

Frequency Contribution Factors Procedure

Consultation paper -Standard consultation for the National Electricity Market

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Explanatory statement and consultation notice

This consultation paper commences the first stage of the standard rules consultation procedure conducted by AEMO to develop and publish a new frequency contribution factors procedure (**FCFP**) as required by National Electricity Rules (**NER**) 11.152.3 (the **proposal**).

The FCFP will have effect under NER 3.15.6AA, which commences on 8 June 2025 under the National Electricity Amendment (Primary Frequency Response incentive arrangements) Rule 2022 (**PFR incentives rule**)¹.

The standard rules consultation procedure is described in NER 8.9.2.

The detailed sections of this consultation paper include more information on the proposal and AEMO's reasons for making it. An early draft of the FCFP reflecting the proposal is published with this consultation paper to provide context.

Consultation notice

AEMO is now consulting on this proposal and invites written submissions from interested persons on the issues identified in this paper to FPPconsultation@aemo.com.au by 5:00pm (Melbourne time) on 6 December 2022.

Submissions may make alternative or additional proposals you consider may better meet the objectives of this consultation and the national electricity objective in section 7 of the National Electricity Law. Please include supporting reasons.

Please note the following important information about submissions:

- All submissions will be published on AEMO's website, other than confidential content.
- Please identify any parts of your submission that you wish to remain confidential, and explain why. AEMO may still publish that information if it does not consider it to be confidential, but will consult with you before doing so. Material identified as confidential may be given less weight in the decisionmaking process than material that is published.
- Submissions received after the closing date and time will not be valid, and AEMO is not obliged to
 consider them. Any late submissions should explain the reason for lateness and the detriment to you
 if AEMO does not consider your submission.

Interested persons can request a meeting with AEMO to discuss any particularly complex, sensitive or confidential matters relating to the proposal. Please refer to NER 8.9.1(k). Meeting requests must be received by the end of the submission period and include reasons for the request. We will try to accommodate reasonable meeting requests but, where appropriate, we may hold joint meetings with other stakeholders or convene a meeting with a broader industry group. Subject to confidentiality restrictions, AEMO will publish a summary of matters discussed at stakeholder meetings.

¹ Final determination and amending rule available on the Australian Energy Market Commission's website at: https://www.aemc.gov.au/rule-changes/primary-frequency-response-incentive-arrangements



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1. Stakeholder consultation process

As required by NER 11.152.3, AEMO is consulting on the initial FCFP in accordance with the standard rules consultation procedure in NER 8.9.2.

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

AEMO's indicative process and timeline for this consultation are outlined below. Future dates may be adjusted, and additional steps may be included, if necessary, as the consultation progresses.

Consultation steps	Dates
Information workshop	19 September 2022
Consultation paper published	31 October 2022
Submissions due on consultation paper	6 December 2022
Draft report published	7 February 2023
Submissions due on draft report	15 March 2023
Final report published	8 June 2023

On 19 September 2022, AEMO held a public information workshop with market participants and other interested parties to explore the PFR incentives rule and to:

- provide a summary of the key policy outcomes from the rule
- flag key matters that AEMO proposes to focus on in consulting on the new FCFP, and
- seek initial feedback on any additional issues that AEMO should consider.

Feedback provided during and subsequent to this workshop has been considered in developing this proposal.

AEMO's webpage for the FPP project is at: https://aemo.com.au/initiatives/major-programs/frequencyperformance-payments-project. Links to relevant pages and meeting materials are located there.



2. Background

2.1. Context for this consultation

On 8 September 2022, the Australian Energy Market Commission (**AEMC**) published its final determination of the PFR incentives rule. The rule provides enduring arrangements to support the control of power system frequency and incentivise plant behaviour that reduces the overall cost of frequency regulation during normal operation. In order to allow participants to have sufficient certainty around the implementation of this new framework for the optimisation and development of their systems, the rule requires AEMO to develop and publish the FCFP by 8 June 2023, to take effect from 8 June 2025 when the main provisions of the PFR incentives rule will commence.

The FCFP will replace the existing Regulation FCAS Contribution Factor Procedure (made under NER 3.15.6A(k)), which currently determines how AEMO calculates the contribution factors for recovering the cost of regulating raise and regulating lower market ancillary services (regulation FCAS) in the national electricity market (NEM). These factors are intended to reflect the extent to which a market participant can be taken to have 'caused' the need for regulation FCAS based on the negative performance of its facilities relevant to target frequency (where this can be measured), with the residual being allocated to market customers based on energy consumption.

The FCFP will reflect significant changes to be introduced by the PFR incentives rule for the recovery of regulation FCAS costs, including the introduction of frequency performance payments for market participants' eligible facilities2 where their primary frequency response (PFR) helps to reduce the frequency deviations which would otherwise require the use of regulation FCAS.

2.2. NER requirements

AEMO is required to publish the initial FCFP under NER 11.152.3, under the transitional provisions of the PFR incentives rule. The FCFP must include the content and be consistent with the principles in NER 3.15.6AA. Stakeholders should note that all references to NER 3.15.6AA are to that clause as introduced by the PFR incentives rule.

2.2.1. Content requirements

NER 3.15.6AA(g) requires the FCFP to include seven mandatory items, described below:

- (1) The criteria for determining whether an eligible unit has 'appropriate metering' that is, metering to allow its individual contribution to the deviation in power system frequency to be assessed.
- (2) A formula to calculate the measure of the need to raise or lower the frequency of the power system in each trading interval, which:
 - (i) must be based on the frequency of the power system in the relevant region(s);
 - (ii) must contain sufficient detail for a relevant participant to estimate the need to raise or lower the frequency of the power system during a trading interval; and

² The PFR incentives rule defines 'eligible units' broadly as scheduled, semi-scheduled and non-scheduled generating units, scheduled and market loads, ancillary services units, and scheduled and non-scheduled bi-directional units.



- (iii) may include parameters to be determined by AEMO from time to time for different elements of the formula.
- (3) The methodology for determining a contribution factor for an eligible unit which reflects its contribution to the deviation in frequency of the power system. This methodology must be consistent with the principles in NER 3.15.6AA(f), summarised in section 2.2.2 below.
- (4) The methodology for determining default contribution factors to apply to an eligible unit:
 - (i) where it is impractical for AEMO to determine a contribution factor for that unit in a trading interval; and
 - (ii) for use in calculating trading amounts to recover the cost of regulation FCAS enabled but not used.
- (5) The data AEMO will use to calculate the contribution factor for an eligible unit with appropriate metering. The data must include the unit's active power output or consumption and a measure of frequency, and may include frequency measured at the connection point or other data AEMO considers relevant.
- (6) The methodology for determining the requirement for corrective response as a measure of the total MW volume that contributed to reducing the deviation in frequency of the power system, and the proportion of enabled regulation FCAS that was used. The requirement for corrective response methodology may include parameters to be determined by AEMO from time to time.
- (7) The methodology for determining a reference trajectory in each trading interval for each eligible unit with appropriate metering. This must consider the relevant dispatch target or level, and any information provided by the relevant participant relating to the expected trajectory of nonscheduled units. Other relevant matters may also inform the methodology.

2.2.2. Principles for determining contribution factors

In determining the contribution factors to apply to eligible units in a trading interval for the purpose of determining frequency performance payments and cost recovery amounts for regulation FCAS determined to have been used, the FCFP should give effect to the principles listed in NER 3.15.6AA(f), summarised below:

- (1) A negative contribution factor for an eligible unit should reflect the extent to which the unit contributed to increasing the deviation in frequency of the power system.
- (2) A positive contribution factor for an eligible unit should reflect the extent to which the unit contributed to reducing the deviation in frequency of the power system.
- (3) A contribution factor is a number between -1 and 1.
- (4) The residual contribution factor for all eligible units without appropriate metering must be equal across and within all market participant classes involved in the cost recovery process.
- (5) Separate contribution factors must be determined for the contribution to the need to raise or lower the frequency of the power system.
- (6) AEMO must determine a contribution factor for each eligible unit unless in AEMO's reasonable opinion it is impractical to do so, in which case AEMO must determine a default contribution factor.
- (7) A contribution factor for each eligible unit applies for the region(s) relevant to a global market ancillary service requirement or local market ancillary service requirement for each regulation FCAS (raise or lower).



- (8) A default contribution factor for an eligible unit must be determined based on historical data for that unit unless in AEMO's reasonable opinion it is impractical to do so.
- (9) A default contribution factor must only be used in the frequency performance payments calculation to determine a trading amount payable by (not to) a relevant market participant.

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. Proposal discussion

3.1. Description and effect of proposal

The proposal is to make the initial FCFP. The FCFP will describe how AEMO will determine contribution factors and other matters relating to the calculation of *trading amounts* for market participants with respect to the payment and recovery of frequency performance payments and the recovery of regulation FCAS costs, as required by the PFR incentives rule.

3.2. How the proposal meets the objectives

The rationale under the NEO for the underlying rule change is contained in section 2 of the PFR incentives rule determination. In brief, the new frequency performance payments and regulation FCAS cost recovery framework are intended to support power system security by incentivising frequency response in a manner that is flexible and does not discriminate between technologies.

Through this consultation, AEMO will develop an initial FCFP that:

- Meets the requirements and is consistent with the principles of the NER as amended by the PFR incentives rule.
- Supports a system design that is practically implementable at a reasonable cost within the required timeframe and workable in conjunction with AEMO's broader NEM systems.
- As far as practicable, does not create unnecessary implementation complexity for established market participant systems.

3.3. Proposed effective date

The FCFP will take effect on the commencement date of the main provisions of the PFR incentive rule, 8 June 2025.

3.4. Issues for consultation

Submissions may be made on any matter relating to the proposal in this consultation paper and the initial draft of the FCFP published with the paper. As the timeframe for this consultation is limited by the transitional rules to conclude by 8 June 2023, issues that may require further rule changes to address, or that are not the directly impacted by the underlying PFR incentives rule will be considered out of scope for this consultation. In summary, AEMO anticipates the areas of scope to be considered in this consultation to include:

- Criteria for appropriate metering;
- Formulation of frequency measure;
- Method of measuring power system frequency;
- Calculation and application of contribution factors and default contribution factors;
- Formulation of RCR;
- Formulation of Usage;
- Determination of reference trajectory (within the confines of the rule that requires it to be based on target-to-target); and
- Determination of the Residual, both for global and local requirements.



Interested parties are directed to clause 3.15.6AA(f) and (g) of the rule, which describe the requirements of the FCFP, and to the IES analysis³ that supported the AEMC rule change process.

Following the industry workshop held on 19th September 2022, AEMO has identified a number of key areas for feedback and would particularly welcome consideration and feedback on the matters described below.

3.4.1. Frequency Measure

AEMO must calculate the 'need to raise or lower the frequency of the power system...'. This measure (referred to in the IES analysis as the 'Performance Metric') must be based on frequency. A preferred approach for the variables that make up the Frequency Measure is yet to be determined. As contemplated by NER 3.15.6AA(g)(2)(iii), it is anticipated that AEMO will have the ability to fine-tune the weighting between frequency variables on an ongoing basis, and the FCFP would therefore describe the variables, the weighting factors, and how market participants will be informed of any changes in advance of implementation. The change process should facilitate efficient and timely corrections within a predictable framework.

Figure 1 below is illustrative of a range of possible FM formulations calculated for a sample 5-minute period on a day based on historical data from 2021, as well as the Frequency Indicator (FI), which is used in the current Causer Pays procedure.



Figure 1 Data showing a few possible cases for the Frequency Measure

Assessed cases for the Frequency Measure calculation method, shown in Figure 4:

Case 1: Frequency deviations

- Case 2 12-second moving average of frequency deviations
- Case 3: 60-second moving average of frequency deviations
- Case 4: 120-second moving average of frequency deviations

Case 5: Average of 12-second and 60-second moving average of frequency deviations

³ https://www.aemc.gov.au/sites/default/files/2022-

^{05/}IES_%20Frequency%20performance%20payments%20analysis_Final%20Report.pdf



Case 6: Scaled Frequency Indicator (FI), used in the current Causer Pays procedure

For the Frequency Measure, AEMO proposes that frequency would be measured uniquely for each region. An alternative to this proposal would be to measure frequency locally at every connection point - a potential benefit of this would be to mitigate the impact of communications delay, such that the performance of a unit could be measured at the same point in time as power system frequency. However, attempting to measure frequency locally for each eligible unit is likely to substantially increase the complexity and cost of implementation both for AEMO and market participants and a well-tuned Frequency Measure may be able to mitigate the time lag issue without additional cost. It is also possible that the impact of the delay is not material within the settlements timeframe.

Questions

- Are there any alternatives to the proposal that would provide demonstrably greater net benefit to the market than regional measurement?
- What process should AEMO follow to change the weighting of parameters for the frequency measure?
- How should AEMO assess the efficacy of the frequency measure and weightings?

3.4.2. Contribution Factors

Contribution factors are used to apportion payments and receipts of frequency performance payments as well as allocate the costs of the 'used' component of regulation FCAS costs (see section 3.4.4 below). Default contribution factors are used as a substitute for contribution factors where the calculation of a contribution factor is impractical and to allocate the costs of the 'unused' component of regulation FCAS costs.

A possible formulation of contribution factors is contained in section 5 of the draft FCFP. At a high level, the proposed approach is encapsulated in the following diagram:







Deviations for eligible units with appropriate metering and the Residual is determined on a 4 sec basis against a reference trajectory. The deviation can then be multiplied with the Frequency Measure to determine a performance value in MWHz. This number is aggregated at the trading interval level and then finally normalised to give a factor between -1 and 1.

It is worth noting that Performance is separated into 'Raise Performance' and 'Lower Performance'. Raise Performance can only be measured when the Frequency Measure is positive, and vice versa for Lower Performance. It is possible that some trading intervals will have no examples of either Raise or Lower Performance, in which case no FPPs would arise in respect of the relevant raise or lower requirement and all costs in respect said requirement would be allocated based on default contribution factors.

Default contribution factors for eligible units with appropriate metering and the Residual will generally be calculated by averaging Performance over a historical period and then normalising with the pool of Performance values as above.

Questions

- Feedback is sought on the proposed formulation for determining contribution factors in the FCFP. Do you see any issues with the proposal?
- AEMO is assessing possible timeframes for determining average performance for historical default contribution factors. This could be, for example, an eligible unit's average raise or lower performance for a period of a week, or as in the draft FCFP, a certain number of trading intervals for which there is valid raise or lower performance values. What principles should AEMO have regard to in determining this?
- In determining default contribution factors should AEMO exclude good performance or, as in the draft FCFP, should it be a simple average of all performance?



Questions

- What specific circumstances are there where default contribution factors should apply automatically that should be explicitly captured in section 5.3 of the draft FCFP? Where should AEMO have discretion to apply default contribution factors?
- How should offline units contribute to the cost of regulation FCAS? Are there circumstances (such as being offline for an extended period of time) in which a unit should cease being liable and be given a default contribution factor of zero? If so, how should AEMO determine a unit to be offline?

3.4.3. Requirement for corrective response

The requirement for corrective response is 'a measure of the total volume in MW that contributed to reducing the deviation in frequency of the power system' which is used to scale the total amount of frequency performance payments. In the proposal the requirement for corrective response for raise and lower requirements is determined by the 'peak' of aggregate gross deviations in each direction as shown in the figure below:



Figure 3 RCR

One potential issue arises from a simple formulation of RCR as above - there is a risk that with good frequency control, RCR will generally be symmetrical for raise and lower requirements. For example, in a scenario where the power system is generally in need of raise service for a trading interval, a single 4-second period where the Frequency Measure dips from positive to negative, will set RCR for lower requirements for the entire trading interval, when perhaps it should be zero. This could be mitigated through either the formulation of the Frequency Measure itself, or through filtering (perhaps only allowing periods where frequency is outside the PFR deadband to set RCR).

Questions

• Should the requirement for corrective response be capped in certain circumstances? What should those circumstances be?



Questions

- Is the use of a simple maximum value in MW for a 4-second period within a trading interval ideal? What other options are there that meet the rule requirement, and how should AEMO evaluate them?
- Should minimum thresholds apply to the calculation (for example, a minimum number of consecutive raise or lower 4-second intervals before a 4-second interval can be used to potentially determine RCR, or a minimum frequency deviation required to set RCR?)
- Should some types of variable generation be aggregated for the purpose of calculating RCR?
- How should RCR be calculated for global requirements when there are two AGC areas (e.g. Tasmania and Mainland)?

3.4.4. Usage of regulation FCAS

Usage is the factor that determines what percentage of regulation FCAS costs are recovered on the basis of contribution factors (based on measured performance within a trading interval) and what percentage are recovered on the basis of historical default contribution factors. AEMO proposes to calculate Usage as the maximum (at any point during the trading interval) of the sum of positive deviations for all eligible units with appropriate metering that are enabled to provide the relevant service (capped at the level each unit is enabled).

Figures 4 and 5 respectively show deviations of enabled units (RR_NOTCAPPED and LR_NOTCAPPED) against the same deviations, capped by the amount enabled per unit for each trading interval (RR_CAPPED and LR_CAPPED), for the mainland system during a 4-hour period, together with the relevant enabled *regulating raise* and *regulating lower services*, labelled "RREG_ENABLED" and "LREG_ENABLED" in the figures.



Figure 4 Input data for Raise Usage







Regardless of the actual formulation used, Usage will be capped at 100% (the enabled level in dark purple)

Questions

- Are there any preferable alternatives to the draft FCFP formulation of usage?
- Referring to section 7.3 of the draft FCFP, are there any circumstances in which usage should be defined as being equal to zero, for which the requirement for corrective response should not also be zero? In other words, are there any scenarios in which frequency performance payments would not be made, but for which regulation FCAS costs should still be allocated in part to eligible units on the basis of measured frequency performance during that trading interval?

3.4.5. Reference trajectory

The reference trajectory is the baseline against which AEMO will assess whether a unit is deviating for the purposes of calculating contribution factors.

NER 3.15.6AA(g)(7) requires AEMO to determine reference trajectories using target to target measurements from the end of one trading interval to the end of the next. AEMO proposes to follow a 'linear ramp' reference trajectory, on a target-to-target basis. This approach is aligned with the existing approach under the Regulation FCAS Contribution Factors Procedure.

Questions

- There is a lag between the start of the trading interval and when AEMO sends out a dispatch instruction. If this impact is deemed to have a material impact on contribution factors, what are the options to address it?
- Should units that are enabled to provide Regulation FCAS be treated differently? If so, how?

3.4.6. Calculation of the Residual

AEMO proposes to calculate the Residual deviation (MW) on an energy balance basis (as recommended in the IES analysis). However a key point of difference in the draft FCFP is that the proposal suggests that for local requirements, rather than simply being the opposite of all appropriately metered unit deviations in the region, we would also take into account interconnector deviations to determine a more accurate Residual that does not include deviations from other regions.

For global requirements interconnector deviations are irrelevant, however for local requirements, a failure to take into account interconnector deviations can change the proportion of costs that are borne by the local Residual compared to local appropriately metered units (in either direction).

This has the following features:

- Robust contribution factors are normalised, so settlements remain balanced.
- Doesn't artificially attribute good or bad performance to a local Residual which is not responsible for it.
- Means that for local requirements, positive and negative deviations will not offset from a settlement perspective.

Questions

- Are there any complications with this approach that have not been raised?
- Would it be preferable for the impact of interconnector deviations to be borne entirely by the local residual for local requirements? This would enable the the framework to have good and bad performance for appropriately metered units to offset (since the link between deviations and cost would remain intact).
- Should contribution factors for the Residual be capped at zero? (noting that default contribution factors for eligible units that are appropriately metered are capped at zero)

3.4.7. Estimated contribution factors in the Predispatch timeframe

AEMO currently calculates and distributes estimated values in the Dispatch and Predispatch timeframe which represent the aggregate contribution factor (CMPF) and residual (CRMPF) for each local requirement. These values were originally provided in order to estimate contribution factors during periods of asynchronous operation, however local requirements are often necessary to manage power system security even when regions are operating synchronously. Feedback from participants indicate that the estimated values are of assistance in understanding exposure to regulation FCAS costs for local requirements.

Under the new arrangements, AEMO will calculate a contribution factor for each unit every trading interval, which will be published shortly after the end of the interval. As is it clear how each unit relates to a region, the calculation of aggregate contribution factors and residuals for each requirement will be straight forward. AEMO will also publish these aggregate values, allowing participants to understand their exposure to local requirements in the Dispatch timeframe.

AEMO understands that participants may wish to continue receiving estimated values for the Predispatch timeframe. AEMO will not be in a position to estimate actual contribution factors in Predispatch (as this relies on actual power system data), however it is possible for AEMO to publish estimated aggregate values for each requirement using default contribution factors.

Questions

- Do you see value in AEMO publishing estimated aggregate values in the Predispatch timeframe?
- What other data do you consider worthwhile for AEMO to publish?

4. Drafting for proposed changes

To help interested parties respond to this consultation paper, AEMO has published an early draft of the FCFP with this proposal. It should not be considered a complete work and it does not address all the issues described in this consultation paper.

Appendix A. Glossary

Term or acronym	Meaning
AGC	Automatic generation control
Contribution Factor	A factor calculated in accordance with section 5 of this Procedure and applied to an <i>eligible unit</i> (and includes a Default Contribution Factor unless otherwise specified).
Default Contribution Factor	A Contribution Factor determined in accordance with section 5.2 and applied to an <i>eligible unit</i> in the circumstances described in NER 3.15.6AA(g)(4)
Frequency Measure	The indication of need to raise or lower <i>frequency</i> calculated in accordance with section 4 of this Procedure
Frequency Performance Payments	<i>Trading amounts</i> payable by or to a <i>Cost Recovery Market Participant</i> determined under NER 3.15.6AA(b)
Historical Performance Trading Intervals	The most recent X <i>trading intervals</i> prior to 10 <i>business days</i> before the relevant <i>billing period</i> during which the default Contribution Factor will apply
Lower Performance	The performance in MWHz of the Residual or an <i>eligible unit</i> with appropriate metering in respect of <i>trading intervals</i> where the Frequency Measure is negative
NEMDE	National Electricity Market Dispatch Engine
NER	National Electricity Rules, and NER followed by a number refers to that numbered rule or clause of the NER
Performance	Collectively refers to Raise Performance and Lower Performance
Raise Performance	The performance in MWHz of the Residual or an <i>eligible unit</i> with appropriate metering in respect of <i>trading intervals</i> where the Frequency Measure is positive
RCR	Requirement for corrective response
Reference Trajectory	The expected <i>active power</i> output or consumption of an <i>eligible unit</i> or the Residual, calculated in accordance with section 8 of this Procedure
Regulation FCAS	Regulating lower service and regulating raise service
Regulation FCAS Requirement	A binding constraint for Regulation FCAS
Residual	The aggregate of all relevant eligible units without appropriate metering
Usage	The proportion of Regulation FCAS that is deemed Used Regulation FCAS, calculated in accordance with section 7 of this Procedure
Unused Regulation FCAS	Regulation FCAS that is deemed unused and for which costs are recovered in accordance with NER3.15.6AA(d)
Used Regulation FCAS	Regulation FCAS that is deemed used and for which costs are recovered in accordance with NER3.15.6AA(c)