW for LFAS lower. The actual available response in either direction at any point in time depends on its output at the time.

[14] The dispatch guidelines apply to Balancing Portfolio Facilities for dispatch of energy and ancillary services.

When all Facilities are bidding and dispatched individually, this issue will no longer be a constraint. AEMO is currently replacing its EMS system, and the opportunity to enhance this process will be explored.

A1.2 Selection of generators to provide LFAS

The typical provision of LFAS from IPPs in the WEM is currently 30 MW. This results in Balancing Portfolio Facilities providing 42 MW of LFAS raise and 42 MW of LFAS lower – a total range of 84 MW. The Balancing Portfolio Facilities that are preferred by Synergy to provide LFAS have an operating range of about 76–80 MW considering the minimum generation limit. Thus, two Balancing Portfolio Facilities are always required with their full range enabled, and are included in the calculation.

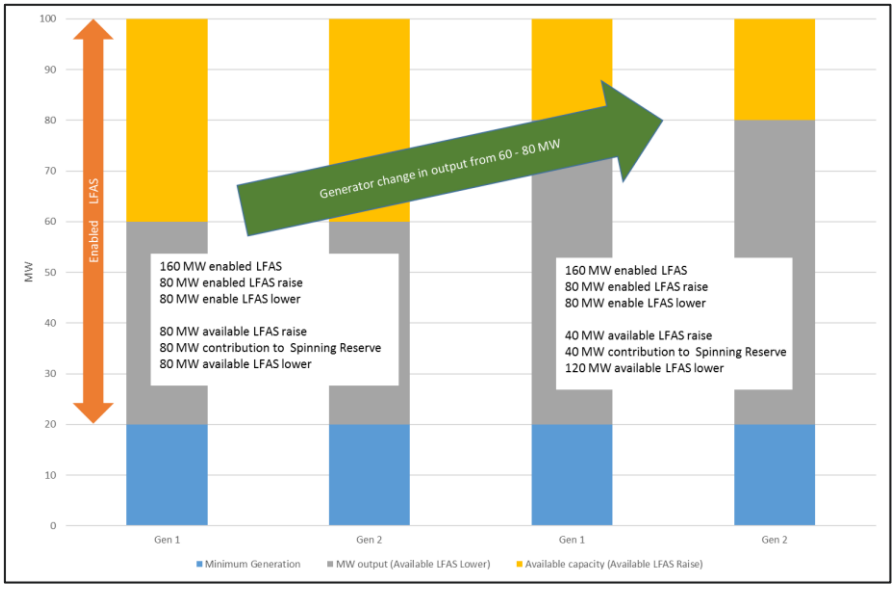
If targeting an absolute value of LFAS was the only objective, it might be possible to use smaller generators in combination with the bigger ones. However, Synergy's dispatch guidelines and AEMO's implementation of these guidelines consider the overall impact of balancing energy and ancillary services requirements throughout the day. Using a small generator would not meet other needs, and may require more frequent generator commitments and decommitments. If two generators providing approximately 78 MW of LFAS capability in each direction are in service together with the 30 MW from the IPPs, it is common for close to 110 MW to be enabled.

A1.3 Contribution of LFAS raise to Spinning Reserve

Another contributing factor to enabling greater than ±72 MW of LFAS relates to the interaction between Spinning Reserve and LFAS. Available Spinning Reserve capacity includes the capacity associated with LFAS raise, from generators also able to provide Spinning Reserve. The enablement of adequate LFAS assists with frequency regulation and the requirement to keep the power system at a secure frequency. The requirement for adequate Spinning Reserve has an immediate power system security impact. If in some periods of time the LFAS raise quantity has been used (that is LFAS-enabled generators have increased their output in response to AGC signals) then the amount of available Spinning Reserve may become lower than 70% of the largest contingency, resulting in potential power system security implications[15]. In these circumstances, additional Synergy gas turbines may be brought online to provide this Spinning Reserve. If this generator has the capability to provide LFAS, it may be enabled to increase the amount of available LFAS capability subsequently used in the calculations.

[15] The WEM Rules require sufficient allocation of capacity to provide Spinning Reserve, not actual Spinning Reserve availability.

Figure 4 Interaction of LFAS and Spinning Reserve



In the example shown in Figure 4, two generators generate 60 MW each. They provide LFAS and contribute 80 MW to Spinning Reserve. If their output increases, the LFAS enablement stays the same. However, the contribution to Spinning Reserve between the two generators drops to 40 MW. If this change persisted, additional Spinning Reserve would need to be made available, potentially by bringing on another generator. If enabled, this generator could also then provide LFAS.

A2. Response to ERA recommendations from 2017 Ancillary Services Report

The ERA made two recommendations in response to AEMO's 2017 Ancillary Services Report:

1. System Management should investigate improving LFAS measurement
2. System Management should investigate the drivers of frequency performance in excess of the standards.

AEMO engaged an independent consultant to assess these recommendations. The scope of work included reviewing the drivers of frequency performance, as well as determining an appropriate methodology for estimating LFAS requirements. The ERA recommendation regarding improving LFAS measurement was considered as a driver towards more accurate estimation of LFAS requirements.

The independent consultant has confirmed that the currently available data does not enable variations in Area Control Error (ACE) caused by frequency changes to be separated out from variations due to AEMO dispatch of the Balancing Portfolio. This challenge will be addressed when individual facilities in the Balancing Portfolio have the capability to bid and receive Dispatch Instructions (Facility Bidding).

The independent consultant made the following conclusions with respect to frequency performance:

1. Frequency regulation in the SWIS is achieved by a combination of AGC and governor action. Because the Technical Rules require the dead band of a generator to be less than 0.05 Hz, many generators will respond to changes in frequency, even within the normal operating band. This governor control works with AGC to ensure frequency remains within the normal operating band and contributes to the frequency performance of the SWIS above the minimum standard.

2. The frequency regulation provided through LFAS will complement the governor response by returning the frequency to 50 Hz.

In addition, appendix A1also outlines that due to the way the Balancing Portfolio is dispatched, more LFAS capability is often enabled than the target 72 MW quantity.