



Part of Energy Queensland



STNW1174

Standard for Low Voltage Embedded Generating Connections

Effective from 6 February 2023

Standard for LV EG Connections

If this standard is a printed version, then the Ergon Energy Network or Energex internet site must be referenced to obtain the latest version to ensure compliance.

Approver		Glenn Springall General Manager Renewables and Distributed Energy	
If RPEQ sign off required insert details below.			
Certified Person name and Position	Registration Number	Certified Person name and Position	Registration Number
Jennifer Gannon	12770	Robert Coggan	11801

Abstract: This standard provides the requirements for connecting Fixed Embedded Generating (EG) Systems in Parallel with a Distribution Network Service Provider's Low Voltage Distribution Network. This standard covers Inverter Energy System connections from 30 kVA to 1,500 kVA and rotating machine connections from 0 kVA to 1,500 kVA.

Keywords: embedded, dynamic, generating, low voltage, IES, solar, photovoltaic, wind, diesel, rotating, connection, rotating machine, 1,500 kVA, 1500 kVA, 1.5 MVA.

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1 Introduction

1.1 Purpose

The purpose of this Standard is to provide Proponents of a Fixed EG System with information about their obligations in respect of connecting to, and interfacing with the Energex or Ergon Energy Network's Distribution System. It has been developed to ensure the safe and stable Parallel operation¹ of Fixed EG Systems connected to the DNSP's Distribution Network without causing a material degradation in the quality of supply to Distribution Network users.

1.2 Scope

This Standard applies to Fixed EG Connections that are a new connection or a connection alteration, and:

- are intended to be connected to, and capable of operating in Parallel with the Distribution System; and
- meet all other technical requirements as set out in this Standard.

This Standard does not apply to:

- electric vehicles, unless the Electric Vehicle Supply Equipment (EVSE) is capable of generating electricity to the Distribution System or electrical installation (in which case the requirements of this Standard shall apply);
- electrical equipment that does not generate electricity, unless they impact on the ability of the Fixed EG System to meet the technical requirements of this Standard.
- off grid systems not connected in parallel with the Distribution System.
- stand-by generating systems with a Break-before-make changeover, configured to ensure the generating system cannot be connected in Parallel with the Distribution System.
- EG Systems covered by the following Energex and Ergon Energy Network connection standards:

Standard Number	Title
STNW1170	Standard for Small IES Connections
STNW1175	Standard for HV EG Connections
STNW3510	Dynamic Standard for Small IES Connections
STNW3511	Dynamic Standard for LV EG Connections
STNW3512	Standard for LV EG Connections to Isolated Networks

The technical requirements in this Standard comply with the National DER Connection Guidelines for a Fixed EG Connection as published by the Energy Networks Association (ENA), with the exception of the deviations set out in Appendix A: Deviations from the National DER Connection Guidelines.

¹ Section 225 of the *Electrical Safety Regulation 2013* requires that any person who has generating plant must comply with the DNSP's conditions for ensuring safe and stable Parallel operation of the private generating plant with the works of the electricity entity.

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1.3 Obligation of Proponents

Proponents shall:

- a. obtain consent from the DNSP before interconnecting their Fixed EG System with the Distribution System.
- b. ensure that the design is certified by a Registered Professional Engineer of Queensland (RPEQ).
- c. comply with this Standard and the terms and conditions of the relevant Connection Contract.
- d. ensure construction, operation and maintenance of the proposed Fixed EG System, and its connection to the Distribution System, complies with the relevant Energy Laws, including any applicable regulations, standards, manuals, guidelines and codes of practice as they apply in Queensland.
- e. not connect additional inverters, make modifications, or install additional EG Units (including any Energy Storage Systems), without the prior written agreement of the DNSP.
- f. meet the commissioning requirements applicable for connections to the LV Distribution System and complete commissioning under a commissioning plan certified by an RPEQ.

2 Definitions and abbreviations

2.1 Definitions²

Term	Definition
Accredited Person	A person accredited by a peak industry body as having demonstrated their competence to design and/or install renewable energy and/or ESS. This includes Accredited Installers, Designers and Supervisors operating within the classification of their accreditation. To be eligible to produce Renewable Energy Certificates a CEC accredited person must be engaged. In all instances though, a person authorised under the <i>Electrical Safety Act 2002</i> (Qld) is required to certify the installation.
Anti-islanding Protection	A protection system to detect islanded conditions and disconnect the inverter(s) or rotating plant from the Distribution System.
Break-before-make	Break-before-make operation is used in a switch that is configured to break (open) the first set of contacts before engaging (closing) the new contacts.
Central Protection	Central Protection is the protection system installed to perform the functions of: coordinating multiple EG Unit installations at one site, providing protection for the entire EG Energy System installation and islanding protection to the connected grid as well as preserving safety of grid personnel and the general public.
Connection Contract	A contract formed by the making and acceptance of a <i>connection offer</i> under Chapter 5A of the NER (or an offer to <i>connect</i> under Chapter 5, where the Proponent has made an election under rule 5A.A.2 of the NER.
Connection Assets	Those components of a Distribution System which are used to provide <i>connection services</i> .

² Terms in italics and not otherwise defined in this document, have the meaning given to that term in the NER or National Energy Retail Law.

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Term	Definition
Connection Point	An agreed point of supply established between the DNSP's Distribution System and a Proponent's Premises.
Demand Response	The automated alteration of an inverter mode of operation in response to an initiating signal originating from or defined by the DNSP.
DER Technical Standards	Means the requirements for <i>embedded generating units</i> under Australian Standard AS4777.2:2020 as in force from time to time
Distribution Network	A <i>network</i> which is not a <i>transmission network</i> . This Standard refers to the Low Voltage portion of the Distribution Network.
Distribution System	A <i>distribution network</i> , together with the <i>connection assets</i> associated with the <i>distribution network</i> , which is connected to another <i>transmission system</i> or <i>distribution system</i> . The relevant Low Voltage section of the <i>distribution system</i> owned and operated by the DNSP to which the EG Unit(s) is, or will be, <i>connected</i> .
Distribution Network Service Provider (or DNSP)	A person who engages in the activity of owning, controlling, or operating a <i>distribution system</i> . Depending on the context means either Energex (who owns and operates the Distribution System in South East Queensland) or Ergon Energy Network (who owns and operates the Distribution System in the remainder of Queensland).
Embedded Generating Unit (or EG Unit)	A Generating Unit connected to a Distribution Network and not having direct access to the transmission network.
Emergency Backstop Mechanism	Involves the use of Generation Signalling Devices to provide a Demand Response that causes an IES to temporarily cease or reduce generation in emergency contingency events within the <i>power system</i> . The mechanism may be called upon to respond to a direction by AEMO issued in accordance with the NEL.
Energy Laws	Relevant laws relating to the subject matter of this Standard.
Energy Storage System (or ESS)	A system comprising one or more components (e.g. batteries) that store electricity generated by Distributed Energy Resources or directly from the grid, and that can discharge the electricity to loads.
Export	Net electricity that is fed into the Distribution System through the Connection Point.
Fixed EG Connection	A <i>connection</i> between an EG System and the Distribution System having predetermined limits for settings applied to the Fixed EG System during installation and are not able to be changed.
Fixed Embedded Generating System(s) (or Fixed EG System(s))	One or more Embedded Generating Units and auxiliary equipment that comprise either an Inverter Energy System or Rotating Machines and interconnect with the Distribution System at a Connection Point.
Generating Unit	The plant used in the production of electricity and all related equipment essential to its functioning as a single entity.
Generation	The production of electrical power by converting another form of energy in a Generating Unit.

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Term	Definition
Generation Signalling Device (GSD)	A DRED providing functionalities and capabilities to achieve Demand Response, which satisfies the requirements of AS/NZS 4755.1 ³ .
High Voltage (or HV)	Any voltage greater than 1 kV a.c.
Inverter Energy System (or IES)	A system comprising one or more inverters together with one or more energy sources (which may include batteries for energy storage) and controls, with an aggregate installed nameplate capacity of 30 kVA to 1,500 kVA.
Isolation Device	Device designed to safely prevent the flow of current such as circuit breaker or contactor.
Low Voltage (or LV)	A voltage of no more than 1,000 V a.c. or 1,500 V d.c.
Network Coupling Point	The point at which Connection Assets join the shared Distribution Network, used to identify the distribution service price payable by the Proponent.
Non-export	An EG Unit that is capable of operating in Parallel with the Distribution System and which is designed and configured to prevent any Export of electricity to the Distribution System across the Connection Point.
Parallel (or Grid Connected)	This is where the EG Unit is configured such that the EG Unit and the Distribution System may operate in parallel from time to time (even if this is a very short period of time). This includes circumstances where an Energy Storage Systems can be tied directly or indirectly back to the Distribution System through an AS/NZS 4777.2 grid connect inverter. It is irrelevant whether the EG Unit (including any Energy Storage System) Exports.
Partial-export	An EG Unit that is capable of operating in Parallel with the Distribution System and which is designed and configured to only Export as prescribed to operate in Section 4.3.1 of this Standard.
Premises	Means any land (whether a single block or multiple contiguous blocks), building(s) (whether whole or part), and structure(s) (or adjuncts thereto) that are owned, occupied or controlled by the Proponent in the vicinity of the proposed connection and which can reasonably be considered to be part of a single overarching operation.
Power Limiting	The ability to reduce or stop power output from a Fixed EG System when Export exceeds a defined value.
Proponent	The relevant owner, operator, or controller of the Fixed EG System (or their agent).
PSCAD™/EMTDC™	Refers to a software package developed by the Manitoba-HVDC Research Centre that comprises a power systems computer-aided design package which includes an electromagnetic transients (including DC) simulation engine, and which is used to carry out electromagnetic transient type studies.
Rotating Machines	Electric rotating machinery with an aggregate installed nameplate capacity of 0 kVA to 1,500 kVA).
Single Wire Earth Return (or SWER)	Parts of the electrical high voltage Distribution Network that use a single live conductor with the earth as the return current path. All premises are supplied at LV either as single-phase or split-phase electric power.

³ A list of Approved GSD can be found at Energex at: <https://www.energex.com.au/home/our-services/connections/low-voltage-generation/emergency-backstop-mechanism> and Ergon Energy Network at: <https://www.ergon.com.au/network/connections/low-voltage-generation/emergency-backstop-mechanism>

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Term	Definition
Standard	This document that is entitled “Standard for Low Voltage Embedded Generating Connections”.
Technical Study	A study to evaluate the effects that the proposed connection of the Fixed EG System will have on the Distribution System under different loading conditions or in the event of particular faults. A document will be produced for the Proponent that has requirements as part of the Connection Contract.

2.2 Abbreviations

Term, abbreviation, or acronym	Definition
AC or a.c	Alternating current
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AFLC	Audio Frequency Load Control
AS/NZS	A jointly developed Australian and New Zealand Standard
AS	Australian Standard
ANSI	American National Standards Institute
CBD	Central Business District
CEC	Clean Energy Council
DC or d.c.	Direct current
DER	Distributed Energy Resources
DRED	Demand Response Enabling Device
EG	Embedded Generating
EMC	Electromagnetic Compatibility
EVSE	Electric Vehicle Supply Equipment
GPR	Grid Protection Relay
GSD	Generation Signalling Device
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
LV	Low Voltage
NEL	National Electricity Law
NER	National Electricity Rules
NVD	Neutral Voltage Displacement
PV	Photovoltaic
QECM	Queensland Electricity Connection Manual
RPEQ	Registered Professional Engineer of Queensland

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2.3 Terminology

In this Standard:

- the word “shall” indicates a mandatory requirement that the Proponent must comply with;
- the word “should” indicates a recommended requirement that will not be mandatorily imposed on the Proponent; and
- the word “may” indicates a requirement that the DNSP may determine the Proponent must comply with.

2.3.1 Subcategories

The technical requirements set out in this Standard shall apply to the following subcategories of Fixed EG Systems described in Table 1:

Table 1 Subcategories

LV EG IES ≤ 30 kVA fixed connection ¹	LV EG IES > 30 kVA and ≤ 200 kVA fixed connection	LV EG IES > 200 kVA fixed connection	LV EG rotating machines fixed connection	LV EG non- standard fixed connection
System capacity < 30 kVA	System capacity > 30 kVA and ≤ 200 kVA	System capacity > 200 kVA and ≤ 1,500 kVA ¹	System capacity > 0 kVA and ≤ 1,500 kVA ¹	Connecting to Brisbane CBD network, connections >1,500 kVA and <5 MVA or premises with more than one LV Connection Point.

Note 1 : LV EG IES fixed connections for main grid and SWER which are not covered by the standard STNW1170.

The following arrangements are considered to be non-standard and shall be assessed for technical limitations identified on a case-by-case basis:

- connecting Fixed EG Systems within the Brisbane CBD Distribution System where that system is likely to contribute to an increase in the fault rating limitations of network infrastructure. The Fixed EG Systems will be limited to systems that will not effectively contribute to a rise in fault level at the Connection Point (e.g. bumpless transfer and IES);
- connections involving a Premises with has more than one LV Connection Point, or the Proponent’s network(s) is connected to more than one LV Connection Point. These will be considered in terms of their aggregated impact on the Distribution Network;
- LV connections with an aggregated capacity > 1,500 kVA and <5 MVA. Refer to Appendix E for further details on requirements that may be required for these non-standard connection arrangements;
- connections to an Isolated Network that are covered by STNW3512 “Standard for LV EG Connections to Isolated Networks”; and
- connections to a HV network/s that are covered by STNW1175 “Standard for HV EG Connections”.

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If further clarification is required to determine which subcategory applies to a Proponent, please contact:

For Ergon Energy Network – ergongeneration@energyq.com.au

For Energex – energexgeneration@energyq.com.au

3 Relevant rules, regulations, standards and codes

3.1 Standards and codes

There are a range of applicable standards and industry codes which define connection types and applicable requirements, as set out below.

In the event of any inconsistency between:

- Australian and international standards and industry codes (except for legislated industry codes); and
- this Standard,

this Standard will prevail.

3.1.1 Energex controlled documents

A copy of the latest version of this Standard may be obtained by searching for STNW1174 from the following website: <https://www.energex.com.au/>

Other controlled documents include:

Document number	Document name	Document type
Manual 01811	Queensland Electricity Connection Manual	Reference
STNW1175	Standard for HV EG Connections	Standard
STNW3511	Dynamic Standard for LV EG Connections	Standard

3.1.2 Ergon Energy Network controlled documents

A copy of the latest version of this Standard may be obtained by searching for STNW1174 from the following website: <https://www.ergon.com.au/>

Other controlled documents include:

Document number	Document name	Document type
NA000403R509	Queensland Electricity Connection Manual	Reference
STNW1175	Standard for HV EG Connections	Standard
STNW3511	Dynamic Standard for LV EG Connections	Standard
STNW3512	Standard for EG Connections on Isolated Networks	Standard

3.1.3 Australian and New Zealand Standards

Document number	Document name	Document type
AS/NZS 3000	Electrical Installations – Wiring Rules	AU/NZ Joint Standard
AS/NZS 4755.1	Demand response capabilities and supporting technologies for electrical products – Part 1: Demand response framework	AU/NZ Joint Standard

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Document number	Document name	Document type
	and requirements for demand response enabling devices (DREDS)	
AS/NZS 4777.1	Grid connection of energy systems via inverters Part 1: Installation requirements	AU/NZ Joint Standard
AS/NZS 4777.2	Grid connection of energy systems via inverters Part 2: Inverter requirements	AU/NZ Joint Standard
AS/NZS 5033	Installation and Safety Requirements for Photovoltaic (PV) Arrays	AU/NZ Joint Standard
AS/NZS 5139	Electrical Installations – Safety of battery systems for use with power conversion equipment	AU/NZ Joint Standard
AS 60034.1	Rotating electrical machines, Part 1: Rating and performance	Australian Standard
AS 60034.22	Rotating electrical machines, Part 22: AC generators for reciprocating internal combustion (RIC) engine driven generating sets	Australian Standard
AS 60038	Standard Voltages	Australian Standard
AS 61869	Instrument transformers (multiple parts)	Australian Standard
AS 61000.3.100	Electromagnetic compatibility (EMC) limits – Steady state voltage limits in public electricity systems	Australian Standard
AS/NZS IEC 60947.6.1	Low-voltage switchgear and controlgear	AU/NZ Joint Standard
AS/NZS 61000.4.30	Electromagnetic compatibility (EMC) – Part 4.30: Testing and measurement techniques – Power quality measurement methods	AU/NZ Joint Standard
AS NZS IEC 62116	Utility-interconnected photovoltaic inverters – Test procedure of islanding prevention measures	AU/NZ Joint Standard
SA/SNZ TR IEC 61000.3.14	Electromagnetic compatibility (EMC) – Part 3.14: Limits - Assessment of emission limits for harmonics, interharmonics, voltage fluctuations and unbalance for the connection of disturbing installations to LV power systems	AU/NZ Joint Standard
SA/SNZ TR IEC 61000.3.15	Electromagnetic compatibility (EMC), Part 3.15: Limits— Assessment of low frequency electromagnetic immunity and emission requirements for dispersed generation systems in LV network	AU/NZ Technical Report

3.1.4 International Standards

Document number	Document name	Document type
IEC 60255-1	Measuring relays and protection equipment – Part 1: Common requirements	International Standard
IEC 60255-26	Electrical relays – Part 26: Electromagnetic compatibility requirements	International Standard
IEC 60255-27	Electrical relays – Part 27: Product safety requirements	International Standard

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IEC 60255-127	Measuring relays and protection equipment – Part 127: Functional requirements for over/under voltage protection	International Standard
IEC 60255-181	Measuring relays and protection equipment – Part 181: Functional requirements for frequency protection	International Standard
IEC 60617	Graphical symbols for diagrams	International Standard
IEEE Std 519	IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems	IEEE Standard
IEEE Std C37.2	IEEE Standard Electrical Power System Device Function Numbers, Acronyms, and Contact Designations	IEEE Standard

3.2 Legislation and regulation

Set out below is a list of the related legislation and regulations (which may be amended, replaced, repealed, or have further instruments enacted from time to time).

In the event of any inconsistency between:

- legislation and regulation; and
- this Standard,

the legislation and regulations will prevail.

Document name	Document type
Construction and operation of solar farms – Code of Practice 2019	Code of Practice
DER Technical Standard	Regulation
<i>Electricity Act 1994 (Qld)</i>	Legislation
<i>Electricity Regulation 2006 (Qld)</i>	Regulation
<i>Electrical Safety Act 2002 (Qld)</i>	Legislation
<i>Electrical Safety Regulation 2013 (Qld)</i>	Regulation
<i>Electricity – National Scheme (Queensland) Act 1997 (Qld)</i>	Legislation
National Electricity (Queensland) Law, as defined in the <i>Electricity – National Scheme (Queensland) Act 1997 (Qld)</i>	Regulation
<i>National Energy Retail Law (Queensland) Act 2014 (Qld)</i>	Legislation
National Energy Retail Law (Queensland), as defined in the <i>National Energy Retail Law (Queensland) Act 2014 (Qld)</i>	Regulation
National Electricity Rules	Regulation
<i>Professional Engineers Act 2002 (Qld)</i>	Legislation

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4 Technical requirements

4.1 Labelling and signage

All Fixed EG Systems shall comply with AS/NZS 3000.

Labels and signs on the IES Fixed EG Systems, including cables, shall additionally meet the requirements of AS/NZS 4777.1, AS/NZS 5033 and AS/NZS 5139.

4.2 Maximum system capacity

Provided there is no constraint identified by the DNSP, the maximum aggregate system capacity for standard Fixed EG Connections for each subcategory covered under this Standard shall be as per Table 2.

Under this Standard, the aggregate maximum system capacity of a Fixed EG System at a Connection Point is 1,500 kVA.

Table 2 Maximum system capacity by subcategory

LV EG IES ≤ 30 kVA fixed connection	LV EG IES > 30 kVA and ≤ 200 kVA fixed connection	LV EG IES > 200 kVA fixed connection	LV EG rotating machines fixed connection	LV EG non- standard fixed connection ¹
10 kVA per phase	200 kVA	1,500 kVA	1,500 kVA	As per Technical Study

Note 1 : Refer to Section 2.3.1 for more information on LV EG non-standard fixed connections.

There is no limit for DC-coupled DER capacity. The limits for a Technical Study will be based on the aggregated AC capacity of the Fixed EG Units at the Premises.

For Premises with multiple LV Connection Points, Premises with network(s) connected to multiple Connection Points, or Fixed EG system(s) within a Premise being connected to multiple Connection Points:

- a. The maximum capacity for a Connection Point in respect of a Premise is based on the aggregate of all EG Units connected, or proposed to be connected within the Premise.
- b. The requirements set out in this Standard and the Technical Study will be applied and determined based on the aggregate maximum capacity of all the EG Units connected, or proposed to be connected, within the Premise.

The Fixed EG System (comprising all EG Units capable of connecting to the Distribution System through a Connection Point) shall be designed so that it does not exceed the ratings of equipment both within the Distribution System and the Proponent's side of the Connection Point when the Fixed EG System operates in Parallel.

Nameplate rating for any EG Unit shall be based on the maximum continuous rating of the EG Unit throughout this Standard.

4.3 Generation control

For all Fixed EG Systems that may connect to the Distribution System,

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Table 3 defines the operation types, nature of Parallel operation and Export capability.

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Table 3 Types of Fixed EG Systems

Operation Type	Parallel Operation		Export Capability
	Duration	Frequency	
Bumpless transfer	up to 2 seconds	N/A	Non-export only
Stand-by ¹ (for testing only)	up to 6 hours	Every 3 months	Either Export or Non-export
Continuous Parallel	Greater than 24 hours	In a year	Either Export or Non-export

Note 1: Stand-by operation is for operating Fixed EG System for maintenance purposes. If the Fixed EG System is part of a generation aggregation system, then it is automatically classified as continuous Parallel regardless of planned duration or frequency.

4.3.1 Export limits at Connection Point

4.3.1.1 Export limit study

The Export limit shall be assessed and determined by the DNSP based on:

- a. penetration of Fixed EG Systems on the Distribution System;
- b. asset capacity limits on the Distribution System;
- c. power quality checks on the Distribution System;
- d. voltage regulation impacts on the Distribution System; and
- e. Distribution System protection impacts.

Additional constraints may apply to non-standard Fixed EG System connections (including those referred to in Section 2.3.1). An indicative Export limit may be provided by the DNSP at the enquiry stage of the applicable connection process.

4.3.1.2 Export limit types

A Proponent can elect to have Partial-export or Non-export Fixed EG System.

Partial-export Fixed EG Systems shall be designed and operated to limit the amount of Export into the Distribution System to an agreed export threshold as set out in the relevant Connection Contract.

Full Export Fixed EG Systems will not incorporate any such limitations and can Export into the Distribution System to the full nameplate capacity (full AC rating) of that Fixed EG System.

4.3.1.3 Export limit settings

Export limits shall be interpreted as “soft” and meet the definition of soft Export limits in clause 3.4.8 of AS/NZS 4777.1. Export limits shall be set to meet Table 4.

Table 4 Export limit settings

	Non-export	Partial-export
Export limit setting (kW)	0	<i>k</i> of total inverter rating

Note: Where *k* is equal to the approved Partial-export power value as a per unit value of the EG Unit capacity.

The Export ability of the Proponent’s Fixed EG System to Export at the limits described above are not guaranteed and will depend on the characteristics of the Distribution Network, which may change over time. Circumstances which may cause the Export to be constrained include but are not limited to when power quality response modes are in operation.

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4.3.2 Site Generation limit downstream of Connection Point

This section has been left intentionally blank.

4.3.3 Phase balance

For Premises with a multiphase connection to the Distribution System, the EG Unit(s) shall be configured to ensure the difference in power generated into any two phases does not exceed 5 kVA (20 A) per phase in normal operation. In accordance with clause 4.1 of the QECM, Proponents shall also ensure that the current in any phase does not exceed the current in any other phase by more than 20 A. Multiphase connections shall install phase balance protection where required under Section 4.7.2.2 of this Standard.

4.3.4 Emergency Backstop Mechanism

4.3.4.1 Application

Fixed EG Connections that satisfy the following conditions shall comply with Section 4.3.4.2 of this Standard to enable the Emergency Backstop Mechanism:

- a. the aggregated system capacity of all inverters⁴ at the Premises is equal to or above 10 kVA; and
- b. the Distribution System has AFLC service available at the Connection Point⁵.

4.3.4.2 Configuration for an Emergency Backstop Mechanism

Subject to Section 4.3.4.1 of this Standard, a Proponent shall ensure that any Fixed EG Connection is configured to comply with the following requirements:

- a. installation of a GSD in accordance with the QECM Supplement No.2 for all inverters that:
 1. are, or were, installed or altered pursuant to a Connection Contract dated on or from 6 February 2023; and
 2. are not connected exclusively with an ESS DC source;
- b. the inverter is configured to enable functionality of the demand response mode DRM 0 in compliance with AS/NZS 4777.2.
- c. where the inverter does not have an integrated device for the demand response mode, an external device is installed in accordance with clause 3.2.1 of AS/NZS 4777.2.

4.4 Inverter Energy Systems

The following requirements apply to IES that include LV EG inverters:

- a. Inverters shall be tested and certified by an authorised testing laboratory as being compliant with AS/NZS 4777.2 (with an accreditation number issued).
- b. The inverters should be registered with Clean Energy Council (CEC) as approved grid connect inverters.
- c. The inverters shall be tested and certified by an authorised testing laboratory as being compliant with AS/NZS IEC 62116 for active Anti-islanding Protection.
- d. The inverters shall be installed in compliance with AS/NZS 4777.1 for IES less than or equal to 200 kVA.

⁴ Including inverters with ESS DC sources.

⁵ AFLC service availability can be checked for Energen at: <https://www.energen.com.au/home/our-services/connections/low-voltage-generation/emergency-backstop-mechanism> and Ergon Energy Network at: <https://www.ergon.com.au/network/connections/low-voltage-generation/emergency-backstop-mechanism>

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- e. The inverters shall have both volt-var and volt-watt response modes available and be capable of operating the modes concurrently, as per Section 4.10.2 of this Standard.
- f. The inverters shall be set to the regional setting “Australia A”.

4.4.1 Energy Storage System (ESS)

The connection of an ESS (such as batteries) capable of supplying electricity to an electrical installation such as a premises or the Distribution System is considered Grid Connected, unless the inverter is connected behind a break-before-make switch in compliance with AS/NZS IEC 60947.6.1.

Where the ESS is considered to be Grid Connected:

- a. The ESS shall be subject to the requirements of this Standard.
- b. The inverters for the ESS shall be installed in accordance with Section 4.4 of this Standard.
- c. The installation of the ESS shall comply with AS/NZS 5139.
- d. ESS are either externally DC coupled to an AC inverter or packaged as a product into an integrated system with an AC inverter. The following requirements shall apply to ESS inverters:
 - 1. the inverter capacity for the ESS will be included in the aggregated nameplate rating of inverters within the Premises behind the Connection Point (forming part of the Proponent’s installation).
 - 2. the Export limit for the ESS inverter will be considered as part of the aggregated Export limit at the Connection Point.

The installation and commissioning of an ESS shall be certified as compliant by an Accredited Person.

4.5 Network connection and isolation

Fixed EG Systems can be connected to the Distribution System through a shared or dedicated transformer arrangement. Connection to, and Parallel operation with any part of the Distribution System is dependent upon compliance with the requirements outlined in this Standard at each Connection Point where the Fixed EG System can Parallel.

Unless otherwise agreed with the DNSP, a Fixed EG System shall only connect to the Distribution System via one Connection Point.

It is the Proponent’s responsibility to provide an Isolation Device at the Connection Point, Fixed EG System transformer(s) (if required) and all associated protection controls and ancillary equipment.

The Proponent shall provide a means of isolation that is capable of disconnecting the whole of the Fixed EG System from the Distribution System. Where the Fixed EG System is an aggregate of smaller distributed EG Units, multiple isolation points may exist.

Fixed EG Systems that supply only part of the Proponent’s installation shall have approved mechanisms in place to prevent the following:

- a. Parallel connection of the DNSP’s distribution transformers; and
- b. connection of the Fixed EG System to the Distribution System occurring without synchronisation and the operation of associated protection systems.

Network connection and isolation requirements shall be in accordance with AS/NZS 4777.1 and AS/NZS 3000 for all Fixed EG Systems.

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In addition, the following requirements shall apply:

1. mechanical isolation shall be in accordance with AS/NZS 3000 in that the isolator must always be readily accessible.
2. any means of isolation (where lockable) shall be able to be locked in the open position only.

4.5.1 Changeover switches for bumpless transfer

Bumpless transfer for Fixed EG Systems shall incorporate a Make-before-break automatic transfer switch compliant with AS/NZS IEC 60947.6.1. Parallel operation with the Distribution System shall comply with the duration limits shown in

Table 3.

4.6 Earthing

The earthing requirements shall include:

- a. for all Fixed EG Systems including IES, earthing requirements shall be as per AS/NZS 4777.1 and AS/NZS 3000.
- b. all Fixed EG Systems including Rotating Machines shall have earthing requirements as per AS/NZS 3000 and AS/NZS 3010.
- c. any ESS shall have earthing requirements as per AS/NZS 3000 and AS/NZS 5139.

4.6.1 Multiple Earth Neutral

Fixed EG Systems that are connected to the Distribution System via a delta/star transformer (delta on the Distribution System side), may have the neutral directly connected to earth via a Multiple Earth Neutral (MEN) link, in accordance with AS/NZS 3000.

4.6.2 Neutral harmonics

Effective isolation of the neutral may be required to inhibit the flow of harmonic currents through the neutral. The Proponent shall advise the DNSP of their proposed method to limit harmonic currents through the neutral.

4.7 Protection

Fault levels shall not exceed the equipment rating of the Fixed EG System, Distribution Network equipment, associated switchgear, and protection equipment. Where the Fixed EG System is able to contribute to fault levels, the DNSP shall:

- a. conduct fault studies which includes the fault contribution from the Proponent's Fixed EG System; and
- b. provide the Proponent with the existing fault levels and protection equipment ratings to assess whether the design of the Fixed EG System exceeds relevant equipment ratings.

Where it is determined the design of the Fixed EG System has the potential to raise the fault levels on the Distribution Network beyond the capacity of the DNSP's protection device(s) and/or equipment, the Proponent shall meet the cost to upgrade the protection device(s) and/or equipment, and ensure that their switchboard and equipment can withstand the total prospective fault currents.

Fault level considerations shall be made for the following configurations of Fixed EG Systems with Rotating Machines:

1. bumpless transfer Fixed EG Systems shall have fault levels considered only within the Proponent's installation; and
2. stand-by Fixed EG Systems shall have a pro-rata factor applied to the prospective fault levels, which shall be dependent on the number of Fixed EG System connected to the relevant part of the Distribution System at the same time; and
3. continuous Parallel Fixed EG Systems shall have fault levels considered for both HV and LV Distribution Systems.

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4.7.1 Inverter integrated protection

The inverter integrated protection requirements for inverters connected to the Distribution System shall comply with AS/NZS 4777.2 for active anti-islanding requirements. Other inverter settings including passive anti-islanding settings shall be set to the values given in Table 5 that is consistent with Table 4.1 and Table 4.2 from AS/NZS 4777.2.

Table 5 Prescribed Inverter Settings

Parameter	Settings	Trip delay time	Maximum disconnection time
Undervoltage 2(V<)	70 V	1 s	2 s
Undervoltage 1 (V<)	180 V	10 s	11 s
Overvoltage 1 (V>)	265 V	1 s	2 s
Overvoltage 2 (V>>)	275 V	—	0.2 s
Underfrequency (F<)	47 Hz	1 s	2 s
Overfrequency (F>)	52 Hz	—	0.2 s
Reconnect time	60 seconds	N/A	N/A

4.7.2 Central Protection

The functional requirements for Central Protection are outlined in Table 6.

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Table 6 Central Protection requirements

Protection Requirements	LV EG IES					LV EG rotating machines	
	≤ 30 kVA	> 30 kVA and ≤ 200 kVA		> 200 kVA		Export	Non-export
	Export	Export	Non-export	Export	Non-export		
Grid reverse power (32R)	No	No	No	No	No	No	No
Power Limit protection (32)	No ¹	No ¹	No ¹	No ¹	No ¹	No ¹	Yes
Generator circuit phase balance protection (46/47)	No	No	No	No	No	No	No
Grid overcurrent fault and earth fault protection (50/51)	No	No	No	No	No	Yes	Yes
Passive Anti-islanding Protection (27U/O, 59U/O, 81U/O, 81R)	No	Yes	Yes	Yes	Yes	Yes	Yes
Inter-tripping	No						

Note 1: Non-export or Partial-export systems shall meet the requirements of Section 4.7.2.6 Power Limiting Protection.

Where the Fixed EG System comprises multiple inverters, all inverters on all three phases of the Fixed EG System shall simultaneously disconnect from the Distribution Network in response to the operation of protection or automatic controls.

The Grid Protection Relay (GPR) shall be installed to provide back-up protection functions to ensure the Distribution Network (at the Connection Point) and the installation are not exposed to a hazardous condition from the Fixed EG System.

The GPR shall meet the following requirements:

- a. coordinate multiple IES installations for one Connection Point¹;
- b. provide protection functionality using one relay for all IES installations for the one Connection Point¹;
- c. provide level 1 backup protection functions as prescribed in Table 7 for IES and Table 8 for rotating machines to meet the requirements of this Standard²;
- d. be integrated in such a way that it fails safe, and Fixed EG System(s) do not generate whilst the GPR is out of service;
- e. open the Isolation Device at either the Proponent's Connection Point or the Fixed EG System(s); and
- f. preserve safety of grid personnel and the general public.

The GPR shall be connected as close to the Connection Point as practicable, referencing a single point beyond the Connection Point within the customer's installation.

The GPR reference point shall be connected at a location that has a lower impedance to the Connection Point than any EG Unit connected within the customer's installation.

Note 1: Where there are both IES and rotating machine Fixed EG Systems connected at a single Connection Point, two GPRs are allowed to be installed where one GPR shall coordinate all IES and one GPR shall coordinate all Rotating Machines.

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Note 2: One GPR may be used for the entire installation, to coordinate IES and Rotating Machine Fixed EG Systems connected at a single Connection Point, where voltage and frequency setpoints align with Table 7. NVD and Power Limiting requirements shall continue to apply as per Rotating Machine requirements.

Further information on GPR arrangements can be found in Appendix B: Connection arrangement requirements.

Protection equipment shall operate the Isolation Device either directly or through interposing equipment. Such protection equipment and any interposing equipment shall have certified compliance with the following:

- IEC 60255-1 Common requirements;
- IEC 60255-26 EMC requirements;
- IEC 60255-27 Product safety requirements;
- IEC 60255-127 Functional requirements for over/under voltage protection; and
- IEC 60255-181 Functional requirements for frequency protection.

Marshalling of protection trips through control equipment shall be compliant with IEC 60255.

The instrument transformers used to interface the protection equipment with the Proponent's installation shall have certified compliance with:

- AS 61869.1 General requirements
- AS 61869.2 Additional requirements for current transformers;
- AS 61869.3 Additional requirements for inductive voltage transformers; and
- AS 61869.4 Additional requirements for combined transformers.

The GPR functionality in compliance with AS/NZS 4777.1 shall apply to all Fixed EG Systems as per Table 7 and Table 8. Under and over voltage protection shall be installed to monitor all three phases. The Level 1 backup protection is for passive Anti-Islanding Protection.

Table 7 IES GPR Functions and settings

Protection functional description	ANSI/IEEE C37.2 Code	IEC 60617 Code	Default Setting	Time Delay
Level 1 backup protection				
Under voltage 2 (UV)	27P	U<	70 V _{I-n}	3.0 s
Under voltage 1 (UV)	27P	U<	180 V _{I-n}	12.0 s
Over voltage (OV)	59P	U>	275 V _{I-n}	0.2 s
Under frequency (UF)	81U	f<	47 Hz	3.0 s
Over frequency (OF)	81O	f>	52 Hz	2.0 s
Rate of change of frequency (ROCOF)	81R	df/dt	±4 Hz/s	0.5 s ¹

Note 1: Sampling period for calculation of ROCOF specific to the GPR can be additional to the time delay setting.

Table 8 Rotating Machine GPR Functions and default settings

Protection functional description	ANSI/IEEE C37.2 Code	IEC 60617 Code	Default Setting	Time Delay
Level 1 backup protection				
Under voltage (UV)	27P	U<	180 V _{L-n}	11.0 s
Over voltage (OV)	59P	U>	265 V _{L-n}	1.0 s
Under frequency (UF)	81U	f<	47 Hz	2.0 s
Over frequency (OF)	81O	f>	52 Hz	2.0 s
Rate of change of frequency (ROCOF)	81R	df/dt	See Note 1	0.5 s ¹
Level 2 backup protection				
Neutral voltage displacement (NVD) ²	59N	U0>	20%	3.0 s
Non-Export Fixed EG Systems				
Power Limit protection	32	P→	From Technical Study ³	From Technical Study ³

Note 1: ROCOF calculated by the Proponent to ensure an island is not sustained when the Distribution System is de-energised. Where the calculated value is greater than 3 Hz/s, the DNSP shall be consulted. Sampling period for calculation of ROCOF specific to the GPR can be additional to the time delay setting.

Note 2: HV NVD as per Section 4.7.6.2 of this Standard.

Note 3: As per Section 4.7.2.6 of this Standard.

4.7.2.1 Grid reverse power protection

This section has been left intentionally blank.

4.7.2.2 Phase balance protection

Phase balance protection shall be required where:

- inverters are connected across more than one phase at a Connection Point;
- one or more inverters are single phase; and
- one or more phase has greater than 5 kVA of aggregate inverter capacity.

Phase balance protection shall respond to current imbalance at the Connection Point caused by the aggregate IES EG Units on each phase, between phases greater than 20 A (5 kVA) by disconnecting all of the inverters from the installation automatically within 30 seconds.

Disconnection for phase balance shall be by a method compliant with clause 3.4.4.2 of AS/NZS 4777.1. Phase balance protection shall meet the central protection requirements of clause 3.4.4.1 of AS/NZS 4777.1.

If required for Rotating Machines, specific settings for current unbalance protection shall be determined by a connection specific Technical Study.

Voltage unbalance protection may be required for rotating machine Fixed EG Systems and shall be specified from a Technical Study at the time of the connection.

4.7.2.3 Overcurrent and earth fault protection

Overcurrent and earth fault protection shall be provided at the Rotating Machines isolating switch in accordance with the equipment rating. The overcurrent and earth fault protection relays shall provide compensation for under voltage field weakening. Compensation for under voltage field weakening is not required where the Proponent can demonstrate that voltage depression at the Fixed EG System during fault events shall not adversely impact on the operation of the protection scheme.

Overcurrent and earth fault protection for the facility shall also be provided at the Fixed EG System in accordance with AS/NZS 3000. This protection shall be set to detect faults within the Proponent's installation. Any additional requirements for overcurrent facility fault, overcurrent grid fault and earth fault protection may be advised by the DNSP in the Technical Study.

4.7.2.4 Passive Anti-islanding Protection

Passive anti-islanding settings shall be as per Table 5 for IES Fixed EG Systems inverters.

Rotating Machine EG Unit(s) protection shall have the Level 1 backup protection functions from Table 8 that form the passive Anti-islanding Protection unless otherwise specified in the Technical Study. These functions shall have settings coordinating with the rotating machine GPR settings as outlined in Table 8.

An additional Anti-islanding Protection relay shall be installed if the Rotating Machine EG Unit(s) protection do not incorporate Level 1 back up protection as per Table 8. This relay is to operate the Isolation Device at the Connection Point. This relay shall provide backup protection functions in Parallel with the GPR for loss of mains.

4.7.2.5 Inter-tripping

The Proponent's design shall not require an inter-trip from the DNSP.

4.7.2.6 Power Limit protection

Where the Fixed EG System has been approved by the DNSP as either a Non-export or Partial-export system and does not employ a "soft" controls as described in Section 4.3.1 of this Standard, Power Limit protection shall be installed at the Connection Point or upstream of all EG unit(s) within the Connection Point. Any Power Limiting protection settings shall meet the requirements of Table 4.

4.7.3 Interlocking

Fail-safe interlocking mechanisms shall be required as specified in Table 9 for installations with multiple transformers and/or Connection Points, bumpless transfer and off grid connections.

Table 9 Interlocking requirements

Connection arrangement	Fail-safe interlocking ¹ requirements
Multiple transformers and/or Connection Points	No distribution transformers are connected in Parallel
Bumpless transfer	During the transfer from one source to another, the interlock operation cannot enable the EG Unit and the Distribution System to both supply the load at the same time longer than the maximum allowable duration for bumpless transfer in Table 3 of Section 4.3 of this Standard. No distribution transformers will be connected in Parallel any point during the bumpless transfer.
Off grid	During the transfer from one source to another the interlock operation cannot allow the Generating Unit and the Distribution System to both supply the load at the same time.

Note 1: The interlocking mechanism should be a manual (key based) fail-safe system. Automated controlled fail-safe interlocking systems may be allowed upon approval of a functional design and operational specification certified by an RPEQ in the application stage.

4.7.4 Isolation Device fail protection

Loss of mains and Anti-islanding Protection scheme design shall make allowance for the failed operation of an Isolation Device.

The protection scheme shall not operate the same Isolation Device for both primary and backup protection. There may be multiple Isolation Devices for either primary or backup protection.

The Proponent may elect to use another form of Isolation Device fail protection, such as a circuit breaker fail (CBF) scheme, subject to the DNSP's agreement.

4.7.4.1 Wireless Transfer

Where a Fixed EG System's GPR and export monitoring device is remote from the Fixed EG System's Isolation Device or inverters, a wireless communication system may be used. A GPR and export monitoring device utilising a wireless communication system shall meet the following requirements:

- a. have a supervised wireless communications link;
- b. have a communication delay that does not exceed 0.5 seconds; and
- c. disconnect the Fixed EG System from the Distribution System for any loss of communications longer than 5 seconds.

4.7.5 Synchronisation

The DNSPs apply an automatic feeder re-closing scheme on the majority of their Distribution Network. Automatic re-energisation of the feeder during this process opens the circuit breaker (with minimum delay) following a power system fault, and then attempts to automatically re-energise the feeder component after a predefined disconnected time (dead time). Automatic reclosing can happen multiple times depending on the Distribution Network location.

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The Fixed EG System shall disconnect within this dead time upon a loss of mains power to ensure safe restoration. Failure of the Fixed EG System to so disconnect when there is a loss of supply from the Distribution System may result in damage to the Fixed EG System.

When the system voltage has been restored on the Distribution System side of the Connection Point, and the voltage and frequency have been maintained within protection limits for a period of no less than 60 seconds, the Fixed EG System may reconnect with the Distribution Network.

The Fixed EG System shall incorporate either automatic or operator-controlled equipment that ensures the frequency, voltages, and phase sequence of the Fixed EG System is identical with (synchronised to) those in the Distribution Network before it connects to the Distribution System. The Fixed EG System shall not reconnect until it is synchronised with the Distribution Network.

4.7.6 Additional requirements for Rotating Machine Fixed EG Systems

4.7.6.1 Standards compliance

All Fixed EG Systems comprising a Rotating Machine EG Unit(s) that are installed under this Standard shall be compliant with:

- a. AS 60034.1 Rotating electrical machines, Part 1: Rating and performance; and
- b. AS 60034.22 Rotating electrical machines, Part 22: AC generators for reciprocating internal combustion (RIC) engine driven generating sets.

Fixed EG Systems comprising Rotating Machine EG Unit(s) installed under this Standard, shall meet the protection requirements in Table 10 for NVD, loss of mains and Anti-islanding Protection based on operation type.

Table 10 Requirements for Rotating Machine Fixed EG Systems

	Bumpless transfer	Stand-by	Continuous Parallel
HV NVD	No	No	Yes
Loss of mains protection	No	Yes	Yes
Anti-islanding Protection	No	Yes	Yes

4.7.6.2 Neutral Voltage Displacement (NVD) protection

NVD protection shall be installed for Fixed EG Systems comprising a Rotating Machine EG Unit(s) in accordance with Table 10.

NVD protection is required to ensure that a Fixed EG System disconnects if there is a high voltage network earth fault. NVD protection requires either phase-neutral or an open delta voltage measurement of the relevant part of the HV Distribution Network.

NVD protection requires equipment to be installed on the DNSP's assets.

4.8 Operating voltage and frequency

The proposed installation shall be able to operate within the limits of supply voltage:

$$V_{\text{phase-to-neutral}} = 230 \text{ V } +10\% / -6\%.$$

The maximum sustained voltage set point, $V_{\text{nom-max}}$ as per AS/NZS 4777.2 shall be set at 258 V.

The Fixed EG System shall be designed and operated so that there is a maximum 2% voltage rise from the EG Unit terminals to the Connection Point.

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4.9 Metering

4.9.1 Bulk metered connections

Where connections are bulk metered, like a strata titled development (such as townhouses or a retirement village), as illustrated in Figure 7 of Appendix B, there are three supply options available to the Proponent:

- Option 1 – aggregated Fixed EG Systems off a separate circuit from the main switchboard that are not separately metered by the Proponent;
- Option 2 – separate reticulation circuit for Fixed EG Systems and individual metering of each Fixed EG System by the Proponent; or
- Option 3 – aggregated Fixed EG Systems and Premises load off from mixed circuits.

Option 1 requires a GPR in accordance with Section 4.7.2 of this Standard. Options 2 and 3 may have the requirement for additional Anti-islanding Protection waived if the total installed capacity is less than 30% of the nameplate rating of the transformer supplying the bulk metered connection.

4.10 Power quality

4.10.1 General

All power quality measurements and limits are with reference to the Connection Point.

4.10.1.1 Voltage changes and flicker

The Proponent shall ensure that the Fixed EG System is designed and commissioned to:

- a. achieve the acceptable level and frequency of step voltage changes advised by the DNSP following the Technical Study.
- b. the flicker contribution limits for Fixed EG Systems is as per Table 11. The limits are considered as the direct contribution of the Fixed EG System (i.e. the difference in flicker values between when the EG is operational and not operational).

Table 11 Flicker contributions limits

Connection type	P_{st}	P_{it}
Dedicated distribution transformer	0.50	0.40
Shared distribution transformer	0.30	0.25

4.10.1.2 Short duration over voltages

The Proponent should comply with Section 7.6 of SA/SNZ TR IEC 61000.3.15 in order to minimise damage to its equipment from short duration over voltages.

The transient voltage limits for Fixed EG Systems comprising an IES EG unit(s) specified in Clause 2.9 of AS/NZS 4777.2 shall be met by Proponents.

4.10.1.3 Harmonic Distortion

Harmonic voltage limits permitted to be injected into the Distribution System at the Network Coupling Point shall be as agreed with the DNSP and specified in the Connection Contract.

Harmonic current emission limits shall be allocated in accordance with IEEE 519. The harmonic current distortion level of the Fixed EG System should be less than the emission limits specified by the DNSP when all the EG Units of the Fixed EG System are in service.

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4.10.1.4 Voltage Unbalance

The Proponent shall ensure that the current injected in each phase at each at the LV Connection Point is balanced so as to achieve average voltage unbalance less than or equal to the values set out in Table 12, where the average voltage unbalance is determined using the following formula:

$$\text{average voltage unbalance (\%)} = \text{average}_{\text{period}} \left(\frac{\text{negative sequence voltage}}{\text{positive sequence voltage}} \right) \times 100$$

Table 12 Voltage Unbalance levels

Condition	Averaging period	Voltage Unbalance
No contingency	30 minutes	2.0%
Credible contingency event	30 minutes	2.0%
General	10 minutes	2.5%
Once per hour	1 minute	3.0%

4.10.1.5 Disturbance Issues

Disturbance to the LV network shall be assessed against SA/SNZ TR IEC 61000.3.14.

Measurement of voltage disturbances shall be in accordance with AS/NZS 61000.4.30 using Class A instruments.

4.10.2 IES power quality response modes

The volt–var and volt–watt response modes specified in Clause 3.3.2.2, Clause 3.3.2.3 and Clause 3.4.3 of AS/NZS 4777.2 shall both be enabled as per below Table 13, Table 14 and Table 15 for IES.

Table 13 Volt–var response mode settings

Reference	Voltage	Inverter reactive power level (Q) % of S _{rated}
V _{V1}	207 V	44% supplying
V _{V2}	220 V	0%
V _{V3}	240 V	0%
V _{V4}	258 V	60% absorbing

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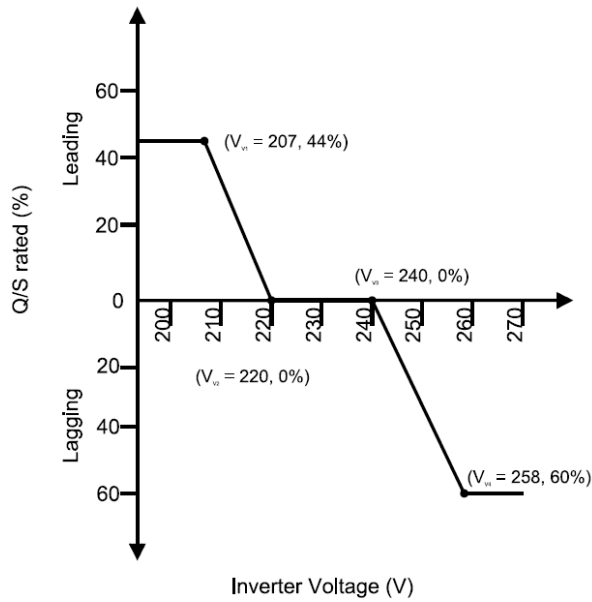


Figure 1: Volt-var response mode

Table 14 Volt-watt response mode settings

Reference	Voltage	Inverter maximum active power output level (P) % of S_{rated}
V_{W1}	253 V	100%
V_{W4}	260 V	20%

Note 1 – Where P is the output power of the inverter and P_{rated} is the rated output power of the inverter

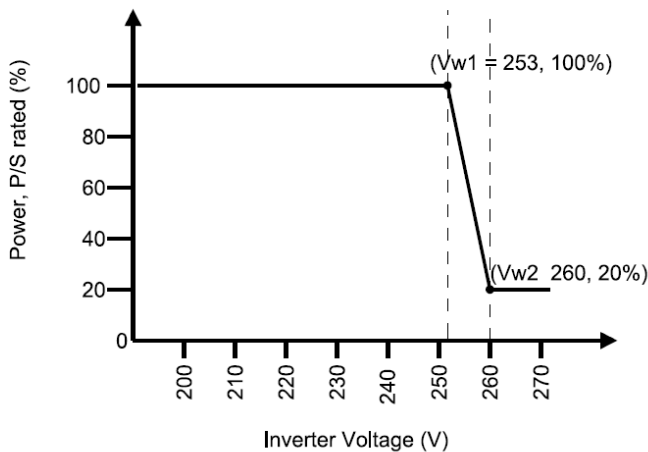


Figure 2: Volt-watt response mode

Table 15 Volt-watt response mode settings for inverters with energy storage when charging

Reference	Voltage	Power Input, $P_{charge}/P_{rated-ch}$ (%)
V_{W1-ch}	207 V	20%
V_{W2-ch}	215 V	100%

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Power quality response modes shall commence and complete in accordance with their defined characteristics in clause 3.3.2 and 3.4.3 in AS/NZS 4777.2 within the relevant times specified in Table 16 below:

Table 16 Maximum response time for power quality response modes

Response commencement time	Response completion time
1 s	10 s

4.10.3 LV EG rotating machines power quality response

An Fixed EG System comprising a Rotating Machine EG Unit(s) shall be designed and operated to adequately control real and reactive power output to achieve a power factor at the Connection Point of greater than 0.8 lagging and not leading unless otherwise agreed to in writing by the DNSP.

4.11 Communications systems

This section has been left intentionally blank.

4.12 Data and information

4.12.1 Static data and information

Static data and information shall be provided by the Proponent to the DNSP in accordance with Appendix D: Static Data and Information.

4.12.2 Dynamic data and information

This section has been left intentionally blank.

4.13 Cybersecurity

This section has been left intentionally blank.

4.14 Technical Studies

Technical Studies shall be undertaken by the DNSP as part of the connection application and in accordance with jurisdictional requirements. Technical Study requirements are shown in Table 17 and Table 18. Unless otherwise specified in the notes for Table 17, the DNSP shall be performing the Technical Study.

Table 17 Technical Study requirements for IES Fixed EG Systems

Technical study	≤ 30 kVA	> 30 kVA and ≤ 200 kVA		> 200 kVA	
	Export	Export	Non-export	Export	Non-export
Voltage regulation	Yes	Yes	No	Yes	No
Power flow	Yes	Yes	No	Yes	No
Fault level	Yes	Yes	Yes	Yes	Yes
Protection grading	No	No	No	No	No

Table 18 Technical Study requirements for Rotating Machine Fixed EG Systems

Technical study	Bumpless transfer	Stand-by		Continuous Parallel	
		Non-export	Export	Non-export	Export
Voltage regulation	No	No	Yes	No	Yes
Power flow	No	No	Yes	No	Yes
Fault level	No	Yes	Yes	Yes	Yes
Protection grading	No	Yes	Yes	Yes ¹	Yes ¹

Note 1: The Proponent shall do the study based on DNSP’s upstream protection settings.

Where the Fixed EG System is greater than 200 kVA and is identified to be connecting to a Distribution System with constraints, the DNSP may require the Proponent to provide a manufacturer-developed EMT model of the EG unit(s) with relevant site-specific settings. The EMT model shall be developed using PSCAD™/EMTDC™.

5 Connection application process, fees and charges

The connection application process for the connections referred to in this Standard are outlined in Chapter 5A of the NER (or where the Proponent has made an election under Rule 5A.A.2 of the NER) and can be found on both DNSP’s websites:

Energex: <https://www.energex.com.au/home/our-services/connections/major-business/large-generation-and-batteries>

Ergon Energy Network: <https://www.ergon.com.au/network/connections/major-business-connections/large-scale-solar>

Information regarding fees and charges applicable to Proponents is available at the following links:

Energex: <https://www.energex.com.au/home/our-services/connections/residential/connection-charges>

Ergon Energy Network: <https://www.ergon.com.au/network/connections/residential-connections/connection-services-charges>

6 Testing and commissioning

Testing and commissioning requirements for Fixed EG Connections include:

- a. testing and commissioning plans shall be prepared by the Proponent and may be required to be approved by the DNSP under the Connection Contract.

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- b. the commissioning plan, certification and acceptance shall be provided by an RPEQ⁶.
- c. testing and commissioning acceptance may require the DNSP to carry out witnessing at the DNSP's expense.
- d. for IES, testing and commissioning requirements shall be in accordance with AS/NZS 4777.1, AS/NZS 3000, AS/NZS 3017 and AS/NZS 5033 (where applicable), the equipment manufacturer's specifications and the DNSP technical requirements to demonstrate that the Fixed EG Systems including IES complies with the requirements set out in the Connection Contract.
- e. for Rotating Machines, testing, and commissioning requirements shall be in accordance with the equipment manufacturer's specifications and the DNSP's technical requirements and shall demonstrate that the LV EG rotating machines system meets the requirements of the Connection Contract.
- f. the Proponent shall submit a compliance report as outlined in the Connection Contract that comprises (but is not limited to) the final approved drawings, test results and specifications.

The application of testing and commissioning requirements shall be applied to specific subcategories as shown in Table 19.

Table 19 Testing and commissioning requirements

Testing and commissioning requirements	LV EG IES					LV EG rotating machines	
	≤ 30 kVA	> 30 kVA and ≤ 200 kVA		> 200 kVA		Export	Non-export
	Export	Export	Non-export	Export	Non-export		
Protection settings and performance	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Power quality settings and performance	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Export limits settings and performance	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Communications settings and performance	No	No	No	No	No	No	No
Shutdown Procedures	No	No	No	No	No	Yes	Yes
Confirm system is as per specifications	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Confirm SLD is located on site	Yes	Yes	Yes	Yes	Yes	Yes	Yes

⁶ Engineering supervision by an RPEQ need not be required for the commissioning of an EG System with bumpless transfer connection to the Distribution System if compliant with Section 4.5.1 and Section 4.7.3.

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7 Operations and maintenance

Operations and maintenance requirements for Fixed EG Connections shall include, but are not be limited to:

- a. an operation and maintenance plan shall be produced, with a copy to remain on site.
- b. the Fixed EG System shall be operated and maintained to ensure compliance at all times with the Connection Contract and all applicable legislation (including Energy Laws), codes, and/or other regulatory instruments.
- c. operation and maintenance reports may be required by the DNSP at a specified interval no more frequently than annually.
- d. the electrical installation at the supply address shall be maintained in a safe condition.
- e. subject to item f below, the Proponent shall ensure that any changes to the electrical installation at the supply address are performed by an electrician lawfully permitted to do the work and that the Proponent holds a Certificate of Compliance issued in respect of any of the changes;
- f. the Proponent shall seek DNSP approval prior to altering the connection in terms of an addition, upgrade, extension, expansion, augmentation, or any other kind of alteration, including changing inverter/GPR settings.
- g. The Proponent shall notify the DNSP of any scheduled and unscheduled protection or communications outages or failures.

The DNSP may at its own cost inspect the Proponent's Fixed EG System at any time. The DNSP may require access to the site of the Fixed EG System and isolation points for Distribution System maintenance and testing purposes.

Distribution System maintenance may cause interruptions to the operation of the Fixed EG System. Co-operative scheduling of these activities should be undertaken to reduce the outage period and minimise the associated impacts.

If the DNSP through an audit or an investigation determines that the Fixed EG System is non-compliant with the Connection Contract, the Proponent shall be advised of this in writing. If the concern has a material impact, the DNSP shall disconnect the Fixed EG System until the non-compliance has been remediated by the Proponent to the DNSP's satisfaction.

Appendix A: Deviations from the National DER Connection Guidelines (informative)

Table 20 Deviations from National DER Connection Guidelines

Section	Description of deviations	Type of deviation	Justification
1.2	Removed single-phase or three-phase for reference for the definition of the scope.	n/a	To remove any ambiguity regarding the limit of a single-phase connection. The DNSP assesses the aggregate capacity at the Connection Point.
1.2 and various other instances	“rotating machines” used instead “Non-IES”	Promote improved benefit to Australia’s electricity system	Rotating machines or rotating electrical machines is an established term used in Industry and IEC standards.
1.2	EVSEs that generate electricity at a.c. with the ability to export to the LV network or electrical installation is included in scope	Promote improved benefit to Australia’s electricity system	Existing policy acknowledging the ability of ESS to generate and export as an IES.
1.2	Removed reference to demand response and demand management systems from scope exclusions.	Jurisdiction requirement	For better clarity and alignment with introduction of Emergency Backstop Mechanism utilising Demand Response capability.
1.2, 2.3.1, 4.2, 4.4	Removed exclusion for ESS in both total system capacity and export limits for IES. Included a new sub-section 4.4.1 for additional information regarding ESS.	Promote improved benefit to Australia’s electricity system	ESS can have an integrated inverter and have an AC or DC output. An ESS with integrated inverter would not be excluded from either total system capacity or export limit for IES due to impact on the Distribution System.
2.1	Excludes definitions for Distributed Energy Resources, Registered Generator, small registered generator, Micro Embedded Generation connection, Model connection contract, Aggregator related terminology, Market generating unit, standard connection, technical requirements document in this Standard.	n/a	Documentation policy to not include definitions not required within the Standard. The DNSP will develop a position on aggregation and include at a later stage.
2.1	Different definitions for Proponent, IES, LV, Central Protection. Italics is used to highlight specific terms in NER/National Energy Retail Law not defined in this Standard.	Promote improved benefit to Australia’s electricity system	For better clarity and alignment with other related documents.
2.2	AEMO, AER, CPEng, GDL, MV, SWIS, WEM, NBN, NEM, NMI, WEM, xDSL Excluded. Some acronyms also moved to the definitions section.	n/a	Documentation policy to not include abbreviations not required within the Standard.

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Section	Description of deviations	Type of deviation	Justification
2.3.1	The term "Basic" is removed.	Promote improved benefit to Australia's electricity system	The term "Basic" references a particular service contract type whilst the Standard covers greater scope.
2.3.1	Non-standard networks defined as a category.	Promote improved benefit to Australia's electricity system	Acknowledges specific networks and conditions that requires changes in technical requirements.
4.1, 4.4.1 and 4.6	AS/NZS 5139 included instead of AS/NZS 3011.	Promote improved benefit to Australia's electricity system	AS/NZS 5139 has been published since the ENA guideline was released which is an update on all ESS installation and application requirements including safety. AS/NZS 5139 covers all the main ESS types whereas AS/NZS 3011 covered only lead-acid and nickel cadmium types.
4.3 and 4.5	Introduced the bumpless transfer mode of operation and associated requirements.	Promote improved benefit to Australia's electricity system	Covers the gap of requirements for bumpless transfer mode.
4.3.4	Inclusion of new Section to include requirements for an Emergency Backstop Mechanism	Jurisdictional requirement	New requirement for Emergency Backstop Mechanism.
4.4	Revision to clause requiring mandatory accreditation to inverters with Clean Energy Council.	Promote improved benefit to Australia's electricity system	Allowance for provision of evidence of certified compliance to DNSP for >100 kVA non-listed inverters.
4.7.1	AS/NZS 4777.1 excluded from inverter anti-islanding requirements.	Promote improved benefit to Australia's electricity system	AS/NZS 4777.1 anti-islanding requirements are in reference to Central Protection.
4.7.2	Included requirements regarding Protection device/equipment standards compliance in previous use in Queensland. Facility fault protection removed from Central Protection.	Promote improved benefit to Australia's electricity system	Compliance to best practice standards improves safety and performance.
4.7.2	Modified table 2 of AS/NZS 4777.1 with different disconnection times.	Promote improved benefit to Australia's electricity system	A time grading for protection between EG units and Central Protection could be advantageous. It's also prescribed in AS/NZS 4777.1.
4.7.2, 4.7.2.1, 4.7.2.2	Grid reverse power and generator phase balance is not required at a Central Protection level.	Promote improved benefit to Australia's electricity system	Duplication of generating unit level protection for central protection is not required for Grid Protection. A Proponent can avoid additional costs by only having to design and locate this protection at the generating unit level.

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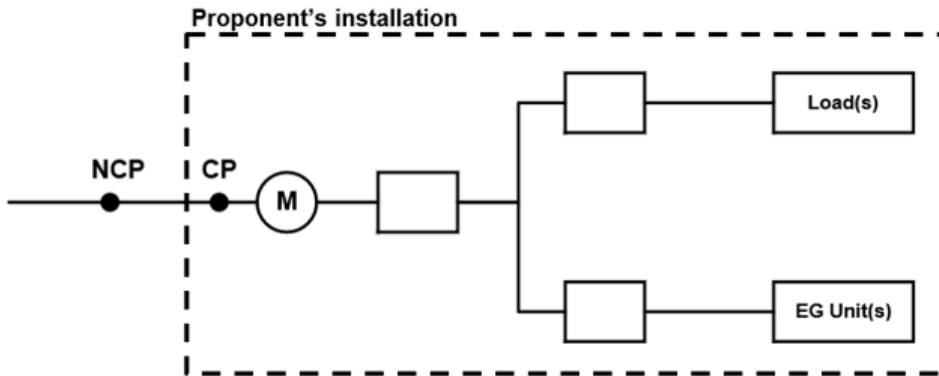
Section	Description of deviations	Type of deviation	Justification
4.7.3	Interlocking requirements are covered in phase balance protection.	Promote improved benefit to Australia's electricity system	
4.7.2.3	Title shortened to "Overcurrent and earth fault protection"	n/a	Shortened to improve readability and formatting.
4.7.2.4	Passive anti-islanding section reworded to highlight the EG unit level requirements.	Promote improved benefit to Australia's electricity system	Central protection section covers anti-islanding requirements and settings for a grid-backup perspective.
4.7.2.5	Inter-tripping requirements removed.	Promote improved benefit to Australia's electricity system	Inter-tripping is not a standard requirement for LV connections due to the cost and complexity of this solution.
4.7.2.6	Reverse power for the grid is included where Export limitation is not "soft" controlled as per Section 4.3.1.2.	Promote improved benefit to Australia's electricity system	Provides another design option for certain scenarios where it may be more effective, particularly where multiple inverters are being utilised.
4.7.4	Power factor controls replaced with an Isolation device fail section.	n/a	Power factor controls is a better fit in Section 4.10.
4.7.6.1	Specified Australian Standards compliance requirements for rotating machines in a new sub-section.	Promote improved benefit to Australia's electricity system	Enables assessment and connection of rotating machines. Provides confidence in the operational performance of the rotating machines connected to the Distribution Network.
4.7.6.2	Included NVD protection requirement for rotating machines in a new sub-section.	n/a	Ensures best practice safety compliance for HV faults.
4.10.1.5	Included information regarding the criteria around Disturbance investigations in a new-subsection.	Promote improved benefit to Australia's electricity system	
4.14	Changes to the Technical Study requirements section.	Promote improved benefit to Australia's electricity system	The standard is covering two DNSPs and there are minor differences between the Technical Study requirements between the DNSPs. This section has been updated accordingly.
6	Changes to commissioning requirements.	Promote improved benefit to Australia's electricity system	
7	Removed the requirement for DNSP to require an operation and maintenance plan for sign-off on connection.	Promote improved benefit to Australia's electricity system	This is not currently a requirement.
Appendix D	Changed some items to suit DER register requirements.	Jurisdictional requirement	

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Section	Description of deviations	Type of deviation	Justification
Appendix E	Included a summary version of the requirements for connection in a new Appendix.	Promote improved benefit to Australia's electricity system	

Appendix B: Connection arrangement requirements (normative)

Following figure is a representation for a LV Fixed EG Connection with an aggregate capacity ≤ 30 kVA as considered in this Standard.




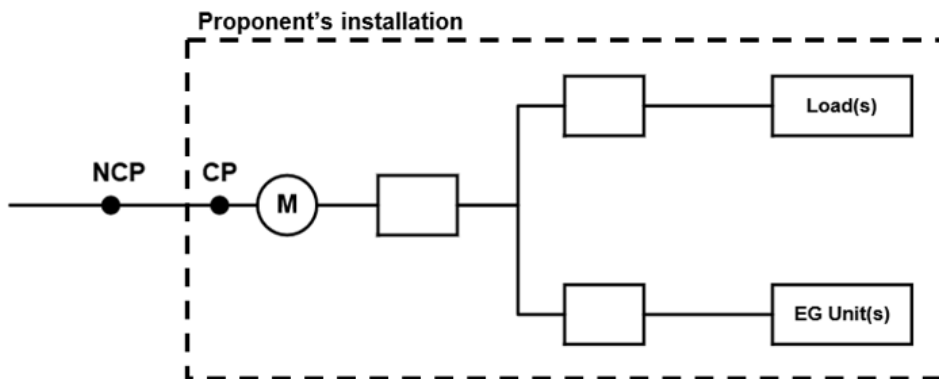
- NCP** Network Coupling Point
- CP** Connection Point
- M** Metering
-  Isolation Device

Figure 3: LV EG Installation representation for aggregate capacity ≤ 30 kVA

Following figure is a representation for a LV Fixed EG Connection with an aggregate capacity > 30 kVA as considered in this Standard.




- NCP** Network Coupling Point
- CP** Connection Point
- M** Metering
-  Isolation Device with protection functions

Figure 4: LV EG Installation representation for aggregate capacity > 30 kVA and $\leq 1,500$ kVA

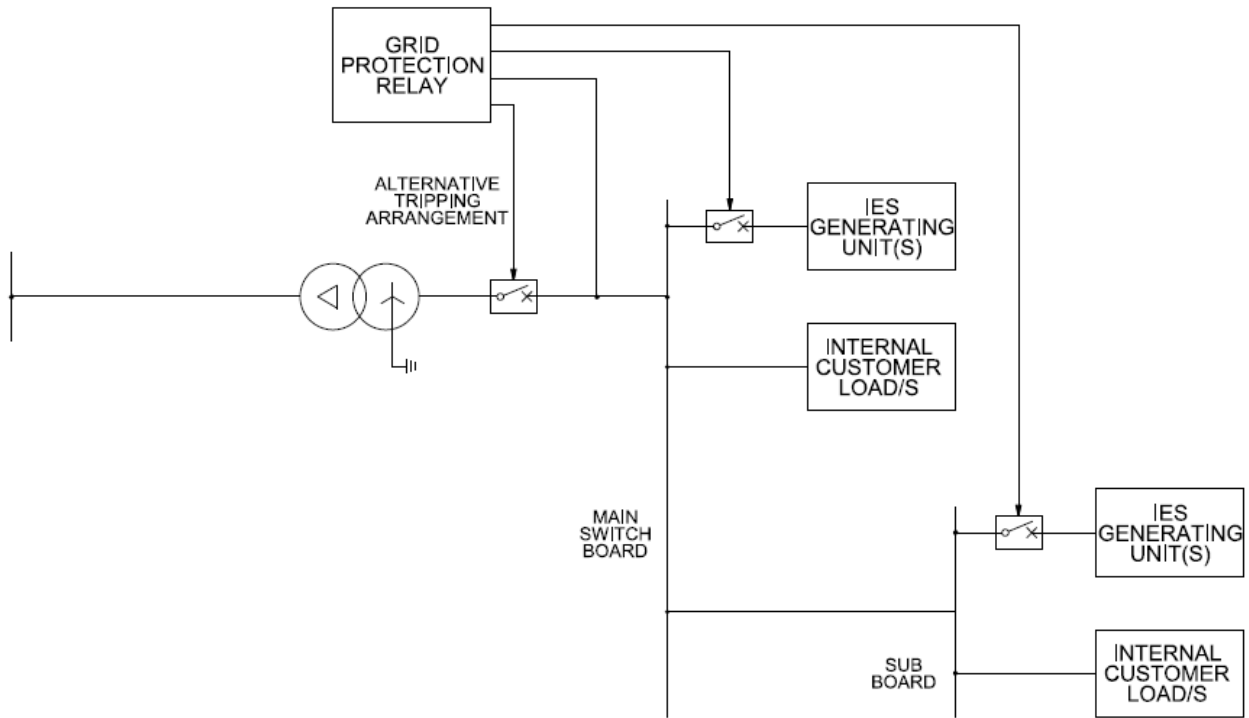


Figure 5: Protection arrangement for Fixed EG Systems comprising IES EG unit(s)

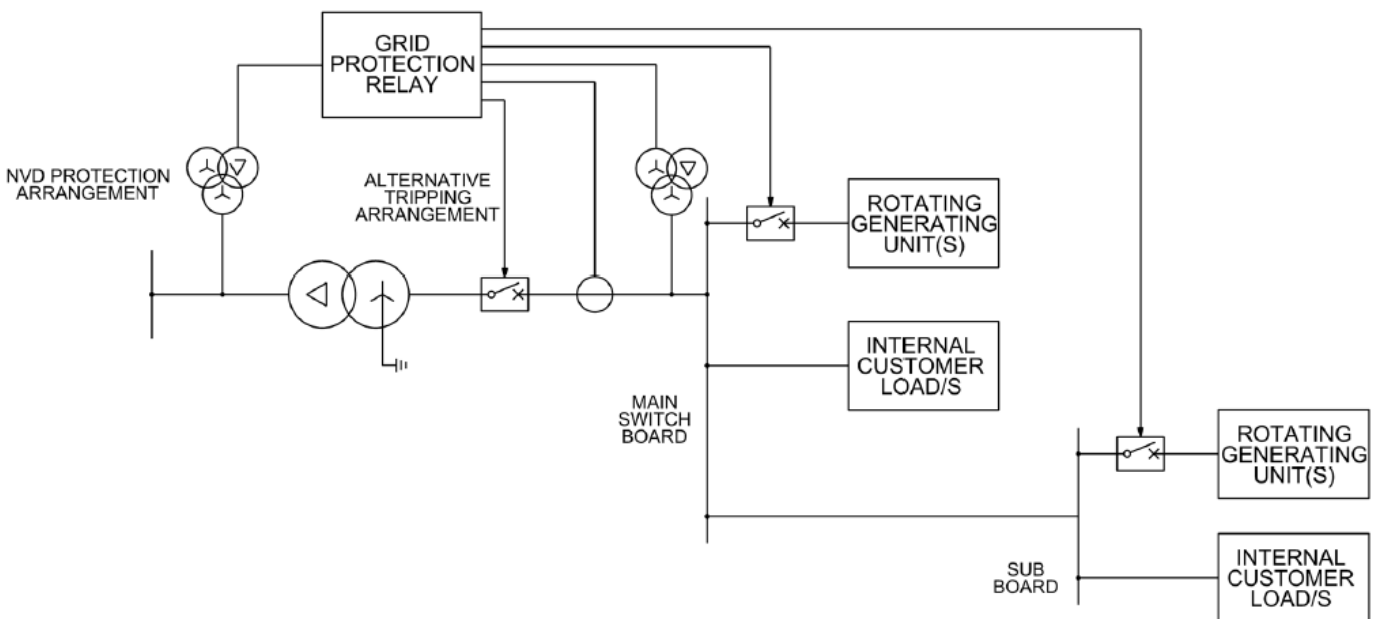


Figure 6: Protection arrangement for Fixed EG Systems comprising rotating EG unit(s)

Standard for LV EG Connections

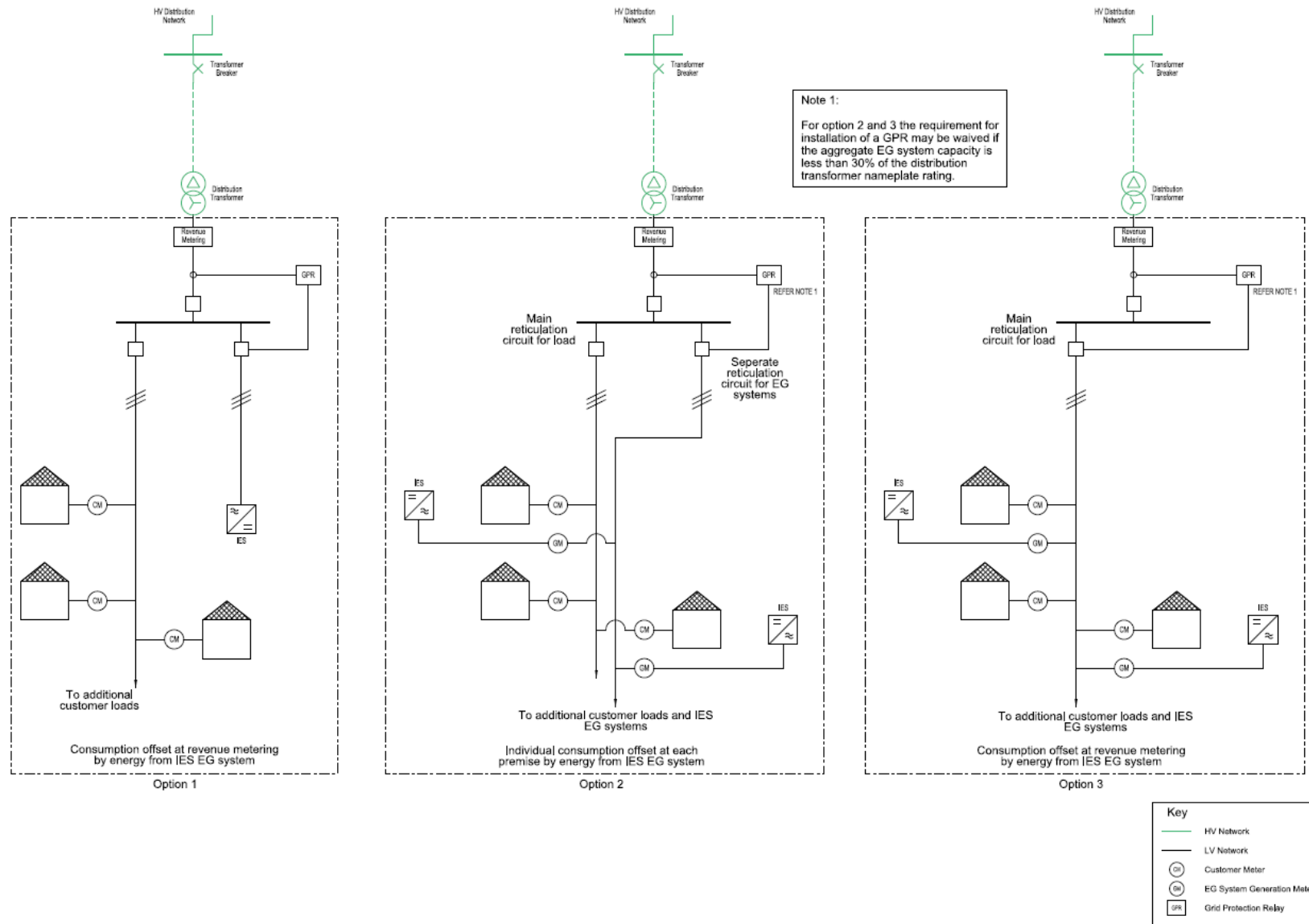


Figure 7: Protection arrangement for Fixed EG Systems comprising IES EG unit(s)

Appendix C: Model Standing Offer (informative)

The model standing offer for Energex is available at:

https://www.energex.com.au/_data/assets/pdf_file/0004/835492/Model-Standing-Offer-Basic-Connection-IES-Form-0646.pdf

The model standing offer for Ergon Energy Network is available at:

https://www.ergon.com.au/_data/assets/pdf_file/0003/835554/SR000101R115-Model-Standing-Offer-connecting-MEGUs.pdf

Appendix D: Static data and information (informative)

Static data and information shall be provided by the Proponent to the DNSP based on your application type and may include some of the following below (but not limited to):

1. NMI meter numbers
2. System information
 - a. Detailed single line diagram demonstrating Fixed EG Units connected, and proposed for connection, at the Premise (including detail of any interlocking).
 - b. Number of phases available and number of phases DER installed
 - c. Energy source
 - d. Maximum output rating
 - e. Any proposed Export limit (full / partial / minimal) and method of Export control
 - f. Metering scheme information (gross or net)
3. Inverter
 - a. Make, model and manufacturer
 - b. Number installed
 - c. Power quality modes
4. Device information
 - a. Type (e.g. panel, battery)
 - b. Make, model and manufacturer
 - c. Number installed
5. Applicant and Customer information
 - a. Type
 - b. Business and / or Personal Names
 - c. Address and contact information
6. Installer information

Appendix E: Fixed EG systems between 1,500 kVA and 5 MVA (normative)

Premises with one or multiple Fixed EG Systems where the aggregated nameplate capacity of the EG Unit(s) is between 1,500 kVA and 5 MVA may be connected to the LV Distribution Network in agreement with the DNSP. Applications will be subject to additional Technical Studies to those described in Section 4.14. The following additional requirements in Table 21 should be used as a guide for the minimum requirements for Fixed EG Systems between 1,500 kVA and 5 MVA. The criteria in Table 21, shall be applied based on the aggregate capacity of the Fixed EG system, as defined in Section 4.2, and for all Fixed EG systems connected and proposed for connection at the premises. Technical requirements may be subject to system strength test outcomes if the Short Circuit Ratio is ≤ 5 .

Table 21 Over 1,500 kVA installation requirements

Requirement	IES Systems		Rotating Machines	
	Export	Non-export	Export	Non-export
Automatic Circuit Recloser (ACR) ¹	Yes	Yes	Yes	Yes
Power Limit Protection ²	Yes	Yes	Yes	Yes
Power Quality monitor ³	Yes ³	Yes ³	Yes ³	No
EMT Study ³	Yes ³	Yes ³	No	No
Development of Operating Protocol	Yes	No	Yes	No

Note 1: The DNSP shall own and install an ACR as close to the LV Connection Point as possible on the connecting HV feeder. The DNSP may require installation multiple ACR devices or HV NVD, for any of the Connection Points supplying the Premises or for any connected network(s), to ensure adequate protection based on the connection configuration. The Proponent will be responsible for any costs for the ACR(s) or HV NVD system(s), as relevant.

Note 2: Backup protection functionality implemented at the LV to protect each connecting distribution transformer.

Note 3: Subject to system strength test and Technical Study results.

Please be aware that where the aggregated nameplate capacity of EG Unit(s) at the premises exceed 5 MVA, Class B requirements under “STNW1175 Standard for Connection of Embedded Generating Systems to a Distributor’s HV Network” shall apply as relevant. Chapter 5.3A of the NER applies to connections of these sizes and the Proponent shall supply the DNSP with advice from AEMO regarding any requirements relating to registration as a Generator.

Appendix F: LV Fixed EG Connection arrangement requirements summary (informative)

	≤ 30 kVA IES (3 Phase or SWER)	> 30 kVA ≤ 1,500 kVA IES (3 Phase)				> 30 kVA ≤ 1,500 kVA rotating machines (3 Phase)			
	Shared or dedicated transformer	Shared transformer		Dedicated transformer		Shared or dedicated transformer			
		Export	Non-export	Export	Non-export	Export	Limited Parallel operation		Continuous Parallel operation
						Bumpless transfer	Stand-by (6 hr per 3 months)	Non-export	Export
Level 1 Backup protection ¹	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Level 2 Backup protection ²	No	No	No	No	No	No	No	Yes ²	Yes ²
Grid reverse power protection	No	No	No	No	No	No	No	Yes	Yes
AS/NZS 4777.2 inverters required with active anti-islanding to AS/NZS IEC 62116 requirements	Yes	Yes	Yes	Yes	Yes	Not Applicable			
Distribution System capacity review required	Yes	No	Yes	No	Yes	No	No	No	Yes
Power quality to AS/NZS 61000 series requirements	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes
Fault level contribution to the Distribution System included in the DNSP's Technical Study ³	No	No	No	No	No	No	Yes	Yes	Yes
RPEQ design and commissioning plan	Yes	Yes	Yes	Yes	Yes	Yes ⁴	Yes	Yes	Yes

1. Level 1 backup protection – Over and under voltage, over and under frequency and rate of change of frequency.
2. Level 2 backup protection – Neutral voltage detection/unbalance.
3. Fault current contribution is dependent on size, number, and hours of operation
4. RPEQ commissioning is not required if there is no electronically controlled interlocking arrangement as per S 4.7.3 and transfer switch's standards compliance in S 4.5.1.



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energex.com.au

PO Box 1090, Townsville QLD 4810
GPO Box 1461, Brisbane QLD 4001

Ergon Energy Network
ABN 50 087 646 062
Energex is the trading name of
Energex Limited
ABN 40 078 849 055