Frequency Performance Payments – next step for 'Causer Pays'

Fact Sheet

This fact sheet explains Frequency Performance Payments (FPP) that extends the existing 'Causer Pays' approach for recovering the cost of Regulation Frequency Control Ancillary Service (Reg-FCAS) and incentivising good frequency control in the NEM.

What is Causer Pays?

At an interval of 5 minutes AEMO clears the energy market, setting a schedule of generating unit dispatch 'targets' for units to meet at the end of the interval. At the same time Reg-FCAS is 'enabled', allowing AEMO to adjust a selected group of generating units' output between each dispatch and pricing calculation. The aim of Reg-FCAS is to control supply/demand balance to manage small deviations that naturally occur in the power system, acting to correct slow changes in frequency that result.

For all large generators and some loads, AEMO records 4-second data of active power for generation or load. This allows a units' deviation to be assessed, every 4-seconds, between actual measurement and an ideal "reference trajectory".

These deviations form the basis for determining a unit's performance and for allocating the cost of Reg-FCAS. A deviation is deemed to be good or bad, depending on whether it is aligned with a central 4-second "frequency measure". Factors, based on performance, are calculated using a sample of data for 28 days; the same factor is used for both raise and lower Reg-FCAS, and calculated per participant.

If a unit has more bad deviations when the frequency measure is at its worst, then it is debited a share of Reg-FCAS. If a unit has more good deviations, it can avoid paying for Reg-FCAS. The share is called a "contribution factor". The contribution factor (which represents a percentage of the overall contribution) is multiplied by the cost of Reg-FCAS to calculate a debit amount in settlement.

Providers of Reg-FCAS are paid directly, and so the contribution factors simply create debit amounts.

What is changing?

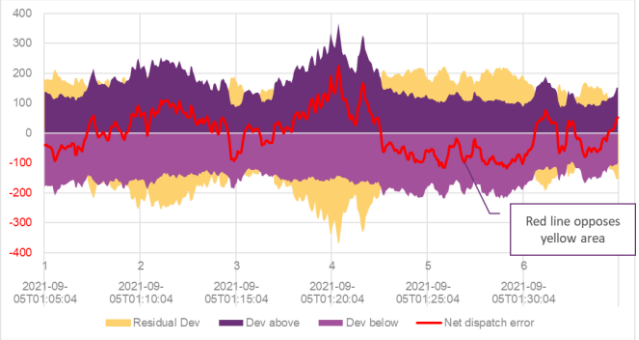
On 8th September 2022, the Primary Frequency Response Incentive Arrangements rule change was made, mandating substantial changes to causer pays processes as well as implementing a framework for making payments to primary frequency response providers.

A key difference to the current causer pays process is that performance is calculated for each trading interval (real-time factors) which is then used to determine the new FPPs and the allocation of a portion of Regulation FCAS costs.

Calculating 4-sec deviations:

Performance will be calculated for each *trading interval* based on 4-seconds deviations against each unit's reference trajectory. Not all elements of the power system are measured at 4-seconds (this is why we have dispatch forecasts). Elements not metered are simply assumed to oppose the sum of the metered

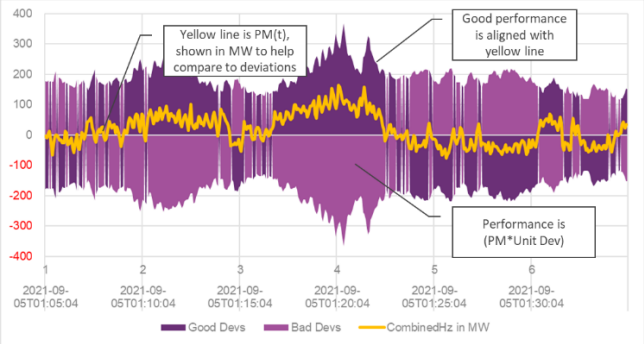
elements, so all deviations balance.



This is known as the residual deviation and is treated the same as any other metered element. In the earlier figure the residual deviation is the yellow area, and directly opposes the sum of the metered elements, which is the red line.

Calculating 4-sec performance:

The frequency measure is a weighted average of a raw and delayed (say 30 secs) deviation in frequency from 50Hz.



The frequency measure indicates which 4-sec deviations are good or bad. Dark purple represents good and light purple represents bad. The 4-sec frequency measure also shows how good or bad a deviation is, by the scale of the frequency measure.

The 4-sec frequency measure is deliberately modified to be the **inverse** of the frequency deviation:

- Deviations for eligible units are calculated with respect to their impact on the power system – so a positive deviation represents a net increase in MW for the power system, whether caused by more generation, or less load.
- When the sign of the deviation of an eligible unit is the same as the sign of the frequency measure, that deviation is deemed to be 'good' and the product of the two leads to a positive performance value for the unit.
- Performance is in units MW*HzDev where positive is good and negative is bad.

Categorising and aggregating 4-sec performance:

4-sec performance data is "flagged" for the Raise or Lower Reg-FCAS, as shown in the table

		Relevant FCAS service	
		Regulating Raise	Regulating Lower
4-second performance measure	Positive	*Applicable*	*Not applicable*
	Negative	*Not applicable*	*Applicable*

When the frequency measure is positive, the 4-sec performance data is used for Regulating Raise. When negative, for Regulating Lower. This is a hard split in the data.

Unit performance is aggregated per 5-minute dispatch interval, or 75 values, with the *mean* performance value calculated per unit which is then used to determine contribution factors.

Calculate contribution factors:

Where practical, Contribution Factors (CFs) must be calculated each *trading interval*, and separately for services Raise and Lower. This will be by FCAS Requirement. CFs are a number between -1 to 1, and sum to 0. A CF represents a share of the total:

CF = Good unit performance / ∑(Good performance) (vice versa for bad performance)

A unit will have a raise CF and a lower CF. A negative CF result in a debit, a positive will result in a credit.

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Trading amounts

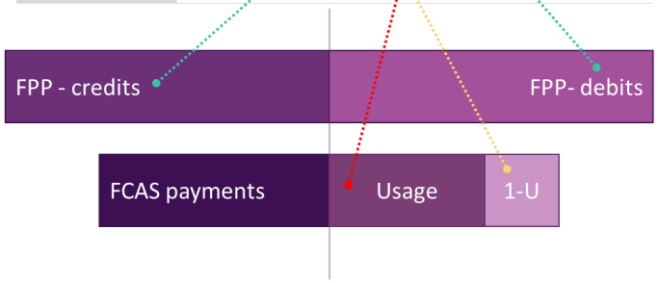
The following table and schematic summarise the settlement transactions and amending clauses.

Under FPP credits equal debits, so the scheme is self-funding. Note FPP can be less or more than Reg-FCAS costs.

Reg-FCAS payments to enabled units are funded by separate used and unused debit amounts.

Please note the costs allocated to the CF for the residual deviation are the elements without, so the costs are spread on a $ per MWh basis.

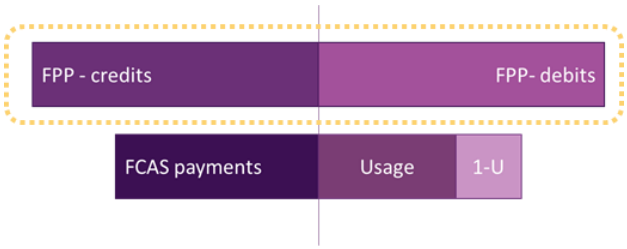
Trading Amounts	Eligible unit	Residual deviation
Frequency Performance Payments – 3.15.6AA (b)	3.15.6AA (b)(1)	3.15.6AA (b)(2)
	$TA = \boldsymbol{CF} \times \frac{P_{regulation}}{12} \times RCR$	$TA = \boldsymbol{RCF} \times \frac{P_{regulation}}{12} \times RCR \times \frac{TE}{ATE}$
Recovery of Regulation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



Factors are separated by Raise and Lower requirements, which would repeat the table. This means a minimum of twelve types of settlement transaction occur and these may be repeated where a regulation requirement applies by region or group of regions. Aligning the calculations of CFs to the dispatch of Reg-FCAS better aligns cost to cause.

Frequency Performance Payments (FPP):

Frequency Performance Payments is a financial mechanism that provides market participants with an incentive to provide 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 units that contribute to poor frequency outcomes for the *power system* pay good performing units for their service.



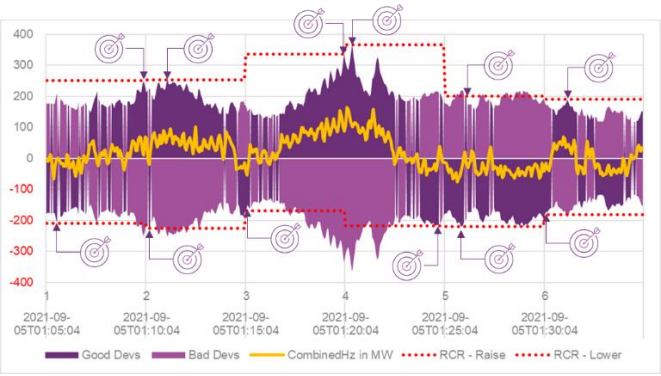
A trading amount is $CF \times \text{Price} \times \text{Volume}$:

$$TA = CF \times (P_{regulation}/12) \times RCR$$

Where:

- $P_{regulation}$ is the Marginal Price of the global or local requirement; and
- Volume is Requirement for Corrective Response (RCR) within trading interval.

RCR is something like the "capacity" value of good deviations (a gross measure of error) over the 5 minutes. In the following figure the good deviations are shown in dark purple, aligned with the yellow frequency measure. If a simple capacity value of good deviations was used to set RCR, then it would be the red dotted lines for the two services, raise and lower (lower expressed as a negative value). It is expected RCR varies from the amount of Reg-FCAS procured by AEMO and can be zero at times.

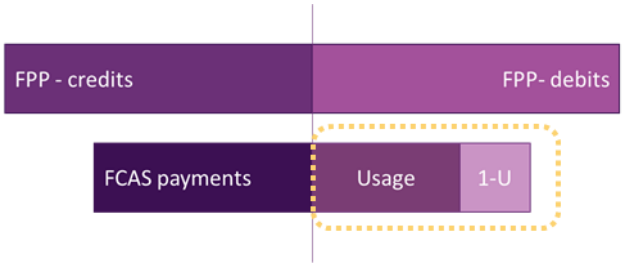


Cost recovery of Reg-FCAS:

Because a CF is calculated for the 5-minute interval, it is possible to split the allocation of Reg-FCAS payments, known as "TSFCAS", between that which is "used" and not.

Used cost recovery:

Only the negative factors are used, "NCF", because only debits are made to recover the cost.

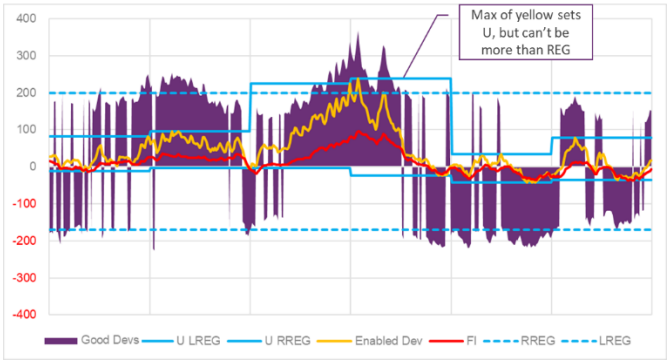


"U" or usage sets the proportion of Reg-FCAS costs allocated on CFs calculated that trading interval:

$$TA = TSFCAS \times U \times \boldsymbol{NCF}$$

The NCFs calculated for the 5-minutes are to be used to recover the "used" amount, with U expected to be something like RCR, (the maximum of the sum of good deviations within the 5-minutes) but limited to a sample of only those units enabled for Reg-FCAS.

The following figure shows how U could be calculated. The yellow line indicates the good deviations of the enabled units for Reg-FCAS, and is overlaid the good deviations of all units, (purple area). The amount of Reg-FCAS enabled is the blue dotted lines and the blue solid lines are the values for U. The negative values are for lower.



Unused cost recovery:

The remaining proportion, assumed not to be used, is 1 – Usage. The debit amounts are therefore:

$$TA = TSFCAS \times (1 - U) \times \boldsymbol{DCF}$$

DCF is a default contribution factor, however note that again, only negative DCFs will be used. This is expected to be calculated using negative mean unit performance over a long sample period, for example days or weeks. An option may be to calculate the NDCF using the mean performance of only those units online during the 5 minutes.

If AEMO cannot calculate CFs, RCR, U for the 5-minute interval, probably because data is unavailable, no FPP are made, and all Reg-FCAS costs are recovered by using the NDCFs.

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AEMO's implementation of FPP Project and development of Frequency Contribution Factors Procedure (FCFP) timeline: