

# Frequency Contribution Factors Procedure Technical Workshop



1:00pm-3:00pm AEDT  
21 Feb 2023



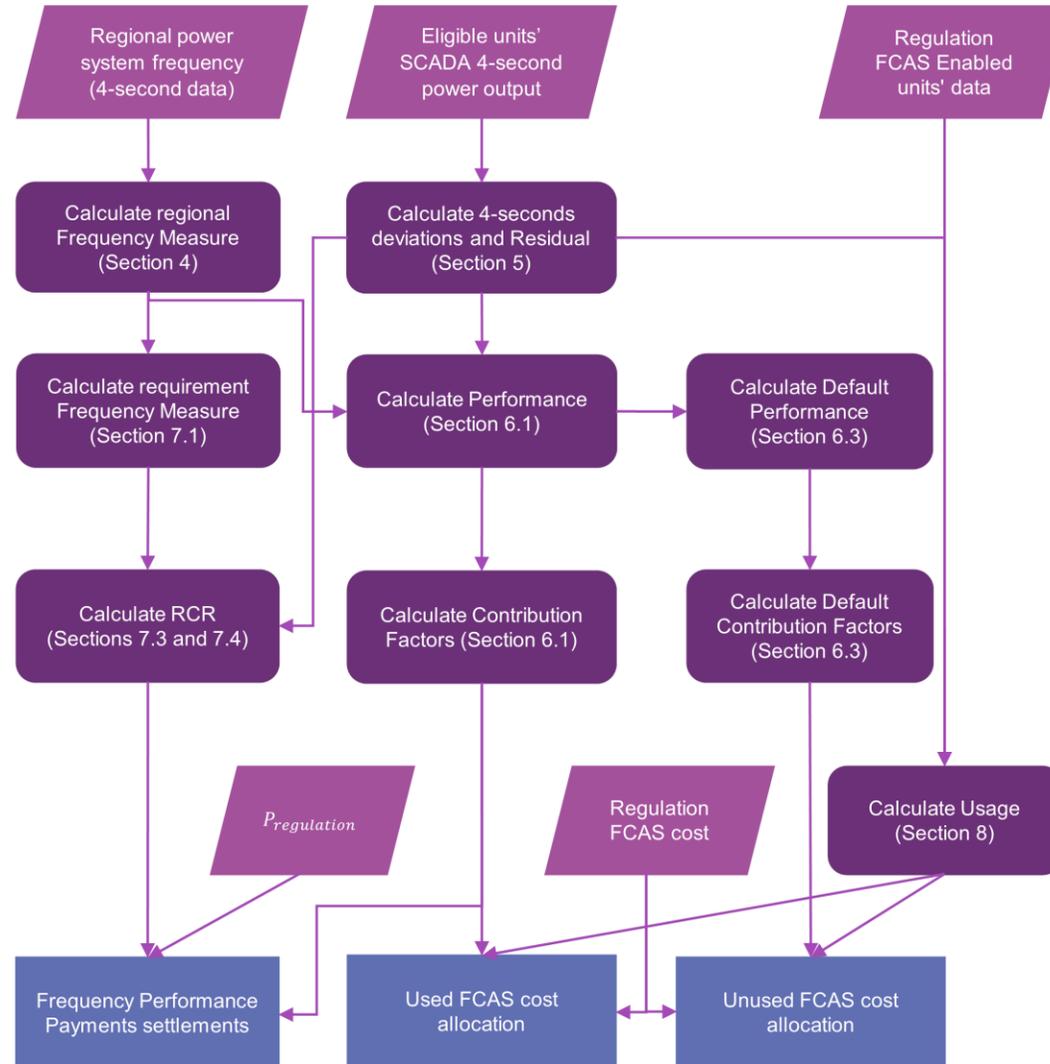
# Agenda

#	Time	Topic	Presenter(s)
1	5 min	Welcome & Introductions	Hugh Ridgway
2	60 min	End to end calculation of FPP trading amounts	Hugh Ridgway and Sahand Karimi
3	50 min	Questions	
4	5 min	Thanks and close	Hugh Ridgway

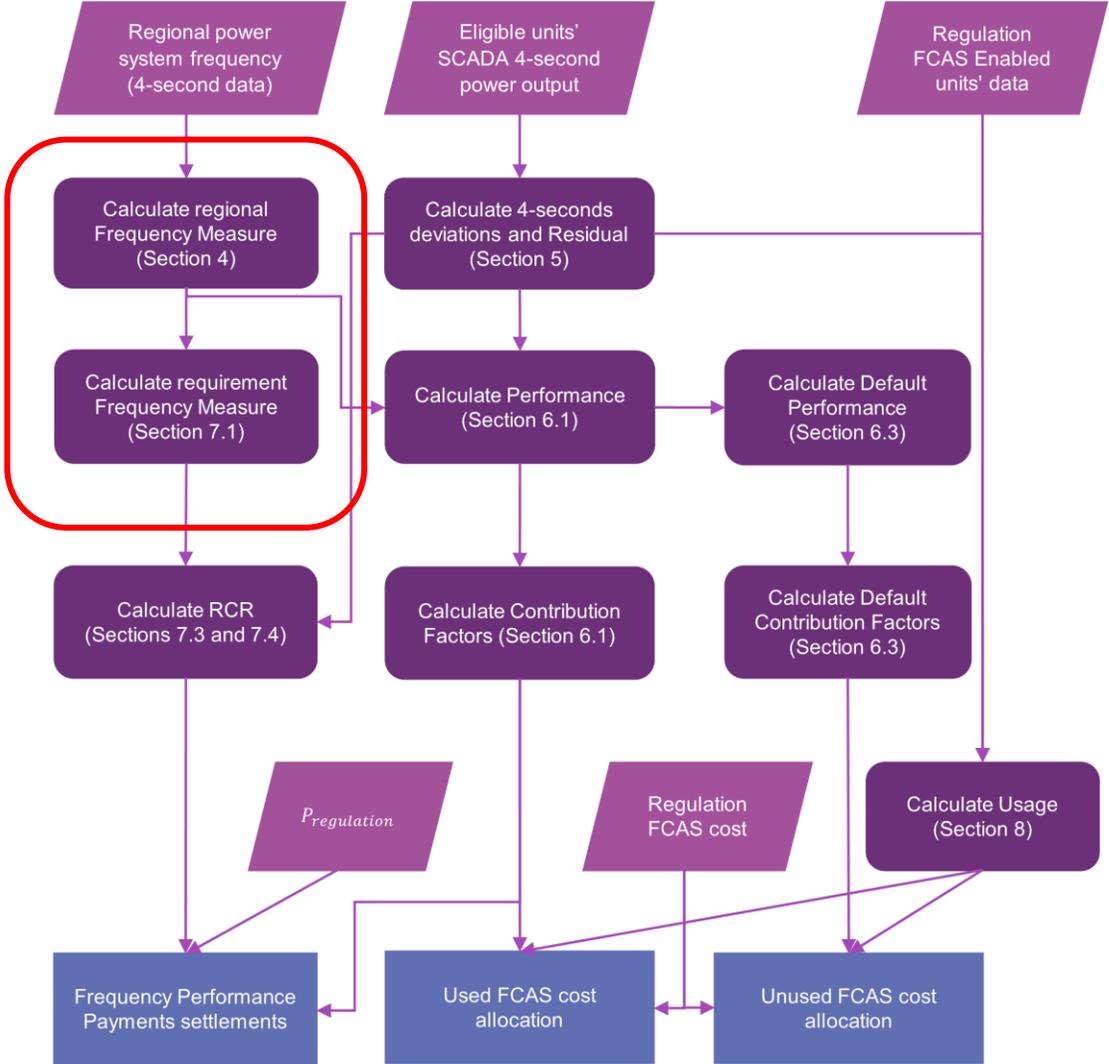


Please note that this forum will be recorded for the purposes of assisting AEMO accurately capturing feedback.

# Procedure flowchart



# Frequency Measure (FM)



# Formulation of frequency measure

- Performance measure to be an exponential weighted moving average, with a smoothing factor parameter (alpha) that adjusts the relative emphasis on timing of frequency deviations.

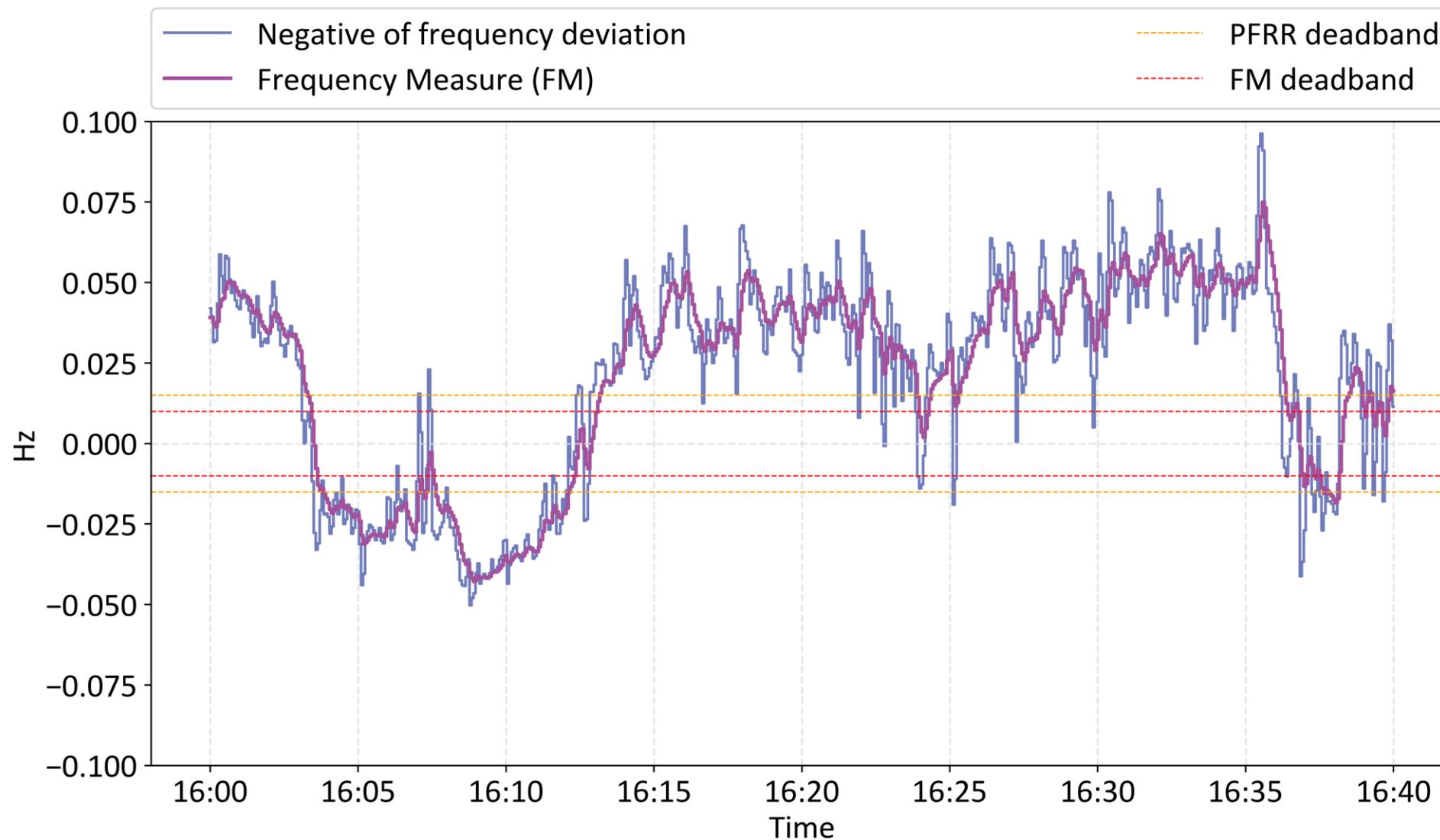
$$FM_t = (1 - \alpha)FM_{t-1} + \alpha(-FD_t)$$

- Selected on the basis of performance under 5 criteria:
  - Correlation with real-time frequency deviations
  - Correlation with deviations for the past 10 seconds (as per interim PFRR)
  - Correlation with deviations for the past 16 seconds (accounting for 6 sec latency)
  - Correlation with deviations should decrease over time
  - The frequency measure should have minimal erratic changes (i.e. be smoothed)

# Frequency measure conditions

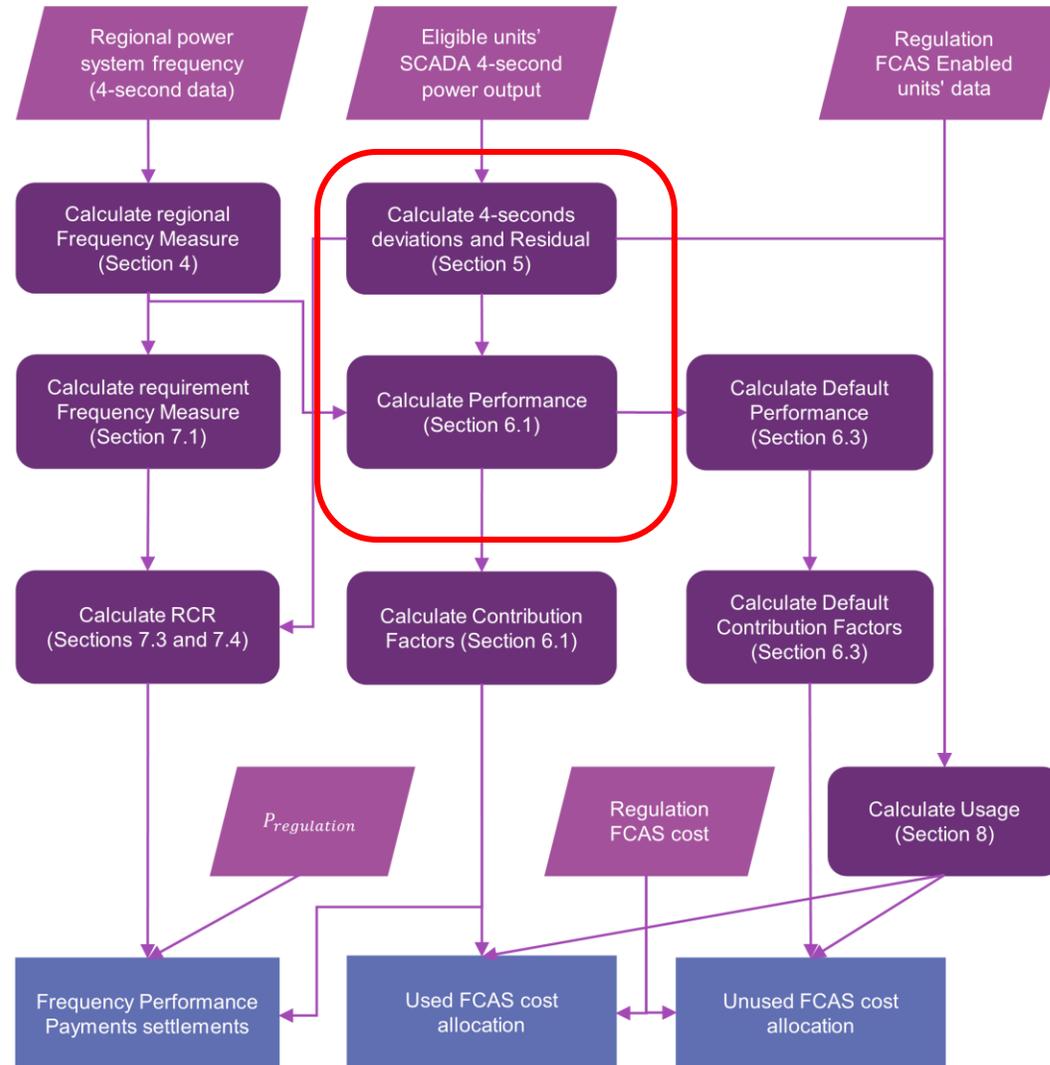
- In some cases, the frequency measure may not be a good indicator of the need to raise or lower system frequency. AEMO has identified the following cases:
  - Less than 7 four-second intervals within a TI in the relevant direction (raise or lower)
  - No four-second intervals where the frequency measure is outside a +/- 0.01Hz deadband
  - AGC area does not = regulation requirements in NEMDE
  - A large number of SCADA points have failed
- When a condition is met, Usage and RCR = 0 and Performance is null.

# Frequency Measure (FM)



Case study:  
8 trading intervals  
in Aug 2021

# Performance

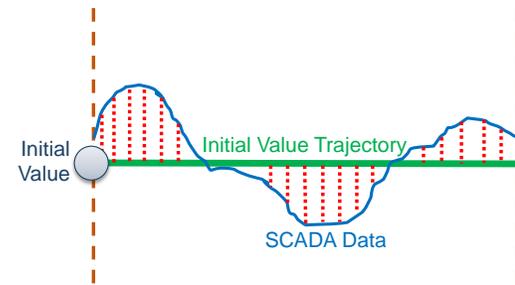


# Reference Trajectory and Deviation

- Ref trajectory of SS/S units:

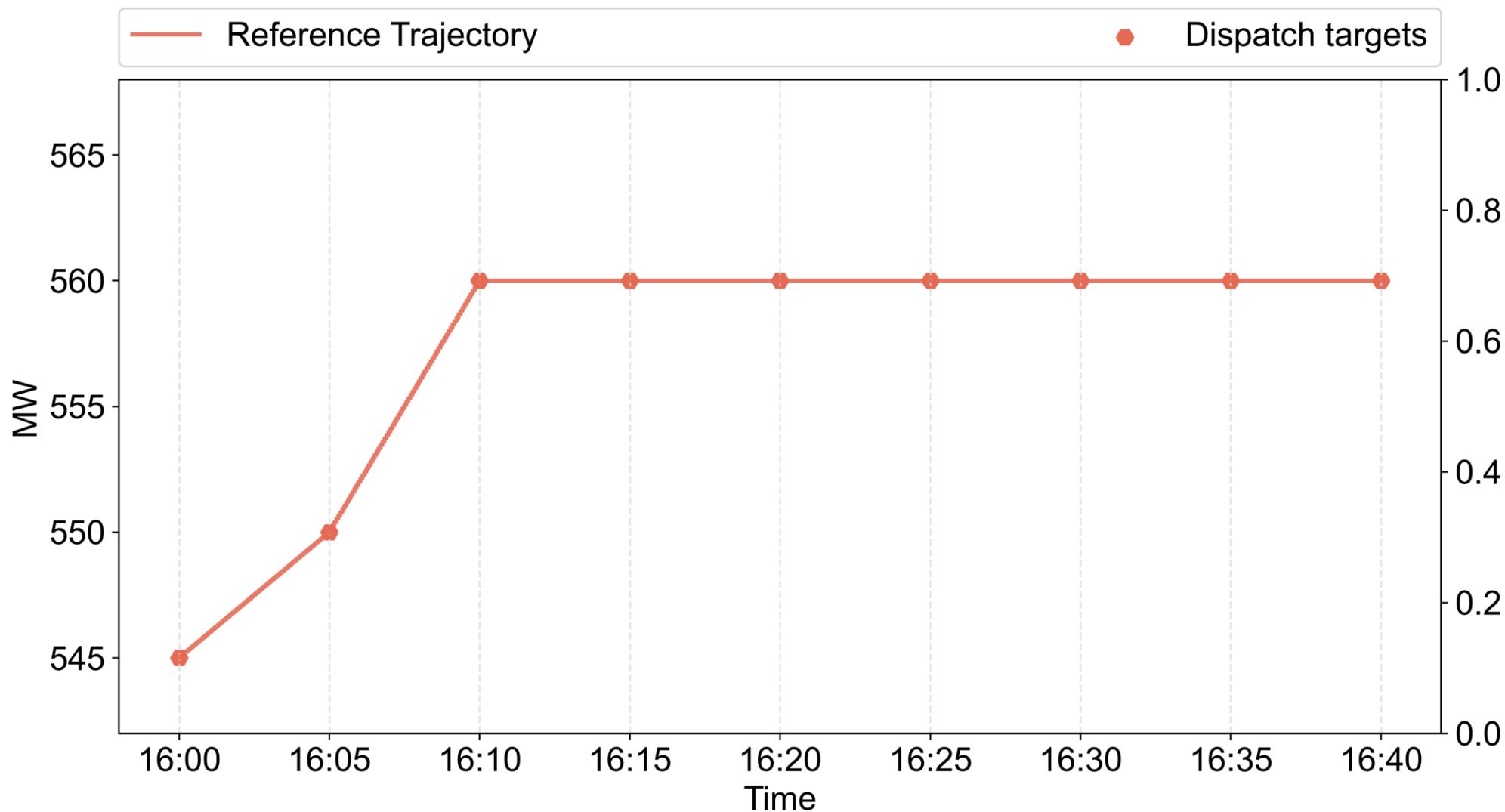


- Ref trajectory of NS units:



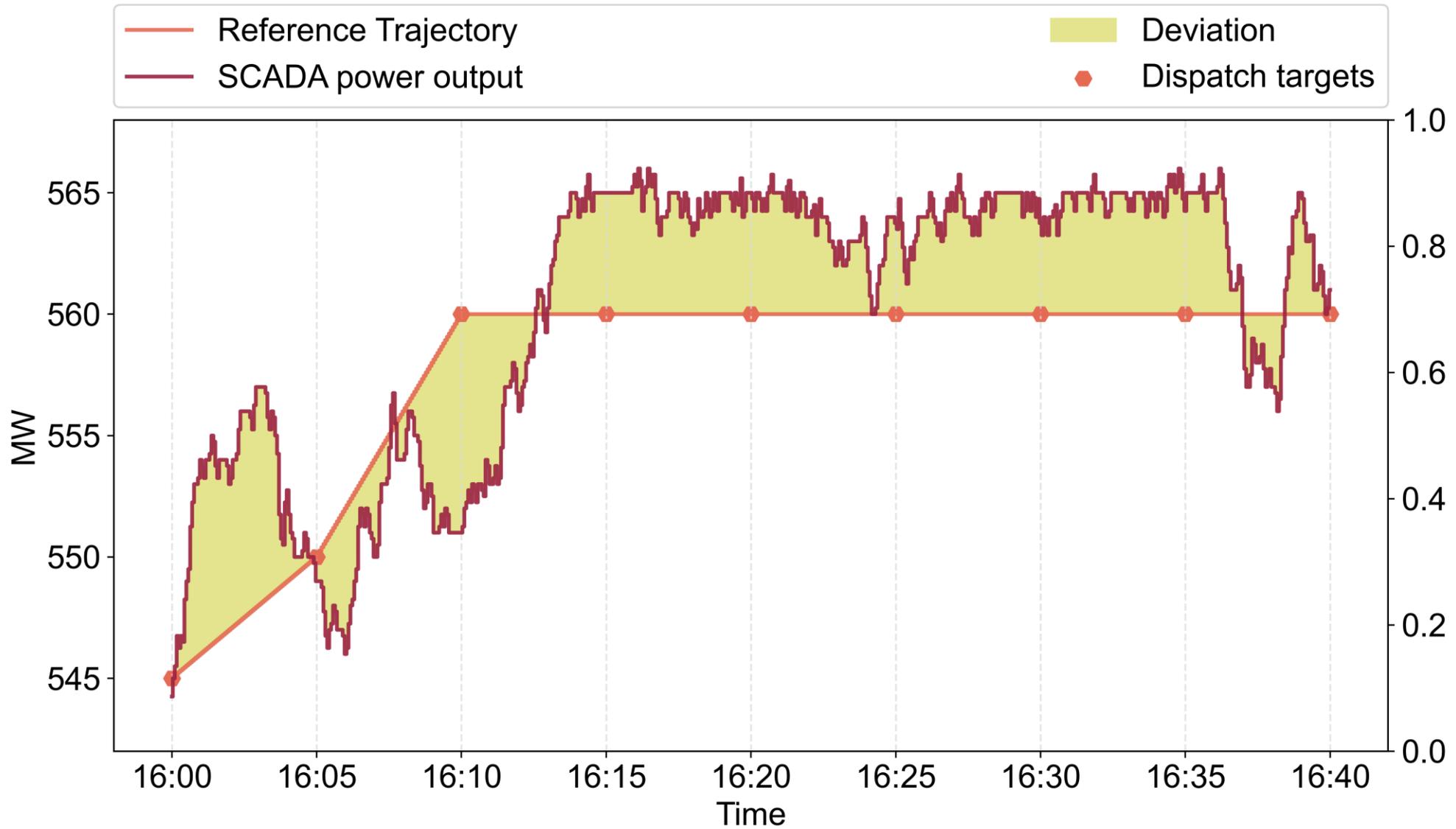
- Calculating the Deviation:  $Dev_t = Gen_t - Ref_t$
- Residual deviation is the opposite of deviation of all metered units in the relevant area.

# Reference trajectory for a coal PS >500 MW



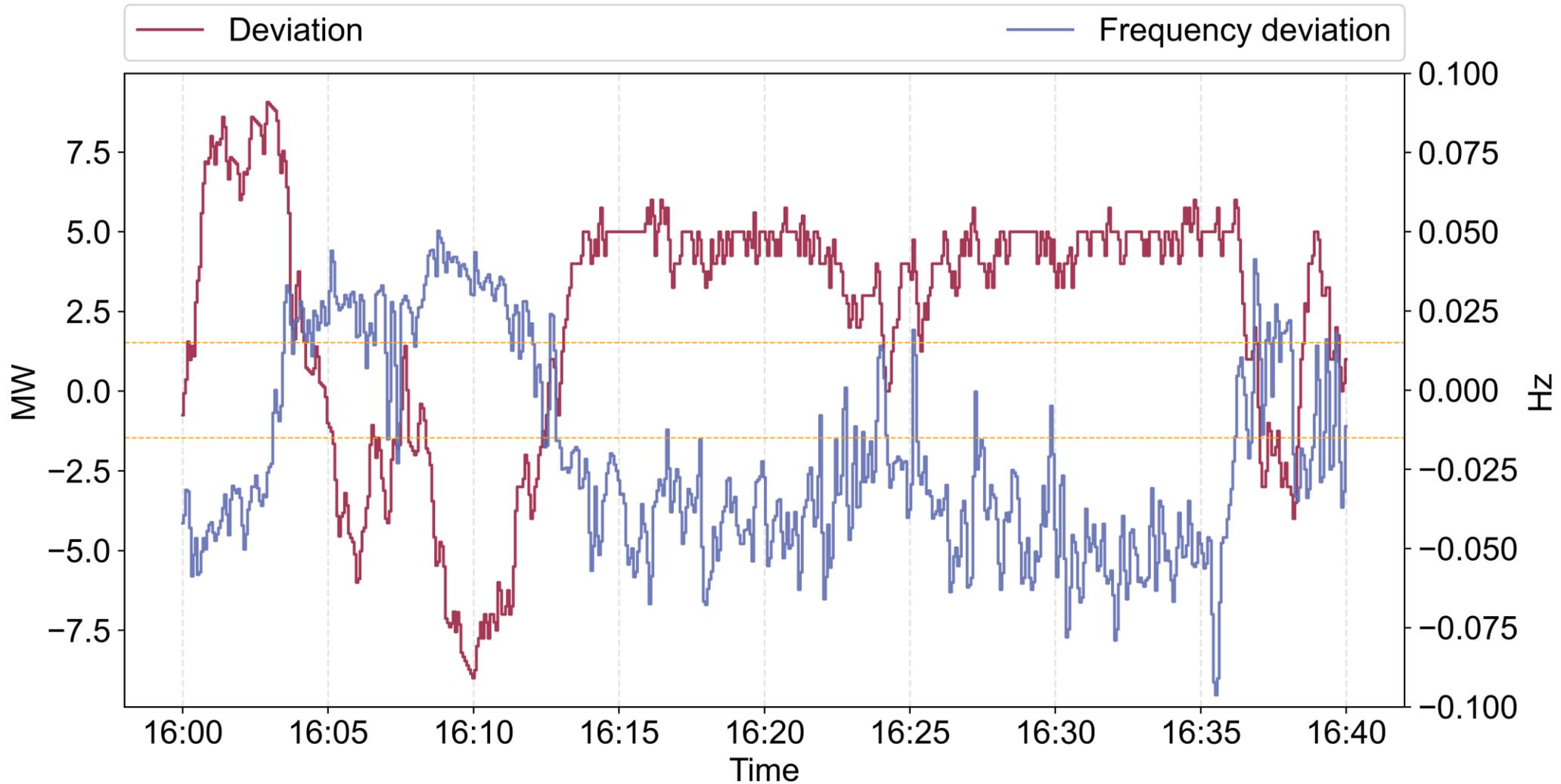
Case study:  
8 trading intervals  
in Aug 2021

# Reference Trajectory and Deviation



Case study:  
8 trading intervals  
in Aug 2021

# Deviation and frequency deviation



Case study:  
8 trading intervals  
in Aug 2021

# Performance

- In each 4 second:

Raise performance =  $\text{Max}(0, FM) * \text{Deviation}$

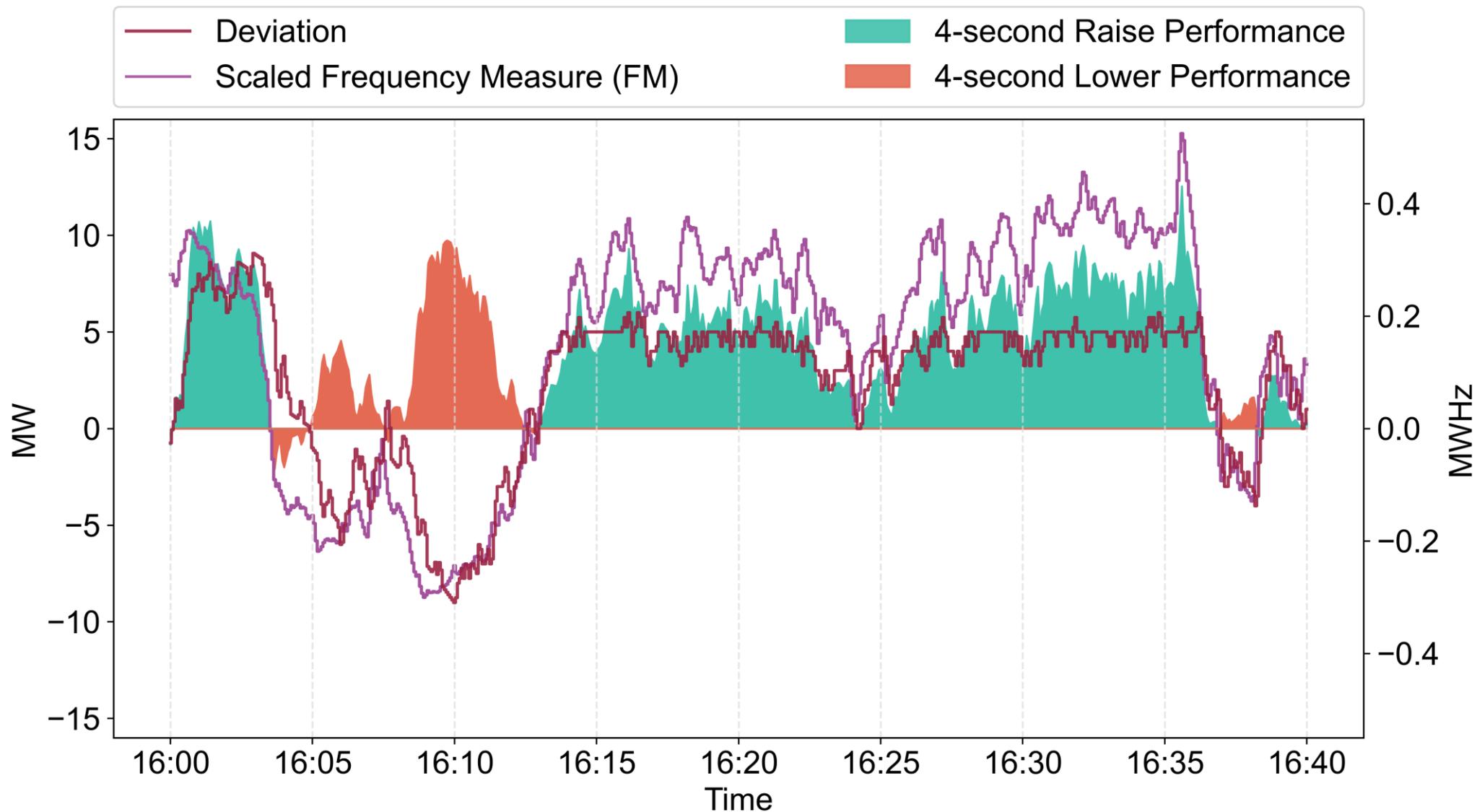
Lower performance =  $\text{Min}(0, FM) * \text{Deviation}$

- In each trading interval:

$$p^{raise} = \sum_{t=1}^{75} \max(0, FM_t^R) \times Dev_t$$

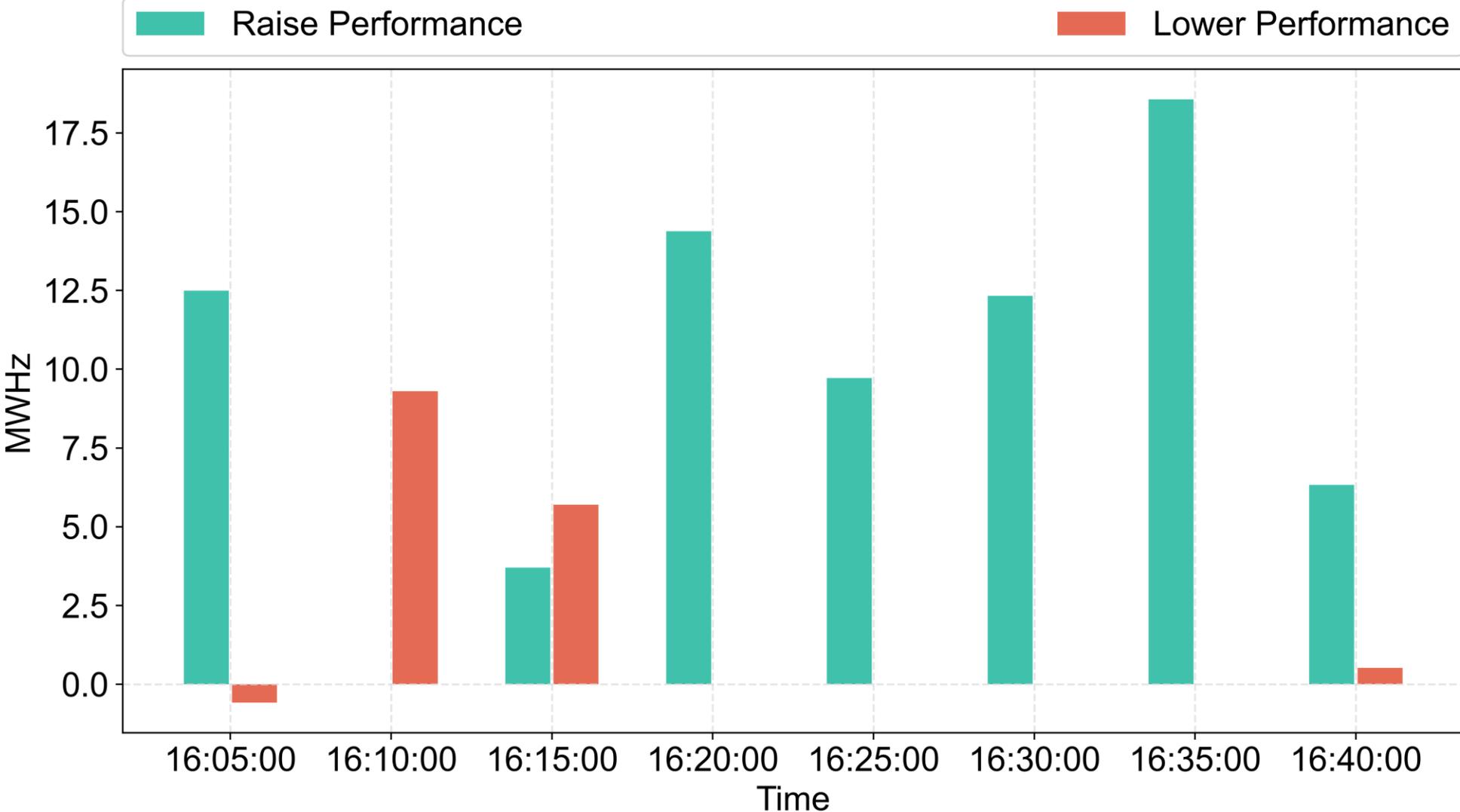
$$p^{lower} = \sum_{t=1}^{75} \min(0, FM_t^R) \times Dev_t$$

# 4-second performance



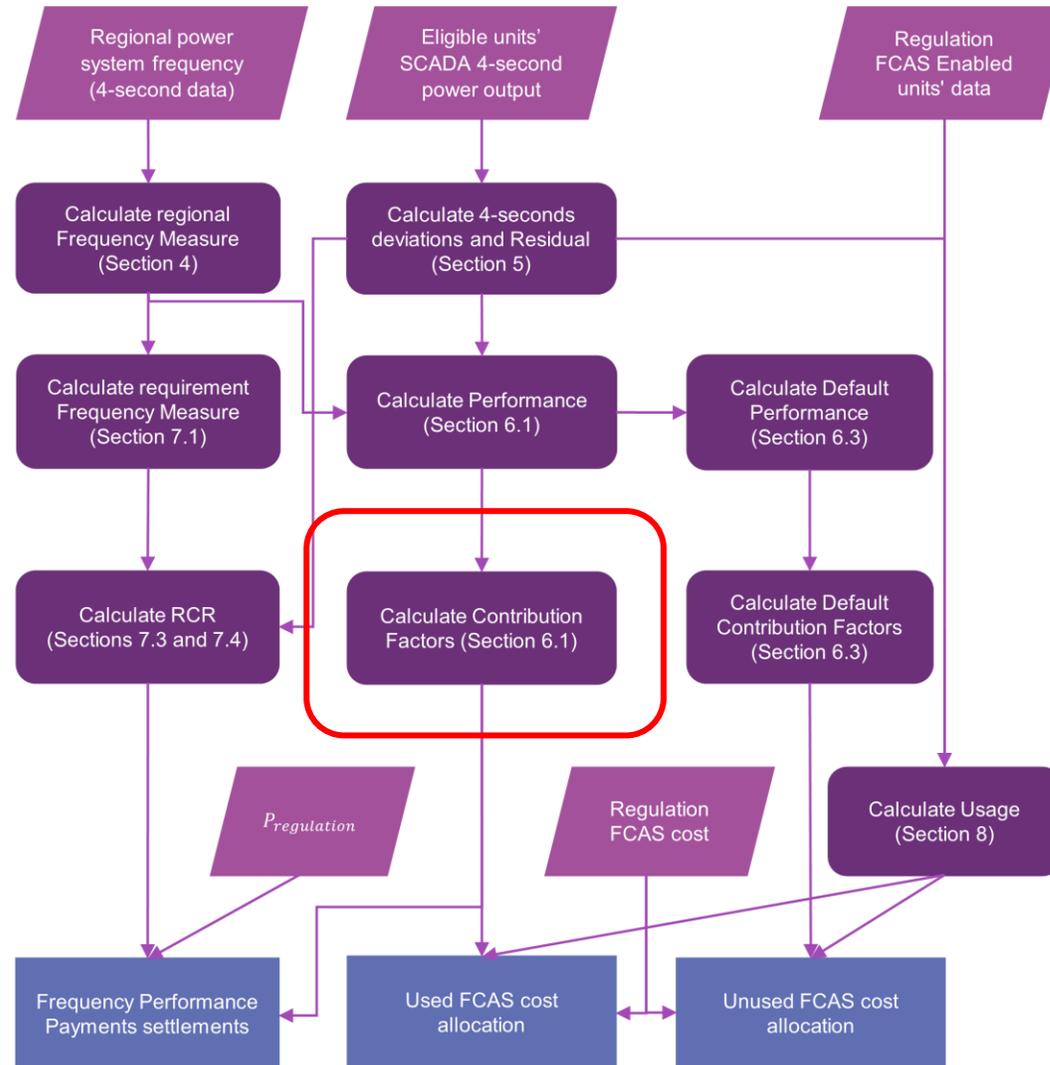
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8 trading intervals  
in Aug 2021

# Performance



Case study:  
8 trading intervals  
in Aug 2021

# Contribution Factors



# Contribution Factors

- Largely unchanged from issues paper and covered earlier. Cross-references from the rule:

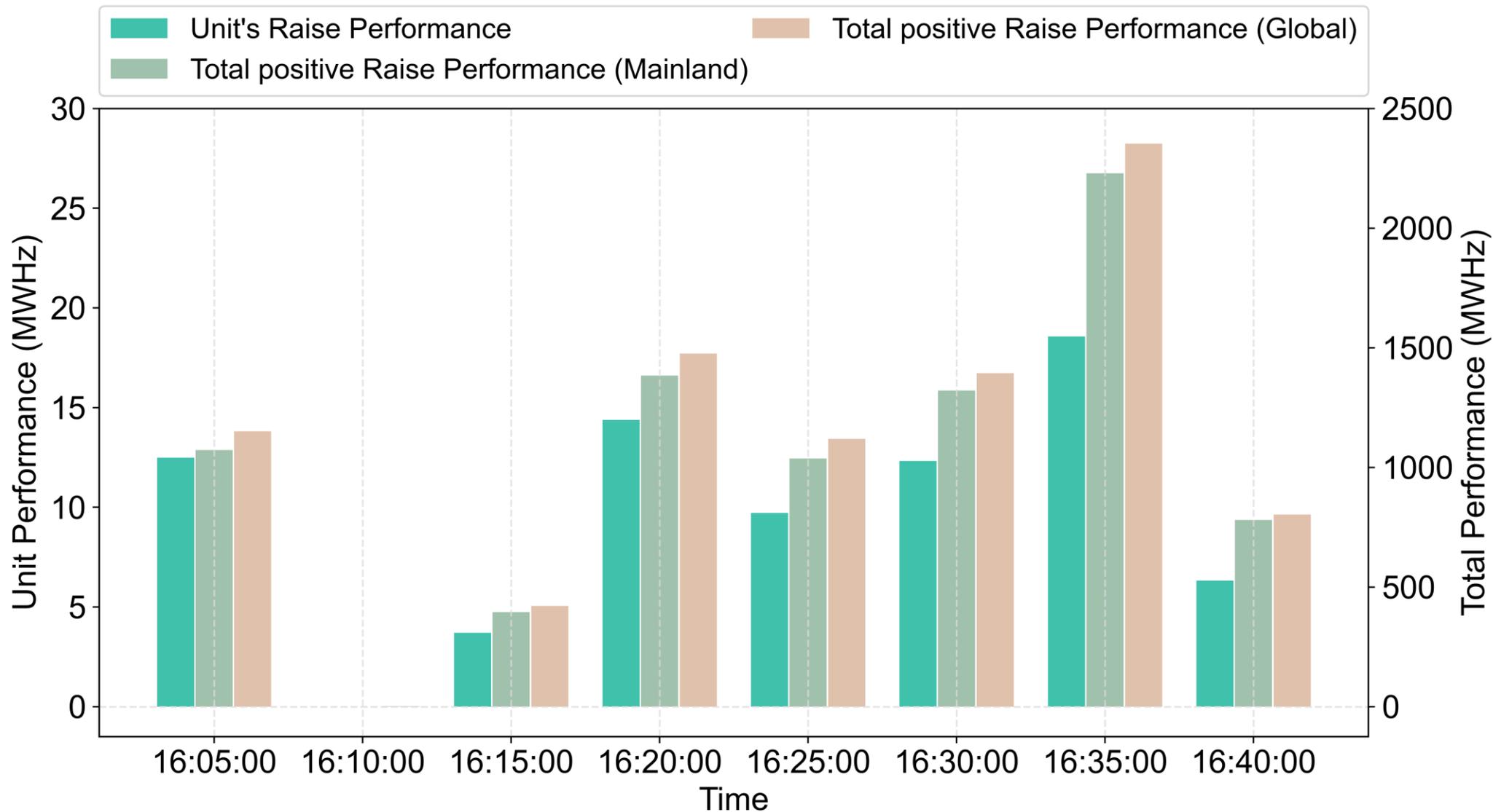
Relevant Rule	Variable in settlement equation	Cross-reference
3.15.6AA(b)	CF, RCF	Calculated under sections 6.1.2 (for raise requirements) and 6.1.4 (for lower requirements) of this Procedure. There is no distinction in this Procedure between RCF and CF as they are calculated together in the same manner. The Residual is effectively treated as just another eligible unit with appropriate metering for this purpose.
3.15.6AA(c)	NCF, NRCF	As above. There is no separate calculation for Negative Contribution Factors; we simply ignore positive Contribution Factors when applying this NER settlement equation.
3.15.6AA(d)	DCF, DRCF	Calculated under section 6.3.1 of this Procedure. There is no distinction in this Procedure between DCF and DRCF as they are calculated together in the same manner. The Residual is effectively treated as just another eligible unit with appropriate metering for this purpose.

# Contribution Factors

- For each unit in each requirement in each trading interval:

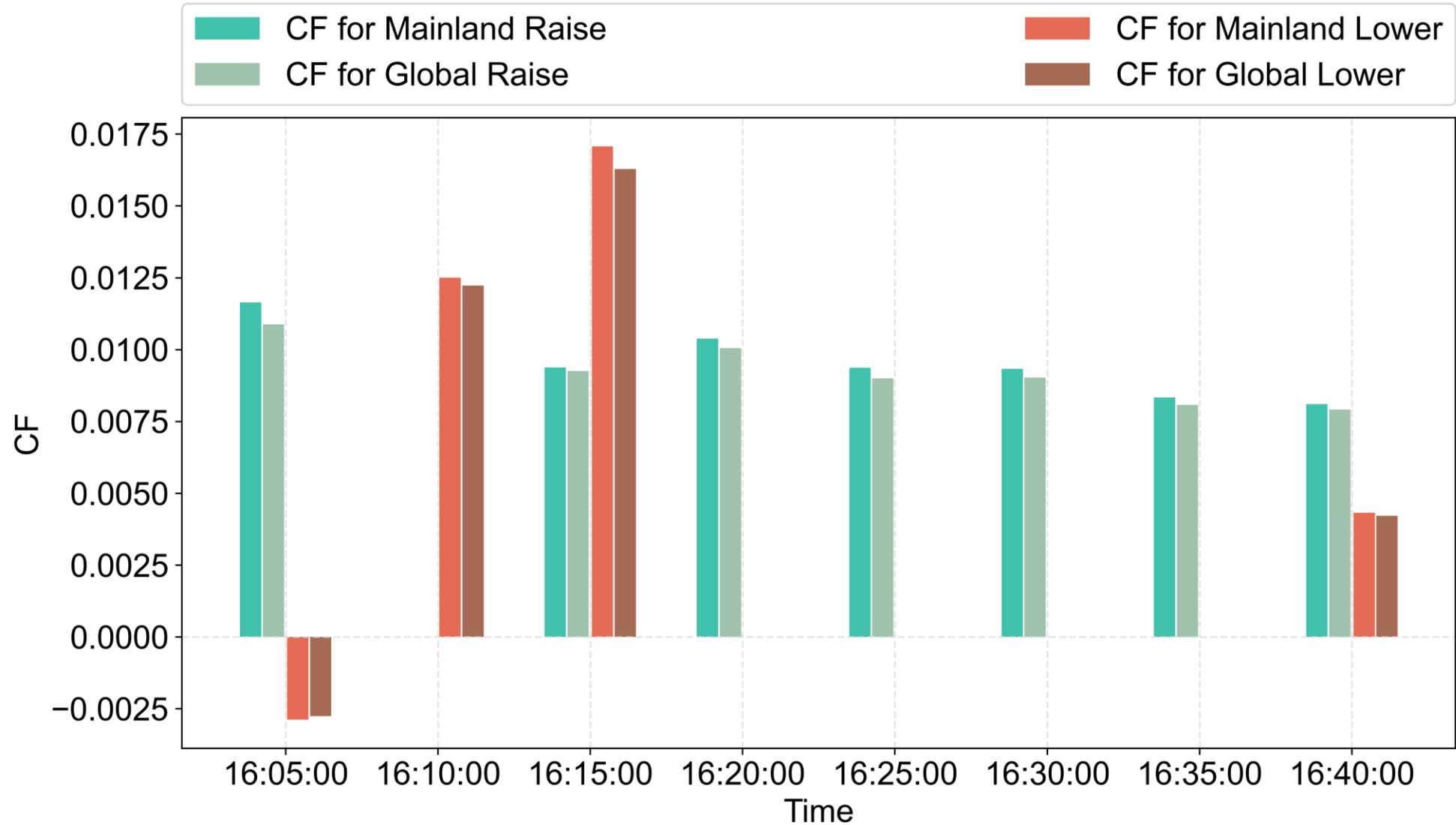
$$\frac{\text{The unit's performance}}{\text{Total performance in the **requirement** with the same sign}}$$

# Raise Performance of the unit vs the system



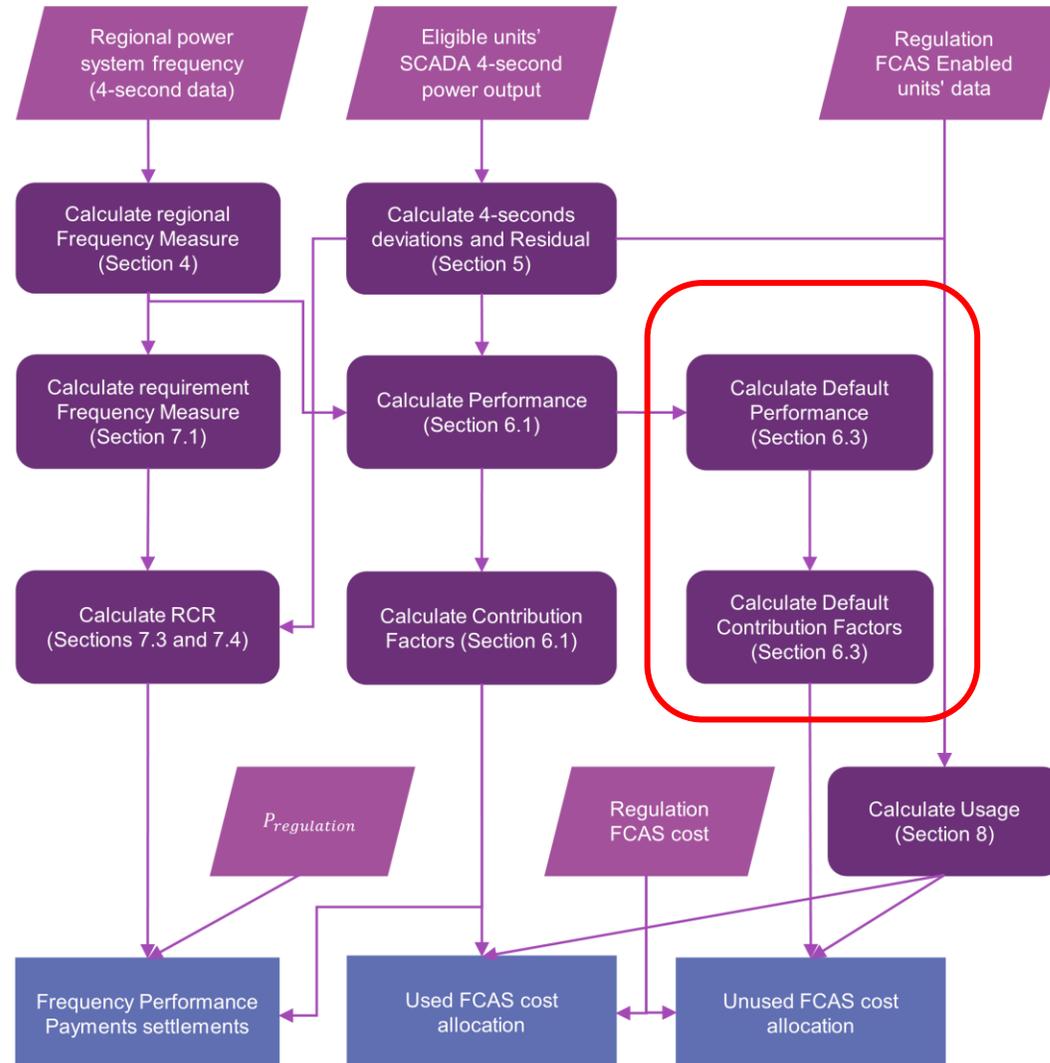
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# Contribution Factors



Case study:  
8 trading intervals  
in Aug 2021

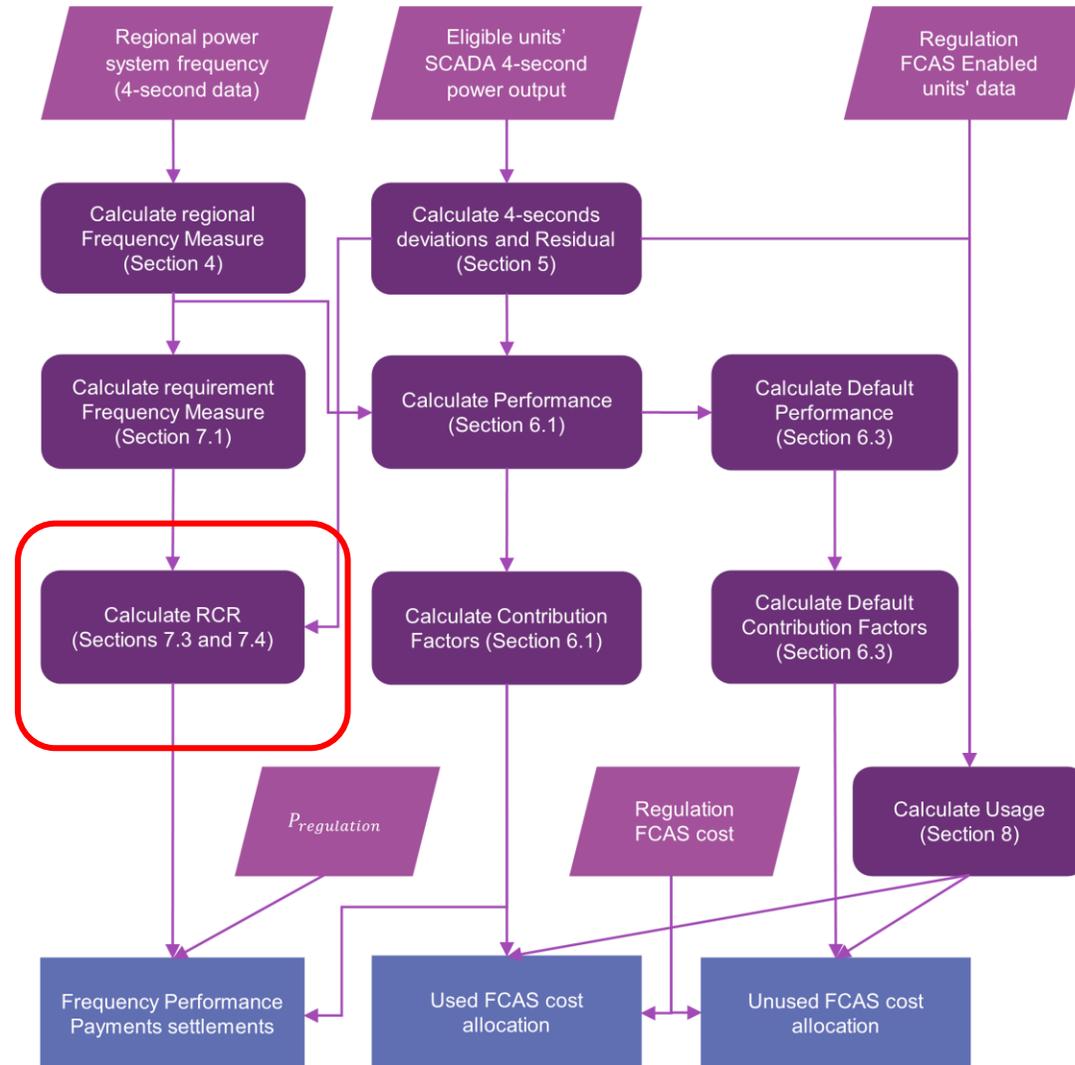
# Default Contribution Factors



# Default Contribution Factors

- A default contribution factor is a contribution factor that is determined based on historical performance.
- Three types of default contribution factor:
  1. For use in determining ‘unused’ Reg FCAS cost allocation. Performance for each TI in the 28-day period capped at zero, then averaged.
  2. For use in determining a unit’s ‘used’ Reg FCAS cost allocation only where actual performance for a TI is null. Performance calculated as under (1) above.
  3. For use in determining a unit’s FPP outcomes only where actual performance for a TI is null. Performance averaged for each TI in the 28-day period, *then* capped at zero. Good performance can offset bad.

# Requirement for Corrective Response (RCR)



# Requirement for Corrective Response

- A number used to represent the volume including PFR that is being provided at its peak for each TI (i.e. the peak sum of all the good deviations)
- Since the price (Pregulation) is a 5 min capacity price, it is appropriate to treat the volume as a capacity volume, compared to say, averaging the total amount of PFR provided across the TI.
- Global requirements will only use periods of time where the FM for Tas and Mainland are aligned to determine RCR.
- Note a proposed RCR cap, which is a change.

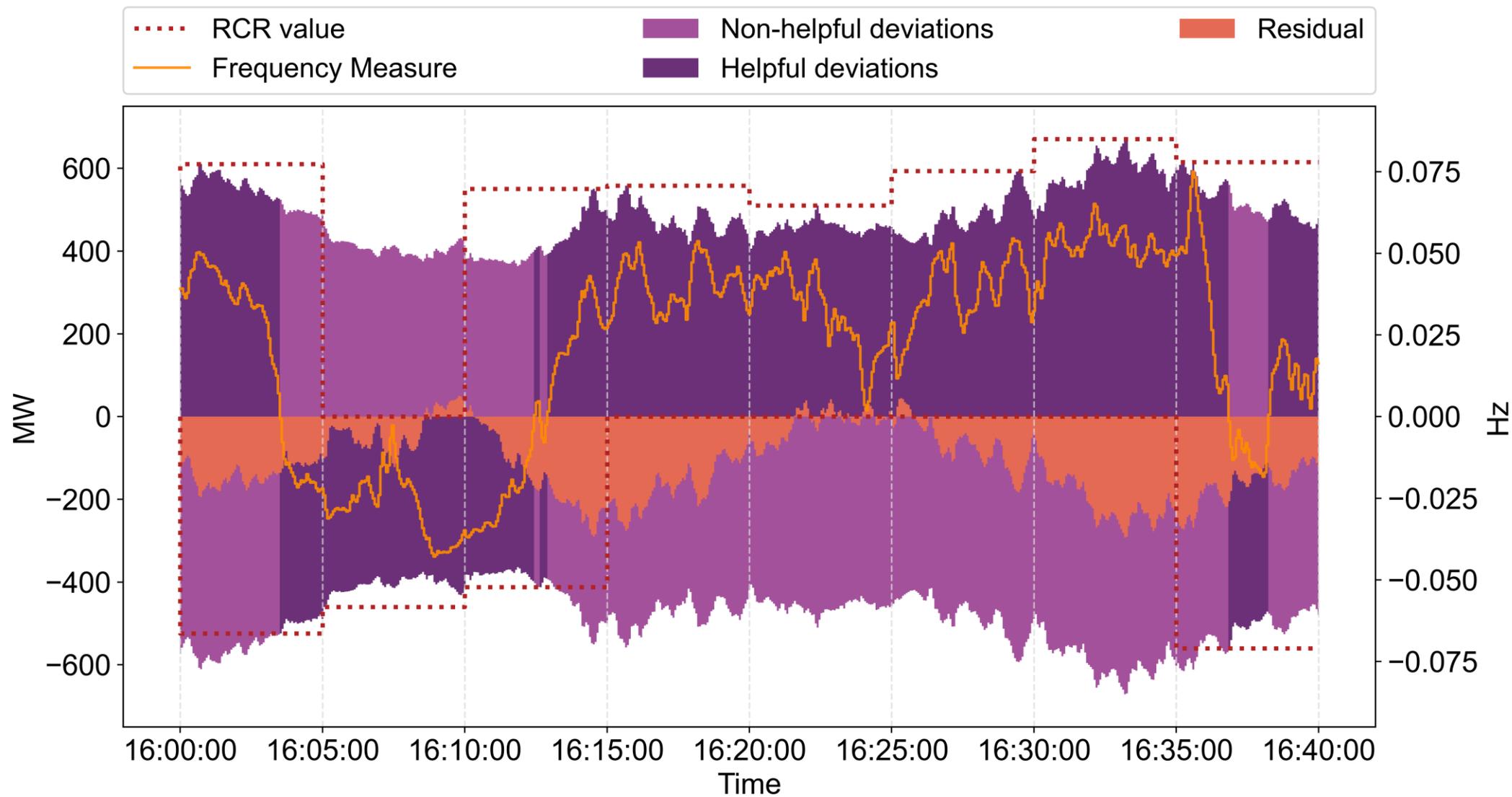
# RCR

- For each raise requirement, in each trading interval:

$$SumPosDev_t^{req} = \sum_m \max(0, Dev_{m,t}) + \max(0, Dev_{Res,t}^{req})$$

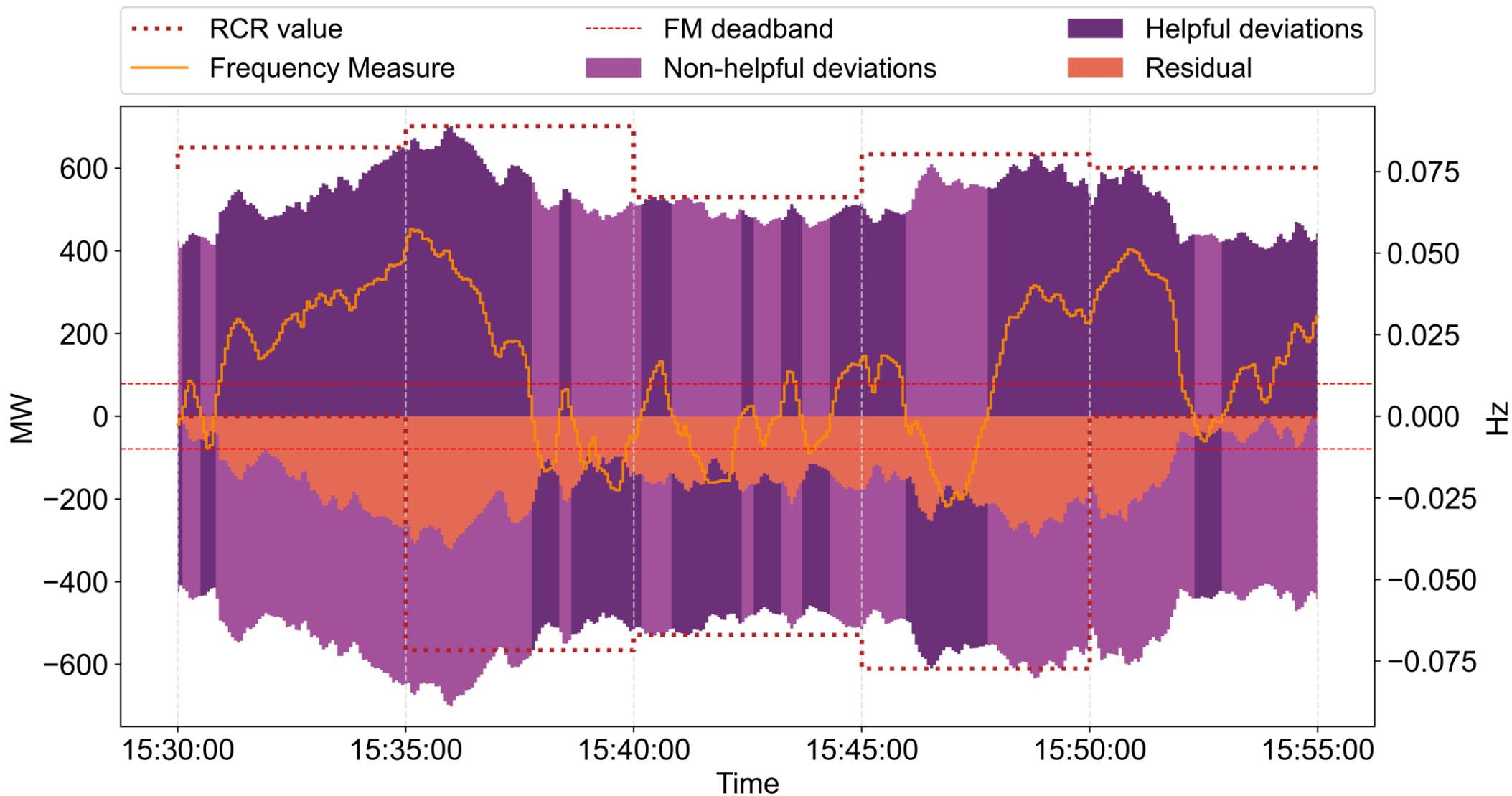
$$RCR_{req}^{raise} = \max \left( \begin{array}{l} SumPosDev_t^{req} \\ \text{where } FM_t^{req} > 0 \end{array} \right)$$

# RCR for Mainland requirement

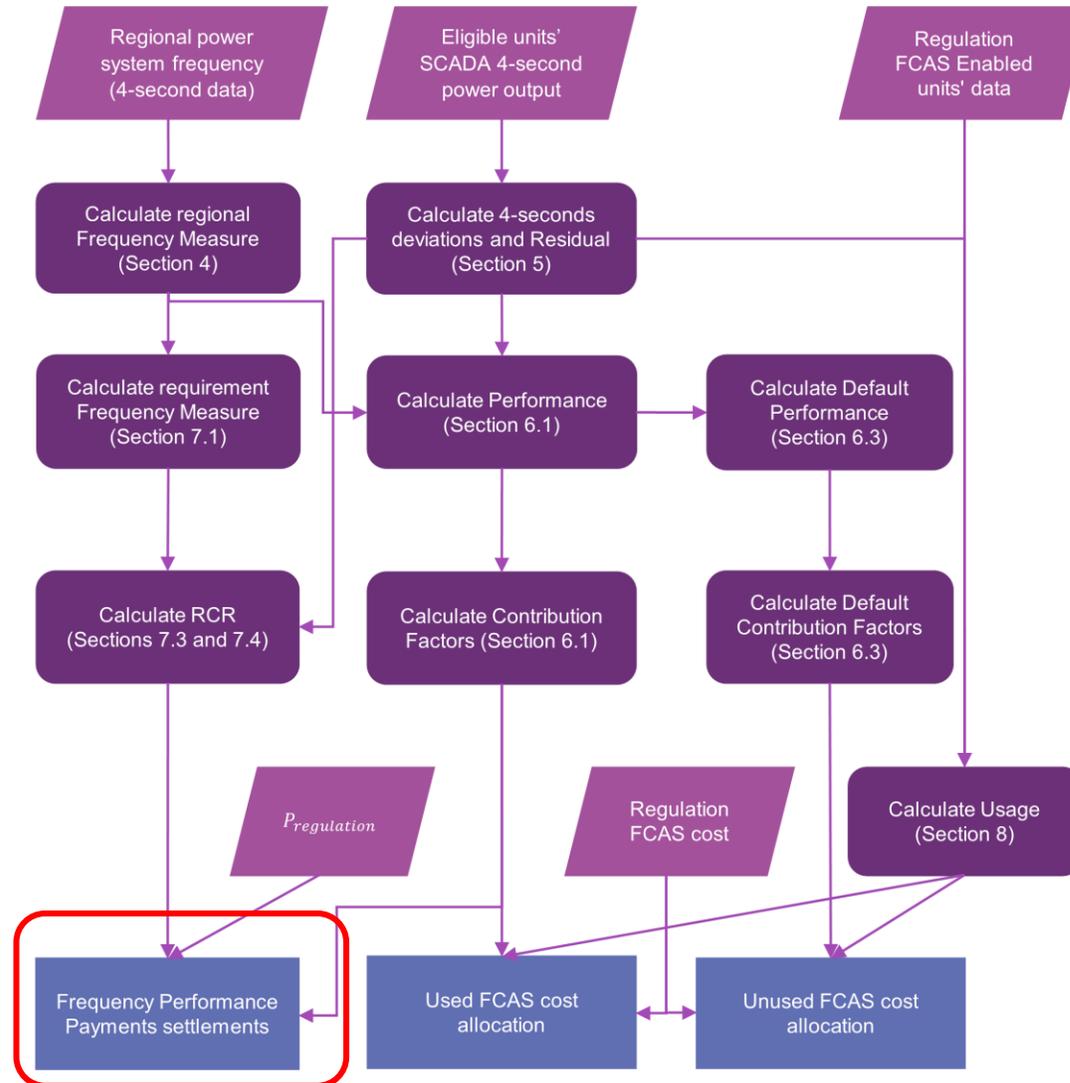


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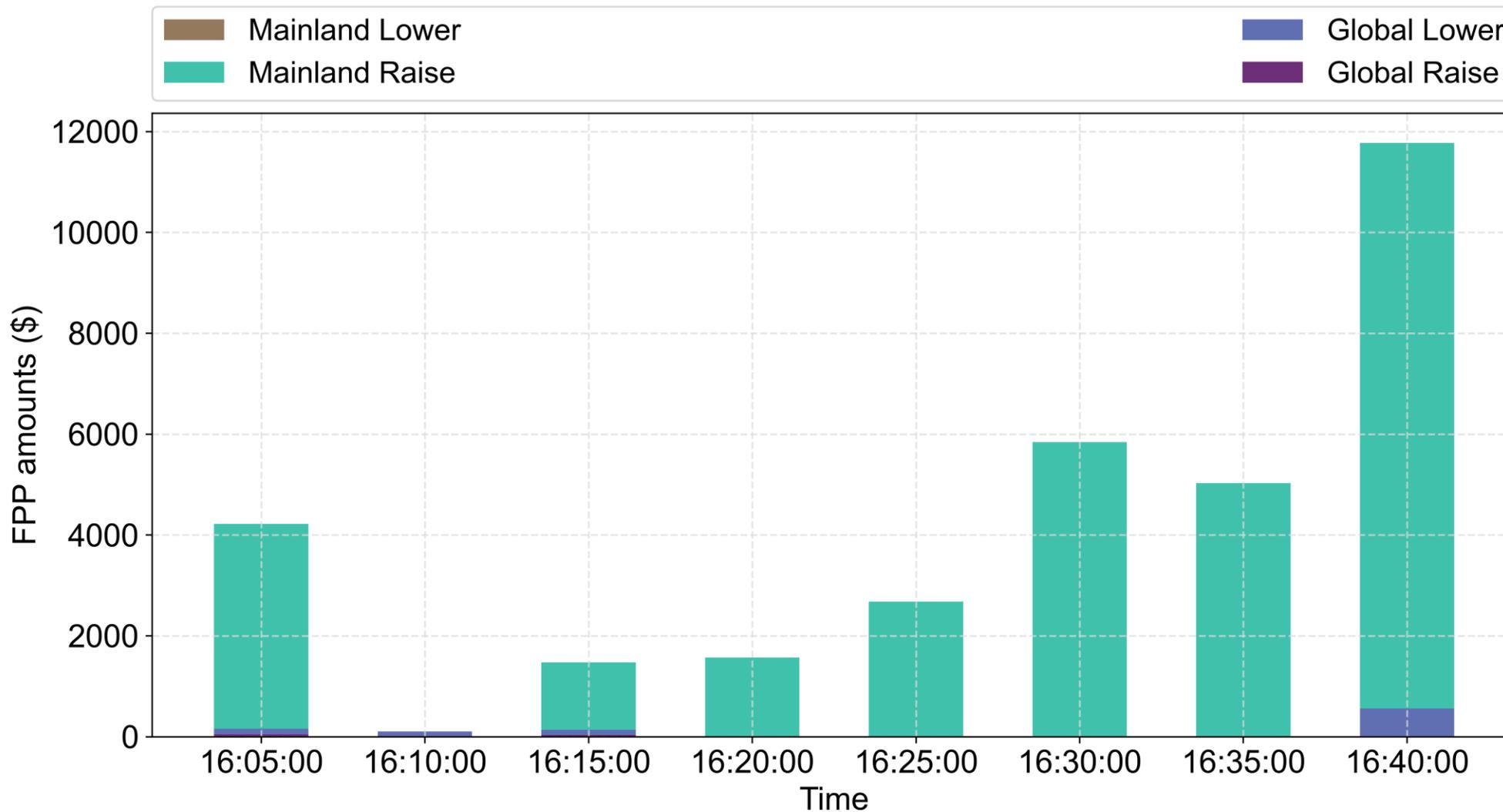
# RCR (impact of FM conditions)



# FPP settlement



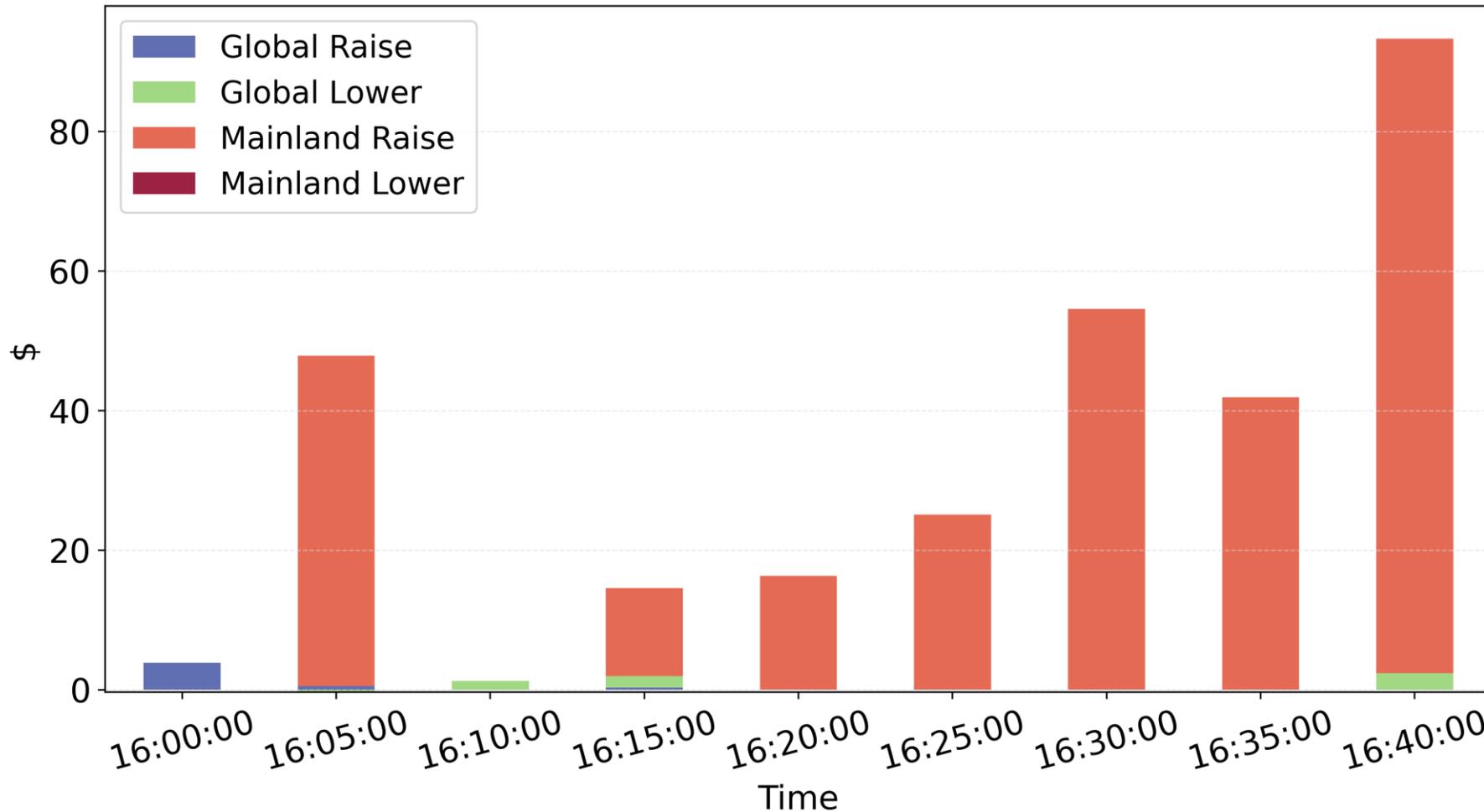
# FPP amounts = RCR × REG price



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# FPP trading amounts of the unit

= CF × FPP amount

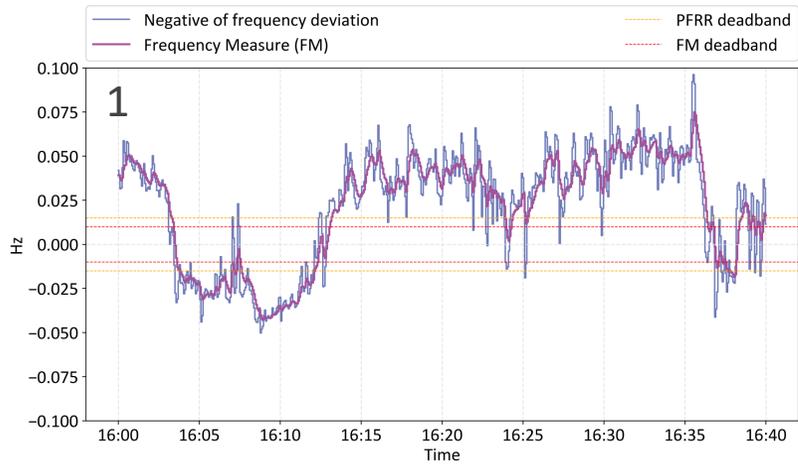


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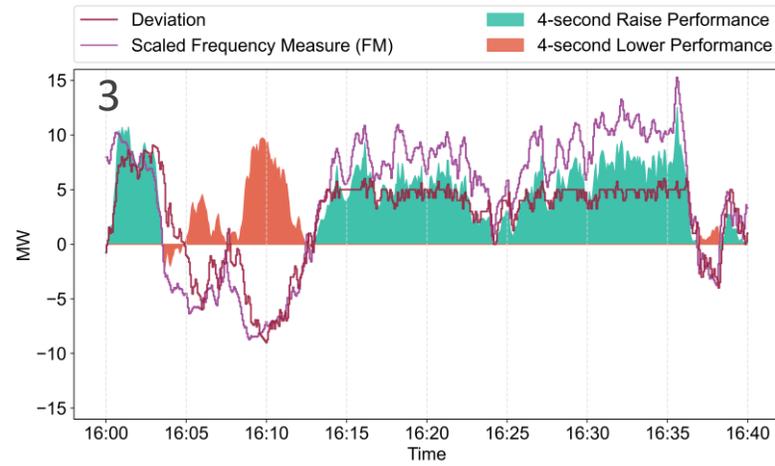
# Summary of FPP



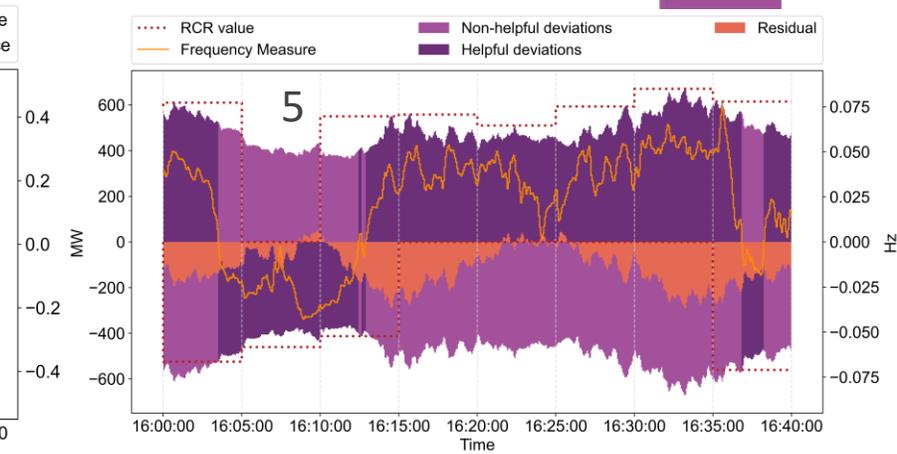
Frequency Measure



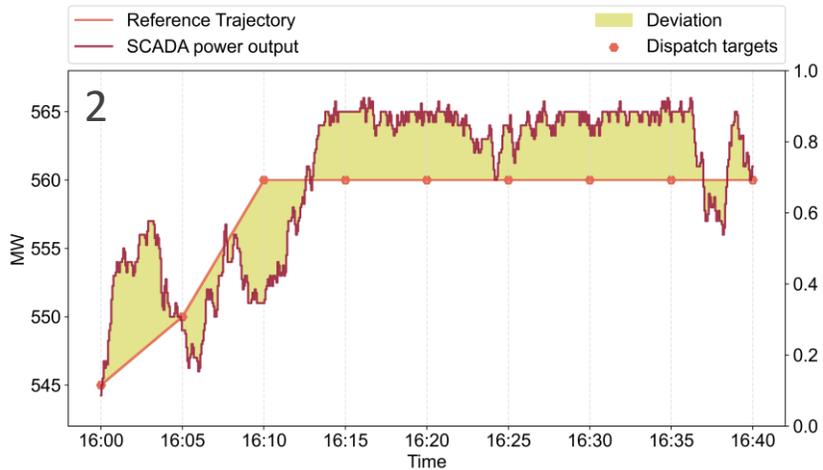
Performance



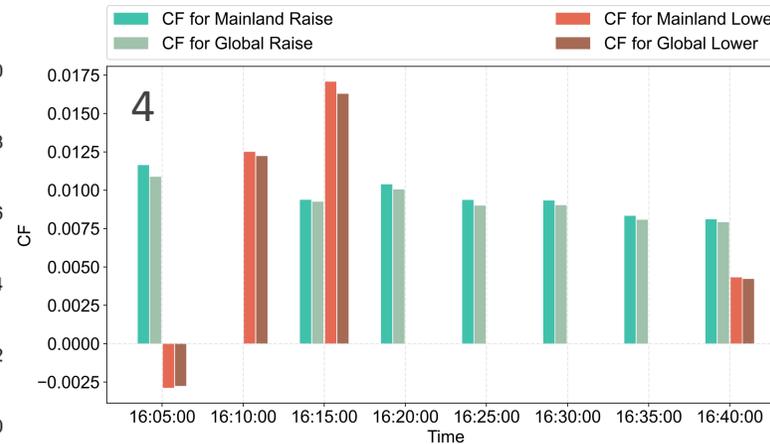
RCR



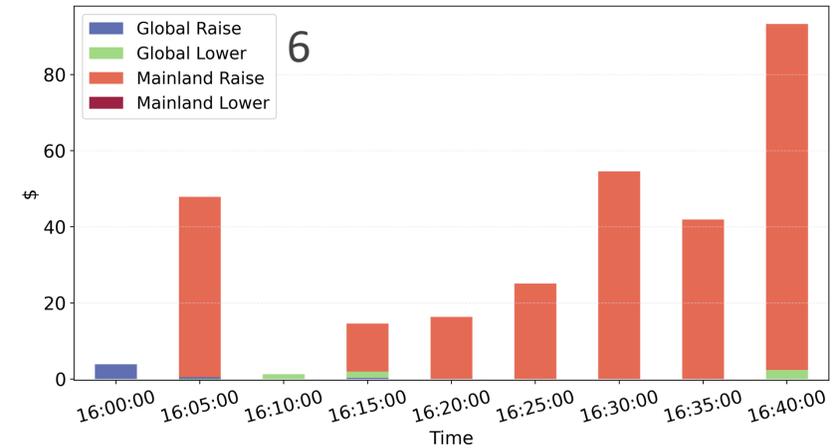
Deviations



Contribution Factor



FPPs

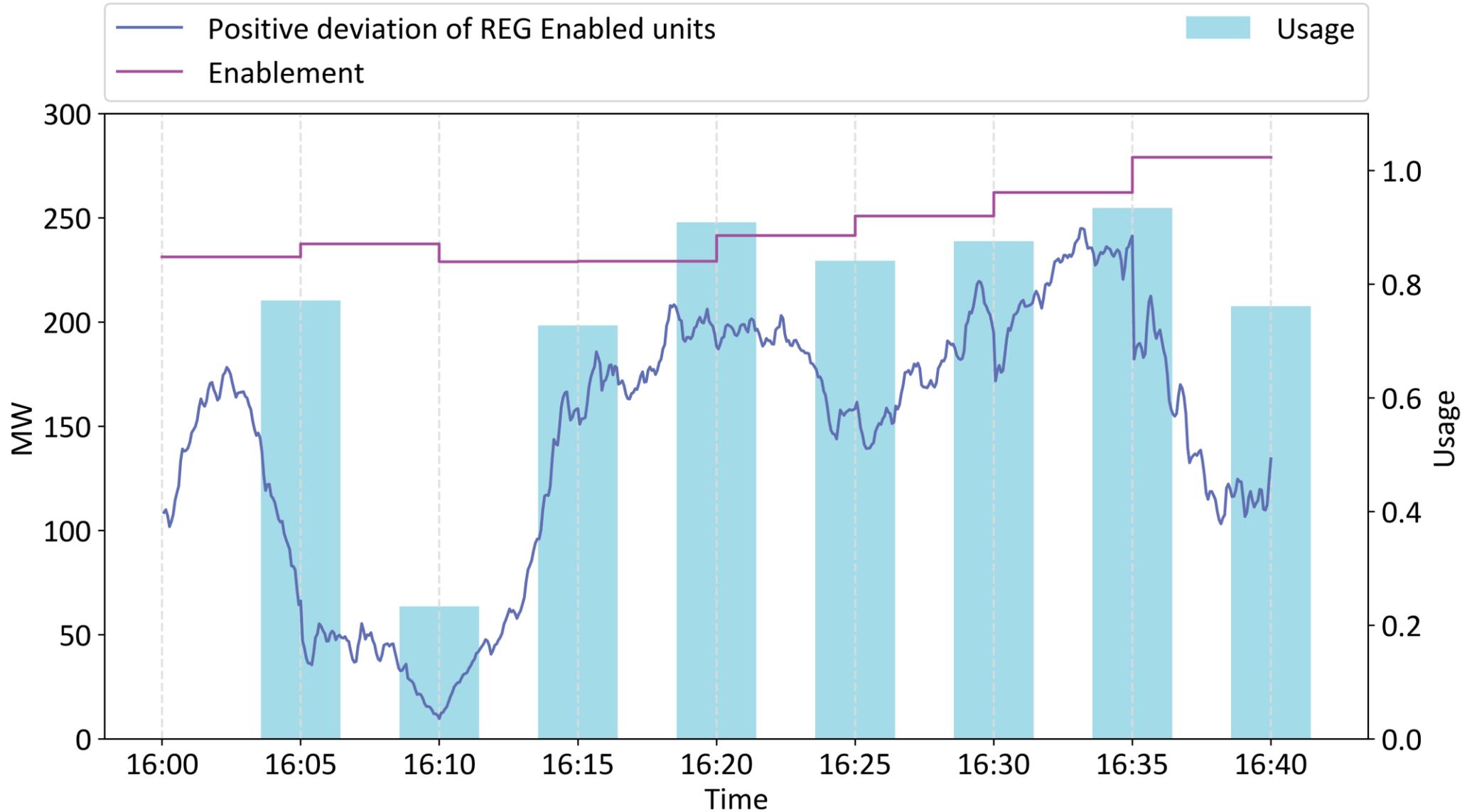




# Usage

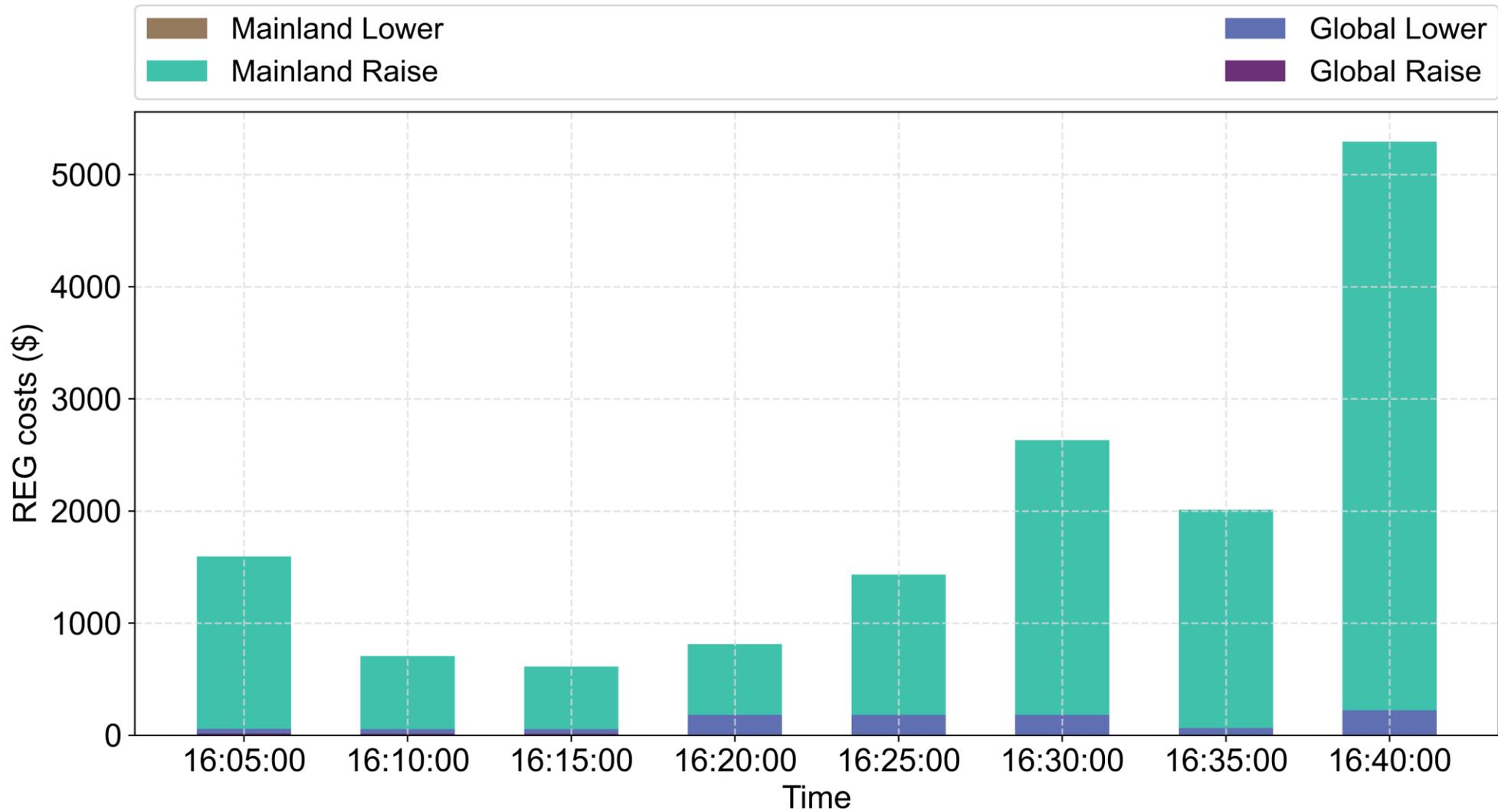
- No change from issues paper – still simply the peak sum of deviations of units enabled for Regulation FCAS, capped by the amount of enablement.

# Usage



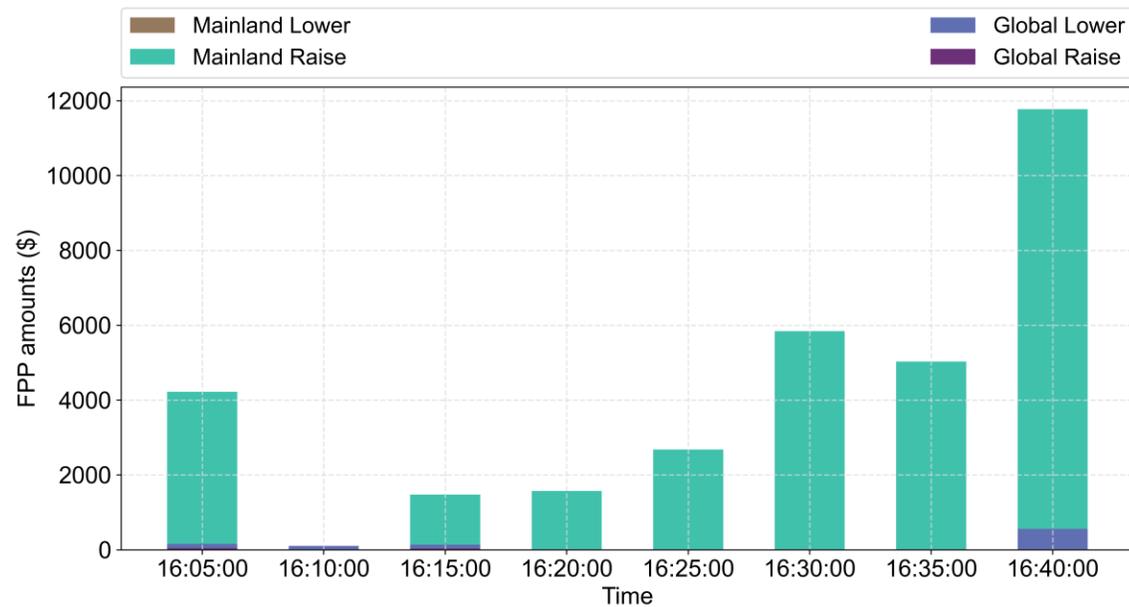
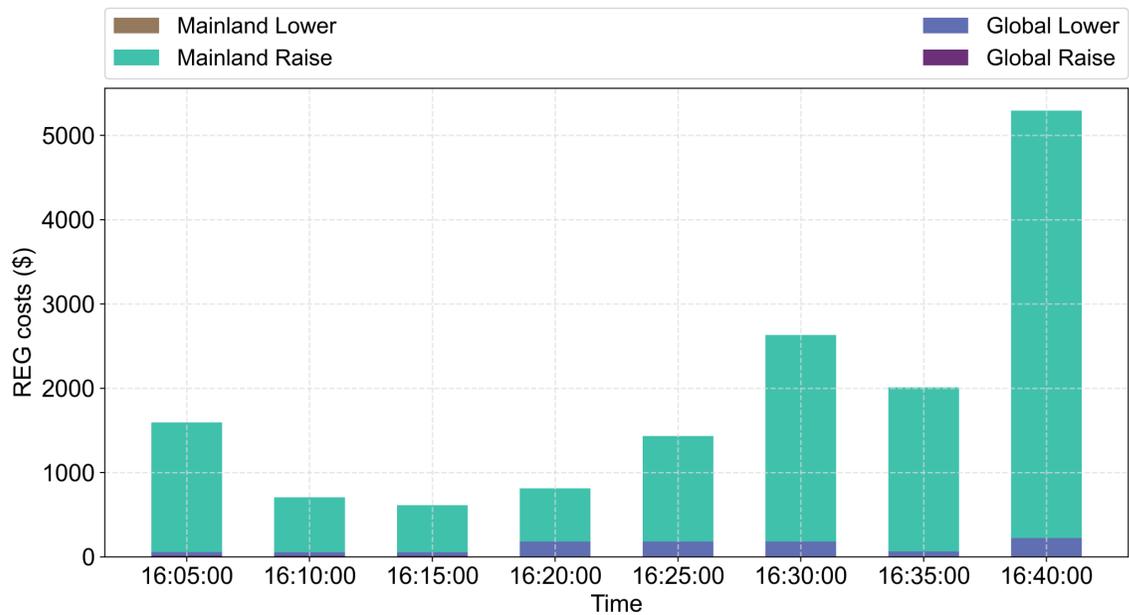
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# REG costs



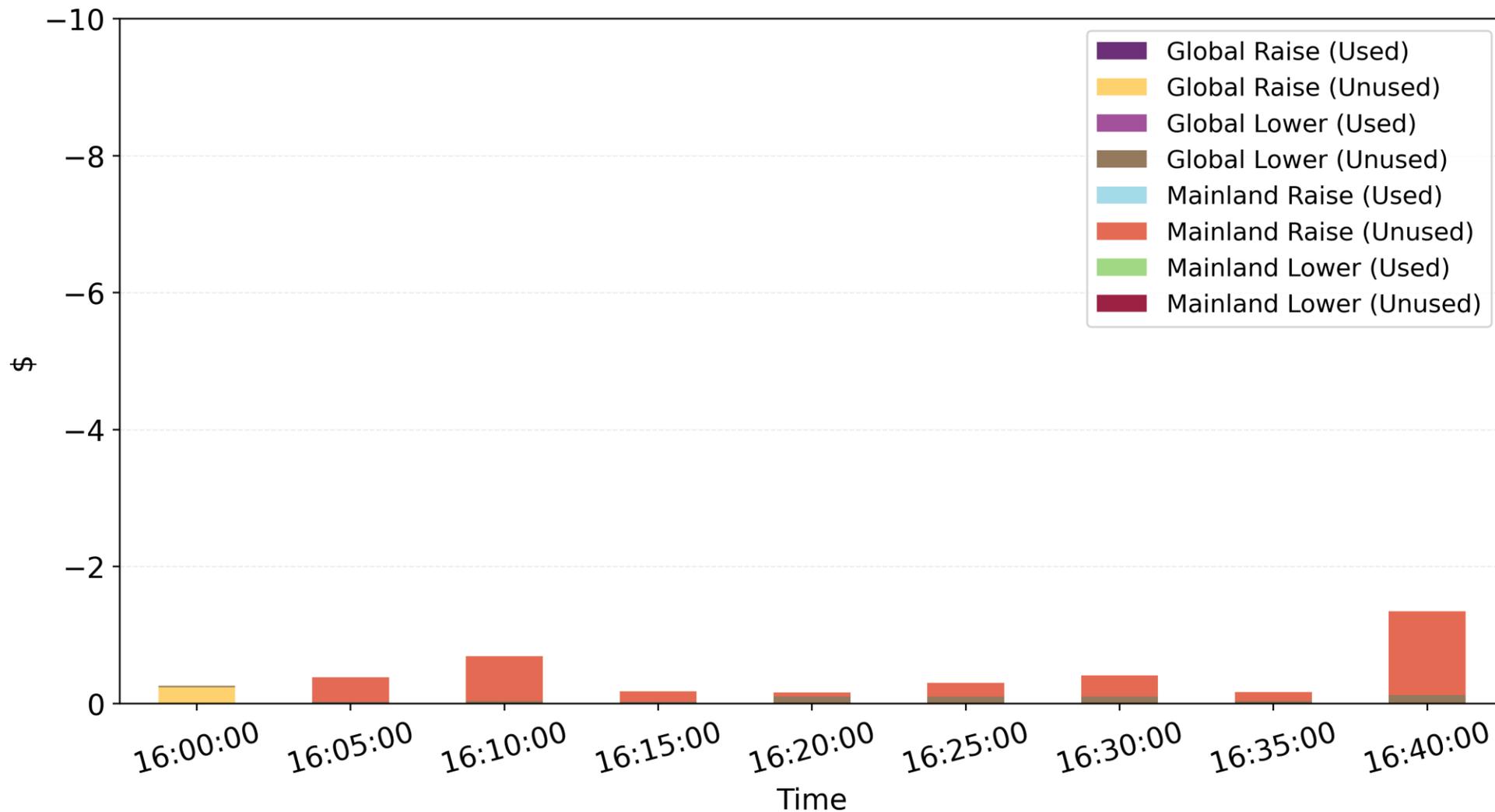
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# REG costs (left) vs FPP amounts (right)



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8 trading intervals  
in Aug 2021

# REG costs allocated to the unit

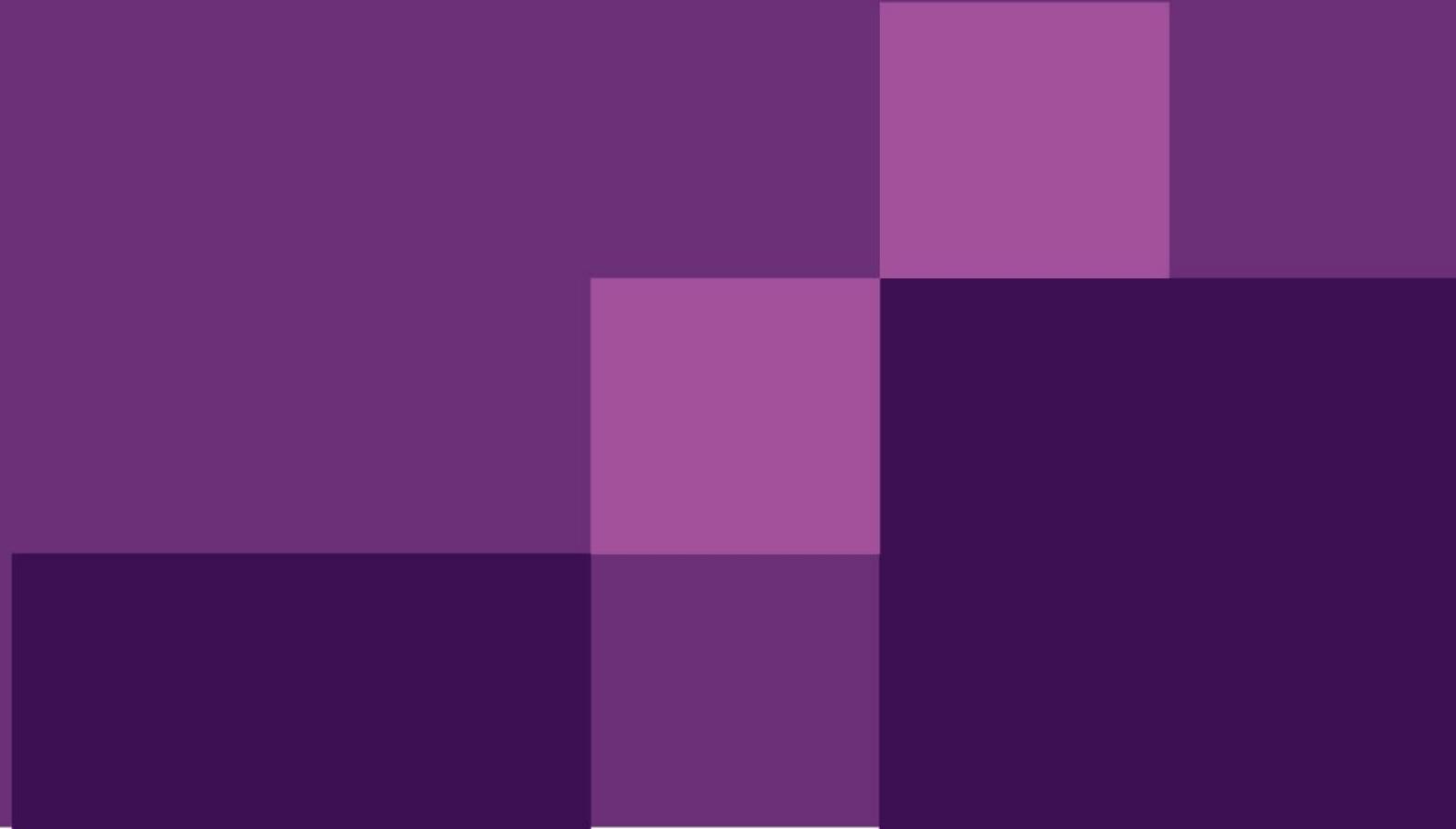


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# Other matters

- Data provision – to be discussed in subsequent workshop
- RCR cap
- Aggregated dispatch conformance
- Late publication of contribution factors

# Q&A



# Important dates

- Forum to discuss what information AEMO will provide participants (and in what form) for information reporting related to the FPP project – 28 February 2023
- Submissions for second round due 15 March 2023



For more information visit

**[aemo.com.au](https://aemo.com.au)**

<https://aemo.com.au/consultations/current-and-closed-consultations/frequency-contribution-factors-procedure>