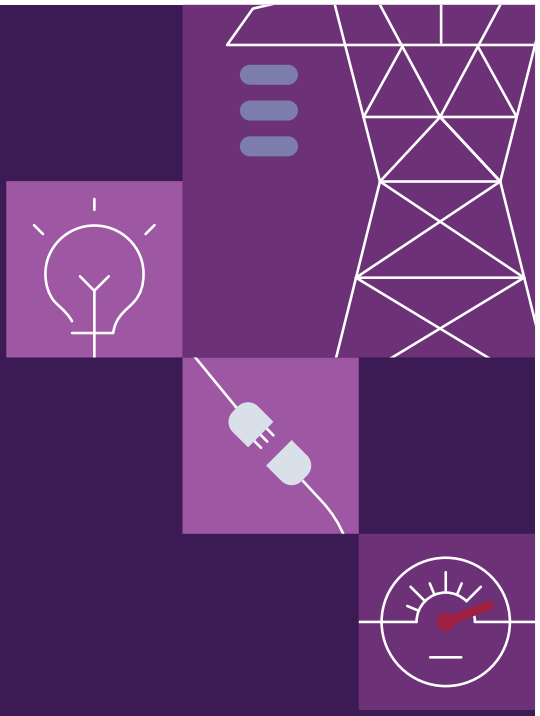
AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Victorian Planning



Request for Information – System Strength Services

Published Date:	14 July 2023
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Closing date:	5:00pm (AEST) 6 October 2023

Contents

Section A Introduction

A.1 Background

The Australian Energy Market Operator Limited (AEMO) is the independent organisation responsible for operating eastern, south-eastern and western energy markets and systems in accordance with the National Electricity Rules, Wholesale Electricity Market Rules, National Gas Rules and Gas Services Information Rules. Its functions include:

- market and system operator of the National Electricity Market (NEM) across eastern and south-eastern Australia;
- market and system operator of the Wholesale Electricity Market and South West Interconnected System in Western Australia;
- market and system operator of the Victorian Declared Wholesale Gas Market;
- operator of the short-term trading market (wholesale) for gas hubs in Sydney, Adelaide and Brisbane, the Wallumbilla gas supply hub (wholesale), and the Moomba Gas Supply Hub in South Australia;
- market operator of a number of retail gas markets in eastern and southern Australia;
- national transmission planning for the NEM; and,
- planning, authorising, contracting for and directing *augmentation* of the *declared transmission system* for Victoria (Victorian Transmission Network).

With its broad national focus for the future, AEMO's objectives are to promote efficient investment in and operation of Australia's electricity and gas services in the long-term interests of consumers with respect to price, quality, safety, reliability and security of energy supply.

A.2 Context

In October 2021, the Australian Energy Market Commission (AEMC) made its final rule determination on Efficient Management of System Strength on the Power System. This new system strength framework is intended to enable a more rapid connection of inverter-based resources (IBR) such as solar and wind, with solutions that achieve economies of scale. Under this framework, AEMO Victorian Planning (AVP) will be responsible for proactive provision of system strength services, as the Victorian System Strength Service Provider (SSSP), to facilitate efficient generator and storage connections.

Under the new framework, the SSSP must meet the new power system standard, comprising:

- A minimum fault level requirement for power system security at each system strength node.
- A requirement for stable voltage waveforms at connection points to host levels of IBR forecast by AEMO (as the System Planner), also known as the efficient level of system strength, at each system strength node.

AVP is required to plan to meet the standard (both minimum and efficient levels) from 2 December 2025 onwards.

A.3 This RFI

AVP is undertaking this Request for Information (RFI) to understand the availability of options for system strength services within and outside the Victorian *declared shared network* that enable compliance with the system strength requirement at the various System Strength Nodes.

The purpose of this RFI is to:

- assess the technical and economic feasibility of meeting the system strength standard from potential services revealed through this RFI;
- request information to assess the Respondent's capability and capacity to deliver these service options; and
- inform AVP's Regulatory Investment Test – Transmission (RIT-T) assessment.

Accordingly, AVP is issuing this RFI to persons who may be interested in providing system strength services. Details regarding the specific requirements of the system strength services are set out in Section C Requirement for Services.

Responses to this RFI will inform the development of AVP's RIT-T for Victorian System Strength including the technical and economic assessment of credible options to meet AEMO's system strength requirements over different time horizons. The RIT-T is a whole-of-market economic benefits test and optimisation; its conclusions will assess potential network and non-network solutions and identify the preferred option (or portfolio of options) that will maximise net market benefits.

It is anticipated that once the preferred option has been identified through the RIT-T process, AVP will run a competitive procurement process and/or commercial negotiations to deliver the required system strength services.

This RFI is being undertaken on a technology-neutral basis, and Respondents are welcome to offer conventional and innovative solutions that meet the requirements outlined in Section C, including with respect to technologies and technical solutions and commercial arrangements.

In anticipation of the national electricity objective (NEO) incorporating an emission reductions objective, we request that information be provided outlining the emissions of the system strength services and measures proposed to be taken to reduce or offset those emissions including the estimated costs of those measures.

A.4 Prerequisites

Respondents do not have to satisfy any particular requirements to respond to this RFI, but they should bear in mind that should they be interested in responding to a potential future Call for Expressions of Interest (CEI) or Invitation to Tender (ITT), a successful respondent must be able to demonstrate (among other things) the following to AVP's satisfaction to be awarded a contract:

- is registered or will successfully register in a relevant category under the National Electricity Law (NEL) and the National Electricity Rules (NER);
- holds or can obtain the relevant licences under the *Electricity Industry Act 2000* (Vic) and any necessary planning approvals to undertake the Project;
- has demonstrated capability and expertise to undertake all activities leading to a successful Project outcome so as to provide the Services;

- is of sufficient financial standing to be able to install, use or modify the Facility so as to provide the Services and has or will have any financing arrangements needed to support the provision of the Services for the Term;
- has in place or will affect arrangements with suppliers, service providers and other parties necessary to complete / upgrade the Facility (as required) so as to provide the Services; and
- has demonstrated capability of successfully delivering projects or services of similar size, type, value and complexity as those required to provide the Services.

Responses to this RFI should indicate how the Respondent intends to satisfy these prerequisites.

A.5 Indicative timetable

This timetable is provided to give Respondents an indication of the anticipated timing for the procurement and delivery process. Please note this is subject to change.

Activity	Date
Issue date of RFI	14 July 2023
Closing Date of RFI	5:00 pm (Melbourne time) 6 October 2023
Expression of Interest	March 2024
Invitation to Tender	August 2024
Contract award	March 2025
Construction completion and commissioning	From 2 December 2025

A.6 Written Q&A process

To facilitate the RFI Process, AVP will operate a limited online Q&A process. Potential Respondents must submit questions to AVP relating to the RFI Process via this email address: systemstrengthVIC@aemo.com.au.

The Q&A facility opens five business days after the RFI is released and closes five business days prior to the closing date.

Please note that:

- AVP will answer questions at its discretion.
- If it does answer questions, AVP will endeavour to make responses available to all potential Respondents (without identifying the party that submitted the relevant question).
- Notwithstanding the above dot point, AVP understands that some specific questions or responses (for example, regarding a particular Facility or Service) are sensitive and it would be appropriate not to circulate the response. If a potential Respondent does not wish a question or response to be made available to others, it must identify the question as 'Commercially sensitive – not for circulation', together with an explanation of why the information is sensitive for AVP to consider.

A.7 Glossary

In this document:

- a capitalised word or phrase has the meaning set out opposite that word or phrase below;
- a word or phrase *in this style* has the same meaning as given to that term in the NER;
- unless the context otherwise requires, this document will be interpreted in accordance with Schedule 2 of the NEL.

Term	Definition
Addendum	Any document issued by AEMO after the date of this RFI and labelled as an "Addendum" to this RFI; collectively known as "Addenda".
AEMO	Australian Energy Market Operator Limited ABN 94 072 010 327. References to AEMO include, where the context requires, AEMO's employees, officers, contractors, consultants, advisers and other persons authorised to act for AEMO.
AEMO Contact	The contact specified on the cover of this RFI.
AusNet Services	AusNet Transmission Group Pty Ltd ABN 78 079 798 173 and any Related Entity of that company.
Business Day	A day other than Saturday, Sunday and any other day not taken to be a public holiday in Australia and its States.
Closing Date	The date specified on the cover of this RFI.
Declared Shared Network	The "declared shared network" (as defined in the NEL) for Victoria. In summary, it's the electricity transmission network within the State of Victoria (excluding connection assets).
Facility	Any facility or facilities proposed to be installed, used or modified (as the case may be) by the Recipient in order to provide the Services. This includes all shared network *augmentations*, interface/connection works and required control and communications schemes to enable delivery of the services.
MVAr	Megavolt ampere of reactive power
MW	Megawatt
NEL	The National Electricity Law, being the law set out in the schedule to the National Electricity (South Australia) Act 1996 (SA), as it applies in Victoria.
NER	National Electricity Rules referred to in the NEL.
NSP	*Network Service Provider*.
Project	The project described in subsection A.2, including the design, construction, commissioning, installation and modification (as the case may be) and operation of the Facility, the provision of the Services and any ancillary or related activities connected with the delivery of the Facility or the Services.
Recipient	A person in Receipt of this RFI.
Related Entity	Has the meaning given in the *Corporations Act 2001* (Cth).
Representatives	In respect of a Recipient includes any Related Entity, and includes in relation to that Recipient or Related Entity, its employees, agents, advisers, consultants, contractors and persons to whom it supplies this RFI or any other documents issued in relation to the RFI Process by AEMO.
Respondent	A person submitting a Response. Where a Respondent is a consortium, a reference to "Respondent" includes a reference to each consortium member individually.
Response	The document submitted by a Recipient in relation to the provision of the Services in response to this RFI.
RIT-T	Regulatory Investment Test for Transmission.
Services	The services set out at subsection **Error! Reference source not found.**, including, where the context requires, Related Services set out at subsection **Error! Reference source not found.**.
Term	The number of years which the Recipient proposes to provide the Services.

Section B System strength standard

System strength can broadly be described as the ability of the power system to maintain and control voltage waveform at any given location in the power system, both during steady state operation and following a disturbance.

Declining minimum operational demand caused by increasing distributed photovoltaics (DPV), changing dispatch of synchronous generating units and rapid uptake of variable renewable energy (VRE) resources have combined to reduce the levels of system strength available in parts of the Victorian power system. This has resulted in the need for system strength services to support the stable operation of existing equipment and to host further IBR as the Australian electricity sector transformation continues.

The AEMC has completed a rule change[1] from the previous system strength framework, which relies on shortfall declaration to a framework the enables SSSPs to meet a new system strength standard on a forward-looking basis. The system strength standard is as shown in Figure 1.

- **Minimum fault level** – system strength can partly be represented by the amount of electrical power that flows when there is a disturbance on the system, referred to as fault level and measured in megavolt amperes (MVA). A minimum fault level is required to ensure a secure power system for the existing system normal and enable network protection systems and voltage control devices to operate correctly.
- **Stable voltage waveform criteria** – other aspects of system strength aside from fault level are also important to ensure IBR can connect and remain stable during steady state conditions and following credible contingency events. AEMO (as national planner) has defined four criteria in its System Strength Requirements Methodology[2] which describe these aspects of system strength.

A power system with low system strength may exhibit one or more of the following[3]:

- Wider area undamped voltage and power oscillations.
- Generator fault ride-through degradation.
- Mal-operation or failure of protection equipment to operate.
- Prolonged voltage recovery after a disturbance.
- Larger voltage step changes after switching capacitor or reactor banks.
- Instability of generator/dynamic plant voltage control systems.
- Increased harmonic distortion (depending on network harmonic impedances).
- Deeper voltage dips and higher over-voltages.

An example of a power system with low system strength is the system strength gap as identified at Red Cliffs[4].

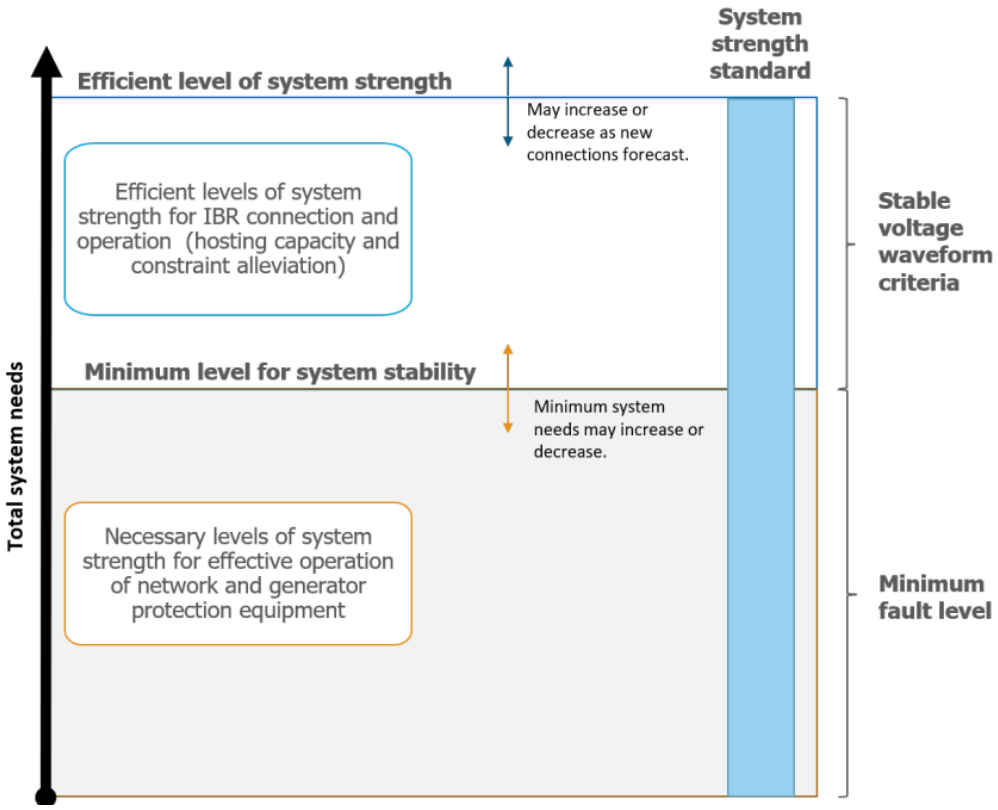
[1] AEMC, Efficient Management of system strength on the power system, at https://www.aemc.gov.au/rule-changes/efficient-management-system-strength-power-system. AEMC, Efficient Management of system strength on the power system, at https://www.aemc.gov.au/rule-changes/efficient-management-system-strength-power-system.

[2] AEMO System Strength Requirements Methodology, at https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/system-strength-requirements/system-strength-requirements-methodology.pdf?la=en.

[3] AEMO, 2020 System Strength Explained, at https://aemo.com.au/-/media/files/electricity/nem/system-strength-explained.pdf. AEMO, 2020 System Strength Explained, at https://aemo.com.au/-/media/files/electricity/nem/system-strength-explained.pdf.

[4] AEMO, 2019 Power System Limitations December, at https://www.aemo.com.au/-/media/Files/Electricity/NEM/Network_Connections/Power-System-Limitations-December.pdf. AEMO, 2019 Power System Limitations December, at https://www.aemo.com.au/-/media/Files/Electricity/NEM/Network_Connections/Power-System-Limitations-December.pdf.

Figure 1 System strength standard



Source: AEMC National Electricity Amendment (Efficient Management of System Strength on The Power System) Rule 2021 Final Determination.

AEMO (as national planner) publishes an annual System Strength report that outlines the system strength requirement for Victoria in accordance with AEMO's System Strength Requirement Methodology[5]. The requirements are defined at system strength Nodes. The information used in this RFI is based on AEMO's 2022 System Strength Report[6], which contain the following nodes:

- Dederang 220 kilovolts (kV).
- Hazelwood 500 kV.
- Moorabool 220 kV.
- Red Cliffs 220 kV.
- Thomastown 220 kV.

B.1 Minimum fault level

Clause S5.1a.9 of the NER outlines the standard which sets a minimum three phase fault level requirement for power system security (expressed in MVA), sufficient to enable:

- correct operation of protection systems of networks and Network Users (both transmission and distribution);

[5] AEMO, 2022 System Strength Requirement Methodology, at https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/system-strength-requirements/system-strength-requirements-methodology.pdf. AEMO, 2022 System Strength Requirement Methodology, at https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/system-strength-requirements/system-strength-requirements-methodology.pdf.

[6] AEMO, 2022 System Strength Report, at https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/operability/2022/2022-system-strength-report.pdf?la=en. AEMO, 2022 System Strength Report, at https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/operability/2022/2022-system-strength-report.pdf?la=en.

- stable voltage control systems; and
- the power system to remain stable following any credible contingency event or protected event.

B.2 Stable voltage waveform criteria

Additionally, NER S5.1a.9 outlines the requirement for stable voltage waveforms at connection points (also known as the efficient level of system strength) as part of the standard, such that:

- in steady state conditions, plant does not create, amplify, or reflect instabilities; and
- avoidance of voltage waveform instability following any credible contingency event or protected event is not dependent on plant disconnecting or varying active power or reactive power transfers, other than in accordance with performance standards.

The System Strength Requirements Methodology provides further description of a stable voltage waveform based on four criteria. It should be noted that the description is not intended to characterise the behaviour of IBR during a fault. Rather, it attempts to describe criteria to achieve stable voltage waveform conditions under which IBR can operate without difficulty. In addition, this description is designed to facilitate a shift away from considering voltage waveform stability largely as an outcome of fault level contribution. The four criteria are:

- **Voltage magnitude** – the positive-sequence root mean squared (RMS) voltage magnitude at a connection point does not violate the limits pertaining to voltage excursions, and the permissible voltage step change created by reactive power injection or absorption.
- **Change in voltage phase angle** – change in the steady-state RMS voltage phase angle at a connection point should not be excessive following injection or absorption of active power. A value between 30 and 60 electrical degrees could be used as a reasonable threshold to measure the steady-state change in voltage phase angle following active power injection or absorption at a connection point, noting this is not a hard limit.
- **Voltage waveform distortion** – the three-phase instantaneous voltage waveform distortion at a connection point should not exceed acceptable planning levels for pre-and post-contingent conditions. This can be assessed with reference to NER Schedule 5.1a, and acceptable voltage waveform distortion should be consistent with NER S5.1a.6.
- **Voltage oscillations** – any undamped steady-state RMS voltage oscillations anywhere in the power system should not exceed an acceptable planning threshold. A proposed planning threshold for acceptable oscillations of up to 0.5% peak-peak RMS voltage is being considered by the Power System Security Working Group and Power System Modelling Reference Group convened by AEMO .

B.3 Solutions to meet the system strength standard

This RFI is being undertaken on a technology-neutral basis, and Respondents are welcome to propose conventional and innovative services that fully or partially meet either component of the system strength standard. AVP expects that a co-ordinated mix of network and non-network solutions will be the most efficient approach to meet the system strength standard. This may involve contracting with new and existing energy market participants and establishing new technologies and system strength services to ensure ongoing power system security. These could include:

- Synchronous machine – synchronous condensers and synchronous generators such as coal, gas and hydro are capable of providing system strength services when dispatched as quantified in the current Victorian system strength minimum generator combinations for a secure state[7].
- Modification to existing synchronous generators – synchronous generators may either be able to dynamically switch between operation as a synchronous condenser and operation as a generator, whilst other synchronous generators may permanently convert from operation as a generator to operation as a synchronous condenser where hybrid operation is not feasible. AEMO as part of its Engineering framework has published a paper exploring the feasibility and technical challenges of converting of synchronous generation into synchronous condensers[8].
- Grid forming batteries, generators, SVCs and STATCOMs – grid-forming inverters, when appropriately tuned and configured, may be capable of providing system strength services. AEMO as part of its Engineering Framework has published a voluntary standard for grid forming inverters outlining the core technical capabilities which power electronic devices should have in order to be categorised as grid-forming inverters[9].

The Victorian Government has invested in two system strength projects[10] (Kerang Battery Energy Storage System (125 megawatts (MW)) and Ararat Synchronous Condenser (250 MVA)) as part of Stage 1 of the Renewable Energy Zone (REZ) Development Plan in the Murray River and Western Victoria REZs. These projects will be made available to meet Victoria's system strength requirement at all system strength nodes, especially at Moorabool and Red Cliffs. The projects are anticipated to unlock up to 300 MW and 600 MW of new renewable energy in the respective REZs.

B.4 Operational Security Mechanism

The AEMC is currently consulting on its Operational Security Mechanism (OSM) rule change. The OSM aims to provide a framework for scheduling of system strength services procured through this RIT-T. A forward directions note[11] was released in May 2023 indicating that the close-to-real-time market approach proposed in the draft determination would be costly and complex to implement, prompting a need for a more simple and timely solution.

The method of dispatching system strength services and the division of responsibility between AEMO and SSSPs is still subject to the final determination of the OSM rule change. AVP does not anticipate that the outcome of the OSM will materially impact the decision making of this RIT-T, however any system strength service will need to accommodate the introduction of such a mechanism.

A directions paper is expected to be released for the OSM rule change in mid-2023 with a final determination expected by the end of 2023. AVP will include provisions relevant to OSM and OSM-like mechanisms in any eventual procurement contract.

[7] AEMO, April 2023 Transfer Limit Advice – System Strength in SA and Victoria, at https://www.aemo.com.au/-/media/files/electricity/nem/security_and_reliability/congestion-information/transfer-limit-advice-system-strength.pdf. AEMO, April 2023 Transfer Limit Advice – System Strength in SA and Victoria, at https://www.aemo.com.au/-/media/files/electricity/nem/security_and_reliability/congestion-information/transfer-limit-advice-system-strength.pdf.

[8] ARENA, Repurposing Existing Generators as Synchronous Condensers, at https://arena.gov.au/assets/2023/06/repurposing-existing-generators-as-synchronous-condensers-report.pdf.

[9] AEMO, May 2023, Voluntary Specification for Grid-forming Inverters, at https://aemo.com.au/-/media/files/initiatives/primary-frequency-response/2023/gfm-voluntary-spec.pdf?la=en&hash=F8D999025BBC565E86F3B0E19E40A08E#:~:text=This%20%E2%80%98voluntary%20specification%E2%80%99%20is%20a%20preliminary%20document%20to,in%20order%20to%20be%20categorised%20as%20grid-forming%20inverters.

[10] DEECA, Transmission and Grid Upgrades, at https://www.energy.vic.gov.au/renewable-energy/transmission-and-grid-upgrades. DEECA, Transmission and Grid Upgrades, at https://www.energy.vic.gov.au/renewable-energy/transmission-and-grid-upgrades.

[11] AEMC, Update on the direction for the Operational Security Mechanism rule change, at https://www.aemc.gov.au/sites/default/files/2023-05/Forward%20direction%20note.pdf.

Section C Requirement for Services

The high level functional requirements for the Services are set out below.

Any capability at the Facility exceeding the requirements of the Services may be deployed by the Respondent for other purposes, provided that such use does not prejudice the Respondent's ability to provide the Services.

AVP expects that the Services should not result in any resources being withdrawn from the national electricity market for the purposes of providing the service. To the extent that the Services rely on an existing or committed Facility, Respondents must provide details of the proposed changes to the Facility and market offerings which would result from the provision of the Services.

AVP is seeking information on services that will enable AVP to meet the minimum fault level requirement, as shown in Table 1, and services that will enable AVP to meet the stable voltage waveform criterion with the forecast IBR connection, as shown in 0. It should be noted the table has modified forecast IBR generation compared to AEMO's 2022 System Strength Report to reflect recent generation commitments as outlined in the May 2023 Generation Information[12].

Table 1 Victorian minimum fault level requirement (MVA)

System strength node & voltage	Pre-contingency fault level requirement (MVA)	Post-contingency fault level requirement (MVA)[A]
Dederang 220 kV	3,500	3,300
Hazelwood 500 kV	7,700	7,150
Moorabool 220 kV	4,600	4,050
Red Cliffs 220 kV	1,786	1,036
Thomastown 220 kV	4,700	4,500

A. Fault level for critical contingencies as identified in AEMO System Strength Report.

Table 2 AEMO System Strength Report 2022 – modified forecast IBR generation (MW)

System strength node	2025	2026	2027	2028	2029	2030	2031	2032	2033
Moorabool	0	0	92	92	92	153	944	1,456	1,556
Hazelwood	374	394	394	394	833	1,482	2,001	2,001	2,001
Dederang	0	0	0	0	0	0	0	264	264
Red Cliffs	0	0	0	0	0	0	0	354	1,437
Thomastown	0	0	0	0	0	0	0	0	0

C.1 Operation and availability

The solutions should be capable of contributing to meet minimum fault level requirements at each system strength node at all times of the year, from 2 December 2025 onwards. As minimum fault level requirement needs to be met all times, it is expected that the portfolio of selected services will cumulatively be available at

[12] NEM Generation Information May 2023- https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/generation-information

all times. As such, AVP will consider solutions with continuous availability and service availability provided as requested by AEMO on an as needed basis.

The solutions should be capable of contributing towards stable voltage waveform with the forecasted IBR generation at each system strength node, from 2 December 2025 onwards. The service provided can be continuously available or efficiently dispatched to maintain system security and maximise the value of energy trade.

AVP also places great importance on the flexibility of planned outages such that the portfolio of system strength services are able to meet the system strength standard at all times.

C.2 Technical requirement

C.2.1 Minimum requirement

The solution must:

- be capable of operating continuously during contracted periods at the contracted capability;
- be capable of operating continuously after single line trips;
- incorporate the capability to transmit 4-second SCADA signals to AEMO;
- provide a material quantity of system strength, for example from solutions with a rated capacity greater than 50 MVA;
- comply with any relevant performance standards specified in the applicable connection agreement (whether or not registered with AEMO); and
- comply with any applicable requirements of the NER.

C.2.2 Minimum fault level

The solution that enables AVP to meet minimum fault level requirements should be capable of sustained high fault level contribution to ensure correct operation of both primary and back up protection systems in both transmission and distribution networks.

C.2.3 Stable voltage waveform

Stable voltage waveform does not have a network metric (like fault level) that allows a straightforward assessment of a service in relation to the forecast IBR connection. The ability of any service to ensure the four stable voltage waveform criteria as outlined in Section B.2 is highly dependent on local network parameters and generation dispatch in addition to the proposed service technology type and design.

As such, any services proposed to provide system strength will be required to provide detailed models to allow for validation conducted through detailed PSS®E and PSCAD™ Electromagnetic Transient (EMT) studies.

AEMO has estimated the approximate fault level that may be required to ensure a stable voltage waveform for new connecting IBR, as an indicative proxy for the size of system strength services required to meet the efficient level, above and beyond the minimum fault level requirements as shown in Table 3. Due to the variable nature of renewable generation, some quantum of these system strength services may be required most of the time, and others less frequently.

Table 3 Estimated additional fault level (MVA) required to ensure stable voltage waveform for forecast new IBR connection

System strength node	Location[A]	2030	2031	2032	2033
Moorabool	Mortlake 500 kV Terminal Station	0	0	100	200
	Bulgana 500 kV Terminal Station	100	300	1,750	2,800
Hazelwood	Hazelwood 500 kV Terminal Station	300	1,300	1,350	1,500
Red Cliffs	New 220 kV terminal station near Kerang[B]	0	0	0	1,900

A: The locations in **Error! Reference source not found.** are indicative only.
B: New terminal station established as part of VNI West.

AVP acknowledges that system strength services have been procured under the Victorian Government's REZ Development Plan which suggests a certain ratio of installed capacity of new plant (synchronous condenser and grid-forming BESS) to supportable new IBR. Nevertheless, this has to be evaluated on a case-by case basis; as noted earlier, technology choice and design and local network parameters will impact the effectiveness of any proposed system strength services. This is especially true for new technologies like grid-forming BESS where different designs will have different effectiveness in maintaining a stable voltage waveform.

AVP also strongly recommend that any grid forming solutions consider the recommendations contained in the Australian Renewable Energy Agency's (ARENA's) report into PSCAD™ assessment of the effectiveness of grid-forming batteries[13] and AEMO's Voluntary Specification for Grid Forming Inverters[14].

AVP would be seeking for the Respondent to provide both PSS®E and PSCAD™ (v5) models, as well as demonstrating in Single Machine Infinite Bus (SMIB) models with a low SCR connection that the proposed service will be capable of meeting the four criteria in the stable voltage waveform.

C.2.4 Economic and commercial

The RIT-T as a "reliability corrective action" is a whole-of-market economic benefits test which seeks to identify the transmission investment option(s) that maximises net market benefits/minimise net economic detriment while meeting the system strength standard– which may include network and/or non-network solutions. In August 2020, the Australian Energy Regulator (AER) published an update to its RIT-T Application Guidelines which clarified that RIT-T analysis should reflect total costs and market-wide benefits of credible non-network options (a change from the previous approach, in which costs of non-network options were estimated based on costs that could be expected in a tender process). As a result, in this RFI, AVP is seeking

[13] At https://arena.gov.au/knowledge-bank/pscad-assessment-of-the-effectiveness-of-grid-forming-batteries/. At https://arena.gov.au/knowledge-bank/pscad-assessment-of-the-effectiveness-of-grid-forming-batteries/.
[14] At https://aemo.com.au/-/media/files/initiatives/primary-frequency-response/2023/gfm-voluntary-spec.pdf?la=en&hash=F8D999025BBC565E86F3B0E19E40A08E.

information about both the expected economic cost (regardless of ownership) and the expected contract price of proposed options.

Existing and committed assets are considered to have no capital costs, although modifications to existing facilities may include incremental capital investment which should be included.

As noted above, AVP will also consider services offered on demand as requested by AEMO.

C.2.5 Location

The proposed solutions that provide system strength services are not restricted by state boundaries. Solutions which contribute to meeting Victoria's needs can be located outside of Victoria.

System strength naturally diminishes with electrical distance as a result of the network's impedance, which is a function of physical distance and the capacity of the network. As such, non-network options that are located closer (electrically) to the system strength need will provide a greater system strength contribution. Solutions may also contribute to meeting system strength requirements at more than one system strength node.

AVP is required to ensure that the system strength standard is met for both system normal and following a credible contingency or protected event. Therefore, consideration will be given to the proposed services ability to provide system strength services post any credible network contingency to the system strength node and IBR generation clusters (REZs) in meeting minimum fault level and efficient level requirements respectively.

C.3 Other services

The proposed solution may be able to provide additional or modified services to AVP relating to the system strength service which are of benefit to the overall system.

Respondents are encouraged to develop, identify and outline any other services (such as inertia and voltage control) offered to AVP and the extent to which they can be provided, together with the benefits and any associated additional costs.

AEMO's *Victorian Annual Planning Report*, *Integrated System Plan*, System Security Reports[15] and limits advice[16] may provide further information to assist in informing any offer of Related Services that a Respondent may consider.

C.4 Requirements subject to change

Please note that the scope and detailed specification of the Services described in this RFI are subject to change as AVP receives more information during the RFI Process and the broader RIT-T process.

[15] At https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/system-security-planning.
[16] At https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/system-operations/congestion-information-resource/limits-advice.

Section D Structure and content of response

Respondents should supply the information required below in this section by filling in the separate word document with the following schedules titled Returnable Schedules – System Strength Services .

Responses should be in the form specified in this section with any additional information provided as attachments or appendices. Any assumptions made should be clearly stated in the Response. AVP reserves the right to verify claims made in any Response.

D.1 Service Information Schedule

Organisational information

Parameter	Applicable technology	Description	Response
Company name	All	Name of the company submitting this RFI	
ABN	All	ABN of the company submitting this RFI	
Key contact name	All	Name of the key contact for this RFI	
Contact email address	All	Email address for the key contact	
Contact phone number	All	Phone number for the key contact	

Please also provide, in no more than three pages, evidence of capability and capacity to deliver the proposed service, including:

- experience in delivering system strength or related services;
- expected project delivery timeframes, where relevant; and
- evidence of technical maturity and economic feasibility (cost-effectiveness) of proposed solution.

Proposed service

Proposed service parameters are to be defined under Reference Conditions where relevant. For any parameter where Reference Conditions are unachievable, please state the value of the parameter and the accompanying alternative condition.

Reference Condition

Condition	Description
Ambient dry bulb temperature	50°C.
Relative humidity	As per local conditions - using one or more nearby BOM stations interpreting coincident humidity with high ambient dry bulb temperature in the past 30 years (Service Provider to justify).
System frequency	50 Hz
Power factor	0.93

Service parameter

Parameter	Applicable technology	Unit	Description	Response
Solution name / address	All	N/A	Name and/or address of the solution (or multiple units that form part of the solution)	
Service connection point	All	N/A	Connection point of the service on the Victorian declared shared network	
Technology type	All	N/A	e.g. synchronous generator, grid forming battery, grid forming renewables, synchronous condenser	
Rated capacity	All	MVA	Rated capacity of the solution	
Number of units & unit size	All	N/A, MVA	Number of synchronous condensers/inverter and size of each unit	
Rated capacity	BESS	MWh	Energy storage capacity	
Available date	All	N/A	Expected date for the proposed system strength service to be made available. For proposed new or modified project, this project must have completed construction, grid connection, testing and all commissioning activities and be available to provide the proposed system strength service.	
Service start date	All	N/A	Proposed start date for providing system strength services	
Service end date	All	N/A	Proposed end date for providing system strength services	

Parameter	Applicable technology	Unit	Description	Response
Service contract operating model	All	N/A	Continuous/ on AEMO request/ other (please define)	
Minimum service contract period	All	N/A	Minimum service contract period required by service	

Technical parameters

Parameter	Applicable technology	Unit	Description	Response
Fault current contribution & duration at POC	All	MVA	Level of three phase, line to line and single line to ground fault contribution in MVA at the connection point and duration of sustained fault level contribution (up to a minimum of 3s). Eg: **Duration (s)** / **3 phase fault level (MVA)** / **Line to line fault level (MVA)** / **Single phase to ground fault level (MVA)** **xx** XXXX XXXX XXXX **yy** YYYY YYYY YYYY	
Continuous Reactive Power Capability at POC	All	MVAr	Range of reactive power capability of service offered at the connection point. (steady state reactive capability diagram showing POC voltage vs POC reactive power).	
Short term Reactive Power Capability at POC	All	MVAr	Range of reactive power capability of service offered at the connection point. (short term reactive capability diagram showing p.u. overload vs. time)	
Overload capacity & duration	All	MVA or %, s	The overload capacity of the plant in MVA or percent of Rated Capacity and duration of this capacity as measured at the connection point. (short-term overload capability graph (p.u. overload vs. time))	
Low and high voltage ride through capabilities	All		Capability of service to ride through low and high voltage	
Minimum stable operating level	All	MW	Minimum stable operating level of each unit in MW	
Active-Reactive Power Capability Curve at POC	All	MW/ MVAr	Active-Reactive Power Capability Curve at 0.9, 1.0 and 1.1 p.u voltage at the connection point.	

Parameter	Applicable technology	Unit	Description	Response
Impedance of the machine	All	p.u.	Synchronous, transient and sub transient impedance of the machine in per unit with MVA base clearly indicated	
Impedance of the transformer	All	p.u.	Impedance of the transformer, in per unit with MVA base clearly indicated	
Vector group of the transformer	All	N/A	For example, Star/Delta, Delta/Star, Star/Delta/Delta etc.	
Line impedance	All	p.u.	An estimate of line impedance to the point of connection of the transmission network	
Control & Communication Signals	All	N/A	Dispatch communications protocol with AEMO	
Inertia contribution	All	MW.s	Inertia or synthetic inertia contribution of the solution (if flywheel is proposed as an option then inertia with and without flywheel should be noted)	
Asset Life	All	Years	Anticipated asset life that is capable of delivering the service	

Please also provide

- any relevant single line diagram (SLD) associated with the service;
- PSS®E (version 34.5 or later) model and PSCAD™ (version 5) model that accurately represent the service at scale and how it will operate, and that are compliant with AEMO's Dynamic Model Acceptance Test (DMAT) Guideline requirements; and
- associated Releasable User Guide, manual, library files and list compatible of Intel Fortran compiler versions.

Operational capability

Parameter	Applicable technology	Unit	Description	Response
Service annual availability	All	%	Annual availability of the solution to provide system strength services, represented as a percentage of a year	
Start-up time	All	Hours/ minutes	Expected time following a request for enablement before the solution can provide contracted system strength services	

Parameter	Applicable technology	Unit	Description	Response
Shut down time	All	Hours/ minutes	Expected time following a request for disablement before the solution can cease to provide contracted system strength services	
Continuous running time	All	Hours	Maximum period of time the solution can be run continuously when providing system strength services	
Annual maintenance duration	All	Hours/ %	Duration of a year in which the solution would be offline for maintenance	
Periods of unavailability	All	N/A	Likely month/day/time that the solution will be unavailable to provide contracted system strength services (if any)	
Frequency & duration of maintenance	All	Number & hour per year	Number of major & minor maintenance period per year and the associated unavailability duration.	

Economic and commercial

Parameter	Applicable technology	Unit	Description	Response
Project status	All	N/A	• Existing • Existing with non-committed modifications • Existing with committed modifications • Committed project • Non-committed project Will the proposed system strength services be provided by assets that meet the definition of 'committed project' under the AER's RIT-T Application Guidelines, using the following criteria: a) The respondent has obtained all required planning consents, construction approvals and licenses, including completion and acceptance of any necessary environmental impact statement b) Construction has either commenced or a firm commencement date has been set c) The respondent has purchased/settled/acquired land (or commenced legal proceedings to acquire land) for the purposes of construction	

Parameter	Applicable technology	Unit	Description	Response
			d) Contracts for supply and construction of the major components of the necessary plant and equipment (such as generators, turbines, boilers, transmission towers, conductors, terminal station equipment) have been finalised and executed, including any provisions for cancellation payments e) The necessary financing arrangements, including any debt plans, have been finalised and contracts executed.	
Capital Cost	Non- committed project	$,000	Total capital cost (regardless of ownership)[17] for the proposed solution, including costs of plant/equipment, land, civil works, grid connection assets and development costs. If possible, please reflect the actual spend profile for the project (otherwise, lump sum). These costs must exclude a rate of return on capital, and should not subtract any: • Expected payments from AVP • Expected payments or revenues from energy (and related) markets • External funding contributions (e.g. grants) Existing or committed assets are considered to have zero capital cost (i.e. are a sunk cost). However, capital costs associated with modifying or upgrading existing facilities to provide system strength services should be included.	
Fixed operating cost	All	$,000	Annual fixed operation and maintenance (FOM) costs of the underlying resource	
Variable operational Cost	All	$,000 per MWh or hour	Expected running costs of the underlying resource, including fuel costs and variable operations and maintenance (VOM)	
Annual electricity consumption	All	MWh	Expected electricity consumption to provide required service. Please indicate if the cost of electricity has been factored in the operating costs.	
External contributions	New projects	$,000	Expected external funding (or is expected to receive external funding) for the project, such as from ARENA or government.	

[17] As per RIT-T guidelines, capital costs are considered $0 for existing or committed assets, and for new assets the total capital cost of the underlying resource for the non-network solution (i.e. regardless of ownership).

Parameter	Applicable technology	Unit	Description	Response
Greenhouse gas emissions (scope 1)	All	tCO2e/MWh or tCO2e/hour	Estimated scope 1 greenhouse gas emissions from providing system strength services	
Greenhouse gas emissions (scope 2)	All	tCO2e/MWh or tCO2e/hour	Estimated scope 2 greenhouse gas emissions from providing system strength services	
Other market benefits	All		Beyond system strength services, describe other services that the assets/project will provide in energy and related markets (e.g. wholesale energy market, ancillary services markets, other network support services).	
Expected system strength contract price	All	.$,000	Proposed fees payable for the provision of system strength services. The fee structure should include the following components (in line with the draft OSM structure): • Establishment Fee: one-off setup cost, if applicable. • Availability Fee: monthly payment for the service to be made available to AEMO. This is intended to cover fixed costs for providing the service. • Enablement Fee: $ per event, intended to cover the cost of the service being enabled/activated. • Variable Fee: $/MWh fee to operate at the minimum stable operating level for synchronous generators, or $/hour for other solutions Please specify whether fees are in real or nominal terms, and any indexation methodology that applies	

Parameter	Description of measure	Cost of measure
Emissions reduction measures to be taken		

Please also provide:

- Details of any material assumption used to prepare the Response.

Section E The RFI process

E.1 Legal status

This RFI is not an offer. It is an invitation for persons to submit a Response only. This RFI must not be construed, interpreted or relied upon, whether expressly or impliedly, as an offer capable of acceptance by any person.

Neither this RFI, nor a Response submitted by a Recipient, has any contractual effect and does not create any AVP, promissory, restitutionary or other rights to proceed with the Project.

AEMO is under no obligation to complete the process outlined in this RFI or to proceed with the acquisition of any Services. AVP may change the process or the description of the requirements outlined in this RFI at any time prior to its close.

E.2 Confidentiality of AEMO's information

In the course of this RFI Process, including as part of the written Q&A process, Respondents may receive confidential information about AEMO and its activities. It is provided solely to enable Respondents to submit Responses. Respondents are not permitted to disclose or to use any such information received in this RFI Process for any other purpose. Respondents must take all reasonable steps (both physically and electronically) to protect the confidentiality of any such information received in this RFI Process and all communications relating to it, including the Recipient's Response.

E.3 Intellectual property in this RFI

Unless otherwise indicated in this RFI, AEMO owns such intellectual property rights as may exist in this RFI and any other documents provided to Respondents by or on behalf of AEMO in connection with the RFI Process. Respondents are permitted to use and copy this RFI for the sole purpose of preparing and submitting a Response.

E.4 Requests for further information

If Respondents find any discrepancy, error, or have any doubt as to the meaning or completeness of this RFI, or require clarification on any aspect of it, they should notify the AEMO Contact in writing, not less than 14 days before the Closing Date. AVP may issue further information to all Respondents clarifying the discrepancy, error, doubt, or query (as the case may be) and may, in its absolute discretion, extend the Closing Date.

AVP reserves the right not to respond to any question or request, irrespective of when it is received.

No representation or explanation to Respondents as to the meaning of this RFI, or as to anything to be done or not to be done by the Respondent, will be taken to be included in this RFI unless it is contained in an Addendum.

E.5 Submitting a Response

A Response must meet the following requirements:

- the form of Response must follow the structure and include the information requirements in 0 (“

- Structure and content of response");
- if the Recipient cannot provide any of the required information, the Recipient must state this in the Response, with reasons;
- the person submitting the Response must be authorised to do so on behalf of the Recipient; and
- the Response must be sent to AVP at systemstrengthVIC@aemo.com.au in accordance with the instructions on its website by 4:00 pm (Melbourne time) on the Closing Date.

AVP is not obliged to make an offer to contract with a proponent as a result of this RFI.

AVP will use submissions to enable an assessment and/or comparison of network and non-network solutions to meet system strength needs, required as part of the RIT-T process. Respondents should clearly identify any confidential or commercially sensitive information included in their proposals that they do not wish to be disclosed publicly.

E.6 Respondents to perform own due diligence

By submitting a Response, a Recipient is taken to have:

- read and understood the requirements of this RFI;
- made all reasonable enquiries, investigations and assessments relevant to the risks, contingencies, costs, procedures and other circumstances relating to the Project; and
- satisfied itself as to the correctness and sufficiency of its Response.

This RFI does not constitute legal or business advice and should not be relied on as a substitute for obtaining detailed advice about those matters, including the NEM, the NER, or any other applicable laws, procedures or policies.

E.7 Use of Responses

Upon submission, all Responses become the property of AEMO. Subject to this paragraph, Respondents will retain all intellectual property rights contained in the Response.

Notwithstanding the above, each Recipient, by submission of their Response, is deemed to have granted:

AEMO a licence (which includes a right to sublicense to their professional advisers) to reproduce the whole, or any portion, of their Response for the purposes of enabling AVP to inform and complete the RIT-T, and to define its requirements for the Services and the content of any future CEI, ITT or other document describing or relating to the System Strength needs.

E.8 No reimbursement of costs

AEMO and its Representatives will not be responsible for, and no Recipient is entitled to be reimbursed for, any expense, liability or loss incurred in the preparation and submission of its Response, including (without limitation) for any costs incurred in attending meetings with AVP, submitting any questions to, or reviewing any responses from, AVP under the written Q&A process, or providing any further clarification requested by AVP.

E.9 No publicity

Respondents must not make any public or media announcement about this RFI or the outcome of this RFI without AVP's prior written permission.

E.10 Material disclosure

AVP notifies Respondents as follows:

a) *declared transmission system operators* (including AusNet Services, Transmission Operations Australia and TransGrid) and their Related Entities (within the meaning of the *Corporations Act 2001* (Cth)) are able to respond to this RFI; and

b) no participant or intending in the national electricity market is prohibited from responding to this RFI.

Each Recipient and Respondent acknowledges and agrees that it has been made aware of the matters outlined in this subsection E.10.

E.11 No obligation to call for tenders or enter into contract

Notwithstanding the outcome of this RFI (and subsequent RIT-T) and without limiting any other rights AVP may have, AVP is under no obligation to call for expressions of interest or tenders from or to enter into a contract with any respondent or any other person.

Schedule 1 Service Information

Returnable schedule as noted in D.1and captured in word document “Returnable Schedule – Service Information.docx”