Department of Planning and Environment

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NSW REZ Access Standards intended to apply to Central-West Orana REZ

Consultation package

April 2022

Acknowledgement of Country

The Department of Planning and Environment acknowledges that it stands on Aboriginal land. We acknowledge the Traditional Custodians of the land and we show our respect for Elders past, present and emerging through thoughtful and collaborative approaches to our work, seeking to demonstrate our ongoing commitment to providing places in which Aboriginal people are included socially, culturally and economically.

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These NSW REZ Access Standards are intended to apply to Central-West Orana REZ.

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Shortened forms and definitions

access rights network	Specified network infrastructure forming part of a Renewable Energy Zone (REZ) to which an access rights regime applies under the CWO REZ Access Scheme. For the CWO REZ, the access rights network is expected to comprise the new network infrastructure specified in the CWO REZ Declaration within the geographical boundary of the CWO REZ
access rights regime	A regime forming part of an access scheme that requires persons seeking access to the access rights network to hold access rights
access scheme	A scheme that authorises or prohibits access to, and use of specified network infrastructure in a REZ by a REZ network operator and operators of generation and storage infrastructure
REZ Access Standards	Specific Generator Performance Standards and Inverter Based Resource standards that are intended to apply in the Central-West Orana REZ in NSW that proponents will be required to meet as a condition of the access rights tender and must propose in their application to connect to the access rights network.
AAS	An automatic access standard as defined in the National Electricity Rules (NER)
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator Limited
CWO	Central-West Orana
CWO REZ access right holders	Proponents of generation and storage infrastructure that are awarded access rights to the CWO REZ access rights network in accordance with the CWO REZ Access Scheme
CWO REZ Access Scheme	The access scheme for CWO REZ proposed to be declared by the Minister for Energy under section 24 of the *Electricity Infrastructure Investment Act 2020*
DC	Direct current
Department	NSW Department of Planning and Environment
DNSP	Distributed network service provider
EII Act	*Electricity Infrastructure Investment Act 2020* (NSW)
EnergyCo	The Energy Corporation of NSW
EOI	Expression of interest

ESS	Energy storage system
FCAS	Frequency control ancillary services
generators	Generation and storage proponents wishing to connect to the access rights network
GPS	Generator Performance Standards
IBR	Inverter based resources
IBR standards	Inverter based resource standards
ISP	AEMO's draft 2022 Integrated System Plan
LCOE	Levelised cost of electricity
LTESA	Long-term energy service agreement as defined in the EII Act
MAS	A minimum access standard as a defined in the NER
NAS	A negotiated access standard as a defined in the NER
NEM	National Electricity Market
NER	National Electricity Rules
NSP	Network service provider
OLTC	on-line tap changer
OEM	Original equipment manufacturer
POD	Power oscillation damping
PTNSP	Primary TNSP under the NER; in NSW this is Transgrid
REZ	Renewable Energy Zone
REZ Network Operator(s)	A person authorised or directed to carry out a REZ network infrastructure project under the EII Act
Roadmap	Electricity Infrastructure Roadmap
RoCoF	Rate of change of frequency
SCR	Short circuit ratio
TNSP	A transmission network service provider under the NER

Introduction

Purpose

The Electricity Infrastructure Roadmap is the New South Wales (NSW) Government's plan to transform our electricity system into one that is cheap, clean and reliable. It will directly support the development of new electricity infrastructure in NSW. The Roadmap will deliver at least five Renewable Energy Zones (REZs) across NSW.

It is intended that EnergyCo be appointed as Infrastructure Planner under the EII Act for the first five REZs. EnergyCo was appointed as Infrastructure Planner for CWO REZ in November 2021.

EnergyCo, in collaboration with Transgrid and AEMO, is seeking feedback on the draft REZ Access Standards. These REZ Access Standards are intended to apply to CWO REZ in order to implement the CWO REZ Access Scheme, under the Roadmap. The REZ Access Standards would apply to projects awarded access rights in the first tender of access rights allocated under the CWO REZ Access Scheme.

EnergyCo will shortly launch an invitation for expressions of interest (EOI) for candidate foundation generators for CWO REZ. Successful applicants will participate in an engagement process to inform the design of the access rights network for the CWO REZ to be provided by the CWO REZ Network Operator.

In addition, EnergyCo is considering ways to improve the connection process for generation and storage infrastructure projects within a REZ. EnergyCo is proposing a streamlined connection process. Delivered through a REZ Access Standard, the streamlined connection process is expected to involve a batched connection assessment process and centralised system strength to improve connection timeframes, provide greater certainty, and reduce re-work and costs compared to the open access connection process. Setting of REZ Access Standards is a key element for the proposed streamlined connection process. Further details for consultation on the streamlined connection process will be provided in a separate paper in April, in line with the launch of the EOI for candidate foundation generators.

Access schemes

Access schemes will coordinate energy infrastructure investment in NSW. They are fundamental to realising the objectives of the Roadmap, the EII Act and Infrastructure Investment Objectives Report. The CWO REZ Access Scheme will be the first of its kind in the NEM.

In December 2021, the Department published the *REZ access rights and scheme design: Central-West Orana* consultation paper, with a straw-person access model for CWO REZ. This included the overarching design of the CWO REZ Access Scheme as would apply to the access rights network, as well as a streamlined connections process for the connection of projects awarded access rights under the CWO REZ Access Scheme.

The streamlined connection process, outlined in Figure 1, is intended to include:

- a higher IBR standard designed to optimise centrally provided system strength services, proposed to achieve efficiencies in design and procurement
- batched power system studies for all REZ proponents awarded access rights, expected to include a collective optimisation of the performance of the first tender of generators to connect to the REZ. This collective optimisation is referred to as 'plant tuning'
- the provision of final R1 standard models by proponents for assessment within the batched power system studies
- for clauses 5.2.5.5 and 5.2.5.13, a range of plant performance levels for certain parameters. Generators will nominate their expected level of performance within the range; the generator may be required to meet a different performance level within the specified range resulting from the plant tuning undertaken within the batched power system studies.

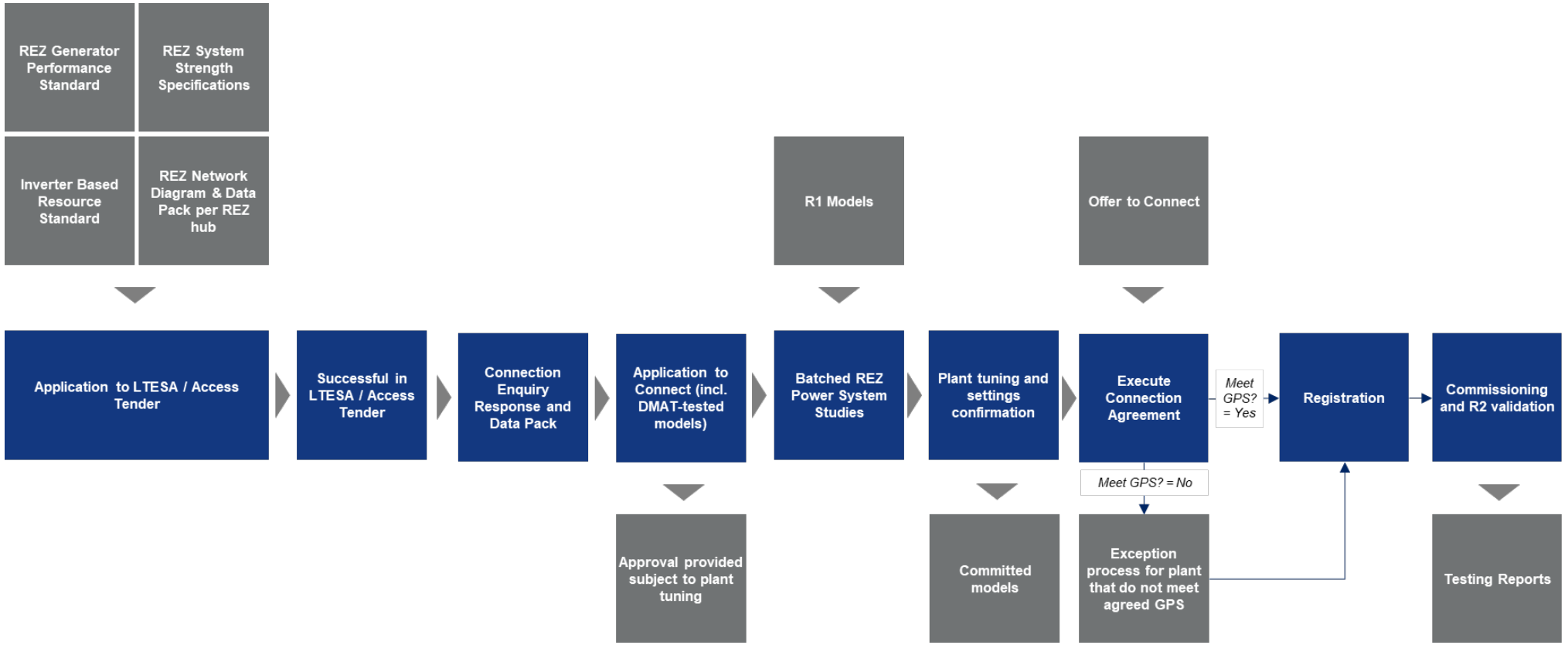

Figure 1 Updated streamlined connection process

REZ Access Standards consultation

EnergyCo has consulted with Transgrid and AEMO to develop the REZ Access Standards.

Proponents will need to agree to meet these standards as a condition of the access rights tender and to propose the REZ Access Standards in their application to connect to the REZ. The REZ Access Standards are intended to be treated in the same way as AAS under the NER for the purpose of connections to the CWO access rights network[1]. This will avoid the time-consuming process of negotiating Generator Performance Standards (GPS) under the NER as it currently applies.

It is intended that the REZ Access Standards are set at a level that can be met by reasonable quality equipment that is currently in the market, and proponents accept they will not be negotiated. This consultation invites interested parties to provide feedback on the proposed standards.

Consulting on policy design and key implementation matters is an important part of the Department's Roadmap implementation strategy. EnergyCo has adopted a structured approach to seeking feedback through a series of papers on key policy areas. Key papers that have been released for stakeholder engagement on policy and design issues to inform Roadmap implementation are located in our Virtual Engagement Room. Details on current consultations, relevant briefing sessions and how to make submissions are available on the Roadmap website.

This consultation paper includes:

- the methodology used to develop the draft REZ Access Standards
- a summary of the REZ Access Standards, including key considerations when a change from the AAS has been proposed
- the full list of draft REZ Access Standards (**Appendix A**).

It is intended that REZ Access Standards will be applied to the first tender of CWO REZ access rights allocations. On this basis the standards have been developed for asynchronous generating systems. EnergyCo, in consultation with Transgrid and AEMO, will review these standards for application in future tenders of access rights allocation in the CWO REZ and any future renewable energy zones. Any feedback on the need for standards for synchronous generating systems to be set lower than the levels proposed in this consultation paper will be considered as part of this consultation process.

[1] Draft modifications to the NER will not be CWO REZ specific but will be drafted such that the relevant connecting plant must propose the REZ Access Standards that are applicable to the relevant REZ and access rights allocation that they are participating in.

Making a submission

EnergyCo, Transgrid and AEMO are seeking feedback on the draft REZ Access Standards. Your feedback will help inform the final REZ Access Standards to be applied to projects awarded access rights in the first tender of access rights allocated under the CWO REZ Access Scheme.

To ensure the consultation process is conducted efficiently and practicably, EnergyCo has developed a feedback form for submissions on the draft REZ Access Standards (see **Appendix B**). Key questions are also provided in 'Have your say' boxes throughout this consultation paper and we encourage stakeholders to use these questions in their submissions, including in their consideration of the draft REZ Access Standards (**Appendix A**).

You are invited to provide your feedback by the closing date of **27 April 2022**, using the form, via email to **Electricity.Roadmap@dpie.nsw.gov.au**. Please put your name and 'REZ Access Standards' in the subject line.

EnergyCo, in collaboration with Transgrid and AEMO, will review the feedback provided and update the draft REZ Access Standards, publishing the final REZ Access Standards in late May 2022.

The consultation timeline and other key implementation milestone dates are outlined in Table 1**.**

Table 1 Consultation implementation timeline

Milestone	Indicative dates
REZ Access Standards consultation package released to market	5 April 2022
Public webinars	11 April 2022
REZ Access Standards submissions close	27 April 2022
Review feedback and update REZ Access Standards as appropriate	27 April – late May 2022
Invitation for EOI for candidate foundation generators in CWO REZ	Mid April
Consultation paper on streamlined connection process	Mid April
Final REZ Access Standards published	Late May 2022
Modifications to the NER finalised	Q3 2022
Access Scheme declaration gazettal	Q3 2022
Access right tender commences	Q4 2022

Please note that providing a submission is entirely voluntary, is not assessable, and does not in any way include, exclude, advance or diminish any entity from any future procurement or competitive process in regard to REZ access rights and/or long-term energy service agreements (LTESAs) under the Roadmap, or any other NSW Government program.

If a submission author considers any content in their submission to be revealing of protectable corporate intellectual property, they should clearly note and define this in their submission. In the absence of an explicit declaration to the contrary, the Department will assume the information provided is not considered intellectual property of the respondent. If you wish for your written submission to remain confidential (except to department project staff/officers, Transgrid and AEMO for the purposes of consultation to finalise the REZ Access Standards, and their advisers, who are subject to appropriate confidentiality arrangements), please clearly state this in your submission. The Department may disclose confidential information provided by you to:

- the NSW Minister for Energy or Minister's office
- the Treasurer or NSW Treasury
- the NSW Ombudsman, Audit Office of NSW or as may be otherwise required for auditing purposes or Parliamentary accountability
- directly relevant departmental staff/officers, consultants and advisers
- AEMO, Transgrid, Energy Security Board (ESB), Australian Energy Market Commission (AEMC), Australian Energy Regulator (AER) or the Australian Competition and Consumer Commission (ACCC)
- AEMO Services Limited in its capacity as Consumer Trustee under the EII Act, including its staff/officers, consultants and advisers
- the Clean Energy Finance Corporation (CEFC) or the Australian Renewable Energy Agency (ARENA) or distribution network service providers (DNSPs)
- other parties where authorised or required by law to be disclosed.

Where the Department discloses this information to any of these parties, it will inform them that the information is strictly confidential. The Department may publish or reference aggregated findings from the consultation process in an anonymised way that does not reveal confidential information.

REZ Access Standards

Rationale of the REZ Access Standards development

The REZ Access Standards set out the technical performance for generators connecting to the CWO REZ access rights network. Similar to the existing access standards applied to generators connecting to network infrastructure across the NEM, the proposed REZ Access Standards propose access standards against the technical requirements in NER Schedule 5.2 with the addition of two REZ IBR standards. A key principle in assessing compliance with the technical requirements is that they must demonstrate that each proposed access standard will not adversely impact power system security (for AEMO advisory matters) and quality of supply to other network users, in the context of the CWO access rights network configuration and design.

The rationale for the REZ Access Standards development was proposed based on the ultimate goal of streamlining the connection process for generators for the purpose of the CWO REZ. Key considerations during the access standards development include:

- statistical review of historically negotiated performance standards
  - clauses where an AAS (automatic access standard) is typically met
  - clauses where an NAS (negotiated access standard) has been proposed and agreed
- review of the reasoning behind the deviation of the performance standard from the AAS
- review at a global level of the technical risks
- review of performance characteristics and limitations in different asynchronous generator technology types
- the impacts of the generating system design on performance outcomes.

For the development of REZ IBR (inverter based resource) standards the following approach was followed:

- bring forward the implementation of new access standards for IBR to provide a risk mitigation measure in the connection of asynchronous generators. IBRs connecting under standard NER processes will be required to meet inverter based resource standards from March 2023
- review the access standards introduced by the system strength rule change[2]
- review system strength capabilities and limitations of different grids following IBR plant based on site-specific OEM (original equipment manufacturer) models of existing/committed generators
- consider power system events that could test the limits of the IBR plant capability
- review technical considerations where deviating from the new access standards introduced by the efficient management of system strength rule change may be warranted.

[2] Efficient management of system strength on the power system rule change (AEMC)

Summary of the REZ Access Standards

Table 2 outlines a summary of the clauses that have been amended and the extent of the amendments for the draft REZ Access Standards. The full list of draft REZ Access Standards is provided in **Appendix A**. Generators should note, schedule 5.2 of the NER other than the technical requirements referred to in Table 2 will continue to apply:

- S5.2.1 (Outline of requirements)
- S5.2.2 (Application of settings)
- S5.2.3 (Technical matters to be coordinated)
- S5.2.4 (Provision of information)
- general requirements applicable to relevant technical requirements except as specified below.

The proposed REZ Access Standards will apply to projects awarded access rights in the first tender of access rights allocated under the CWO REZ Access Scheme. On this basis, the standards have been developed for asynchronous generating systems; however, should proponents of synchronous generation wish to participate in this consultation process, they should consider standards consistent with those proposed in this consultation, together with any AAS elements that are specific to synchronous generation. Any feedback on the need for standards for synchronous generating systems to be set lower than these levels will be considered as part of this consultation process.

The proposed standards are intended to apply to energy storage systems (ESS) as well as generating systems. Guidance has been provided in the drafting on the requirements for ESS. In most standards, the generating standards apply to ESS and hybrid systems considering bi-directional operation. In some clauses, more specific guidance is provided. In addition to the proposed REZ Access Standards, ESS will be required to meet the customer standards in Schedule 5.3 of the NER that are not covered in REZ GPS at the AAS.

Table 2 Summary of the clauses being changed

Level of change proposed	Clause
Standards with amended technical requirements	S5.2.5.1 Reactive power capability S5.2.5.3 Generating system response to frequency disturbances S5.2.5.4 Generating system response to voltage disturbances S5.2.5.5 Generating system response to disturbances following contingency events S5.2.5.8 Protection of generating systems from power system disturbances[3] S5.2.5.10 Protection to trip plant for unstable operation S5.2.5.11 Frequency control S5.2.5.13 Voltage and reactive power control
Standards brought forward – efficient management of system strength	S5.2.5.15 Short circuit ratio S5.2.5.16 Voltage phase angle shift
Proposed to remain at minimum access standard level	S5.2.5.6 Quality of electricity generated and continuous uninterrupted operation

[3] Note that clause S5.2.5.8 only has a minimum access standard level.

Level of change proposed	Clause
Proposed to remain at automatic access standard level	S5.2.5.2 Quality of electricity generated S5.2.5.7 Partial load rejection S5.2.5.9 Protection systems that impact on power system security S5.2.5.12 Impact on network capability S5.2.5.14 Active power control S5.2.6.1 and 4.11.1 Remote monitoring S5.2.6.2 and 4.11.3 Communications equipment S5.2.8 Fault current

Detailed review of amended performance standards

S5.2.5.1 – Reactive power capability

Key considerations

- Typically a NAS.
- Consideration of efficiency in generating system design with respect to reduction of reactive power capability from generating unit to connection point.
- Many large generating systems (particularly large wind farms with extensive reticulation systems) cannot meet the AAS requirement, without additional reactive plant or oversizing the plant.
- Based on survey of agreed GPS:
  - it is recognised that 40–50% of generators have reduced capacitive reactive power capability (with respect to the AAS requirement) at higher levels of active power (top right corner)
  - on the inductive side, a reduced reactive power capability on the top left corner (at rated active power) or on the bottom left corner (low active power level) is also seen across 10–20% of generator connections.
- There is additional installed capacity from an individual generating system's size and the total transfer capacity at the boundary point to the shared transmission network.
- It is anticipated that any impact due to the reduction of the available reactive power capability could be addressed by the plants, provided by the system strength provided centrally.
- Technical requirements to capture temperature de-rating and reactive power at night (Q at night) capability/wind free capability to be included in accordance with current primary TNSP (PTNSP) practices.

Amended technical requirements

- Reduction in the requirement for capacitive reactive power when active power is greater than 90% of rated active power of the generating system.
- Reduction in requirement for inductive reactive power at less than 35% of rated active power level; that is, bottom left corner. Note that this allowance cannot be used in conjunction with a reduction of the inductive reactive power capability above 80% real of rated active power.
- Reduction in the requirement for inductive reactive power for active power levels greater than 80% of rated active power of the generating system; that is, top left corner. Note that this allowance cannot be used in conjunction with a reduction of the inductive reactive power capability below 35% of rated active power output.

Have your say

1. Will the proposed relaxation of the performance requirements (below AAS) make a material difference to the cost of a generating system?
2. Are the requirements set at the right levels?
3. Considering that some generating systems may have a connection to the access rights network at medium voltage (MV) level, is the requirement to meet these standards at 1.1 per unit (pu) and 0.9 pu voltages a barrier to connection for some technologies?
4. If the reactive power requirements at 1.1 pu and 0.9 pu would impose additional costs, what alternative technical options should be considered and what would be the cost implications of such requirements?

S5.2.5.3 – Generating system response to frequency disturbances

Key considerations

- AEMO's ISP shows declining inertia levels in the mainland NEM, as thermal units retire. Inertia shortfalls can occur earlier than expected if coal fired power stations retire early or move to flexible operation.
- In NSW, with the retirement of Eraring, Bayswater, Liddell and Vales Point power stations it is expected that higher Rate of Change of Frequency (RoCoF) will be experienced following multiple generator trip events.
- It is not clear that fast-frequency response frequency control ancillary services (FCAS) will operate fast enough to prevent initial high RoCoF that could occur in this scenario.
- To future proof the power system, it is critical to ensure IBR plants have sufficient capability to withstand and maintain stable operation in the event of high RoCoF events and avoid cascading failures.
- Based on analysis of the capability of a subset of existing asynchronous generating systems, well-tuned asynchronous generating units and ESS have capability to withstand and achieve stable operation for RoCoF of 6 hertz per second (Hz/s).

Amended technical requirement

- The generating system must remain in continuous uninterrupted operation for RoCoF up to ±6 Hz/s for 0.25 seconds, ±3 Hz/s for 1.00 second for the frequency disturbances outlined in the AAS requirement under clause S5.2.5.3 of the NER.
- No other changes to the current NER requirements for S5.2.5.3.

Have your say

5. Are there any impediments to modern, commercially available types of asynchronous generating units meeting the requirement of continuous uninterrupted operation required to meet the proposed standard?
6. What would be the implications of the proposed standard for grid forming inverters that emulate certain synchronous machine performance characteristics?

S5.2.5.4 – Generating system response to voltage disturbances

Key considerations

- For those generators with a connection point at medium voltage (typically below 66 kV), a main transformer with on-line tap changer (OLTC) capability may not be present in the balance of plant design. Without an OLTC the generating system is not able to regulate the voltages across the collector system during over-voltage conditions for long durations required by the clause.
- It is assumed that medium voltage connection points will be supplied from the transmission system (HV level) via a transformer with an OLTC. This OLTC would normally regulate the medium voltage level ensuring voltage levels of the connection point remain within system standards. The OLTC will therefore operate during long duration over-voltages bringing the connection point within normal voltage ranges.
- Application of very high, shorter duration over-voltages at the medium voltage level also means that, for assessment purposes, the generating system voltage controls cannot influence the medium voltage system over-voltage, which is more onerous than if the over-voltages were applied on a high voltage connection point, where the intervening transformer impedance means the generating system voltage controls can reduce the over-voltage to some extent.
- It is recognised that to meet the AAS, a transformer with OLTC is required. Without a transformer with an OLTC the AAS requirements can be achieved at a higher voltage level location, beyond the upstream network transformer. An appropriate point of application of the AAS level requirement would typically be the high voltage terminals of the relevant network transformer.
- For generating systems connecting to the transmission system (HV) level a transformer OLTC allows for the voltage of the reticulation system to be regulated for the long duration over-voltages. It is therefore expected that for generating systems connected to the transmission system the AAS is applicable.
- The under-voltage requirements 70−80% and 80−90% of normal voltage of 2 s and 10 s respectively are within the typically tap change timeframes and therefore the performance requirements irrespective of the generating system's transformer or OLTC configuration. It is considered the under-voltage AAS requirement is appropriate for all generating system connection configurations.

Amended technical requirements

- For generating systems with a connection point up to 66 kV without a main transformer with an OLTC, the access standard shifts the voltage disturbance (over-voltage only) location to the 'point of application' instead of the connection point. The 'point of application' is the electrically-nearest transmission system voltage. Typically, the 'point of application' will be the HV terminals of the transformer supplying the connection point.
- For generating systems connecting to the transmission system (HV) level, the connection point remains the voltage disturbance (over- and under-voltage) location for continuous uninterrupted operation of the generating system.
- The under-voltage limits remain unchanged from the AAS as the main transformer OLTC is typically unable to assist in the ride-through capability.

Have your say

7. If the existing AAS levels were applied to generating systems/ ESS at medium voltage connection points, which voltage ranges of the AAS requirement would current generating plant or ESS technologies have difficulty meeting? Provide details and evidence of the technical design or equipment limitations.
8. If technical impediments have been identified in the previous question, would the affected technologies be able to meet the existing AAS requirements with additional equipment, and if so, at what cost?
9. Considering the previous two questions, is the proposed standard reasonable?

S5.2.5.5 – Generating system response to disturbances following contingency events

Key considerations

- Historically, S5.2.5.5 performance has been negotiated in previously agreed GPS, primarily due to:
  - failure to meet reactive current injection/absorption criteria for AAS
  - failure to meet active power recovery time criteria specified in the AAS.
- It is recognised that applying the requirements for AAS for reactive current injection and absorption at the connection point and the active power recovery time of 100 milliseconds (ms) as the REZ Access Standard may be too onerous.
- It is also unlikely optimal performance of the access rights network may be achieved by applying the most aggressive control responses across every generator connected to that network.

Reactive current response magnitude

- While the generator's reactive current response is in relation to the voltage measured at generating unit terminals, the generating system must have the capability to respond at an appropriate level at its connection point in order to support the network voltage during a disturbance.
- To ensure the generating system will not adversely affect power system security irrespective of the size, plant design, technology, and location of the connection, a certain level of performance requirement is to be set at the connection point while providing flexibility to allow the reactive current contribution to be assessed at a location other than the connection point.

Commencement of reactive current response

- Consideration is also given to relaxing the AAS requirement for magnitude of the voltage range where a reactive current response is commenced to make allowance for the voltage differential between the connection point and the furthest generating unit of a generating system under different operating conditions.

Active power recovery

- It is understood that a rapid recovery of active power may not be possible or desirable in some instances due to local power system conditions. Conversely, if a large number of plants in a geographical area recover slowly following a fault event, the slow recovery can cause an energy deficit that translates into additional frequency ancillary service requirements within the NEM.

- Based on statistical analysis of generator connections across the NEM, it is recognised that up to 60−70% generators can meet active power recovery time of 250 ms.
- Consideration is given to the appropriate level that can be reasonably achieved by a well-designed generating system while providing flexibility to optimise the plant settings during REZ dynamic assessments.
- It is recognised that to achieve the best performance from the REZ, coordination of plant tuning may be required. This tuning process can be undertaken across all REZ generators in a batch assessment and may impact the performance level required for active power recovery.

Amended technical requirements

Reactive current response magnitude

- The reactive current contribution may be assessed at a location other than the connection point including generating unit terminals or another location within the relevant generating system, provided a certain level of performance is met at the connection point.
- If the reactive current contribution is assessed at the connection point, the maximum continuous current of the generating system is to be determined based on the rated active power and the maximum reactive power capability proposed under clause S5.2.5.1 and the nominal voltage at the connection point. If the reactive current contribution is assessed at the generating unit terminals, the maximum continuous current is to be determined based on the nameplate rating and the nominal voltage at the generating unit terminals.
- To assist in the maintenance of power system voltages during the application of the fault, the generating system must supply or absorb:
  - capacitive reactive current in addition to its pre-disturbance level of 4% of the maximum continuous current for each 1% reduction of the generating unit terminal voltage, subject to having measures to meet at least 2% of its maximum continuous current for each 1% reduction of the connection point voltage
  - inductive reactive current in addition to its pre-disturbance level of 6% of the maximum continuous current for each 1% increase of the generating unit terminal voltage, subject to having measures to meet at least 2% of its maximum continuous current for each 1% increase of the connection point voltage.
- The proposed reactive current magnitudes (at terminal level) have been set at AAS level but may be revised if required to achieve optimal performance of the REZ. The 2%/% at the connection point is mandated as a design requirement. The proponent must demonstrate that this level of performance can be achieved at the connection point considering the design of the generating system and the level of injection/absorption required at the generating unit terminals.

Reactive current response rise time and settling time assessment

- This standard is under further review. See further explanation and request for feedback below.
- The rise time and settling time associated with the reactive current response is to be assessed at the generating unit terminals.

- Where the generating system is required to sustain a response duration of greater than 2 s, the reactive current rise time and settling time must be as soon as practicable and must be adequately damped.

Commencement of reactive current response

- The generating system must commence a response:
  - when the connection point or the terminal voltage is in an under-voltage range of 80–90% of normal voltage
  - when the connection point or the terminal voltage is in an over-voltage range of 110–120% of normal voltage.
- These ranges may be varied with the agreement of the parties responsible for setting the REZ Access Standards (provided the magnitude of the range between the upper and lower bounds remains at a delta of 10%).

Active power recovery

- The generating system must return to at least 95% of the pre-fault active power output, after clearance of the fault, within 250 ms.

Have your say

10. Multiple fault ride-through – the performance standard has been proposed at AAS level for this clause. Does this pose an impediment to connection of some types of asynchronous generating units or systems? If so, provide details and evidence of technical limitations and propose alternative performance standards that the plant can meet.
11. Active power recovery – does a maximum active power recovery of 250 ms represent an impediment to connection of modern, asynchronous generating systems? If so, provide details and supporting evidence and suggest an alternative level.
12. Reactive current rise time and settling time – consideration is being given to relaxing the reactive current rise time and settling time clause, for which the AAS and minimum access standard (MAS) are virtually the same, representing a barrier to entry for some technologies. Specific issues include:
    - application of a rise time and settling time assumes that a fault leads to a step change in voltage, and in response a step in reactive current injection, whereas in practice voltages during faults are seldom clean steps
    - the response of generating systems during faults is also often more complex than a simple step response and can include slow changes following the initial current injection, so that the response does not settle during the fault
    - the definition of settling time has error bands defined as 10% of the step change. For shallow faults this results in very small error bands, which affects the calculated setting time. The clause does not specify test conditions, only performance outputs
    - wind turbine OEMs have documented, in a proposed NER change[4], that for some doubly-fed induction generator (type 3) technologies there is a large DC component in the fault current that results in a large swing in the calculated positive sequence current. It takes at least a full cycle (20 ms) to eliminate the swing, causing more than 20 ms delay in the rise time and settling time.

[4] see link under 'More information'

To address these issues, redrafting of this clause is under consideration. The following amendments are being considered:

- omit the settling time requirement, provided the reactive current response is adequately damped over the duration of the fault
- allow a range 40−60 ms for the rise time, which may be assessed at the generating unit terminals (or auxiliary equipment terminals if provided for this purpose)
- provide that any delay in commencement of the reactive current response must not result in reactive current injection decreasing at the connection point below its pre-fault level.

Specific feedback is sought on whether this would address the observed issues around the current drafting. If this level of performance would still represent an impediment to connection, please provide details and alternative performance standards that would remove the impediment, and supporting evidence of why they are required.

S5.2.5.8 – Protection of generating systems from power system disturbances

Key considerations

- The current MAS requirement includes trip of the generating system as one of the three options for reduction of generation when the frequency of the power system (as measured at the connection point) exceeds a level nominated by AEMO.
- From a system security point of view, it is undesirable to have multiple generating systems trip during an over frequency event, irrespective of the magnitude of the frequency variation above a certain nominated level.
- To efficiently operate a safe and secure power system the preferred response is for a generating system to have facilities to automatically and rapidly reduce its generation in proportion to the frequency disturbance experienced.
- Generating systems demonstrate this capability of proportional response in clause S5.2.5.11, where the generating system is required to have the capability of operating in frequency response mode such that it automatically provides a proportional response to rise or fall of power system frequency.
- Most asynchronous generating systems already comply with this requirement.

Amended technical requirement

- Disconnecting the generating system from the power system within 1 s is excluded as an option available for generating systems to meet the MAS criteria for reduction of generation when the frequency of the power system (as measured at the connection point) exceeds a level nominated by AEMO.
- No other changes to the current NER requirements for S5.2.5.8.

Have your say

13. Is the proposed removal of the option to trip within 1 s for over frequency reasonable?

S5.2.5.10 – Protection to trip plant for unstable operation

Key considerations

Historically the performance standards for asynchronous generating systems for this clause have often been negotiated. This is due to the absence of dedicated protection systems in asynchronous plant to disconnect the generating system if it is becoming unstable. It has been observed in the NEM that asynchronous generating systems can participate in voltage oscillations, due to interactions between their control systems. In a REZ there will be a high density of asynchronous generating systems, and over the life of the plant, the system strength of the mainland NEM is expected to decline further, which could exacerbate oscillations resulting from control interactions. The key challenge for power system operators is to understand which generating systems are contributing to the problem. The wording of the current AAS implies disconnection of a plant if an oscillation is detected, but discrimination is needed between those plants causing an oscillation and those that are responding to damp it.

- As there will be a large amount of generation connected within the area of the REZ, there is potential for adverse interactions between generating systems.
- It is important for the control rooms to have information to help them understand which plant or plants are contributing to an oscillation and which ones are damping it, so they can take appropriate action.
- The generating system is to have capability to promptly disconnect based on an agreed protocol if directed by a control room and configurable to trip or ramp down automatically.
- There are various attributes of an oscillation which would impact the necessary action , for example, the extent to which the generating system is exacerbating the oscillation, the oscillation magnitude and whether it is damped or growing, can trigger different alarms and actions.
- As the technology to identify the source of an oscillation is not fully mature, the proposed standard requires it only for voltage oscillations. AEMO has provided a document, included in this consultation package, which explains how the relationship between voltage and reactive power can be used to assess the contribution of a plant to a voltage oscillation measured at its connection point. (see Appendix C).
- As the experience with the technology grows, there may be value in adjusting the triggers and actions to improve power system security. The proposed standard includes ability for AEMO or the PTNSP to require changes to triggers or actions.

Amended technical requirements

- The proposed standard requires the generating system to have an instability detection system capable of detecting voltage, reactive power and active power oscillations, and sending alarms to AEMO and the PTNSP.
- For voltage oscillations that are not adequately damped, there is an additional requirement to identify whether the generating system is contributing to the oscillation.
- To allow for improvements to be made to the detection system over time, AEMO and the PTNSP may request changes to the triggers and the actions associated with them, for the purpose of improving power system security.

Have your say

Although most asynchronous generating systems have not been required or capable of meeting the AAS for this clause in the past, the need for detection systems to be implemented, including ones that can identify whether the generating system is exacerbating or damping the oscillations, is becoming urgent.

14. Does the proposed standard strike the right balance, considering the technology is still evolving and not commercially available, but is likely to be needed in the REZ context?
15. What would be the cost and time impacts of requiring the voltage oscillations to be detected and alarmed based on the contribution of the generating system to the voltage oscillations?

S5.2.5.11 – Frequency control

Key considerations

- Under the NER, the AAS requirement for clause S5.2.5.11(b)(2) excludes the wording 'subject to energy source availability', while the MAS includes the dependency of the response on energy source availability.
- It is recognised that for intermittent generating systems, the primary energy source availability may be beyond the generator's reasonable control.

Amended technical requirements

- A generating system must be capable of operating in frequency response mode such that, subject to energy source availability, it automatically provides a proportional response to rise/fall in the frequency of the power system as measured at the connection point. The response is required to be sufficiently rapid and sustained for a sufficient period for the generator to be in a position to offer measurable amounts of all market ancillary services for the provision of power system frequency control.

Have your say

16. Is the proposed inclusion of the phrase 'subject to energy source availability' for semi-scheduled generators required or is it implicitly understood?

S5.2.5.13 – Voltage and reactive power control

Key considerations

- The S5.2.5.13 performance standard has typically been negotiated, primarily due to:
  - lack of power oscillation damping (POD) capability of the voltage control system
  - failure to meet the AAS requirement for reactive power rise time of 2 s.

POD requirement

- Considering the potential for oscillations due to control interactions between generating systems that are in close electrical proximity within the REZ, POD capability is recognised as an important capability to be included in the generating system design.

- The requirement for enabling and appropriate tuning of the POD can be determined during detailed assessments.
- At present, there are few committed asynchronous generating systems in NSW where requirement for a POD has been included in the GPS.

Reactive power rise time

- It is recognised that the performance characteristics of a generating system's response to a step change in voltage or voltage setpoint are dependent on the fault level at the connection point and the tuning capability of the associated generator technology.
- A generating system connecting at a lower fault level tends to have a faster, but more oscillatory and less stable response, while at high fault levels the response can be slower, but well damped with no subsequent oscillatory behaviour.
- Considering the potential for control system interactions between generating systems in close electrical proximity within the REZ, it is recognised that a coordinated approach to tuning of voltage controllers should provide the optimal performance outcome for the REZ and the power system, rather than setting an onerous performance standard that may have adverse system impacts.

Active power settling time

- The settling time calculation includes error bands based on either the sustained change or the maximum change of an output quantity. For voltage steps, when the resulting sustained change in active power and/or the overshoot is very small, the settling time criterion is not meaningful, as the small error bands can lead to extended settling times. However, for active power excursions above a certain threshold, the requirement for meeting settling time criteria should still apply. A general requirement for adequate damping should also still apply.

Operation in reactive power and power factor control

- While operation in either reactive power mode or power factor control is useful under certain circumstances, it is expected the operation of REZ generating systems will predominantly be in voltage droop control mode. To support streamlining the connection process, it is recognised that some simplification of the compliance requirements can be made in terms of the operation modes. The proposed standard omits the settling time compliance requirement for reactive power and power factor setpoint changes but retains the settling time requirement for 5% voltage disturbance.

Amended technical requirements

- For a 5% step change in the voltage setpoint, the generating system must have a voltage control system that has a reactive power rise time of less than 4 s. This reactive power rise time requirement value is subject to the batch tuning process.
- A threshold level of 5 MW active power excursion (sustained or maximum) has been added, below which active power settling time is deemed to be satisfactory.
- For power factor control and reactive power control, the requirement to demonstrate settling time compliance for a 50% reactive power step has been removed, but the settling time requirement for a 5% voltage disturbance has been retained.

- No other changes to the current AAS requirement for S5.2.5.13.

Have your say

17. Do options to install PODs exist for commercially available generating unit/ ESS units?
18. What would be the cost and time impacts of requiring a POD?
19. If proponents (or OEMs) have concerns regarding the requirement for POD being mandated in the performance standards, please provide supporting details to explain your concerns.
20. Is a reactive rise time of less than 4 s reasonable, as a mandatory standard?
21. Is the 5 MW threshold (error bands +/− 0.5 MW) set at an appropriate level?
22. Is the relaxation of the reactive power mode and power factor mode assessment requirement at an appropriate level?

S5.2.5.15 – Short circuit ratio

Key considerations

- The AEMC's recent system strength rule change[5] will introduce a new performance standard in Schedule 5.2 of the NER, requiring a connecting generating system to be capable of stable operation at a short circuit ratio (SCR) of 3 at its connection point.
- A coordinated, centralised approach to provision of system strength for the access rights network is proposed to achieve efficiencies in design and procurement. This will avoid the need to model the system strength impacts of each project individually and the inefficiencies that can be created by decentralised provision of system strength.
- The SCR proposed in the draft REZ Access Standards is set at a level that aims to optimise the balance of centrally provided system strength remediation against increased requirements of equipment performance, with the goal of minimising the total cost of the CWO REZ, in turn minimising the overall cost to consumers.
- Based on a review of a sample IBR plant's capability, an SCR of 1.8 has been proposed as an appropriate performance standard that a well-tuned IBR plant of reasonable quality should be able to meet.
- Feedback from industry on the proposed SCR capability is strongly encouraged, to ensure it is set at the right level.

Amended technical requirements

- SCR is to be determined based on the three-phase fault level at the connection point and the generating system's rated active power.
- The generating system must have plant capability sufficient to operate stably and remain connected at an SCR of 1.8 at the connection point, assessed in accordance with the system strength impact assessment guidelines established under NER clause 4.6.6.

[5] see link under ' More information'

- If the generating system is not capable of meeting an SCR of 1.8, the generator may achieve compliance by:
  - undertaking investment in its plant to achieve plant capability sufficient to operate stably and remain connected at an SCR of 1.8
  - procuring services to enable the generating system to operate stably and remain connected at an SCR of 1.8 (calculated using a three-phase fault level at the connection point that excludes any contribution from the facilities providing the service).

Have your say

23. Would a minimum SCR of 1.8 at the connection point require projects employing commercially available, modern, well-tuned generating units to install or contract for other equipment to meet this requirement?
24. If so, what would be an appropriate minimum SCR at the connection point that the generating system could meet without relying on additional equipment?
25. What additional costs, if any, would setting a minimum SCR of 1.8 at the connection point impose on projects? Please provide details of changes to levelised cost of electricity (LCOE; $/MWh).
26. Please provide details and supporting evidence if proposing an alternative level.
27. We would welcome feedback from asynchronous generating units and ESS OEMs on the capability of their commercially available plant to meet this requirement.

S5.2.5.16 – Voltage phase angle shift

Key considerations

- The AEMC's system strength rule change determined a need to exclude the use of phase shift protection in generating systems.
- The determination limited the use of vector shift or similar protection relay that would operate for a voltage phase angle shift less than or equal to 20 degrees, as measured at the connection point; however, system investigations demonstrate that credible contingencies can result in phase shifts up to 40 degrees.
- Within the REZ there will be an over-subscription to account for the intermittency of generation with the expectation of storage to absorb excess energy, therefore resulting in additional loading on transmission lines; faults on this network would also increase the likelihood of large impedance changes.
- Reviewing each of the other performance standards there is a consistent theme of the requirement to operate continuously and in a stable manner; for example, adequately damped, continuous uninterrupted operation – the omission of this requirement appears to be inconsistent with other performance standards, where plant protection and operation are usually coordinated.

Amended technical requirements

- Bringing forward the application of the voltage phase angle shift requirements under the efficient management of system strength on the power system rule change.
- Increasing the minimum phase shift protection exclusion from 20 degrees to 40 degrees.
- Incorporation of a requirement to remain connected and to operate stably for phase angle changes up to 40 degrees at the connection point.

Have your say

28. We would welcome feedback from asynchronous generating units and ESS OEMs on the capability of their commercially available plant to meet this requirement.

More information

The current network connection process

Efficient management of system strength on the power system rule change (AEMC)

Electricity Infrastructure Investment Act 2020

Electricity Infrastructure Roadmap website

Electricity Infrastructure Roadmap Virtual Engagement Room

Email address for submissions: Electricity.Roadmap@dpie.nsw.gov.au

National Electricity Rules (AEMC)

Pending request for change to the NER regarding requirements of S5.2.5.5

Renewable Energy Zone (Central-West Orana) Order 2021 – CWO REZ Declaration (PDF 41MB)

REZ access rights and scheme design: Central-West Orana – consultation paper (PDF 1.1MB)

Appendices

Appendix A – Draft REZ Access Standards Template

Appendix B – Have your say – feedback form

Appendix C – S5.2.5.10 Technical Note