



# Implementation of the National Electricity Amendment (Mandatory Primary Frequency Response) Rule 2020

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**Status as at 5 May 2023**

A report for the National Electricity Market

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# Important notice

## PURPOSE

AEMO publishes this report to inform industry about AEMO's implementation of the National Electricity Amendment (Mandatory Primary Frequency Response) Rule 2020 (Mandatory PFR Rule).

This publication has been prepared by AEMO using information available at 5 May 2023. This information will be updated and superseded by future implementation reports until full implementation.

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## Current version release details

Version	Effective date	Summary of changes
25	8/5/23	Status as at 5 May 2023

Note: There is a full version history at the end of this document.

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# 1. Summary

This report provides information on the implementation of the National Electricity Amendment (Mandatory Primary Frequency Response) Rule 2020<sup>1</sup> (Mandatory PFR Rule). It will be updated regularly as implementation proceeds.

The Mandatory PFR Rule affects *Scheduled Generators* and *Semi-Scheduled Generators* (Affected Generators), whose *generating systems* (Affected GS) are required to provide *primary frequency response* (PFR) in accordance with the *primary frequency response parameters* (PFRP) specified in the *Primary Frequency Response Requirements* (PFRR), unless exempted or a variation to those requirements is granted by AEMO.

Implementation of the Mandatory PFR Rule commenced from late September 2020. Around 53,600 MW, or around 89% of Affected GS subject to the Mandatory PFR rule, have now either:

- implemented setting changes to become fully compliant with the PFR rule requirements, or
- implemented setting changes that represent an agreed variation from the default requirements outlined in the PFRR, or
- advised they were already in compliance with the PFR rule requirements, or
- agreed to implement compliant PFR settings at the end of their commissioning process, or at some other agreed future date, or
- agreed in-principle PFR settings, but require upgraded control system software before these settings can be implemented
- been granted an exemption from the requirement of the Mandatory PFR rule by AEMO.

Almost all capacity now remaining to implement PFR settings consistent with the Mandatory PFR rule requirements consists of Semi-Scheduled Generators (i.e. Wind and PV). A number of these generators will require control system software updates to meet the requirements of the Mandatory PFR rule, as their current control systems are not capable of complying. Work to implement the requirements of the Mandatory PFR rule across the NEM fleet of Semi-Scheduled generation remains ongoing.

## 2. Applications for Variation or Exemption

As outlined in the PFRR, generators may apply to either vary the default PFR requirements outlined in the PFRR, or to be fully exempted from the requirements of the Mandatory PFR rule.

Table 1 details the number of applications for variation received in respect of Affected GSs, those granted and those still under consideration as at the date of this report.

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<sup>1</sup> Available at <https://www.aemc.gov.au/rule-changes/mandatory-primary-frequency-response>.

**Table 1 Variations**

	Applications for Variation	Variations Granted	Variations not Granted	Variations being Assessed
<b>Number of Affected GS</b>	47	45	2	

Table 2 details the number of applications for exemption received in respect of Affected GSs, those granted and those still under consideration as at the date of this report. This summary also includes generation where a standing exemption was applied.

**Table 2 Exemptions**

	Applications for Exemption	Exemptions Granted	Exemptions not Granted	Exemptions being Assessed
<b>Number of Affected GS</b>	38	15	20	3

# 3. Implementation of PFR Settings

## 3.1 Implementation of PFR setting changes

Information on implementation of PFR Settings, including timing, is shown in Table 3. This table also includes information on generation where PFR exemptions or variations have been granted.

Some Affected Generators indicated a preference to make staged changes to frequency response deadbands, in which case, more than one implementation date has been listed in Table 3. Other Affected Generators elected to alter settings in one step, and in these cases, a single implementation date is listed.

A number of Semi-Scheduled Affected GS are experiencing delays in implementation of PFR settings, and now form the majority of the Affected GS remaining to complete PFR setting changes. This is discussed further in section 3.2.

## 3.2 Implementation for Semi-Scheduled Generation

The Mandatory PFR Rule represents a material change to the operation of some Semi-Scheduled generation. Much of this generation had either not previously operated in frequency response mode, or had previously operated with PFR settings such that response to frequency was a relatively rare event.

To comply with the requirements of the Mandatory PFR rule, Semi-Scheduled generators must be capable of overall active power control allowing for simultaneous MW curtailment, MW ramping, frequency response outside a relatively small frequency deadband, and ongoing variation in input energy.

It has been identified through testing that many existing Semi-Scheduled generators are unable to simultaneously coordinate these various requirements around overall active power control. These sites will require updates to control software, particularly to Power Plant Controllers (PPC) or similar, to comply with these requirements of the Mandatory PFR rule. This is materially different to Scheduled generation, where almost all Scheduled generators were able to comply by making setting changes to existing control systems.

In some cases, control software supplied with the even the newest Affected GS for some OEMs is still unable to meet the requirements of the Mandatory PFR rule. In these cases, either further software development by the OEMs is required, followed by site upgrades, or alternately some form of variation to the PFR requirements will need to be granted, to allow compliance with the Mandatory PFR rule.

Control system software updates to allow compliance with the Mandatory PFR rule can involve the site operator, the local NSP, multiple teams within AEMO, and in some cases 3<sup>rd</sup> party consultants. The risk of unintended changes in plant performance when making control system software updates must be handled carefully. The complexity of this process, along with resource limitations across the industry, have seen ongoing delays.

AEMO have been prioritising PFR implementation for Semi-Scheduled generation for those OEMs with the greatest installed MW capacity. With around 20 different Semi-Scheduled generation OEMs in the NEM, this has delayed implementation for sites using equipment from OEMs used in a smaller number of sites.

At the time of writing, PFR setting changes have either already been implemented, or an agreement is in place for implementation of settings changes, across 36 Semi-Scheduled Affected GSs using seven major OEMs' equipment, as reported in Table 3.

While AEMO have agreed in-principle PFR settings for a number of additional existing Semi-Scheduled generators, in many cases implementation has been unable to proceed, due to lack of availability of suitable control system software. Where PFR Settings have been agreed but a planned implementation date has not yet been confirmed, Table 3 contains a “#” symbol for relevant Affected GSs in the relevant column regarding implementation date.

Work to rollout PFR across the semi-scheduled generation fleet remains ongoing.

### 3.3 Change to Automatic Generation Control (AGC)

Automatic Generation Control (AGC) is used by AEMO to remotely control the output of some generation. It is used both for ramping generation between 5-minute energy spot market targets, and for slower, centralised (secondary) response to changes in power system frequency. AEMO procures secondary frequency control MW reserves (Regulation FCAS) via a 5-minute spot market, for subsequent use by AEMO's AGC to support power system frequency control.

Following the changes in generator primary frequency control settings commencing in late September 2020, and the resultant changes in power system frequency conditions, a number of changes were made to AEMO's AGC area level tuning. These changes commenced from 9 December 2020 and were aimed at ensuring better utilisation of available Regulation FCAS.

Changes to AGC area level parameters covered AGC deadbands, minor adjustments to gains, changes to make integral area control error (ACE) more persistent and enablement of AGC basepoint adjustment. No changes were made to Regulation FCAS constraint equations, which govern the MW volume of Regulation FCAS reserve procurement, or to individual generator AGC tuning as part of this work.

Following these changes, the daily distribution of NEM frequency became narrower, suggesting these AGC changes improved the control of frequency under normal operating conditions. However, it was identified in early January 2021 that the introduction of AGC basepoint adjustment interfered with data transfer processes used by the existing causer pays process, which allocates Regulation FCAS costs.

To address the impacts on the causer pays process, the change to implement AGC basepoint adjustment was reversed on 18 January 2021. The impact of other AGC changes on power system frequency control continues to be monitored.

AEMO are also now considering how the Primary Frequency Response Incentive<sup>2</sup> rule, published on 8 September 2022, which include changes to the arrangements for allocation of Regulation FCAS costs, may

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<sup>2</sup> For more details on primary frequency response incentives see: <https://www.aemc.gov.au/rule-changes/primary-frequency-response-incentive-arrangements>

affect AEMO's ability to tune AGC to better support power system frequency control. In particular, AEMO are assessing options to improve AGC performance prior to commencement of Primary Frequency Response Incentives rule in mid 2025.

### 3.4 Consultation on final Primary Frequency Response Requirements (PFRR)

In June 2020 AEMO published the Interim Primary Frequency Response Requirements (PFRR)<sup>3</sup>. This document outlined the basic technical performance requirements for Affected Generating Systems to comply with the Mandatory PFR rule. It also described a process for managing the initial transition of the existing generation fleet to comply with the Mandatory PFR rule, including a process for managing changes to control system settings on existing Affected GS in a coordinated manner.

The Primary Frequency Response Incentives rule, published on 8 September 2022, required AEMO to consult on and determine any amendments to the Interim PFRR, and to publish final PFRR by 8 May 2023. This consultation has now concluded, and on 4 May 2023 AEMO published the final PFRR<sup>4</sup>, effective from 8 May 2023.

## 4. Register of Affected GS

Table 3 details, for each Affected GS, the planned or actual dates for completion of implementation of the PFR Settings agreed with AEMO, and whether AEMO has granted an exemption or variation from the PFRP.

Where a variation has been granted, the table also indicates which PFRP has been varied. Where further information regarding a variation or exemption is provided as a footnote, that information has been included with the consent of the Affected Generator.

A single implementation date under the 'Stage 1' column indicates that full implementation of the PFR Settings is to be, or has been, achieved by that date. The 'Stage 2' column will only be populated where the frequency deadband has been tightened in two stages, or other control changes have been made in more than one step.

At the time of writing, Affected GSs with an installed capacity of approximately 40,800 MW have either fully implemented PFR Settings, or were already providing PFR that meets the PFRP.

An additional 3,100 MW of generation will implement PFR settings at or prior to the completion of commissioning, or at an agreed future date.

This collectively represents approximately 74% of the approximately 58,900 MW of NEM installed capacity that is required to meet the Mandatory PFR Rule<sup>5</sup>.

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<sup>3</sup> Available at: <https://aemo.com.au/-/media/files/initiatives/primary-frequency-response/2020/interim-pfrr.pdf>

<sup>4</sup> Available at: <https://aemo.com.au/consultations/current-and-closed-consultations/primary-frequency-response-requirements>

<sup>5</sup> This figure excludes capacity that has been exempted from the provisions of the PFR rule.

**Table 3 Register of Affected GS**

Affected GS Name	DUID	Reg Cap (MW)	PFR Settings changes to be (or have been) implemented for ongoing operation by		Exemption	Variation	PFRP Varied
			Stage 1	Stage 2 <sup>6</sup>			
Adelaide Desalination Plant PV	ADPPV1	19	#				
Adelaide Desalination Plant BESS	ADPBA1G	6	6 Aug 21				
Angaston PS	ANGAST1	50	25 Jun 21				
Ararat WF	ARWF1	241	#				
Avonlie SF	AVLSF1 <sup>7</sup>	254	Prior to or upon completion of commissioning				
Bairnsdale PS	BDL01	47	2 Dec 21				
Bairnsdale PS	BDL02	47	2 Dec 21				
Bald Hills WF	BALDHWF1	106	11 Aug 21				
Ballarat BESS	BALBG1	30	30 Oct 21				
Bango 973 WF	BANGOWF1	159	#				
Bango 999 WF	BANGOWF2	84	#				
Barcaldine PS	BARCALDN	37	8 Jun 22				
Barker Inlet PS	BARKIPS1	211	Pre-existing		Yes	Response time <sup>8</sup>	
Barron Gorge PS	BARRON-1	30	6 May 21				
Barron Gorge PS	BARRON-2	30	6 May 21				
Bastyan PS	BASTYAN	80	Pre-existing				
Bayswater PS	BW01	660	29 Sep 20	14 Oct 20			
Bayswater PS	BW02	660	16 Oct 20				
Bayswater PS	BW03	660	3 Nov 20				
Bayswater PS	BW04	660	29 Sep 20	14 Oct 20			
Bell Bay Three PS	BBTHREE1	35	Pre-existing				
Bell Bay Three PS	BBTHREE2	35	Pre-existing				
Bell Bay Three PS	BBTHREE3	35	Pre-existing				
Berrybank WF	BRYB1WF1	180	28 Oct 21				

<sup>6</sup> This column will be populated only when deadband adjustments will be made in two stages.

<sup>7</sup> To be confirmed following registration.

<sup>8</sup> AEMO has granted a variation in respect of response time, where 12 sec is required to achieve a 5% change in output.

Affected GS Name	DUID	Reg Cap (MW)	PFR Settings changes to be (or have been) implemented for ongoing operation by		Exemption	Variation	PFRP Varied
			Stage 1	Stage 2 <sup>6</sup>			
Beryl SF	BERYLSF1	98	#				
Blowering PS	BLOWERNG	80			Yes <sup>9</sup>		
Bluegrass SF	BLUEGSF1	183	Prior to or upon completion of commissioning				
Boco Rock WF	BOCORWF1	113	Pre-existing			Yes	Deadband <sup>10</sup>
Bodangora WF	BODWF1	113	30 Jun 23				
Bogong / Mackay PS	MCKAY1	300	22 Oct 20				
Bolivar PS <sup>11</sup>	BOLIVPS1	123	30 Mar 21				
Bolivar Wastewater Plant PV	BOWWPV1	6	#				
Bolivar Wastewater Plant BESS	BOWWBA1G	3	13 May 22				
Bomen SF	BOMENSF1	121	#				
Braemar PS	BRAEMAR1	168	9 July 22				
Braemar PS	BRAEMAR2	168	30 Jun 22				
Braemar PS	BRAEMAR3	168	30 Jun 22				
Braemar 2 PS	BRAEMAR5	173	30 Mar 21	30 Jun 23			
Braemar 2 PS	BRAEMAR6	173	30 Mar 21	30 Jun 23			
Braemar 2 PS	BRAEMAR7	173	30 Mar 21	30 Jun 23			
Broken Hill SF	BROKENH1	53	#				
Callide B PS	CALL_B_1	350	8 Nov 20	18 Nov 20			
Callide B PS	CALL_B_2	350	30 Sep 20	28 Oct 20			
Callide C PS	CPP_3	420	9 Nov 20	26 Nov 20		Yes	Response time
Callide C PS	CPP_4	420	10 Dec 20			Yes	Response time
Capital BESS	CBESS1 <sup>12</sup>	100	Prior to or upon completion of commissioning				
Cattle Hill WF	CLHLWF1	148	#				
Cethana PS	CETHANA	85	Pre-existing				

<sup>9</sup> AEMO has granted an exemption on the basis of environmental restrictions imposed by a 3<sup>rd</sup> party..

<sup>10</sup> AEMO has granted a variation to the deadband at  $\pm 100$  mHz based on the currently known capabilities of the Affected GS for a period of 36 months.

<sup>11</sup> Was previously SA Temporary Generation South, generating units relocated to new site.

<sup>12</sup> To be confirmed following registration

Affected GS Name	DUID	Reg Cap (MW)	PFR Settings changes to be (or have been) implemented for ongoing operation by		Exemption	Variation	PFRP Varied
			Stage 1	Stage 2 <sup>6</sup>			
Cherry Tree WF	CHYTW1	57	29 Nov 21				
Christies Beach WWTP BESS	CBWWBA1G	2	Prior to or upon completion of commissioning				
Clare SF	CLARESF1	110	#				
Clements Gap WF	CLEMG1	57		Yes <sup>13</sup>			
Clermont SF	CLERMSF1	92	#				
Coleambally SF	COLEASF1	180	#		Yes	Deadband <sup>14</sup>	
Collector WF	COLWF01	226	Prior to or upon completion of commissioning				
Colongra PS	CG1	181	4 Jun 21				
Colongra PS	CG2	181	4 Jun 21				
Colongra PS	CG3	181	4 Jun 21				
Colongra PS	CG4	181	3 Jun 21				
Columboola SF	COLUMSF1	217	#				
Condamine PS	CPSA	144	19 May 21				
Coopers Gap WF	COOPGWF1	452	Prior to or upon completion of commissioning				
Corowa SF	CRWASF1	36	#				
Crookwell 2 WF	CROOK2WF	96	#				
Crowlands WF	CROWLWF1	79	6 Jun 22		Yes	Deadband <sup>15</sup>	
Crudine Ridge WF	CRURWF1	138	#				
Darling Downs PS	DDPS1	644	15 Jun 20				
Darling Downs SF	DDSF1	121	#				
Darlington Point SF	DARLSF1	324	#				
Dartmouth PS	DARTM1	185	17 Nov 20				
Daydream SF	DAYDSF1	167	#				
Devils Gate PS	DEVILS_G	60	30 Jun 21				

<sup>13</sup> AEMO has granted an exemption on the basis of inherent incapability to meet the PFR requirements.

<sup>14</sup> The Affected GS will be operated with a deadband of  $\pm 0.020$  Hz due to the 2-digit precision of the frequency measurement used.

<sup>15</sup> The Affected GS will be operated with a deadband of  $\pm 0.075$  Hz, to ensure that changes in active power output due to frequency always act to correct system frequency.

Affected GS Name	DUID	Reg Cap (MW)	PFR Settings changes to be (or have been) implemented for ongoing operation by		Exemption	Variation	PFRP Varied
			Stage 1	Stage 2 <sup>6</sup>			
Dry Creek PS	DRYCGT1	52	13 Jan 21				
Dry Creek PS	DRYCGT2	52	13 Jan 21				
Dry Creek PS	DRYCGT3	52	13 Jan 21				
Dundonnell 1 WF	DUNDWF1	168	8 Jun 22				
Dundonnell 2 WF	DUNDWF1	46	8 Jun 22				
Dundonnell 3 WF	DUNDWF1	121	8 Jun 22				
Eildon PS	EILDON1	60	11 Mar 21				
Eildon PS	EILDON2	60	11 Mar 21				
Elaine WF	ELAINWF1	83	26 Oct 22				
Emerald SF	EMERASF1	88	#				
Eraring PS	ER01	720	27 Oct 20		Yes	Response time	
Eraring PS	ER02	720	16 Oct 20		Yes	Response time	
Eraring PS	ER03	720	13 Oct 20		Yes	Response time	
Eraring PS	ER04	720	20 Oct 20		Yes	Response time	
Finley SF	FINLYSF1	162	#				
Fisher PS	FISHER	43	Pre-existing		Yes	Deadband, Response Time <sup>16</sup>	
Gangarri SF	GANGARR1	162	#				
Gannawarra BESS	GANNBG1	30	25 May 21				
Gladstone PS <sup>17</sup>	GSTONE1	280					
Gladstone PS	GSTONE2	280					
Gladstone PS	GSTONE3	280					
Gladstone PS	GSTONE4	280					
Gladstone PS	GSTONE5	280					
Gladstone PS	GSTONE6	280					
Glenrowan West SF	GLRWNSF1	132	#				

<sup>16</sup> AEMO has granted a variation to the deadband at  $\pm 100$  mHz, and has recorded a response time of 15 seconds for a 5% change in output, based on the currently known capabilities of the Affected GS.

<sup>17</sup> In November 2021, CS Energy gave the AER a notice of non-compliance with the PFR requirements for Gladstone PS under the Queensland jurisdictional derogations in the National Electricity Rules. Clause 9.34.6 relieves CS Energy from compliance with a rules requirement if it is unable to obtain the necessary cooperation from the counterparties to the legacy agreements for the operation of Gladstone PS in the NEM. The AER is required to report quarterly on the non-compliance and its impact on the market under clause 9.34.6(l). The initial AER report can be found [here](#)

Affected GS Name	DUID	Reg Cap (MW)	PFR Settings changes to be (or have been) implemented for ongoing operation by		Exemption	Variation	PFRP Varied
			Stage 1	Stage 2 <sup>6</sup>			
Gordon PS	GORDON	432	Unit 1 – 16 Dec 20 Unit 2 – 28 Sep 20 Unit 3 – 29 Sep 20				
Granville Harbour WF	GRANWF1	111	7 May 21	21 Oct 21			
Gullen Range 1 WF	GULLRWF1	165	#				
Gullen Range 2 WF	GULLRWF2	110	#				
Gunning WF	GUNNING1	47	#				
Guthega PS	GUTHEGA	60	27 Jan 21				
Hallett PS <sup>18</sup>	AGLHAL	217	27 Oct 20				
Hallett WF	HALLWF1	95			Yes <sup>19</sup>		
Hallett 2 WF	HALLWF2	71			Yes <sup>20</sup>		
Happy Valley WWTP BESS	HVWWBA1G	8	17 June 22				
Happy Valley WWTP PV	HVWWPV1	4	#				
Haughton SF	HAUGHT11	132	#				
Hazelwood BESS	HBESSG1 <sup>21</sup>	150	Prior to or upon completion of commissioning				
Hillston SF	HILLSTN1	85	#				
Hornsedale Power Reserve	HPRG1	150	9 March 21	7 Jul 22			
Hornsedale 1 WF	HDWF1	112	#				
Hornsedale 2 WF	HDWF2	102	#				
Hornsedale 3 WF	HDWF3	102	#				
Hume PS	HUMEV HUMENSW	58			Yes		
Jeeralang PS	JLA01	51	19 Jan 21				
Jeeralang PS	JLA02	51	19 Jan 21				
Jeeralang PS	JLA03	51	19 Jan 21				

<sup>18</sup> Applicable to one *generating unit*, remainder previously complied with the PFRP.

<sup>19</sup> AEMO has granted an exemption on the basis of inherent incapability to meet the PFR requirements.

<sup>20</sup> AEMO has granted an exemption on the basis of inherent incapability to meet the PFR requirements.

<sup>21</sup> To be confirmed following registration

Affected GS Name	DUID	Reg Cap (MW)	PFR Settings changes to be (or have been) implemented for ongoing operation by		Exemption	Variation	PFRP Varied
			Stage 1	Stage 2 <sup>6</sup>			
Jeeralang PS	JLA04	51	19 Jan 21				
Jeeralang PS	JLB01	76	19 Jan 21				
Jeeralang PS	JLB02	76	19 Jan 21				
Jeeralang PS	JLB03	76	19 Jan 21				
Jemalong SF	JEMALNG1	50	#				
John Butters PS	JBUTTERS	144	1 Jul 21				
June SF	JUNEEF1	36	#				
Kaban WF	KABANWF1	152	Prior to or upon completion of commissioning				
Karadoc SF	KARSF1	104	#				
Kareeya PS	KAREEYA1	21	10 May 22				
Kareeya PS	KAREEYA2	21	24 May 22				
Kareeya PS	KAREEYA3	21	14 June 22				
Kareeya PS	KAREEYA4	21	24 Jan 22				
Kiamal SF	KIAMSF1	239	1 April 21	25 Nov 21 <sup>22</sup>			
Kiata WF	KIATAWF1	31	21 Jan 22				
Kidston SF	KSP1	50	#				
Kogan Creek PS	KPP_1	744	19 Nov 20	26 Nov 20			
Ladbroke Grove PS	LADBROK1	40	30 Aug 21				
Ladbroke Grove PS	LADBROK2	40	30 Aug 21				
Lake Bonney BESS	LBBG1	25	8 Dec 21				
Lake Bonney 2 WF	LKBONNY2	159			Yes <sup>23</sup>		
Lake Bonney 3 WF	LKBONNY3	39			Yes <sup>24</sup>		
Lake Echo PS	LK_ECHO	32	30 June 22			Yes	Response Time <sup>25</sup>
Laverton Nth PS	LNGS1	156	13 April 22			Yes	Deadband <sup>26</sup>

<sup>22</sup> Kiamal SF is currently providing PFR beyond a frequency deadband of +150 mHz, due to the capability of the currently installed control software.

<sup>23</sup> AEMO has granted an exemption on the basis of inherent incapability to meet the PFR requirements.

<sup>24</sup> AEMO has granted an exemption on the basis of inherent incapability to meet the PFR requirements.

<sup>25</sup> AEMO recorded a response time of 15 seconds for a 5% change in output, based on the currently known capabilities of the Affected GS.

<sup>26</sup> AEMO has granted a variation to the deadband at  $\pm 100$  mHz based on the currently known capabilities of the Affected GS for a period of 12 months.

Affected GS Name	DUID	Reg Cap (MW)	PFR Settings changes to be (or have been) implemented for ongoing operation by		Exemption	Variation	PFRP Varied
			Stage 1	Stage 2 <sup>6</sup>			
Laverton Nth PS	LNGS2	156	13 April 22			Yes	Deadband <sup>27</sup>
Lemonthyme PS Wilmot PS	LEM_WIL	82	31 Mar 21			Yes <sup>28</sup>	
Liapootah PS				Liapootah – Settings already in place			
Wayatinah PS	LI_WY_CA	173	Wayatinah – 26 May 21				
Catagunya PS			Catagunya Unit 1 – 26 May 21				
			Catagunya Unit 2 – 21 Jun 22				
Lilyvale SF	LILYSF1	118	#				
Limondale 1 SF	LIMOSF1	275	#				
Limondale 2 SF	LIMOSF2	38	#				
Lincoln Gap WF Stage 1	LGAPWF1	126	#				
Lonsdale PS	LONSDALE	21	30 Apr 25				
Loy Yang A PS	LYA1	560	14 Oct 20				
Loy Yang A PS	LYA2	530	14 Oct 20	11 Nov 20			
Loy Yang A PS	LYA3	560	17 Nov 20				
Loy Yang A PS	LYA4	560	15 Oct 20				
Loy Yang B PS	LOYYB1	500	15 Dec 20	18 Dec 20			
Loy Yang B PS	LOYYB2	500	30 Sep 20	28 Oct 20			
Macarthur WF	MACARTH1	420	8 Feb 21				
Mackintosh PS	MACKNTSH	80	18 Mar 21				
Mannum Adelaide Pipe PV2	MAPS2PV1	13	#				
Mannum Adelaide Pipe PV3	MAPS3PV1	12	26 Apr 23 <sup>29</sup>				
Meadowbank PS	MEADOWBK	40	Pre-existing			Yes	Deadband <sup>30</sup>

<sup>27</sup> AEMO has granted a variation to the deadband at  $\pm 100$  mHz based on the currently known capabilities of the Affected GS for a period of 12 months.

<sup>28</sup> The *generating unit* at Lemonthyme PS is inherently incapable of meeting the PFR requirements. The *generating unit* at Wilmot PS meets all requirements.

<sup>29</sup> The Mannum-Adelaide pipeline 3 PV generation is currently providing PFR beyond a frequency deadband of +150 mHz, due to the capability of the currently installed control software.

<sup>30</sup> AEMO has granted a variation to the deadband at  $\pm 150$  mHz, based on the currently known capabilities of the Affected GS.

Affected GS Name	DUID	Reg Cap (MW)	PFR Settings changes to be (or have been) implemented for ongoing operation by		Exemption	Variation	PFRP Varied
			Stage 1	Stage 2 <sup>6</sup>			
Millmerran PS	MPP_1	426	1 Oct 20	28 Oct 20		Yes	Response time
Millmerran PS	MPP_2	426	12 Nov 20			Yes	Response time
Mintaro PS	MINTARO	90	27 Nov 20				
Moorabool WF	MOORAWF1	312	#			Yes	Deadband <sup>31</sup>
Moree SF	MOREESF1	57	#				
Morgan Whyalla Pump PV1	MWPS1PV1	6	#				
Morgan Whyalla Pump PV2	MWPS2PV1	6	#				
Morgan Whyalla Pump PV3	MWPS3PV1	8	#				
Morgan Whyalla Pump PV4	MWPS4PV1	6	#				
Mortlake PS	MORTLK11	283	30 Sep 20				
Mortlake PS	MORTLK12	283	6 Nov 20				
Mount Emerald WF	MEWF1	180	8 Oct 21				
Mt Gellibrand WF	MTGELWF1	138	#				
Mt Mercer WF	MERCER01	131	13 Dec 22			Yes <sup>32</sup>	
Mt Piper PS	MP1	730	21 Dec 20				
Mt Piper PS	MP2	700	29 Sep 20	28 Oct 20			
Mt Stuart PS	MSTUART3	131	22 Apr 21				
Murra Warra WF	MUWAWF1	231	#				
Murra Warra 2 WF	MUWAWF2	204	7 Feb 2023				
Murray PS <sup>33</sup>	MURRAY	1500	30 March 21				
Murray Bridge - Onkaparinga Pump Station No 2 PV	MBPS2PV1	10	#				
Musselroe WF	MUSSELR1	168	5 Aug 21	30 Jun 23			
Nevertire SF	NEVERSF1	132	#				
Newport PS	NPS	500	28 Sep 20	19 Oct 20			
North Brown Hill WF	NBHWF1	132			Yes <sup>34</sup>		

<sup>31</sup> AEMO has granted a variation to the deadband at  $\pm 100$  mHz based on the currently known capabilities of the Affected GS..

<sup>32</sup> The Affected GS will provide frequency response only for rising frequency.

<sup>33</sup> One *generating unit* (out of 14) had PFR Settings implemented in Oct 2021.

<sup>34</sup> AEMO has granted an exemption on the basis of inherent incapability to meet the PFR requirements

Affected GS Name	DUID	Reg Cap (MW)	PFR Settings changes to be (or have been) implemented for ongoing operation by		Exemption	Variation	PFRP Varied
			Stage 1	Stage 2 <sup>6</sup>			
Numurkah SF	NUMURSF1	112	#			Yes	Deadband <sup>35</sup>
Nyngan SF	NYNGAN1	100	#				
Oakey PS	Oakey1	144	30 Mar 21	2 Sep 21		Yes	Deadband
Oakey PS	Oakey2	144	30 Mar 21	2 Sep 21		Yes	Deadband
Oakey 1 SF	Oakey1SF	30	#				
Oakey 2 SF	Oakey2SF	65	#				
Oaklands Hill WF	OAKLAND1	67			Yes <sup>36</sup>		
Osborne PS	OSB-AG	180	Pre-existing				
Parkes SF	PARSF1	55	#				
Pelican Point PS	PPCCGT	478	30 Sep 20				
Phillip Island BESS	PIBESSG1 <sup>37</sup>	5	Prior to or upon completion of commissioning				
Poatina PS	POAT220	200	Pre-existing			Yes	Deadband, Response Time <sup>38</sup>
Poatina PS	POAT110	100	Pre-existing			Yes	Deadband, Response Time <sup>39</sup>
Port Lincoln PS	POR01	50	Pre-existing				
Port Lincoln PS	POR03	23	17 Jun 21				
Port Stanvac PS	PTSTAN1	58	1 Mar 23				
Quarantine PS	QPS1	29	31 Aug 21				
Quarantine PS	QPS2	24	30 Jun 24				
Quarantine PS	QPS3	24	7 Feb 22				
Quarantine PS	QPS4	24	30 Jun 24				
Quarantine PS	QPS5	128	1 April 21				
Reece PS	REECE1	116	16 Mar 21				
Reece PS	REECE2	116	31 Mar 21				

<sup>35</sup> The Affected GS will be operated with a deadband of  $\pm 0.020$  Hz due to the 2-digit precision of the frequency measurement used.

<sup>36</sup> AEMO has granted an exemption on the basis of inherent incapability to meet the PFR requirements.

<sup>37</sup> To be confirmed following registration

<sup>38</sup> The variation to the deadband is at  $\pm 100$  mHz. The variations were granted due to the inherent capability and design of the Affected GS.

<sup>39</sup> The variation to the deadband is at  $\pm 100$  mHz. The variations were granted due to the inherent capability and design of the Affected GS.

Affected GS Name	DUID	Reg Cap (MW)	PFR Settings changes to be (or have been) implemented for ongoing operation by		Exemption	Variation	PFRP Varied
			Stage 1	Stage 2 <sup>6</sup>			
Riverina BESS 1	RESS1G <sup>40</sup>	80		Prior to or upon completion of commissioning			
Ross River SF	RRSF1	128	#			Yes	Deadband
Roma PS	ROMA_7	40		Pre-existing		Yes	Deadband, Droop, Response time
Roma PS	ROMA_8	40		Pre-existing		Yes	Deadband, Droop, Response time
Rugby Run SF	RUGBYR1	83	#				
Rye Park WF	DUID1 <sup>41</sup>	128 <sup>42</sup>		Prior to or upon completion of commissioning			
Rye Park WF	DUID2 <sup>43</sup>	128 <sup>44</sup>		Prior to or upon completion of commissioning			
Rye Park WF	DUID3 <sup>45</sup>	128 <sup>46</sup>		Prior to or upon completion of commissioning			
Salt Creek WF	SALTCRK1	54		23 Sept 21			
Sapphire WF	SAPHWF1	270		23 Mar 21			
Sebastapol SF	SEBSF01	90	#				
Shoalhaven PS	SHGEN	240		Bendeela Unit 1 – 30 Oct 23			
				Bendeela Unit 2 - 31 Aug 21			
				Kangaroo Valley Unit 3 -30 Oct 24			
				Kangaroo Valley Unit 4–17 Feb 22			
Silverton WF	STWF1	198		30 Jun 23			
Smithfield Energy Facility	SITHE01	185		Pre-existing			

<sup>40</sup> To be confirmed following registration

<sup>41</sup> To be confirmed following registration

<sup>42</sup> To be confirmed following registration

<sup>43</sup> To be confirmed following registration

<sup>44</sup> To be confirmed following registration

<sup>45</sup> To be confirmed following registration

<sup>46</sup> To be confirmed following registration

Affected GS Name	DUID	Reg Cap (MW)	PFR Settings changes to be (or have been) implemented for ongoing operation by		Exemption	Variation	PFRP Varied
			Stage 1	Stage 2 <sup>6</sup>			
Snapper Point PS	SNAPPER1	154	Pre-existing				
Snowtown WF	SNOWTWN1	99			Yes		
Snowtown WF Stage 2	SNOWNTH1	144	#				
Snowtown Sth WF	SNOWSTH1	126	#				
Snuggery PS	SNUG1	63	Unit 1 – Pre Existing			Yes	Response Time <sup>47</sup>
			Unit 2 – 15 Jun 21				
			Unit 3 – Pre Existing				
Somerton PS	AGLSOM	170	2 Jul 21				
Stanwell PS	STAN-1	365	27 Oct 20				
Stanwell PS	STAN-2	365	27 Oct 20				
Stanwell PS	STAN-3	365	27 Oct 20				
Stanwell PS	STAN-4	365	29 Oct 20				
Stockyard Hill WF	STOCKYD1	531	#			Yes	Deadband <sup>48</sup>
Sunraysia SF	SUNRSF1	228	#				
Susan River SF	SRSF1	85	#				
Swanbank E PS	SWAN_E	385	8 Dec 20			Yes	Response Time
Tailem Bend 2 BESS	TB2BG1	42	Prior to or upon completion of commissioning				
Tailem Bend 2 SF	TB2SF1	87	Prior to or upon completion of commissioning				
Tallawarra PS	TALWA1	440	22 Apr 21				
Tamar Valley CCGT	TVCC201	208	Pre-existing				
Tamar Valley OCGT	TVPP104	58	24 Nov 21				
Taralga WF	TARALGA1	106	2 Aug 22				

<sup>47</sup> Unit 2 does not meet the response time requirement, requiring up to 30 seconds to achieve a 5% change in output.

<sup>48</sup> AEMO has granted a variation to the deadband at  $\pm 100$  mHz based on the currently known capabilities of the Affected GS..

Affected GS Name	DUID	Reg Cap (MW)	PFR Settings changes to be (or have been) implemented for ongoing operation by		Exemption	Variation	PFRP Varied
			Stage 1	Stage 2 <sup>6</sup>			
Tarong North PS	TNPS1	443	21 Oct 20			Yes	Droop, Response Time <sup>49</sup>
Tarong PS	TARONG#1	350	27 Oct 20				
Tarong PS	TARONG#2	350	3 Nov 20				
Tarong PS	TARONG#3	350	27 Oct 20				
Tarong PS	TARONG#4	350	27 Oct 20				
Tarraleah PS	TARRALEA	90			Yes <sup>50</sup>		
The Bluff WF	BLUFF1	53			Yes <sup>51</sup>		
Torrens Island B PS	TORRB1	200	3 Mar 21			Yes	Droop <sup>52</sup>
Torrens Island B PS	TORRB2	200	3 Mar 21			Yes	Droop <sup>53</sup>
Torrens Island B PS	TORRB3	200	15 Mar 21			Yes	Droop <sup>54</sup>
Torrens Island B PS	TORRB4	200	2 Mar 21			Yes	Droop <sup>55</sup>
Torrens Island BESS	TIBG1 <sup>56</sup>	250	Prior to or upon completion of commissioning				
Townsville PS	YABULU	160	Pre-existing				
Townsville PS	YABULU2	82			Yes <sup>57</sup>		
Trevallyn PS	TREVALLN	93	Unit 1 - 28 Sep 22	Unit 2 - 31 Mar 21		Yes	Response Time <sup>58</sup>
			Unit 3 - Pre-existing	Unit 4 - 14 Jul 21			
Tribute PS	TRIBUTE	83	Pre-existing				
Tumut 3 PS	TUMUT3	1500	17 Dec 20				
Tumut 1 & 2 PS	UPPTUMUT	616	18 Dec 20				

<sup>49</sup> The droop characteristics applied to the unit do not meet the requirement for a droop of 5% or less at all levels of frequency change.

<sup>50</sup> AEMO has granted an exemption on the basis of inherent incapability to meet the PFR requirements.

<sup>51</sup> AEMO has granted an exemption on the basis of inherent incapability to meet the PFR requirements.

<sup>52</sup> Droop varies with loading level, and may exceed 5% at high output.

<sup>53</sup> Droop varies with loading level, and may exceed 5% at high output.

<sup>54</sup> Droop varies with loading level, and may exceed 5% at high output.

<sup>55</sup> Droop varies with loading level, and may exceed 5% at high output.

<sup>56</sup> To be confirmed following Registration

<sup>57</sup> This DUID is the Steam Turbine of a combined cycle unit, and as such is granted a standing exemption from the PFR requirements.

<sup>58</sup> Response Time for Units 1 & 2 is 11 seconds for a 5% change in output.

Affected GS Name	DUID	Reg Cap (MW)	PFR Settings changes to be (or have been) implemented for ongoing operation by		Exemption	Variation	PFRP Varied
			Stage 1	Stage 2 <sup>6</sup>			
Tungatinah PS	TUNGATIN	125	14 Jul 21	24 May 22			
Uranquinty PS	URANQ11	166	30 Apr 21	19 April 23		Yes	Deadband <sup>59</sup>
Uranquinty PS	URANQ12	166	30 Apr 21	19 April 23		Yes	Deadband <sup>60</sup>
Uranquinty PS	URANQ13	166	30 Apr 21	6 Dec 22		Yes	Deadband <sup>61</sup>
Uranquinty PS	URANQ14	166	30 Apr 21	19 April 23		Yes	Deadband <sup>62</sup>
Vales Point B PS	VP5	660	30 Sep 20			Yes	Deadband <sup>63</sup>
Vales Point B PS	VP6	660	30 Sep 20			Yes	Deadband <sup>64</sup>
Valley Power	VPGS1	50	16 Mar 21				
Valley Power	VPGS2	50	17 Mar 21				
Valley Power	VPGS3	50	17 Mar 21				
Valley Power	VPGS4	50	17 Mar 21				
Valley Power	VPGS5	50	18 Mar 21				
Valley Power	VPGS6	50	18 Mar 21				
Victorian Big Battery	VBBG1	300	16 Nov 21				
Wallgrove BESS	WALGRVG1	50	21 Dec 21	16 Nov 22			
Wandoan BESS	WANDBG1	100	3 Jun 22				
Wandoan South SF 1	WANDSF1 <sup>65</sup>	159	Prior to or upon completion of commissioning				
Warwick 1 SF	WARWSF1	39	#				
Warwick 2 SF	WARWSF2	39	#				
Waterloo WF	WATERLWF	130			Yes <sup>66</sup>		
Wellington SF	WELLSF1	216	#				
Wemen SF	WEMENSF1	97	#				
West Kiewa PS	WKIEWA1	31	4 Aug 21				
West Kiewa PS	WKIEWA2	31	4 Aug 21				

<sup>59</sup> AEMO has granted a variation to the deadband at  $\pm 50$  mHz based on the unique condition of the Affected GS.

<sup>60</sup> AEMO has granted a variation to the deadband at  $\pm 50$  mHz based on the unique condition of the Affected GS.

<sup>61</sup> AEMO has granted a variation to the deadband at  $\pm 50$  mHz based on the unique condition of the Affected GS.

<sup>62</sup> AEMO has granted a variation to the deadband at  $\pm 50$  mHz based on the unique condition of the Affected GS.

<sup>63</sup> AEMO has granted a variation to the DCS FCAS control deadband at  $\pm 100$  mHz based on the unique condition of the Affected GS.

<sup>64</sup> AEMO has granted a variation to the DCS FCAS control deadband at  $\pm 100$  mHz based on the unique condition of the Affected GS.

<sup>65</sup> To be confirmed following registration

<sup>66</sup> AEMO has granted an exemption on the basis of inherent incapability to meet the PFR requirements.

Affected GS Name	DUID	Reg Cap (MW)	PFR Settings changes to be (or have been) implemented for ongoing operation by		Exemption	Variation	PFRP Varied
			Stage 1	Stage 2 <sup>6</sup>			
West Wyalong SF	WSTWYSF1	105	Prior to or upon completion of commissioning				
Western Downs Green Power Hub	WDGPH1	501	#				
Willogeleche WF	WGW1	119	31 May 23				
Wivenhoe PS	W/HOE#1	285	26 Oct 20			Yes	Response Time
Wivenhoe PS	W/HOE#2	285	26 Oct 20			Yes	Response Time
Woodlawn WF	WOODLWN1	48			Yes <sup>67</sup>		
Yallourn W PS	YWPS1	360	28 Oct 20				
Yallourn W PS	YWPS2	360	29 Sep 20	28 Oct 20			
Yallourn W PS	YWPS3	380	29 Sep 20	28 Oct 20			
Yallourn W PS	YWPS4	380	29 Sep 20	28 Oct 20			
Yatpool SF	YATSF1	94	#				
Yendon WF	YENDWF1	144	#				

<sup>67</sup> AEMO has granted an exemption on the basis of inherent incapability to meet the PFR requirements.

# 5. Impact on Frequency Performance

AEMO provides detailed reporting on power system frequency performance in its Frequency and Time Error Monitoring reports<sup>68</sup> published quarterly. The most recent report was published on 14 February 2023.

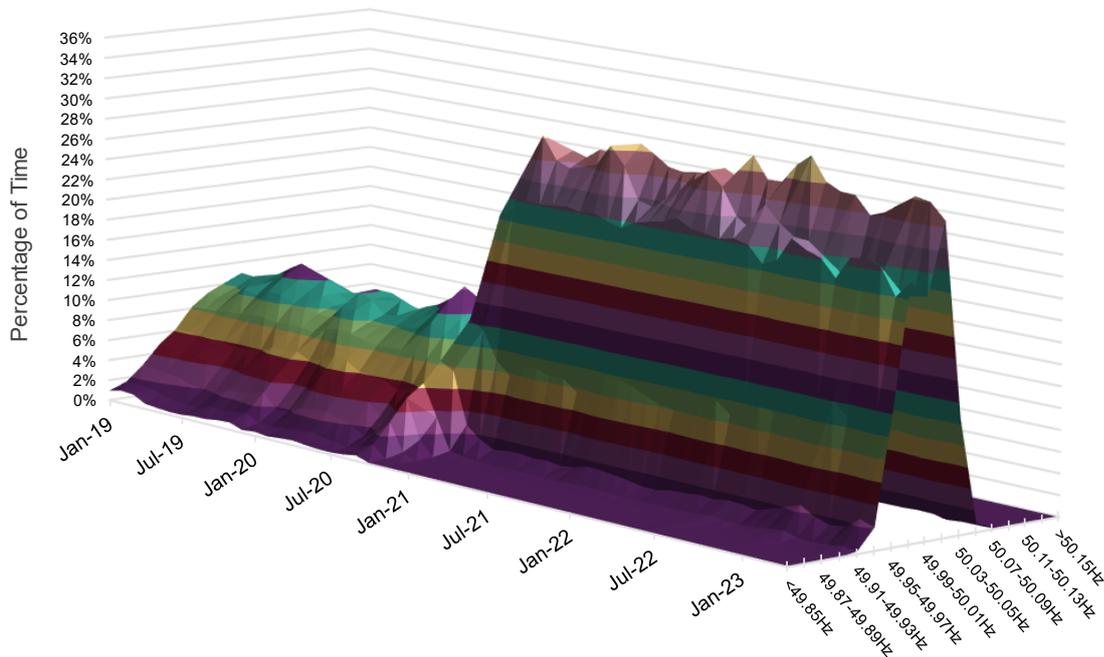
This report focuses on a sub-set of the matters raised in the quarterly report and provides some information focusing on relatively recent frequency performance to help capture impacts on power system frequency that are (at least in part) associated with the implementation of the Mandatory PFR Rule.

Figure 1 shows the monthly frequency distribution from January 2019. It covers a period from well prior to Affected Generators beginning to implementation of their PFR Settings from around the end of September 2020, until now.

This figure shows continued improvement in the closeness of the distribution of frequency around 50 Hz, particularly from the second half of October 2020, where many generators moved from interim to final PFR settings.

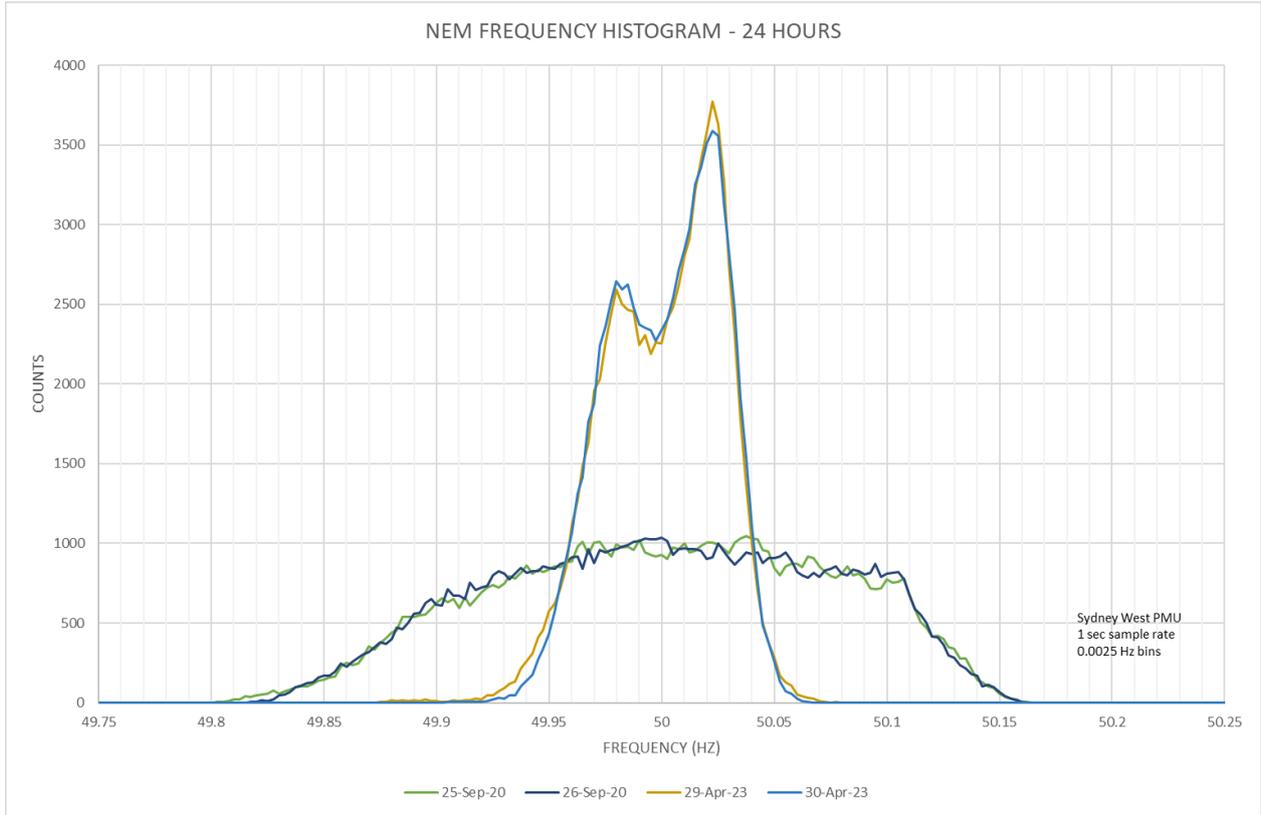
Figure 2 shows a comparison of the daily frequency distribution, from late September 2020, immediately before implementation of PFR setting changes commenced, and April 2023.

**Figure 1 Monthly frequency distribution (data from 01 Jan 2019 to 30 Apr 2023)**



**Figure 2 Comparison of NEM frequency distribution – Sep 2020 vs Apr 2023**

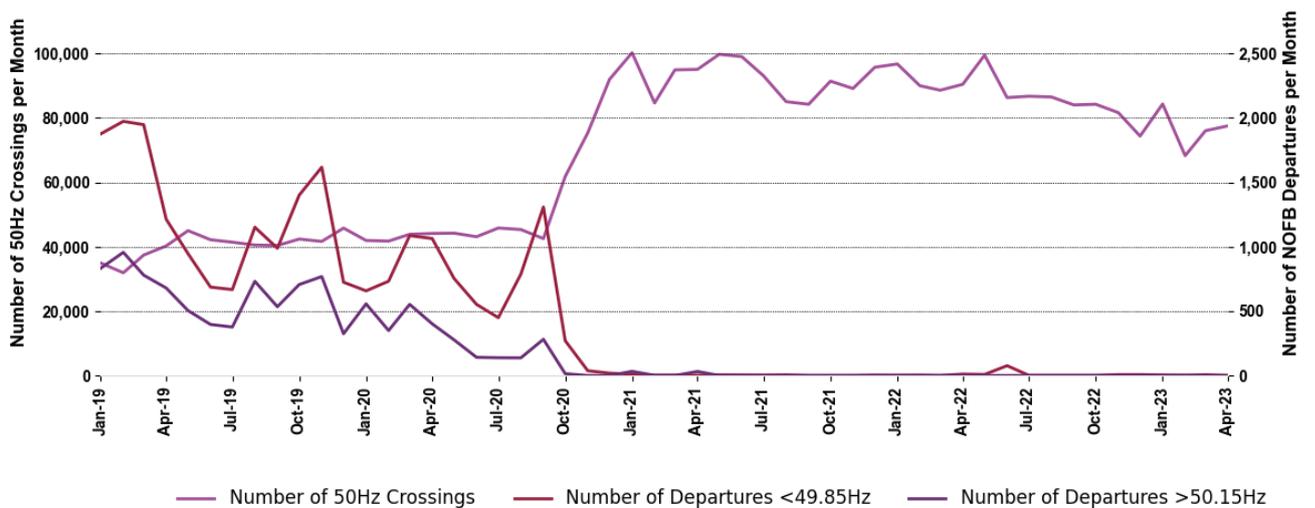
<sup>68</sup> Available at <https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/system-operations/ancillary-services/frequency-and-time-deviation-monitoring>.



The total number of departures from the normal operating frequency band (NOFB) and the number of times frequency crossed the nominal 50 Hz is shown on a monthly basis in Figure 23Figure 3.

These figures show a significant reduction in the number of excursions outside the NOFB following the commencement of implementation of PFR setting changes from the end of September 2020. This trend is particularly evident since mid-October 2020, and has persisted since that time.

**Figure 3 Monthly frequency crossings – under 49.85 Hz, across 50 Hz, beyond 50.15 Hz**



# Glossary

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

<b>Term</b>	<b>Definition</b>
Affected Generator	As defined in the IPFRR.
Affected GS	As defined in the IPFRR.
AEMC	Australian Energy Markets Commission
AER	Australian Energy Regulator
AGC	Automatic Generation Control
BESS	Battery Energy Storage System
CCGT	Combined Cycle Gas Turbine.
DUID	Dispatchable unit identification.
GT	Gas Turbine
HP	Hold Point. A point during commissioning of new <i>plant</i> determined by reference to <i>generation</i> output.
IPFRR	Interim Primary Frequency Response Requirements.
Mandatory PFR Rule	National Electricity Amendment (Mandatory Primary Frequency Response) Rule 2020.
NOFB	<i>normal operating frequency band.</i>
PFR	<i>primary frequency response.</i>
PFR Settings	The settings to achieve the provision of PFR in accordance with the IPFRR, as notified to an Affected Generator by AEMO.
PFRP	<i>primary frequency response parameters.</i>
PS	Power Station.
PV	Photovoltaic
Results	As defined in the IPFRR.
RTS	Return to service following an <i>outage</i> .
SF	Solar Farm.
Tranche 1	Affected GS with a <i>nameplate rating</i> of >200 MW.
Tranche 2	Affected GS with a <i>nameplate rating</i> between 80 MW and 200 MW.
Tranche 3	Affected GS with a <i>nameplate rating</i> of <80 MW.
WF	Wind Farm.

# Version release history

Version	Effective date	Summary of changes
1	28/7/2020	Status as at 17 July 2020
2	12/8/2020	Status as at 7 Aug 2020
3	31/8/2020	Status as at 28 Aug 2020
4	14/9/2020	Status as at 11 Sep 2020
5	28/9/2020	Status as at 25 Sep 2020
6	12/10/2020	Status as at 9 Oct 2020
7	26/10/2020	Status as at 23 Oct 2020
8	9/11/2020	Status as at 6 Nov 2020
9	30/11/2020	Status as at 27 Nov 2020
10	16/12/2020	Status as at 15 Dec 2020
11	21/1/2021	Status as at 20 Jan 2021
12	17/2/2021	Status as at 16 Feb 2021
13	16/3/2021	Status as at 15 Mar 2021
14	14/4/2021	Status as at 13 Apr 2021
15	19/5/2021	Status as at 18 May 2021
16	28/6/2021	Status as at 25 June 2021
17	26/7/2021	Status as at 23 July 2021
18	30/8/2021	Status as at 27 Aug 2021
19	5/10/2021	Status as at 1 Oct 2021
20	18/11/2021	Status as at 17 Nov 2021
21	21/1/2022	Status as at 20 Jan 2022
22	28/3/2022	Status as at 25 Mar 2022
23	14/6/2022	Status as at 10 Jun 2022
24	18/11/2022	Status as at 17 Nov 2022