GOVERNMENT OF WESTERN AUSTRALIA

Department of Energy and Economic Diversification

Energy Policy WA

Power System Security and Reliability Standards Review

Consultation Paper

System Strength regulatory incentives framework and Technical standards for hybrid systems

20 August 2026

Contents

Abbreviations

Term	Definition
AEMO	Australian Energy Market Operator
DEED	Department of Energy and Economic Diversification
EMT models	Electromagnetic Transient models
ESM Rules	Electricity System and Market Rules
ESR	Electric Storage Resources
GFL	Grid-following (inverters)
GFM	Grid-forming (inverters)
GPS	Generator Performance Standards
IBR	Inverter based resources
NCESS	Non-Co-optimised Essential System Services
NEM	National Electricity Market
SEO	State Electricity Objective
SWIS	South West Interconnected System
WEM	Wholesale Electricity Market

Executive summary

Western Australia is transitioning to a lower-emissions electricity system as ageing coal-fired generators retire and are replaced by inverter-based resources (IBRs) such as wind, solar and electric storage. While essential for decarbonisation, this transition changes how the power system operates and creates new challenges for maintaining power system security, particularly for system strength.

These challenges are highlighted in the Australian Energy Market Operator's (AEMO's) 2025 Wholesale Electricity Market Electricity Statement of Opportunities (WEM ESOO), which projects that system strength will decline sharply in several key locations as coal-fired generation retires and is replaced by IBRs.

To support a secure and reliable transition, the Department of Energy and Economic Diversification (DEED), in consultation with AEMO and Western Power, progressed reforms through the Power System Security and Reliability Standards Review, with consultation papers published in June and December 2025. These reforms included:

- the design of a system strength framework for the South West Interconnected System (SWIS), establishing clear roles and responsibilities to address existing and forecast system strength shortfalls; and
- reducing barriers to connection for new technologies by clarifying grid-forming (GFM) inverter requirements and adjusting performance standards to realise the benefits of GFM capability.

An Information Paper and Exposure Draft published at the same time as this Paper outlines the relevant review outcomes and draft Electricity System and Market Amending Rules to implement those reforms.

This Consultation Paper builds on those policy outcomes and seeks stakeholder views on additional, targeted measures to complement them. In particular:

- While centralised procurement can address forecast system strength shortfalls, additional measures, including an appropriate regulatory incentives framework, is expected to be required to minimise these shortfalls and reduce costs to consumers.
- Proponents seeking to connect systems that combine GFM and grid-following (GFL) inverter technologies (hybrid systems) require guidance on the applicable Technical Requirements.
- Participant electromagnetic transient (EMT) models will become increasingly important for the accuracy of the Network Operator and AEMO modelling activities, which would require existing participants to provide these models.
- As more IBRs connect to the system, the need for changes to control settings is increasing as an essential operational tool for maintaining power system stability and performance.

Stakeholder consultation – Call for submissions

Stakeholders are invited to provide feedback on the proposed review outcomes in this Consultation Paper.

Submissions can be emailed to: energymarkets@deed.wa.gov.au

Stakeholders should clearly specify if information they provide in their submission is confidential and, where possible, separate confidential information from non-confidential information. Those making any claim for confidentiality should consider the Freedom of Information Act 1992, which imposes obligations in respect to the release of documents.

Public submissions will be published on www.energy.wa.gov.au.

The consultation period closes at **5:00 PM AWST on 21 September 2026**. Late submissions may not be considered.

Summary of proposed review outcomes and rationale

Table 1:1 lists draft PSSR Standards Review outcomes and supporting rationale for:

- Regulatory incentives to minimise existing and forecast system strength shortfalls.
- Applicable Technical Requirements for hybrid systems.
- Provisions for submission of EMT models by existing facilities.
- Enhancing the provisions for enabling changes to control setting to support System Strength.

Table 1:1 Proposed outcomes and rationale

Proposed Outcome	Rationale
Regulatory incentives	
Proposal 1:1 New Electric Storage Resources (ESR) seeking to connect in network regions identified in the System Strength Report as having low system strength will be required to meet Grid-forming (GFM) inverter technical standards.	Mandating GFM capability in areas with existing and forecast low system strength ensures new connections adopt technologies that inherently improve and support the system rather than add to existing or forecast system strength shortfalls. By targeting locations identified in the System Strength Report, the requirement prevents design choices that could exacerbate system strength challenges. Retaining the "do no harm" provisions in the existing connection framework outside these locations provides a sufficient safeguard in areas where there are no forecast system strength shortfalls. DEED considers that system strength constraints imposed by AEMO, informed by a Western Power Limit Advice will provide a natural incentive for Market Participants to mitigate system strength challenges as conditions change and create operational and commercial signals for ESR proponents to convert to GFM or invest in improved capability. This combined approach is expected to minimise forecast system strength shortfalls, while striking an appropriate balance between allocating costs to those best placed to mitigate their system strength impacts (IBRs) and sharing any residual system strength costs (i.e. those incurred as a result of centralised procurement activities to mitigate any residual
Proposal 1:2 For new ESR connecting outside locations identified as low system strength regions in the System Strength Report, the existing connection framework will continue to apply, with current "do no harm" provisions remaining in effect.	
Proposal 1:3 Consistent with operational practices under provisions in the ESM Rules, if a System Strength Report identifies a system strength shortfall, AEMO may apply operational constraints informed by relevant Limit Advice. This may result in output limitations, including	

Proposed Outcome	Rationale
curtailment, for affected ESR proponents (refer to proposal 1:4 below).	system strength shortfalls through the Non-Co-optimised Essential System Services (NCESS) framework). The framework is aimed at addressing all limbs of the State Electricity Objective (SEO) i.e. to maintain system security, minimise costs to consumers and allow the connection of more renewable generation.
Proposal 1:4 The ESM Rules will prescribe a curtailment prioritisation framework to manage system strength in network regions with low system strength, under which facilities will be prioritised for curtailment as follows: 1. **Facilities operating in non-compliance with their Registered Generator Performance Standard (GPS),** if that non-compliance is causing a PSSR impact that cannot otherwise be managed without curtailment; 2. **ESR located in regions identified in the System Strength Report as experiencing low system strength**, that have not converted to GFM capability, or otherwise remediated their system strength impacts; • Consistent with operational practices under provisions in the ESM Rules, if a System Strength Report identifies a system strength shortfall, AEMO may apply operational constraints informed by relevant Limit Advice, which may result in output limitations, including curtailment, for affected ESR proponents. 3. **If practical, existing facilities in non-compliance with electromagnetic transient (EMT) model submission requirements** (refer to Proposal 3:1); and 4. When curtailment of facilities under items 1, 2 and 3 is insufficient to address the identified system strength shortfall or associated power system security risk, other facilities in the affected region may be subject to operational limits or	The proposed curtailment prioritisation framework aims to provide a clear and transparent mechanism through the Limit Advice and Constraint Equations framework in the ESM Rules to enable a clear allocation of responsibility between AEMO and Western Power to manage system strength risks in the short to medium term while self-mitigation has not yet occurred. Rule drafting will include the proposed uplifts to the existing Limit Advice and Constraint Equations arrangements to implement this framework. By specifying in advance when and how curtailment may be applied, the framework provides greater certainty for market participants, reduces reliance on discretionary intervention, and ensures curtailment decisions are applied consistently and are proportionate to system needs. The prioritisation framework is aimed at addressing all limbs of the SEO i.e. to maintain system security, minimise costs to consumers and allow the connection of more renewable generation. It is aimed at incentivising and recognising the right behaviour and discouraging non-compliance with the ESM Rules, while ensuring that power system security remains as the overarching principle.

Proposed Outcome	Rationale
curtailment, in accordance with the relevant Limit Advice and implemented through applicable Constraint Equations. Notwithstanding these prioritisation principles, the overarching principle will be the maintenance of power system security.	
Proposal 1:5 When two or more facilities are tied in a curtailment scenario, the tie will be resolved in accordance with high-level principles set out in the ESM Rules and a method detailed in a WEM Procedure, such as the application of relevant coefficients.	This proposed approach provides a transparent and consistent mechanism for resolving ties between facilities in curtailment scenarios. By applying a predefined methodology, it reduces the potential for inconsistent decision-making and supports outcomes that are predictable, equitable and consistently applied across participants.
Technical Requirements for 'hybrid systems' For the purpose of this Consultation Paper, the term 'hybrid system' is used to describe a collection of IBRs combining GFM and GFL inverter technologies, excluding loads, assessed as a single integrated entity.	
Proposal 2:1 The ESM Rules will prescribe that hybrid systems are assessed for Generator Performance Standard (GPS) as integrated systems at the Connection Point or, where applicable at its Measurement Point. Compliance will be based on the combined performance of all sub-systems and operating modes covering all credible combinations that could materially affect power system security, result in adverse interactions between sub-systems, or mask the true performance of the facility. Under this framework, GFM capability will be assessed at a sub-system level, but the overall facility may be assessed as either GFM or grid-following (GFL) when considered as an integrated system across the credible operating-modes. The assessment methodology will be outlined in a WEM Procedure.	DEED has received stakeholder feedback indicating that greater clarity is needed for proponents seeking to connect hybrid systems that incorporate both GFM and GFL technologies. The behaviour of hybrid systems at the Connection Point is critical for understanding system impacts as the systems behaviour may differ markedly under different operating modes. However, the use of the Connection Point as the compliance reference point may not be appropriate in all circumstances. For Separate Facilities, as defined in the ESM Rules, the Measurement Point is proposed as the applicable compliance reference point. The proposed framework introduces sub-system capability assessments and operating modes to provide accurate assessment of hybrid systems performance, while maintaining flexibility in facility design and ensuring system security is maintained. This includes recognising that GFM capability for ESR is assessed at the sub-system level, rather than being required for the integrated system at the Connection Point or, where applicable, the Measurement Point. The proposed approach to GPS structuring recognises that, in certain circumstances, a more complex registration framework may be necessary to appropriately reflect operational and compliance arrangements. It also acknowledges that variations in system configurations, including differences in configuration or functional design, may give rise to the establishment of more than one GPS within a given system.
Proposal 2:2 **Compliance requirements per operating-mode** Compliance will be assessed using an integrated system model and assessed across credible operating modes that materially affect	

Proposed Outcome	Rationale
performance, against the associated compliance obligations at the Connection Point or, where applicable, the Measurement Point. The operating-mode requirements will define which sub-systems are available at a point in time, the available active and reactive (power/current) headroom, the expected connection point response, any operational constraints being invoked and the compliance pathway relied upon. The credible operating modes may include both sub-systems online, GFM-only operation, GFL-only operation where credible, ESR charging and discharging, low state of charge, and high active-power export with limited current headroom.	To provide proponents with early clarity on the applicable compliance pathway, and to minimise the risk of late-stage design changes requirements, project delays, or additional costs, it is proposed that the hybrid system assessment be undertaken as early as practicable in the connection process. For new development projects, the R0 stage is considered the appropriate assessment point in the connection process.
Proposal 2:3 **Registered GPS structuring** A flexible framework will be applied for the allocation and structure of GPS for hybrid systems, reflecting the extent to which sub-systems materially and independently influence performance at the Connection Point or, where applicable, the Measurement Point. The framework will identify the likely GPS structure based on the technical evidence. The GPS structure will include either: • a single Registered GPS supported by sub-system evidence; • a single Registered GPS supported by structured annexures; or • multiple Registered GPSs, when this is necessary to reflect material and independent sub-system influence on Connection Point or, where applicable, Measurement Point performance.	

Proposal 2:4 **Timing of assessment** For new project development the hybrid system assessment and classification will be undertaken at the R0 stage in the connection process. For staged developments or retrofit projects, the relevant assessment will occur at the earliest practicable modification assessment stage associated with the proposed GFM addition. As outlined in Proposal 2:1, a WEM Procedure will provide the details for the assessment methodology, technical requirements and evidentiary requirements.	
Provisions for submission of EMT models by existing facilities	
Proposal 3:1 Market Participants responsible for Transmission-connected Generating System with a Nameplate Rating of 10 MVA or greater will be required, upon request from the Network Operator, to obtain and provide adequate EMT models to support system studies. The Network Operator will specify timeframes for the provision of the EMT models, with flexibility to prioritise and stage requests based on system strength risks and broader power system security considerations.	Access to suitable EMT models is increasingly important for understanding system behaviour and supporting its secure operation. New connection applicants must provide EMT models as part of the connection process, but there is no such requirement for existing facilities. The proposed requirement for existing proponents to provide EMT models is to address gaps in system visibility, system strength risks and broader power system security needs. Allowing the Network Operator to prioritise and stage requests further limits unnecessary burden.
Proposal 3:2 The Network Operator will be required to reimburse a Market Participant's reasonable costs for the development of the EMT models.	Introducing requirements for the Network Operator to reimburse reasonable costs for the development of these EMT models addresses equity concerns and helps ensure the requirements are proportionate.
Proposal 3:3 The provisions requiring a Market Participant to provide an EMT models for an existing facility within specified timeframes will be a civil penalty provision.	Given the importance of EMT models for system strength assessment as part of GPS and power system security, DEED considers that the requirement to provide EMT models should be a civil penalty provision as well as, if practicable, included as a trigger for curtailment in the prioritisation order (refer to Proposal 1:4).

Framework for control settings changes	
Proposal 4:1 Introduce new terms that distinguish between Registered GPS capability and operational settings: • Registered capability – the fundamental technical capability of a facility approved under the Registered GPS; and • Operational settings – control parameters that may be adjusted over time to suit system or regional conditions, while remaining within the approved capability. The ESM Rules will include provisions to enable Western Power to review and require changes to new and existing facility control settings (beyond the existing scope for voltage control settings) when required to address system strength or related power system impacts. A WEM Procedure will outline the process for requiring changes, including when these requirements would be triggered and any consultation that may be required.	The existing framework provides Western Power with the ability to require changes to documented voltage control settings for system security purposes. Building on this existing ability, and consistent with Proposal 20 of the June 2025 Consultation Paper, consideration is being given by DEED, Western Power and AEMO to broadening the framework to encompass a wider range of control, protection and performance settings. This recognises that IBRs can materially influence system strength and broader power system security outcomes through settings beyond voltage control setting . This enhanced ability would be supported by a clear and transparent mechanism for reviewing and implementing settings changes when necessary to maintain power system security. The distinction between operational settings and registered capability will support operational flexibility and more targeted reassessment approaches, without requiring unnecessary reassessment of a facility's approved capability or compromising system security outcomes. A Western Power WEM Procedure will clearly specify: • the circumstances in which the Network Operator may exercise this requirement; • the triggers for requiring changes; and • the consultation requirements to be undertaken with participants and AEMO prior to requiring any changes.

1. Introduction

1.1. Background and context

The energy transition introducing system strength challenges

Western Australia's energy sector is undergoing a transition to a low emissions energy system, with the demand profile and electricity supply sources changing rapidly. Over the coming decades, more intermittent and distributed generation will enter the market, energy storage technology will continue to mature, and ageing thermal generators will retire.

This structural shift in the generation mix is reshaping the power system dynamics at pace. As inverter-based resources (IBRs), such as electric storage, wind and solar, become the dominant source of new supply, maintaining adequate system strength is critical to ensuring their stable integration and to preserving the overall power system security and reliability.

These challenges are highlighted in the Australian Energy Market Operator (AEMO's) 2025 Wholesale Electricity Market Electricity Statement of Opportunities (WEM ESOO), which projects that system strength will decline sharply in several key locations as coal-fired generation retires and is replaced by IBRs.

AEMO's assessment identifies regions of the South West Interconnected System (SWIS) where system strength is expected to fall to materially reduced or low levels, particularly in electrically weak and fringe areas of the network. Without deliberate reform, the changing characteristics of the generation fleet risk increasing operational complexity, system vulnerability, and long-term costs to consumers.

At the same time, opportunities exist to cost-effectively manage these risks and maintain power system security through the energy transition. Advanced inverter capabilities, particularly grid-forming (GFM) technologies are expected to play an increasingly important role in supporting system strength and enabling the secure integration of IBRs compared to traditional grid-following (GFL) technologies.

Reform work to date and the need for further measures

Recognising both the challenges and opportunities, the Department of Energy and Economic Diversification (DEED) undertook consultation on a system strength framework in June 2025. Building on stakeholder feedback, DEED published an Information Paper on 20 August 2026 establishing a framework that clarifies and allocates roles and responsibilities for AEMO, Western Power and the Coordinator of Energy (Coordinator) to maintain system strength, including arrangements for the centralised procurement of forecast system strength shortfalls by the Network Operator.

DEED considers that a centralised system strength framework – which proactively plans for system strength requirement, reduces system strength shortfalls and procures sufficient system strength to meet the anticipated fleet needs – will provide greater planning certainty for both the Network Operator and proponents seeking connection. A coordinated approach reduces the risk of piecemeal or reactive investment, assists in unlocking renewable, lower-cost generation and Electric Storage Resources (ESR) that may otherwise be constrained from entering the market, and supports outcomes that minimise whole of system costs over the long term.

In parallel, DEED progressed work on differentiated standards for GFM and GFL inverters through a Western Power technical paper, published December 2025. The outcomes of this work were published alongside the system strength framework in an Information Paper.

The introduction of differentiated standards for GFM and GFL inverters was proposed for three key reasons:

- to respond to industry feedback that certain requirements framed around behaviour may not be appropriate or achievable for some of the emerging GFM technologies;
- to provide clearer and more predictable technical requirements for proponents and original equipment manufacturers, thereby supporting confidence in GFM deployment within the SWIS; and
- to ensure that the inherent system benefits of GFM technology - including improved system strength characteristics and increased hosting capacity – are realised as part of the transition.

Stakeholders have indicated that an appropriate incentive framework may be necessary to support the uptake of GFM inverter technology in the context of the differentiated standards. Stakeholders have also highlighted the need for clearer Technical Requirements for hybrid systems (IBRs that incorporate both GFM and GFL inverter technologies).

DEED recognises the importance of minimising existing and forecast system strength shortfalls to reduce the overall costs to consumers, rather than relying solely on centralised procurement once gaps become apparent. A well-considered incentive framework will therefore be critical to ensure that all limbs of the State Electricity Objective (SEO) are met, while maintaining investment confidence and system security throughout the transition.

Clear and consistent guidance for proponents seeking to connect IBRs with hybrid configurations will also be necessary to support a complete and coherent GFM and GFL technical standards framework.

In addition, participant electromagnetic transient (EMT) models are important for the completeness and accuracy of Western Power and AEMO modelling activities needed for system strength assessment and power system security. Consideration should be given to

requiring existing facilities to provide EMT models, alongside new connection applicants that already submit these models as part of the connection process.

As more IBRs connect to the system, changes to control settings is becoming a key operational tool for maintaining power system stability and performance. A clear and transparent pathway for control setting adjustments or changes, by enhancing the existing provisions, will be important to support secure and effective system operation.

1.2. Structure of this paper

This Consultation Paper outlines the options considered and 13 proposed outcomes related to the following matters:

- regulatory incentive mechanisms;
- technical requirements for hybrid systems;
- requirements for the provision of EMT models; and
- changes to facilities control settings.

1.3. Stakeholder engagement

DEED conducted a series of workshops with AEMO and Western Power between January and June 2026 to identify and assess potential regulatory incentives options. These workshops considered the merits, risks and implementation considerations associated with each option.

2. System strength incentives framework

2.1. Role of regulatory incentives

Regulatory incentives operate through obligations and standards, while financial mechanisms influence behaviour by altering the economic consequences of investment and operational decisions. In many cases, financial incentives can complement regulatory levers or provide an alternative mechanism to achieve similar policy outcomes.

DEED understands that GFM inverters typically involve higher upfront capital costs than GFL technology. In the absence of clear regulatory signals or requirements, proponents are likely to optimise for minimum-cost compliance. This behaviour is economically rational at the project level, reducing the likelihood that enhanced GFM capability will be deployed voluntarily, but may not deliver outcomes that are efficient at the system level and impact on system security.

In a framework where the Network Operator is responsible for centrally procuring system strength services to address forecast shortfalls, this dynamic may also give rise to a free-rider problems: proponents may rely on centrally procured system strength services rather than investing in capability that could reduce or defer the need for such procurement, shifting costs to the broader customer base, including end consumers, through the Non-Co-optimised Essential System Services (NCESS) framework.

To address all limbs of the SEO i.e. to maintain system security, minimise long-term costs to consumers and allow the connection of more renewable generation, the incentive framework should ensure that system strength capability is delivered by the parties best placed to provide it, at least cost to the overall system. Well-designed incentives can support this outcome by aligning private investment decisions with system needs and reducing reliance on expensive, centrally procured solutions.

An effective incentive framework should therefore:

- allocate responsibility for system strength capability to those best placed to provide it;
- minimise inefficient cost shifting and cross-subsidisation; and
- provide clear, upfront signals to proponents about the operational and commercial implications of their technology and location choices.

2.2. Options

The following section outlines and assesses potential regulatory and financial incentives options and their prospective role within an integrated incentive framework to address the identified system strength issues and meet the objectives outlined above. Each option has

been considered in terms of its effectiveness, equity implications, administrative complexity and interaction with existing regulatory settings.

The options are not mutually exclusive and may be implemented in combination to achieve the desired policy outcomes.

Table 2:1 illustrates how certain regulatory levers may interact with, or be substituted by, financial incentives. A description and discussion of options is provided in Table 2:2 and Table 2:3.

Table 2:1 Regulatory and financial incentive options and their interaction

Regulatory lever	Related or alternative financial lever
Set minimum standards for connection	• Charges applied to higher-risk GFL inverters
Require GFM capability for ESR in pre-defined circumstances	• Compensation for GFL-to-GFM conversion for existing participants • Contracts with system strength service providers • System strength charge (which may encourage capability beyond minimum standard)
Curtailment to manage system strength conditions	• Priority access arrangements for IBR that do not adversely impact system strength conditions
Rely on existing 'do no harm' provisions requirement / self-remediation	• Proponent funded 'do no harm' mitigation costs • System strength charge with option to avoid it, if self-remediation occurs
Impose regulatory limit on IBR penetration per node	• System strength charge incorporating a locational factor

Table 2:2 Overview of regulatory incentive options

Option	Description and discussion
1. Require GFM capability for ESR in pre-defined circumstances	This option would require the use of GFM inverters in pre-defined circumstances. Variations could include mandating GFM capability for specific: • technologies (battery energy storage systems or all IBR, including wind and/or solar generation); • locations (all connection points or select system strength-constrained areas); and • classes of proponents (e.g. new entrants only, or both new and existing participants). DEED understands that GFM capability for wind generation remains relatively unproven at a commercial scale, which may present technical and cost risks if mandated prematurely. This has the potential to also undermine the third limb of the SEO. DEED also recognises that a blanket geographic requirement may be unnecessary and, in some circumstances, counterproductive if imposed in areas where system strength conditions are already adequate and forecast to remain adequate. Requiring existing participants to retrofit or convert existing facilities from GFL to GFM capability may create additional compliance and administrative costs, including potential amendments to approved Generator Performance Standards (GPS). While GFM inverters typically involve higher upfront capital costs than GFL technology, proponents may benefit from reduced curtailment risk and improved operational flexibility. In addition, these proponents may benefit from system strength services procured centrally by the Network Operator (to alleviate forecast system strength shortfalls), particularly as these services or solutions would be funded through the NCESS framework. A mandated approach would minimise or reduce inefficient cross-subsidies.

Option	Description and discussion
2. Curtailment to manage system strength conditions	DEED understands that, as part of managing power system security, AEMO may curtail facilities output if required to manage system strength and other security constraints. Appropriately targeted curtailment can provide a timely and proportionate response to emerging system conditions and will continue to play an important role in maintaining secure and reliable system operation. The frequency of curtailment also provides clear and transparent operational signals to the market. Where system strength constraints arise, exposure to curtailment can encourage proponents to consider mitigation options and proactively manage system strength impacts, for example, through the adoption GFM capability or the procurement of equivalent services, thereby reducing the likelihood or severity of future constraints. At the same time, DEED recognises that sustained or widespread curtailment may negatively impact market and investment outcomes over time, including project risk allocation and financing considerations, and may affect the utilisation of lower-emissions generation. For this reason, curtailment is best applied within a broader framework that supports efficient long-term system outcomes while maintaining alignment with the cost, security and reliability, and environmental objectives of the SEO.
3. Rely on existing 'do no harm' provisions	The existing connection framework requires proponents to demonstrate compliance with applicable technical performance standards and to avoid causing adverse impacts on the network. Under this option, the Network Operator could apply the existing "do not harm" provisions for new connections, requiring proponents to not degrade system strength conditions. In practice, this may implicitly require the adoption of GFM capability or the procurement of equivalent mitigation measures in certain locations on the network. While this approach leverages existing regulatory mechanisms, it may introduce uncertainty for proponents, if expectations are not clearly articulated. It may also result in case-by-case determinations rather than a transparent, system-wide framework.
4. Impose regulatory limit on IBR penetration per node	This option would involve implementing a cap on IBRs at individual nodes or locations to manage system strength risk. Although administratively straightforward, such caps may lead to under-utilisation of network capacity. Over time, this approach may compromise the environmental limb of the SEO and inhibit least-cost decarbonisation outcomes.

Table 2:3 Overview of financial incentive options

Option	Description and discussion
5. Charges applied to higher risk GFL inverters	This option would involve applying a charge to new proposals to connect GFL inverters in circumstances where GFM capability is technically feasible, and/or to existing participants operating a GFL IBR. DEED considers that this option would only be appropriate where GFM technology is technically and commercially viable for all facilities (currently primarily limited to ESR). DEED acknowledges that designing an appropriate charging methodology – including determining the level of charge required to encourage GFM uptake or conversion – would be complex and may introduce uncertainty. This option may operate as an alternative to mandating GFM capability in defined circumstances (as outlined in proposal 1 below), by creating an economic preference rather than a regulatory requirement.
6. Compensation for GFL-to-GFM conversion	This option would involve the Network Operator providing reasonable compensation to existing participants to support conversion from GFL to GFM capability in targeted circumstances where doing so would represent a lower whole-of-system cost solution to an existing or forecast system strength shortfall. To facilitate timely and efficient implementation, this option could be supported by a regulatory mechanism enabling the Network Operator to request conversion in defined circumstances. DEED acknowledges that this option may require amendments to existing approved GPS, potentially reopening aspects of the connection process and imposing administrative costs on participants. This option would be an alternative to a regulatory requirement that existing participants self-fund conversions on the request of the Network Operator.
7. Contracts with system strength service providers	This option would involve the Network Operator entering contracts with providers of system strength services to address localised system strength issues at specific locations. Under the proposed centralised procurement framework, the Network Operator may procure network or non-network solutions that minimise the total cost of alleviating forecast system strength shortfall. This approach provides flexibility but is likely to increase the risk of socialising cost, if not complemented by appropriate cost-reflective charges or obligations to connecting generators.

Option	Description and discussion
8. System Strength Charge	This option, informed by the approach in the National Electricity Market (NEM), would seek to allocate incremental cost of system strength services to generators that contribute to system strength shortfalls, rather than socialising those costs entirely across consumers. In the NEM, the charge incorporates both locational and modelling components. Proponents may reduce or avoid the charge where modelling demonstrates that their facility does not increase the system strength requirement (for example, through self-remediation or enhanced technical performance). The locational element provides a signal to connect in areas with stronger system strength conditions. DEED notes that in the NEM, system strength service contracts have also been used alongside the charge, suggesting that the charge alone may not always provide a sufficient incentive for enhanced capability. This mechanism would be complex to design and implement in the WEM, and would require careful calibration to avoid unintended investment signals.
9. Proponent funded 'do no harm' mitigation costs	This option would involve a connection applicant funding mitigation measures necessary to ensure their facility does not degrade system strength conditions. DEED acknowledges that this approach treats system strength primarily as a connection issue, rather than a shared network challenge or service. In a framework where the Network Operator is required to proactively procure system strength to address forecast shortfalls, this signal may be weakened.
10. Priority access arrangements for facilities that do not adversely impact system strength conditions	This option would involve granting priority dispatch or access rights to facilities that demonstrably do not adversely impact on system strength conditions, creating a natural pathway through the existing dispatch arrangements.

2.3. Proposal

Regulatory incentives

International experience suggests that GFM inverter technologies can provide superior system strength support than GFL technologies. To inform consideration of the proposed reforms, AEMO has undertaken indicative case studies examining the impact of increased deployment of GFM ESRs in areas affected by system strength constraints (refer to Appendix A).

While illustrative in nature and requiring further modelling, the preliminary case studies suggest that greater uptake of GFM technologies, whether by new facilities or conversion of existing facilities, will assist in reducing forecast system strength shortfalls and support power system security outcomes during the energy transition.

DEED proposes a calibrated combination of regulatory incentives, comprising Options 1 to 3 (as outlined in Table 2:2), to minimise the likelihood of forecast system strength

shortfalls, and in turn, reduce reliance on centralised procurement by the Network Operator, thereby minimising costs to consumers.

This combined approach is aimed at addressing all limbs of the SEO and expected to strike an appropriate balance between allocating costs to those best placed to mitigate their system strength impacts (IBRs) and sharing any residual system strength costs (i.e. those incurred as a result of centralised procurement activities to mitigate any residual system strength shortfall through the NCESS framework).

DEED considers that it is appropriate to mandate GFM technical standards for new ESR connecting in part of the network identified as having existing or forecast system strength shortfalls. These locations will be identified in AEMO's System Strength Report[1].

Targeted mandating in constrained areas ensures that investment signals are proportionate and location-specific, while avoiding unnecessary costs in parts of the network where system strength conditions are adequate.

DEED recognises the importance of providing regulatory certainty to proponents seeking to connect to the power system. Projects that have reached a sufficient level of commitment at the time the new rules commence would not be subject to the new GFM capability requirement at the time of their connection.

DEED considers that achieving R0 GPS registration, which is an early stage in the GPS process indicating that technical requirements for connection have been sufficiently progressed, or entering into a standard access contract, represents a prudent level of commitment and demonstrates a sufficient level of progress toward securing connection.

In other areas of the network, and for non-ESR connecting IBRs, DEED considers that reliance on the existing connection framework – including the 'do no harm' provisions – remains appropriate and provides a sufficient safeguard in areas where there are no forecast system strength shortfalls. This approach preserves flexibility while ensuring that new connections do not exacerbate system strength conditions.

DEED considers that exposure to curtailment prioritisation will remain an important operational and commercial signal for existing ESR participants, to voluntarily self-mitigate system strength impacts.

Three scenarios and principles for curtailment prioritisation have been proposed to be implemented through the Limit Advice and Constraint Equations framework in the ESM Rules, supported by targeted uplifts to that framework through ESM Amending Rules, with

[1] The System Strength Report will provide transparency and certainty to proponents by publishing the quantitative criteria used to identify low system strength conditions and system strength shortfalls, and identifying network regions with existing and forecast system strength shortfalls through a system strength assessment.

power system security remaining the overriding principle for applying the priority order (see Table 2:4). For example, in scenario two where the System Strength Report identifies a current system strength shortfall, ESR facilities in the affected region will be prioritised for curtailment where this is required to maintain system strength.

Table 2:4 Proposed prioritisation framework approach

	Scenario	Curtailment prioritisation order	Clarifying comment	
Notwithstanding these prioritisation principles, the overarching principle will be the maintenance of power system security.				
1.	**Facilities operating in non-compliance with their Registered Generator Performance Standard (GPS)** if that non-compliance is causing a PSSR impact that cannot otherwise be managed without curtailment;	Curtailed first.	1. Security comes first	Constraint actions must always be driven by what is needed to keep the power system secure and reliable (meaning the impacts of real-time constraints should not result in worse reliability/security outcomes)
2.	**ESR located in regions identified in the System Strength Report as experiencing low system strength**, that have not converted to GFM capability, or otherwise remediated their system strength impacts; Consistent with operational practices under provisions in the ESM Rules, if a System Strength Report identifies a system strength shortfall, AEMO may apply operational constraints informed by relevant Limit Advice, which may result in output limitations, including curtailment, for affected ESR facilities.	Curtailed second. Facilities to be curtailed in order based on their contribution to the system strength condition, their contribution to relieving that condition, and their remediation status (refer to clarifying comment).	2. Non-compliance only matters if it affects system strength risk	A facility should not be constrained just because it is non-compliant. It should only be prioritised for constraint where the non-compliance creates, worsens, or prevents assessment of the relevant system strength issue. *To note: This does not limit the ability to address the non-compliance through the mechanisms available under the ESM Rules and the relevant regulations.*
3.	**If practical, existing facilities in non-compliance with electromagnetic transient (EMT) model submission requirements** (refer to proposal 3:1).	Curtailed last.	3. Remediation should be recognised	GFM IBR or equivalent capability should result in more favourable constraint treatment where justified.
			4. Tie-breaks	If facilities are technically equivalent, the tie-breaking arrangements should be outlined in a WEM Procedure or AEMO constraint process.

	Scenario	Curtailment prioritisation order	Clarifying comment
4.	When curtailment of facilities under items 1, 2 and 3 is insufficient to address the identified system strength shortfall or associated power system security risk, other facilities in the affected region may be subject to operational limits or curtailment, in accordance with the relevant Limit Advice and implemented through applicable constraint equations.		

The proposed curtailment prioritisation framework aims to:

- address all limbs of the SEO and provide a clear and transparent mechanism to manage system strength risks in the short to medium term where self-mitigation has not yet occurred;
- incentivise and recognise the right behaviour and discourage non-compliance with the ESM Rules;
- create clear operational and commercial signals and a natural incentive through existing arrangements for proponents to convert to GFM capability or invest in improved capability; and
- enable a clear allocation of responsibility between AEMO and Western Power.

Financial incentives

While financial mechanisms have been used in other markets to influence participant behaviour and support system strength outcomes, DEED does not consider that financial incentives, to complement the proposed regulatory incentives, are required in the WEM.

The financial incentive-based approaches would be complex to design and calibrate, may require significant changes to connection arrangements, and could increase administrative and compliance burdens without delivering commensurate benefits. Experience in other jurisdictions, such as the NEM, also indicates that financial charges alone are often insufficient and typically require complementary contractual arrangements, adding further complexity.

Proposal 1:

1:1 New ESR seeking to connect in network regions identified in the System Strength Report as having low system strength will be required to meet GFM inverter technical standards.

1:2 For new ESR connecting outside locations identified as low system strength regions in the System Strength Report, the existing connection framework will continue to apply, with current “do no harm” provisions remaining in effect.

1:3 Consistent with operational practices under provisions in the ESM Rules, if a System Strength Report identifies a system strength shortfall, AEMO may apply operational constraints informed by relevant Limit Advice. This may result in output limitations, including curtailment, for affected ESR proponents (refer to proposal 1:4 below).

1:4 The ESM Rules will prescribe a curtailment prioritisation framework to manage system strength in network regions with low system strength, under which facilities will be prioritised for curtailment as follows:

1. Facilities operating in non-compliance with their Registered Generator Performance Standard (GPS), if that non-compliance is causing a PSSR impact that cannot otherwise be managed without curtailment;

2. ESR Facilities located in regions identified in the System Strength Report as experiencing low system strength, that have not converted to GFM capability, or otherwise remediated their system strength impacts;

    - Consistent with operational practices under provisions in the ESM Rules, if a System Strength Report identifies a system strength shortfall, AEMO may apply operational constraints informed by relevant Limit Advice, which may result in output limitations, including curtailment, for affected ESR proponents.

3. If practical, existing facilities in non-compliance with electromagnetic transient (EMT) model submission requirements (refer to Proposal 3:1); and

4. When curtailment of facilities under items 1, 2 and 3 is insufficient to address the identified system strength shortfall or associated power system security risk, other facilities in the affected region may be subject to operational limits or curtailment, in accordance with the relevant Limit Advice and implemented through applicable Constraint Equations.

Notwithstanding these prioritisation principles, the overarching principle will be the maintenance of power system security.

1:5 When two or more facilities are tied in a curtailment scenario, the tie will be resolved in accordance with high-level principles set out in the ESM Rules and a method detailed in a WEM Procedure, such as the application of relevant coefficients.

Consultation questions

1(a) If stakeholders do not support mandating GFM inverter technical standards for new ESR in network locations identified as experiencing existing or forecast system strength shortfalls:

- What are the reasons for this position?
- What evidence or analysis supports the position?

1(b) If stakeholders do not support the proposed prioritisation framework as a mechanism to manage system strength conditions where existing ESR have not remediated their impacts:

- What are the reasons for this position?
- What evidence or analysis supports the position?

3. Hybrid systems framework

3.1. Technical standards for hybrid systems

Several hybrid configurations are now emerging across the WEM and globally, with diverse technology mixes and coupling arrangements. These configurations typically combine wind and/or solar generation employing inverter-based technologies with co-located ESR. For the purpose of this Consultation Paper, the term ‘hybrid system’ is used to describe a collection of IBRs combining both GFL and GFM technologies, excluding loads, that are assessed as a single integrated entity.

Hybrid systems can operate in multiple modes and configurations. This creates challenges for how compliance with access standards is assessed and enforced, as facility behaviour at the connection point is dependent on the interaction between sub-systems and their operating state.

The Technical Paper published in December 2025 did not propose Technical Requirements for hybrid systems that combine GFM and GFL inverter-based technologies. However, stakeholder feedback has indicated that hybrid systems require more explicit and structured treatment to provide clarity to proponents on how these systems will be assessed.

Stakeholders emphasised the importance of ensuring that compliance obligations:

- appropriately reflect the functional roles and interactions of hybrid sub-components; and
- do not unintentionally constrain efficient or innovative project configurations.

3.2. Options and proposal

DEED recognises the need to provide clearer guidance to proponents seeking to connect these new systems and to establish a coherent end-to-end framework. Any proposed approach should provide certainty to proponents on connection requirements, reducing barriers for connection, while also addressing risks to system security as a result of these connections.

While hybrid-specific regulatory frameworks remain under development internationally, relevant material indicates several emerging core principles:

- assessment at the connection point as the primary reference for compliance;
- explicit treatment of current limitation behaviour;
- the need for integrated facility modelling; and

- recognition that sub-system behaviour remains relevant when interpreting facility-level performance.

DEED also recognises that the behaviour of the facility at the Connection Point, where it interfaces with the grid, is critically important. Consistent with emerging international practice, DEED proposes to retain the Connection Point as the primary compliance reference or, where applicable, the Measurement Point, while strengthening this assessment through:

- structured sub-system capability assessments, if GFM requirements would be required for ESR sub-components in low system strength areas specified in accordance with Proposal 1:1; and
- operating-modes that capture all credible combinations of a facility's operation conditions that materially affect performance.

This approach reflects that system impacts arise at the Connection Point, while recognising that those outcomes depend on sub-system capability and interaction. It allows proponents flexibility in technology selection, facility configuration and control strategies, while ensuring that power system security and performance requirements are met.

To illustrate, the pathway to demonstrate GFM performance will generally involve steps to:

- demonstrate GFM capability of the GFM subsystem;
- demonstrate that the integrated GFM/GFL system delivers the required GFM response at the Connection Point or, where relevant, the Measurement Point;
- demonstrate this across the credible operating-mode matrix;
- show that the GFL subsystem does not materially dilute, obscure, or mask the GFM response;
- define the GPS structure needed to make those obligations clear and enforceable.

Whether the addition of an ESR (retrofit configurations) to an existing facility will require a full reassessment of all existing GPS obligations versus a partial sub-system assessment will be dependent on whether it has the potential to materially impact or change any of the characteristics, performance or capacity of the generating units or generating works in respect of a Technical Requirement. This assessment will be informed by the existing Relevant Generator Modification process and procedures set out in Chapter 3A of the ESM Rules.

Compliance requirements per operating-mode

As outlined above, DEED considers that compliance should be demonstrated across a set of operating-modes, covering all credible facility states that materially affect performance.

The most onerous credible operating condition within this framework should determine the applicable performance requirements.

The operating-mode requirements will define which sub-systems are available, the available active and reactive (power/current) headroom, the expected connection point response, any operational constraints being invoked, and the compliance pathway relied upon.

Table 3:1 outline examples of credible operating modes that may apply, together with the associated compliance obligations at the Connection Point.

Table 3:1 Operating-mode matrix: compliance requirements per mode

Mode	Sub-systems available	GFM contribution	Current limitation risk	GFM pathway	Clarifying comment
1 — Both online	GFM ESR + GFL	**Full**	**Moderate**	**Conditional**	GFM contribution must be demonstrated rather than assumed from ratings
2 — GFM-only	GFM ESR only	**Full**	**Moderate**	**✓ Qualifies**	
3 — GFL-only	GFL only; GFM ESR absent	**None**	**N/A**	**N/A**	GFL obligations apply only; re-entry to GFM pathway must be defined and re-verified
4 — GFM ESR charging + GFL	GFM ESR (consuming) + GFL	**Partial**	**High**	**Conditional**	Dynamic sufficiency under reduced headroom; stable current-limit entry and exit
5 — Low State of charge + high export	GFM ESR (near limit) + GFL	**Minimum**	**Very high**	**▲ Reference test**	Likely the reference qualification case for many hybrids; representative in-service settings required

Registered GPS structures

DEED has also considered the structure of Registered GPS applying to hybrid systems.

Four assessment cases have been identified, with a likely structure being either:

- a single Registered GPS supported by sub-system evidence;

- a single Registered GPS supported by structured annexures; or
- multiple Registered GPSs when this is necessary to reflect material and independent sub-system influence on connection-point performance.

This approach recognises that multiple GPSs should not be mandatory for all hybrid systems but may be appropriate when sub-systems materially and independently influence facility behaviour.

DEED recognises that some hybrid system configurations may require a more complex GPS registration structure. It is important to clarify that, while a hybrid system may be associated with one or more Registered GPSs, a single Registered GPS cannot apply across multiple Registered Facilities in the WEM.

DEED also recognises that a wide range of hybrid system configurations may arise in practice, and that some arrangements may require assessment on a case-by-case basis. Table 3.2 provides illustrative examples of some facility characteristics and the corresponding GPS registration structure that may be expected to apply.

Table 3:2 Examples of GPS structure options for hybrid systems

Case	Typical characteristics	Proposed GPS structure	Clarifying comment
A	DC-coupled hybrid system or a single shared inverter presenting to the AC network	A single Registered GPS for the combined system	DC-coupled hybrid is the primary real-world example. Single-controller merged architectures are a second but uncommon example. Some tightly integrated AC-coupled configurations may approach this case. However, a high standard of technical justification would be required, supported by subsystem capability statements and the operating mode matrix.
B	GFM is the primary compliance focus but there are distinct GFL obligations that must be explicitly and separately assured	A single Registered GPS supported by structured annexures capturing the GFL obligations.	The primary GPS is determined by which sub-system carries the binding performance obligations at the Connection Point or, where applicable, the Measurement Point across the operating-mode matrix.
C	Integrated new-build hybrid system in which both GFM ESR and GFL independently and materially shape the Connection Point response	Multiple Registered GPSs should generally apply if subsystems have a material and independent influence on Connection Point or, where	In Case C, complexity arises from physics and the proponent must justify the need for multiple layers. A single Registered GPS with

	across credible operating modes.	applicable, the Measurement Point performance. A single Registered GPS with appropriately structured annexes may be justified in specific circumstances but should not be regarded as the default approach.	well-structured annexures may be sufficient if the GFM/GFL system is an integrated new-build arrangement and the evidence shows that Connection Point or, where applicable, Measurement Point performance, subsystem obligations, masking risk and compliance accountability are clear.
D	Retrofit, multi-OEM or independently dispatchable configuration with credible interaction or masking risk	Default is multiple Registered GPSs, (the combined system, GFM ESR sub-system, GFL sub-system) unless the proponent demonstrates that fewer layers adequately capture compliance risk.	These arrangements create a higher risk because integrated design cannot automatically be relied upon to manage interactions. In these circumstances, the proponent should demonstrate that a single GPS with annexures provides equivalent technical clarity.

Timing of assessment and implementation considerations

DEED considers that the criteria for determining the appropriate compliance pathway should be specified in the ESM Rules, while maintaining flexibility for the Network Operator to adopt streamlined arrangements where this is practical and proportionate.

It is also proposed that the hybrid system assessment be undertaken as early as practicable in the connection process, with the R0 gateway as the assessment stage for new projects. This is intended to provide early clarity to proponents on the applicable compliance pathway, thereby avoiding late stage changes that could create material project risks or delays. Under this approach, the R0 stage would establish the preliminary classification, GPS structure, operating mode assessment, and an initial assessment of dynamic performance.

For staged developments or retrofit projects, the R0 stage may have already been completed. In these circumstances, the relevant assessment should occur at the earliest practicable modification assessment stage associated with the proposed GFM addition behind the existing Connection Point or, where applicable, the Measurement Point.

As outlined above, it is proposed that the existing Relevant Generator Modification process established under Chapters 3A.13 and 3A.14 of the ESM Rules will continue to apply. It is further proposed that the content of the associated guideline be transferred to a WEM Procedure and enhanced to provide greater clarity regarding the assessment methodology, technical requirements and evidentiary requirements.

The timeframes by which those procedures should be developed would be covered by transitional arrangements to allow sufficient time for those additional enhancements to be made.

Proposal 2:

2:1 The ESM Rules will prescribe that hybrid systems are assessed for Generator Performance Standard (GPS) as integrated systems at the Connection Point or, where applicable, at their Measurement Point. Compliance will be based on the combined performance of all sub-systems and operating modes covering all credible combinations that could materially affect power system security, result in adverse interactions between sub-systems, or mask the true performance of the facility.

Under this framework, GFM capability will be assessed at a sub-system level, but the overall facility may be assessed as either GFM or GFL when considered as an integrated system across the credible operating-modes.

The assessment methodology will be outlined in a WEM Procedure.

2:2 Compliance requirements per operating-mode

Compliance will be assessed using an integrated system model and assessed across credible operating modes that materially affect performance, against the associated compliance obligations at the Connection Point or, where applicable, the Measurement Point.

The operating-mode requirements will define which sub-systems are available at a point in time, the available active and reactive (power/current) headroom, the expected connection point response, any operational constraints being invoked and the compliance pathway relied upon.

The credible operating modes may include both sub-systems online, GFM-only operation, GFL-only operation where credible, ESR charging and discharging, low state of charge, and high active-power export with limited current headroom.

2:3 Registered GPS structuring

A flexible framework will be applied for the allocation and structure of GPS for hybrid systems, reflecting the extent to which sub-systems materially and independently influence performance at the Connection Point or, where applicable, the Measurement Point. The framework will identify the likely GPS structure based on the technical evidence. The GPS structure will include either:

- a single Registered GPS supported by sub-system evidence;
- a single Registered GPS supported by structured annexures; or
- multiple Registered GPSs, when this is necessary to reflect material and independent sub system influence on Connection Point or, where applicable, Measurement Point performance.

2:4 Timing of assessment

For new project development the hybrid system assessment and classification will be undertaken at the R0 stage in the connection process.

For staged developments or retrofit projects, the relevant assessment will occur at the earliest practicable modification assessment stage associated with the proposed GFM addition.

As outlined in Proposal 2:1, a WEM Procedure will provide the details for the assessment methodology, technical requirements and evidentiary requirements.

Consultation questions

2(a) If stakeholders do not support the proposed approach to assess hybrid systems at the Connection Point or, where applicable, the Measurement Point, supported by structured sub-system capability assessments, an operating mode matrix and GPS structuring:

- What are the reasons for this position?
- What evidence, analysis or practical experience supports the position?

2 (b) Do stakeholders consider that the Relevant Generator Modification process set out in Chapter 3A of the ESM Rules provides a sufficient framework for assessing retrofit configurations to existing facilities?

4. Submission of EMT models by existing facilities

4.1. Role of EMT models

Western Power performs system studies for both operational and planning purposes. These studies rely on technical modelling (including models provided by generators) to assess system behaviour and aim to ensure that the power system remains secure, stable and reliable.

As the generation mix evolves, a larger number of facilities are connecting to the grid through IBRs. This type of facility typically interacts with the network in a different way to that of non-IBRs i.e. has different operating and performance characteristics.

While Western Power has developed EMT representations of parts of the SWIS, experience to date indicates that internally developed models are not sufficient for all oscillation, weak-grid and system strength studies, and that Original Equipment Manufacturer (OEM)-specific EMT models provide a more reliable basis for representing facility behaviour in these circumstances.

This is consistent with AEMO's current modelling framework in the NEM, which requires models capable of representing the impact of facility controls and protection systems on power system security, and with AEMO's recent SWIS East Country incident report[2], which identified reliable EMT models for legacy generators as an important area for further improvement.

During workshops with AEMO and Western Power, it was identified that new proponents are required to provide EMT models as condition of connection. However, the existing ESM Rules do not clearly provide for the collection of equivalent models from Transmission Connected Generating Systems that connected prior to this requirement being imposed.

As outlined above, access to accurate EMT models is critical to enabling Western Power and AEMO to undertake robust system strength studies, assess system impacts for prospective connections, and improve the accuracy of system strength shortfalls forecasting. Without these models, system studies may rely on conservative assumptions, potentially overstating the risks or increasing the likelihood of inefficient outcomes.

4.2. Options and proposal

DEED considered a range of options to address this gap:

[2] AEMO | Incident reports

1. Require existing facilities to provide EMT models at their own cost.
2. Require existing facilities to provide EMT models, with reasonable costs funded by the Network Operator.
3. Where models are not provided, rely on proxy models.
4. Where models are not provided, prioritise curtailment of those facilities ahead of new entrants.

Requiring participants to fund the development of EMT models for existing facilities may present challenges, as many of these installations were not originally designed with EMT modelling requirements in mind. Control systems at such facilities could at times be bespoke, outdated or poorly documented, which can make the retrospective development of EMT models complex.

DEED recognises that the development of EMT models will impose resource and cost on Market Participants, which will vary depending on factors such as facility size, age, technology type, and the availability of equipment and design information.

Accordingly, DEED proposes a combined approach drawing on Options 2 and 4, requiring Market Participants responsible for Transmission Connected Generating Systems with a Nameplate Rating[3] of 10 MVA or greater to obtain and provide adequate EMT models to the Network Operator upon request.

To address equity concerns and provide regulatory certainty for participants, the Network Operator should provide reasonable compensation for the development of the EMT model. Consideration for recoverable costs should include:

- EMT model development;
- Model validation and verification, including physical testing if required.

As EMT models are not required in all circumstances and all at once, the Network Operator will have discretion to request the EMT models (and pay reasonable compensation) in a staged manner informed by an assessment of system strength risks and broader power system security considerations.

Given the importance of EMT models for system strength assessment and power system security, it is proposed that the requirement to provide EMT models should be a civil penalty provision as well as, if practical, included as a trigger for curtailment in the prioritisation order (refer to Proposal 1:4).

The proposed review outcome is intended to address gaps in system visibility, system strength risks and broader system security needs. It is aimed at incentivising and recognising the right behaviour and discouraging non-compliance with the ESM Rules.

[3] As defined in Western Power's Technical Rules.

Proposal 3

3:1 Market Participants responsible for Transmission Connected Generating System with a Nameplate Rating of 10 MVA or greater will be required, upon request from the Network Operator, to obtain and provide adequate EMT models to support system studies.

The Network Operator will specify timeframes for the provision of the EMT models, with flexibility to prioritise and stage requests based on system strength risks and broader power system security considerations.

3:2 The Network Operator will be required to reimburse a Market Participant's reasonable costs for the development of the EMT models.

3:3 The provisions requiring a Market Participant to provide an EMT models for an existing facility within specified timeframes will be a civil penalty provision.

Consultation questions

3(a) If stakeholders do not support requiring EMT models from existing facilities based on system strength risks and broader power system security considerations:

- What are the reasons for not supporting the proposal.
- What evidence, analysis or practical experience that justify this position.

3(b) If stakeholders do not support the proposed approach to introduce a cost compensation mechanism for EMT model development for existing facilities:

- What are the reasons for not supporting the proposal.
- What evidence, analysis or practical experience that justify this position.

3(c) If stakeholders do not support the use of curtailment, where practical, in accordance with the curtailment prioritisation framework (refer to Proposal 1.4), where a Market Participant is non-compliant with EMT model submission requirements:

- What are the reasons for not supporting the proposal.
- What evidence, analysis or practical experience that justify this position.

5. Framework for control settings changes

5.1. Changes to control settings to support System Strength

IBRs can materially affect system security through a wider range of configurable control, protection and performance settings. Changes to control settings is an essential operational tool for maintaining power system performance and stability. In some circumstances, system strength, fault level and control interaction issues can be mitigated or resolved through targeted changes to a facility's control settings rather than through network augmentation or operational measures (such as constraining-on synchronous generation and/or constraining-off IBRs).

All facilities connected to, or seeking to connect to, the power system are required to have a Registered GPS in order to participate in the market. The technical requirements comprising a facility's GPS are prescribed in Appendix 12 of the ESM Rules, while the framework for applying those requirements through connection, compliance and performance monitoring processes is prescribed in Chapter 3A of the ESM Rules.

The existing GPS framework is primarily focused on establishing and maintaining the approved technical capability of a facility. However, a facility's actual performance is also influenced by the operational control settings implemented within that approved capability envelope. The nature and materiality of any change, and its impact on facility performance, will determine whether a facility can continue to operate within its existing Registered GPS, or whether reassessment under the existing GPS modification framework may be required. Some changes may remain within a facility's approved capability and performance envelope, while others may alter the basis on which the facility was assessed and its Registered GPS .

The existing regulatory framework provides a limited mechanism for adjusting or changing facility control settings. While the Technical Rules currently provide for Western Power to review and request changes to documented voltage control settings for system security purposes, this provision has not yet been replicated in the ESM Rules' GPS framework. In addition, there is currently no clearly defined process governing how changes to registered voltage control settings are to be initiated, assessed, consulted on, implemented or verified, nor are there prescribed roles, responsibilities or timeframes for Western Power, AEMO or Market Participants.

As the energy transition continues and the system is characterised by more IBRs, the complexity of interacting control schemes will increase. The absence of a clearly defined framework may reduce the effectiveness of arrangements for addressing emerging system strength and control interaction issues. Greater clarity would support Western Power, AEMO and Market Participants to implement changes across existing facilities to improve

system outcomes and reduce the need for more restrictive operational measures such as curtailment.

AEMO and Western Power contend that an improved, fit-for-purpose framework is required to support the review and changes to control settings when necessary to maintain or restore power system security. Such a framework would provide a pathway to more efficient resolution of emergent system security issues, while maintaining appropriate regulatory oversight.

5.2. Proposal

Extensive discussions between DEED, AEMO and Western Power suggests that the existing arrangements relating to changes to voltage control settings may no longer be sufficient to address emerging power system security challenges. As the power system evolves and becomes increasingly reliant on IBRs, a clear and transparent mechanism is needed to enable Western Power to review, and if necessary require, changes to facility control settings. Such a mechanism would support the management of evolving system strength requirements, facilitate coordinated responses to emerging system security issues and contribute to the secure and reliable operation of the power system.

The need for such a framework is also consistent with previous reform proposals outlined in the June 2025 Consultation Paper on Proposal 20 for the ESM Rules to adopt certain PSSR related provisions from Western Power's September 2023 Proposed Technical Rules Amendments (2023 Proposed Technical Rules). This included a provision that would allow Western Power to review control and protection settings and arrange for modification of settings where necessary to improve power system security, reliability and quality of supply:

3.2.7 Changes to control and protection settings

(a) The Network Service Provider may undertake a review of the control and protection system settings within a User's facility to determine whether there is a need for any modification to those settings to improve power system security, power system reliability or the quality of supply to other Users.

(b) Where the review completed in accordance with clause 3.2.7(a) identifies a need to alter existing settings the User must make any changes requested.

Building on this earlier proposal, consideration is now being given to whether an enhanced and more clearly defined framework should be established within the ESM Rules to support the review and amendment of control and protection settings when required to maintain or restore power system security. Such a framework could also provide a mechanism for coordinated settings changes across one or more facilities, while ensuring appropriate consultation, technical assessment and governance arrangements are in place.

This should be limited to settings that are necessary to maintain power system security and reliability and should be clearly defined and appropriately limited in a WEM Procedure, which would specify:

- the circumstances in which the Western Power may exercise this requirement;
- the triggers for requiring changes; and
- the consultation requirements to be undertaken with AEMO and Market Participants when Western Power makes it's a determination to require a change to a facility's control settings.

Consideration should also be given to leveraging the existing processes for GPS modifications under the ESM Rules and the assessment processes in section 3A.13 of the ESM Rules, where appropriate. However, consultation with stakeholders has identified the importance of ensuring that required amendments to operational settings do not unnecessarily trigger modification processes that were designed to assess changes to a facility's technical capability.

To support this framework, it is proposed to introduce new terms that distinguish between registered GPS capability and operational settings:

- registered capability – the fundamental technical capability of a facility approved under the Registered GPS; and
- operational settings – control parameters that may be adjusted over time to suit system or regional conditions, while remaining within the approved capability.

Establishing this distinction would support the necessary operational flexibility and more targeted reassessment approaches, without requiring unnecessary reassessment of a facility's approved capability or compromising system security outcomes.

Discussions between DEED, AEMO and Western Power have also highlighted the importance of carefully considering how any additional mechanisms interact with the Registered GPS and the Potential Relevant Generator Modification (PRGM) provisions in section 3A.12 of the ESM Rules. Where a proposed settings change result in the facility operating outside its approved capability envelope, there may be merit in establishing a streamlined and low-cost assessment process. This would help ensure that settings changes necessary to address system security issues can be implemented efficiently, while maintaining transparent technical assessment and regulatory oversight.

Considerations will be given to whether a more streamlined approach can be taken to the identification, assessment and implementation of control settings and how such an approach may interact with existing GPS registration, facility modification, compliance and testing requirements. In particular, if changes to operational settings require aspects of a facility's Registered GPS to be reconsidered, there may be value in developing an assessment process that is targeted, proportionate and capable of being implemented within shorter timeframes and at minimal cost. Further work would be required to

determine how this could improve system security outcomes and reduce operational risks without creating a disproportionate burden on connection, assessment and compliance processes.

Lastly, meaningful assessments of control interaction, the identification of issues and the need for potential settings changes, is highly dependent on the availability of accurate and validated EMT models. As such, the design of any framework for enabling changes to control setting changes must be closely linked to the proposed EMT model reforms being considered as part of this Consultation Paper (refer to section 4).

Proposal 4:

4:1 Introduce new terms that distinguish between registered GPS capability and operational settings:

- Registered capability – the fundamental technical capability of a facility approved under the Registered GPS; and
- Operational settings – control parameters that may be adjusted over time to suit system or regional conditions, while remaining within the approved capability.

The ESM Rules will include provisions to enable Western Power to review and require changes to new and existing facility control settings (beyond the existing scope for voltage control settings) when required to address system strength or related power system impacts.

A WEM Procedure will outline the process for requiring changes, including when these requirements would be triggered and any consultation that may be required.

Consultation questions

4 (a) If stakeholders do not support the proposed approach to enable changes to control settings to support system strength:

- What are the reasons for this position?
- What evidence, analysis or practical experience supports the position?

4(b) Are there particular control, protection or performance settings that should be included or excluded from the scope of the proposal?

4 (c) Do stakeholders consider there are any practical, technical, or commercial challenges associated with requiring changes to control settings under the GPS framework?

Appendix A – AEMO System Strength case studies

Disclaimer

The system strength case studies in this Appendix have been developed by AEMO at the request of DEED. The Appendix includes three case studies for: Eneabba Terminal, Regans Terminal and Shotts Terminal. The purpose of these case studies is to illustrate the potential benefits of connecting or converting GFM capability at electrically weak parts of the network, while highlighting any remaining system strength limitations that may require further assessment or investment. The information is indicative only and reflects an interim methodology.

The case studies may not align with:

- the future outcomes of the proposed Rules currently under consultation;
- the methodology or outcomes that may be published in a future System Strength Report; or
- statements published in the 2025 WEM ESOO.

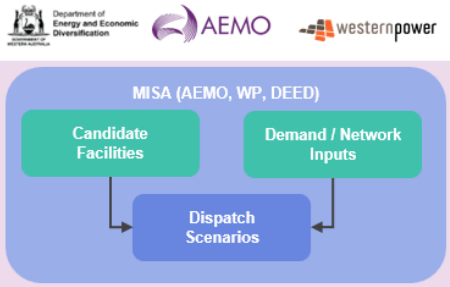
The analysis has been prepared on a best-endeavours basis using information available at the time of preparation. It should not be relied upon in place of Limit Advice issued by Western Power. The case studies do not indicate, imply or determine any requirements for investments.

Background

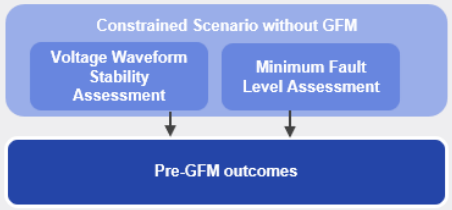
- System strength is a major component for maintaining security of the future power system.
- System strength will weaken as synchronous generators retire and are largely replaced with grid-following (GFL) inverter-based resources ('IBR', such as batteries or wind-farms).
- In the 2025 WEM ESOO, AEMO forecast that Shotts Terminal (a substation located near Collie), one of the strongest areas of the SWIS, would become a weak node due to the closure of coal-fired power stations and connection of ~650 MW of GFL battery storage by 2027.
- International experience is that grid-forming batteries (GFM) improve components of system strength (voltage waveform stability) compared to GFL.
  - The level of contribution of GFM toward maintaining voltage waveform stability and minimum levels of 3-phase fault level (to enable safe operation of protection equipment) is still an emerging field of research and operational experience.
- AEMO has performed indicative assessment of the impact of implementing proposals 1.1 and 1.2 of EPWA's (draft) Consultation Paper, adopting GFM system strength assumptions from recent studies by Transgrid and VicGrid and applying non-thermal constraints to maintain Short Circuit Ratio ('SCR', as an indicator of voltage waveform stability) at different locations in the SWIS. For the purposes of the case study:
  - All modelled GFL BESS in weak areas (3<SCR<5) are assumed to either convert to GFM or connect as GFM, consistent with the intent of Proposals 1.2 and 1.3 (as applicable). Depending on the proposed Rules, the outcome and the timing may differ.
  - The contribution toward required minimum 3-phase fault level is assumed to be zero.
- The case studies indicate the impact of GFM and constraints to maintain synchronous generation levels at three locations over three time periods: before the conversion or connection of GFM (2027), following the connection or conversion (2029) and towards the end of the horizon (2032).

Case study approach

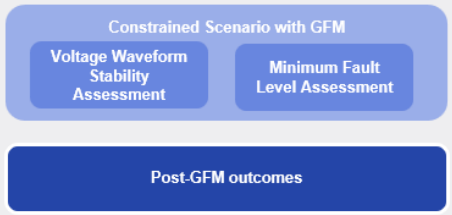
- This Case Study **uses a simplified System Strength screening assessment** at three locations – Shotts Terminal, Eneabba Terminal and Regan Terminal - to provide an indication of the potential effect of the mitigations involving Grid-Forming (GFM) technologies under proposals 1.1 and 1.2 of the Consultation Paper.
- The Case Study is **not intended to replicate the future System Strength Report, Shortfall assessment, or reflect system conditions with dispatch interventions (including constraints) that would be in place in locations with identified system strength shortfalls.**



Sources of information: Methodology, Inputs, Scenarios and Assumptions (MISA) agreed by AEMO, WP, DEED in advance of formal arrangements under the proposed System Strength Framework to be implemented under ESM Amending Rules.
Limitations: Methodology developed ad-hoc, may not replicate final approach to Facility assumptions as part of System Strength Framework, network inputs based on previous TSP modelling.



GFL contribution methodology: Constrained scenario leverages SCR (Voltage Waveform Stability) and Fault Level assessments, inclusive of dispatch mitigations. It does not include contributions from GFM facilities and is intended to provide a baseline/benchmark to provide an indication of the effect of GFM policy proposals.
Limitations: Dispatch mitigations for system strength are based on simplified constraints and will require formal limit advice to confirm shortfalls.



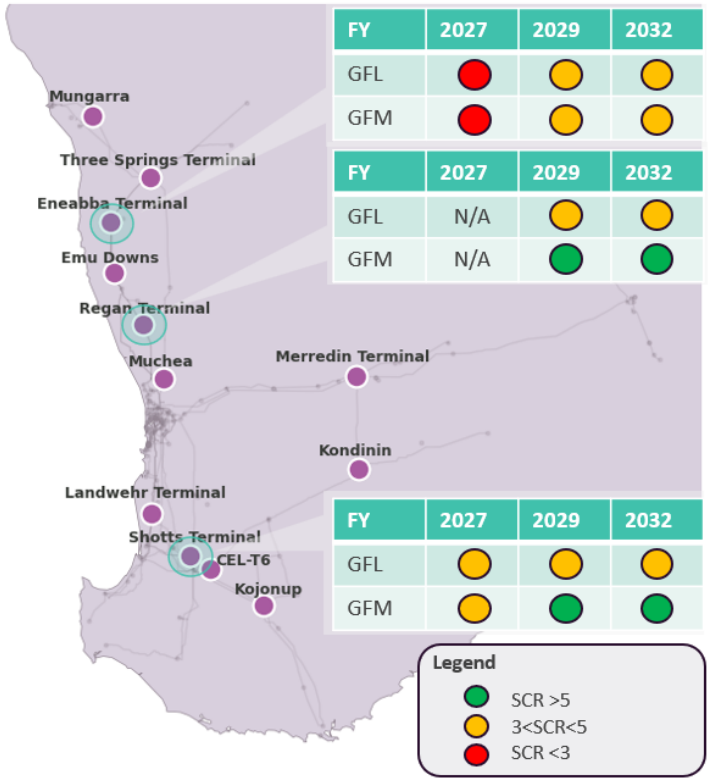
GFM contribution methodology: The approach remains the same, with the addition that selected ESR are built as or converted to GFM from 2028 (proposal 1.1). This allows post-GFM outcomes to be directly compared against the pre-GFM outcomes. The analysis assumes that the selected GFL BESS will convert to GFM rather than being curtailed on an ongoing basis, which is aligned with the policy intent of proposal 1.2.
Limitations: Dispatch mitigations for system strength are based on simplified constraints. Contributions from GFM are based on a static factor.

IMPORTANT
Grid-Forming Technologies – Contribution to Voltage Waveform Stability

Ahead of formal advice from Western Power, AEMO explored the potential impact for GFM in- line with studies by Transgrid and VicGrid. AEMO assumed GFM ESR fault current "boost factor" (as a contribution toward SCR only) of 3 times the rated output. The specific contribution of GFM will vary based on the Facility and location. For the purposes of the case study, a static factor of 3 is assumed.

This additional fault level contribution (> 1pu) included in the assessment should not be interpreted as a physical increase in network fault level. It is introduced solely to represent the voltage waveform support characteristics of GFM inverters within an SCR-based assessment framework. As the SCR metric lacks an explicit mechanism for quantifying GFM waveform stability support, this effect is represented through an equivalent fault level contribution.

Case Study Results



FY	2027	2029	2032
GFL			
GFM			

FY	2027	2029	2032
GFL	N/A		
GFM	N/A		

FY	2027	2029	2032
GFL			
GFM			

Assumed ESR conversions to GFM

Terminal	MW	MWh
Kemerton 132 kV	100	400
Merredin 132 kV	100	400
Muchea 132 kV	150	900
Regan	700	3,600
Shotts	950	4,200
Three Springs	400	2,400
Total	**2,400**	**11,900**

Outcomes

- Shotts indicates the benefit of the conversion of existing Facilities to GFM.
- Regan indicates the benefit of Facilities connecting as GFM
  - Note, Regan Terminal will be constructed as part of CEL North, expected in service is in 2029
- Eneabba indicates the impact when addition of further GFL Facilities (such as wind farms) exceeds the modelled contribution of GFM Facilities
- These studies indicate the effectiveness of GFM in providing voltage stability only. Further assessment is required to establish fault current adequacy for proper operation of protection systems.

4