Network Standard

Document No.
NS194

Title:
Inverter Energy Systems

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Revision

No	Date	Description	Technical Approver	Authorised By
0	3/10/2018	Initial	Manager Secondary Systems	Head AEP&S
1	17/12/2021	Conversion to new template and inclusion of new requirements from AS/NZS 4777.2 2020	Glenn Cooper	Brett Hawkeswood
2	6/09/2023	Remove requirement for installation inspector to inspect every IES prior to permanent electrification.	Dean Starkey	Glenn Cooper
3	30/03/2026	Updated to reflect changes in AS/NZS 4777.1:2024. Restructured to group by size of system.	Matthew Cupples	Evan Riddell
4	7/07/2026	Annexure J was added for non-registered generator connections where AS4777 does not apply. Other minor corrections carried out to the previous version.	Duminda Thenuwara	Evan Riddell
5	10/09/2026	Title changed to Inverter Energy Systems. Following sections were included: Emergency backstop, Use of Third Party Systems, Total capacity and export limits, Communication systems. Fully separated inverter-based systems from rotating machinery (which will be in NS197).	Adam Bradford / Alan Luc	Evan Riddell

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List of Annexures

Scope

This document outlines the requirements for connection of Inverter Energy Systems (IES) to the Ausgrid network. IES are generators that are able to connect in parallel to Ausgrid's network which use power electronics to generate the required AC waveform. IES systems typically have solar (PV) panels and/or chemical batteries connected as a DC supply source for the inverter. However, they may also connect other DC power sources such as hydrogen fuel cells or asynchronous AC generators driven by wind turbines, hydro or fossil fuel power sources.

This standard is primarily focussed on export and generation control and limits, additional anti-islanding protection requirements, along with select other technical requirements which are related to protection, or are often implemented using the same equipment (e.g. voltage and power quality control). There are differing requirements depending on IES rated capacity and total IES capacity.

It also covers earthing requirements for IES and establishes technical review and approval requirements based on IES rated capacity.

The requirements for IES short circuit protection systems are not covered in this standard. Further information can be found in AS/NZS 3000, Service and Installation Rules of NSW, and the National Electricity Rules.

Standby IES which use a 'break before make' transfer system and hence will never operate in parallel with the Ausgrid's network are covered in Section 8.3 of the Service and Installation Rules of NSW to which there are no additional requirements as a result of this standard. Standalone IES power system also have no further requirements in this standard since they do not interact with the Ausgrid network.

Where AS/NZS 4777 is the applicable technical standard for Inverter Energy Systems, these AS/NZS 4777 requirements apply in full other than where a limited variation or additional requirement is specified by this NS194.

Reference Documents

All work covered in this document must conform to all relevant Legislation, Standards, Codes of Practice and Network Standards.

Ausgrid Documents

Ausgrid Deemed Standard Connection Contract

Ausgrid Model Standing Offer for Basic Connection Services

Ausgrid Model Standing Offer for Standard Connection Services

Negotiated Ongoing Connection Contract: Embedded Generators

NS116 Design Standards for Distribution Earthing

NS197 Rotating Machines Connected to Ausgrid Network

NS238 Supply Quality

Other Standards and Documents

AS 2467:2008 Maintenance of electrical switchgear

AS/NZS 3000:2018 Electrical installations

AS/NZS 3835 Earth potential rise – protection of telecommunication network users, personnel and plant

AS/NZS 4853 Electrical hazards on metallic pipelines

AS/NZS 4777.1:2024 Grid connection of energy systems via inverters
Part 1: Installation requirements

AS/NZS 4777.2:2020 Grid connection of energy systems via inverters
Part 2: Inverter requirements

AS/NZS 5033:2021 Installation and safety requirements for photovoltaic (PV) arrays

AS/NZS 5139:2019 Electrical installations – Safety of battery systems for use with power conversion equipment

AS 5385 Smart energy profile application protocol (Adoption of IEEE Std 2030.5-2018)

SA TS 5573 Common Smart Inverter Profile – Australia with Test Procedures

Clean Energy Council website (https://www.cleanenergycouncil.org.au)

ENA DOC 025-2010 EG-0 Power System Earthing Guide Pt 1: Management Principles

ENA Guideline for the preparation for connection of Embedded Generation within Distribution Networks – 2011

IEC 60255 Measuring relays and protection equipment – multiple parts

IEC 61869-3 Instrument transformers – Part 3: Additional requirements for inductive voltage transformers

National Electricity Rules

NSW-ACT Utility Interconnection Handbook

Service and Installation Rules of NSW

Acts and Regulations

Electricity Supply (General) Regulation 2014 (NSW)

Electricity Supply (Safety and Network Management) Regulation 2014

Work Health and Safety Act 2011 and Regulation 2025

Clause	Standard Requirements

1 Inverter Energy System

1.1 General

1.1.1 Inverter Energy Systems (IES) are comprised of one or more power sources (e.g. solar PV, wind energy or battery energy storage systems (BESS)) connected through one or more inverters to the same electrical installation.

1.1.2 Electric Vehicle Supply Equipment (EVSE) and Vehicle-to-Grid (V2G) systems which incorporate a permanently positioned inverter (such as fixed to a wall), throughout this standard shall be considered the same as a battery inverter where no solar ports exist, and a hybrid inverter where solar ports are present.

1.1.3 IES installations to be connected to Ausgrid's network shall be approved for connection to each connection point by Ausgrid and compliant with AS/NZS 4777.1. Refer to Annexure H: for information regarding additional requirements where AS/NZS 4777 does not apply.

1.1.4 New inverters shall be a make and model that is selected from the Ausgrid Connection Application Portal drop-down list or otherwise have explicit written equipment connection approval from Ausgrid. Designers and installers of IES systems shall have the relevant accreditation issued by Solar Accreditation Australia (SAA).

1.1.5 Inverter power quality settings shall be enabled and configured in accordance with AS/NZS 4777.2. The Region setting shall be set to "Australia A". For all other modes and operation that are not covered by a regional setting then default settings of AS/NZS 4777.2:2020 apply.

1.2 Use of Third Party Systems

1.2.1 Any IES that is controlled by a Common Smart Inverter Profile – Australia (CSIP-AUS) compliant Software Communication Client (SCC), must be connected and configured with the respective Original Equipment Manufacturer (OEM) system prior to registration with Ausgrid's Backstop Utility Server and commencement of the Capability Test. The OEM's systems will be required to maintain ongoing compliance for Backstop Enabled IES.

1.2.2 All IES installers within the Ausgrid network must have a login to the NSW Consumer Energy Resources (CER) Installer Portal. All approved inverter-based applications up to 1 MVA of total capacity will be electronically transferred through to the NSW CER Installer Portal, where a licensed installer will need to complete the commissioning process.

1.2.3 The NSW CER Installer Portal will enable an installer to submit their Certificate of Compliance for Electrical Work (CCEW) to the NSW Building Commission without needing to log in to the BC eCert portal. Ausgrid will be automatically provided with a copy of the CCEW from the NSW CER Installer Portal and installers therefore do not need to manually arrange for this to occur.

1.2.4 For any embedded generation connections or amendments which do not use the NSW CER Installer Portal, the installer shall complete the CCEW through the BC eCert portal.

1.2.5 Unless specifically advised in the Connection Offer, there is no requirement for an applicant or installer to interact with the AEMO Distributed Energy Resource Register (DERR) portal as successful completion of the NSW CER Installer Portal process will automatically upload the installation's information to the AEMO DERR. The AEMO DERR is used by Ausgrid to populate the existing equipment component in an Embedded Generation connection application.

1.2.6 When making an Embedded Generation connection application in the Ausgrid Connection Application Portal, applicants are encouraged to update Ausgrid's record of existing site equipment to reflect the equipment currently within the electrical installation.

1.3 Emergency Backstop Enablement

1.3.1 From 23 November 2026, for installations up to a total inverter capacity of 200 kVA at a connection point where new and/or replacement PV inverter/s are being installed, the new and/or replacement PV inverters shall be listed by the Clean Energy Council with a SCC certified to the latest version of CSIP-AUS, SA TS 5573.The SCC and inverter combination shall comply with the NSW-ACT Utility Interconnection Handbook including Ausgrid's minimum Test Profiles.

1.3.2 From the Backstop Launch Date of 22 February 2027, Ausgrid will only approve the connection of a new or replacement PV inverter, or additional PV modules connected to a new or existing inverter, if the inverter will be a Backstop Enabled IES or Backstop Exempt IES.

1.3.3 A **Backstop Enabled IES** is defined as an inverter that:

- Has been approved for connection to Ausgrid's electrical network;
- Has PV modules electrically connected to it;
- Is configured to receive and implement control commands issued by Ausgrid either:
  - From Ausgrid's Backstop Utility Server through an SCC (after configuring the inverter using the OEM app); or
  - Using Supervisory Control and Data Acquisition (SCADA); and
- Has successfully completed:
  - Ausgrid's Capability Test through the NSW CER Installer Portal; or
  - A SCADA Commissioning Test demonstrating at least equivalent remote curtailment capability.

1.3.4 For an inverter first installed after the Backstop Launch Date without PV modules electrically connected to it, if a customer wishes to later add PV modules, a connection application shall be submitted and the inverter will be required to be a Backstop Enabled IES.

1.3.5 Where multiple Backstop Enabled IES are to be installed at a connection point and CSIP-AUS is used for control at that connection point, a single SCC is required and it must be listed by the Clean Energy Council as certified with all Backstop Enabled IES at the connection point.

1.3.6 A **Backstop Exempt IES** is defined as an inverter installed at a connection point where Ausgrid's Connection Offer exempts the connection point from backstop requirements due to the unavailability of suitable internet communications (see clause 3.1.3). The total PV inverter capacity installed at the connection point after the Backstop Launch Date must be ≤ 30 kVA.

1.3.7 A **Non-Backstop IES** is defined as an inverter that:

- Does not have PV modules electrically connected to it; or
- Is a PV inverter installed prior to the Backstop Launch Date; or
- Is a like-for-like replacement under the inverter manufacturer's warranty arrangements (i.e. exact model replacement); or
- Is connected within a registered Embedded Network; or
- Is a registered Generator with AEMO.

2 Total Capacity and Export Limits

2.1 Total Inverter Capacity

2.1.1 The total inverter capacity of IES connections shall comply with Table 1 below.

2.1.2 Maximum system capacities greater than Table 1 below may be allowed following a technical assessment by Ausgrid. Applications for higher total inverter capacity may be approved following Ausgrid technical assessment and detailed in the Connection Offer.

2.2 Export Limits at the Connection Point

2.2.1 At any time, the applicable export limit for a connection point, as defined in Table 1, shall be determined by the Connection Offer in effect. Connection applications will be automatically approved if the application complies with the limits in that table. All IES installed at a connection point shall comply with the limits set out in Table 1.

2.2.2 Applications for higher export limits may be approved following Ausgrid technical assessment and detailed in the Connection Offer.

2.2.3 Export limits shall be interpreted as “soft”, consistent with the definition within AS/NZS 4777.1.

2.2.4 Export limits shall be interpreted as a maximum limit. The ability of the IES to export at the export limit is not guaranteed, but rather, it will depend upon network characteristics which may change over time. Output may need to be constrained as set out in the clauses in this section, including but not limited to inverter power output where power quality response modes are in operation.

2.2.5 Where a connection point has a mixture of Backstop Enabled IES and Non-Backstop IES, the Backstop Enabled IES shall take into consideration generation from the Non-Backstop IES and curtail where necessary to comply with the export limit at the connection point.

2.2.6 The installer shall locally configure Non-Backstop IES to comply with the Static Export Limits shown in Table 1 except for PV inverters installed prior to the Backstop Launch Date.

2.3 Emergency Backstop Curtailment and Testing

2.3.1 During an Emergency Backstop event, where Ausgrid is required by the Australian Energy Market Operator (AEMO) to reduce distributed generation output, Ausgrid may issue curtailment instructions to any Backstop Enabled IES to:

- Reduce the permitted export limit as metered at the point of connection to zero; and/or
- Limit inverter generation output as metered internally by the inverter to zero where further curtailment beyond export limiting is requirement to maintain grid stability.

2.3.2 Ausgrid may periodically carry out testing of its export and curtailment capabilities to Backstop Enabled IES.

Table 1 Inverter Capacity and Export limits at the connection point

Number of Phases with IES connected	Total Inverter Capacity when Auto-approved	Backstop Enabled IES			Backstop Exempt IES	Non-Backstop IES	Ausgrid Technical Assessment Option
		Flexible Export Limit (per site)	Fixed Export Limit (per site)	Default Export Limit (per site)	Static Export Limit (per site)	Static Export Limit (per site)	
Single Phase	≤ 30 kVA	1.5 to 10 kW*	3 kW	1.5 kW	1.5 kW	10 kW*^	Not available
Two Phases	≤ 200 kVA	1.5 to 20 kW (max 10 kW per phase)	3 kW	1.5 kW	1.5 kW	20 kW^ (max 10 kW per phase)	Export limit > 20 kW. (Total inverter capacity shall not exceed 200 kVA.)
Three Phases	≤ 200 kVA	1.5 to 30 kW (max 10 kW per phase)	3 kW	1.5 kW	1.5 kW	30 kW^ (max 10 kW per phase)	Total inverter capacity > 200 kVA and/or export limit > 30 kW

***For a single phase connection point, Ausgrid permits up to 10 kW export for Flexible Export Limit and up to 10 kW as the Static Export Limit for Non-Backstop IES. These are a variation from the 5 kW indicated in AS/NZS 4777.1:2024 Appendix C.2.**

^These export limits also apply to child metered connections within an embedded network, where the export beyond the child meter shall not exceed the Non-Backstop IES Export Limits.

Phase Balancing shall comply with the requirements of AS/NZS 4777.1

3 Communication Systems

3.1 Communication Requirements

3.1.1 The Communication Requirements for specific situations are shown in Table 2 below and will be specified in the Connection Offer.

Table 2 Communication Requirements for Varying IES Capacities and Types

Total IES Capacity at the Connection Point	IES Type	Ausgrid Connected Communication Requirements
≤ 30 kVA	Backstop Enabled IES	CSIP-AUS
	Backstop Exempt IES	Exemptions from backstop may apply if an Ausgrid technical assessment agrees that internet is not available.
	Non-Backstop IES	No communications with Ausgrid required
> 30 kVA to ≤ 200 kVA	Backstop Enabled IES	CSIP-AUS
	Non-Backstop IES	No communications with Ausgrid required
> 200 kVA to ≤ 1 MVA	Backstop Enabled IES	CSIP-AUS or SCADA
	BESS	May require SCADA (at Ausgrid's discretion)
	Other Non-Backstop IES	No communications with Ausgrid required
> 1 MVA	Backstop Enabled IES	SCADA
	BESS	SCADA
	Other Non-Backstop IES	May require SCADA (at Ausgrid's discretion)

3.1.2 Stable internet connectivity is a fundamental requirement for Backstop Enabled IES to comply with export limits under flexible or fixed export connection agreements and respond to the Emergency Backstop Mechanism.

3.1.3 A site that does not have suitable internet communications is typically considered to be a site with neither fixed internet connection nor access to Telstra Mobile Basic Coverage (as per Telstra Coverage map).

3.1.4 Sites without suitable internet communications will be limited in their Connection Agreement to the Static Export options in Table 1. In this instance, a Static Export Limit shall apply and shall be locally set across all Backstop Exempt IES and Non-Backstop IES.

3.1.5 For SCADA communications on an exceptional basis, Ausgrid may consider a private fibre or radio connection to Ausgrid's communications network as an alternative to internet connectivity requirements.

3.2 CSIP-AUS Communications and Capability Test

3.2.1 In order to complete Ausgrid's Capability Test, Backstop Enabled IES must be connected to the internet with a permanent internet connection such as NBN. A temporary connection such as a mobile hotspot can be used for the Capability Test when permanent internet is not available.

3.2.2 Through the NSW CER Installer Portal, the Installer shall successfully complete Ausgrid's Capability Test for Backstop Enabled IES. There are two different tests which may be run, depending on the total inverter capacity: Export Limit Test and Generation Limit Test.

3.2.3 An Export Limit Test tests the IES response to export limit controls from Ausgrid. This is generally used for installations with total capacity ≤ 30 kVA and requires:

- At least 500 W of solar export to be available at the time of testing (the installer may need to isolate any non-critical circuits within the site that are consuming electrical load to meet 500 W); and
- Any non-backstop generation (such as legacy solar and batteries) to have their generation temporarily disabled to ensure they do not interfere with the testing.

3.2.4 A Generation Limit Test tests the IES response to generation limit controls from Ausgrid. This is used in the following circumstances:

- Larger commercial installations or where critical circuits are consuming too much load to enable a stable export of at least 500 W from the NMI; or
- Sites that use one or more Inverter Power Sharing Devices; or
- As a fallback for installations with total capacity ≤ 30 kVA when there is insufficient export for from the NMI to successfully completed the export test.

The Generation Limit Test requires at least 500 W of solar generation across the Backstop Enabled IES and the connection point needs to remain importing for the duration of the test.

3.2.5 For a fully commissioned Backstop Enabled IES, some time after a loss of CSIP-AUS communications between the inverter and Ausgrid's Backstop Utility Server, the inverter will apply the Default Export Limit shown in Table 1 until the communications are restored. The time before the inverter applies the Default Export Limit will depend on factors including: active (non-default) export limits sent by Ausgrid, inverter design, local communications, and the SCC implementation and compliance with CSIP-AUS.

3.3 SCADA Communications

3.3.1 Ausgrid will typically require SCADA to be used for connection points with a total inverter capacity over 1 MVA, regardless of the availability of CSIP-AUS communications.

3.3.2 Sites incorporating BESS with a total inverter capacity over 200 kVA may be required to implement SCADA communications, regardless of the availability of CSIP-AUS communications, subject to a case-by-case assessment, where Ausgrid determines that the enhanced monitoring, control and operational performance provided by SCADA is necessary for the safe and reliable operation of Ausgrid's electrical network.

3.3.3 Where multiple IES are connected in proximity and controlled or operated as a coordinated unit, Ausgrid will assess SCADA communication requirements based on the aggregate capacity of these inverters. This may apply where:

- The inverters have a common operator or owner such as in the case of an Embedded Network for an industrial complex or large campus.
- The system is designed for the inverters to exhibit coordinated control behaviour, irrespective of whether the inverters are behind a common network connection point.

This is not intended to apply to:

- Independently owned and operated inverters behind a common network connection point such as in the case of an Embedded Network for residential customers; and
- Separately owned inverters which are coincidentally enrolled in the same Virtual Power Plant.

4 Interface Protection

4.1 General requirements

4.1.1 Where interface protection is required by AS/NZS 4777.1:2024 for IES up to 200 kVA, the protection requirements shall be as per the requirements of that standard.

4.1.2 All IES with a total inverter capacity of greater than 200 kVA connected to a single network supply point shall use interface protection as per the requirements of clause 5 and Annexure A.

4.1.3 Interface protection shall obtain its measured input values (e.g. voltage, current) upstream of all inverters connected at the electrical installation (i.e. closer to the point of connection).

4.2 Residential Clusters

4.2.1 A residential cluster refers to a group of residential premises connected to a single network supply point and includes embedded networks and multi-NMI sites that share a network connection. They are typically comprised of lifestyle or retirement villages, standalone houses on community title, townhouses, units, villas or multi-dwelling units, or other residential embedded networks.

4.2.2 Interface protection is not required for an individual installation within a residential cluster if:

- The installation is residential and part of a cluster sharing a common Ausgrid low voltage supply point; and
- The installation has independent retail metering or child metering and its own switchboard; and
- The total inverter capacity behind the independent metering is no more than 30 kVA; and
- For Embedded networks only: upon exceeding 200 kVA total inverter capacity for the embedded network, export limiting behind the child meter shall be commissioned for all new and upgraded sites connected to a single network supply point. The limit shall be set to no more than 10 kW per phase (or an alternate value if required by Ausgrid). Once commissioned, the export limit shall have the ability be adjustable down to zero through a software settings change.

4.2.3 Interface protection shall be implemented for individual installations within a residential cluster where:

- The total inverter capacity behind the common supply point exceeds 200 kVA; and
- The individual installation total inverter capacity exceeds 30 kVA.

4.2.4 Ausgrid, at its sole discretion, may specifically require interface protection to be installed at a site regardless of the conditions above being satisfied.

4.2.5 Examples of residential cluster installations and how these rules are applied are given in Annexure E.

5 Anti-Islanding protection

5.1 General

5.1.1 The following anti-islanding protection design requirements are applicable to all Inverter Energy Systems of greater than 200 kVA (except for those exempt from interface protection in section 4.2).

5.1.2 Embedded generation anti-islanding protection shall be designed to prevent parallel generation from synchronising with island generation sources e.g. standby generation.

5.1.3 Suitable test and isolation links shall be provided on all inputs and outputs of the anti islanding protection device or devices to allow secondary injection testing without the need to disconnect and then re-terminate wires.

5.2 Redundancy and circuit breaker fail

5.2.1 Redundancy and CBF shall be provided through the anti-islanding protection relays (or interface protection) tripping a CB/contactor independent to the inverter using independent power supplies.

5.2.2 Main and Backup anti-islanding protection should disconnect the IES only, and not isolate other loads in the electrical installation.

5.3 Voltage and frequency limits

5.3.1 Ausgrid's allowable ranges for voltage and frequency elements for Inverter Energy Systems are detailed in Annexure B: – Protection Set Point Limits.

5.3.2 Suitable voltage settings for HV operating IES must be negotiated on a case-by-case basis.

5.3.3 For HV connections, sustained overvoltage protection is not required to protect Ausgrid's network.

5.4 Export IES

5.4.1 For IES that are intended to export power to Ausgrid's network, refer to the requirements of Annexure A to Annexure H.

5.4.2 Inter-tripping is the preferred anti-islanding protection (see also Section 5.7) for export IES and may be mandated as a requirement for some sites as part of a technical review by Ausgrid[1].

5.5 No-export IES

5.5.1 For IES which are not intended to export power to Ausgrid's network, refer to the requirements of Annexure A to Annexure H.

5.5.2 Duplicate Low Forward Power or Inter-trip is the preferred anti-islanding protection for no-export IES.

5.5.3 Settings and details of Grid Low Forward/Reverse Power protection must be negotiated with Ausgrid on a case-by-case basis[2].

5.6 Neutral voltage displacement

5.6.1 IES installations with a HV connection point to Ausgrid's network with IES capacity greater than 200 kVA should implement Neutral Voltage Displacement (NVD) protection.

5.6.2 Neutral Voltage Displacement shall use Voltage Transformers (VT's) connected at the High Voltage connection point voltage. (i.e. 11 kV for an 11 kV connection). Particular attention is needed to confirm that the VT's are of the correct configuration/type for use with this form of protection.

5.6.3 Refer to Annexure D for Voltage Transformer technical requirements when used for NVD protection.

5.6.4 Suitable NVD settings shall be negotiated with Ausgrid on a case-by-case basis. Refer to Annexure B: Protection Set Points Limits.

5.6.5 For IES connected within installations that have a low voltage connection point to the grid, NVD is typically not required. Where NVD is identified as a site specific condition by Ausgrid as part of technical review the location and responsibility of installing VTs shall be negotiated during the assessment process.

5.7 Inter-tripping (including Communications Link) between Ausgrid and Customer

5.7.1 Where inter-tripping is the anti-islanding protection, it shall be appropriate for all credible islanding scenarios as determined by Ausgrid.

5.7.2 Inter-tripping shall meet the requirements of fail-safe as per Clause 5.9.

5.7.3 A communications link shall be continuously monitored for integrity.

5.7.4 In the event that the communication link fails, the IES shall be automatically disconnected within 5 seconds and remain disconnected until the link is restored.

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[1] If the proponent implements Vector Shift and ROCOF protection, they must accept that the anti-islanding protection may trip for system disturbances and fault events both within and external to the local network that the generator is connected to. Experience has shown setting of these schemes to be difficult to avoid nuisance tripping while providing adequate protection.

[2] Grid Reverse Power Protection is not the same as Generator Reverse Power Protection.

5.7.5 Inter-tripping and communications between Ausgrid and the generator facility shall be provided over dedicated dark fibre cores.

5.8 Inter-tripping and Communications within a Generator Facility

5.8.1 Where the customer is using communications to provide remote tripping to meet the requirements of this standard, this shall be fail-safe in accordance with Clause 5.9.

5.8.2 In the event that the communication link fails then the generator shall be automatically disconnected within 5 seconds and remain disconnected until the link is restored.

5.8.3 A relay trip signal to a remote contactor/CB over communications link shall be via a dedicated signal, i.e. cannot trip the remote CB/contactor by disrupting the comms and waiting for the loss of comms operation.

5.9 Fail-Safe

5.9.1 Relay power supplies, tripping, communications link and circuitry associated with the anti-islanding protection systems shall be fail-safe. That is any failure of any part of the system shall result in the generator being disconnected and unable to be re-connected to Ausgrid's network.

5.9.2 Circuit breakers with shunt trips shall not be used. Where AC (or DC) supplies are proposed to be used, normally open contactors held in by healthy AC (or DC) volts or undervoltage release of circuit breakers on loss of AC (or DC) supply, relay fail and system fail shall be required.

5.9.3 Alternate arrangements to clause 5.9.1 and 5.9.2 will be considered provided the following two points are met.

- The proponent has an approved Installation Safety Management Plan.
- Requirements for the ongoing inspection, maintenance and testing of the network and anti-islanding protection systems are specified within the Connection Agreement.

5.10 Connection, reconnection and synchronisation

5.10.1 The device controlling generator connection to the grid shall verify normal supply conditions on the grid for all connected phases (i.e. all three phases for a three phase connection) for a period of at least 1 minute prior to the device enabling connection.

5.10.2 Synchronisation or zero voltage on the generator side of the switching point shall be confirmed before the generator is paralleled to Ausgrid's network. When these conditions are met, automatic reconnection is permitted.

5.10.3 Where there are multiple points of automatic reconnection in the installation, each point shall independently monitor and verify normal supply conditions on the grid for all connected phases for a period of at least 1 minute before enabling automatic reconnection.

5.10.4 Where a manual reset has been nominated as required by Ausgrid, the generator will not be allowed to be automatically reconnected to the network. Ausgrid will negotiate the requirements of these proposals on a case by case basis with the proponent.

5.11 Relay requirements

5.11.1 Relays used to meet the requirements of Section 6 of this standard shall be approved by Ausgrid. A list of pre-approved relays and their available functions can be found on Ausgrid's website 'NS194 Approved Protection Relay List'.

5.11.2 For HV connected installations, at least one layer of protection (backup or main) shall be compliant with the appropriate severity class of IEC 60255.

5.12 Testing and verification facilities

5.12.1 Inputs and outputs of anti-islanding protection relays shall be provided with suitable facilities to allow secondary injection testing of the relay to be undertaken without the need to disconnect and re-terminate wires. This includes:

- Isolation links on protection relay AC measurement inputs
- Isolation links in series with protection relay contact outputs

- Test injection and measurement points compatible with 4 mm banana plugs. Measurement points must be available on both sides of relay contacts, and
- Separate relay fail contact to allow testing.

5.12.2 All protection cabling shall be appropriately labelled, and the labels shall corroborate with all drawings and documentation provided in the Protection Design Pack.

5.12.3 Anti-islanding devices that are to undergo secondary injection testing shall also be capable of indicating locally what protection element has operated – this can be done via Human Interface Devices such as screens, LEDs or via a locally connected computer.

5.12.4 Prior to the installation being energised, it shall be possible to check the operation of any CBs and contactors operated by the anti-islanding protection. This is to be done without the generator/IES being in operation.

6 Protection Design Review and Commissioning

6.1 Design

6.1.1 Where interface protection is required, a complete Protection Design Pack (see Annexure C:– Design Pack) shall be submitted as part of the connection application for record keeping and auditing.

6.1.2 Ausgrid will conduct a technical review to confirm compliance with this standard, and to identify the need for any site specific conditions.

6.2 Commissioning

6.2.1 In addition to all testing and commissioning requirements of AS/NZS 4777.1, and AS/NZS 4777.2, secondary injection testing of the interface protection relay shall be carried out on-site to confirm the system meets the requirements of this standard, including but not limited to failsafe, tripping logic, and protection element accuracy.

6.2.2 The secondary injection testing shall be carried out by a qualified electrical tester with calibrated test equipment, and the results shall be recorded in a test report along with the results of testing detailed in AS/NZS 4777.1, 7.6 – Commissioning.

6.2.3 The test report shall be signed by the qualified electrical tester. This report shall be provided to Ausgrid for record keeping.

6.3 Inspections and compliance auditing

6.3.1 Ausgrid reserves the right to audit any designs and testing used for embedded generation connection to its network. In accordance with Ausgrid's Customer Installation Safety Plan an embedded generator may be inspected for electrical safety, compliance with the relevant standards and consistency with supplied design information at any time.

6.3.2 Where a major defect is identified, the IES shall be disconnected until the defect is rectified and the installation is reinspected to the satisfaction of Ausgrid. Where a minor defect is identified Ausgrid's standard defect process shall be followed.

6.3.3 If reinspection of an IES is required, it will incur a reinspection fee in accordance with Ausgrid's Alternative Control Services Fee Schedule.

6.4 Complex Interface Protection Commissioning Requirements

6.4.1 Complex Interface Protection is classified as a system which has more than 200 kVA of IES capacity controlled by one or more interface protection relays and at least one of the following properties:

- All Interface Protection relays behind a network connection point control more than 500 kVA of inverter capacity
- The IES is behind a HVC connection point.
- The system also incorporates rotating machine generation exceeding 30 kVA that may be connected in parallel to the network for more than one second.

- There is a communications interface (such as Wi-Fi or Ethernet) required to send a trip signal from the relay to any contactor connecting the IES to the grid.
- The system is required to use and of: Neutral Voltage Displacement, Grid Low Forward Power, Grid Reverse Power, or inter-tripping.
- Otherwise where Ausgrid determines the interface protection requirements are complex and need to meet the requirement of Clause 9.3.

6.4.2 Following design approval, the proponent shall provide Ausgrid with an appropriate test plan to be used for commissioning. Ausgrid must inform the proponent if the plan is adequate, or if any changes are needed to confirm that the generator's anti-islanding protection systems are adequately tested.

6.4.3 The proponent shall arrange with Ausgrid for an Ausgrid representative to be present for all testing relating to the anti-islanding protection. The testing shall include at a minimum:

- Secondary injection testing of relay logic, failsafe, and set point accuracy,
- Correct operation of all disconnection devices (tested prior to generator connection to the grid),
- Scheme logic, synchronisation, and reconnection procedure, and
- Primary anti-islanding testing in accordance with Clause 6.5.

6.4.4 Proponents shall allocate sufficient time to allow test plan review and resource allocation by Ausgrid. Ausgrid accepts no liability or warranty for any designs or equipment as part of the design approval or witness testing process.

6.5 Primary Anti-islanding testing

6.5.1 Primary anti-islanding testing is required to confirm the adequacy of the Vector Shift and Rate of Change of Frequency (ROCOF) settings.

6.5.2 The requirements of primary anti-islanding testing will depend on the characteristics of the generator and the electrical installation. Proponents should note that primary anti-islanding testing will often require the switching of a significant amount of active load, which may necessitate disruptions to normal electrical supply in the electrical installation. For example, opening off the generator installation from the Ausgrid network to simulate a 'real world' event.

6.5.3 Details on all primary anti-islanding testing configurations and requirements are to be discussed and agreed with Ausgrid.

6.5.4 Where primary testing of anti-islanding testing does not confirm positive operation, more sensitive Vector Shift and/or ROCOF settings may be required.

7 Fault Levels, Loading and Scheduling

7.1 Ausgrid shall prohibit the connection of a IES where Ausgrid's network may become compromised under high-fault level or abnormal conditions.

7.2 Generation level shall be curtailed to a level that will ensure Ausgrid's network is not overloaded.

7.3 In some locations, connections may be allowed with the additional provision of a control signal from Ausgrid that results in the generating unit being either taken off-line (i.e. a 'soft-trip') or inhibited from starting up. Also see Clause 5.7– Inter-tripping (and Communications Link).

7.4 Upon assessment of the proposed connection, Ausgrid will advise the proponent if any fault level or loading issues exist whereby scheduling may be required as part of the installation.

8 Earthing

8.1 General

8.1.1 The proponent is required to demonstrate that the generator installation has an earthing system that has been designed to limit any step, touch and transferred potentials to safe values using the principles detailed in “ENA DOC 025-2010 EG-0 Power System Earthing Guide Pt1: Management Principles”.

8.1.2 Equipment used to interface to the distribution network (e.g. step up transformer or circuit breaker) shall comply with NS116 – Design Standards for Distribution Earthing.

8.1.3 Generation schemes working in parallel with the distribution network in effect become an integral part of the electricity distribution network. Therefore, neutral earthing arrangements for the private generators and any interconnection transformers shall be designed to suit the requirements of both the distribution network and the electrical installation and details provided to Ausgrid.

8.1.4 Additionally, the earthing system of the Generator shall be designed to limit the voltages impressed onto surrounding utility infrastructure under earth fault conditions. For metallic pipelines the tolerable voltages (or acceptable assumptions to determine them) are presented in AS/NZS 4853 and for telecommunications assets the voltage limits should comply with AS/NZS 3835.

8.2 Low voltage generators

8.2.1 Generators connected to the network via a delta/star transformer with the delta on the network side may have their neutral directly connected to earth (i.e. via an MEN link).

8.2.2 Effective isolation of this neutral may be required to inhibit the flow of harmonics through the neutral and the generator’s method to limit harmonics may be discussed and agreed to by Ausgrid. The use of 4-pole switching may be required if the generator can operate in standby mode.

8.3 High voltage generators

8.3.1 The generator’s high voltage star point shall be effectively isolated from earth (i.e. isolated or earthed via a high impedance) to avoid any earth fault contributions flowing into the Ausgrid system and to inhibit the flow of harmonic currents through the neutral. Each case will be discussed with the proponent on its merits.

9 Multiple Embedded Generator Systems

9.1 Mixed embedded generator systems

9.1.1 Where a combination of embedded IES and rotating machines are connected at an electrical installation, they shall meet the requirements of this standard and Ausgrid Standard NS197 for the respective generator type of capacity equal to the total nameplate rating of all embedded generator types connected behind the network connection point.

9.2 Interface protection where Rotating Machines are also connected

9.2.1 Where network parallelled rotating machine generators with total capacity of greater than 30 kVA are also connected behind the same connection point as the IES. there shall be at least one layer of anti-islanding protection meeting the relevant requirements of this standard and Ausgrid Standard NS197. The operation of this protection shall result in the disconnection of all embedded generators in the electrical installation.

9.3 Existing embedded generators

9.3.1 Where an electrical installation already has embedded generation installed, and new generating sources are proposed to be connected, the entire installation shall comply with this standard. This may require upgrading or retrofitting existing protection systems.

10 Registered Generators

10.1 For generators intended to connect to the Ausgrid network under the NER Chapter 5 framework, subject to a detailed application and offer to connect, the installation (point of connection/private installation incoming supply) may be required to comply with this Network Standard where not in conflict with Schedule 5.2 of the NER.

11 Alteration to Approved Design

11.1 The premises owner or occupier shall not modify the approved design, change protection equipment or protection settings of the embedded generator equipment without informing and receiving prior written authorisation from Ausgrid.

11.2 Upon receipt of a written request to modify the approved design and/or settings, Ausgrid will advise the proponent if it is considered necessary to undertake a new technical assessment on the impact on Ausgrid's network.

11.3 If a new technical assessment is required, then it will be charged in accordance with Ausgrid's alternative control services fee schedule.

Annexure A: IES Protection Summary

A1 Table A1: IES greater than 200 kVA protection requirements

Backup Protection and Associated Requirements	Reference Section
Mandatory backup protection requirements	
Neutral Voltage Displacement (For HV connections only)	Annexure B
Under voltage and Over voltage	As per AS/NZS 4777.1
Under frequency and Over frequency	As per ASNZS 4777.1
At least 1 of the following 4 backup anti-islanding protections	
Grid Reverse Power	5.5
Grid Low Forward Power	5.5
Inter-tripping	5.7, 5.8
ROCOF and Vector Shift[1]	6.5

[1] If Vector Shift and ROCOF protection are implemented, it must accept that the anti-islanding protection may trip for system disturbances and fault events both within and external to the local network that the generator is connected to. Experience has shown setting of these schemes to be difficult to avoid nuisance tripping while providing adequate protection.

Annexure B: Protection Set Point Limits

B1 The following table defines the outer limits that will be considered acceptable for Main or Backup anti-islanding protection. Set-points may be chosen as required to suit the proponent's generator/installation within these limits. Tested accuracy should be based on manufacturer's specification, however it must not exceed +/- 2% for voltage based elements, +/- 1% for Under frequency and Over frequency elements, and +/- 5% for time delays (smaller accuracy tolerances may be required in some instances for grading purposes).

Appropriate settings for HV OV/UV protection must be negotiated with Ausgrid when required.

Main protection settings are to be at least as sensitive and at least as fast as the Backup protection settings.

Table B1: Protection elements and set point limits

Protection Element	Pickup	Delay
All generator types as required		
Rate of Change of Frequency (ROCOF) for all IES requiring interface protection	As per AS/NZS 4777.1	
Vector Shift (VS) for all IES requiring interface protection	8 degrees (strong/urban network)	0 s
	12 degrees (weak/rural network)	
Grid Reverse Power (GRP)	Negotiated during assessment	
Grid Low Forward Power (GLFP)	Negotiated during assessment	
Neutral Voltage Displacement (NVD)	10%-20% of Phase to Neutral Voltage	2s

Annexure C: Design Pack for IES Requiring Interface Protection

C1 For all IES that require Interface Protection, a Design Information Pack must be submitted with the application that includes:

- A statement confirming the proposed maximum export of the IES.
- Single Line Diagram detailing.
  - Details of all IES including
    - location
    - Manufacturer.
    - Model number.
    - Compliance with AS/NZS4777.2 and any adjusted settings.
  - Location of all CTs and VTs and CB's providing the protection required to meet the requirements of this standard
  - The connection of VTs, CTs to relay and tripping sequence of relays being proposed to meet the requirements of this document
  - Clear identification of the interface protection location for IES connection, including CT, VT and tripping arrangement
  - Specification, ratio and class of CTs and VTs being used for protection requirements of this document
- List of protection functions being proposed to meet the requirements of this standard, referring to Annexure A.
- Details of the protection relay(s) being proposed, including:
  - Manufacturer.
  - Full model number / order code showing selected options.
  - Full settings list of all configurable set-points as intended to be programmed.
- If Inter-tripping is used as the anti-islanding protection, clear statement and identification of how the inter-trip and communications link will meet the requirements of fail-safe in Section 5.9.
- A description on the proposed modes of operation of the IES (such as on grid only, or multimode.
- Details of any existing embedded generation (IES and/or rotating machine) connected to Ausgrid's network within the same connection point.

C2 The information in the Design Pack should enable the Ausgrid officer to determine the full behaviour of the scheme without ambiguity. The relationship between protection device inputs, protection device elements, protection device output contacts and switchgear must be clear and readily apparent.

C3 All drawings must be appropriately titled, revision controlled, and marked with the name and contact details of the responsible suitably qualified person.

Annexure D: Instrument Transformer Requirements

D1 Magnetic Voltage Transformers as per IEC 61869-3:

Voltage transformers used for Neutral Voltage Displacement must meet the following criteria;

- Ratio: Primary Voltage/110V (line to line voltages), For example on an 11 kV system, 11,000V/110V.
- Protection class VT (3 x single-phase or 5 limb 3-phase),
- Rated accuracy class ≤ 5%, e.g. 3P,
- Rated voltage factor of 1.9 for isolated neutral systems; and
- Rated burden that is suitable for the relay installation (including secondary wiring, etc).

D2 Current Transformers as per IEC 61869-2:

Current transformers for Low Forward Power and Reverse Power Protection must meet the following criteria;

- Metering Class with 5% accuracy

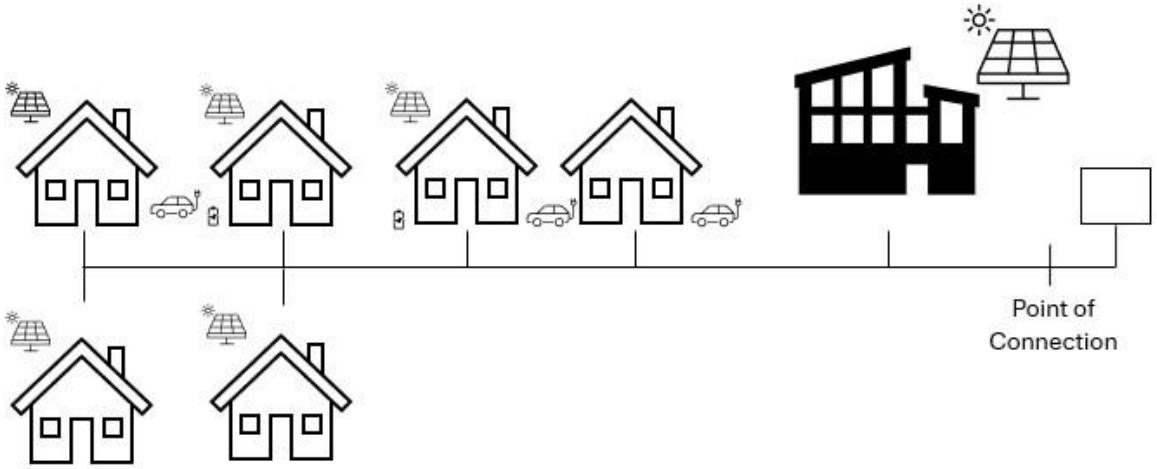
Annexure E: Examples of Residential Cluster Installations

E1 4 x 30 kVA IES systems comprising of solar, batteries or V2G. 1 x 50 kVA system (such as a club house).

Total = 170 kVA inverter capacity and hence Assessed as <200 kVA

No requirement for interface protection under NS194 or AS4777.1 on any system

E2 6 x 30 kVA IES systems comprising of solar, batteries or V2G. 1 x 50 kVA system (60 kVA added to example G1)



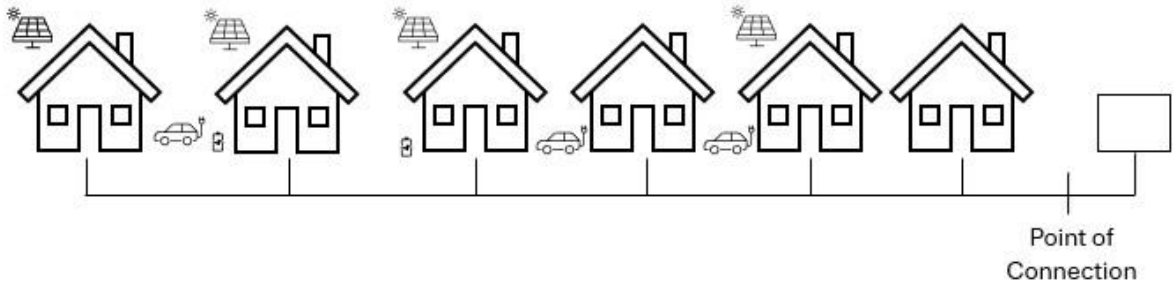
Total = 230 kVA inverter capacity and hence assessed as >200 kVA

Dispensation applies to all installations up to 30 kVA

Interface protection shall be added to any new and existing >30 kVA installations.

Note: Installations approved prior to November 2025 will not be required to install interface protection until there is an alteration or addition to the >30 kVA installation.

E3 Residential Cluster – Aggregate >200 kVA. 50 x 10 kVA IES systems comprising of solar, batteries or V2G



Aggregate >200 kVA

No installation >30 kVA

Dispensation applies: No requirement for interface protection

Annexure F: Example Single Line Diagrams

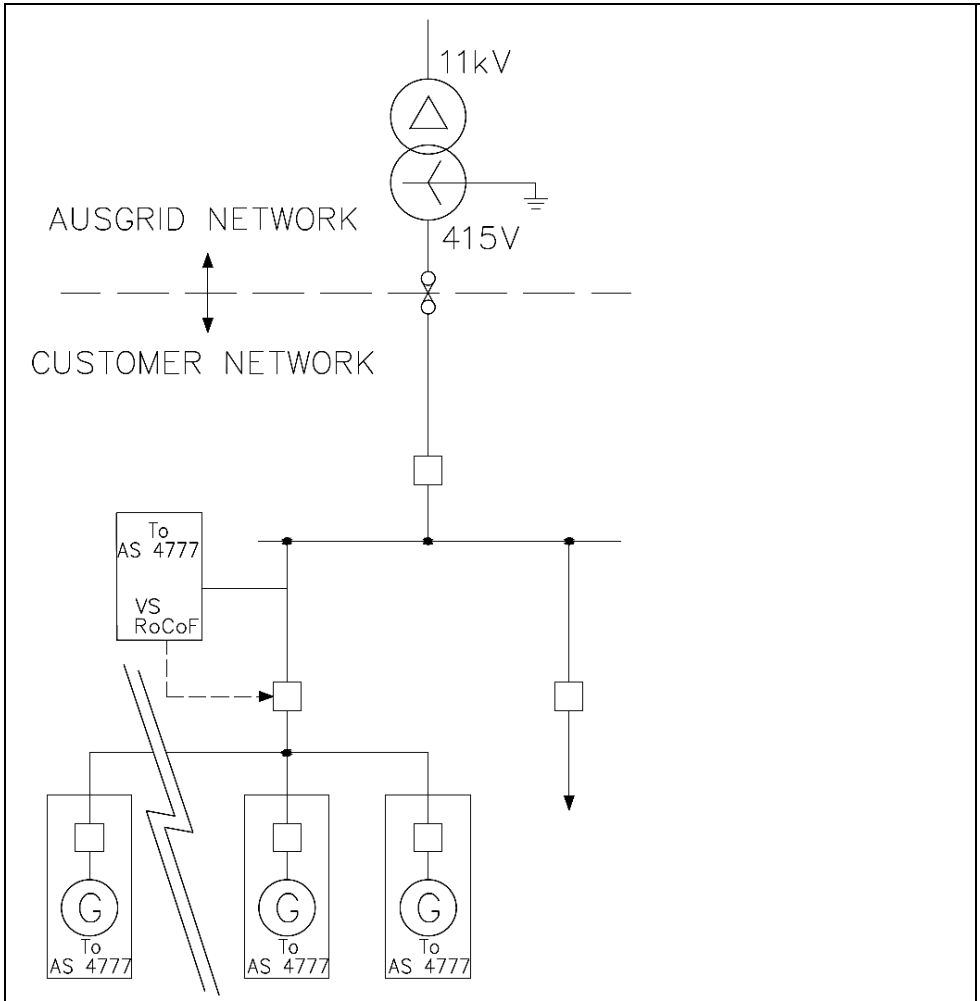


Figure F1: LV connection point, IES with interface protection

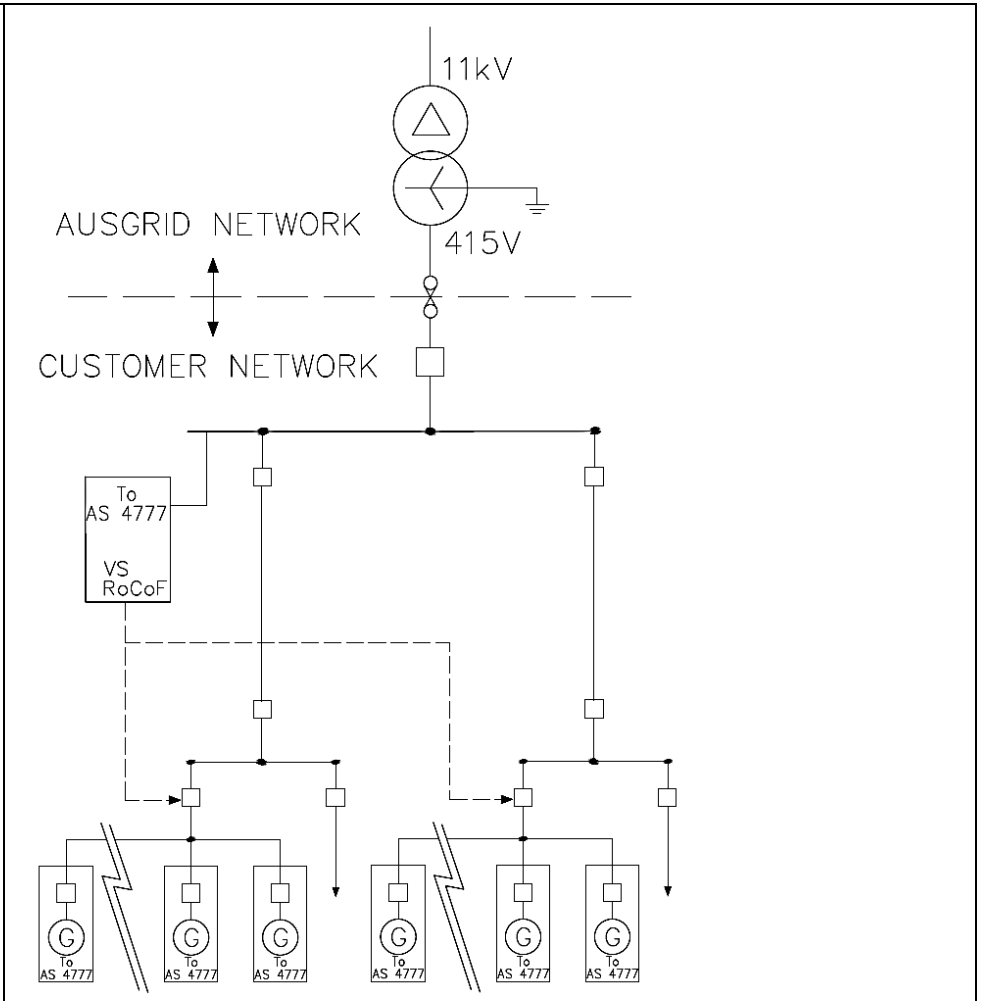


Figure F2: LV connection point, IES with interface protection across multiple switchboards

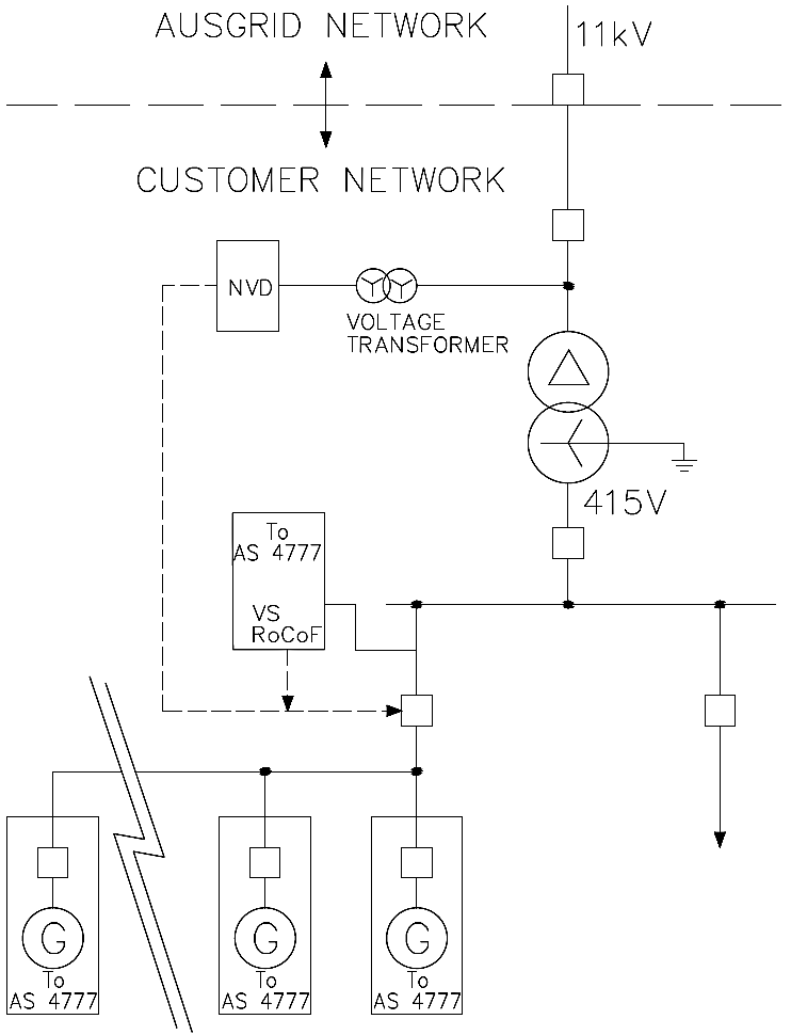


Figure F3: HV connection point, >200 kVA IES with interface protection

Annexure G: Multi-tenanted Site Examples

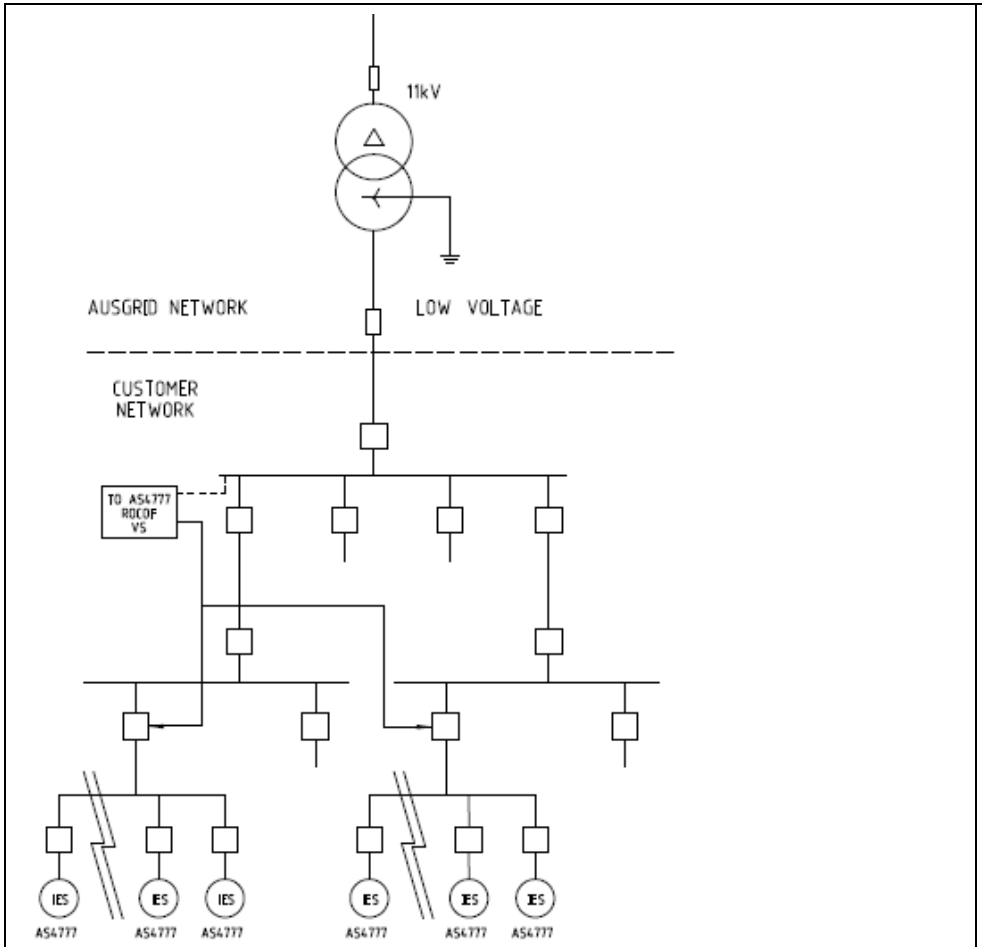


Figure G1: Multi-tenant with single Interface Protection Device

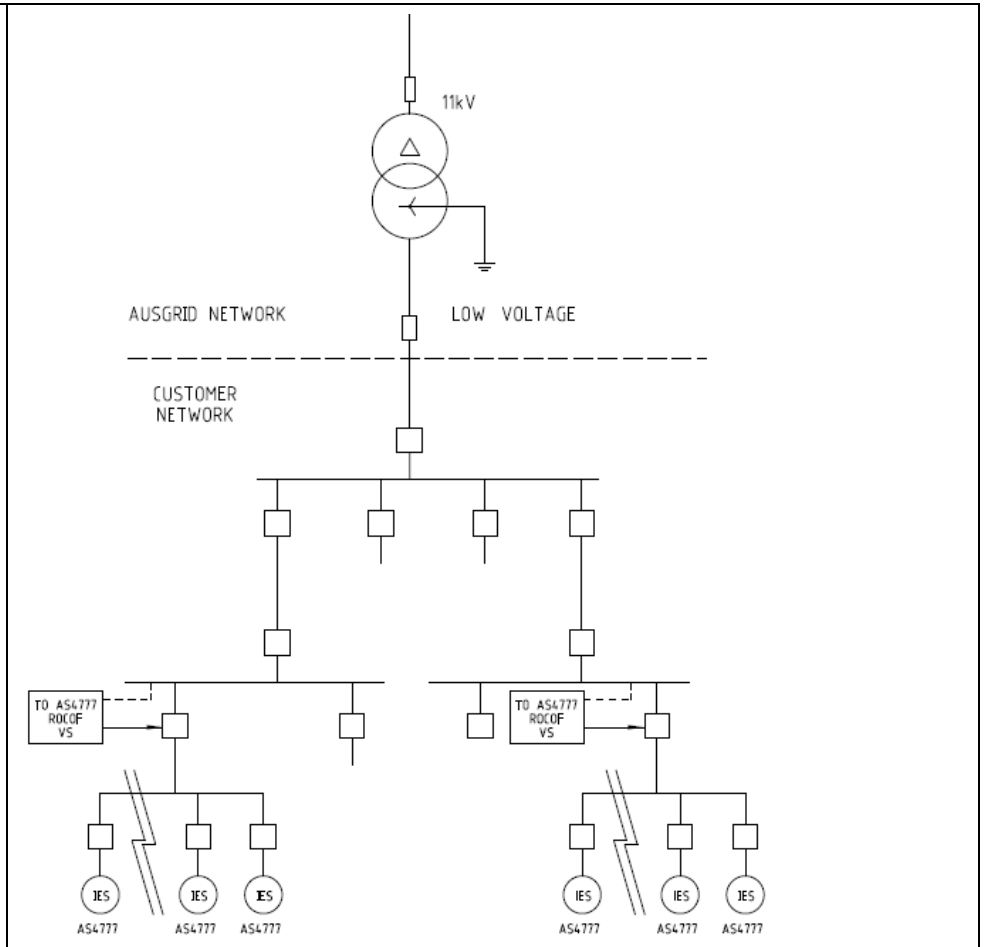


Figure G2: Multi-tenant with multiple Interface Protection Devices

Annexure H: Ausgrid Technical Requirements for 200 kW – 5 MW DER where AS/NZS 4777.2 is not applied

H1 For registered generators (generally from 5MW+) NER chapter 5 mandates NER schedule 5.2 as the technical standard (unless exempt from registration).

H2 Between 200 kW and 5 MW Ausgrid considers AS4777 may not be practical to apply in some applications. These are summarised by the tabled below:

Table H1: Summary of technical requirements by connection type

Connection Type	Description	Size range	Applicable Requirements
LV-connected	LV IES without other LV loads	200 kW - 5 MW	NS194 and Annexure H
HV-connected	LV IES, without other LV loads	200 kW – <5 MW	NS194 incl. Annexure H
	LV IES, other than 230/400 V nominal values	200 kW – <5 MW	NS194 incl. Annexure H
HV-connected / LV-connected	Synchronous generation	< 5 MW	NS197
HV/Sub-Transmission	Generating systems or integrated resource systems subject to AEMO-issued exemption from registration	5 MW – <30 MW	May apply relevant aspects of NER S5.2, and/or site specific Ausgrid requirements
Sub-Transmission (above 11kV)	IES generation	Any	Site specific requirements determined in response to formal enquiry.

H3 Voltage control and reactive power

IES operation must not adversely affect local voltage or the performance of upstream voltage regulation devices. General requirements may include:

Voltage operating range: IES must operate satisfactorily across the allowable voltage band at the point of connection.

Reactive power capability: Minimum lagging and leading reactive power capability may be required to support local voltage levels.

Voltage Control modes: Ability to operate in voltage control with droop, Q-control, or power factor control

H4 Power quality and harmonic emissions

IES must comply with relevant harmonic and power quality standards to avoid adverse impacts on network customers or equipment. Considerations include:

- Background harmonic levels: The local harmonic environment varies by site; permissible harmonic emissions are allocated based on available headroom.
- Compliance with standards: Generators must meet limits set by standards such as AS/NZS 61000 series or IEC 61000, including individual harmonic limits, total harmonic distortion (THD), and flicker.
- Inverter switching behaviour: Inverter-based systems must ensure that switching harmonics fall within acceptable limits and that filters (if required) are appropriately designed.
- Measurement and verification: Post-connection testing may be required to confirm harmonic performance under various operating conditions.

H5 Ausgrid's assessment

Ausgrid will assess the following conditions and advise if any mitigation is required:

- Thermal limits
- Voltage constraints
- Fault level contribution
- System strength

H6 Power system data requirements by connection stage

Power system data shall be provided to Ausgrid during the relevant connection process stage as follows:

Preliminary enquiry stage

- Rated MW/MVAr capability

Design stage

- Single-line diagram with connection arrangement
- Voltage control mode
- Reactive power capability curve (P-Q curve)
- Proposed Power Plant Controller (PPC)/inverter settings/parameters
- Transformer and line impedances
- Fault current contributions
- Anti islanding protection design per Annexure C:
- RMS model in PSSE capable of load flow and short circuit analysis
- EMT Model in PSCAD (if required)

Commissioning stage

- As-built line and transformer impedances
- Updated PPC/inverter settings/parameters
- Verification of voltage control and reactive power capability
- 2 weeks pre commissioning PQ monitoring data
- Post commissioning PQ monitoring data as requested


Ausgrid