



Primary Frequency Response Requirements

Final Report – Standard consultation for the National Electricity Market

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Executive summary

The publication of this final report concludes the standard consultation procedure conducted by AEMO to amend the Primary Frequency Response Requirements (**PFRR**) under the National Electricity Rules (**NER**) (the **proposal**).

This consultation was undertaken as required by NER 11.152.2, following the procedure in NER 8.9.2. It follows the determination by the Australian Energy Market Commission (**AEMC**) in September 2022 of the National Electricity Amendment (Primary frequency response incentive arrangements) Rule 2022 (**PFR incentives rule**), which continued the mandatory primary frequency response (**PFR**) obligations in the NER¹. The amended PFRR determined by AEMO replaces the interim PFRR, addressing the requirements in NER 4.4.2A.

AEMO received four submissions in the first stage of its consultation on the proposal and another four submissions in the second stage.

Based on the feedback received and further review, AEMO has made material changes to the draft PFRR to address the following matters:

- A new process whereby AEMO may initiate a process to alter PFR Settings following agreement with Affected Generators.
- More granular references to the types, and combinations, of dispatch instructions Affected Generators will need to respond to.
- Clarification of the frequency response obligations from battery energy storage systems (**BESSs**) when charging.
- While AEMO has not amended the minimum required deadband for Affected generating systems (**GSs**), it is prepared to develop a program of adjusting deadbands on selected GSs to address the slow frequency oscillations seen on the power system.

After considering all submissions, AEMO's proposal is to make the Primary Frequency Response Requirements in the form published with this report, with an effective date of **8 May 2023**.

¹ These obligations had previously been set to sunset on 4 June 2023.

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1. Stakeholder consultation process

As required by National Electricity Rules (**NER**) 11.152.2 and 4.4.2A(a), AEMO has consulted on a proposal to amend the Primary Frequency Response Requirements (**PFRR**) (**the proposal**) in accordance with the standard rules consultation procedure in NER 8.9.2.

Note that this document uses terms defined in the NER and in the Interim PFRR, which are intended to have the same meanings. There is a glossary of additional terms and abbreviations in Appendix A.

AEMO's process and timeline for this consultation are outlined below.

Table 1 Consultation process and timeline

Consultation steps	Dates
Consultation paper published	6 December 2022
Submissions closed on consultation paper	16 January 2023
Draft report published	20 February 2023
Submissions closed on draft report	21 March 2023
Final report published	4 May 2023

AEMO's consultation webpage for the proposal is at <https://aemo.com.au/consultations/current-and-closed-consultations/primary-frequency-response-requirements>. It contains all previous published papers and reports, written submissions, and other consultation documents or reference material (other than material identified as confidential).

In response to its consultation paper on the proposal, AEMO received four written submissions, from the Australian Energy Council (**AEC**), Delta Electricity, Origin Energy and Shell Energy.

AEMO published a draft report of its review of the submissions and an updated draft of the PFRR, following which a further four written submissions were received. These were from the AEC, CS Energy, Delta Electricity and Shell Energy.

AEMO thanks all stakeholders for their feedback on the proposal, which has been considered in preparing this final report.

2. Background

2.1. Context for this consultation

On 8 September 2022, the Australian Energy Market Commission (**AEMC**) made the National Electricity Amendment (Primary frequency response incentive arrangements) Rule 2022 (**PFR incentives rule**).

The PFR incentives rule provides enduring arrangements to support the control of power system frequency through mandatory primary frequency response (**PFR**) in combination with incentives for plant behaviour that reduces the overall cost of frequency regulation during normal operation. This consultation concerns only those provisions in the PFR incentives rule that apply to the PFRR.

The transitional provisions of the PFR incentives rule require AEMO to develop and publish the PFRR by 8 May 2023, after consultation in accordance with NER 8.9.

2.2. NER requirements

AEMO published the Interim PFRR under NER 11.122.2 in accordance with the transitional provisions of the National Electricity Amendment (Mandatory primary frequency response) Rule 2020 (**Mandatory PFR rule**).

The PFRR are required to be made under NER 4.4.2A(a). Paragraphs (b) and (c) detail what the PFRR must, and must not, include, and are reproduced here for convenience:

- (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 *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* may request, and *AEMO* may approve, a variation to, or exemption from, any *primary frequency response parameters* applicable to its *scheduled generating system* or *semi-scheduled generating system*;
 - (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 system* or *semi-scheduled generating system*, 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* 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* to:
 - (1) maintain stored energy in its *generating 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 system* 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).

NER 4.4.2B(a) details AEMO's required considerations for approval of variations and exemptions referred to in NER 4.4.2A(b)(3), as follows:

- (a) In considering whether to approve an exemption from, or a variation to, any of the *primary frequency response parameters* applicable to a *Scheduled Generator's* or *Semi-Scheduled Generator's generating system*, AEMO must have regard to:
 - (1) the capability of the *generating system* to operate in *frequency response mode*;
 - (2) the stability of the *generating 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* 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* has been able to establish to AEMO's reasonable satisfaction that the implementation of the *primary frequency response parameters* applicable to 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* to be able to operate in *frequency response mode*; and
 - (ii) the likely operation and maintenance costs of operating the *generating system* in *frequency response mode*,

relative to the revenue earned from the provision of *energy* and *market ancillary services* by the *generating 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.

2.3. The national electricity objective

Within the specific requirements of the NER applicable to this proposal, AEMO will seek to make a determination that is consistent with the national electricity objective (NEO) and, where considering options, to select the one best aligned with the NEO.

The NEO is expressed in section 7 of the National Electricity Law as:

to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to:

- (a) price, quality, safety, reliability and security of supply of electricity; and
- (b) the reliability, safety and security of the national electricity system.

3. List of material issues

The key material issues arising from the draft report or raised in submissions are listed in Table 2.

Table 2 List of material issues

No.	Issue	Raised by
1.	Slow frequency oscillations	AEC, CS Energy, Delta Electricity
2.	Mechanism to permit wider deadbands	AEC, CS Energy
3.	Interaction between PFR and MASS	AEC, CS Energy, Delta Electricity, Shell Energy
4.	Provision of PFR by BESS	AEC, CS Energy, Delta Electricity, Shell Energy
5.	Other drafting or technical considerations	AEMO

Each of the material issues in Table 2 is discussed in Section 4.

4. Discussion of material issues

4.1. Slow frequency oscillations

4.1.1. Issue summary and submissions

During the first stage of this consultation, Delta Electricity raised the matter of ongoing slow frequency oscillations in power system frequency, and how it might be addressed.

In the draft report, AEMO acknowledged ongoing small oscillations in frequency, and noted that these are undesirable in principle. AEMO also indicated it was not aware of any historical analysis or modelling that was able to reproduce or predict similar small, slow frequency oscillations either in the NEM or comparable power systems.

AEMO considered the best course of action was to work with industry on solutions proposed via separate expert advice, and that a simple, high-level specification document such as the PFRR is not where solutions to this type of phenomenon would be identified.

AEMO noted the variation process in the PFRR provided a sufficient avenue where Affected Generators who considered that their plant might be contributing to the phenomenon could seek to widen the Affected generating systems' (**GS**) deadband settings. If, for example, it could be demonstrated, such as via field testing or modelling, that altering settings at certain plants was effective at reducing such oscillations, the existing variation process would provide an avenue for capturing such alterations on an ongoing basis.

Most submissions received in the second stage address the issue of slow frequency oscillations:

Australian Energy Council:

Since its last submission to this consultation, the AEC has submitted expert advice to the Reliability Panel that universal very narrow governor deadbands may be contributing to some unexplained oscillations and asymmetry in the NEM's frequency characteristic. The AEC's advisor has recommended a progressive relaxation of deadbands to confirm this hypothesis.

The NER provides AEMO the right to implement wider (but not narrower) deadbands on plant than the PFCB. The Requirements should anticipate AEMO doing this and incorporate a mechanism for it.

CS Energy

CS Energy is concerned with AEMO's response to the Delta Electricity submission in Section 4.5 Testing and demonstration of stability detailed on page 15 in the Draft Report²,

Regarding the issue raised by Delta Electricity on erratic movements in power system frequency, if material power system security issues are identified, AEMO will work with industry to determine the underlying causes and implement appropriate remedial actions.

This observation, its impact and potential remediation has been raised with AEMO on numerous occasions in PFR forums and submissions to consultations on this subject including the recent Reliability Panel (RP) consultation on the Review of the Frequency operating standard 2022³. CS Energy highlighted its concerns in its submission⁴ on page 3.

AEMO has publicly stated that it notes the phenomena but at this stage does not propose any action that is inconsistent with its response to the Delta Electricity submission detailed above.

Furthermore, the AEC submitted an expert advice paper⁵ on the same consultation to the Reliability Panel postulating that the present universal very narrow governor dead bands may be contributing to some unexplained oscillations and asymmetry in the NEM's frequency characteristic.

CS Energy would be disappointed and concerned if AEMO did not address the observed unexplained oscillations and asymmetry in the NEM's frequency characteristic. The NER enable AEMO to implement wider (but not narrower) dead bands on plant rather than just adhere to the PFCB. The PFRR should anticipate AEMO doing this in its response to the observed unexplained oscillations and asymmetry in the NEM's frequency characteristic and incorporate a mechanism to address the phenomena.

Delta Electricity

Delta Electricity remains concerned that AEMO intend to continue to seek the now defined Frequency Operating Standard (FOS) Primary Frequency Control Band (**PFCB**) as the mandated default deadband directed by the PFRR. The NER do not describe this requirement. As AEMO illuminated succinctly on page 21 of the draft report, in bold text, the Mandatory PFR rule direct that the maximum allowable deadbands resulting from the PFRR **must not be narrower than the PFCB**. The valid interpretation from the FOS does not direct AEMO to mandate in the PFRR that every Unit seek to provide deadbands set at the PFCB in the PFRR. AEMO specialists continue to seek tighter deadbands even though they are also aware erraticism and oscillatory behaviour exists across the NEM and cannot be produced with the power system models available to AEMO. Efforts to eliminate erraticism in the frequency condition cannot be expected to be driven by individual participants. It must be driven by the central operator and the PFRR is a strong NER driven document that can support an effort in this capacity. Unfortunately, no revision in this direction appears to be arising from this review.

Regardless of the inadequacy of modelling, which ought not be singularly relied upon in approaches towards effective operation of the power system even though it does provide some guidance, it is also AEMO's task, under NER 4.4.1(a) to control frequency. Admitting a common mode oscillation exists that is presently uncontrolled but also being cautious in experimentation just because it is unclear that variations in deadbands might be a valid consideration in making some sort of attempt to investigate and eliminate the erraticism, suggests a lack of concern amongst AEMO specialists that the problem carries any seriousness associated with it. AEMO produce the PFRR and can seek, if imagination, initiative and commitment to NER 4.4.1(a) was included within actions to amend and implement via the PFRR, to, amongst other strategies, assign variations to the deadbands to regions, generating systems and generating units in deliberate attempts to find a smoother overall outcome for the resultant frequency condition.

Delta Electricity was not meaning to suggest that AEMO seek to modify the universal minimum PFR requirements but to recognise that deploying the PFCB rigidly as **the** automatic default PFRR deadband unless individual generators demonstrate specific local Unit reasoning to vary from it as would be required by an unaltered PFRR, is not what the NER mandate and may not be the best approach considering obligations of NER 4.4.1(a) and that, in fact, wording in the PFRR, in pursuit of efforts to reduce and eliminate overall erraticism, proposing some variations to deadbands above the PFCB at strategic positions in the NEM, initiated,

² https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2022/primary-frequency-response-requirements/draft-report.pdf?la=en

³ <https://www.aemc.gov.au/market-reviews-advice/review-frequency-operating-standard-2022>

⁴ https://www.aemc.gov.au/sites/default/files/2023-02/CS%20Energy%20Limited%20%20Submission%20to%20Frequency%20Operating%20Standard%20Review_1.pdf

⁵ <https://www.aemc.gov.au/sites/default/files/2023-02/AEC%20attachment%20%E2%80%93%20Provecta%20technical%20report.pdf>

designed and pinpointed by AEMO to suit each installed network and sub-network configuration, and/or proposing a targeted and scheduled assortment of varied deadbands to explore the impacts on the erraticism to learn what might influence it, might actually assist in identifying the causes of the erraticism and therefore take steps towards reducing or eliminating it. Even trials of different deadbands might assist. These steps are arguably required by NER 4.4.1(a) and the PFRR is a strong NER driven document whereby AEMO can centrally coordinate such activity.

AEMO may recall that oscillations between AVR's of Units are tunable. Delta Electricity considers interactions between governors are also but there are inadequate mechanisms in the NER to do so except via the PFRR. With AVR's, modelling is inherently more accurate and more regularly applied by replacement alterations as these devices are more routinely replaced. It is well known that oscillations occurring between AVR's are more rapid with closer machines, reduce where between intraregional machines and reduce further between interregional machines. Replacements of governor mechanisms are less common and the full control mechanisms less understood particularly since reactions from slower secondary forms of speed control were included in NEM related primary frequency response delivery as is driven by the PFRR. Oscillations due to conflicting governor controllers are probably slower, and definitely more complex, in general than those attributable to AVR's. Slower because the reaction times of the secondary speed reactions from large Units involve the fuel and boiler reactions with 2-3 minute time constants but more complex due to the fact the overall reaction if a conglomerated delivery from reasonably rapid reactions occurring via mechanical-hydraulic and electrohydraulic governor and the release or retarding of stored energy behind throttle valves. There is an initial rapid reaction to a speed change (not an absolute speed or frequency value) followed sometime later by reactions from the boiler upon the steam system and then the load setter, often via a similar mechanism, to the governor, well after the initial reaction and also with reference to an absolute value of frequency. AVR's and power system stabiliser settings also need proper designs to suit the Network and it is doubtful that all stabilisers, expected to detect and prevent oscillations would have similar deadbands in their control circuits in effecting stable control. As governor combined with boiler reactions are a more complex overall response than AVR's including elements with direct instantaneous response from mechanical-hydraulic controllers with zero actual deadband but 30-60mHz deadbands coupled alongside slower reactions with a defined deadband of, in AEMO's directed PFRR ± 15 mHz, and with great variations in delivery due to fuel quality, burner configurations and atmospheric conditions, it is considered highly unlikely that the theoretical condition AEMO is seeking i.e. tighter deadbands should yield the best overall frequency condition, is correct in application on the complex system. In the absence of adequate modelling guidance and perhaps inadequate or incomplete models of the all the electrical and mechanical aspects of speed control, experimentation with the system assignment of deadbands, which should be simple to arrange now most machines are operating at very tight deadbands, is recommended, but, except via the PFRR, it is probably not achievable and, with this review close to finalisation, unless AEMO is about to attempt to consider this as new information, the option to pursue this possibility sooner rather than later or after a network event illuminates the need to do so, has been lost. If AEMO was to reconsider as a result of this response, it is recommended another review period of the PFRR be immediately proposed. Through an appropriate revision to the PFRR, AEMO, the system operator, could if it saw fit, centrally coordinate a search and eliminate process proactively in pursuit of NER 4.4.1(a) with the assistance of all participants, from which, AEMO and participants could mutually learn and collaboratively develop methods and adjustments that reduce or eliminate the causes of the erraticism.

In absence of efforts in the direction of reducing the erraticism, Delta Electricity remains concerned that AEMO's approach detailed in the draft report, and the proposed PFRR, will continue to assign the general system frequency erraticism to being unsolvable by AEMO and only a problem should it present so for any participant, in which case AEMO expects the participant to pursue the problem locally within the confines of the NER and AEMO's PFRR if concerns warrant. In the absence of any centrally coordinated efforts to reduce or eliminate it, frequency unsteadiness will remain uncontrolled. Continued unchecked, it is likely the erraticism, widening peak to peak amplitudes that appear to be occurring at times, tight deadbands from the PFRR combined with NEM apathy in pursuit of NER 4.4.1(a) to investigate and eliminate the causes of the erraticism, will deliver longer term damage to components of older machines, reduce the life of the fleet and all electrical machines operating in the NEM and potentially induce long term power supply shortages should multiple machines experience a series of cascading failures of governing mechanisms.

4.1.2. AEMO's assessment

As noted in the draft report, it is unclear whether modifying the universal minimum PFR requirement for all plant types and technologies will be effective to address these slow oscillations in power system frequency. In contrast, implementing PFR deadbands at the level specified by the PFCB, with a process for variation or exemption as required, has resulted in demonstrable improvements to the control of power system frequency.

AEMO notes that its core responsibility as power system operator is to use its reasonable endeavours to maintain the power system in a secure operating state. While frequency is only one of many

parameters that affect power system security, AEMO's role in respect of power system frequency is set out in NER 4.4.1:

AEMO must use its reasonable endeavours to:

- (a) control the *power system frequency*; and
- (b) ensure that the *frequency operating standards* are achieved.

It is implicit in AEMO's power system security responsibilities that it should not deliberately take actions that could jeopardise power system security including, in the present circumstances, the power system frequency control that has been established through near-universal narrow-band PFR. This means:

- AEMO needs to be satisfied that any issue with power system operation has been identified correctly both as to its existence and extent.
- Having identified an issue, AEMO needs to examine potential solutions to identify a technically and economically feasible solution that has a reasonable prospect of successful implementation without material adverse consequences.

AEMO notes the Provecta technical report provided as part of the AEC's submission during the second stage of the Reliability Panel Panel's review of the Frequency Operating Standard (FOS) 2022⁶. In its report, Provecta provides a hypothesis that the universal application of very narrow governor deadbands may be contributing to unexplained oscillations from some plant and asymmetry in the NEM's frequency characteristic. In its submission, the AEC notes that Provecta "has recommended a progressive relaxation of deadbands to confirm this hypothesis."

AEMO considers the hypothesis put forward by Provecta credible and worth exploring further. Importantly, and consistent with the clarification made in Delta Electricity's submission, AEMO understands that Provecta suggests that relaxing deadbands at selected Affected GSs could be an effective, rather than universal relaxation of frequency deadbands across all generation in the NEM.

The approach suggested by Provecta is simple, reversible, and are understood to be consistent with settings used by some relevant Affected GSs in recent years.

AEMO agrees that it is desirable to commence a process of testing progressively wider deadbands with relevant Affected GSs, to assist in identifying the cause and potential solutions to the slow frequency oscillations issue. A timeframe and approach for this workstream will be developed with industry input. AEMO anticipates that the approach will take into consideration the impact of modifying deadbands on power system security and Affected GS performance.

4.1.3. AEMO's conclusion

AEMO will not widen the minimum deadband specified in section 3.2.1 of the PFRR, but will implement a program with relevant Affected Generators to test Provecta's hypothesis within the bounds of its power system security responsibilities.

The process by which this can occur will be reflected in the PFRR, and is discussed in section 4.2.

⁶ <https://www.aemc.gov.au/market-reviews-advice/review-frequency-operating-standard-2022>

4.2. Mechanism to permit wider deadbands to address other power system security issues

4.2.1. Issue summary and submissions

The submissions in section 4.1.1 indicated that the PFRR should include a mechanism to permit wider deadbands than the PFCB, or other modifications to the PFR Settings, in the context of responding to, or testing solutions for, the slow frequency oscillations. Delta Electricity's submission, in particular, included detailed suggestions for alternative processes that could allow for a coordinated schedule of responses.

AEMO has considered the possibility of including a mechanism to allow the application of agreed modifications in such circumstances for selected Affected GSs, to address identified power system security issues.

4.2.2. AEMO's assessment

While the variation process in section 6 of the PFRR could be used to implement any modifications to individual PFR Settings that are likely to be effective to address other power system phenomena, AEMO agrees that it may be clearer for the PFRR to recognise these different circumstances through a separate, AEMO-initiated, variation process involving discussion and agreement with relevant Affected Generators. This is somewhat different from the variation and exemption concept outlined in the NER (as a request-approve process) but the PFRR may include additional content that is relevant to their subject matter.

4.2.3. AEMO's conclusion

AEMO has included a new section 6.8 of the PFRR, providing for a relatively straightforward but flexible mechanism for AEMO to propose variations to PFR Settings if it considers they are likely to improve power system security. The variation would be requested by AEMO and, if agreed with the Affected Generator, AEMO would document the terms of the variation.

The process will be supported by a new template response to an Affected Generator based on the existing template in Appendix C.

4.3. Interaction between PFR and MASS

4.3.1. Issue summary and submissions

In the draft report, AEMO identified certain changes to section 2.3 of the PFRR to address the need for greater cross-referencing with the Market Ancillary Service Specification (**MASS**).

Three submissions raised concerns about how those changes affect the interaction between the provision of PFR and the MASS.

AEC

The Draft's section 2.3(b) suggests that PFR is expected from systems with a zero energy dispatch target but who are providing Regulation FCAS and at that moment have a positive AGC set point. This is not the AEC's understanding of the NER which is that the only determining trigger of the obligation is a positive energy dispatch target.

CS Energy

Further clarity is sought on the Draft PFRR section 2.3 (b). CS Energy was of the understanding that the NER required delivery of PFR where an Affected Generator receives a dispatch instruction in respect of an Affected GS to generate a quantity of energy greater than 0 MW.

CS Energy was not aware that the delivery of PFR would extend to where an Affected Generator receives a dispatch instruction in respect of an Affected GS for a quantity of Regulation FCAS greater than 0 MW coincident with a dispatch instruction in respect of an Affected GS to generate a quantity of energy not greater than 0 MW, the Affected GS' desired output should be the summation of the AGC setpoint and the PFR Settings as required by section 10.3 of the MASS.

The wording of section 2.3 is clear but it does not reflect the requirements as specified in the NER.

The ambiguity is further exacerbated when read in conjunction with section 4.3. Clarification is required for energy storage systems including Battery Energy Storage Systems (BESS) that continue to provide regulation FCAS when in charging mode do not require the provision of PFR.

Shell Energy

To provide additional clarity we suggest that section 2.3 should be amended to accurately reflect the type of dispatch instruction in accordance with the NER, as opposed to being left in the ambiguous form of a more generalised "dispatch instruction" term. Each sub clause should be clearly reference to the applicable dispatch instruction in the NER.

In addition, the current section 2.3(b) requires additional clarification to meet the requirements of NER 4.4.2(c1). The current wording of the PFRR suggests that a NER 4.9.3A dispatch instruction for regulation FCAS in isolation requires an affected GS to provide PFR which Shell Energy considers is an incorrect interpretation of the NER. Our understanding of the NER is that an affected GS that receives a NER 4.9.3A dispatch instruction for the provision of regulation FCAS greater than 0 MW, but is not also issued a NER 4.9.2 dispatch instruction for active energy dispatch greater than 0 MW, is not required to provide PFR. This is because NER 4.4.2(c1) is specific to only a NER 4.9.2 dispatch instruction. For a NER 4.9.3A dispatch instruction in isolation the Affected GS's desired output should be the AGC setpoint. Only where an Affected GS receives both a NER 4.9.3A dispatch instruction for regulation FCAS and a NER 4.9.2 dispatch instruction to provide active energy dispatch greater than 0 MW in the same trading interval would the requirement as currently indicated in section 2.3(b) be correct.

This distinction allows for an energy storage system to continue to provide regulation FCAS when in charging mode without requiring the provision of PFR.

We also recommend a change, outlined below, to make it clear that intent of the PFRR is that a semi-scheduled generator subject to a semi-dispatch interval may exceed its dispatch instruction for the provision of PFR.

We offer the following revised wording for section 2.3 for AEMO's consideration.

- (a) Where an Affected Generator receives a **NER 4.9.2** dispatch instruction in respect of an Affected GS for a quantity of energy greater than 0 MW, the Affected GS' output is to be varied in accordance with the PFR Settings **subject to section 2.2**. If the dispatch instruction is received by AGC, the desired output should be the summation of the AGC setpoint and the PFR Settings as described in section 10.3 of the market ancillary service specification (MASS).
- (b) Where an Affected Generator receives **both a NER 4.9.3A** dispatch instruction in respect of an Affected GS for a quantity of Regulation FCAS greater than 0 MW and a **NER 4.9.2 dispatch instruction for a quantity of energy greater than 0 MW in respect of an Affected GS**, the Affected GS' desired output should be the summation of the AGC setpoint and the PFR Settings **subject to section 2.2** as required by section 10.3 of the MASS.
- (c) **Where an Affected Generator receives a NER 4.9.3A dispatch instruction in respect of an Affected GS for a quantity of Regulation FCAS greater than 0 MW, but that Affected GS is not issued a NER 4.9.2 dispatch instruction to provide energy in the same dispatch trading interval, the Affected GS' desired output should be the AGC setpoint subject to section 2.2 as required by the MASS.**
- (d) Where an Affected Generator receives a **NER 4.9.3A** dispatch instruction in respect of an Affected GS for a quantity of Contingency FCAS, but that Affected GS is not issued a **4.9.2 dispatch instruction** to provide energy in the same dispatch trading interval, the Affected GS must comply with the requirements for the relevant Contingency FCAS, as set out in the MASS.
- (e) Where an Affected GS is operating in a semi-dispatch interval and a frequency deviation would cause an increase in output exceeding its NER 4.9.2 dispatch instruction, where possible, the Affected GS' output should be increased to provide PFR.

4.3.2. AEMO's assessment

- These submissions indicated residual concerns about the way in which AEMO has drafted section 2.3 of the PFRR in three respects.

Dispatch instruction

- A dispatch instruction to generate energy is a dispatch instruction under NER 4.9.2. It cannot be anything else. Nevertheless, because NER 4.4.2(c1) explicitly references NER 4.9.2, AEMO will amend section 2.3 to include references to NER 4.9.2 and NER 4.9.3A, where appropriate.

Regulation FCAS

AEMO considers that there is a need to delineate the required outcomes when an Affected GS receives, for the same trading interval:

- A NER 4.9.3A dispatch instruction to provide Regulation FCAS only.
- A NER 4.9.2 dispatch instruction to generate more than 0 MW and a 4.9.3A dispatch instruction to provide Regulation FCAS.
- For the sake of completeness, AEMO will do the same for Contingency FCAS.

The amended provisions make it clear that an Affected Generator is permitted, but not required, to provide PFR on a consistent basis, independent of FCAS or energy dispatch instructions. AEMO considers this clarification reflects the control designs in use and behaviour of most Affected GSs at present.

Semi-scheduled plant

AEMO understands that the concern expressed by Shell Energy is that Affected GSs comprised of semi-scheduled plant should be able to exceed their dispatch levels in a semi-dispatch interval if they are required to provide PFR.

AEMO considers this to be an acceptable clarification, noting that NER 4.9.8(a1) explicitly relieves the obligation to comply with a dispatch instruction by reason of a generating unit's operation in frequency response mode.

4.3.3. AEMO's conclusion

AEMO will make the following amendments to section 2.3 of the PFRR:

- The section will be broken into sub-sections for clarity.
- Each paragraph will be specific as to which type of dispatch instruction is being referred to, by reference to the relevant NER clauses, and confirm both the required output and the circumstances in which the Affected GS may provide PFR but is not required to do so.
- It will be made clear that Affected GSs that are semi-scheduled are permitted to exceed their dispatch levels during a semi-dispatch interval if they are required to provide PFR during that semi-dispatch interval.

4.4. Provision of PFR by BESS

4.4.1. Issue summary and submissions

In the consultation paper and draft report, AEMO proposed to amend section 4.3 of the PFRR to clarify that there is no requirement for BESS to inhibit the provision of PFR when charging, and noted an expectation (amended in the draft to a preference) that PFR Settings would, in fact, not change by reference to direction of flow.

AEMO emphasised the need for a consistent response from all plant to support the resilience and predictability of the power system's response to disturbances and noted that it is considering a rule change proposal to address issues relating to the continued application of PFR to BESS.

All submissions addressed this issue.

AEC

The AEC thanks AEMO for responding to its and members concerns regarding the initial draft of section 4.3 that appeared to imply, contrary to the expectations of NER 4.42(c1), that storage is obliged to provide PFR while charging.

The revised wording now correctly recognises that the NER does not oblige this. Instead the Draft now states that AEMO “prefers” that PFR settings do not change based on energy flows.

The AEC suggests that AEMO's preference for a different rule is irrelevant. An AEMO procedure must implement the NER in the way it is written and should not state alternative preferences. AEMO need only clarify in the last sentence of 4.3 that it will allow systems to not change settings based on energy flow direction, rather than prefer.

CS Electricity

While AEMO has responded to concerns raised in submissions regarding the implication in the initial Draft PFRR that BESS in a charging mode are obligated to provide PFR. The Draft PFRR⁷ states in section 4.3 that,

Although Affected GSs comprising battery energy storage systems are not required by NER 4.4.2(c1) to provide PFR while they are consuming energy, for power system operation purposes AEMO prefers that their PFR Settings do not change by reference to the direction of energy flows for which they are dispatched.

CS Energy views it as ambiguous and inappropriate to state a preference that the does not reflect the obligations specified in NER 4.4.2(c1).

Delta Electricity

Regarding wording that is not required by the NER to be in the PFRR, Delta Electricity does not agree there is any necessity to include AEMOs preferences for how BESS operate in the PFRR. The preference is best provided by AEMO on a case-by-case basis in private discussion with relevant battery proponents. The draft report is already a historical reference to reflect on but persisting with the inclusion of AEMOs preferences in the PFRR on this specific point whilst not including other preferences on any number of other points for the PFRR could produce the opposite of AEMO's preference. Some participants will see the inclusion as oversight and deliberately avoid complying with it as a result, whilst others, should they be asked one on one, instead of having to interpret AEMOs preferences from the PFRR, may respond favourably to private requests at the appropriate time for the project. If AEMO maintains the viewpoint that the NER ought to mandate the delivery, then, as suggested previously, a NER change request to have the industry consult on it is recommended instead of the wording of the proposed PFRR.

Shell Energy

We note AEMO's proposed changes to section 4.3 but consider the revised draft words do not meet the requirements of NER 4.4.2(c1). It is not only when charging that an energy storage system (ESS) is not required to provide PFR. An ESS is only required to provide PFR when it has been issued a NER 4.9.2 dispatch instruction for the provision of active energy output greater than 0 MW. We also consider the wording of the section should not be restricted to BESS and should apply to all energy storage systems in general.

We offer the following revised wording for AEMO's consideration.

Subject to NER 4.4.2(c1), PFR must remain continuously enabled at the PFR Settings, unless agreed with AEMO, independent of ancillary services enablement.

Although Affected GSs comprising an energy storage system **are only required by NER 4.4.2(c1) to provide PFR in periods when the Affect GS has been issued a NER 4.9.2 dispatch instruction for active energy output greater than 0 MW**, for power system operational purposes AEMO prefers that their PFR Settings for energy storage systems do not change by reference to the direction of energy flows for which they are dispatched.

⁷ https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2022/primary-frequency-response-requirements/final-pfr-requirements--draft-determination-clean.pdf?la=en

Whilst AEMO prefers that PFR settings for energy storage systems do not change by reference to the direction of energy flows for which they are dispatched, AEMO's agreement is not required to disable the provision of PFR when an energy storage system has not been issued a NER 4.9.2 dispatch instruction for active energy output greater than 0 MW.

This last paragraph ensures that AEMO does not impose a requirement on an energy storage system in the PFRR that does not align with NER 4.4.2(c1).

4.4.2. AEMO's assessment

As drafted, section 4.3 of the PFRR indicates that consistent settings are preferable from a power system operation perspective. As noted in the draft report, the PFRR are developed and updated through rules consultation processes and, like any similar instrument, it is both permitted and appropriate for them to include appropriate explanation and guidance at a level of specificity that is not prescribed in the NER. The NER prescribe the **minimum** content of the PFRR and do not contain an exhaustive list of issues the PFRR must address.

For transparency, AEMO again notes its intention to propose a change to the NER to address the application of the PFR obligation to BESS when the 'integrating energy storage systems in the NEM' rule⁸ comes into full effect in June 2024. While the outcome of that proposal will, of course, be subject to consultation by the AEMC, AEMO considers it is important for BESS operators to be aware of AEMO's intention when considering the design of their plant or any changes to it.

4.4.3. AEMO's conclusion

To address the submissions, AEMO will amend section 4.3 of the PFRR to state that, while there is no requirement for Affected Generators to apply different PFR Settings by reference to the direction of flow, they are permitted to do so subject to the generally applicable requirements in the NER for the approval of new or changed control system settings.

4.5. Other drafting or technical considerations

4.5.1. Issue summary and submissions

AEMO sought submissions on whether there were any other drafting or technical considerations that should be considered for inclusion or amendment in the PFRR. No suggestions were made on issues other than those discussed in the preceding sections.

On final review, however, AEMO has identified that:

- It omitted to delete a superfluous definition in the draft PFRR published with the draft report.
- There is some repetitive text in Appendix C.

4.5.2. AEMO's conclusion

The final PFRR has been amended to remove the superfluous definition of 'Proposed PFR Settings' from the glossary and repetitive text in Appendix C (AEMO response to application for exemption or variation).

⁸ National Electricity Amendment (Integrating energy storage systems into the NEM) Rule 2021 No. 13, <https://www.aemc.gov.au/rule-changes/integrating-energy-storage-systems-nem>

5. Final determination on proposal

Having considered the matters raised in submissions to the draft report, AEMO's final determination is to make the Primary Frequency Response Requirements in the form published with this final report, in accordance with NER 11.152.2 and 4.4.2A.

A marked-up version of the final PFRR has also been published to show changes from the Interim PFRR.

Appendix A. Glossary

Terms defined in the NER and the Interim PFRR have the same meanings when used in this final report. Other defined terms and acronyms are listed in the following table.

Term or acronym	Meaning
AEMC	Australian Energy Market Commission.
BESS	Battery energy storage system.
Contingency FCAS	As described in the MASS.
FOS	Frequency Operating Standard.
Interim PFRR	AEMO's Interim Primary Frequency Response Requirements , dated 4 June 2020.
Mandatory PFR rule	The AEMC's National Electricity Amendment (Mandatory primary frequency response) Rule 2020 .
MASS	AEMO's Market Ancillary Service Specification .
PFCB	Primary frequency control band, as defined in the Frequency Operating Standard .
PFR	Primary frequency response.
PFR incentives rule	The AEMC's National Electricity Amendment (Primary frequency response incentive arrangements) Rule 2022 .
PFRR	Primary Frequency Response Requirements, the subject of this consultation.
Regulation FCAS	As described in the MASS.