DNSP Guideline – Technical Requirements for sub 5 MW DER Connections

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Contents

Tables

Current version release details

Version	Effective date	Summary of changes
1.0	25 November 2025	First release

Note: There is a full version history at the end of this document.

1. Introduction

1.1. Purpose

This guideline specifies recommended technical performance requirements relevant to the security and reliability of the National Electricity Market (**NEM**) bulk power system, for application to relevant distributed energy resource (**DER**) connections with a capacity of up to < 5 megawatts (**MW**). The guideline has been developed to support continued growth in the volume of DER connections in this size range by ensuring they are aligned with system security and reliability needs.

AEMO has consulted with distribution network service providers (**DNSPs**) and other interested NEM stakeholders in developing this guideline. Its key objective is to meet power system needs by facilitating consistent performance requirements across NEM distribution systems. The application of this guideline is recommended, but not mandatory – it is published as a resource for DNSPs in their development and application of suitable technical connection requirements to assist overall power system performance.

This guideline does not consider technical requirements for performance aspects that are only relevant for the local distribution network, nor does it address modelling and commissioning requirements, which are likely to vary based on individual connection and network characteristics. In the case of any overlap between the requirements in this guideline and other requirements relevant to a DNSP's network or connection process, the DNSP should determine how best to resolve those matters.

For more information on the objectives and scope of the guideline, and the matters considered in its development, please refer to AEMO's Final Consultation Report.

1.2. Coverage

This guideline applies to DER connections with a nameplate rating less than 5 MW[1] , to the extent not covered by:

- AS/NZS 4777.2:2020 for low voltage (**LV**) connected inverter-based DER[2], or
- National Electricity Rules (**NER**) Schedule 5.2 (S5.2) (typically not applied to DER connections below 5 MW, other than registered participant systems).

The guideline is not intended to apply retrospectively, but should be considered for new connections and connection alterations, including changes in grid output capability.

The scope of systems covered by this guideline is outlined below across two categories:

- DER and connection voltage, and
- DER Registration.

[1] DNSPs may also use it to guide the negotiation of performance requirements for registration-exempt DER systems 5 MW and above where appropriate.

[2] In this context LV refers to 230 volts (**V**)/400 V inverters. The scope of AS/NZS 4777.1 allows for its application to inverter energy system (**IES**) connections at voltages above 1,000 V alternating current (**AC**) (defined as high voltage [**HV**]), where LV load is part of the connection. AEMO understands that the requirement for local load was included so AS/NZS 4777 could not be applied to a DER installation, such as a solar photovoltaic (**PV**) installation, that is large and connected at a higher voltage but consists of LV inverters. Such DER installations should be covered by alternative standards, such as NER S5.2 or those recommended in this guideline, depending on the installation size.

Table 1 identifies the systems covered by AS/NZS 4777.2:2020, NER S5.2 and the guideline.

Table 1 Applicable requirements based on DER and connection voltage

Connection voltage	Description	Size range	Applicable requirements
HV connected	LV inverter-based systems, with HV load	< 5 MW	This guideline
	LV inverter-based systems, without LV load	< 5 MW	This guideline
	LV inverter-based systems, with LV load	< 5 MW	AS/NZS 4777.2:2020
	LV inverter-based systems, other than 230/400 V nominal values	< 5 MW	This guideline
	HV inverter-based systems	< 5 MW	This guideline
LV connected	LV inverter-based systems	< 1.5 MW[3]	AS/NZS 4777.2:2020
HV connected/LV connected	Synchronous generation	< 5 MW	This guideline
HV connected/LV connected	Generating systems or integrated resource systems subject to AEMO-issued exemption from registration	5 MW – < 30 MW	Subject to exemption conditions, NER S5.2 requirements, and/or relevant aspects of this guideline

Where multiple DER at separate DNSP connection points are aggregated over a wider area – such that they can operate in an orchestrated or co-ordinated manner – performance requirements should be applied for individual plant in the aggregation based on the criteria in Table 1 above.

1.3. Compliance with the guideline

The guideline does not replace the need to include performance requirements in the connection agreement between a DER proponent and the DNSP. Rather, the guideline specifies requirements for bulk power system security for DNSPs to incorporate within their DER connection policies.

Where the requirements in this guideline are applied, compliance with those requirements will be assessed and managed through the DNSP connection process and ongoing connection agreement with the DER proponent.

1.4. Glossary

Terms that are defined in the NER have the same meanings when used in this guideline. Table 2 lists abbreviations used in this guideline.

[3] This threshold may vary by DNSP, based on location within the network and their specific connection policies; 1.5 MW appears to typically be the maximum size for DERs to be connected at LV network.

Table 2 Abbreviations

Abbreviation	Meaning
AEMO	Australian Energy Market Operator
BESS	battery energy storage system
DER	distributed energy resources
DNSP	distribution network service provider
FCAS	frequency control ancillary service/s
FOS	frequency operating standard
HV	high voltage (in this context means not LV)
Hz	hertz
Hz/s	hertz per second
kW	kilowatt/s
IBR	inverter-based resource/s
LV	low voltage (with reference to AS/NZS 4777.1:2024)
MAS	minimum access standard (with reference to NER S5.2)
ms	millisecond/s
MW	megawatt/s
NEM	National Electricity Market
NER	National Electricity Rules
NSP	network service provider
OEM	original equipment manufacturer
PPC	power plant controller
PFR	primary frequency response
RoCoF	rate of change of frequency
S5.2	Schedule 5.2 of the NER

2. Performance requirements for security of the bulk supply system

The requirements in this guideline are intended to apply at the point of connection between the DER plant the DNSPs network. However, AEMO acknowledges that for some requirements the difference between specifying performance at the connection point versus at the DER level (inverter/battery terminal) will be minimal. Therefore, unless expressly specified, the point of application or measurement is at the discretion of the DNSP, to be agreed with the DER connection applicant for each requirement.

Separate performance requirements have been defined for different DER connections as follows:

- new connections and connection alterations of inverter-based resources (**IBR**) including generation and storage,
- new connections and connection alterations of synchronous generation, and
- relevant changes to the operation of legacy plant in relation to the network, such as existing standby generation seeking to also synchronise with the DNSP network.

Table 3 Performance requirements for security of the bulk supply system

Focus Area	DER classification	Proposed performance level
Frequency ride-through	**IBR and Synchronous generation**	The capability should be aligned with the FOS for islanded conditions. Mainland: • At frequencies from 49.5 hertz (**Hz**) to 50.5 Hz, the DER shall be capable of remaining in continuous operation. • At frequencies from 49.0 Hz to 49.5 Hz and from 50.5 Hz to 51.0 Hz, the DER shall be capable of remaining in continuous operation for at least 10 minutes. • At frequencies from 47.0 Hz to 49.0 Hz and from 51.0 Hz to 52.0 Hz, the DER shall be capable of remaining in continuous operation for at least 2 minutes. Tasmania: • At frequencies from 49.0 Hz to 51.0 Hz, the DER shall be capable of remaining in continuous operation. • At frequencies from 48.0 Hz to 49.0 Hz and from 51.0 Hz to 52.0 Hz, the DER shall be capable of remaining in continuous operation for at least 10 minutes. • At frequencies from 47.0 Hz to 48.0 Hz and from 52.0 Hz to 55.0 Hz, the DER shall be capable of remaining in continuous operation for at least 2 minutes.
	Legacy plant	Performance to be agreed with DNSP based on plant capability with appropriate safety margins.

Focus Area	DER classification	Proposed performance level
RoCoF ride-through	**IBR**	The DER shall be capable of remaining in continuous operation for RoCoF up to: • ±4 hertz per second (**Hz/s**) for a duration of 250 milliseconds (**ms**); and • the FOS requirement for ±1 Hz/s over any 500 ms period.
	Synchronous generation	The DER shall be capable of remaining in continuous operation for rate of change of frequency (**RoCoF**) up to: Mainland: • ±1 Hz/s over any 500 ms period; and • ±3 Hz/s over any 300 ms period. Tasmania: • ±3 Hz/s over any 250 ms.
	Legacy plant	Performance to be agreed with DNSP based on plant capability with appropriate safety margins.
Voltage excursion ride-through	**IBR**	The DER shall be capable of remaining in continuous operation at any active power for voltages as follows (as a percentage of nominal voltage): • >125% to 130% for up to 60 ms, unless disconnection is required by the DNSP[4] • >120% to 125% for up to 100 ms, unless disconnection is required or allowed by the DNSP • >118% to 120% for up to 350 ms • >110% to 118% for up to 900 ms • Continuously for 90% to 110% • <90% to 78% for up to 10000 ms • <78% to 70% for up to 2000 ms • <70% to 30% for up to 1000 ms • <30% to 0% for up to 150 ms, if required by the DNSP. Alternatively, the DNSP can agree to apply the minimum access standard in NER S5.2.5.4. These requirements apply: • at the connection point for HV connections • at unit terminals or connection point for LV connections.
	Synchronous generation and legacy plant	Performance to be agreed with DNSP based on plant capability with appropriate safety margins.
Phase angle shift ride-through	**IBR**	The DER shall be capable of remaining in continuous operation for: • 60 degrees for single-phase disturbances • 20 degrees for three-phase disturbances Alternatively, the DNSP may agree to the DER not including any vector shift or similar relay or protective function that acts upon voltage phase angle which might operate for phase angle changes less than 20 degrees.

[4] The DNSP may require disconnection of the inverters between 120% and 130% of nominal voltage.

<table>
<tr><th>Focus Area</th><th>DER classification</th><th>Proposed performance level</th></tr>
<tr><td></td><td></td><td>Note: in AS/NZS 4777.2:2020 the requirements are at inverter terminal level, but the phase angle at inverter terminals is approximately the same as the connection point.</td></tr>
<tr><td></td><td>Synchronous generation and legacy plant</td><td>Performance to be agreed with DNSP based on plant capability with appropriate safety margins.</td></tr>
<tr><td>Active power curtailment, by remote signal</td><td>All DER</td><td>There should be capability at the site to receive a control signal from designated DNSP interface points to (at minimum) disconnect the DER or curtail DER active power to a level specified by the DNSP.
The capability is intended to be available and utilised if the DER is required to be curtailed for system security.
DNSPs may require more dynamic and controls and limiting on-site.
The required response can be achieved in different ways, including:
Disconnecting and reconnecting the DER; or
Curtailment through the power plant controller (PPC).</td></tr>
<tr><td>Remote monitoring</td><td>All DER above 200 kW size</td><td>There should be remote monitoring capability at the site to collect and communicate data to designated DNSP interface points, both:
Aggregated by DER technology – quantities aggregated by DER technologies onsite (e.g. solar inverters, batteries)
Site-level – measured at the point of connection with the DNSP’s network.
Data should be collected at a sampling interval ≤60seconds (except for the site voltage measurement) and communicated to the DNSP in (near) real-time.
Accuracy
DER-level data is required to be captured at ±4% of accuracy, consistent with AS/NZS 4777.2:2020 Table 2.5.
Site-level data is required to be captured at ±1% of accuracy.
Data specification
<table>
<tr><th>Level</th><th>Required Data Point</th><th>Description</th><th>Units</th><th>Notes</th></tr>
<tr><td rowspan="3">Aggregated by DER technology</td><td>Active power</td><td>Active power generated / consumed by PV / BESS</td><td>kW / -kW</td><td>Min, Max, Average</td></tr>
<tr><td>Reactive power</td><td>Reactive power generated / consumed by PV / BESS</td><td>kVAr/ -kVAr</td><td>Min, Max, Average</td></tr>
<tr><td>Battery SOC</td><td>Battery state of charge (usable)</td><td>%</td><td>Min, Max, Average</td></tr>
<tr><td rowspan="2">Site level</td><td>Active power</td><td>Active power exported / imported from the site</td><td>kW / -kW</td><td>Min, Max, Average</td></tr>
<tr><td>Reactive power</td><td>Reactive power exported / imported from the site</td><td>kVAr / -kVAr</td><td>Min, Max, Average</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Focus Area</th><th>DER classification</th><th>Proposed performance level</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><td></td><td>Active Power Curtailment Status[5]</td><td>Active / Inactive</td><td>-</td><td>-</td></tr>
<tr><td></td><td>Site voltage</td><td>AC voltage over the period measured at meter board. Note: Per phase with ≤200ms measurement interval</td><td>V</td><td>Min, Max, Average</td></tr>
<tr><td rowspan="2">Gross Load[6]</td><td>Active Power*</td><td>Site level active power - ∑ (DER aggregated by technology) active power</td><td>kW</td><td>Min, Max, Average</td></tr>
<tr><td>Reactive Power*</td><td>Site level reactive power - ∑ (DER aggregated by technology) reactive power</td><td>kVAr</td><td>Min, Max, Average</td></tr>
</table>
*These values are derived through additional calculations based on the active and reactive power data from the DER aggregation by technology and site level, as presented in the rows above. Detailed formula is shown in the footnote 6.
</td></tr>
<tr><td>Ramp rate limit</td><td>All DER</td><td>
The maximum ramp rate for DER output should not exceed:

20% of maximum generation or maximum consumption per minute for DER acting solely as a generator or load (e.g. DPV)
20% of (maximum generation + maximum consumption) per minute for bidirectional DER (e.g. BESS)[7] moving from generation to consumption or vice versa.

There are situations where a higher ramp rate is supported. The permitted exceptions are as below:

When providing contingency or regulation frequency control ancillary services (FCAS)
When providing active power response to oppose a significant frequency deviation
There is a low battery charge condition in a BESS when exporting
When net output of a hybrid DER is being controlled at the connection point
When operating in an intentional island (and frequency control is required)
When operating in accordance with a run-back scheme agreed with the DNSP.

Prioritisation of responses
</td></tr>
</table>

[5] Referring to the active power curtailment focus area in this table, specifically relating to management for system security, such as system restoration or maintaining minimum system load. This control signal is distinct from, and takes precedence over, any market-based signals related to price responsiveness.

[6] Gross Load = Site imported power+ ∑DER generation - Site exported power - ∑DER consumed

[7] Consistent with the interpretation for bidirectional units in the NEM (e.g. a battery storage system) refer to Section 3.5.1.4 of AEMO's *Application Guide for Registration as an Integrated Resource Provider in the NEM*, at https://www.aemo.com.au/-/media/files/electricity/nem/participant_information/registration/2024/application-guide-nem-integrated-resource-provider.pdf?rev=0d0dbe6f4bf94850895fd74355499cae&sc_lang=en. Furthermore, the Dispatch Procedure refers bidirectional unit moves from generation to consumption or vice versa during a trading interval and the ramp rates are calculated based on formula in Appendix C of *Power System Security Guidelines*, at https://www.aemo.com.au/-/media/files/electricity/nem/security_and_reliability/power_system_ops/procedures/so_op_3705-dispatch.pdf?la=en. For example, a 1 MW battery storage system with 1 MW maximum generation and 1 MW consumption is allowed ramp rate of up to 0.4 MW/minute.

Focus Area	DER classification	Proposed performance level
		The prioritisation framework would also apply as adopted from AS/NZS 4777.2:2020. This includes the required responses and the order of activation described below: • Level 1: Disturbance withstand – The system must be capable of continuous operation during defined voltage and frequency disturbances in accordance with the disturbance withstand capability timeframes specified above – until the duration exceeds time limits of the DNSP's passive anti-islanding settings. • Level 2: Automatic disconnection – Notwithstanding Level 1, the system may be automatically disconnected from the power system by a local or remote control scheme, initiated by the DNSP under certain abnormal and emergency conditions. • Level 3: Generation and/or site-level export limit – Limits may be applied by the DNSP on system output or site-level export for local network or power system security. • Level 4: Sustained operation for frequency disturbances – The system must be capable of sustained operation in accordance with the frequency deviations specified in frequency droop section • Level 5: Voltage and reactive power control – Reactive power support and power factor requirements, in accordance with agreement between the DER operator and the DNSP. • Level 6: Power rate limit – The maximum ramp rate permitted for this performance requirement, in the transition between different functions and responses, noting the permitted exceptions listed above.
Frequency response (with a deadband)	**All DER**	Provide a 5% frequency droop response outside a deadband of: • 49.5 – 50.5 Hz (Mainland) • 49.0 – 51.0 Hz (Tasmania). A more aggressive frequency response (lower droop and/or narrower deadband) may be agreed with AEMO for the provision of frequency control ancillary services, subject to DNSP endorsement.
Subject to DNSP requirements, protection settings to maximise capability beyond ride-through requirements	**All DER**	Subject to DNSP requirements, protection settings must be set to maximise capability to remain in operation beyond ride-through requirements for voltage, frequency and RoCoF, within safe operating limits consistent with good engineering practice.

Version release history

Version	Effective Date	Summary of Changes
1.0	25 November 2025	First issue