INITIAL DRAFT Frequency Contribution Factors Procedure

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Current version release details

Version	Effective date	Summary of changes
1.0	08 June 2025	First issue

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

1. Introduction

1.1. Purpose and scope

This is the Frequency Contribution Factors Procedure (Procedure) made under clause 3.15.6AA of the National Electricity Rules (NER). The contribution factors and other matters determined under this Procedure are used for the purpose of determining the allocation and amount of:

(a)   payments relating to frequency performance under NER 3.15.6AA(b) (Frequency Performance Payments); and

(b)   cost recovery for *regulating raise service* and *regulating lower service* (Regulation FCAS) under NER 3.15.6AA(c) and (d).

This Procedure has effect only for the purposes set out in the NER. The NER and the National Electricity Law prevail over this Procedure to the extent of any inconsistency.

1.2. Definitions and interpretation

1.2.1. Definitions

Terms defined in the National Electricity Law and the NER (in chapter 10 or clause 3.15.6AA) have the same meanings in this Procedure unless otherwise specified in this clause.

Terms defined in the NER are intended to be identified in this Procedure by italicising them, but failure to italicise a defined term does not affect its meaning.

In addition, the words, phrases and abbreviations in the table below have the meanings set out opposite them when used in this Procedure.

Table 1   Glossary

Term	Definition
AGC	Automatic generation control
Contribution Factor	A factor calculated in accordance with section 5 of this Procedure and applied to an *eligible unit* (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 *eligible unit* in the circumstances described in NER 3.15.6AA(g)(4)
Frequency Measure	The indication of need to raise or lower *frequency* calculated in accordance with section 4 of this Procedure
Frequency Performance Payments	*Trading amounts* payable by or to a *Cost Recovery Market Participant* determined under NER 3.15.6AA(b)
Historical Performance Trading Intervals	The most recent X *trading intervals* prior to Y *business days* before the relevant *billing period* during which the default Contribution Factor will apply
Lower Performance	The performance in MWHz of the Residual or an *eligible unit* with appropriate metering in respect of *trading intervals* 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

Commented [CM1]: Indicative approach – parameters and approach to be determined during consultation

Term	Definition
Raise Performance	The performance in MWHz of the Residual or an *eligible unit* with appropriate metering in respect of *trading intervals* where the Frequency Measure is positive
RCR	Requirement for corrective response
Reference Trajectory	The expected *active power* output or consumption of an *eligible unit* 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 unit*s 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)

1.2.2. Interpretation

This Procedure is subject to the principles of interpretation set out in Schedule 2 of the National Electricity Law.

1.3. Related documents

Reference	Title	Location
160-0392	Efficient Dispatch and Localised Recovery of Regulation Services Business Specification	https://www.aemo.com.au/-/media/files/electricity/nem/security_and_reliability/ancillary_services/0160-0049-pdf.pdf
	Power System Data Communication Standard	https://aemo.com.au/-/media/files/electricity/nem/network_connections/transmission-and-distribution/aemo-standard-for-power-system-data-communications.pdf
	Frequency Contribution Factor tuning parameters and input sources	[TBD] – will include weightings for FM, detail on where frequency will be obtained etc.

2. Process overview

2.1. Frequency Performance Payments and Regulation FCAS

Frequency Performance Payments are a financial mechanism that provides *Cost Recovery Market Participants* (among whom the costs of Regulation FCAS may be allocated) with an incentive to operate their *facilities* in a way that provides the *power system* with good primary *frequency* control, and a disincentive against operating in a way that negatively impacts *frequency*. It is a zero-sum system in which *Cost Recovery Market Participants* whose units are determined to contribute to poor *frequency* outcomes fund payments in respect of units with positive *frequency* performance.

Regulation FCAS is a *market ancillary service* that AEMO procures. It provides secondary *frequency* control designed to counteract small changes in *frequency*, and any accumulation of these changes over time.

For each *eligible unit*, each Regulation FCAS Requirement, and each *trading interval*, AEMO calculates a *trading amount* under each of the following clauses of the NER:

(c)   3.15.6AA(b) (Frequency Performance Payments payable to or by *Cost Recovery Market Participants*);

(d)   3.15.6AA(c) (payments to recover the cost of Used Regulation FCAS); and

(e)   3.15.6AA(d) (payments to recover the cost of Unused Regulation FCAS).
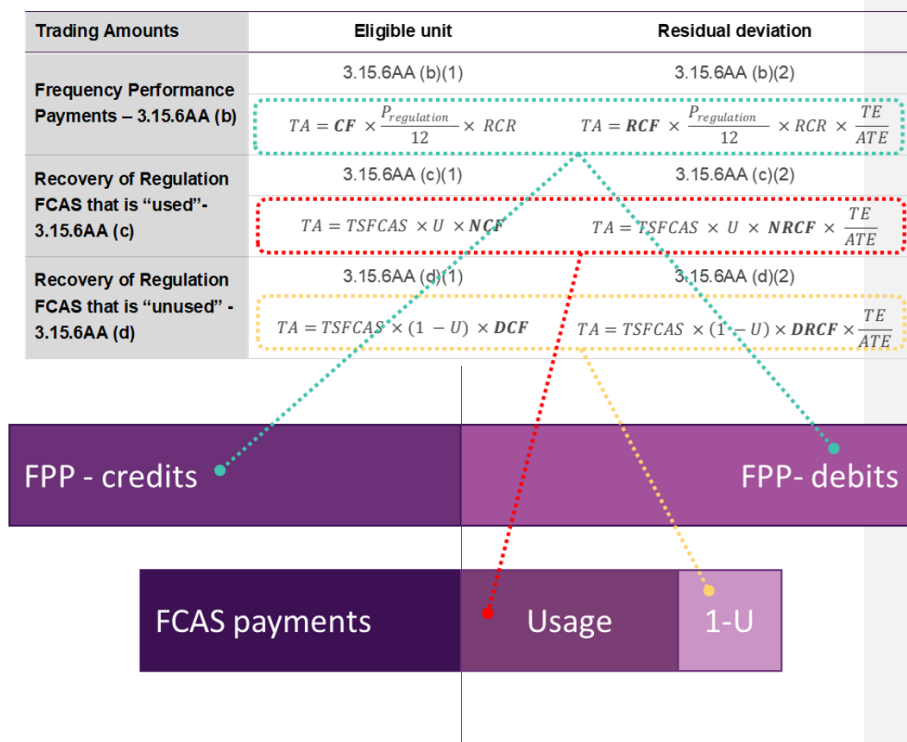
2.2. Calculation overview

Broadly, the process is follows:

- Determine a price for Frequency Performance Payments based on the marginal price of each Regulation FCAS requirement.

- Determine the Frequency Measure which indicates whether there is a need to raise or lower *frequency*.

- Determine the RCR amount which, multiplied with price, scales the total amount of Frequency Performance Payments based on the amount of *frequency* response provided.

- For each *eligible unit* with *appropriate metering* and for the Residual, compare *adjusted gross energy* amounts with a Reference Trajectory to determine Performance.

- Calculate Contribution Factors for *eligible unit*s with *appropriate metering* and for the Residual based on Performance.

- Apportion the Residual Contribution Factor to *eligible unit*s without *appropriate metering* pro rata, based on total *adjusted gross energy* amounts.

- Use the Contribution Factors for each *Cost Recovery Market Participant* to apportion Frequency Performance Payments.

- Calculate usage of Regulation FCAS and apportion costs of Used Regulation FCAS to each *Cost Recovery Market Participant* on the basis of Contribution Factors.

- Apportion the cost of Unused Regulation FCAS to each *Cost Recovery Market Participant* on the basis of Default Contribution Factors (based on historical rather than real-time performance).

Note that for the purposes of this Procedure, relevant *eligible units* are *eligible units* that are located within a *region* subject to the relevant Regulation FCAS Requirement.

Figure 1   Settlement equations

Trading Amounts	Eligible unit	Residual deviation
Frequency Performance Payments – 3.15.6AA (b)	3.15.6AA (b)(1) $TA = CF \times \dfrac{P_{regulation}}{12} \times RCR$	3.15.6AA (b)(2) $TA = RCF \times \dfrac{P_{regulation}}{12} \times RCR \times \dfrac{TE}{ATE}$
Recovery of Regulation FCAS that is "used"- 3.15.6AA (c)	3.15.6AA (c)(1) $TA = TSFCAS \times U \times NCF$	3.15.6AA (c)(2) $TA = TSFCAS \times U \times NRCF \times \dfrac{TE}{ATE}$
Recovery of Regulation FCAS that is "unused" - 3.15.6AA (d)	3.15.6AA (d)(1) $TA = TSFCAS \times (1 - U) \times DCF$	3.15.6AA (d)(2) $TA = TSFCAS \times (1 - U) \times DRCF \times \dfrac{TE}{ATE}$

FPP - credits   FPP- debits

FCAS payments   Usage   1-U

3. Criteria for determining whether an *eligible unit* has appropriate metering

For a *trading interval*, an *eligible unit* will have appropriate metering if it has *remote monitoring equipment* that enables AEMO (in accordance with the *Power System Data Communication Standard*) to receive the active power output or consumption of the *eligible unit* at its *connection point* at intervals of not more than 4 seconds in the Mainland area, and not more than 8 seconds in Tasmania.

4. Determination of the need to raise or lower the frequency of the power system

For each four second interval (eight seconds for the Tasmanian region), AEMO is required to determine a Frequency Measure based on the *frequency* of the *power system* that signals the direction (raise or lower) in which *eligible unit* deviations from the Reference Trajectory are good (helping to correct *power system frequency* towards 50 Hz), or bad, and therefore the direction of financial flows for Frequency Performance Payments.

$$FM = -(x \times FD_x + y \times FD_y)$$

Where:

(a)   FM is the Frequency Measure

(b)   x and y are weighting factors that will be published separately from this Procedure, where x+y=1

(c) FD_x – [DEFINITION TO BE DETERMINED]

(d) FD_y – [DEFINITION TO BE DETERMINED]

> **Commented [HR2]:** These weightings will be separately published as they may be adjusted without a rules consultation (though it is expected that some form of notice will be provided)

> **Commented [HR3]:** These variables are likely to be defined such that AEMO can reflect different unit response times. Some examples are published in the consultation paper.

5.   Contribution factors

Contribution Factors will be determined for each relevant *eligible unit* with *appropriate metering* and for the Residual, for use in the calculation of *trading amounts* under clause 3.15.6AA of the NER.

5.1.   Calculation of Contribution Factors

Unless a Default Contribution Factor applies, the Contribution Factors for Frequency Performance Payments and Used Regulation FCAS will be calculated in accordance with this section 5.1.

Figure 2   Contribution Factor calculation process
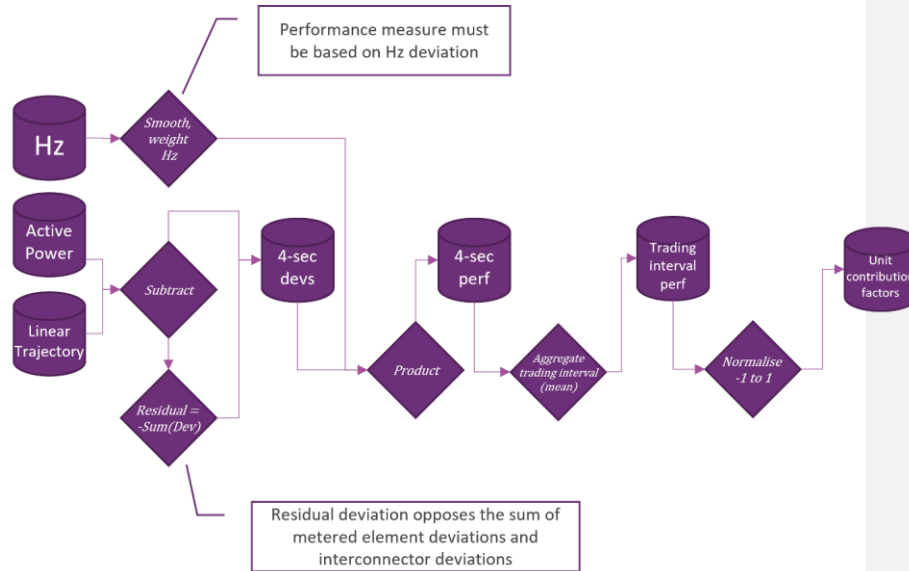
5.1.1. Raise Performance

$$P_{raise} = \sum_{t=1}^{75}(D \times Max(FM, 0))$$

Where:

(e)   P$_{raise}$ is the Raise Performance of an *eligible unit* with *appropriate metering* or the Residual

(a)   t is the index of four-second intervals within the *trading interval*

(b)   D is the deviation from the Target Trajectory in MW at time t. The sign of the deviation is determined from the perspective of the relevant *region* or *regions* of the *power system*. A positive deviation represents a net addition of MW into the relevant *region* or *regions* of the *power system*, and vice versa for negative deviations

(c)   FM is the Frequency Measure at time t

(d)   P$_{raise}$ is null when a default contribution factor is applied

5.1.2. Raise Contribution Factor:

$$CF_{raise} = \frac{P_{raise}}{AP_{raise}}$$

Where:

(a)   CF$_{raise}$ is the Contribution Factor used in respect of *regulating raise services*

(b)   P$_{raise}$ is the Raise Performance

(c)   AP$_{raise}$ is the absolute value of the sum of the Raise Performance for all relevant *eligible unit*s with appropriate metering and the Raise Performance of the Residual, that have the same sign (positive or negative) as P$_{raise}$

5.1.3. Lower Performance

$$P_{lower} = \sum_{t=1}^{75}(D \times Min(FM, 0))$$

Where:

(a)   P$_{lower}$ is the Lower Performance of an *eligible unit* with appropriate metering or the Residual

(b)   t is as defined in section 5.1.1

(c)   D is as defined in section 5.1.1

(d)   FM is as defined in section 5.1.1

(e)   P$_{lower}$ is null when a Default Contribution Factor is applied

5.1.4. Lower Contribution Factor

$$CF_{lower} = \frac{P_{lower}}{AP_{lower}}$$

Where:

(a) CF$_{lower}$ is the Contribution Factor used in respect of *regulating lower service*

(b) P$_{lower}$ is the Lower Performance

(c) A$_{Plower}$ is the absolute value of the sum of the Lower Performance for all relevant eligible units with appropriate metering and the Lower Performance of the Residual, that have the same sign (positive or negative) as P$_{lower}$

5.2. Calculation of Default Contribution Factors

Default Contribution Factors for *eligible units* are based on historical Performance (historical Default Contribution Factors), except where:

(a) there is insufficient data to determine the historical Default Contribution Factor; or

(b) AEMO determines that the Performance data is unreliable.

Where either of these exceptions applies, AEMO will apply a substitute Default Contribution Factor to the relevant *eligible unit* which mimics the Contribution Factor that would be calculated if the *eligible unit* had performed identically to the Residual.

Note that since Default Contribution Factors can only be used to determine *trading amounts* payable by (not to) a *Cost Recovery Market Participant*, Performance values will be capped at zero in the calculation of Default Contribution Factors.

5.2.1. Historical Default Contribution Factor

A historical Default Contribution Factor is calculated in the same manner as an ordinary Contribution Factor under section 5.1, except that Raise Performance and Lower Performance of the *eligible unit* or Residual is substituted with the average of the *eligible unit*'s or Residual's Raise Performance or Lower Performance (whichever is applicable) across the Historical Performance Trading Intervals (defined in the glossary) and capped at zero.

Historical Raise Performance

$$RP_{historical} = Min\{0, \frac{\sum_{TI=1}^{H} P_{raise}}{H}\}$$

Where:

(a) RP$_{historical}$ is the value that will be substituted for Raise Performance where a historical default contribution factor applies

(b) H is the number of *trading intervals* that are Historical Performance Trading Intervals

(c) TI is the index of *trading interval* within the set of Historical Performance Trading Intervals

(d) P$_{raise}$ is as defined in section 5.1.1 for *trading interval* TI

Historical Lower Performance

$$LP_{historical} = Min\{0, \frac{\sum_{TI=1}^{H} P_{lower}}{H}\}$$

Where:

(a) LP$_{historical}$ is the value that will be substituted for Lower Performance where a historical default contribution factor applies

(b) H is the number of *trading intervals* that are Historical Performance Trading Intervals

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Commented [HR4]: As required by the rule, default CFs will generally be based on historical performance. We expect that substitute contribution factors will primarily be used only for new facilities without sufficient history. Consider whether changes to facilities or ownership should trigger the use of substitute default CF.

Commented [HR5]: The rule may not give flexibility to allow AEMO to consider units that have appropriate metering as actually part of the Residual, however if Performance cannot be calculated for such a unit, that unit is factually part of the Residual. In the absence of historical data, we think it preferable to treat units as such.

(c) TI is the chronological order of a *trading interval* within the set of Historical Performance Trading Intervals

(d) P_{lower} is as defined in section 5.1.3 for *trading interval* TI

5.2.2. Substitute Default Contribution Factor

A Substitute Default Contribution Factor is calculated in the same manner as an ordinary Contribution Factor under section 5.1, except that Raise Performance and Lower Performance for the *eligible unit* is substituted with a scaled equivalent to the Residual's Raise Performance and Lower Performance for the relevant period and capped at zero.

Substitute Raise Performance

$$RP_{substitute} = Min\{0, RP_{residual} \times \frac{TE_{am}}{ATE}\}$$

Where:

(a) $RP_{substitute}$ is the value that will be substituted for Raise Performance where a substitute default contribution factor applies

(b) When calculating a trading amount under clauses 3.15.6AA(b) or (c) of the NER, $RP_{residual}$ is the Raise Performance of the Residual applicable to the *trading interval*. When calculating a trading amount under clause 3.15.6AA(d) $RP_{residual}$ is the average Raise Performance of the Residual for the Historical Performance Trading Intervals

(c) TE_{am} is the sum of the absolute value of any *adjusted gross energy* amount for the relevant *eligible unit* with appropriate metering

(d) ATE is as defined in clauses 3.15.6AA(b)(2) and (c)(2) of the NER

Substitute Lower Performance

$$LP_{substitute} = Min\{0, LP_{residual} \times \frac{TE_{am}}{ATE}\}$$

Where:

(a) $LP_{substitute}$ is the value that will be substituted for Lower Performance where a substitute Default Contribution Factor applies

(b) When calculating a trading amount under clauses 3.15.6AA(b) or (c) of the NER, $LP_{residual}$ is the Lower Performance of the Residual applicable to the *trading interval*. When calculating a trading amount under clause 3.15.6AA(d) $LP_{residual}$ is the average Lower Performance of the Residual for the Historical Performance Trading Interval

(c) TE_{am} is the sum of the absolute value of any *adjusted gross energy* amount for the relevant *eligible unit* with appropriate metering

(d) ATE is as defined in clause 3.15.6AA(b)(2) and (c)(2) of the NER

5.3. Application of Default Contribution Factors

5.3.1. Historical Default Contribution Factor

Subject to section 5.3.2, historical Default Contribution Factor will be applied:

(a) to determine the *trading amount* payable by *a Cost Recovery Market Participant* in respect of each *eligible unit* under NER 3.15.6AA(d); and

(b) to determine a *trading amount* payable by a *Cost Recovery Market Participant* under NER 3.15.6AA(b) or (c), where it is impractical for AEMO to determine a Contribution Factor for that unit in a *trading interval* based on the data measured for that *trading interval*. Circumstances that AEMO considers it impractical to calculate Contribution Factors based on data measures during a *trading interval* include:

(i) where AEMO has an incomplete data set of performance for the *eligible unit* in that *trading interval*;

(ii) Where a system separation occurs and the AGC area does not align with the dispatched Regulation FCAS Requirement in NEMDE.

> **Commented [HR6]:** As a general rule, we wish to avoid unnecessarily excluding data and falling back to default contribution factors. Consideration should be given to whether it is appropriate to use default contribution factors in circumstances such as unit trips and contingency events, as well as how AEMO's systems could identify them.

5.3.2. Substitute Default Contribution Factor

Wherever a historical Default Contribution Factor would otherwise be applied and AEMO considers that the calculation of a historical Default Contribution Factor is impractical (for example, data for Historical Performance Trading Intervals does not exist), a substitute Default Contribution Factor will be applied.

6. Requirement for Corrective Response

The RCR is used to scale Frequency Performance Payments in accordance with clause 3.15.6AA(b) and is determined separately for *trading amounts* in respect of *regulating raise service* and *regulating lower service*.

6.1. Raise Requirement for Corrective Response

Subject to section 6.3, in respect of *regulating raise service*, the RCR (RCR raise) in a *trading interval* is equal to the maximum sum, at any point in time during the *trading interval*, of gross values (MW) of all deviations that increase *power system frequency* within relevant *region*s of the *power system* when the Frequency Measure is positive.

6.2. Lower Requirement for Corrective Response

Subject to section 6.3, in respect of *regulating lower service*, the RCR (RCR lower) in a *trading interval* is equal to the maximum sum, at any point in time during the *trading interval*, of the gross values (MW) of all deviations that decrease *power system frequency* within relevant *region*s of the *power system* when the Frequency Measure is negative.

> **Commented [HR7]:** This is an example of how RCR could work. One problem with this simple formulation is that it tends to create symmetrical RCRs for raise and lower as there is no filtering – you only need one 4-sec period where the frequency measure dips in the other direction for the peak to 'flip'. This could be addressed either in the frequency measure itself or perhaps filtering out periods where raw frequency is within the PFR deadband.

6.3. Exceptions

Where:

(a) a system separation occurs and the AGC area does not align with the dispatched Regulation FCAS Requirement in NEMDE;

(b) where there is global bad SCADA; or

(c) where AEMO is otherwise unable to calculate the Performance of the Residual,

the Requirement for Corrective Response will be equal to zero.

Figure 3   RCR visual

7.   Usage of Regulation FCAS

Usage is the factor that determines, for the purposes of clauses 3.15.6AA(c) and (d) of the NER, what percentage of Regulation FCAS costs are recovered on the basis of contribution factors (that are based on measured performance within a *trading interval*) and what percentage are recovered on the basis of Historical Default Contribution Factors.

7.1.   Raise Usage

Subject to section 7.3:

$$U_{raise} = Min\{1, \frac{Dev_{raise}}{Tot_{raise}}\}$$

Where:

(a) U_{raise} is the usage relevant to a *regulating raise service*.

(b) Dev_{raise} is the maximum sum, at any point in time during the *trading interval*, of gross values (MW) of all deviations of *eligible units* that are enabled to provide the relevant *regulating raise service* that increase *power system frequency* within relevant *region*s of the *power system*. These gross values are capped at the total amount of regulation scheduled by NEMDE for each *eligible unit* for the *trading interval*.

(c) Tot_{raise} is the total amount of relevant enabled *regulating raise service*

7.2.   Lower Usage

Subject to section 7.3,

$$U_{lower} = Min\{1, \frac{Dev_{lower}}{Tot_{lower}}\}$$

Where:

(a) U$_{lower}$ is the usage relevant to a *regulating lower service*.

(b) Dev$_{lower}$ is the maximum sum, at any point in time during the *trading interval*, of gross values (MW) of all deviations of *eligible units* that are enabled to provide the relevant *regulating lower service* that decrease *power system frequency* within relevant *region*s of the *power system*. These gross values are capped at the total amount of regulation scheduled by NEMDE for each *eligible unit* for the *trading interval*.

(c) Tot$_{lower}$ is the total amount of relevant enabled *regulating lower service*

7.3. Exceptions

Where the relevant Requirement for Corrective Response is zero, Usage will also be zero.

8. Reference Trajectory and deviation calculation

Four-second deviations (in MW) are calculated by comparing SCADA measurements against a Reference Trajectory which differs depending on the deviation source. The sign of deviations is always with respect to the relevant region of the *power system* – a positive deviation is one that increases the net amount of energy within the power system (more generation or less load) and vice versa for negative deviations. These calculations are described in the following clauses.

> **Commented [HR8]:** This section is an early indication, but largely just follows the existing process for calculating reference trajectories for contribution factors.

8.1. Scheduled and semi-scheduled plant

The Reference Trajectory for *scheduled generating units, semi-scheduled generating units* and *scheduled loads* is illustrated in Table 2.
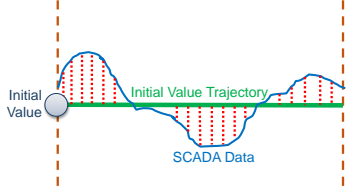
Table 2   Scheduled generating units, semi-scheduled generating units, and scheduled loads

Reference Trajectory	Actual Measurement	Example
Straight line between previous *dispatch target/level* and current *dispatch target/level*.	SCADA metering data for the unit or load.	
Target Trajectory Source: straight line between total cleared values	*Actual Generation* Source: SCADA metered value at each four-second sample.	$$Dev_{Sched} = ActualGeneration - TargetTrajectory$$

8.2. Other market connection points with appropriate metering

The Reference Trajectory for *non-scheduled market generating units* and *non-scheduled market loads* with appropriate metering is illustrated in Table 3.

Table 3   Non-scheduled generating units and non-scheduled loads with appropriate metering

Reference Trajectory	Actual Measurement	Example
Continuation of the initial metered MW level at the start of the current DI.	SCADA metering data for the unit or load.	
Initial Metered Source: SCADA metered value at the start of the *dispatch inteval* held constant for the full five-minute period.	*Actual Generation* Source: SCADA metered value at each four-second sample.	$$Dev_{Nonsched} = ActualGeneration - InitialMetered$$

8.3. Residual

Residual calculations are performed for each region and then aggregated for each requirement.

The Residual will be calculated as the opposite of the aggregate deviation[1] of

1. all appropriately metered eligible units within the relevant region; and

2. interconnectors relevant to the region

> **Commented [HR9]:** See the issues paper for a brief discussion around this. Interconnectors are not relevant to global requirements, but we think it is important to consider them for local requirements as the interconnectors can import substantial amounts or good or bad performance into the local residual if they are not accounted for.
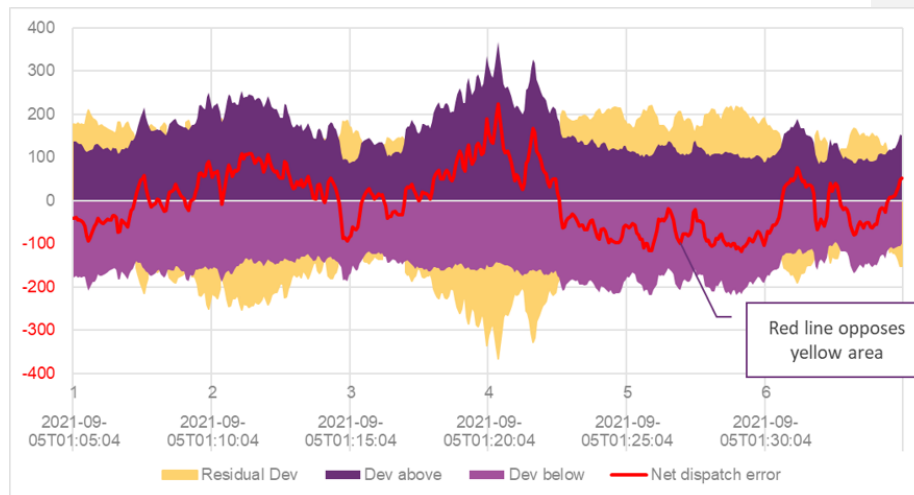
$$Residual\ deviation(R) = -1 \times \left(\sum_{sg \in R} Dev_{Sched}(sg) + \sum_{nsg \in R} Dev_{Nonsched}(nsg) + \sum_{i \in R} Dev_{ic}(i) \right)$$

Where:

(a)   Residual deviation is the Residual deviation for the relevant region denoted by 'R'

(b)   'sg' are scheduled generators or loads within region R with appropriate metering

(c)   'nsg' are non-scheduled generators or loads within region R with appropriate metering

(d)   'i' are interconnectors relevant to region R.

(e) Dev_{sched} is as defined in section 8.1

(f) $Dev_{nonsched}$ is as defined in section 8.2

(g) Dev_{ic} are deviations of interconnectors 'i'

Figure 4   Residual

Version release history

Version	Effective Date	Summary of Changes
1.0	08 June 2025	First issue