

Disclaimer

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The interpretations expressed in this presentation are not binding on AEMO. The interpretation of the impact of NEM reforms may change at any time.

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Welcome

Ulrika Lindholm





We acknowledge the Traditional Custodians of the land, seas and waters across Australia. We honour the wisdom of Aboriginal and Torres Strait Islander Elders past and present and embrace future generations.

We acknowledge that, wherever we work, we do so on Aboriginal and Torres Strait Islander lands. We pay respect to the world's oldest continuing culture and First Nations peoples' deep and continuing connection to Country; and hope that our work can benefit both people and Country.

'Journey of unity: AEMO's Reconciliation Path' by Lani Balzan

AEMO Group is proud to have delivered its first Reconciliation Action Plan in May 2024. 'Journey of unity: AEMO's Reconciliation Path' was created by Wiradjuri artist Lani Balzan to visually narrate our ongoing journey towards reconciliation - a collaborative endeavour that honours First Nations cultures, fosters mutual understanding, and paves the way for a brighter, more inclusive future.

Read our
RAP



Session objectives



Overview of **Frequency Performance Payments** operation and worked examples

Q&A

Opportunity for **Q&A** with key experts in attendance

AGENDA

#	Timing (AEST)	Topic	Presenters
1	11:00am (5 mins)	Arrival and welcome	Ulrika Lindholm
2	11:05am (5 mins)	Opening remarks	Johnny Mangala
3	11:10am (25 mins)	Presentation <ul style="list-style-type: none">- Introduction: FPP deliverables, simple description and flow chart- Overview of FPP operations- Industry readiness	Ulrika Lindholm Yousef Rashid Karen Wilbrink
4	11:35am (25 mins)	Questions	All
6	12:00pm	Close	Ulrika Lindholm

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General Housekeeping

1. Please mute your microphone.
2. Use the 'Chat' function to ask any questions or comments.
 - AEMO SMEs are on the call, who will attempt to respond in the chat.
3. Key questions or comments will be addressed verbally in the Q&A section.
4. In attending this meeting, you are expected to:
 - Contribute constructively.
 - Be respectful, both on the call and in the chat.



Opening remarks

Johnny Mangala
Manager, Systems Commercial
Operations Division



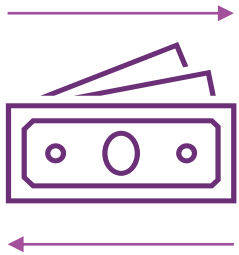


Introduction

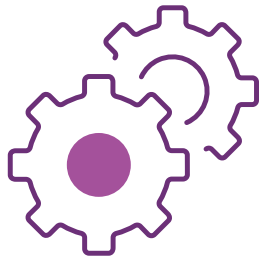
Ulrika Lindholm

NEM Reform Program Stakeholder Engagement Team

FPP - top level deliverables



1. New double-sided frequency performance payments process



2. New process for allocation of Regulation FCAS costs (Contribution Factors or CFs)

FPP – Simple description

In each 5-min NEM trading interval (TI)

AEMO will:



1. Calculate the total value of FPPs by:

- Determining the total extent of helpful frequency contributions by individual facilities.
- Pricing those contributions according to the cost of Regulation FCAS in that TI.

2. Allocate the costs and benefits in one of two ways:

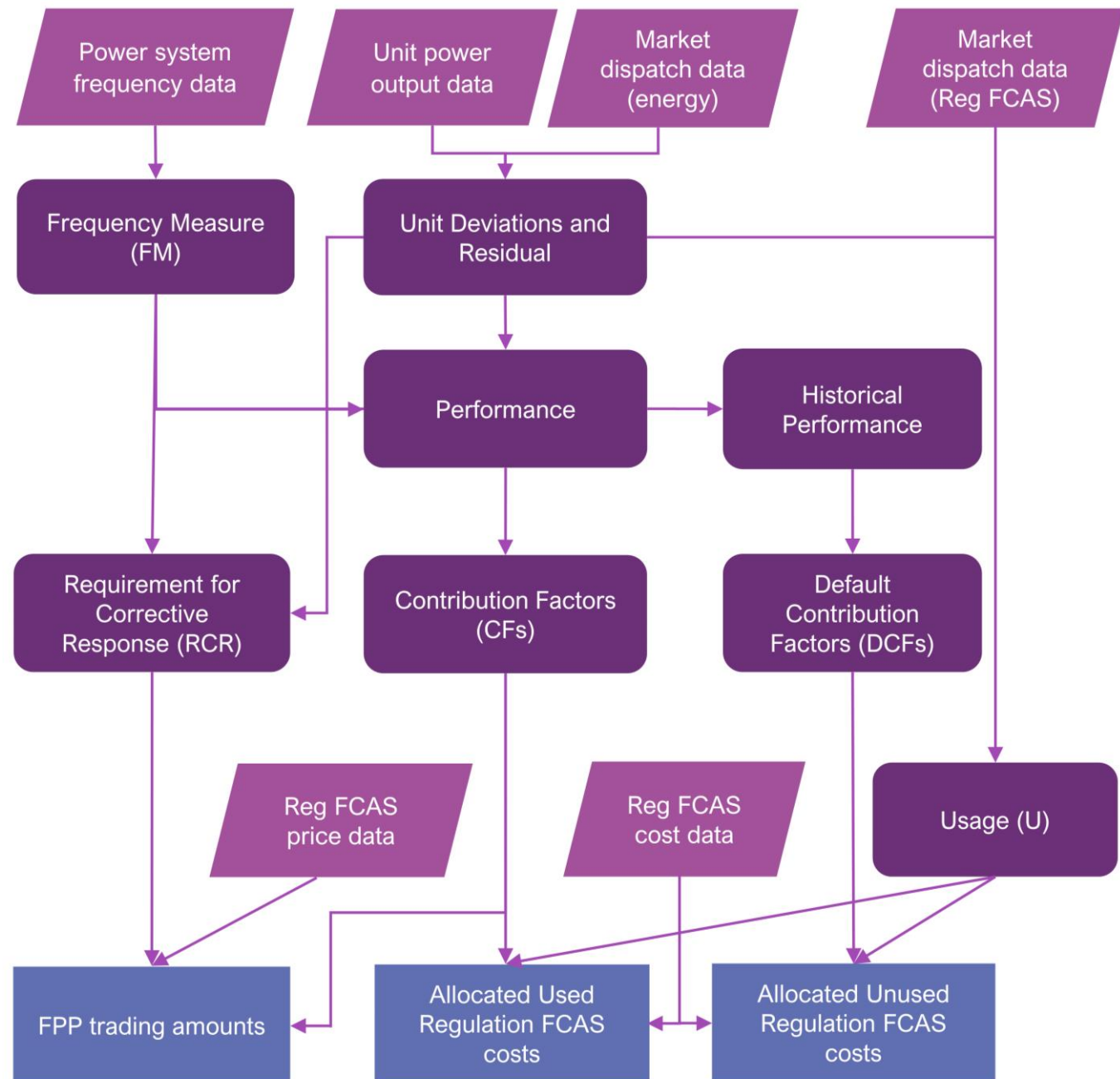
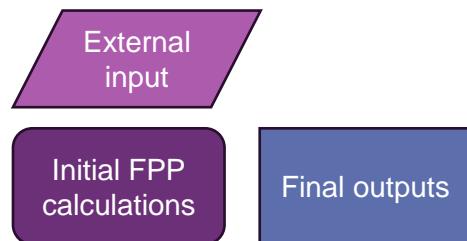


- For scheduled and semi-scheduled generators and customers, who are given dispatch levels by AEMO and provide four-second SCADA data, individual contribution factors are calculated based on the extent (and helpfulness) of any deviation from their dispatch levels.
- For small customers without SCADA (such as households) the ‘residual’ deviation in system frequency is calculated and allocated based on energy consumed.

FCFP process flowchart

The [Frequency Contribution Factors Procedure \(FCFP\)](#) outlines the method by which AEMO measures a unit's frequency performance and how this is used to determine both FPPs and the allocation of Regulation FCAS costs.

KEY



Impacts on different participants

Participant type	Impact level	Impact description
Cost recovery market participants with units to be individually assessed for FPP	High	<ul style="list-style-type: none"> - New CFs to be calculated each trading interval and reported to plant operator the following interval. - Default contribution factors (DCFs) to be calculated where necessary data is unavailable. - Data for all participants published at the start of the next trading day. - FPP included in settlements. - No direct impact on dispatch process, however CFs may inform participant Regulation FCAS offers. - No additional metering requirements.
Cost recovery market participants without units to be individually assessed for FPP	Moderate	<ul style="list-style-type: none"> - Reporting of settlement data requires changes to existing participant interfaces. - Overall cost of FCAS to be recovered from participants expected to increase.
Other participant categories (e.g. NSPs, meter providers)	Minimal	<ul style="list-style-type: none"> - No direct impact.

Non-Financial Operation (NFO) – Purpose and opportunity

- An extended period of NFO of the new FPP system is intended to allow facility operators to familiarise themselves with its operation and see what FPP outcomes would result from actual performance, prior to the commencement of financial flows under the scheme.
- NFO is further intended to allow participants the opportunity to consider how they might respond to the price signals being produced by FPP, before the new rules take effect. Especially where facilities might face poorer financial outcomes under the scheme, this information will provide an opportunity for responses to these price signals to be explored before actual financial penalties take effect.

NFO – What will and won't occur

- NFO is not to be confused with industry or AEMO testing. During NFO, the FPP calculation engine will be in production. The FPP engine will use actual expected participant dispatch levels and actual performance to produce and report FPP outcomes. However, money will not be settled based on these calculations.
- Regulation FCAS will also continue to be recovered under the current Causer Pays arrangements.

Available resources

Type	Details
Technical documents	Participant data model Frequency Contribution Factor Tuning Parameters and Input Sources Frequency Contribution Factors Procedure
Readiness documents	Readiness and go-live criteria: Non-financial operation Industry test strategy Non-financial operation Go Live plan draft
Slide packs	FPP overview webinar FPP Industry impacts and timings workshop FCFP – Stakeholder technical workshop (reporting) FCFP development technical workshop FCFP Consultation (includes financial analysis)
Video explainers	Six video explainers on different aspects of the FPP system are published on the FPP project page on AEMO's website .
General info	AEMO FPP FAQs Overview of the FPP reform FPP calculations and participant outcomes

All resources are available from the FPP project page on AEMO's website: <https://aemo.com.au/initiatives/major-programs/nem-reform-program/nem-reform-program-initiatives/frequency-performance-payments-project>



Overview of FPP Operation

Yousef Rashid
System Commercial Team
Operations Division



Causer Pays vs FPP

Causer Pays	FPP
28 Day Factor	5 Minute Factor
Penalties Only	Penalties and Incentives
FCAS Cost Recovery	FCAS Cost Recovery
Allocated against a portfolio	Allocated to each unit
Aggregate dispatch conformance	Aggregate dispatch conformance

Key FPP Equations

$$TA = CF * \frac{P_{regulation}}{12} * RCR$$

FPP Zero Sum trading amount
New Process

$$TA = TSFCAS * U * NCF$$

$$TA = TSFCAS * (1 - U) * DCF$$

Regulation FCAS cost recovery
Similar to current Causer Pays method

Where:

CF - Contribution Factor.

P_{regulation} - marginal cost of the Regulation FCAS Requirement.

RCR - Requirement for Corrective Response

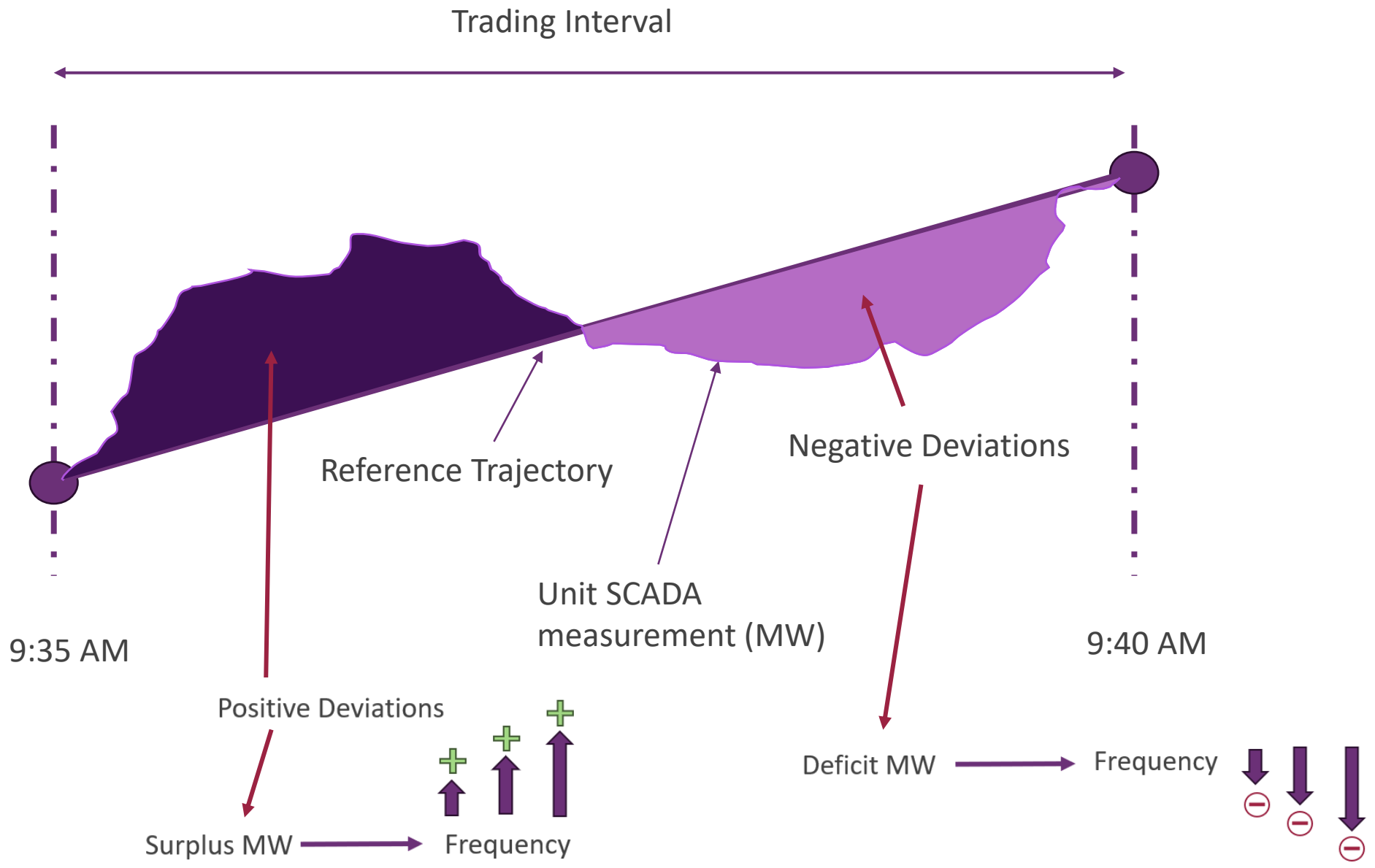
Where:

TSFCAS – the total cost of the Regulation FCAS requirement.

U – Usage.

NCF – Negative Contribution Factor.

DCF – Default Contribution Factor.



Translating the graph before into a table:

4 second intervals

Reference Trajectory

SCADA measurement

Unit Deviation

Timestamp	Ref_t (MW)	Gen_t (MW)	Dev_t (MW)
21:40:00	200	204	4
21:40:04	205	209	4
21:40:08	210	212	2
21:40:12	215	208	-7
21:40:16	220	219	-1

$$Dev_t = Gen_t - Ref_t$$

Are all deviations bad?

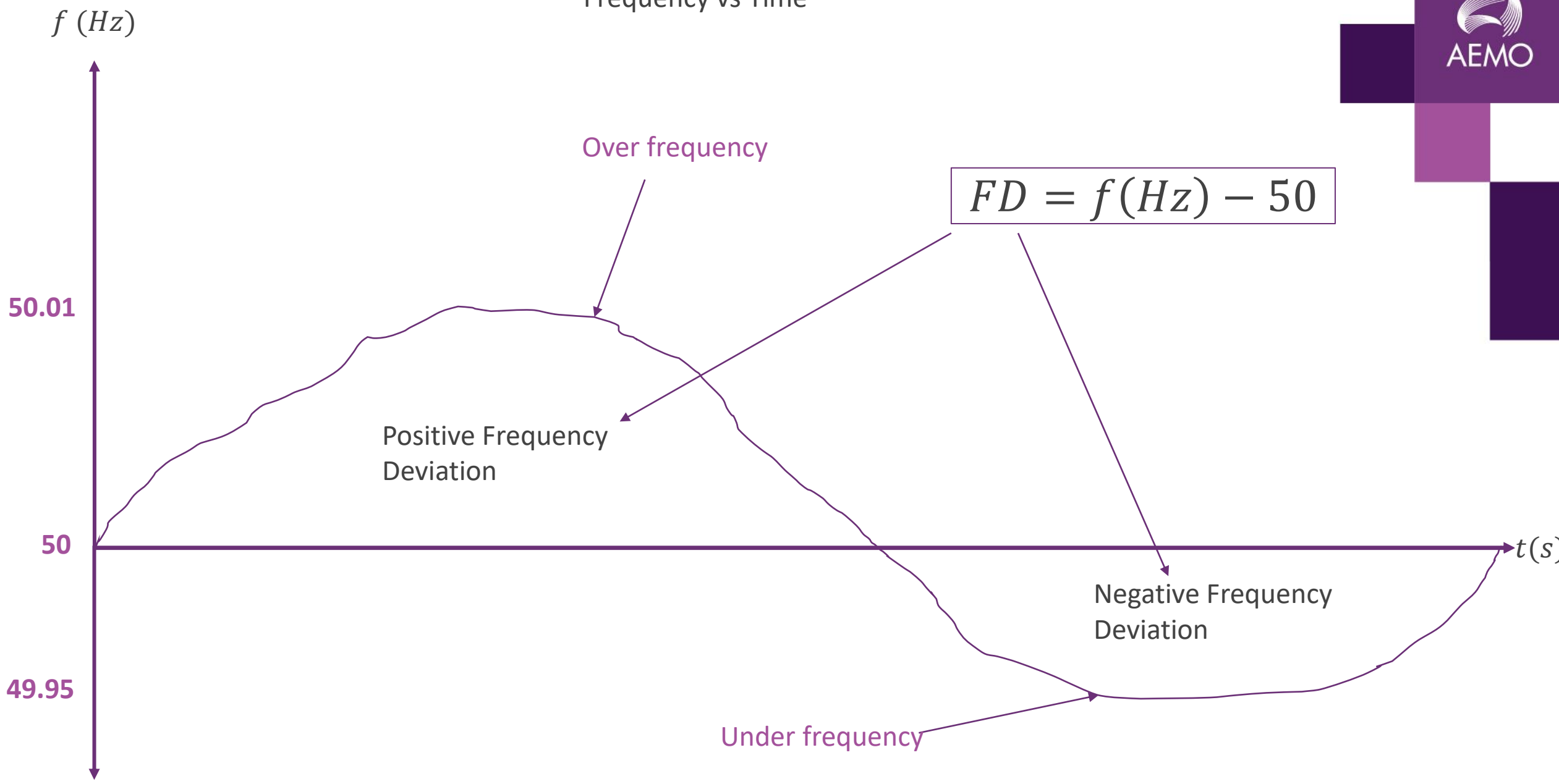
Answered by understanding **Frequency Measure**

Frequency Measure

- Metric to determine if the frequency of the power system needs to be raised or lowered
- Determines whether a Unit's deviation was **helpful** or **non helpful**

Q: How is Frequency Measure calculated?

Frequency vs Time



4 Second
Intervals

Power System
Frequency

Frequency
Deviation

Timestamp	$f(\text{Hz})$	FD_t
21:40:00	49.999	-0.001
21:40:04	49.987	-0.013
21:40:08	50.016	0.016
21:40:12	50.033	0.033
21:40:16	50.022	0.022

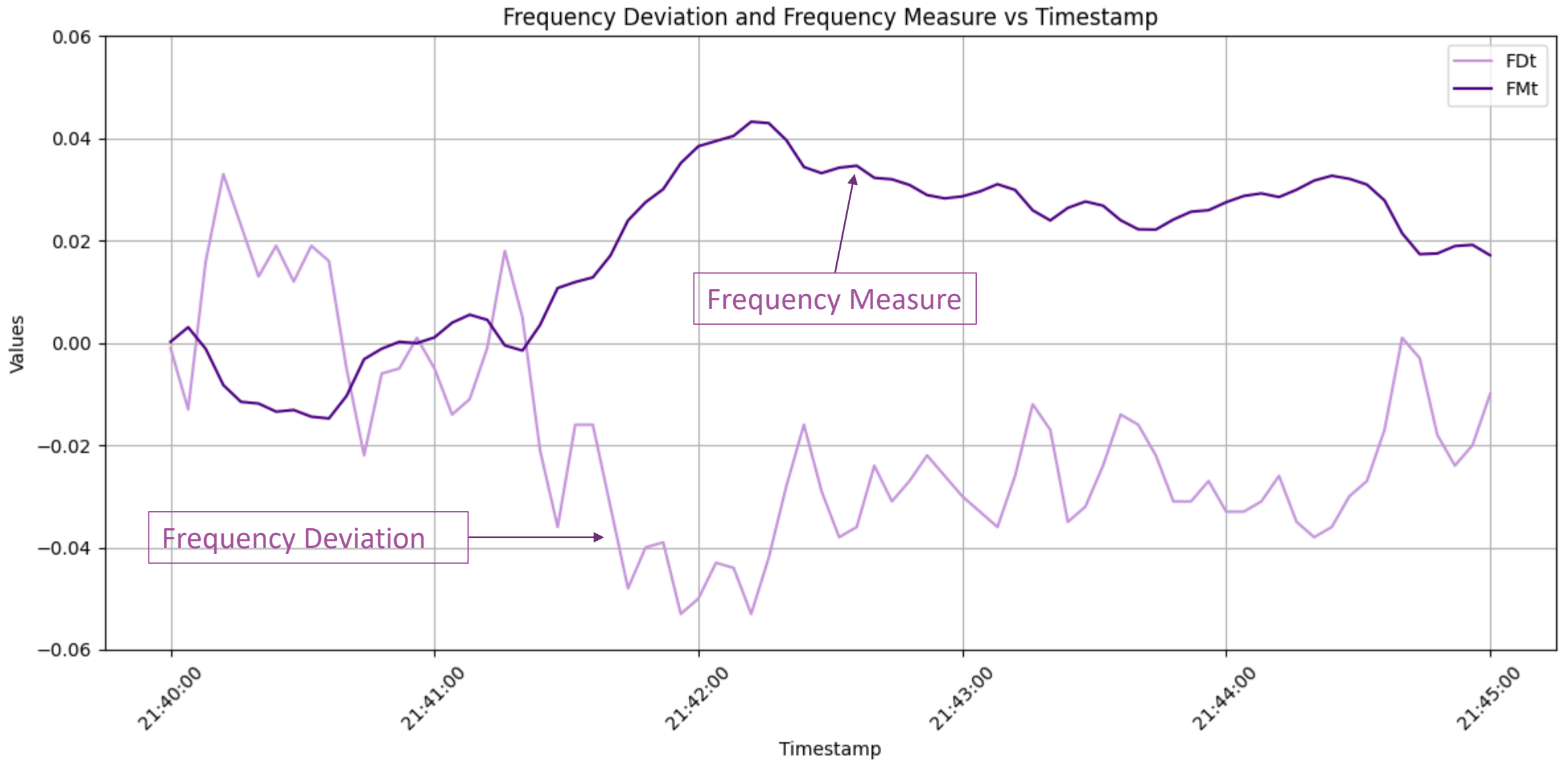
$$FM_t = (1 - \alpha)FM_{t-1} + \alpha(-FD_t)$$

Exponential weighted
moving average

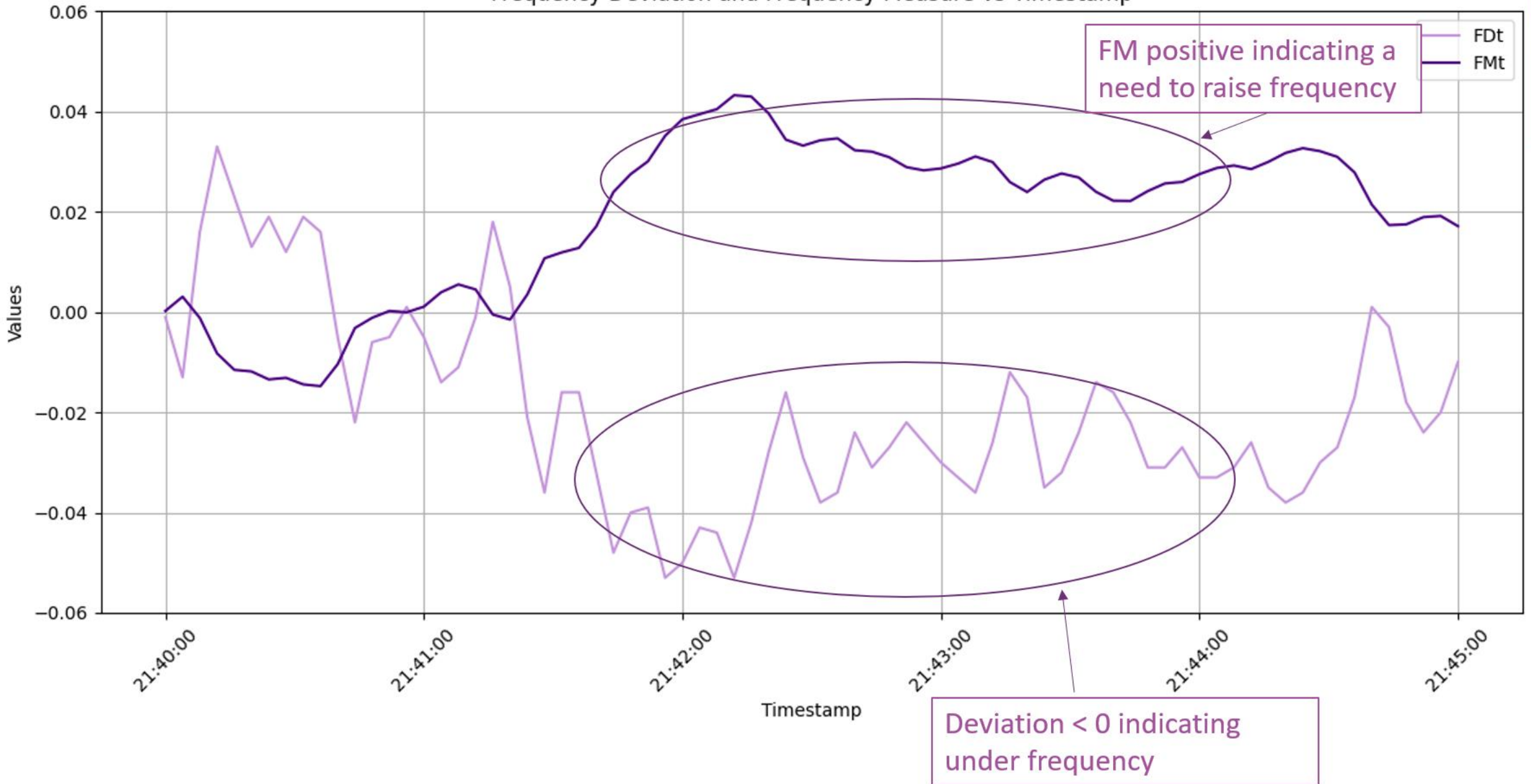
$FM_t > 0$ —————> Indicates a need to RAISE frequency

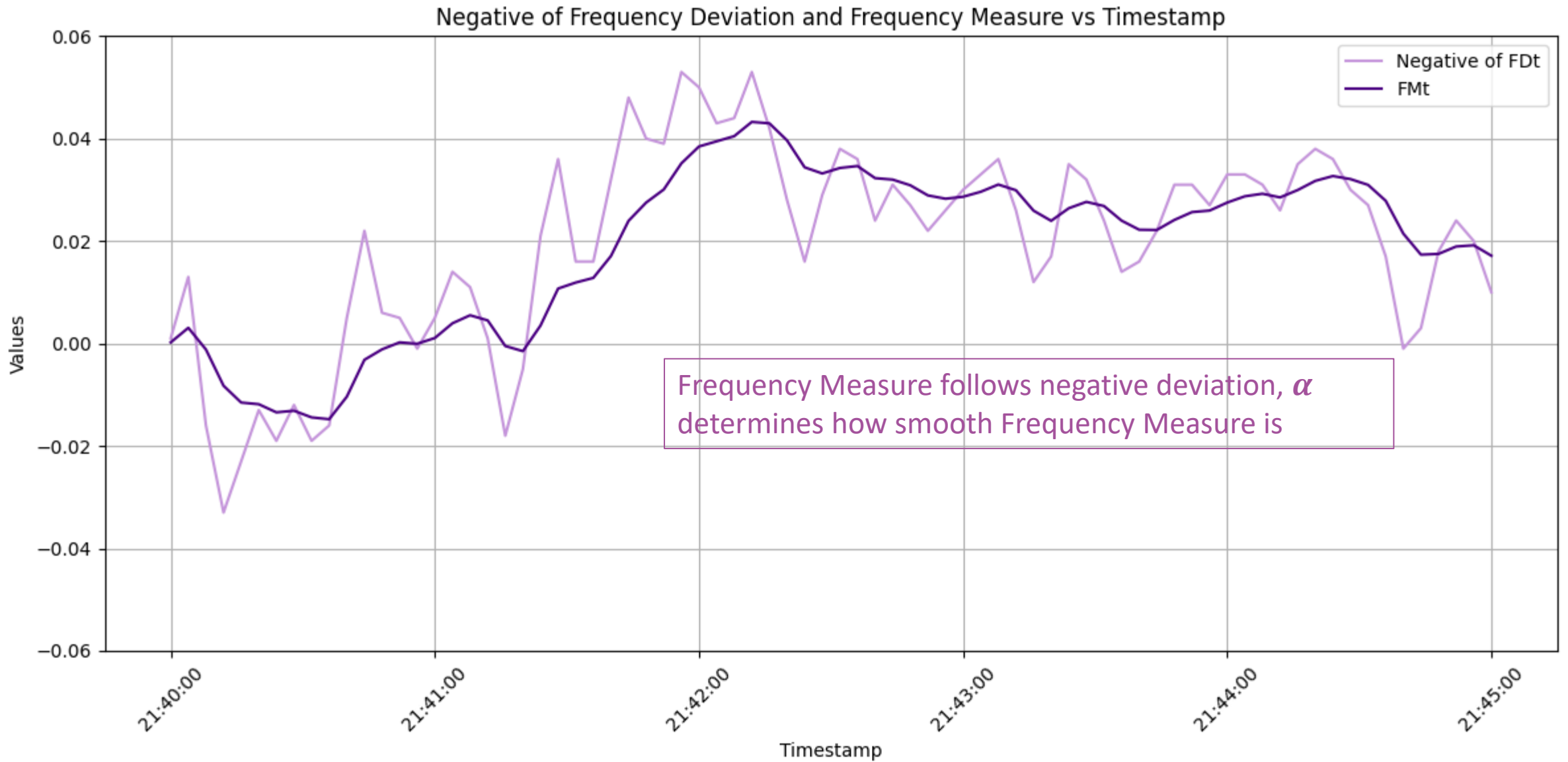
$FM_t < 0$ —————> Indicates a need to LOWER frequency

Note: α is a smoothing constant which helps smooth frequency measure



Frequency Deviation and Frequency Measure vs Timestamp





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

Previous Question:

Are all deviations bad?

- Covered Unit Deviation
- Covered Frequency Measure

Performance of a unit means **how well** the deviations of that unit brought back the frequency to nominal

Performance of a unit is determined by looking at the unit's deviation and comparing it to Frequency Measure.

Timestamp	FM_t	$Dev_t(MW)$
21:40:00	0.000222	4
21:40:04	0.003062	4
21:40:08	-0.001174	2
21:40:12	-0.008247	-7
21:40:16	-0.011525	-1

Intervals with positive FM_t corresponds to RAISE performance

Intervals with negative FM_t corresponds to LOWER performance

Timestamp	FM_t	$Dev_t(MW)$	RAISE Performance	LOWER Performance
21:40:00	0.000222	4	0.000888	0
21:40:04	0.003062	4	0.012248	0
21:40:08	-0.001174	2	0	-0.002348
21:40:12	-0.008247	-7	0	0.057729
21:40:16	-0.011525	-1	0	0.011525

Performance > 0 → Helpful performance

Performance < 0 → Unhelpful performance

Performance is calculated as a sum in a 5 min trading interval

Contribution Factors

- Determines how much a unit contributed to frequency control
- Primary factor to determine cost allocation
- **CF > 0** – indicates an overall **helpful** performance in frequency control – **incentives**
- **CF < 0** – indicates an overall **unhelpful** performance in frequency control – **penalties**

$$CF = \frac{\textit{Unit Performance}}{\textit{Total Performance of all units}^*}$$

Note: Total performance based on raise or lower requirement*

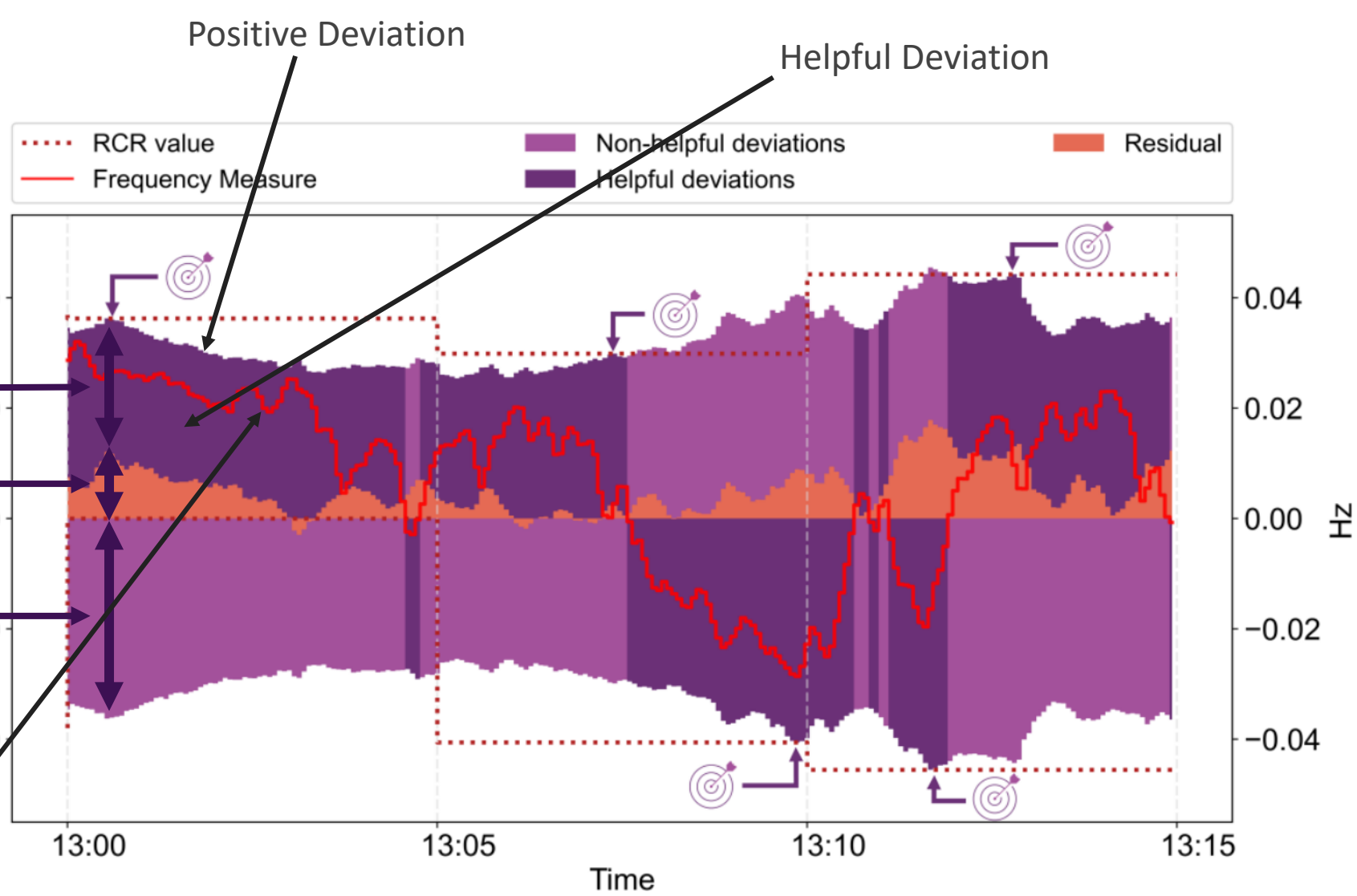
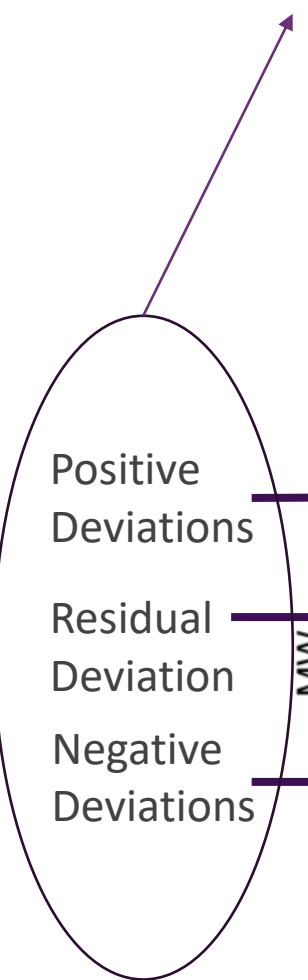
The Residual

- The Residual refers to all facilities connected to the grid **without appropriate metering**.
- Residual Deviation and Performance are calculated on a regional basis.
- AEMO aggregates the Deviations of all units with appropriate metering and the interconnectors within the region, then takes the opposite of that sum to determine the Deviation of the Residual.
- The Residual Performance is calculated on a regional basis which is then aggregated to determine the Residual CF
- The FPP and Regulation FCAS recovery trading amounts are determined based on their total adjusted gross energy amounts.

Requirement for Corrective Response (RCR)

- Maximum/minimum value of the helpful deviations in a 5 minute trading interval
- MW value

Zero Sum system \longrightarrow Positive Deviations + Residual Deviations + Negative Deviations = 0



FPP trading amounts

The FPP trading amount for units with appropriate real-time telemetry will be determined as:

$$TA = CF \times \frac{P_{regulation}}{12} \times RCR$$

Where:

- *CF* - Contribution Factor.
- *P_{regulation}* - marginal cost of the Regulation FCAS Requirement*.
- *RCR* - Requirement for Corrective Response

*Under a normal market scenario

Allocating Regulation FCAS costs

The trading amounts will be allocated based on the amount of enabled Regulation FCAS that was used and unused within a trading interval, as follows:

$$TA_{used} = TSFCAS \times U \times NCF$$

$$TA_{unused} = TSFCAS \times (1 - U) \times DCF$$

Where:

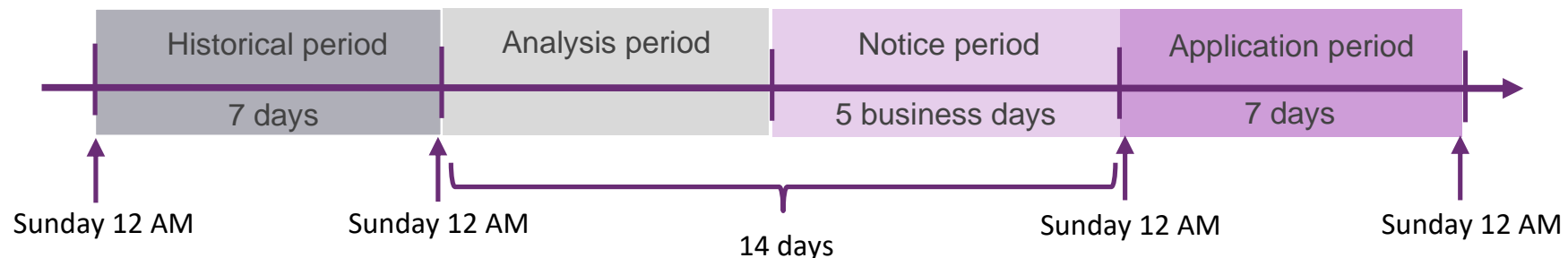
- *TSFCAS* – the total cost of the Regulation FCAS requirement.
- *U* – Usage.
- *NCF* – Negative Contribution Factor.
- *DCF* – Default Contribution Factor.

Usage

- Usage reflects the proportion of enabled Regulation FCAS that was used within a trading interval.
- Usage is used to divide Regulation FCAS costs into Used and Unused costs.
- In each trading interval, Usage is calculated for each Regulation FCAS Requirement.

Default Contribution Factor (DCF)

- Default Contribution Factors are determined based on the Historical Performance of units.
- AEMO calculates **Raise and Lower Historical Performances** for each unit, every week, based on the unit's Performance values over a 7-day historical period.



Improving FPP outcomes

Operators can improve the alignment of a unit's behaviour with its Reference Trajectory through:



- Capital investments in technologies that can follow the plant's set points more closely and/or provide PFR.



- Increasing their headroom to compensate for the inherent limitations on forecasting VRE output.



- Improving the accuracy of their self-forecasts.

Public FPP Data

As part of Electricity Data Model v5.4

- FPP Data will be available to participants in the form of the Data Model v5.4

Cost Estimation – FPP_EST_CST

This report delivers the estimated cost for each FPP unit for each constraint for each 5 minute trading interval*

FPP	NUMBER(18,8)	NO	FPP in AUD (the financial estimate of frequency performance payment calculated for the constraint / bid type / unit). This value can be either positive (credit) or negative (debit). For details on the calculation, please see FPP procedure and supporting documentation.
USED_FCAS	NUMBER(18,8)	NO	Used recovery FCAS in AUD (the financial estimate of the recovery of used FCAS calculated for the constraint / bid type / unit). This value will be either 0 (nil), or a negative value (debit) only. For details on the calculation, please see FPP procedure and supporting documentation.
UNUSED_FCAS	NUMBER(18,8)	NO	Unused recovery FCAS in AUD (the financial estimate of the recovery of unused FCAS calculated for the constraint / bid type / unit). This value will be either 0 (nil), or a negative value (debit) only. For details on the calculation, please see FPP procedure and supporting documentation.

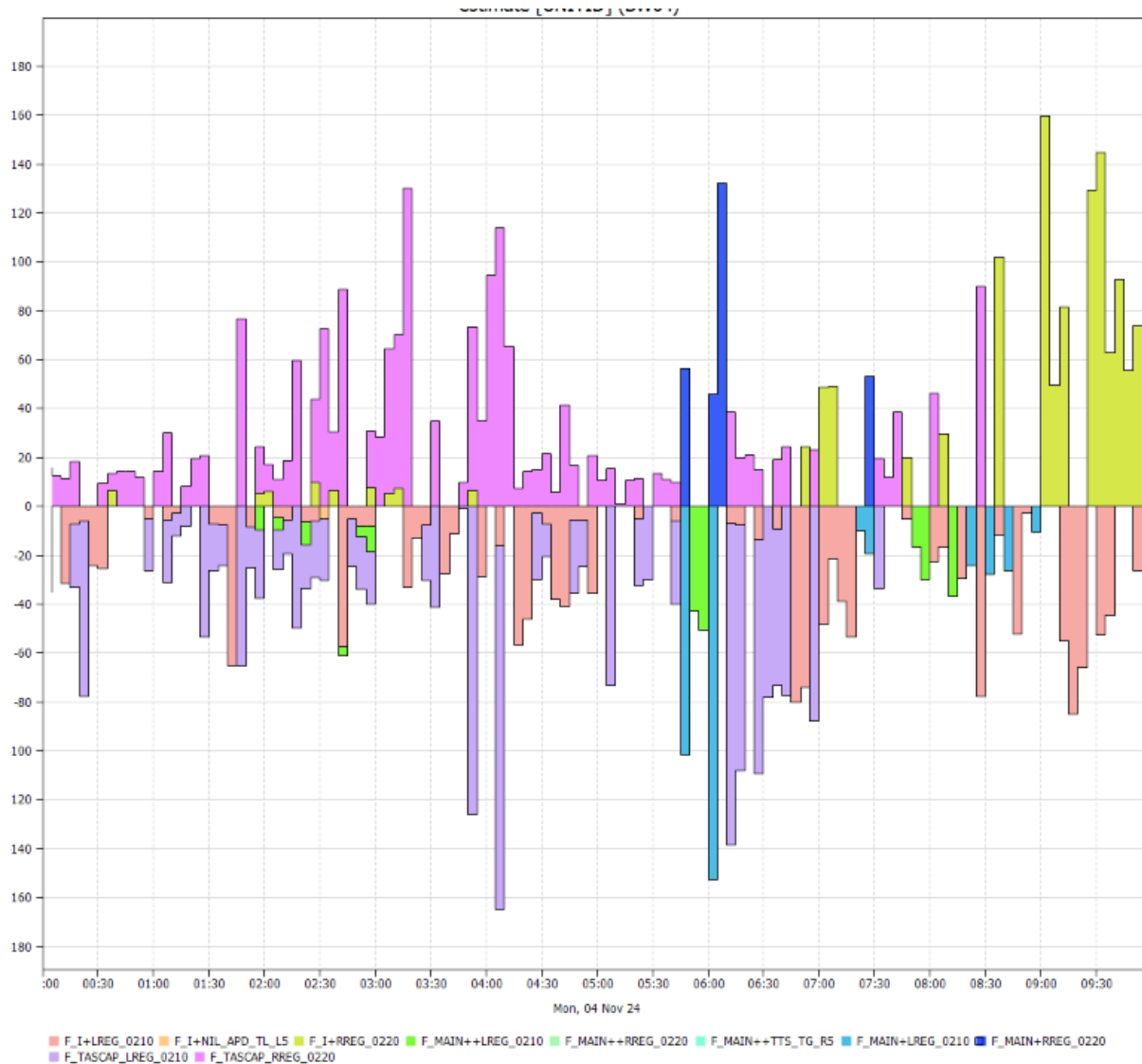
**Only the relevant participant will receive their information as this information is confidential*

Key Dates

- Non financial Operation – 9th December 2024
 1. Opportunity for AEMO to review FPP and to adjust any tuning parameters
 2. Opportunity for industry to familiarise and adjust to FPP

- Financial Go Live – 8th June 2025

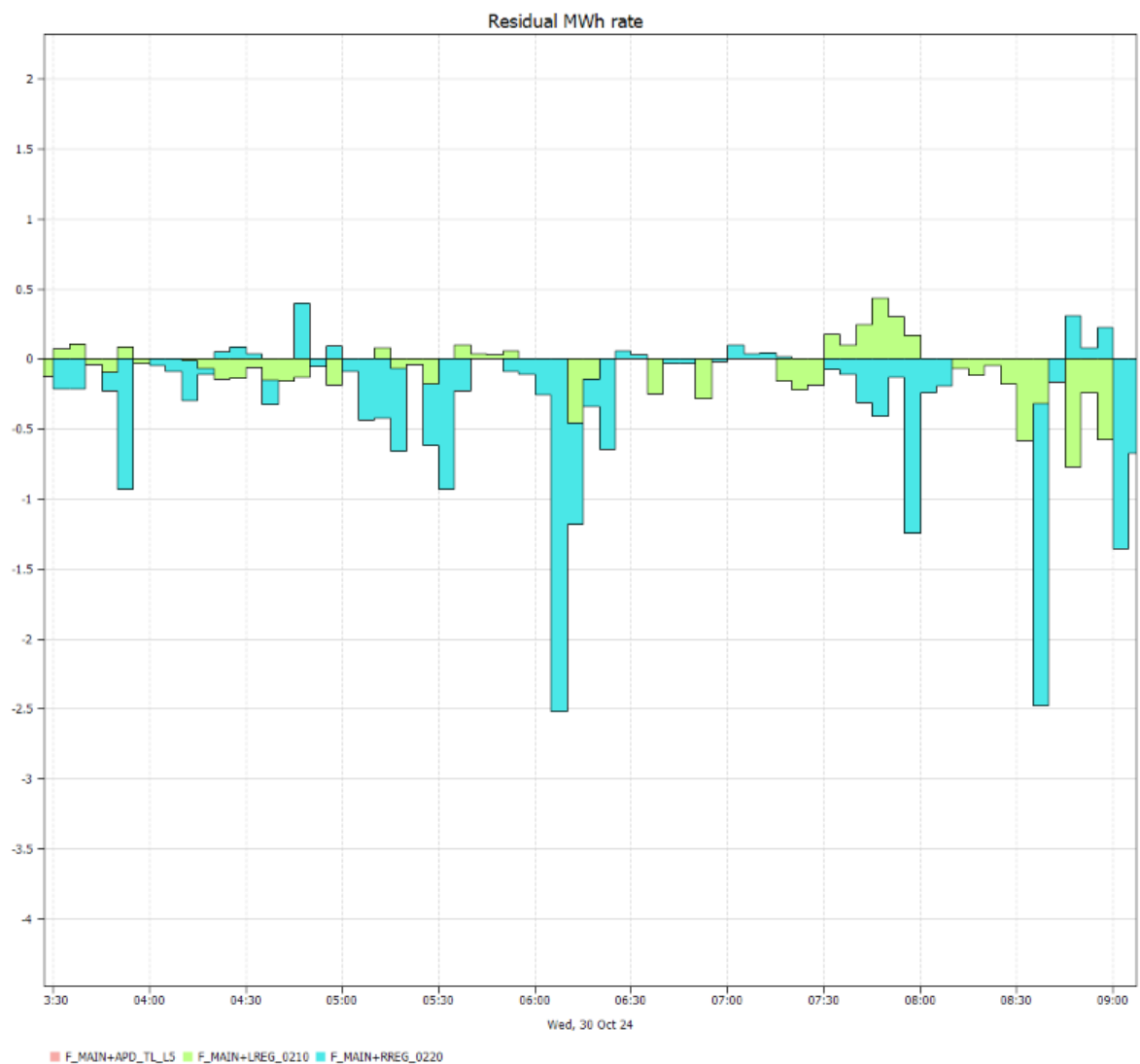
FPP pre-production data



FPP_EST_COST

Note that performance and financial outcomes should not be taken as indicative, as pre-prod utilises test data that does not reflect real-time bidding.

FPP pre-production outcomes



FPP_EST_RESIDUAL_COST_RATE

Note that performance and financial outcomes should not be taken as indicative, as pre-prod utilises test data that does not reflect real-time bidding.

Industry readiness

Karen Wilbrink



Overview of readiness approach

Readiness Approach and go-live criteria – [published 29 Feb 2024](#)

- For FPP-NFO go-live – AEMO solution, business and IT operations needs to be ready. Participant readiness activity not a prerequisite for go-live.
- 6-month period of non-financial operations prior to rule commencement 8 June 2025 - participants can view the implementation of FPP reports as part of own readiness planning at any stage during this period.

How is AEMO supporting participant development?

Data Model

- Data Model v5.4 Technical Specification – updates for FPP reporting - available 15 Apr 2024, monthly updates as required.
- Current version - [Tech Spec Portal](#)
- Data Model v5.4 released to Preprod 9 Oct 2024 and Prod 6 Nov 2024.
- Market Systems User Group (MSUG) sessions for additional support. [Sign up details](#)

Overview of readiness approach

How is AEMO supporting participant development continued?

Industry Testing

- Preprod environment currently available for industry testing until 22 November. Data is successfully populating 'same day', 'next day' and weekly reports.
- Industry [Test Strategy](#) and [Test plan](#) available.
- ITWG Q&A sessions are available for additional support with the 5.4 data model upgrade, review progress on data population and discussion of any defects and explanations of the new tables and data attributes
 - Q&A sessions are scheduled twice weekly from 22 October to 21 November 2024
 - ITWG Members have been sent invitations to the Q&As. Other participants can sign up to these sessions [here](#).
- Next ITWG Forum scheduled Thurs 28 November – both NFO and FO will be discussed.

Transition and Go-live Planning

- No obligated re-registration, accreditation or transitional requirements for existing participants.
- Go-live planning in consultation with participants – [draft available](#), feedback required by 15 Nov, final 18 Nov 2024.

Progress Reporting

- Progress on confirmed readiness milestones is being shared with participants at monthly Implementation Forums. [Sign up](#)
- Go-Live checkpoint held 10 Oct with results shared October Implementation Forum – overall status remains GREEN, with AEMO Solution and business on track for go-live (noting 4 non-mandatory reports will be available after go-live, date TBD).

Questions



What's next

Q&A from all three NFO sessions to be published in FPP FAQ document at [AEMO's website](#).

Join relevant [NEM Reform Program forums](#) to stay informed.

FPP Industry readiness [survey](#)

We are seeking to understand the interest from industry in partaking in the NFO period, in addition to the extent to which industry participants feel informed, ready and prepared to adopt these changes, prior to full rule commencement on 8 June 2025.

Participants are encouraged to provide feedback to help shape readiness support and contribute to a successful Frequency Performance Payments reform implementation.

Outcomes from this survey may be discussed publicly through NEM Reform forums, and only in aggregate so that individual inputs can't be identified. One response per organisation is preferred.

Access survey [here](#). The link will be sent via email to participants on 8 November, closing 29 November 2024.

For more information, contact the project directly at

NEMReform@aemo.com.au