

# Frequency Performance Payments (FPP) Stakeholder webinar



23 February 2024

**Please note that this event will be recorded.  
The recording will be published on AEMO's  
website.**



We acknowledge the Traditional Owners of country throughout Australia and recognise their continuing connection to land, waters and culture.

**We pay respect to their Elders past and present.**

# Agenda

#	Time (AEDT)	Topic	Presenter(s)
1	10:30am – 10:35am	<b>Arrival, welcome and introductions</b>	Oliver Derum
2	10:35am – 10:40am	<b>Introduction from AEMO business owner – Purpose of the webinar</b>	Chris Muffett
3	10:40am – 11:20am (including question time)	<b>Overview of the FPP reform</b> <ul style="list-style-type: none"><li>- AEMC rule change<ul style="list-style-type: none"><li>- Stated purpose (how the new framework promotes the long-term interest of consumers)</li><li>- Key elements: FPPs and Reg FCAS changes</li></ul></li><li>- Frequency Contribution Factors Procedure (FPP process, inc. measurements and calculations).</li><li>- Participant impacts and how outcomes can be improved</li></ul>	Heidi Cummings (presenter), Sahand Karimi Arpanahi (to help answer questions)
4	11:20am – 11:50am (including question time)	<b>The reform implementation process</b> <ul style="list-style-type: none"><li>- Timeline and key milestones</li><li>- Progress to date</li><li>- Remaining stages</li><li>- Non-financial operation – purpose and timing</li><li>- Staying engaged (Regular forums, mailing lists, next ad-hoc FPP forum)</li></ul>	Oliver Derum
5	11:50am – 12.00pm	<b>Additional question time</b>	All
	12:00pm	<b>Close</b>	



# Introduction from AEMO reform owner

Chris Muffett

# Overview of the FPP reform

Heidi Cummings

# Background

- Stable frequency is an important part of maintaining a secure power system.
- Continuous smaller adjustments to frequency are made through:
  - Primary Frequency Response – **PFR**
  - Secondary Frequency Response – **Regulation FCAS**
- Larger frequency response is provided in response to power system events, through **Contingency FCAS**.

## Development of Frequency control in the NEM

1998

2001

2010s

2018

2019

2020

2022

- PFR mandatory for most of the large synchronous generators

- FCAS markets created
- Causer Pays framework created
- PFR no longer mandatory

- Gradual decline in frequency performance as facilities no longer prioritised PFR

- Frequency control framework review
- Queensland and South Australia system separation

- Rule change proposal: removal of disincentives for PFR (AEMO)
- Rule change proposal: Mandatory PFR (AEMO)
- Rule change proposal: NER amendments (Dr. Sokolowski)

- Rule change: Mandatory PFR

- Rule change: PFR Incentives

# What are the goals the FPP reform?

## 1. New double-sided frequency performance payments process



- Incentivise the provision of PFR
- Reward participants that have a helpful frequency performance
- Penalise participants that have an unhelpful frequency performance

## 2. New process for allocation of Regulation FCAS costs

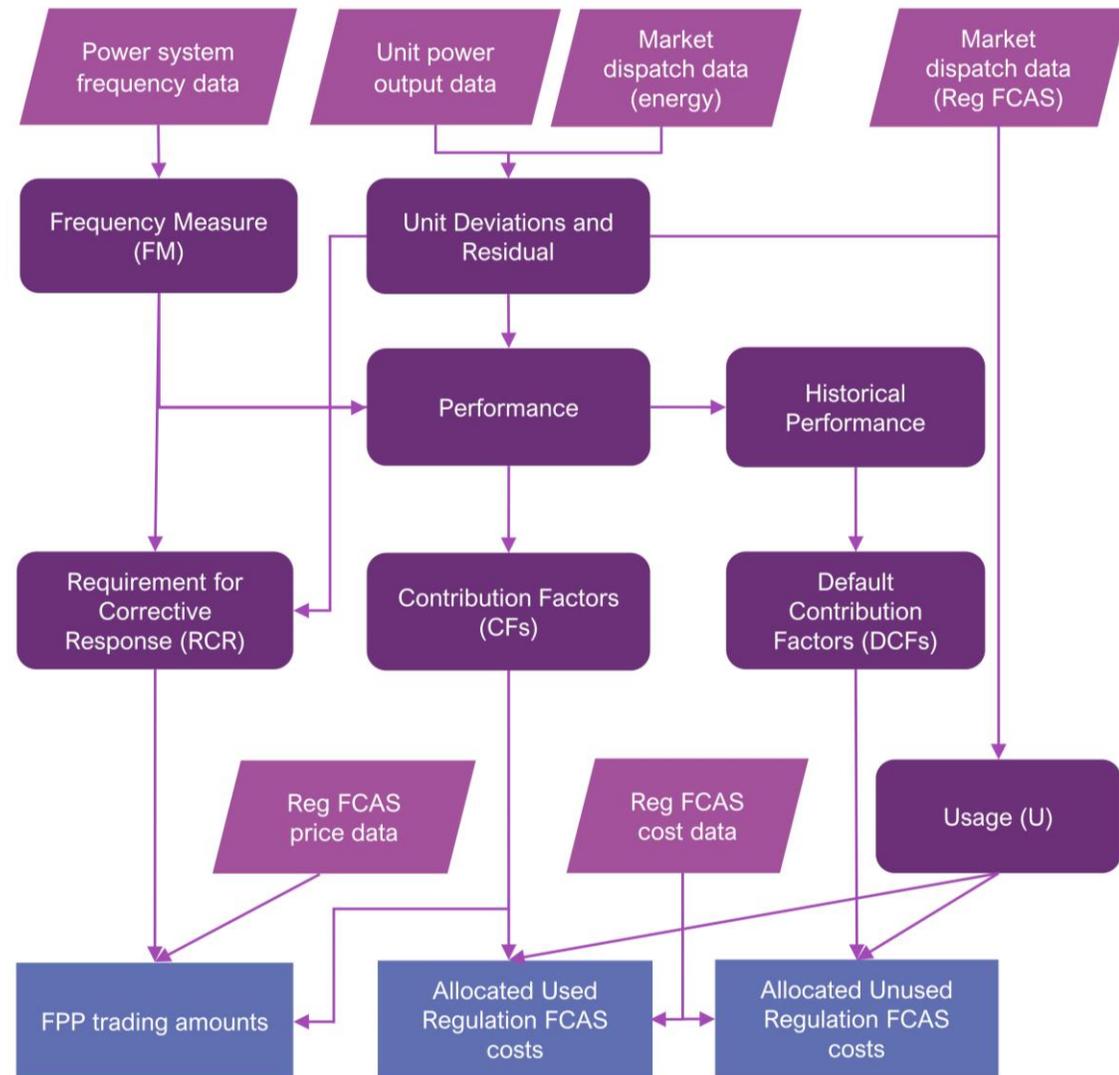


- Replace Causer Pays
- Recover cost from units that have a negative impact on system frequency

# 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.

The whole process is completed once every five-minute trading interval.



# How do we quantify the need for frequency response?

**Frequency measure (FM)** is the metric that reflects the need to raise or lower power system frequency towards 50 Hz.

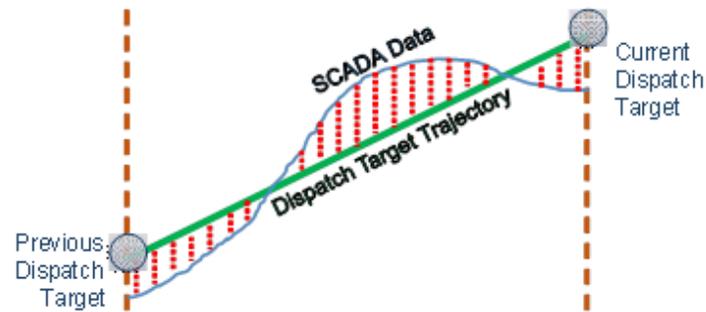
- $FM > 0 \rightarrow$  frequency should be increased.
- $FM < 0 \rightarrow$  frequency should be decreased.

For every region, an FM value is calculated at each 4-second interval, using the frequency deviations within that region.

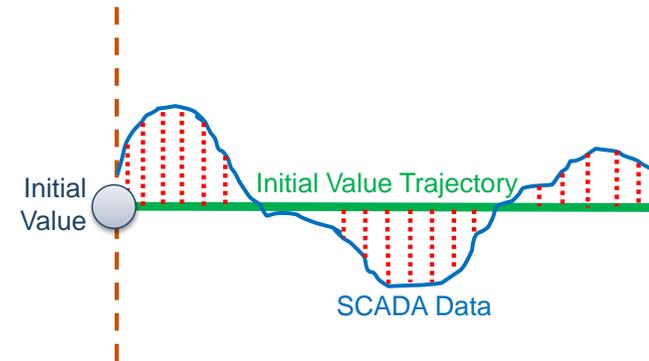
# What is a Reference Trajectory?

A unit's Reference Trajectory shows its expected active power output or consumption.

Ref trajectory of Scheduled and Semi-Scheduled units:



Ref trajectory of Non-Scheduled units:

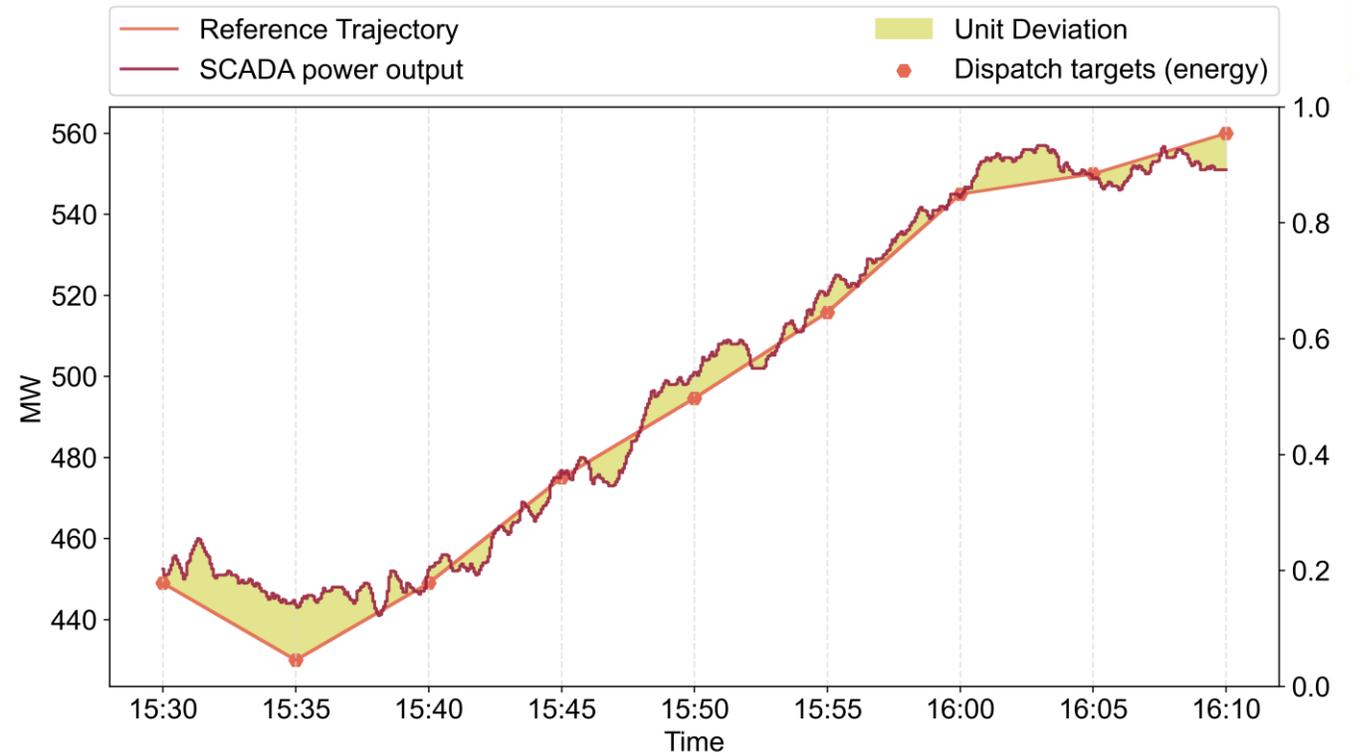


**Dispatch Target** - The active power outcome specified in a dispatch instruction for a scheduled generating unit, semi-scheduled generating unit, scheduled load or scheduled network service, which represents the level to be achieved at the end of the relevant trading interval. For semi-scheduled generating units, this is the same as the dispatch level. For a wholesale demand response unit, this is the active power reduction specified in a dispatch instruction, which represents the level of baseline deviation to be achieved at the end of the relevant trading interval.

# Unit Deviation

AEMO calculates 4-second unit deviations (in MW) by comparing SCADA measurements against its Reference Trajectory.

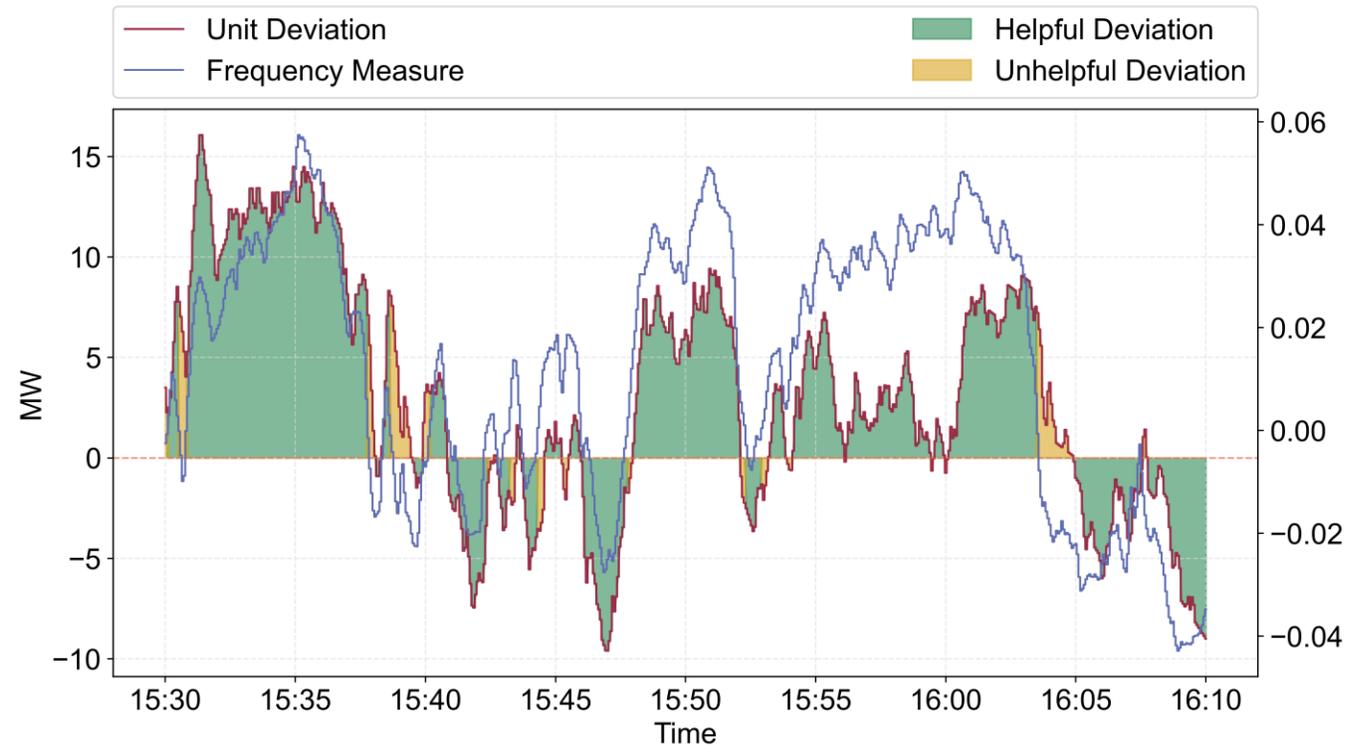
- A positive deviation increases the net amount of energy in the system (more generation or less load)
- A negative deviation decreases the net amount of energy in the system (less generation or more load)



# Performance

- Performance quantifies the degree to which a unit contributes to the frequency control.
- For each unit, AEMO calculates a **Raise and Lower Performances at each trading interval.**
- Performance is calculated based on the FM and unit output Deviation from its Reference Trajectory.

- Helpful performance: a unit deviation that shares the same sign as the FM
- Unhelpful performance: a unit deviation that has the opposite sign to the FM



# Contribution Factors (CFs)

A contribution factor reflects the extent to which the unit contributed to the helpful or unhelpful control of system frequency control.

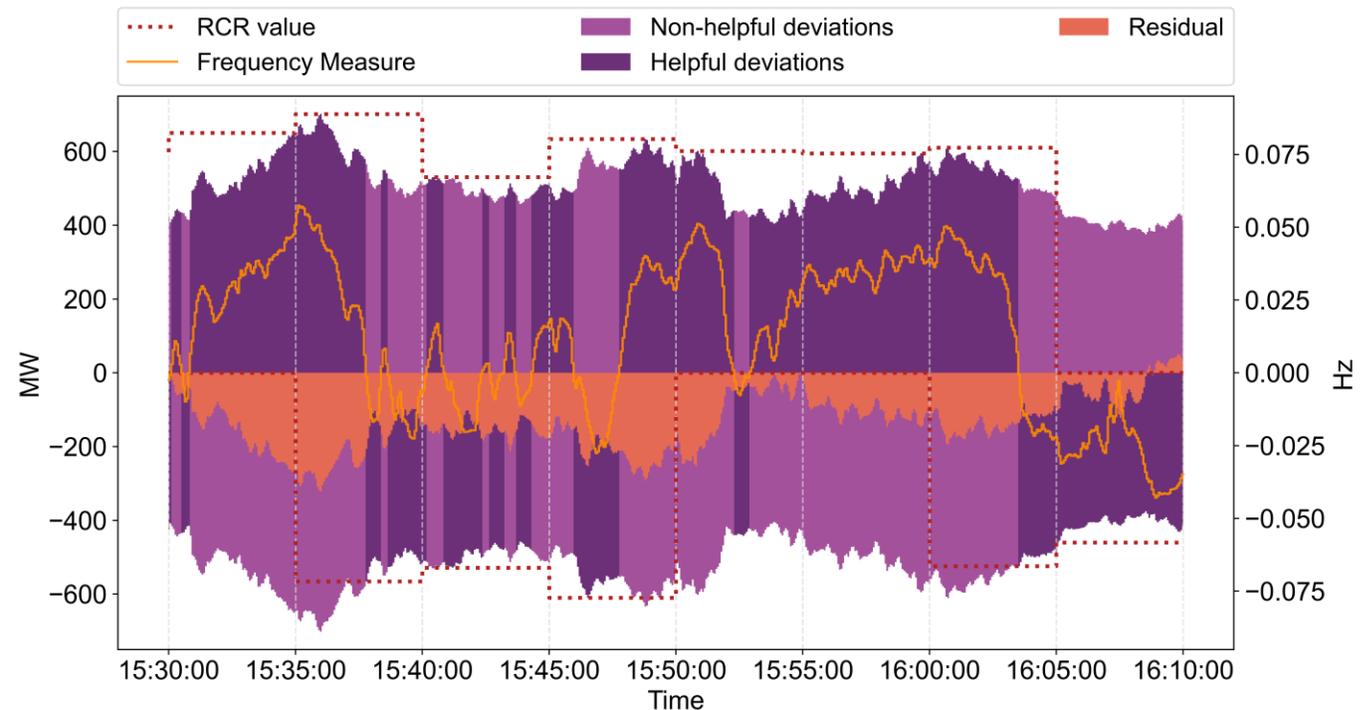
- A CF is between -1 and 1, where:
  - $CF < 0$  – unhelpful frequency performance; used to determine penalties.
  - $CF > 0$  – helpful performance in frequency control; used to determine incentives.
- In **every trading interval**, AEMO calculates a CF for a unit in relation to **each Regulation FCAS Requirement** that is related to the unit as follows:

$$CF = \frac{\text{Unit's Performance}}{\text{Total Performance of all units in the requirement that have the same sign}}$$

# Requirement for Corrective Response (RCR)

The RCR represents the peak volume of helpful response provided by all units in a given trading interval.

- The RCR corresponds to the maximum of the sum of all helpful deviations (including both units and Residual) during that interval.
- An RCR is determined with respect to each Regulation FCAS Requirement.



# 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:

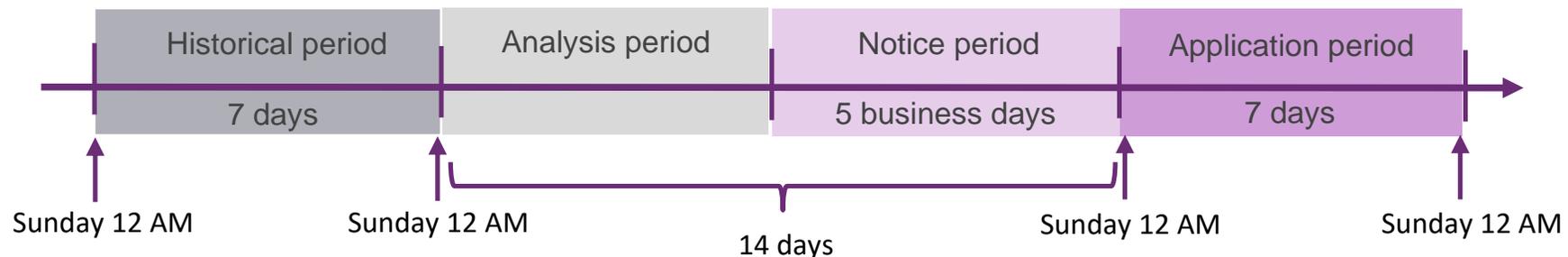
- *CF* - Contribution Factor.
- *P<sub>regulation</sub>* - marginal cost of the Regulation FCAS Requirement.
- *RCR* - Requirement for Corrective Response

# 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.



# 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.

# What is 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.

# Changes and impacts

FPP will see Contribution Factors calculated for every trading interval, with resulting revenue flows. The are two key changes.

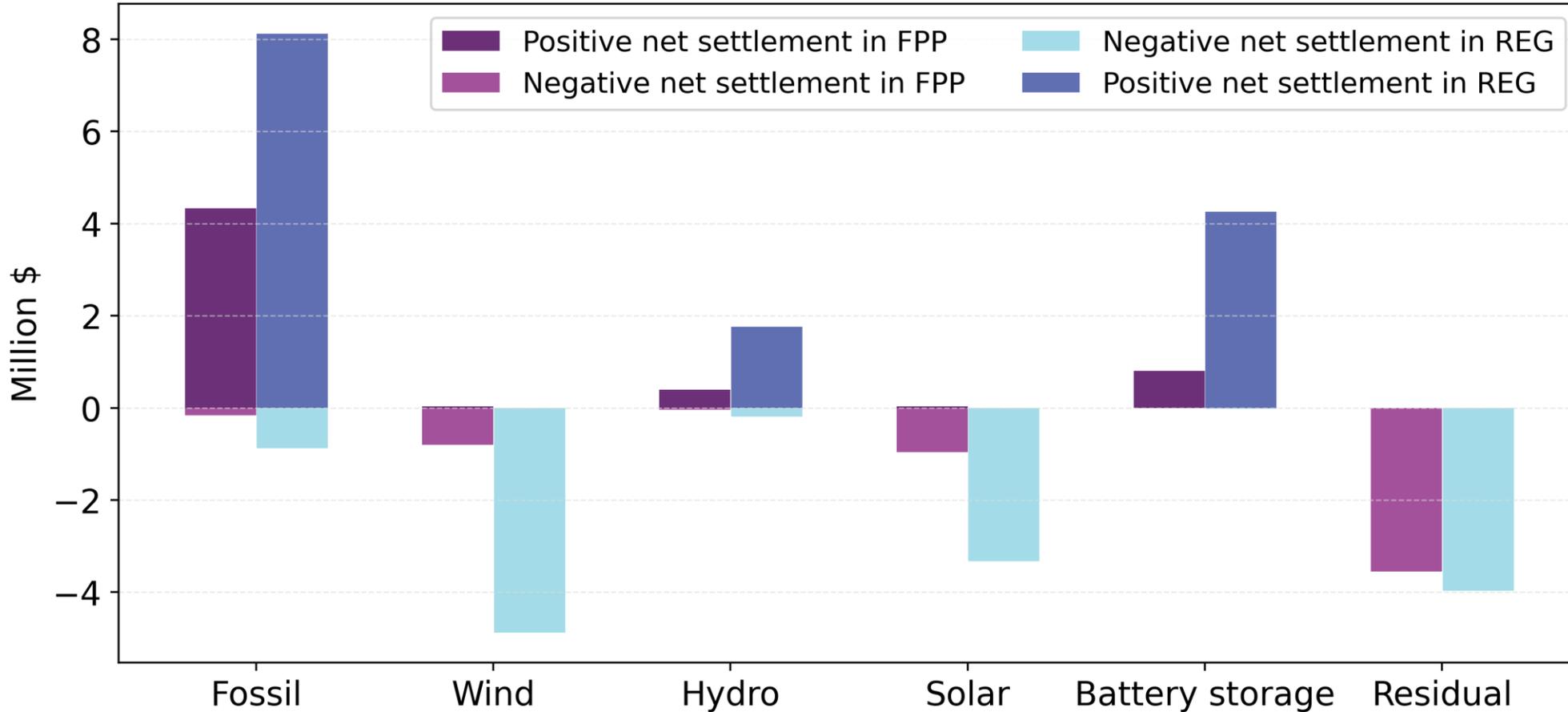
Reporting of new data for all eligible generating units, via NEM Reports/AEMO data interchange

Settlement of frequency performance payments

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

# Net settlements in FPP and REG aggregated by type



\*Values based on total revenues across each sector, not normalised.

Period 20 Jul to 10 Oct 21

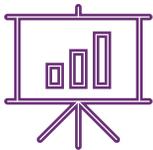
More analysis about the potential financial impact of the FPP reform is provided in slides 10-26 of [this presentation from 15 February 2023](#).

# 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.

# Questions



# The reform implementation process

Oliver Derum





# Key milestones in 2023

Date	Milestone
4 May	<a href="#">Primary Frequency Response Requirements Procedure</a> published, containing updates stemming from the Mandatory Primary Frequency Response rule change.
1 June	<a href="#">Frequency Contribution Factors Procedure</a> published, including the associated Tuning Parameters and Input Sources document. These outline how the FPP arrangements will operate.
30 June	<a href="#">Participant impact assessment</a> published, outlining the expected impact of the FPP reforms on different participants, especially those with units that will be individually assessed for FPP, who will experience the greatest impact.
8 December	High-level technical design published (further details provided on following slides).

# Publication of FPP high-level technical design

- Published 8 December 2023.
- Contains:
  - Succinct summary of FPP's background and intended purpose, as well as the how calculations will be done and the remaining stages of the implementation process.
  - Column names, business rules and other information about the 15 reports AEMO will provide to participants, including at the completion of each 5min calculation.
  - Information about what current reports will be altered or discontinued from 8 June 2025.
- Provided to assist participants to understand how their own systems will be impacted and commence the process of scoping, and potentially procuring, necessary changes to their systems, ahead of the release of the FPP Reports tech spec (5.3.1) in April 2024 (at which point the information can be considered final).

# Reports to be provided (as at 16 Feb)

- Curated 4sec SCADA data
- Regional frequency and frequency measure
- Unit performance (5min)
- Unit contribution factor
- Requirement for Corrective Response (RCR)
- Usage (of Reg FCAS)
- FPP unit estimated cost
- Estimated residual cost rate
- Default performance factor
- Pre-dispatch unit estimated cost
- P5min pre-dispatch unit estimated cost
- Pre-dispatch residual estimated cost
- P5min pre-dispatch residual estimated cost
- Summary of FCAS requirement
- FPP calculation run

# Examples of sample reports

Date and time	CONSTRAINTID	BIDTYPE	RCR	Version
20/07/2021 5:10:00	F_I+LREG_0210	LOWERREG	237.7863	1
20/07/2021 5:10:00	F_I+NIL_APD_TL_L5	LOWERREG	237.7863	1
20/07/2021 5:10:00	F_I+NIL_MG_R5	RAISEREG	211.7725	1
20/07/2021 5:10:00	F_I+RREG_0220	RAISEREG	0	1
20/07/2021 5:10:00	F_MAIN++APD_TL_L5	LOWERREG	231.4095	1
20/07/2021 5:10:00	F_T+NIL_WF_TG_R5	RAISEREG	22.2552	1
20/07/2021 5:10:00	F_I+NIL_MG_R5	RAISEREG	200	2

Sample of the RCR report (left)

Date and Time	Region ID	Frequency	Frequency Measure	Version
14/08/2023 00:05:00	TAS1	49.997	-0.01238	1
14/08/2023 00:05:00	QLD1	49.964	0.015442	1
14/08/2023 00:05:00	NSW1	49.964	0.014613	1
14/08/2023 00:05:00	VIC1	49.987	0.006758	1
14/08/2023 00:05:00	SA1	49.993	0.006007	1
14/08/2023 00:05:04	TAS1	49.973	-0.00363	1
14/08/2023 00:05:04	QLD1	49.977	0.017122	1
14/08/2023 00:05:04	NSW1	49.978	0.016255	1
14/08/2023 00:05:04	VIC1	49.963	0.013479	1
14/08/2023 00:05:04	SA1	49.965	0.01245	1

Sample of the Frequency and Frequency Measure report (right)

# Preparations for non-financial operation (NFO)

Date	Activity
9 Dec 2023	High-level technical design published (with expected external reporting data model)
1 Feb 2024	Participant readiness approach published
29 Feb	Participant readiness criteria published
15 Apr	FPP reporting tech spec published (DM 5.3.1)
7 June	Industry test strategy published
3 July	AEMO internal testing commences
2 Sept	Industry test plan published
22 Oct	AEMO internal development and testing complete
25 Oct	Industry testing commences
8 Nov	Readiness check point (for commencement of NFO)
18 Nov	Industry go live plan published
9 Dec	NFO commences

# Preparations for financial operation (FO)

Date	Activity
22 Sep 2024	Settlements reports tech spec published (DM 5.4)
1 Oct	Participant readiness approach published
1 Dec	AEMO internal testing commences
31 Jan 2025	Market Trial Strategy, Market Trial Approach and Readiness Criteria published
14 March	DM 5.4 released in Pre-Production
17 March	Market Trial Start
31 March	AEMO internal testing Complete
4 June	DM 5.4 released in Production
8 June	FPP rule commencement.

# 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	<a href="#">High-level technical data design</a> <a href="#">Frequency Contribution Factor Tuning Parameters and Input Sources</a> <a href="#">Frequency Contribution Factors Procedure</a> <a href="#">AEMO FPP FAQ document</a>
Readiness documents	<a href="#">Draft Industry Readiness Approach</a>
Slide packs	<a href="#">FPP Industry impacts and timings workshop</a> <a href="#">FCFP – Stakeholder technical workshop (reporting)</a> <a href="#">FCFP development technical workshop</a> <a href="#">FCFP Consultation (includes financial analysis)</a>
Video explainers	Eight video explainers on different aspects of the FPP system are published on the <a href="#">FPP project page on AEMO’s website</a> .
Fact sheets	<a href="#">Overview of the FPP reform</a> <a href="#">FPP calculations and participant outcomes</a>

All resources are available from the FPP project page on AEMO’s website: <https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/ancillary-services/frequency-contribution-factors>

# Staying engaged

As part of the NEM Reform Program, AEMO operates a number of stakeholder forums. The implementation of FPP is regularly discussed at the following open monthly forums:

- **Program Consultative Forum** (see: <https://aemo.com.au/consultations/industry-forums-and-workinggroups/list-of-industry-forums-and-working-groups/program-consultative-forum>)
- **Implementation Forum** (see <https://aemo.com.au/consultations/industry-forums-and-working-groups/listof-industry-forums-and-working-groups/implementation-forum>)
- **Electricity Wholesale Consultative Forum** (see <https://aemo.com.au/consultations/industry-forums-andworking-groups/list-of-industry-forums-and-working-groups/electricity-wholesale-consultative-forum>).

All presentations from previous forums are available on each of the above webpages.

To join the invite list for any of the above forums, email [NEMReform@aemo.com.au](mailto:NEMReform@aemo.com.au).

AEMO will hold a further devoted FPP information session in mid 2024.  
AEMO welcomes the opportunity to present directly to stakeholders, either individually or via existing groups/forums.

# Questions



[NEMReform@aemo.com.au](mailto:NEMReform@aemo.com.au)



[AEMO's FPP project page](#)





For more information visit

[aemo.com.au](http://aemo.com.au)