

Non-Co-optimised Essential System Services Trigger Submission

April 2022

Fast Frequency Response

A submission to the Coordinator of Energy





Important notice

Purpose

AEMO has prepared this document under clause 3.11A.2A of the Wholesale Electricity Market Rules.

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Contents

1	Fast Frequency Response service	4
1.1	Proposal	4
1.2	Trigger	4
1.3	Background	5
1.4	Technical Assessment	7
1.5	Economic Assessment	10
1.6	Other Factors for Consideration	10

Tables

No table of contents entries found.

Figures

Figure 1	Frequency modelling methodology overview.	8
Figure 2	Percentage of time and scale of mitigation measures utilised, 2023 – ESOO Expected (POE 50).	9

1 Fast Frequency Response service

1.1 Proposal

The Australian Energy Market Operator (AEMO) considers that, without procuring a service for Fast Frequency Response (FFR) via the Non-Co-optimised Essential System Services (NCESS) procurement process ahead of the commencement of new market arrangements on 1 October 2023, there is a material risk that AEMO will be unable to operate the power system securely under certain operating conditions, such that, in the event of a contingency, involuntary loadshedding may occur. This risk is emerging due to increased penetration of Distributed Photovoltaics (DPV), which contribute significantly to contingency sizes where tripping in consequence of credible contingencies involving network or generator faults occurs.

Summary

AEMO's system studies relating to DPV tripping have identified that 100 MW of Fast Frequency Response would be capable of reducing intervals at risk of Under Frequency Load Shedding under the largest credible contingency from ca. 5% of intervals to <1%.

AEMO requests that the Coordinator of Energy trigger a NCESS procurement process for up to 100MW of FFR service for the period 1 October 2022 – 1 October 2023.

1.2 Trigger

AEMO has prepared this written submission in accordance with clause 3.11A.2A of the Wholesale Electricity Market Rules (WEM Rules), to request that the Coordinator of Energy (Coordinator) trigger a NCESS procurement process for an FFR service. This submission includes the matters required under clause 3.11A.3 of the WEM Rules to enable the Coordinator to determine whether to trigger the procurement of an NCESS under clause 3.11A.4, including with respect to the matters specified in clause 3.11A.7 of the WEM Rules:

- a) where the issue relates to Power System Security or Power System Reliability, the extent to which an NCESS will address the issue;
- b) the extent to which an NCESS will minimise costs in the Wholesale Electricity Market;
- c) the relative merits between procuring an NCESS or augmenting the network;
- d) the outcome of any investigation of behaviour that reduces the effectiveness of the market, including behaviour related to market power;
- e) whether the procurement of an NCESS is consistent with the Wholesale Market Objectives; and
- f) whether procurement of an NCESS will be in the long-term interests of consumers.

AEMO's analysis indicates that, as system load declines, the impacts of DPV tripping in response to power system disturbances may not be able to be fully mitigated through existing mechanisms under the WEM Rules. AEMO's assessment of this emergent risk has identified a trigger in accordance with clause 3.11A.2A(a) of the WEM Rules:

“ Where AEMO reasonably considers that one or more of the following events has occurred or applies, AEMO must make a submission to request the Coordinator to determine whether or not to trigger an NCESS procurement process in accordance with section 3.11B:

(a) In the course of its normal power system operations, that a significant threat to Power System Security or Power System Reliability exists or is emerging, and the existing mechanisms under these WEM Rules may not be sufficient to address the threat[.]

This trigger submission summarises AEMO’s technical and economic assessment of this risk and proposes procurement of an FFR service under the NCESS framework.

1.3 Background

The South West Interconnected System (SWIS) is continuing to experience a rapid uptake of DPV, which is resulting in declining levels of system load and increased risk exposure to DPV tripping. AEMO has conducted power system modelling to identify the risks associated with DPV tripping under a range of credible contingencies. Our analysis suggests that, at times, the Spinning Reserve Ancillary Service (SRAS) requirements for the SWIS may be insufficient to cater for faults which can involve network and generation and DPV disconnections.

AEMO and Western Power have undertaken assessments which have shown that DPV inverters (compliant with AS4777:2015 and earlier) are affected by severe voltage disturbances such as transmission network faults, and that disconnections can also occur (although at lower rates) during frequency disturbances which cause frequency to fall below specific levels.

Irrespective of cause, unplanned DPV disconnection can increase the size of a contingency, for example when a generator trip is caused by a fault which also causes a proportion of DPV to disconnect. The resultant amount of total generation lost to the system is greater than if no DPV had disconnected. This in turn increases the magnitude of effect to the power system, resulting in significantly greater frequency deviations, which has occurred several times to date. Contingency management measures, such as the amount of primary frequency response held, must therefore be adapted to account for the effects of DPV. Otherwise, contingencies (especially those under low system load conditions) may result in the activation of Under-Frequency Load Shedding (UFLS), where customer loads will be automatically disconnected to maintain power system security.

In September 2021 AEMO published its *Renewable Energy Integration – SWIS Update*¹ report, which identified that emerging conditions such as low system load (as identified in an earlier March 2019 report²) were continuing to impact AEMO’s ability to manage the system. As system load declines to lower levels, the power system becomes less resilient and more vulnerable to disturbances. Fewer synchronous generators can remain online to provide a level of inertia and reserves sufficient to suppress frequency deviations, and to provide other services essential for keeping the power system secure. During these periods of low inertia, frequency response provided through FFR from loads or storage may assist in arresting frequency disturbances without displacing those few synchronous generators.

¹ [Renewable Energy Integration – SWIS Update](#)

² [Integrating Utility-scale Renewables and Distributed Energy Resources in the SWIS](#)

Of the 13 recommendations made by the *SWIS Update* report, three were identified as priorities for immediate implementation. Recommendation 1 identified the capability for an FFR service as a priority action –

“ AEMO to explore contractual options with new providers or technologies to maximise the capability to deliver FFR, where faster frequency services are needed prior to the commencement of new Essential System Services (ESS) arrangements via ETS Stage 1.

The Wholesale Electricity Market (WEM) reforms (as part of stage 1 of the Energy Transformation Strategy) will introduce a new rate of change of frequency (RoCoF) Control Service and Contingency Reserve Raise service (which incorporates a mechanism to value response speed). These new Essential System Services will be co-optimised with energy under security-constrained economic dispatch (SCED). The new market arrangements for the WEM are scheduled to commence on 1 October 2023.

AEMO considers that the new markets will offer appropriate structures for FFR providers to participate in the WEM. Consequently, the issues outlined in this paper are expected to be mitigated from the commencement of the new market arrangements. Interim arrangements will therefore only be necessary to provide a FFR in the period from 1 October 2022 to 1 October 2023.

To this end, AEMO has identified the requirements for an interim NCESS to procure an FFR service.

1.3.1 AEMO's role in the SWIS

AEMO has two primary functions under the WEM Rules:

- Section 2.1A confers functions on AEMO in respect of the WEM under the WEM Regulations.
- Clause 2.1A.1A confers the 'general' function of ensuring that the SWIS operates in a secure and reliable manner (for the purposes of regulation 13(1) of the WEM Regulations).
 - Clause 2.1A.2 then relevantly confers additional System Management functions on AEMO in relation to the WEM, including to procure adequate Ancillary Services where Synergy cannot meet the Ancillary Service Requirements.

The capability to manage frequency control via Ancillary Services is core to AEMO's functionality as System Management, as frequency control is fundamental for sustaining power system security and reliability.

The WEM Rules also place specific obligations on AEMO, including a specific obligation under clause 7.6.1(b) to minimise involuntary load shedding in the SWIS. AEMO has considered whether it can effectively fulfil this obligation using the current suite of Ancillary Services (and the associated procurement processes) in the context of declining levels of system load and higher risk exposure to DPV tripping.

Without procuring a service for FFR ahead of the commencement of new market arrangements on 1 October 2023, there is a significant risk that involuntary load shedding cannot be fully mitigated via measures that increase SRAS and/or limit maximum contingency sizes.

1.3.2 Existing mechanisms and sufficiency

AEMO has considered the existing mechanisms available to it under the WEM Rules to mitigate the issues identified in this submission. AEMO's modelling therefore reflects the quantities of Ancillary Services that could be made available via these mechanisms from the existing fleet. The modelling indicates that the risks identified in this submission have not been fully mitigated. AEMO has determined that further measures would be required.

Specifically, AEMO assessed the extent to which additional Ancillary Services procured through processes outlined in clause 3.11 of the WEM Rules may mitigate the identified risks. It was determined that a service that is capable of delivering a more targeted response than that specified for SRAS under clause 3.9.3 of the WEM Rules would be required. The service would need to provide:

- A response in < 2 seconds
- A sustained response for up to 15 minutes
- Enablement under specific system conditions

AEMO also notes that the process under clause 3.11 of the WEM Rules would necessitate a reassessment of the Ancillary Service Requirements, and that any reassessment may not result in the full mitigation of the risk, in which case further measures would still be required. AEMO considers that the NCESS framework, which was designed to allow targeted services to be identified and procured (subject to oversight by the Coordinator), is the most appropriate mechanism to procure a service that can provide a more targeted response.

1.4 Technical Assessment

Trigger Determination – Technical Need

This section presents relevant analysis to allow the Coordinator to consider the extent to which an NCESS will address the issue presented (Clause 3.11A.7(a) of the WEM Rules).

To quantify the risk associated with DPV tripping and to demonstrate the need for this trigger submission under Clause 2.11A.2A(a), AEMO (working with Western Power) conducted power system modelling³ to identify the risk associated with DPV tripping during a range of worst-case contingencies and the resultant voltage and frequency disturbances. Figure 1 shows a brief overview of the power system modelling methodology that was utilised for this analysis. Note that the modelling assumed a 30 mHz margin from the first stage of UFLS, characterising at risk intervals as “at risk” where calculated frequency nadir was below 48.78 Hz (*viz.* 48.75 Hz for first stage UFLS).

³ See <https://ieeexplore.ieee.org/document/9597823> for information on AEMO’s Real Time Frequency Stability model.

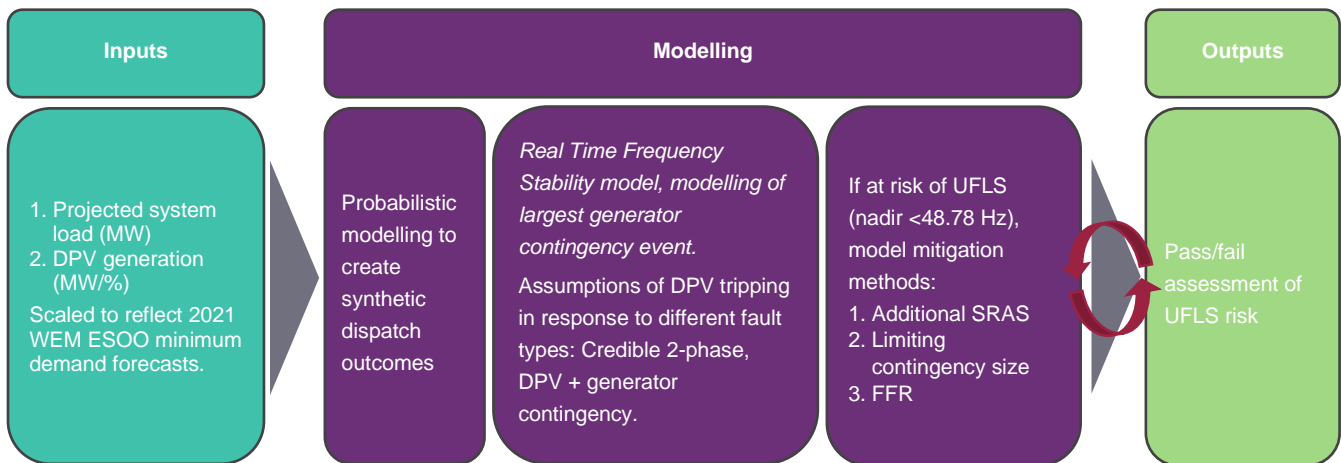


Figure 1 Frequency modelling methodology overview.

The mitigation measures for which AEMO currently has access (or a process to access), include:

1. Enablement of additional SRAS from Synergy Portfolio Facilities.
2. Curtailment of utility-scale generation out-of-merit to minimise contingency sizes.

While these two measures reduce the number of incidents where UFLS may be triggered, as indicated through AEMO modelling, they do not eliminate them (in 5% of modelled intervals). AEMO therefore modelled 100 MW of FFR specified in accordance with Frequency Co-optimised Essential System Services (FCESS) Accreditation Parameters for fast acting Contingency Reserve Raise outlined in the FCESS Accreditation WEM Procedure⁴.

The outcomes of the analysis are presented in Figure 2, showing the interventions made in the absence of FFR (right) and interventions made including FFR (left).

⁴ [WEM Procedure: Frequency Co-Optimised Essential System Services Accreditation](#)

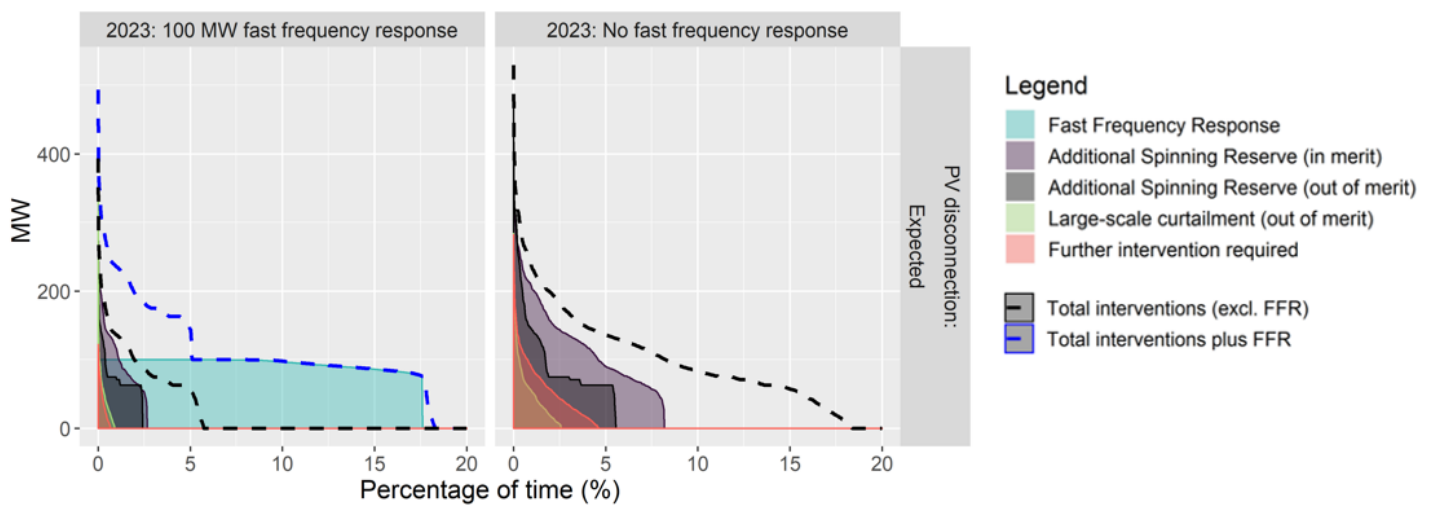


Figure 2 Percentage of time and scale of mitigation measures utilised, 2023 – ESOO Expected (POE 50).

Although the procurement of additional SRAS and curtailment mitigates a proportion of the risk, these mitigation measures are limited by the available options for dispatch. In both instances, this is due to the reliance on capable Facilities⁵ being dispatched above minimum generation and there being sufficient load to support that dispatch.

This same issue was highlighted in AEMO’s *Renewable Energy Integration – SWIS Update*, which described the risk associated with reduced secure dispatch outcomes and highlighted that the risk increases significantly as operational demand reduces. AEMO’s modelling indicates that there is a proportion of intervals in which insufficient load is available for AEMO to dispatch increased levels of SRAS from the available providers.

In the longer term, the management of DPV may assist in increasing load levels to allow for additional SRAS units to be brought online. However, in the near term the level of DPV available under the Emergency Solar Management (ESM) scheme is expected to be relatively small, providing less flexibility to effectively increase load levels, and is intended to be used as a last resort measure. AEMO also considers that carrying FFR may reduce the incidents of ESM where AEMO is required to increase load via ESM to ensure sufficient SRAS providers may be dispatched.

AEMO considers that procurement of FFR from providers with zero minimum generation will maximise flexibility in dispatch, due to such reserves not being contingent on available load. This is critical for AEMO’s ongoing ability to maintain power system security while managing the risk of DPV tripping in low-load conditions.

1.4.1 Timing

AEMO’s analysis supports that FFR will be required to mitigate risk beyond that achieved through existing mitigations (additional SRAS and/or constraining generation) from Q3 2022 through to New WEM Commencement Day (1 October 2023). While the quantity of service is dependent on the characteristics of the FFR delivered, on the basis of AEMO’s modelling assumptions, it has been determined that 100-150 MW of FFR would limit the risk to acceptable levels.

The analysis was able to identify trends, or patterns, for when FFR will most likely be required:

- During the summer and shoulder season - it is expected that the FFR service will be required between 8:30am to 4:00pm, when DPV generation is at its highest.

⁵ Facilities registered for participation in the WEM.

- During winter months due to typically lower DPV generation levels, it is estimated that the FFR service would most likely be required between 10:30am to 2:30pm.

The analysis also identified that varying quantities of FFR will be required, depending on system conditions, for example, DPV generation levels and the number of generating units in service). It is estimated that:

- Lower quantities of FFR are likely needed during morning and evening shoulder solar periods than during peak solar periods.
- Higher quantities of FFR are expected during months of peak solar output (i.e. the summer and shoulder months).

As the requirement for an FFR service is highly dependent on system conditions, operational tools can be utilised to predict and manage the risks highlighted in this paper, and to provide indication ahead of time (in both the planning horizon and in real-time) of the need for FFR or to activate other operational interventions.

1.5 Economic Assessment

Trigger Determination – Cost Minimisation

AEMO has presented relevant analysis to allow the Coordinator to consider the extent to which an NCESS will minimise costs in the Wholesale Electricity Market (Clause 3.11A.7(b) of the WEM Rules).

The Coordinator has redacted this commercially sensitive section in accordance with 3.11A.8 at the request of AEMO.

1.6 Other Factors for Consideration

Trigger Determination – Other factors

This section presents relevant analysis to allow the Coordinator to consider the extent to which an NCESS will meet factors under Clauses 3.11A.7(c) – (f) of the WEM Rules:

- (c) the relative merits between procuring an NCESS or augmenting the network;
- (d) the outcome of any investigation of behaviour that reduces the effectiveness of the market, including behaviour related to market power;
- (e) whether the procurement of an NCESS is consistent with the Wholesale Market Objectives; and
- (f) whether procurement of an NCESS will be in the long-term interests of consumers.

1.6.1 Considerations under 3.11A.7(c)

In making its assessment of the emergent risks to its ability to manage Power System Security, AEMO –

- Did not find any instances of relevant network augmentation being able to mitigate the risk associated with DPV tripping.

- Took into consideration that the uplift in inverter standards through revised Australian Standard AS4777:2020 will not apply to existing installed DPV (approximately 1.7 GW) unless the units are upgraded.

Consequently, AEMO considers that network faults will continue to be a credible contingency for which appropriate Ancillary Services will be required to mitigate risk.

1.6.2 Considerations under 3.11A.7(d)

AEMO is not aware of any market power aspects relating to the identified trigger.

1.6.3 Considerations under 3.11A.7(e)

AEMO considers that the mitigation of issues identified in this submission are consistent with the Wholesale Market Objectives and that the Service Specification can be developed in accordance with the Wholesale Market Objectives. Specifically:

- the specification can be developed such that the service can be delivered by a range of technologies, in accordance with the WEM Objective under clause 1.2.1(c); and
- a competitive procurement process for an FFR NCESS which will ensure the cost of the service is as efficient as possible, in accordance with the WEM Objectives in clauses 1.2.1(a), (b) and (d).

1.6.4 Considerations under 3.11A.7(f)

AEMO considers that the mitigation of issues identified in this submission are in the long-term interest of consumers.