

NEM Reform Program Post Implementation Review

Fast Frequency Response

April 2024





Important notice

Purpose

The purpose of this publication is to not only identify the key learnings and areas for improvement which can be applied across the delivery of future initiatives under the NEM Reform Program, but also consider implementation of the reform against the broader policy or reform objectives, benefits and/or assumptions defined at the time a final rule or policy is made and whether those objectives and benefits have been realised.

This publication has been prepared by AEMO using information available at 18 March 2024.

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Version control

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Executive summary

AEMO's post implementation review acknowledges the collaborative effort, time and resources of AEMO and industry in delivering the various initiatives that comprise the NEM Reform Program ('the Program'). It aims to not only identify the key learnings and areas for improvement which can be applied across the delivery of future initiatives under the Program, but also an evaluation against the broader policy or reform objectives, benefits and/or assumptions defined at the time a final rule or policy is made and whether those objectives and benefits have been realised to date. In drafting its assessment, AEMO note i) this reform is part of a broader package defined by the Energy Security Board as part of the Essential System Services pathway, and ii) the benefits of certain reforms may not be apparent from the outset and instead take time to develop or embed within the operation of the market, or participants' behaviours. For this reason, a subsequent assessment at a later point in time may be warranted.

Initiative summary

The Fast Frequency Response (FFR) initiative was established under the NEM Reform Program ('the Program') to deliver the key changes arising from the *National Electricity Amendment (Fast Frequency Response Market Ancillary Service) Rule 2021 No. 8*.¹

The Infigen Energy Limited (now Iberdrola Australia) initiated rule change highlighted the challenges associated with a transitioning energy system, specifically the decline in system inertia in moving to more flexible, asynchronous generation resources, and the ability for the system to arrest changes in power system frequency.

The Australian Energy Market Commission's (AEMC) final rule determination introduces two new market ancillary services, *very fast (VF) raise and very fast lower*, to help control system frequency and keep the future electricity system secure following sudden and unplanned generation or power system outages, known as contingency events. The market arrangements (registration, scheduling, dispatch, pricing, settlement and cost allocation) for the new market ancillary services are the same as those for the existing fast raise and fast lower services.² These new FFR markets commenced on 9 October 2023.

The implementation arrangements, in addition to market commencement, under the new rule included:

- Revision of the Market Ancillary Services Specification (MASS) by 19 December 2022 to specify the detailed description and performance parameters for the new very fast services.
- Additional reporting requirements for AEMO in its quarterly report on power system frequency, to communicate the basis on which it determined the quantity and type of any market ancillary service or combination of market ancillary services it procured, including, to the extent that is relevant, the relationship between the volume of the market ancillary services procured and the levels of inertia in the power system.

¹ AEMC. Fast frequency response market ancillary service. Website – Last Accessed 4 March 2024. Available here <https://www.aemc.gov.au/rule-changes/fast-frequency-response-market-ancillary-service>

² AEMC. Fast frequency response market ancillary service – Information Sheet. 15 July 2021. Available here <https://www.aemc.gov.au/sites/default/files/2021-07/Fast%20frequency%20response%20market%20ancillary%20services%20infosheet.pdf>



Summary of findings

The FFR initiative became effective from 9 October 2023 when the two new markets for very fast raise and very fast lower ancillary services were introduced into the existing Frequency Control and Ancillary Services (FCAS) markets in the National Electricity Market (NEM).

While the new FFR markets have only been in operation for six months, the following key points have been observed in the delivery of the initiative and through this operation period:

- The initiative was implemented without delays throughout the delivery lifecycle and within the allocated budget (outlined in further detail in sections 3.1 to 3.3).
- Extensive engagement between AEMO and industry throughout the lifecycle of the project resulted in the smooth implementation of the initiative. This included early engagement with participants in the lead up to Registration for new FFR services, allowing time for participants to prepare for the changes introduced by the new Rule change (outlined in further detail in sections 3.4 to 3.6).
- Existing information asymmetry is better addressed through AEMO's additional reporting requirements on the type and volume of any market ancillary services procured over the quarter, as well as the level of inertia of the power system at the time.
- The provision of the new very fast raise and very fast lower services can provide a clear signal incentivising investment in resources contributing to the efficient mix of frequency control ancillary services moving forward – a critical factor as the NEM moves towards lower levels of inertia. It is important to note that while these services are explicitly valued, its strength as an investment signal will be subject to, or dependent on participants observing the impact the services have had on the market and the value they provide, and utilising this in their investment decision-making process.
- Section 4.1 shows that in Q4 2023, when the provision of the new very fast raise and very fast lower services was in place, the total cost of FCAS required to address power system security issues was lower than preceding quarters. While these costs were lower relative to preceding quarters, AEMO note the new FFR markets have only been in operation a short period of time, during which volume caps on dispatch have been in place in line with the transitional arrangements adopted to support the commencement of these markets. AEMO will continue to monitor the outcomes across the various FCAS markets as part of its ongoing reporting activities including as part of its Quarterly Energy Dynamics report.

Further economic benefits of the new services, relative to continuation of the current market ancillary service arrangements (or other alternative arrangements), will only be observed in the medium to longer-term as the NEM's inertia levels continue to decline.



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2 Initiative Summary

The Fast Frequency Response (FFR) initiative was established under the Program to deliver the key changes arising from the *National Electricity Amendment (Fast Frequency Response Market Ancillary Service) Rule 2021 No. 8*.⁴

This rule change was one of seven rule change requests relating to the provision of system services that the AEMC assessed in parallel. Collectively, the AEMC refers to these rule requests as the “system services” rule change requests.⁵ These system services rule change requests complement and are interdependent with the work of the Energy Security Board’s (ESB) and its Post-2025 Electricity Market Design final advice to Energy Ministers.⁶ The FFR initiative specifically was identified as one of the immediate reforms to be progressed under the Essential System Services and Scheduling and Ahead Mechanisms pathway.

On 18 March 2020 Infigen Energy Limited (now Iberdrola Australia), submitted to the Australian Energy Market Commission (AEMC), the FFR rule change proposal seeking the establishment of two new FFR ancillary services markets (FFR Raise and FFR Lower), procuring fast-acting reserves (1-2 second response).⁷ The new FFR markets would operate alongside the NEM’s existing Contingency Frequency Control Ancillary Service (FCAS) markets. In submitting the rule change proposal, Iberdrola Australia noted the challenges associated with a transitioning energy system, specifically the decline in system inertia in moving to more flexible, asynchronous generation resources, and the ability for the system to arrest changes in power system frequency. Iberdrola Australia further went on to note, new and unknown modes of failure, extreme weather conditions and major network events have resulted in greater focus on contingency events and timely response of FCAS.⁸

On 15 July 2021 the AEMC, made a more preferable rule to introduce two new market ancillary services, *very fast (VF) raise (R1) and very fast lower (L1)*, to help control system frequency and keep the future electricity system secure following sudden and unplanned generation or power system outages, known as contingency events. These new market ancillary services are to operate more rapidly than the existing fast raise and fast lower services in response to the locally sensed frequency of the power system in order to arrest a rise and fall in frequency respectively.

The market arrangements (registration, scheduling, issue of dispatch instructions, pricing, settlement and cost allocation) for the new market ancillary services are to be the same as those for the existing fast raise and fast lower FCAS services.⁹ These new FFR markets commenced on 9 October 2023.

The implementation arrangements, in addition to market commencement, under the new rule included:

⁴ AEMC. Fast frequency response market ancillary service. Website – Last Accessed 4 March 2024. Available here <https://www.aemc.gov.au/rule-changes/fast-frequency-response-market-ancillary-service>

⁵ AEMC. Frequency control framework review. Website – Last Accessed 15 March 2024. Available here: [Frequency control frameworks review | AEMC](#)

⁶ Energy Security Board. Post-2025 Market Design Final advice to Energy Ministers Part A. 27 July 2021. <https://www.datocms-assets.com/32572/1629944958-post-2025-market-design-final-advice-to-energy-ministers-part-a.pdf>

⁷ Infigen Energy. Rule Change Request: Operating Reserves and Fast Frequency Response Rule Change. 18 March 2020. Available here <https://www.aemc.gov.au/sites/default/files/2020-03/ERC0296%20Rule%20change%20request.pdf>

⁸ Ibid.

⁹ AEMC. Fast frequency response market ancillary service – Information Sheet. 15 July 2021. Available here <https://www.aemc.gov.au/sites/default/files/2021-07/Fast%20frequency%20response%20market%20ancillary%20services%20infosheet.pdf>

- Revision of the Market Ancillary Services Specification (MASS) by 19 December 2022 to specify the detailed description and performance parameters for the new very fast services.
- Additional reporting requirements for AEMO in its quarterly report on power system frequency, to communicate the basis on which it determined the quantity and type of any market ancillary service or combination of market ancillary services it procured, including, to the extent that is relevant, the relationship between the volume of the market ancillary services procured and the levels of inertia in the power system.

2.1 Impacted stakeholders

The following participant types (who choose to participate in the new FFR markets) were impacted by the FFR initiative¹⁰:

- Market Customers with Scheduled loads,
- Market generators with Scheduled and Semi-scheduled generating units, and
- Demand Response Service Providers (DRSP), Market Customers and Small Generation Aggregator (SGA) with non-scheduled loads.

2.2 Initiative scope

The scope of work implemented via the FFR initiative included:

Procedures and Guidelines	Market Applications	Market Interfaces
<ul style="list-style-type: none"> • Consultation and amendments to the Market Ancillary Service Specification (MASS) on the technical and measurement requirements for VF FCAS. • Registration and technical assessment of VF FCAS providers • Updates to the Constraint Formulation Guidelines and Constraint Implementation Guidelines to implement the approach for VF FCAS in AEMO's dispatch processes. • Updates to the User Guide for the FCAS Verification tool (FCASVT) to incorporate VF FCAS requirements. • Updates to the Wind Farm and Solar Farm Guide to Contingency FCAS Registration to incorporate the provision of VF FCAS. • Updates to the Battery Energy Storage System (BESS) guide to 	<ul style="list-style-type: none"> • Updates to EMMS to accommodate new VF FCAS fields (RAISE1SEC and LOWER1SEC) and associated queries. 	<ul style="list-style-type: none"> • Updates to the FCASVT made available to NEM participants to calculate FCAS delivered by their plant in accordance with the updated MASS. • Extension of EMMS Data Model to support private and public reporting of the VF FCAS data.

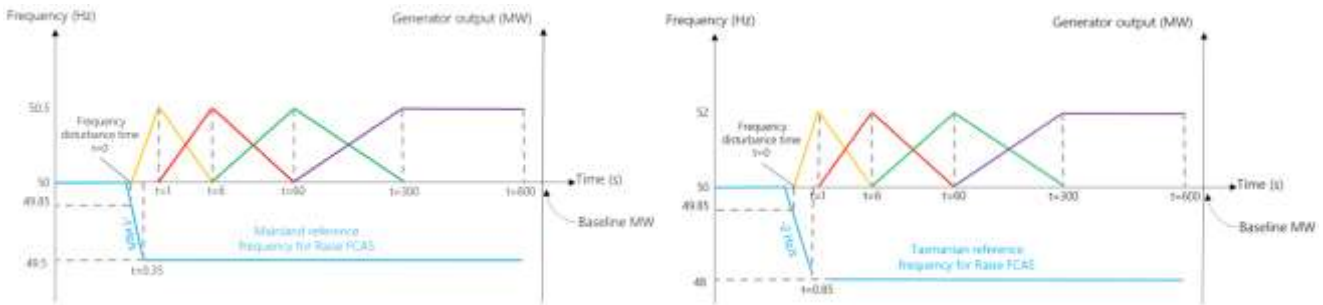
¹⁰ Subject to eligibility.



Procedures and Guidelines	Market Applications	Market Interfaces
Contingency FCAS registration to include testing requirements for VF FCAS.		
Releases	<ul style="list-style-type: none"> • Changes to the EMMS data model (5.2) required to support the FFR implementation were released to pre-production on 20 April 2023 and production on 23 May 2023. • FFR - Part 1 2023 release on 9 August 2023 providing for deployment of registration, Portfolio Management System (PMS) and dispatch system changes. • FFR - Part 2 2023 release on 27 September 2023 providing for deployment of wholesale and settlement system changes. 	
Industry Testing	Industry testing was held between 09 August 2023 to 19 September 2023. Throughout this period AEMO held twice-weekly Q&A sessions commencing from 09 Aug inclusive of overview of issues/defects.	

The figure below highlights the measurement timeframes for the new very fast raise service relative to the existing Raise Contingency FCASs for mainland and Tasmania.

Figure 2. Measurement timeframes for Raise Contingency FCAS for the Mainland and Tasmania



Source: AEMO Market Ancillary Service Specification v8.0 (9 October 2023).

3 Post Implementation Review

AEMO’s post implementation review aims to not only identify the key learnings and areas for improvement which can be applied across delivery of future initiatives under the Program, but also an evaluation against the broader policy or reform objectives, benefits and/or assumptions defined at the time a final rule or policy is made and whether those objectives and benefits have been realised.

In completing this review, AEMO note not all objectives / benefits may be realised from day one (1) of an initiative being delivered. For certain initiatives, this may require further assessment at a later point in time in which the market and its participants / stakeholders have had ample opportunity to engage or participate (e.g., where a new market service has been established), or access to new data fields.

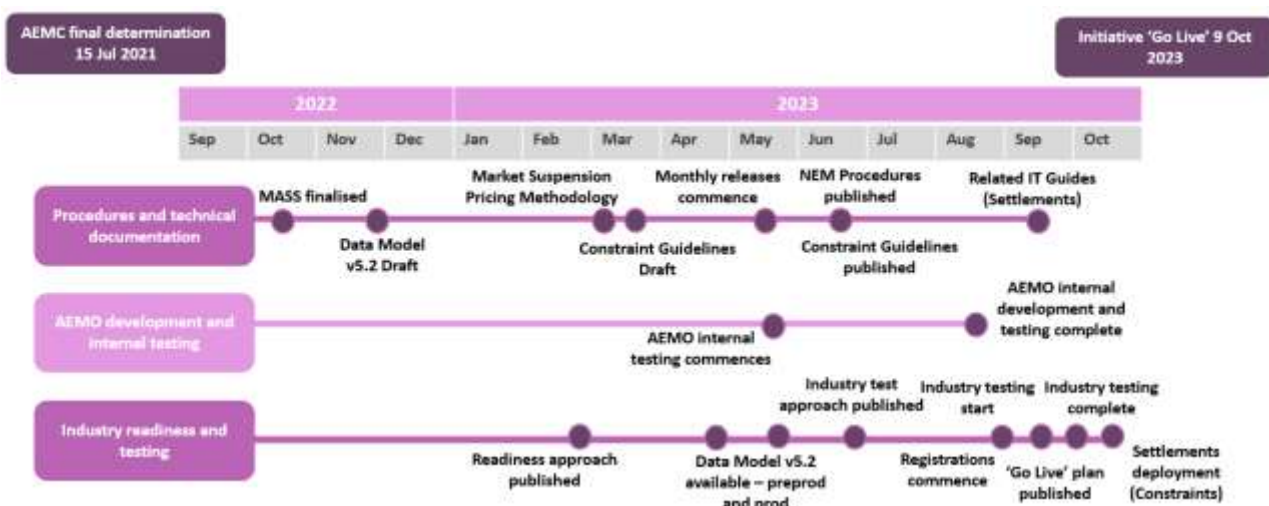
3.1 Delivery on time

AEMO and market participants collaboratively delivered the FFR initiative on time and were able to meet the go-live date of 9 October 2023 as stated in the AEMC’s final determination. Late deployment of testing environments by AEMO due to configuration issues, scaled down and/or segregated environments, and last-minute requirement changes did result in delays to system integration testing (SIT) and user acceptance testing (UAT) timelines. Whilst these delays caused timeline compression late in the implementation period, go-live dates were not compromised.

Upgrades to AEMO wholesale systems required for the FFR initiative were released to industry in two stages:

- The first software release on 9 August 2023 allowed registration for VF FCAS to formally open to enable interested participants to apply to register for VF FCAS in preparation for market start on 9th October, as well as updates to the dispatch system to allow dispatch data accumulation (minimum 4 weeks) in the event of a market suspension event shortly after market start.
- The second software release on 27 September 2023 introduced settlements and billing system updates for VF FCAS and commenced dispatch for VF FCAS.

Figure 3. Delivery timeline



The figure above sets out key milestones achieved by both AEMO and industry participants, from the AEMC final determination on the rule change to implementation of the initiative.

3.2 Delivery of scope

The FFR initiative delivered the scope established as part of the final rule determination. The project scope included updates to existing IT systems, updates to business processes, industry procedures / guidelines, stakeholder engagement and industry readiness activities.

3.3 AEMO implementation costs

The FFR initiative was delivered within AEMO's allocated budget as shown in **Error! Not a valid bookmark self-reference.**¹¹ The actual costs of the FFR initiative will be recovered through AEMO's new NEM2025 Reform Program fee, with recovery from Wholesale Participants (27.5%) and Market Customers (72.5%).¹² Cost recovery for this initiative commences from 1 July 2024 and will continue for a period of seven years.¹³

Table 1. Implementation Costs

Budget	Actual	Variance
\$4,427,460	\$4,255,159	\$172,301

3.4 Uplift, optimisation and cost take-out for industry

The FFR initiative was delivered incrementally upon existing FCAS related systems and processes which reduced implementation costs. This approach was adopted as there were limited additional opportunities or value for industry to implement separate systems and processes for the very fast services.

AEMO note, the opportunities and value from this initiative lie with its ability to reduce the longer-term costs of power system operation, relative to the expected future costs under a continuation of the current market ancillary service arrangements (or other alternative arrangements), by providing a more efficient mix of FCAS services.


3.5 AEMO and industry readiness

AEMO engaged extensively with industry prior to the initiative go-live date to ensure successful integration of the required changes into its own, and participants' systems. An indication of the positive impact of AEMO's extensive industry engagement prior to the initiative's go-live date can be evidenced from the fact that 19 facilities, 7

¹¹ Note these costs do not cover the costs incurred by participants associated with implementation of the initiative.

¹² AEMO's Final Determination on the Participant fee structure for the NEM2025 Reform Program declared NEM project was published on 6 October 2023 and is available on AEMO's website: [AEMO | Participant Fee Structure for the NEM2025 Reform Program Declared NEM Project](#)

¹³ As other initiatives within the NEM2025 Reform Program declared NEM project go live, they too will be rolled into this fee structure.



participants and 498MW of very fast raise, and 337MW of very fast lower were registered to participate as of day one (1).¹⁴

AEMO has also implemented a market transition approach¹⁵ to support the start of the VF FCAS markets by progressively increasing the allowed requirement volumes, while ensuring that sufficient capacity is registered and committed for VF FCAS market participation. As this is the first new FCAS market introduced in many years, a transition approach has allowed for an orderly market-start process. AEMO currently reviews the levels of registered capacity that is committed for VF FCAS market participation on a fortnightly basis and decides whether the allowed requirement volumes can be incremented. The size of increments and length of transition period will be dependent on the level of registered capacity and participation in the VF FCAS services. Once sufficient supply is registered and participating in the VF FCAS markets, the volumetric limits will be removed, and VF FCAS procurement will be equivalent to the underlying VF FCAS requirements.

There were no post-production defects reported, which can again be attributed to AEMO's engagement prior to go-live and during any transitions.

To support integration, AEMO developed and implemented the following plans ahead of the agreed go-live date:

3.5.1 Readiness approach plan

The Readiness approach plan communicated to industry the framework initiatives (including the FFR initiative) under the NEM Reform Program adopt for the 'readiness approach'. Specifically, for the FFR initiative, the plan outlined:

- Go-live Criteria Management – The criteria for decision making on readiness for the initiative to go-live in line with rule commencement timeframes and the efficient operation of the NEM and approach for the initiative.
- Initiative Readiness Reporting – The form of reporting required by participants to meet the go-live criteria decisions, as well as AEMO's progress reporting approach.
- Initiative Industry Testing – The expected approach to the conduct of Industry testing as well as the release testing requirements / considerations (to be validated with industry as part of the Industry Test Strategy development).
- Participant Development Support – The approach to the provision of technical and functional support for participants in their implementation of the initiative, which is guided by the initiative impact assessment view on scale of change and spread across participant categories.
- Transition Support – The approach to the activities required to transition into operation, including a longer-term transition and go-live (cutover) view to manage the scope and timing of required transitional activity.

3.5.2 Service commencement plan

The service commencement plan was developed to ensure stakeholders were aware of AEMO's approach to implementing the new very fast services and outlined:

- The approach to facilitating registration of eligible FCAS providers prior to market start.

¹⁴ Refer to slide 12 from AEMO's [NEM Reform Implementation Forum, Meeting #16](#) on 31 October 2023.

¹⁵ AEMO. Very Fast FCAS Market Transition – Last accessed 15 March 2024. Available: [AEMO | Very Fast FCAS Market Transition](#)

- AEMO’s approach to determine the amount of each service required under different power system conditions to maintain security (consistent with the Frequency Operating Standard).
- How AEMO intended to transition from current Contingency FCAS market arrangements to the new arrangements.

3.5.3 Industry go-live plan

The FFR initiative consisted of a two-stage implementation approach and therefore two go-live plans were published to industry:

1. FFR (Part 1) 2023, 9 August 2023 Go-live plan:
 - Deployment of Registration, Portfolio Management System (PMS) and Dispatch system changes to support the implementation of FFR (Part 1).
 - Deployment of EMMS 5.2 Data Model.
 - Communications during deployment.
 - Support arrangements during the go-live period.
2. FFR (Part 2) 2023, 27 September 2023 Go-live plan:
 - Deployment of Wholesale and Settlement system changes to support the implementation of FFR.
 - Communications during deployment.
 - Support arrangements during the go-live period.

3.5.4 Industry test approach plan

AEMO’s Industry test approach plan provided participants the opportunity to:

- Prove their updated systems against AEMO's market systems.
- Test end-to-end scenarios of updated processes and procedures.
- Contribute to their assessment of overall industry readiness for rule commencement.

The plan also provided a timeline of milestones and (progress to date) for the FFR system changes as well as an indicative participant impact assessment from affected market systems and processes including registration, bidding and dispatch, and settlements.

3.6 Stakeholder feedback

AEMO received positive feedback throughout the implementation of the initiative on its approach to engagement and collaboration with industry. In particular, the following were considered beneficial by stakeholders:

- Availability of information on the project website including technical guides, summaries of frequently asked question (FAQs) and general go live material.
- The level of engagement via AEMO forums and email communications reminding participants about the application processes and other readiness items.
- The timeliness of responses to participant queries.

3.7 What worked well?


The following key themes were identified as aspects of implementation that worked well:

- *Scope & timelines* – The project scope was implemented on time and within budget, with no significant issues faced over the life of the project. This was supported by the early release of key deliverables (e.g., EMMS 5.2 Data Model) and consistent reporting against external milestones.
- *Engagement* – The project team engaged extensively both internally and externally through the lifecycle of the project. This includes supportive input from the business teams to complete the changes, communicate the changes and train other teams on the changes. Further, AEMO encouraged participants to be actively involved in procedural and technical changes. This was achieved with good quality responses and turn outs from participants during information sessions. Further, the FFR email inbox was an efficient means of managing participant queries, volumes and recording responses.
- *Procedure and system changes* – AEMO’s management of updates to the vast number of internal and external documents and phased releases of tools further allowed a smooth implementation of the FFR initiative. The process for such updates was detailed and communicated to industry proactively through various means. Specifically:
 - The industry transition and go-live strategy principles that applied to the August and September 2023 Release changes were met and allowed industry to understand the expectations for the FFR initiative’s implementation. These principles included:
 - Mandated FFR commencement dates to be met.
 - NEM operations to be uninterrupted during periods of transition and go-live.
 - Market system go-live risks to be minimised.
 - Participants to be provided with implementation flexibility where possible.
 - Participants and AEMO to be responsible for their own go-live planning.
 - The industry test approach described the high-level changes to the impacted functions for the implementation of VF FCAS services and allowed participants to test their system with AEMO’s.
 - The readiness approach outlined to industry the framework that would be applied in order for AEMO and industry to be ready for the FFR initiative’s go-live date.
 - The service commencement plan ensured industry knew how AEMO would integrate the VF FCAS services into the existing FCAS market arrangements.

3.8 What areas could be improved?

While the initiative was delivered on time and within budget, FFR was one of the larger initiatives delivered by the NEM Reform Program thus far and there are learnings that will be applied to future projects. The following areas are recommended for continual improvement in any future implementation of initiatives of this nature:

- While timelines for both releases were met, there were instances where the timelines for these releases were put at risk. This was largely attributed to compression of internal-to-AEMO testing timelines and test environment readiness.

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- Continue to look for opportunities to be transparent with participants, both in regard to implementation (e.g., early release of technical specifications), and impacts of the rule change coming into effect (e.g., participation levels in the new markets).

4 Policy Objectives & Reform Value Assessment

In this section AEMO provides an assessment against the stated policy objectives and reform value as documented in the AEMC’s final determination *National Electricity Amendment (Fast Frequency Response Market Ancillary Service) Rule 2021 No. 8*.

In drafting its assessment, AEMO note i) this reform is part of a broader package defined by the Energy Security Board as part of the Essential System Services pathway, and ii) the benefits of certain reforms may not be apparent from the outset and instead take time to develop or embed within the operation of the market, or participants’ behaviours. This is the case for the FFR initiative as greater benefits of the provision of FFR will be more evident in the future as low inertia operating conditions prevail.¹⁶ A subsequent assessment against the policy objectives and reform value may be warranted at a later point in time.

Table 2. Reasons for making the rule

Policy objective / value ¹⁷	Assessment
<p>Optimises the reliable, secure and safe provision of energy in the NEM, such that it is provided at efficient cost to consumers over the long-term</p>	<p>The new market ancillary services under the existing FCAS arrangements are contributing to the reliable, secure and safe provision of energy that promotes the efficient short-run operation, use and longer-term investment in the power system and other system service capability (as shown in section 4.1 below).</p> <p>The provision of the new R1/L1 services is likely to provide a more efficient mix of frequency control ancillary services under the projected levels of inertia in the medium to longer-term relative to the continuation of the current market ancillary service arrangements (or other alternative arrangements). This can be better assessed in the future as low inertia operating conditions prevail.</p>
<p>Provide clearer price signals to promote efficient investment in, operation and use of these market ancillary services to support secure operation of the power system</p>	<p>Establishing a spot market for FFR services, resulting in more efficient dispatch and pricing of services has been achieved. The new markets, together with additional reporting, has created a clear price signal and removed information asymmetry that will in time support investment in technologies capable of the provision of FFR services.</p> <p>A clear price signal for VF FCAS enablement can incentivise investment in technologies capable of providing faster acting frequency control services. This will help manage system frequency more efficiently in the future during periods of low power system inertia over time. However, while these services are explicitly valued, its strength as an investment signal will be subject to, or dependent on participants observing the impact the services have had on the market and the value they provide, and utilising this in their investment decision-making process.</p>

¹⁶ Those as the AEMC note in their Draft Determination for the Fast Frequency Response Market Ancillary Service rule change, although FFR has the potential to assist with frequency management at lower levels of system inertia, FFR and inertia are delivered via different physical mechanisms, and play roles that are not directly interchangeable. FFR is not a direct substitute for synchronous inertia.

¹⁷ AEMC Final Determination National Electricity Amendment (Fast Frequency Response Market Ancillary Service) Rule 2021. 15 July 2021. Available here: <https://www.aemc.gov.au/rule-changes/fast-frequency-response-market-ancillary-service>

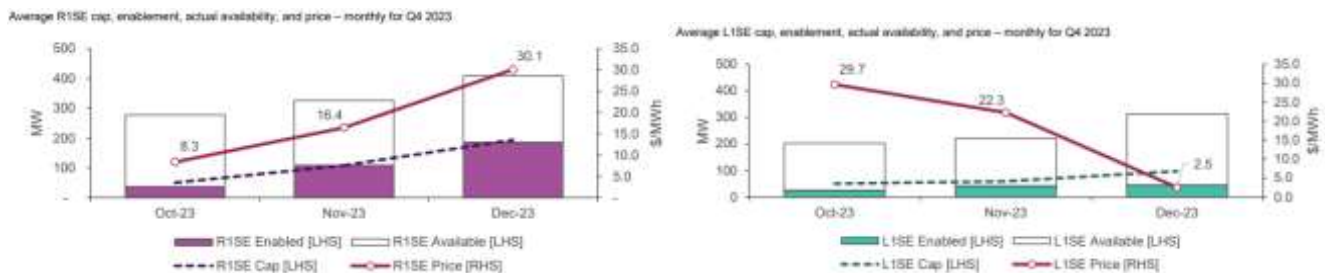
Policy objective / value ¹⁷	Assessment
	<p>The additional reporting requirements captured as part of AEMO’s quarterly report on frequency performance address issues of information asymmetry for stakeholders by supporting access to, and understanding of, information on:</p> <ul style="list-style-type: none"> the basis on which AEMO determined the quantity and type of any market ancillary service or combination of market ancillary services procured over the quarter, and the relationship between the volume of the market ancillary services procured and the level of inertia in the power system.
<p>More targeted, granular procurement of FFR services would result in lower costs compared to the current status quo arrangements of increasing procurement of R6 over time, or other alternative arrangements</p>	<p>As system inertia is expected to decline over the period (through to 2035 according to the ISP), the provision of very fast responding frequency reserves (i.e., R1/L1 services) means contingency frequency response can be procured in a lower cost way than the options of doing nothing or increasing the provision of R6/L6 reserves or other alternative options.</p> <p>It is currently too early to assess the full financial benefits (or savings) of not being required to procure increased quantities of R6/L6 reserves.</p>

4.1 Reform in action

At the commencement of the new FCAS markets on 9 October 2023, VF FCAS levels were capped at 50 MW each for R1 and L1 Contingency FCAS. AEMO applied a market transition approach to support the start of these markets that aims to progressively increase the volume requirements, while ensuring that sufficient capacity is registered and committed for VF FCAS market participation. Following fortnightly reviews of the levels of registered capacity the caps for R1 and L1 services have been progressively raised multiple times since going live in October 2023. The current cap on dispatch of R1 is 250 MW and L1 is 125 MW.¹⁸

As reported in AEMO’s Q4 2023 Quarterly Energy Dynamics report and shown in the figure below, the average enablement for R1 increased in line with the cap increases, and the average monthly price increased from \$8.3/MWh in October 2023, to \$30.1/MWh in December 2023. The average enablement remained relatively constant for L1, and prices decreased over the quarter starting at a high of \$29.7/MWh in October reducing to \$2.5/MWh in December 2023.

Figure 4: R1 price increased and L1 price decreased over the quarter



Source: AEMO Quarterly Energy Dynamics Q4 2023.

¹⁸ The R1 cap increased five times to reach 250 MW while the L1 cap increased twice to reach 100 MW, over the October to December 2023 period. On 12 February 2024 the L1 cap was increased to 125 MW and from 18 March 2024 1300 hrs the R1 cap will be increased to 250 MW.



Over the October to December 2023 period, batteries and demand response supplied the majority of volumes enabled for VF FCAS, with average quarterly enablement of 110 MW for batteries and 31 MW for demand response. Virtual power plant was the only other technology supplying this service, with average enablement of 2 MW.¹⁹

Figure 5 below shows that total FCAS costs reduced in Q4 2023 compared to preceding quarters, particularly preceding fourth quarters, and payments for R1 services contributing \$4.6 million (14%) to total FCAS costs, and payments for L1 contributing \$1.8 million (5%). The figure also shows that R6 and L6 costs decreased in Q4 2023 compared to other quarters. While these costs are lower relative to preceding quarters, AEMO note the R1 and L1 markets have only been in operation a short period of time, during which caps have been in place in line with transitional arrangements described above. AEMO will continue to monitor the outcomes across the various FCAS markets as part of its ongoing reporting activities including as part of its Quarterly Energy Dynamics report.

Figure 5: Quarterly FCAS costs by markets



Reporting Arrangements: Frequency Monitoring – Quarter 4 2023²⁰

The additional reporting requirements on frequency performance in AEMO’s quarterly frequency monitoring reports have now been included in the Q4 2023 report.

Figures 6 and 7 below show the relationship of uncapped R1 and L1 service quantities relative to the system inertia levels in the NEM for Q4 2023.

¹⁹ AEMO. Quarterly Energy Dynamics Q4 2023. January 2024. Available here: <https://aemo.com.au/-/media/files/major-publications/qed/2023/quarterly-energy-dynamics-q4-2023.pdf?la=en&hash=9E82966D60F4FA5050F1AF1109D5F158>

²⁰ AEMO. Frequency Monitoring Q4 2023. February 2024. Available here: https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/ancillary_services/frequency-and-time-error-reports/quarterly-reports/2023/frequency-monitoring-q4-2023.pdf?la=en

Figure 6: Relationship of uncapped R1 service quantities to inertia in Q4 2023

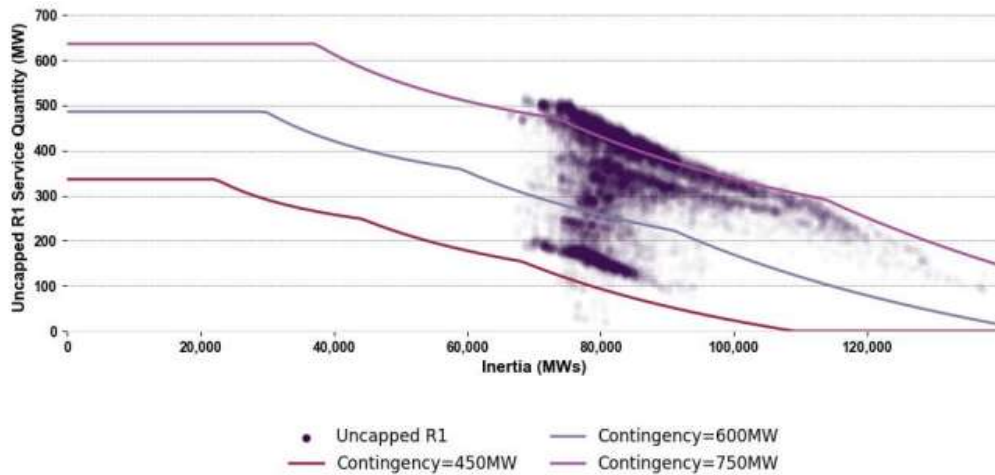
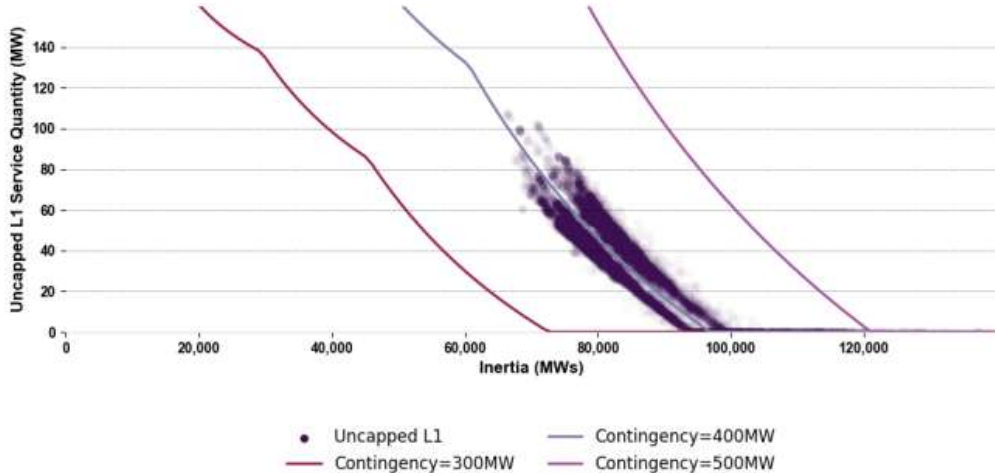


Figure 7: Relationship of uncapped L1 service quantities to inertia in Q4 2023



Victorian incident on 13 February 2024²¹

On Tuesday 13 February 2024 very destructive storms swept across Victoria causing six transmission towers north of Geelong to collapse, severely damaging the transmission and distribution network in the region. As a result, power was cut to more than 500,000 Victorian customers. Additionally, shortly after 1300 hrs (market time) approximately 2.6 GW of generation was lost as all four Loy Yang A units reduced output rapidly and tripped, along with Dundonnell windfarm and Yaloak South windfarm. The loss of a significant amount of generation and transmission towers caused the frequency nadir (minimum post contingency frequency) to reach as low as 49.68 Hz.

The new VF FCAS markets are aimed at arresting frequency following high Rate of Change of Frequency (RoCoF) events, particularly following the loss of a generation unit or transmission element during low level inertia in the power system.

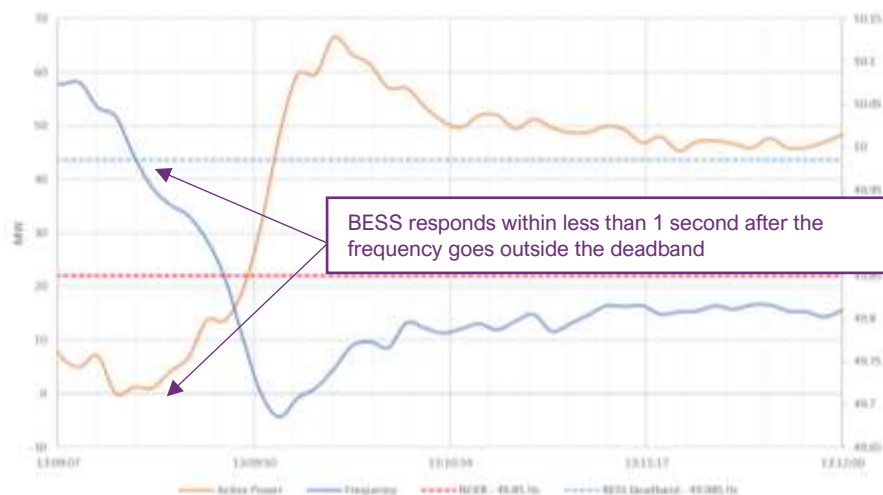
²¹ AEMO. Preliminary Report – Trip of Moorabool – Sydenham 500 kV No. 1 and No. 2 lines on 13 February 2024. February 2024. Available here: https://aemo.com.au/-/media/files/electricity/nem/market_notices_and_events/power_system_incident_reports/2024/preliminary-report--loss-of-moorabool---sydenham-500-kv-lines-on-13-feb-2024.pdf?la=en

In response to the 13 February event, in the trading interval ending at 1310 hrs, 225 MW of R1 was enabled in line with the cap at that time. Figure 8 and Figure 9 highlight the responses of two market participants (two battery energy storage systems (BESS)) in the new VF FCAS markets to this event). The responses of these units, among other units and factors more generally, contributed to the containment of the power system frequency within the limits specified in the Frequency Operating Standard (FOS).²² The figures highlight the respective speed in which they were able to respond, and as a result earn revenue via the new VF FCAS markets.

Figure 8: 13 February 2024 – BESS 1 FCAS response



Figure 9: 13 February 2024 – BESS 2 FCAS response



AEMO note, prior to the introduction of the two new very fast contingency FCAS markets, such services were implicitly provided via the existing 6 second (raise and lower) service enablement. The introduction of explicit price signals can promote efficient investment in, and subsequent operation and use of these market ancillary services. In time, as the NEM sees low inertia operating conditions prevail, the value of these services in managing power system frequency are likely to rise.

²² Reliability Panel – AEMC. Frequency Operating Standard. Effective 9 October 2023. Available here: <https://www.aemc.gov.au/sites/default/files/2024-01/Frequency%20Operating%20Standard.pdf>