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11 May 2023

Ms Victoria Mollard
Executive General Manager, Economics and System Security
Australian Energy Market Commission
[By email]

Dear Victoria,

Rule change proposal - Clarifying mandatory primary frequency response obligations for batteries

This letter informs you AEMO has submitted a proposal to amend the NER. The proposal follows on from three recent amendments:

1. National Electricity Amendment (Mandatory Primary Frequency Response) Rule 2020, made on 26 March 2020 (MPFR Rule)
2. National Electricity Amendment (Integrating energy storage systems into the NEM) Rule 2021, made on 2 December 2021 (IESS Rule)
3. National Electricity Amendment (Primary frequency response incentive arrangements) Rule 2022, made on 8 September 2022 (PFR Incentives Rule).

The amendment proposes to clarify the future obligations on batteries to comply with the Primary Frequency Response Requirements (PFRR). This is necessary because, upon commencement of the IESS Rule on the 3 June 2024 batteries will no longer need to comply with the PFRR.

Further, even with issue caused by the introduction of the IESS Rule corrected, the drafting of the NER only requires a battery to comply with the PFRR when a battery has a dispatch instruction to generate above zero. As the prevalence of batteries grows, limiting primary frequency response in this way will substantially reduce the availability of units operating with the correct control settings.

After carefully studying the Commission's reasoning behind previous determinations AEMO considers the proposed amendment is fundamentally consistent with the original MPFR Rule.

For context, this proposal is unrelated to the implementation of the IESS Rule, because it relates to a technical control setting and not the dispatch model or settlement arrangements set out in that Rule and further updated by the amendment ERC0351, (Implementing integrated energy storage systems) Rule 2023 No. 2.

If you have any questions or wish to arrange a meeting to discuss, please contact Kevin Ly, Group Manager Reform Development & Insights.

Yours sincerely,

Violette Mouchaileh

Executive General Manager – Reform Delivery

Attachments: AEMO rule change proposal

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Electricity Rule Change Proposal

Clarifying mandatory primary frequency response obligations for batteries

May 2023

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Australian Energy Market Operator Ltd ABN 94 072 010 327

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1. Summary

This Rule change proposal has been developed by AEMO to address potential unintended or adverse implications of the following recent rules made by the AEMC:

- National Electricity Amendment (Mandatory Primary Frequency Response) Rule 2020, made on 26 March 2020 (MPFR Rule).
- National Electricity Amendment (Integrating energy storage systems into the NEM) Rule 2021, made on 2 December 2021 (IESS Rule).
- National Electricity Amendment (Primary frequency response incentive arrangements) Rule 2022, made on 8 September 2022 (PFR Incentives Rule).

AEMO has identified two issues with the National Electricity Rules (NER):

1. After the IESS Rule commences, batteries will be classified as bidirectional units (BDUs), with the relevant participant being an Integrated Resource Provider (IRP). The omission of the new IRP category and BDUs classification from the relevant clauses that require participants to comply with the Primary Frequency Response Requirements (PFRR) means that batteries will not need to provide primary frequency response (PFR) when the IESS Rule commences on 3 June 2024. If allowed to stand, the omission of batteries would present significant issues for the frequency control of the power system, which would grow steadily with the installed capacity of registered batteries, leaving the primary frequency response obligation borne solely by scheduled and semi-scheduled generators.

2. Even with the above issue corrected, the current drafting of the NER limits when batteries must comply with the PFRR. As the prevalence of batteries grows, limiting primary frequency response to when a battery has a dispatch instruction to generate above zero will substantially reduce the availability of units operating with the correct control settings.

This proposal to amend the NER has two objectives:

1. To ensure a continuing obligation for batteries to meet the Primary Frequency Response Requirements (PFRR)[1] when the IESS Rule commences on 3 June 2024, by including IRPs and BDUs in NER 4.4.2(c1), 4.4.2A and 4.4.2B.

2. To remove the conditions in NER 4.4.2(c1), that limit the obligation to comply with the PFRR only when a unit receives a non-zero dispatch instruction under NER 4.9.2 to generate, so all capable resources, including batteries, operate in frequency response mode as required by the PFRR when dispatched to produce or consume a non-zero level of energy or enabled for a market ancillary service, subject to NER 4.4.2A(c) and 4.4.2B.

The proposed amendments should take effect from when the IESS Rule commences, being 3 June 2024.

For context, this proposal is unrelated to the implementation of the IESS Rule, because it relates to a technical control setting and not the dispatch model or settlement arrangements set out in that Rule and further updated by the amendment ERC0351, (Implementing integrated energy storage systems) Rule 2023 No. 2.

[1] Made by AEMO under NER 4.4.2A. Interim PFRR available at: https://aemo.com.au/-/media/files/initiatives/primary-frequency-response/2020/interim-pfrr.pdf. Final PFRR currently under consultation, refer to https://aemo.com.au/consultations/current-and-closed-consultations/primary-frequency-response-requirements

2. Relevant Background

2.1. Current framework

Mandatory Primary Frequency Response Rule 2020

The MPFR Rule, effective from 4 June 2020, required all scheduled and semi-scheduled generators to comply with requirements for their relevant plant to respond automatically to changes in power system frequency to support the secure operation of the power system, i.e. mandatory PFR. However, the MPFR Rule included a sunset date of 4 June 2023, based on the AEMC's conclusion that:

- A mandatory requirement for narrow band PFR was not a complete solution for the long term and, on its own, would not incentivise the provision of PFR.
- Further work was required to understand the requirements for maintaining good frequency control, including the appropriateness of mandatory PFR and other alternative and complementary measures.

Key aspects of the MPFR Rule included:

- All scheduled and semi-scheduled generators, who have received a dispatch instruction to generate greater than 0 MW, must operate their plant in accordance with the performance parameters set out in the PFRR.
- AEMO must consult on and publish the PFRR to specify the required performance parameters for generator frequency response, which may vary by plant type.
- Parameters must include a maximum allowable frequency response deadband, not greater than the primary frequency control band (PFCB), to be specified in the frequency operating standard (FOS) and initially set to +/- 0.015 Hz.
- The PFRR cannot require a generator to maintain additional stored energy for the purpose of providing PFR.
- Generators may request, and AEMO may approve, variations or exemptions to the PFRR for individual generating plant.

The MPFR Rule included a new clause 4.4.2(c1) (PFR obligation on scheduled and semi-scheduled generators), a new clause 4.4.2A (PFRR) and a new clause 4.4.2B (Approval of variations or exemptions).

Integrating Energy Storage Systems Rule 2021

The IESS Rule introduced a new registration category, the IRP, and a new type of scheduled plant, the BDU. The rule required extensive drafting changes to the NER and its implementation involves considerable system, process, and operational changes by AEMO, at an estimated cost of $20-30 million[2]. A BDU is defined as plant that can transition linearly between energy production and consumption and may be part of a broader 'integrated resource system', potentially comprising different generation technologies and load. The IESS Rule will be fully implemented on 3 June 2024, with early implementation of some provisions (not relevant to PFR considerations) having occurred in March 2023.

[2] AEMO, Letter Integrating Energy Storage Systems into the NEM – Supplementary Information, 2021 https://www.aemc.gov.au/sites/default/files/2021-12/7._aemo_letter_-_integrating_energy_storage_systems_into_the_nem_-_19_nov_2021.pdf

Existing and new batteries will be the main type of plant classified as BDUs under the IESS Rule. Non-exempt standalone batteries are currently classified as both scheduled generating units and scheduled loads, with the participant registered as both a scheduled generator and a market customer. From 3 June 2024, the operators of all existing scheduled batteries will have to be re-registered as IRPs with their batteries reclassified as BDUs.

From a regulatory perspective, a BDU will be classified and regulated as a single unit, reflecting the reality that it is a single facility with the same control capabilities in either direction of flow at its connection point. Under the IESS Rule, the technical obligations of scheduled generators in NER chapters 4 and 5 will be extended to IRPs – and adapted as required - in respect of scheduled BDUs/integrated resource systems. These changes include the incorporation of integrated resource systems into the access standards of schedule 5.2, where performance requirements currently expressed in terms of generating system output will also cover performance when consuming active power.

Primary Frequency Response Incentive Arrangements Rule 2022

One of the key elements of the PFR Incentives Rule was to make mandatory PFR enduring beyond the MPFR Rule sunset date of 4 June 2023, meaning that all non-exempt scheduled and semi-scheduled generating units must continue to respond automatically to changes in power system frequency in accordance with the PFRR. This requirement was supported by AEMO and independent advice received from GHD, and commenced on 8 September 2022.

The PFR Incentives Rule included a minor amendment to NER 4.4.2(c1) to clarify that the requirement to comply with the PFRR applies to “each Scheduled Generator and Semi-Scheduled Generator that has received a dispatch instruction in accordance with clause 4.9.2 to generate a volume greater than zero MW”.

The AEMC’s final determination described the additional wording as a clarification, consistent with the Mandatory PFR Rule, that generators not dispatched to generate in the energy market are not required to operate in frequency response mode in accordance with the PFRR. Specifically, NER 4.9.2 provides for the issue of dispatch instructions for a level of power from generating units (and BDUs once the IESS Rule commences). Dispatch instructions to ancillary service providers for the provision of a market ancillary service are issued under 4.9.3A(a).

3. Statement of Issue

3.1. Relevant rules as currently made

The NER clauses that are relevant to this proposal are outlined in Table 1 below. The table incorporates the NER amendments made under the IESS and PFR Incentives Rule that have been made but are not yet in effect.

Table 1 Relevant NER clauses

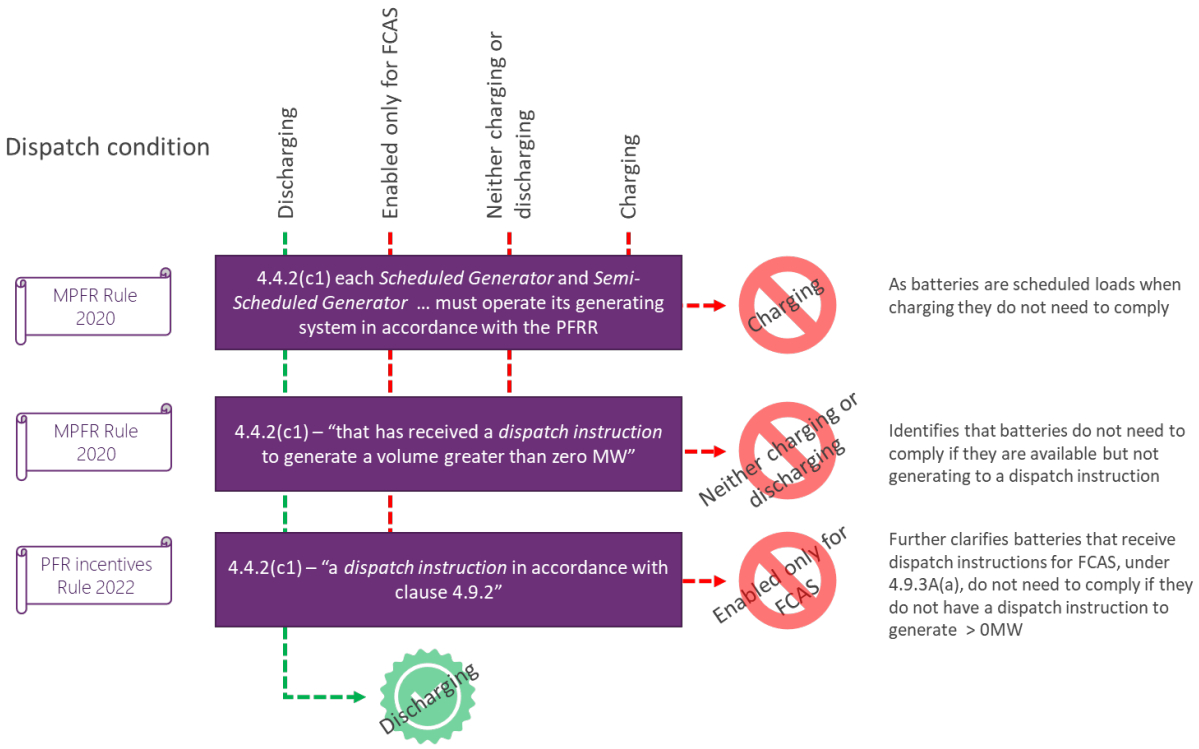
Rule	Summary
4.4.2(c1)	Scheduled generators and semi-scheduled generators receiving a dispatch instruction in accordance with clause 4.9.2 to generate a volume greater than 0 MW must operate their generating systems in accordance with the PFRR
4.9.2	Provides for the issue of dispatch instructions to scheduled generators, semi-scheduled generators and scheduled IRPs that nominate a level or schedule of power, tap position, voltage or reactive power control from their generating units or BDUs.
4.9.3	Provides for the issue of dispatch instructions to registered participants for the consumption of energy by scheduled loads (BDUs will not be scheduled loads, therefore instructions for consumption by BDUs will be issued under 4.9.2)
4.9.3A(a)	Provides for the issue of dispatch instructions to ancillary service providers for the provision of a market ancillary service from any classified ancillary service unit (can include generating units and BDUs among others)
4.4.2A	Outlines the content for the PFRR that apply to scheduled and semi-scheduled generators
4.4.2B	Outlines the considerations AEMO must have regard to when approving exemptions or variations to PFR parameters of a scheduled or semi-scheduled generator's generating system

For context, this proposal is unrelated to the implementation of the IESS Rule, because it relates to a technical control setting and not the dispatch model or settlement arrangements set out in that Rule and further updated by the amendment ERC0351, (Implementing integrated energy storage systems) Rule 2023 No. 2.

3.2. Current application of 4.4.2(c1)

Figure 1 shows how NER 4.4.2(c1) applies to batteries prior to the commencement of the IESS Rule.

Figure 1 Operation of the current 4.4.2(c1) with respect to batteries



Prior to the IESS Rule commencing, most large batteries have a dual classification as scheduled loads and scheduled generating units. The current NER obligation to comply with the PFRR (i.e. to apply the approved PFR settings to relevant plant) is drafted to apply:

- Only to scheduled and semi-scheduled generating units. Most scheduled loads are inherently unable to provide primary frequency response (synchronous pumps may be capable but are not subject to any performance standard equivalent to S5.2.5.11). Although this is not true of batteries, the MPFR Rule did not extend the obligation to batteries acting as scheduled loads in 2020.
- Only when the relevant unit has received a dispatch instruction under clause 4.9.2 to generate a volume greater than 0 MW. These conditions are particularly directed to batteries. They are unnecessary for other scheduled generating units, which are unable to provide PFR when not generating and, (apart from certain plant being enabled under 4.9.3A(a) for delayed raise), can only receive an ancillary service instruction when generating.

3.3. Issue 1 – problems after commencement of the IESS Rule

After the IESS Rule commences, batteries will be classified as BDUs, with the relevant participant being registered as an IRP.

The omission of the new IRP category and BDUs from NER 4.4.2(c1), 4.4.2A and 4.4.2B means that – without a rule change - batteries will not be subject to any PFR requirements once the IESS rule becomes effective on 3 June 2024.

AEMO understands this was an inadvertent omission owing to the sunset date of the Mandatory PFR Rule, which was still current at the time of making the IESS Rule. If not corrected, the omission of batteries would present significant issues for the frequency control of the power system, which would grow steadily with the installed capacity of registered batteries while the PFR obligation is borne solely by scheduled and semi-scheduled generators.

3.4. Issue 2 – problems if current drafting of 4.4.2(c1) persists

Even with Issue 1 corrected, the references in clause 4.4.2(c1), to a non-zero 4.9.2 instruction to generate will continue to limit the circumstances under which the PFRR apply to batteries. In the longer term, this could substantially reduce the availability of units operating with PFR control settings and result in batteries operating in the market with inconsistent control settings across their modes of operation.

Ideally, to maximise the available control base and to ensure all plant operate consistently, a battery's PFR control settings should be applied whenever it is operating (whether dispatched to generate or consume energy or enabled for a market ancillary service), subject to approved exemptions or variations and the existing NER proviso that units are not required to maintain stored energy to provide PFR.

When applied to BDUs, the limitation of the PFR obligation to periods when dispatched to generate more than 0 MW in the energy market appears inconsistent with the intended effect of the IESS Rule in creating the BDU classification. This classification recognised these facilities each as a single unit with capabilities to transition linearly between production and consumption, removing the artificial dual classification as scheduled generation and scheduled load. The very premise of this is that batteries can and do operate identically across their full power range, and this should be reflected in their NER obligations.

3.5. Narrative of issue

This section attempts to describe the reasoning behind previous determinations and why, despite two recent amendments, the NER need to be amended further.

3.5.1. Issue 1 – Ensure batteries continue to comply with the PFRR from 3 June 2024

Although the IESS Rule extended most NER obligations on scheduled generators to IRPs, it did not amend the PFR provisions in NER 4.4.2(c1), 4.4.2A and 4.4.2B. This was because, at the time of making the IESS Rule, these were scheduled to sunset before the IESS Rule amendments would commence in June 2024. This meant it would be necessary to incorporate an extension of these obligations to IRPs only when a decision was made to make mandatory PFR enduring (the PFR Incentives Rule was still under consideration by the AEMC at the time).

The PFR Incentives Rule determined that enduring PFR arrangements (with the addition of new double-sided incentives) were an effective permanent solution for maintaining good power system frequency control, and the original sunset of 4 June 2023 was removed. However, the PFR Incentives Rule omitted the drafting necessary to extend the PFR obligations to IRPs (for BDUs) from 3 June 2024, although the final determination explicitly contemplated that the enduring PFR obligations and related incentive arrangements would apply to batteries. The amendment to NER 4.4.2(c1) was intended to reinforce the intended

extent of the PFR obligations on batteries by including a reference to a **clause 4.9.2** dispatch instruction (thereby excluding ancillary services instructions, which are issued under NER 4.9.3A). If there was no intention for NER 4.4.2(c1) to apply to batteries on an enduring basis, the clarification would have been unnecessary.

To ensure the rapidly growing fleet of batteries in the NEM continue to be required to provide PFR, AEMO considers it necessary for the AEMC to correct the omission from the PFR Incentives Rule by including BDUs and IRPs in NER 4.4.2(c1), 4.4.2A and 4.4.2B, together with reference notes in S5.2.5.11, from the commencement date of the IESS Rule on 3 June 2024.

3.5.2. Issue 2 – Remove limitations that inhibit continuous application of PFRR control settings

By virtue of batteries being separately registered as scheduled loads for their consumption, the PFR obligations on scheduled generators established by the MPFR Rule did not apply when a battery was charging. The PFR obligation was not applied to scheduled loads because there was no performance standard requirement to operate in frequency response mode. There was also no pressing need to incorporate battery charging into the obligation, given the MPFR Rule was expected to sunset after three years. Within that period, the relatively small proportion of grid-scale batteries meant that the amount of PFR available on the system at any time would not be significantly affected by limiting the PFR obligation to periods of dispatch for generation.

MPFR Rule

Despite this, the AEMC considered, (when making the MPFR Rule), that the application of PFRR to batteries could be problematic. There was a particular concern that a battery providing primary frequency response continuously would absorb a significant proportion of the battery's daily warranted cycle, even when the battery has a zero-dispatch instruction. The concern was that batteries, due to their nature of being "always available" would have to provide primary frequency response even if a Participant submitted bids and offers that result in the battery not being cleared (dispatched) for energy or a market ancillary service.

In the draft determination[3], the AEMC stated:

> "*The Commission acknowledges concerns raised by providers of battery energy storage systems that batteries would likely be disproportionately burdened by a mandatory approach since they are always available to the market, even when not enabled for energy or FCAS*".

The stakeholder concern the Commission was responding to, was set out in Infigen's submission to the consultation paper[4], which stated[5]:

> "*for a battery to avoid being mis-used in an environment of mandatory unpriced PFR, bidding such plant unavailable would seem to be more than a theoretical possibility*".

The problem was a potential perverse incentive to bid unavailable to avoid providing PFR, rather than remain available, at zero dispatch, with the battery's bids and offers in the energy and FCAS markets simply not being cleared. The concern was unfairly requiring a battery to

[3] AEMC, Mandatory primary frequency response, Draft rule determination, 19 December 2019, p. 76
[4] AEMC, Primary frequency response rule changes, Consultation paper, 19 September
[5] Infigen – submission to the AEMC Consultation Paper, 31 October 2019, p 6

comply with the PFRR and provide primary frequency response when it was not dispatched in either of the energy and FCAS markets.

The final determination discussed this twice, with the **first excerpt**:

> "*The Commission considers that the application of the mandatory PFR requirement to battery energy storage systems that are not dispatched to generate electricity would be discriminatory, as other generation technologies cannot provide PFR unless they are online and generating*[6]".

And the **second excerpt**, setting out the AEMC's analysis and confirming the draft determination, explaining batteries:

> "*would likely be disproportionately burdened by a mandatory approach since they are always available to the market, even when not enabled for energy or FCAS*[7]".

It is important to note that, unlike most conventional generation, batteries can be enabled for a market ancillary service and operate in frequency response mode as required by the PFRR, whilst not also being dispatched to generate any volume of electricity.

The discussion in the MPFR draft and final determinations indicates the intent to ensure batteries would not be required to provide PFR when not participating in either of the energy or ancillary service markets.

By contrast, the first excerpt and the original drafting of the MPFR rule, (in citing a dispatch instruction to generate greater than zero), premised that it was discriminatory - as between generation technologies - to require primary frequency response under any other condition than a dispatch instruction to generate. This premise was not substantiated by stakeholders' concerns, which focused on ensuring the PFR obligation would be excluded when batteries were neither dispatched for energy nor enabled for FCAS.

PFR Incentives Rule

In response to the PFR Incentives Rule's second directions paper, two stakeholders requested the AEMC to resolve any ambiguity as to whether a battery need comply with the PFRR when only enabled for a market ancillary service, (with a zero-dispatch instruction for energy). In response the AEMC included a minor amendment to NER 4.4.2(c1) to clarify that generators which are not dispatched in the energy market to generate electricity are not required to comply with the PFRR.

The AEMC stated this amendment was consistent with its final determination for the MPFR Rule, referencing the **first excerpt** above from that final determination. As indicated in the above discussion on the MPFR Rule, however, stakeholder submissions and AEMC analysis in that rule indicates that concerns about the disproportionate burden on batteries were limited to periods when they were neither dispatched for energy nor enabled for FCAS.

IESS Rule

One of the most significant effects of the IESS Rule will be to allow batteries to be classified and regulated as a single integrated unit of plant – a BDU as distinct from a scheduled generating unit or scheduled load, reflecting the reality of their equivalent capabilities and

[6] Final determination, p.46
[7] Final determination, p.88

controllability in each direction of flow, and ability to transition linearly from production to consumption and vice versa.

The IESS Rule will generally apply all NER obligations of scheduled generators to IRPs, in respect of their integrated BDUs, and specifically expand some requirements – notably the access standards in schedule 5.2 – to ensure those obligations apply to BDUs across their range of operation.

3.5.3. Summary of the narrative

In summary, the NER needs to be amended further because:

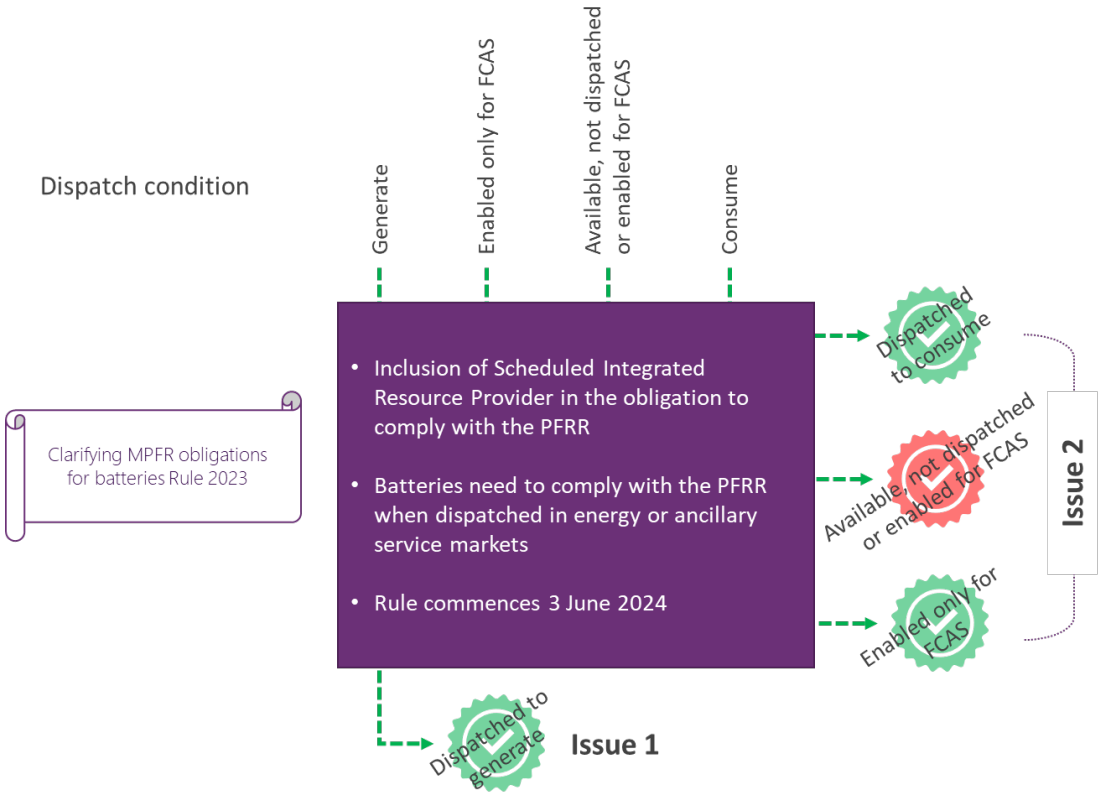
- As the installation of batteries continues in greater numbers and at larger scale, combined with the retirement of large thermal generating unit, their contribution to maintaining good frequency control via the provision of PFR will become increasingly important, and may be insufficient if excluded across significant periods of their operation.
- The PFR Incentives Rule inadvertently omitted the drafting necessary to extend the PFR obligations to IRPs (for BDUs) from 3 June 2024.
- Neither the MPFR Rule nor the PFR Incentives Rule considered in detail the question of whether a battery should comply with the PFRR when charging. It was not necessary to do so based on the policy decision not to apply PFR obligations to scheduled loads, but the IESS Rule changes that position.
- In making the MPFR Rule, the Commission explicitly intended to address stakeholder concerns by allowing batteries relief from complying with the PFRR if they were available to the market, but not dispatched in either of the energy or ancillary service markets.
- However, in the drafting of the MPFR rule, the PFR obligation was made conditional on a dispatch instruction to generate greater than zero, expressed a premise that it was discriminatory as between generation technologies to require PFR under any other condition.
- The PFR Incentives Rule did not reconsider that premise in the light of the IESS Rule or by reconsidering the AEMC's analysis in the MPFR Rule draft and final determinations.

AEMO considers it is not discriminatory for batteries to comply with the PFRR when charging (consistent with other changes made by the IESS Rule) or when solely enabled for a market ancillary service. In these circumstances, the battery is operating commercially and can operate in compliance with the PFRR. The same requirement to comply with PFRR settings should apply to all PFR capable units, without regard to the way different technologies can provide market services. To be clear, AEMO is not proposing that a battery would apply PFRR settings when not operating commercially. That is, the NER should not require a battery to provide PFR when it is available, but not dispatched in any of the energy or market ancillary service markets.

3.6. Summary of the statement of issue

Figure 2 indicates how including Scheduled IRPs in the obligation to comply with the PFRR from 3 June 2024, and the amendment to the limitations for when all relevant units need to comply with the PFRR, should resolve the two issues set out above.

Figure 2 Schematic as to how issues with the NER can be resolved



4. How the proposal will address the issues

4.1. The proposed solution

AEMO proposes the NER be amended so that on commencement of the IESS Rule, IRPs must operate their BDUs in accordance with applicable settings under the PFRR, when dispatched to produce or consume a non-zero level of energy, or enabled for a market ancillary service.

IESS Rule creates appropriate categories to apply obligations

It is important to note that these proposed changes do not discriminate against batteries. On the contrary, the proposal will apply a consistent, technology neutral obligation for all relevant plant to operate with the appropriate control settings as required under the PFRR. This will ensure that control system settings are applied consistently and predictably, and not changed with different modes of operation unless a regulated approval process applies. It will promote certainty and ensure ubiquitous PFR, providing the necessary frequency control capability to support power system security on an ongoing basis.

The references in 4.4.2(c1), to “generate”, “4.9.2 instruction”, and “greater than zero”, were originally all introduced to clarify the extent of the PFR obligation on batteries, so that it was physically equivalent to that of other scheduled generating units.

The IESS Rule has introduced a distinct BDU classification, eliminating the need to consider batteries as both scheduled generation and scheduled load, and recognising that battery capabilities and controls should be valued and regulated equally irrespective of their operation in charging or discharging mode. Importantly, energy dispatch instructions for BDUs under NER 4.9.2 as amended by the IESS Rule will include dispatch in either direction of flow. If any conditions are required for the provision of PFR by BDUs, it would be consistent with the structure of the PFR rules to include these in NER 4.4.2A(c).

The introduction of the IESS Rule, removing batteries from the dual scheduled generating unit and scheduled load classification, allows for the references that were introduced in 4.4.2(c1) to limit the coverage of the obligation for batteries (as shown in Figure 1) to be removed from the NER, and for Integrated Resource Providers to be included in the obligation to comply with the PFRR.

The proposal to apply NER 4.4.2(c1) to periods when dispatched to produce or consume energy or enabled for a market ancillary service is consistent with the intended purpose of the Commission’s original determination and should ensure that when a battery is participating in the market it operates in the correct frequency response mode. Given the market’s role in ensuring adequacy of supply and ancillary service reserves, there should be enough resources available for good control of frequency without requiring obligations to be placed on units when not participating in energy or ancillary markets. Thus, a battery would provide PFR when dispatched or enabled in the energy and ancillary service markets but would not be required to do so when available but not dispatched or enabled. Should the participant wish to avoid providing primary frequency response it can structure bids, offers, market ancillary service offers so that the unit remains available but is not cleared (dispatched) in either the energy or market ancillary service markets.

Primary frequency response is no longer 'unpriced'

The PFR Incentives Rule confirmed that mandatory PFR should not be viewed as a short-term, onerous obligation, but instead, when supplemented with frequency performance payments, is an appropriate measure that meets the NEO. For this reason, it is appropriate that all capable energy production technologies should comply with the PFRR. This will align with the potential for frequency performance payments (incentivising good PFR provision)[8] to be earned for batteries irrespective of the type of dispatch instruction they receive. Under the proposed rule a battery can avoid frequency performance payments should they be insufficient to reward operation when energy and FCAS prices are insufficient to encourage the battery to participate in these markets.

Given the expected future expansion of batteries in the NEM, AEMO considers it important that they operate with PFR settings enabled whenever they are producing, consuming, or solely enabled for a market ancillary service, subject to any other provisions of the NEM, the PFRR, or regulated contracts. This is consistent with the expectation for scheduled and semi-scheduled generating units. Removing the requirements in 4.4.2(c1) that are effectively battery-specific will help ensure that the available control base is maximised as batteries become much more prevalent, and ensure all appropriate plant operates with the same settings in a consistent manner when participating in the market.

In making the PFR Incentives Rule, the AEMC was "*satisfied that the confirmation of the mandatory PFR obligation for scheduled and semi-scheduled generators, combined with double-sided incentive arrangements to value helpful active power deviations and new reporting obligations will, or is likely to, contribute to the achievement of the NEO. This will support system security and deliver reduced costs for frequency control over the long term by encouraging innovation and investment in new capability to provide primary frequency response*[9]". To maximise the benefits from the PFR Incentives Rule, both the mandatory PFR obligation and the incentives should apply universally. AEMO is designing an incentive scheme that is premised on:

- Ubiquitous mandatory PFR providing good control to within a tight deadband from target frequency; and
- Effective Automatic Generation Control - Regulation correcting errors to return the system to target frequency.

Market ancillary services

Unlike other resources such as synchronous generators, batteries can and do provide FCAS without a dispatch instruction to generate. A battery may be enabled for an either contingency (Fast, Slow, Delayed), or regulation FCAS. If a unit is enabled for regulation FCAS then it will continually charge or discharge in response to AGC-Regulation signals issued by AEMO every 4-seconds. These signals do not exceed the enabled amount.

If a unit is enabled only for contingency FCAS, the obligation to respond is set out in the market ancillary service specification (MASS). These obligations require a battery unit to respond in a particular agreed manner, which is categorised as either 'proportional' or 'switched'. All significant batteries are required to operate with proportional controls, which means they must respond once frequency exits a deadband no wider than the mainland intact system normal operating frequency band (NOFB) which is +/-0.15 Hz, and the response must

[8] Frequency performance incentive mechanism to be introduced under a new clause 3.15.6AA under the PFR Incentives Rule.
[9] AEMC, Primary frequency response incentive arrangements, Rule determination, 8 September 2022 p14

be in proportion to the frequency deviation. Switched facilities must respond with a fixed quantity of power once their allocated frequency setting is reached.

With ubiquitous provision of primary frequency response, system frequency should be closer to the PFCB than the NOFB, and therefore AEMO considers it suboptimal for batteries enabled for FCAS in central dispatch to be providing no primary frequency response until system frequency enters the contingency band. The impacts of a lack of control within the NOFB have been well explored throughout the PFR rule change processes, and summarised below:

- Reduce the immediacy of the response, affecting overall control of frequency, and recovery if there is a lack of available headroom on other units that are not enabled but able to respond consistent with the PFRR.
- Reduce the predictability of response, since dynamic behaviour could be subject to market outcomes.
- Increase the burden on other units with available headroom for providing MPFR, including enabled providers of FCAS.

Reducing the burden on batteries, as opposed to other providers of FCAS, may have a negative effect of encouraging, at the margin, batteries to be enabled for regulation, contingency FCAS *or* to be dispatched for energy, rather than together.

This can be avoided by removing the references in 4.4.2(c1) to dispatch instructions to generate greater than zero under clause 4.9.2.

AEMO has previously recognised the benefits of ubiquitous narrow band primary frequency response in response to contingencies[10] and is not concerned if units that are not enabled for FCAS also respond, as specified in the PFRR. This is because the FCAS markets only ensure adequate reserves in central dispatch able to respond to the largest credible contingency and have no role in limiting the response provided to those units enabled. Of course, at times of scarcity of reserves, (at high prices for raise services and low prices for lower services), response will naturally concentrate on the available reserves, being those units enabled for FCAS.

AEMO notes it has enshrined the principle in the MASS that PFR will be counted towards Contingency FCAS obligations (and made it very explicit in v8.0 of the MASS).

The problem therefore is that batteries enabled for FCAS will not respond to a contingency event within the NOFB despite the alignment to Contingency FCAS obligations as defined in the MASS. Ideally all units should always operate with control settings consistent with the PFRR, and thus provide a continuous proportional response from the PFCB and throughout the full range of operating frequency. This should include those batteries enabled for contingency FCAS as proportional controllers.

It must be noted that batteries are increasing their share of regulation and contingency FCAS markets, and it is presently reasonably commonplace for batteries to be enabled for FCAS without clause 4.9.2 dispatch instructions in the energy market. Figure 3 below shows continued increases in FCAS provision by batteries across all FCAS markets, with the

[10] For example, see AEMO's PFR Rule Change: https://www.aemc.gov.au/sites/default/files/2019-08/Rule%20Change%20Proposal%20-%20Mandatory%20Frequency%20Response.pdf
And John Undrill's report for AEMO: https://www.aemc.gov.au/sites/default/files/2019-08/International%20Expert%20Advice%20-%20Notes%20on%20frequency%20control.pdf

aggregate market share by FCAS volume reaching double any other technology (39% market share in Q3 2022).[11]

Figure 3 Quarterly Energy Dynamics, Q3 2022, showing increasing share of FCAS markets for batteries.

Figure 50 Battery provision of FCAS leaps on Q3 2021

Change in FCAS supply by technology – Q3 2022 vs Q3 2021

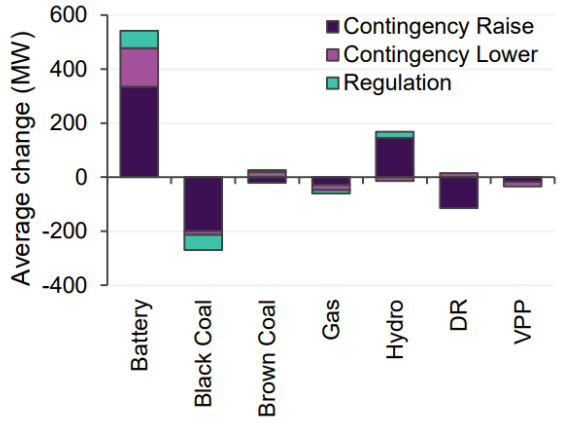
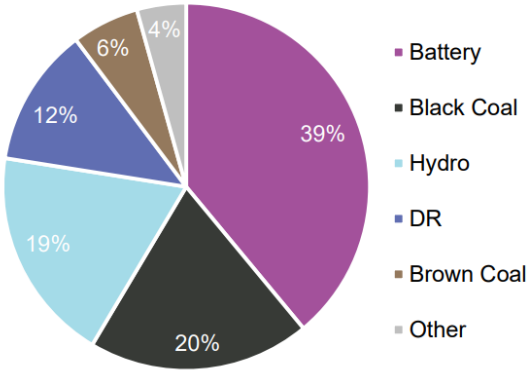


Figure 51 Battery FCAS market share reaches 39%

FCAS volume market share by technology – Q3 2022



[11] AEMO, Quarterly Energy Dynamics Q3 2022, October 2022 https://aemo.com.au/-/media/files/major-publications/qed/2022/qed-q3-2022.pdf?la=en

5. Proposed Rule

5.1. Description of the proposed Rule

Amendments are proposed to NER 4.4.2(c1), 4.4.2A, 4.4.2B and S5.2.5.11, to commence when the IESS Rule commences, being 3 June 2024.

AEMO's proposed Rule amendments will bring BDUs into the mandatory PFR obligation and require them (together with scheduled and semi-scheduled generating units) to be set to operate within the applicable frequency response performance parameters set under the PFRR, whenever dispatched to produce or consume energy at a level other than zero or enabled for a market ancillary service.

The proposed amendments are structured to make 4.4.2(c1) a consistent and comprehensive PFR obligation applicable to scheduled and semi-scheduled Generators and IRPs, incorporating the central element in 4.4.2A(b)(1) that is currently expressed as a requirement for inclusion in the PFRR themselves. The proposed drafting structure removes any doubt that to 'operate in accordance with the [PFRR]' is any different from setting the units to 'operate in frequency response mode within [the PFRR] performance parameters'.

Importantly, reformulating the PFR obligation in this way also aligns with regulatory principles, with the NER setting out the core compliance obligation, and authorising the PFRR to set out the technical detail of the parameters and their application. The prescribed content of the PFRR in 4.4.2A(b)(1) is then streamlined by removing the requirement for the PFRR to include an obligation to operate in accordance with the parameters.

As frequency response settings can be applied at a unit level (rather than necessarily at a system level where there are multiple units), the proposed Rule applies clauses 4.4.2(c1), 4.4.2A and 4.4.2B to relevant participants in respect of their generating units (scheduled and semi-scheduled) and scheduled BDUs. References to generating 'systems' have therefore been changed to 'units', except in 4.4.2A(c)(1), where it should be clear that there is no requirement to maintain stored energy either in the unit or anywhere in the broader system. The reference to units is also consistent with the long-standing frequency control provisions expressed in NER 4.4.2(b) and (c).

5.2. Transitional matters

AEMO has drafted the proposed Rule on the basis that it would come into effect on 3 June 2024, immediately after the commencement of the IESS Rule which introduces the IRP registration category and defines BDUs and integrated resource systems.

AEMO notes that the PFRR, like many other AEMO procedures and guidelines, will need to be amended to recognise these concepts by the IESS Rule effective date. If the AEMC can complete its rule change process in time for any resulting amendments to be incorporated in the procedure change consultations for IESS (AEMO suggests this would require a final determination before the end of 2023), AEMO does not consider any transitional or saving provisions will be necessary.

6. How the Proposed Rule Contributes to the National Electricity Objective (NEO)

The proposed Rule would positively contribute to the National Electricity Objective (NEO) particularly with respect to promoting efficient investment in, and efficient operation and use of electricity by providing consumers with secure and reliable supply of electricity. This is because the proposed Rule would:

- Not require any additional cost for the investment or operation of the services to provide PFR, within the IRP framework established by the IESS Rule.
  - Existing schedule 5.2.5.11(b)(3) requires that IRPs are to be capable of operating in frequency response mode for both charging and discharging.
  - The proposed Rule is merely extending the obligation to comply with the PFRR and is drawing on this existing capability, rather than requiring enhanced capability from new resources.
  - The operating cost of IRPs providing mandatory PFR, while operating in frequency control mode, are compensated through the frequency performance payments, double-sided incentive regime to be determined by AEMO (as discussed in section 4.1.2) because of the PFR Incentives Rule, and through the IRPs offer price (bids) for regulation and contingency FCAS.
  - While batteries are likely to be encouraged to operate with good primary response, consistent with other plant, (because this should allow them to benefit from the frequency performance payments), it should be noted the frequency performance payments are being designed with the PFRR obligation as an underpinning assumption. They are not being designed to encourage certain control settings on plant and aggressive deviations from dispatch. Instead, the PFR Incentives Rule aims to reward plant that comply with dispatch targets, operate with the control settings as set out in the PFRR, provide headroom, or foot room, and provide good quality response to regulation FCAS signals. This supports the ability to understand system response and account for it accordingly in operating and planning the system.
- Enhance system security, as batteries would contribute to the control base and provide mandatory PFR as and when required.
  - The more resources available to provide mandatory PFR the more secure the power system is for consumers.
  - If all units operate with the same control settings, set out in the PFRR, the response to contingencies will be better understood, and managed, making the system more secure.
- Be in the long-term interests of consumers, as the number of IRPs (batteries) in the NEM is increasing.
  - Extending the obligation of mandatory PFR to these resources now ensures the operational and regulatory frameworks that underpin the secure and reliable supply of electricity recognises these resources and appropriately utilises their contribution to maintain good frequency control into the future.

Additionally, mandatory PFR supplemented by incentives has already been found to satisfy the NEO. In its final determination of the PFR Incentives Rule, the AEMC was:

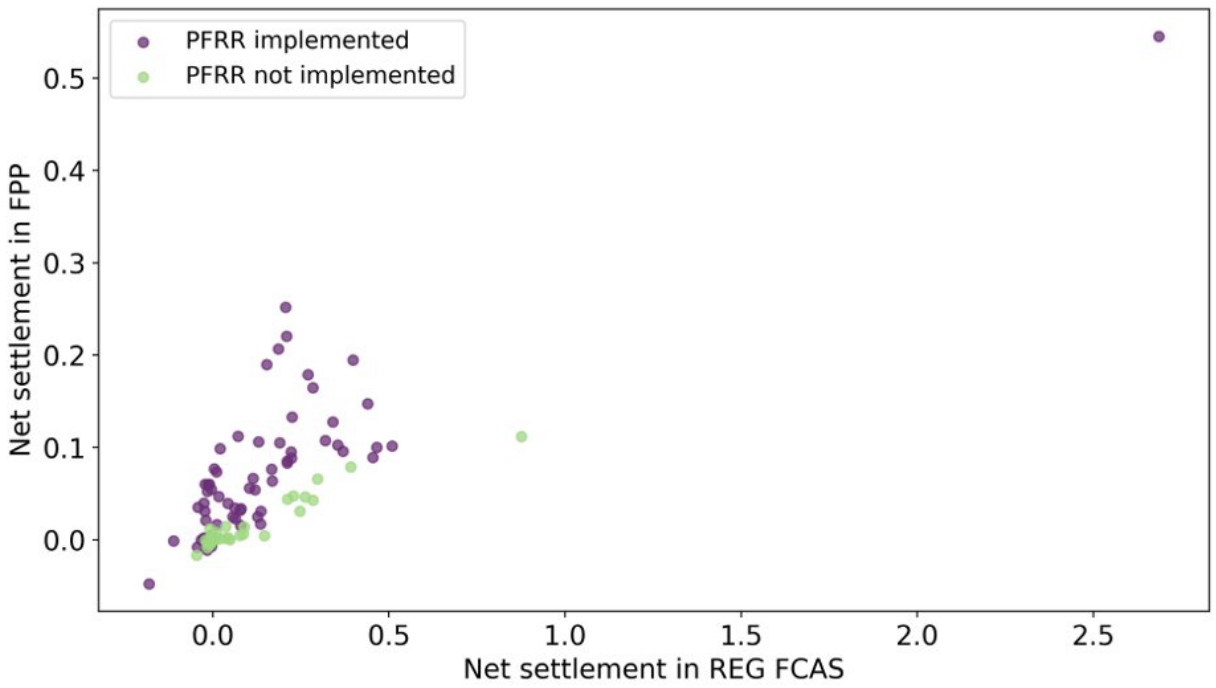
"satisfied that the confirmation of the mandatory PFR obligation for scheduled and semi-scheduled generators, combined with double-sided incentive arrangements to value helpful active power deviations and new reporting obligations will, or is likely to, contribute to the achievement of the NEO. This will support system security and deliver reduced costs for frequency control over the long term by encouraging innovation and investment in new capability to provide primary frequency response"[12].

7. Expected Benefits and Costs of the Proposed Rule

AEMO considers the benefits from this rule form part of the general economic and security benefits from making the MPFR Rule and the subsequent PFR Incentives Rule. Like the effect of making other plant comply with the PFRR, requiring batteries will improve control whilst frequency performance payments, with improved allocation of regulation FCAS, should largely mitigate any costs from doing so.

The PFR Incentives Rule is presently being implemented, and AEMO has recently published a draft procedure for consultation[13]. In supporting information, published to stakeholders[14], AEMO provided the following figure. The "back casting" covering the period between 20 July and 10 October 2021, shows that units which have complied with the obligation to provide PFRR would benefit from the payments.

Figure 4 Correlation between the net settlements in FPP and REG



[12] AEMC, Primary frequency response incentive arrangements, Rule determination, 8 September 2022 p14
[13] https://aemo.com.au/consultations/current-and-closed-consultations/frequency-contribution-factors-procedure
[14] AEMO, Frequency Contribution Factors Procedure Consultation, 2023, https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2022/frequency-contribution-factors-procedure/second-stage/fcfp-consultation-briefing-15-feb-2023.pdf?la=en

The figure presents the net settlement in the Frequency Performance Payments, which represents the net of credits and debits under that element of the scheme and the net settlement for Regulation FCAS, which is the enablement payments less debits to recover the cost of Regulation FCAS.

There is much variability across units that have complied with the PFRR. This is because thermal operating regimes, renewables forecasts, capacity factor/available headroom, and time online also influence the payments the unit will receive under the new frequency performance framework. Nevertheless, AEMO expects units that comply with the PFRR should largely be compensated for the cost of doing so.

AEMO notes the outlier shown in Figure 4 is a large battery that has complied with the PFRR and does not limit the response to periods when it receives a dispatch instruction to generate more than zero.

8. Draft Rule

4.4.2 Operational frequency control requirements

To assist in the effective control of *power system frequency* by *AEMO* the following provisions apply:

[…]

(c1) subject to clause 4.4.2A(c) and to any exemptions or variations approved by *AEMO*, each *Scheduled Generator*, ~~and~~ *Semi-Scheduled Generator* and *Scheduled Integrated Resource Provider* ~~that has received a *dispatch instruction* in accordance with clause 4.9.2 to generate a volume greater than zero MW must operate its *generating system* in accordance with the *Primary Frequency Response Requirements*~~ must set each of its *scheduled generating units*, *semi-scheduled generating units* or *scheduled bidirectional units* to operate in *frequency response mode* within the *primary frequency response parameters* as applicable to the relevant unit, in all periods when the unit is *dispatched* to produce or consume electricity at a level other than zero , or *enabled* for a *market ancillary service*~~that *generating system*~~;

[…]

4.4.2A Primary Frequency Response Requirements

(a) *AEMO* must develop, publish on its website and maintain, the *Primary Frequency Response Requirements* in accordance with the *Rules consultation procedures*.

(b) The *Primary Frequency Response Requirements* must include:

(1) ~~a requirement that *Scheduled Generators* and *Semi-Scheduled Generators* set their *generating systems* to operate in *frequency response mode* within~~ one or more performance parameters (which may be specific to different types of *plant*), which:

(i) must include maximum allowable deadbands which must not be narrower than the *primary frequency control band* outside of which a *scheduled generating unit*, *semi-scheduled generating unit* or *scheduled bidirectional unit*~~*Scheduled Generators* and *Semi-Scheduled Generators*~~ must provide *primary frequency response*; and

(ii) may include (but are not limited to):

(A) droop; and

(B) response time,

(the *primary frequency response parameters*);

(2) subject to rule 4.4.2B, the conditions or criteria on which a *Scheduled Generator*, ~~or~~ *Semi-Scheduled Generator* or *Scheduled Integrated Resource Provider* may request, and *AEMO* may approve, a variation to, or exemption from, any *primary frequency response parameters*

applicable to its ~~*scheduled* generating~~ units ~~system, *semi-scheduled generating system*~~ or *bidirectional units*;

(3) the process and timing for an application for a variation to, or exemption from, any *primary frequency response parameters* applicable to a ~~*scheduled* generating~~ *unit* ~~*system* or *semi-scheduled generating system*~~ or *bidirectional unit*, and the process for approval by *AEMO* of such variation or exemption; and

(4) details of the information to be provided by *Scheduled Generators*, ~~and~~ *Semi-Scheduled Generators* and *Scheduled Integrated Resource Providers* to verify compliance with the *Primary Frequency Response Requirements* and any compliance audits or tests to be conducted by *AEMO*.

(c) The *Primary Frequency Response Requirements* must not require a *Scheduled Generator*, ~~or~~ *Semi-Scheduled Generator* or *Scheduled Integrated Resource Provider* to:

(1) maintain stored *energy* in its *generating system* or *integrated resource system* for the purposes of satisfying clause 4.4.2(c1); or

(2) install or modify monitoring equipment to monitor and record the *primary frequency response* of its *generating unit* or *bidirectional unit* to changes in the *frequency* of the *power system* for the purpose of verifying ~~the *Scheduled Generator's* or *Semi-Scheduled Generator's*~~ compliance with clause 4.4.2(c1).

(d) *AEMO* must publish on its website and maintain, a register of *Scheduled Generators*, ~~and~~ *Semi-Scheduled Generators* and *Integrated Resource Providers* who have been granted a variation or exemption from any *primary frequency response parameters* in the *Primary Frequency Response Requirements*.

(e) *AEMO* may make minor or administrative amendments to the *Primary Frequency Response Requirements* without complying with the *Rules consultation procedures.*

4.4.2B Approval of variations or exemptions

(a) In considering whether to approve an exemption from, or a variation to, any of the *primary frequency response parameters* applicable to a *scheduled generating system, semi-scheduled generating system* or *scheduled integrated resource system,* ~~*Scheduled Generator's* or *Semi-Scheduled Generator's generating system,*~~ *AEMO* must have regard to:

(1) the capability of the *generating system* or *integrated resource system* to operate in *frequency response mode*;

(2) the stability of the *generating system* or *integrated resource system* when operating in *frequency response mode,* and the potential impact this may have on *power system security*;

(3) any other physical characteristics of the *generating system* or *integrated resource system* which may affect its ability to operate in *frequency*

response mode, including (but not limited to) *dispatch inflexibility profile,* operating requirements, or *energy constraints; and*

(4) whether the *Scheduled Generator*, ~~or~~ *Semi-Scheduled Generator* or *Scheduled Integrated Resource Provider* has been able to establish to *AEMO's* reasonable satisfaction that the implementation of the *primary frequency response parameters* applicable to the *generating system* or *integrated resource system* ~~that *Scheduled Generator's* or *Semi-Scheduled Generator's generating system*~~ will be unreasonably onerous having regard to (among other things):

(i) the likely costs of modifying the *generating system* or *integrated resource system* to be able to operate in *frequency response mode*; and

(ii) the likely operation and maintenance costs of operating the *generating system* or *integrated resource system* in *frequency response mode*,

relative to the revenue earned from the provision of *energy* and *market ancillary services* by the *generating system* or *integrated resource system* in relation to its operation in the *NEM* during the 12 months prior to the date of the application for exemption or variation, as applicable.

(b) A dispute between *AEMO* and a *Scheduled Generator*, ~~or~~ *Semi-Scheduled Generator* or *Scheduled Integrated Resource Provider* relating to a variation or exemption from any of the *primary frequency response parameters* applicable to a *generating system* or *integrated resource system* ~~*Scheduled Generator's* or *Semi-Scheduled Generator's generating system*~~ may be determined under rule 8.2.

(c) Information provided to *AEMO* by a *Scheduled Generator*, ~~or~~ *Semi-Scheduled Generator* or *Scheduled Integrated Resource Provider* as part of an application for variation or exemption under clause 4.4.2B(a)(4) is *confidential information*.

S5.2.5.11 Frequency control

…

(b) The *automatic access standard* is:

…

Note

Clause 4.4.2(b) of the *Rules* sets out the obligations on *Generators* and *Integrated Resource Providers* in relation to compliance with the technical requirements in clause S5.2.5.11, including being capable of operating in *frequency response mode*.[15] Clause 4.4.2(c1) of the *Rules* sets out the obligations on ~~*Scheduled* and *Semi-Scheduled* *Generators*~~ and *Integrated Resource Providers* in relation to the operation of their *generating systems* and *integrated resource systems* in accordance with the *Primary Frequency Response Requirements*.

…

[15] References to IRP in the first part of the note to paragraphs (b) and (c) were added in the IESS Rule, effective 3 June 2024.

(c) The *minimum access standard* is:

…

Note

Clause 4.4.2(b) of the *Rules* sets out the obligations on *Generators* and *Integrated Resource Providers* in relation to compliance with the technical requirements in clause S5.2.5.11, including being capable of operating in *frequency response mode*. Clause 4.4.2(c1) of the *Rules* sets out the obligations on ~~*Scheduled* and *Semi-Scheduled*~~ *Generators* and *Integrated Resource Providers* in relation to the operation of their *generating systems* and *integrated resource systems* in accordance with the *Primary Frequency Response Requirements*.