Part of the Energy Queensland Group

Connection Standard

Standard for Micro Embedded Generating Units (0 - ≤30 kVA)

These standards ensure that Ergon Energy's and Energex's requirements are met. If this standard is a printed version then the Ergon Energy or Energex internet site must be referenced to obtain the latest version to ensure compliance.

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Abstract: This standard has been prepared by Ergon Energy and Energex to provide owners and proponents of micro embedded generating (EG) unit installations (0 - ≤30kVA) information about their rights and obligations for the connection to and interfacing with the Ergon Energy or Energex Distribution Network. This standard is agnostic to the generation source (e.g. Solar, Wind etc), encapsulates energy storage (e.g. batteries), and includes energy from hybrid combinations (e.g. solar plus batteries) that connect to the electrical network via an inverter. In all instances, installations of a micro EG unit shall be compliant with the requirements of all parts of AS/NZS 4777 series.

Ergon Energy and Energex as the Queensland Distribution Network Service Providers have an inherent obligation to ensure that micro EG units do not cause a material degradation in the quality of supply to other network users and do not adversely affect operation of the distribution network.

Keywords: micro embedded generating unit, inverter, solar, photovoltaic, wind, energy storage system, export, low voltage, LV, PV, micro EG unit, ESS

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Joint Standard Document between Energex and Ergon Energy
ENERGEX Limited ABN 40 078 849 055 ■ Ergon Energy Corporation Limited ABN 50 087 646 062

Standard for Micro Embedded Generating Units (0 - ≤30 kVA)

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1 Overview

1.1 Purpose

The object of this Standard is to provide Proponents of micro embedded generating (EG) units information about their obligations for connection to and interfacing with the Ergon Energy or Energex networks. This connection standard has been developed to ensure safe and stable parallel operation of micro EG units connected to Ergon Energy's or Energex's networks at the Proponents premise, in accordance with Section 225 of the Queensland Electrical Safety Regulation 2013. When connected to the Ergon Energy or Energex networks, a micro EG unit can impact the operating conditions, voltage profile and feeder load.

It is the Proponent and their electrical contractor's responsibility to ensure the proposed micro EG unit equipment and installation complies with the relevant national standards and regulations, in addition to this connection standard. The Proponent shall not add additional inverters, make modifications or install additional micro EG units, including energy storage systems (ESS), without prior written agreement from the DNSP. Proponent shall only connect the inverters, panels and batteries, where relevant, of the make and model with the capacities and export limit as approved in the application with the DNSP.

1.2 Scope

This Standard outlines the requirements for micro EG units with a total aggregate nameplate rating up to but not exceeding 30 kVA at a single connection point; that are intended to be connected to and capable of operating in parallel with any part of Ergon Energy's or Energex's distribution networks. This Standard is agnostic of the generation source and encapsulates ESS as well.

1.3 Application

This Standard applies to low voltage and high voltage customers connecting a micro EG unit up to and including 30 kVA total generation at a single connection point.

This Standard does not apply to:

- back-up generation that does not operate in parallel with the distribution network;
- synchronous embedded generators driven by hydro turbines, gas engines, gas turbines or diesel engines; or
- EGs of over 30 kVA. For such EGs, please refer to:
    - SNTW1174 Standard for Connection of Embedded Generating Systems (>30 kW to 1,500 kW) to a Distributor's LV Network
    - STNW1175 Standard for Connection of Embedded Generating Systems to a Distributor's HV Network

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2 References

2.1 Energex controlled documents

A copy of the latest version of this Energex Standard may be obtained by searching for solar connection from the following website:

https://www.energex.com.au/

Document number or location (if applicable)	Document name	Document type
Manual 01811	Queensland Electricity Connection Manual	Reference

2.2 Ergon Energy controlled documents

A copy of the latest version of this Ergon Energy Standard may be obtained by searching for solar connection from the following website:

https://www.ergon.com.au/

Document number	Document name	Document type
STGG001	Standard for Micro Embedded Generating Units (0 - ≤30 kVA) with Generation Management in Isolated Networks	Standard
NA000403R509	Queensland Electricity Connection Manual	Reference

2.3 Other documents

2.3.1 Australian and New Zealand Standards

Document number or location (if applicable)	Document name	Document type
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
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
AS/NZS 61000.4.30	Electromagnetic compatibility (EMC) - Part 4.30: Testing and measurement techniques—Power quality measurement methods	AU/NZ Joint Standard

2.3.2 International Standards

Document number or location (if applicable)	Document name	Document type
IEC 62116	Utility-interconnected photovoltaic inverters – Test procedure of islanding prevention measures	International Standard

2.4 Legislation, regulations, rules, and codes

This Standard refers to the following legislation:

Legislation, regulations, rules, and codes	Document type
Electricity Act 1994 (Qld)	Legislation
Electricity Regulation 2006 (Qld)	Regulation
Electrical Safety Act 2002 (Qld)	Legislation
Electrical Safety Regulation 2013 (Qld)	Regulation
Electricity – National Scheme (Queensland) Act 1997 (Qld)	Legislation
National Electricity (Queensland) Law, as defined in the Electricity – National Scheme (Queensland) Act 1997 (Qld)	Regulation
National Energy Retail Law (Queensland) Act 2014 (Qld)	Legislation
National Energy Retail Law (Queensland), as defined in the National Energy Retail Law (Queensland) Act 2014 (Qld)	Regulation
National Electricity Rules	Regulation
Professional Engineers Act 2002 (Qld)	Legislation

3 Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this standard, the following definitions apply:

Term	Definition
accredited person	Means a person accredited by a peak industry body as having demonstrated their competence to design and/or install renewable energy and/or energy storage systems. This includes Accredited Installers, Designers and Supervisors operating within the classification of their accreditation. To be eligible for Renewable Energy Certificates a CEC accredited person must be engaged. In all instances though, a person authorised under the Queensland Electrical Safety Act 2002 is required to certify the installation.
Act	Means the Queensland Electricity Act 1994.
Australian Energy Market Operator	The Australian Energy Market Operator, responsible for the operation of the national electricity market under the NER.
anti-islanding protection	A protection system to detect islanded conditions and disconnect the inverter(s) from the network. This is a requirement as per AS/NZS 4777.
Break before make switch	A switch that is configured to break (open) the first set of contacts before engaging (closing) the new contacts. This prevents the momentary connection of the old and new signal paths.
connection point	The point at which the DNSP's assets end and the customer's assets start. The location of the connection point can range from the point of entry on a residence, to a low voltage fuse on a pole or pillar to the low voltage terminals of a distribution transformer.
Distribution Network Service Provider	As described in NER chapter 10, a person who engages in the activity of owning, controlling or operating a distribution system and who is registered by AEMO as a network service provider under Chapter 2. Energex is the owner, lessor and operator of the South East Queensland electricity distribution network. Ergon Energy is the owner, lessor and operator of the Queensland electricity distribution network excluding the South East corner operated by Energex. This term will be used to indicate Energex or Ergon Energy as relevant to the Proponent.
energy laws	Relevant laws relating to the subject matter of this Standard as included in Section 2.4 of this Standard where applicable.
energy storage systems	Means a system that has the ability to both collect and generate electrical energy as required, using a storage medium such as mechanical, electrochemical, chemical, or thermal. This includes, for instance, batteries – which consist of various chemistries. The complete system may include a management system for monitoring, controlling and protecting the system and its components.
embedded generator	A generator that is connected to a Proponent's electrical installation and capable of operating in parallel to the distribution network.
export or exported	The quantity of energy generated by the micro EG unit equipment and delivered

energy	to the distribution network.
full-export	A micro EG unit that is paralleled with the distribution network and which exports electricity to the distribution network up to the rated capacity of the inverter.
generation source	Is the energy generation source supplying the micro EG unit. For instance this includes, but is not limited to solar PV, wind turbine, hydro turbine, fuel cells, combined heat and power plants, and energy storage.
High Voltage (HV)	Means a voltage greater than or equal to 1,000V.
hybrid inverter	Is an inverter which can operate in both parallel and non-parallel operation modes.
inverter	Performs the conversion of the DC output of the generation source into a utility frequency AC power that can be fed into the supply network.
isolated network	Refers to the small remote electricity networks operated by Ergon Energy that are not connected to the main electricity network, and supplied via dedicated power station.
Low Voltage (LV)	Means a voltage of no more than 1,000 V.
micro embedded generating unit	Means a generating unit having a capability of less than 10 kVA for a single phase connection or 30 kVA for a three phase connection, or as contemplated by AS/NZS 4777.
minimal-export	A micro EG unit that is paralleled with the distribution network and which is designed and configured to only export electricity into the distribution network as prescribed to operate in Section 5.9.1 of this Standard.
network coupling point	The point at which connection assets join a distribution network, used to identify the distribution service price payable by a Connection Applicant.
non-parallel operation	A micro EG unit which can supply customer load in back-up, also known as “off-grid”, arrangement which is not connected in parallel and does not synchronise with the distribution network. Loads shall be isolated from the distribution network when being supplied from the non-parallel micro EG unit.
parallel operation	Also called “grid connected”, this is where the micro EG unit is configured such that the micro EG unit and the distribution network may operate in parallel from time to time (even if this is a very short period of time). This includes where energy storage systems can be tied directly or indirectly back to the distribution network through an AS/NZS 4777 grid connect inverter. It is irrelevant whether the micro EG unit (including any energy storage system) exports any electricity to the distribution network.
partial-export	A micro EG unit that is paralleled with the distribution network and which is designed and configured to only export electricity into the distribution network as prescribed to operate in Section 5.9.1 of this Standard.
power limiting operation:	The ability to reduce or stop power output from inverters when export power exceeds a defined value.
Proponent	Means the Generator, Customer or developer or their agent (e.g. Consulting Engineers).
qualified person	Means a person authorised under the Queensland Electrical Safety Act 2002 to

	complete electrical work, or authorised under the Queensland Professional Engineers Act 2002 to perform professional engineering work, as appropriate.
reactive power	The rate at which reactive energy is transferred, which is a necessary part of an alternating current system containing inductive and capacitive components, as it regulates the voltage within the system.
Retailer	Means the entity who is authorised to sell electricity to the customer at the premises.
shall	Indicates that a statement is mandatory.
supply network	As described in Section 8 of the *Electricity Act 1994* (Qld), a system or part of a system, of electric lines, substations and associated equipment, other than a transmission grid, for distributing electricity to customers, whether or not generating plant is connected to it.
three phase balanced inverters	Means a three phase inverter configured for three phase connection to the LV network. The inverter output shall be balanced across all three phases at all times whilst connected to the Network and all three phases simultaneously disconnect from, or connect to the Network in response to protection or automatic controls (e.g. anti-islanding and subsequent reconnection).

3.2 Acronyms and abbreviations

The following abbreviations and acronyms appear in this standard.

Term, abbreviation or acronym	Definition
AEMO	Australian Energy Market Operator
BBM	Break-Before-Make
CEC	Clean Energy Council
DNSP	Distribution Network Service Provider
DRM	Demand Response Mode
EG	Embedded Generation
EMC	Electromagnetic Compatibility
ESS	Energy Storage System
LV	Low Voltage
HV	High Voltage
NER	National Electricity Rules
PV	Photovoltaic
RPC	Reactive Power Control
RPEQ	Registered Professional Engineer of Queensland
SWER	Singe Wire Earth Return

4 Connection Assessment Requirements

This Section provides details of the specific technical considerations made by the DNSP for the connection of a micro EG unit, in relation to set AS/NZS 4777.2 compliant inverter capacity thresholds. These thresholds are the sum of all new or existing inverters connected in parallel to the distribution network at the Proponent's premises. A summary of the requirements and thresholds are provided in Table 1. It is important to note that any specified differences between requirements for connection to the SWER and Isolated Networks compared to the main grid are reflective of the differences in topology and design of the comparable networks.

Table 1 Micro EG units Connection Requirements (0 - ≤30 kVA)

Inverter Export Limit (kVA) Per Phase	Main Grid	SWER Networks	Isolated Networks
0 ⬇ 2 (Ergon) 3 (Energex)	No RPC	No RPC	No RPC
⬇ 5	RPC	No RPC	No RPC
⬇ 10	RPC	No RPC	No RPC

Manual Assessment Automated Assessment

Note 1: For details on single-phase and multi-phase balance requirements see Section 5.4 of this Standard.

Note 2: For details on export limitation see Section 5.9.1 of this Standard.

Note 3: RPC = Reactive Power Control. For details on power quality modes see Section 5.10 of this Standard.

Note 4: Reactive Power Control is not required by default for SWER or Isolated Networks however, may be required as part of the connection agreement.

5 Technical Requirements and Performance Standards

5.1 Scope

The following outlines the mandatory technical requirements that are applicable to the Proponents proposed micro EG unit and the premises where the micro EG unit connection point resides. In all instances, a micro EG unit shall meet the mandatory requirements of all parts of AS/NZS 4777.1, AS/NZS 4777.2 and IEC62116.

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The additional technical requirements in this standard have been developed for the safety of the DNSP's and the Proponent's people and assets under foreseeable operating conditions. These requirements enable operation of the micro EG unit in parallel with the supply network without interference to the continuity and quality of supply to the DNSP's other customers.

5.2 Remote Network Supply Arrangements

5.2.1 Ergon Energy SWER Networks

SWER networks, located within the Ergon Energy supply network, typically consist of higher network impedances, longer LV and High Voltage (HV) feeders, and lower capacity transformers, in comparison to the standard urban and rural networks. As such the capacity of micro EG units which these networks can safely accept is somewhat lower than normal LV networks.

5.2.2 Ergon Energy Isolated Networks

Isolated networks, not connected to the main grid and supplied by Ergon Energy with dedicated power stations, while having typically higher network impedances and lower capacity transformers, also have finite micro EG unit hosting capacities. These hosting capacities are based on several factors, largely underpinned by the technical limitations of the existing generating plant that is used to provide electricity to the networks. Hosting capacities are set to ensure reliable supply and relate to online generation reserve to make up for sudden loss of intermittent generation sources, and to prevent operation of the diesel plant at below their minimum loading requirements for extended periods of time. As such the collective capacity of micro EG units which these networks can safely accept is determined on a network-by-network basis, and in order to effectively manage this, a manual assessment is required for all micro EG units connecting to an isolated network.

For micro EG units connecting to an isolated network that has exceed its hosting capacity, additional requirements will apply as per STGG001 Standard for Micro Embedded Generating Units (0 - ≤30 kVA) with Generation Management in Isolated Networks.

5.3 Remote Network Supply Arrangements

The Proponent shall ensure that the micro EG units and other systems and facilities at the premises operate satisfactorily:

- for the full range of variation of system parameters and characteristics; and
- within the distortions and disturbances specified in these technical requirements.

Ergon Energy and Energex do not guarantee the operation of any customer appliances, including micro EG unit and their associated components. The Proponent should take necessary steps to ensure their micro EG unit operates as anticipated and shall adhere to their connection agreement.

5.4 Inverter Phase Limits

5.4.1 Phase Balance

For premises with a multiphase connection to the network, the inverter(s) shall be configured to ensure the difference in power generated into any two phases does not exceed 5 kVA 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 20A. Multiphase connections shall install phase balance protection where required under Section 5.9.2 of this Standard.

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5.4.2 Single Phase Limits

For a single phase connection, the aggregate inverter capacity shall be a maximum of 10 kVA at the connection point.

For a single phase connection, the aggregate export capacity shall be a maximum of 5 kVA at the connection point. Where a premise has an aggregate inverter capacity that exceeds 5 kVA at the connection point, total export shall be limited to 5 kVA or less via partial- or minimal- export operation, as per Section 5.9.1 of this Standard.

Proponents with a single phase connection wishing to have an inverter capacity greater than 10 kVA or export greater than 5 kVA will need to apply to upgrade their service to two or three phases.

5.4.3 SWER Networks

An exception is made for SWER as it is a single phase LV network connecting to a single phase HV network. For Proponents on SWER networks:

- Applications to connect ≤ 10kVA single phase inverter capacity with export limit ≤ 2kVA will not require technical assessments.
- Applications to connect ≤ 10kVA single phase inverter capacity with export limit > 2kVA are permitted but will require a technical assessment.
- For any single phase installations with total inverter capacity > 10kVA – whether minimal-, partial- or full-export – a technical assessment will be required.

5.4.4 Two phase limits

For a two phase connection, the aggregate inverter capacity shall be a maximum of 10 kVA per phase at the connection point. For a two phase connection, the aggregate export capacity shall be a maximum of 5 kVA per phase at the connection point. Where a premise has an aggregate inverter capacity that exceeds 5 kVA per phase at the connection point, total export shall be limited to 5 kVA per phase or less via partial- or minimal- export operation, in accordance with Section 5.9.1 of this Standard.

5.4.5 Three phase limits

For a three phase connection under this Standard, the aggregate inverter capacity shall be a maximum of 10 kVA per phase at the connection point. For a three phase connection under this Standard, the aggregate export capacity shall be a maximum of 10 kVA per phase at the connection point. Where the premise has an aggregate inverter capacity that exceeds approved export limits at the connection point the total export shall be limited via partial- or minimal- export operation, as per Section 5.9.1 of this Standard.

Proponents with a three phase connection wishing to have an aggregate inverter capacity greater than 30 kVA or export greater than 30 kVA will need to comply with the relevant connection standard for the system and network connection as per Section 1.3 of this Standard.

5.5 Micro-inverters

Micro EG units using micro-inverters shall be treated in the same way and subject to the same rules as any inverter. The summated inverter ratings and export limits shall be used in Table 1 to determine requirements. Internal voltage rise calculations shall use the closest AC isolator to the start of the inverter string as the generation start point.

Where 50% or more of the number of micro inverters on a single phase are tripped due to an anti-islanding protection operation, all micro-inverters in the system shall disconnect.

5.6 Changeover Switches

Any generation connected behind a break-before-make (BBM) switch – that is it isolates the changeover circuit when transferring between grid supply to generation supply - will be considered as off-grid. However, any generation connected behind a make-before-break switch – that is it results in a momentary connection between grid supply and generation supply circuits when performing a changeover - will be considered as grid connected and therefore will be required to comply with this Standard.

5.7 Energy Storage System (ESS)

An ESS (such as batteries) provides an independent source of power and is defined as having the ability to operate in parallel with the grid via an inverter, regardless of whether charged directly from the grid or through energy produced from a generation source. Connection of an ESS is only allowed through a parallel operating AS/NZS 4777.1 and AS/NZS 4777.2 compliant inverter, in line with other forms of micro EG units.

There are a number of guidelines referring to the safe installation of energy systems (including energy storage systems) in Section 2 of this standard.

Switches to isolate the ESS from the main switchboard shall be clearly identified and accessible to the DNSP's Quality of Supply Officers in the event of an investigation.

ESS is also required to meet the following conditions:

a) For both parallel and hybrid connected micro EG's, the system shall be certified for compliance by an Accredited Person accredited by the CEC PV grid connect systems, and either grid-connected or stand-alone battery storage systems.
b) The total capacity of inverters cannot be increased under the terms of the agreement and any such increase would require reapplication to the DNSP.

Given the limitations of isolated networks to support intermittent generation sources, ESS are assessed on a case by case basis for connection on Ergon Energy's isolated networks.

5.8 Electric Vehicles

Electric Vehicles that are only capable of charging from the grid are not considered a micro EG unit but rather only a load and are subject to the requirements outlined in Section 4.2 of the QECM.

An electric vehicle shall be considered a micro EG unit and therefore be subject to the requirements of both Section 4.2 of the QECM and this Standard, where it is:

- Capable of exporting energy into the Proponent's premises but not the supply network, resulting in a minimal-export configuration (also referred to as Vehicle-to-Building or V2B); OR
- Capable of exporting energy into the supply network, resulting in either a full- or partial-export configuration (also referred to as Vehicle-to-Grid or V2G).

5.9 Protection of the Distribution Network

Inverters connected to the supply network shall be compliant to AS/NZS 4777.1 and AS/NZS 4777.2. The inverter settings shall be set to the values given in Table 2.

Table 2 Prescribed Inverter Settings

Parameter	Settings[1]
Vnom_max	Energex – 257V Ergon Energy – 255V
Overvoltage 1 (V>)	260V
Overvoltage 2 (V>>)	265V
Undervoltage (V<)	180V
Overfrequency (F>)	52Hz
Underfrequency (F<)	47Hz
Disconnect time	As per AS4777.2
Reconnect time	60 – 90 seconds

Note 1: These settings apply to inverters certified to AS/NZS 4777.2

5.9.1 Power Limiting Operation

Where the connection of a micro EG installation to a distribution network has been approved on the basis that the export of energy to the distribution network is limited (that is, either a minimal-export or partial-export arrangement to a specified export limit) the Proponent shall ensure this limit complies with soft limit export control as specified in Clause 3.4.8 of AS/NZS 4777.1. The micro EG installation shall additionally comply with the following requirements:

- the export limit and over-voltage trip settings:
  - shall be set to the DNSP's requirements;
  - shall be set and activated by a person qualified and authorised to carry out this work; and
  - shall not be changed by anyone other than by an Accredited Person that is suitably qualified;
- the power limiting operation:
  - shall be achieved via a device which complies with the requirements specified in Clause 3.4.8.3 of AS/NZS 4777.1; and
  - shall not create flicker problems on the low voltage distribution network as a result of continuously switching inverters on and off. The maximum step size for switching must be limited to 15 kVA (3 phase), although lower step sizes are preferred.

For configurations where an inverter provides the power limitation capability, the total cumulative export of all the inverters shall not exceed approved export limit. The export control of the micro EG installation shall not interfere with anti-islanding protection of the inverter(s).

Settings for export limitation are provided in Table 3:

Table 3 Export Limit Settings

	Minimal Export	Partial Export
Export limit (kVA)	0.05 of total inverter rating	*k* of total inverter rating

Note 1: Where k is equal to the approved partial-export power value as a per unit value of the inverter capacity. For example where the approved partial-export value is 2.5kVA of a 5kVA inverter, k = 0.5 (or 50%).

Note 2: As per AS/NZ4777.1Clause 3.4.8.3 (b), the export limit shall not be exceeded for a period greater than 15 seconds.

5.9.2 Phase balance protection

Phase balance protection shall respond to current imbalance at the connection point caused by the aggregate Micro 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 Phase balance protection is required for Micro EG Units as specified in Table 4.

The Proponent shall ensure the design and the commissioning plan and report for the phase balance protection is carried out under engineering supervision by a Registered Professional Engineer of Queensland (RPEQ). A copy of these records shall be made available to the DSNP on request.

Table 4 Requirements for phase balance protection functions

Aggregate inverter capacity at Connection Point	Inverter capacity ≤ 10 kVA		Inverter capacity ≤ 20 kVA		Inverter capacity ≤ 30 kVA		Inverter capacity ≤ 30 kVA	
Inverter connection type	Single phase		Two phase		three phase		three phase	
Inverter type	Single phase inverter/s		multiple single phase inverters		Multiple inverters with at least one single phase		Three phase inverter/s	
One or more phase has greater than 5 kVA of aggregate inverter capacity	No	Yes	No	Yes	No	Yes	No	Yes
Phase balance protection required	No	No	No	Yes	No	Yes	No	No

5.10 Power Quality Modes

In accordance with Section 4 of this Standard, the DNSP may request the Proponent to implement a non-unity power factor setting on the inverter to reduce voltage rise at the network coupling point. In these cases inverters shall be used with the ability to vary power factor from unity down to 0.8 lagging, in accordance with Section 6.3 of AS/NZS 4777.2. The default setting for export capable micro EG unit shall be as per Table 5 unless otherwise negotiated with the DNSP.

Where required to implement a non-unity power factor configuration, the approved power quality response modes are:

- Fixed power factor mode (AS/NZS 4777.2 Section 6.3.3), or
- Volt-var response mode (AS/NZS 4777.2 Section 6.3.2.3)

Settings for the default modes are as defined in Table 5 and Table 6. If the DNSP provides an alternate lagging power factor for connection to reduce voltage rise at the network coupling point these settings shall be used in lieu of the default settings.

Table 5 Fixed power factor setting

Reference	Setting
Fixed power factor	0.9 lagging

Table 6 Volt-var response mode settings

Reference	Voltage	Var% rated VA	Power Factor
V1	207 V	31% leading (sourcing vars)	0.95 leading
V2	220 V	0%	1
V3	248 V	0%	1
V4	253 V	44% lagging (absorbing vars)	0.9 lagging

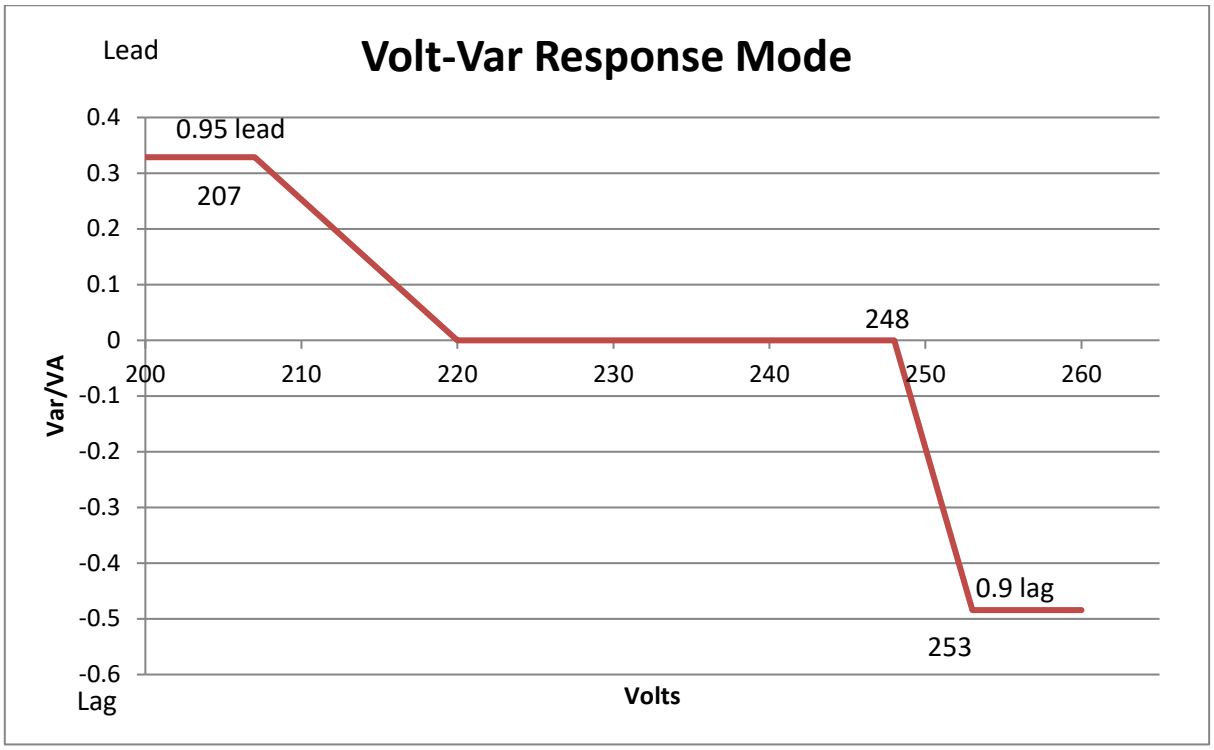

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Figure 1 Alternate volt-var mode settings

Power Quality Mode settings shall be the same for all of the inverters at site. While all new inverters shall operate with an approved power quality response mode, multiple power quality mode settings are allowed where the following is satisfied:

- All inverters installed on or after 30 September 2015 operate with an approved power quality response mode.
- Inverters installed prior to 30 September 2015 which are not capable of operating with an approved power quality response mode are operating at unity power factor.
- Replacement inverters, other than warranty replacements, shall be configured to achieve the power quality mode settings being the same for all inverters at site.

5.11 Demand Response Modes

Although not a mandatory requirement for general connections, where a Demand Response Mode capability is required as a result of the network connection agreement, the inverter shall be capable of the following modes as a minimum:

Table 7 DRM Response Modes

Mode	Description
DRM 0	Operate the disconnection device
DRM 1	Do not consume power
DRM 4	Increase power consumption (subject to constraints from other active DRMs)
DRM 5	Do not generate power
DRM 8	Increase power generation (subject to constraints from other active DRMs)

Note1: DRM 1 and 4 are only relevant to micro EG units with energy storage system.

5.12 Steady State Voltage

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

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

The proposed micro EG unit installation shall not cause more than 2% voltage rise at the network coupling point. Voltage rise shall be calculated in accordance with AS/NZ 4777.1. As a guide:

- Single inverter: voltage rise is calculated from the a.c. terminals of the inverter to the network coupling point.
- Multiple inverters with single a.c. isolation point (e.g. micro-inverters): voltage rise is calculated from where the interconnecting a.c. cable connects into the fixed installation wiring to the network coupling point.
- Multiple inverters with multiple a.c. isolation points: the voltage rise of all IES connected shall be considered together in calculation of the voltage rise for the micro EG unit installation.

5.13 Disturbance Issues

Disturbance to the LV network shall be assessed against BS EN61000-3-14 “Electromagnetic compatibility (EMC) – Part 3-14 – Assessment of emission limits for connection of disturbing installations to LV Power Systems.”

Measurement of voltage disturbances shall be as described in AS/NZS 61000.4.30 using Class A or S instruments.

The DNSP may undertake, or may reasonably require, a program of tests performed at the Proponent’s cost, to ensure compliance with these disturbance limits under suspicion of breach. If such tests determine that the limits specified in this Section are exceeded and the non-compliance is due to the micro EG unit, then the Proponent shall take remedial action at its own expense to reduce any disturbance caused by the micro EG unit to less than the allowable levels. If the tests demonstrate compliance, or that the non-compliance is not caused by the operation of the micro EG unit, then the DNSP will reimburse the Proponent for the reasonable expenses incurred by the Proponent as a result of conducting the tests. If the tests demonstrate that the Proponent has altered settings of the inverter or ancillary equipment from the originally approved settings, the DNSP shall disconnect the micro EG unit until the settings are changed and provisions have been taken to ensure indiscriminate changes are unable to be made in the future.

5.14 Checklist and Accreditation of System

For all new and augmented connections, the Accredited Person shall ensure compliance of the system and complete the compliance checklist in Annex A, and a copy of this checklist shall be left on site for the DNSP’s Connection Officers.

5.15 Commissioning

Commissioning tests for the inverter shall be in accordance with AS/NZS 4777.1 including:

- Operate the Main Switch (Inverter Supply) and verify the connection time is greater than 60 seconds.
- Isolate the Main Switch (Mains Supply) and verify the disconnect time is less than 2 seconds.
- Where power limiting operation is required, disconnect customer load and confirm export to the grid does not exceed approved limits.

Where the meter at the premises is an electromechanical meter, the micro EG unit shall be left with DC isolators on and AC isolators off until the Proponent’s electricity retailer has confirmed that the metering equipment at the premises has been modified or reconfigured to comply with the energy laws.

Annex A Compliance Checklist (normative)

The purpose of this compliance checklist is to aid the Proponent with the design and commissioning of the micro EG unit to ensure it meets the requirements, as per this Standard.

Table 8 General Inverter Settings

Parameter	Settings
Vnom-max	Energex - 257V Ergon Energy – 255V
Reactive Power Control	Fixed Power Factor of 0.9 lagging (inductive) OR Volt-var - As per Figure 1 V_1 = 207V; PF_1 = 0.95 leading V_2 = 220V; PF_2 = 1 V_3 = 248V; PF_3 = 1 V_4 = 253V; PF_4 = 0.9 lagging
Reconnect time	60 – 90 seconds

Table 9 Disconnection Times

Parameter	Settings	Trip Time Delay	Maximum Disconnection Time
Overvoltage 1 (V>)	260V	1s	2s
Overvoltage 2 (V>>)	265V	-	0.2s
Undervoltage (V<)	180V	1s	2s
Overfrequency (F>)	52Hz	-	0.2s
Underfrequency (F<)	47Hz	1s	2s

Table 10 Power Limiting Settings

Parameter	Settings
Export Power Limit	As approved
Time Delay	15s

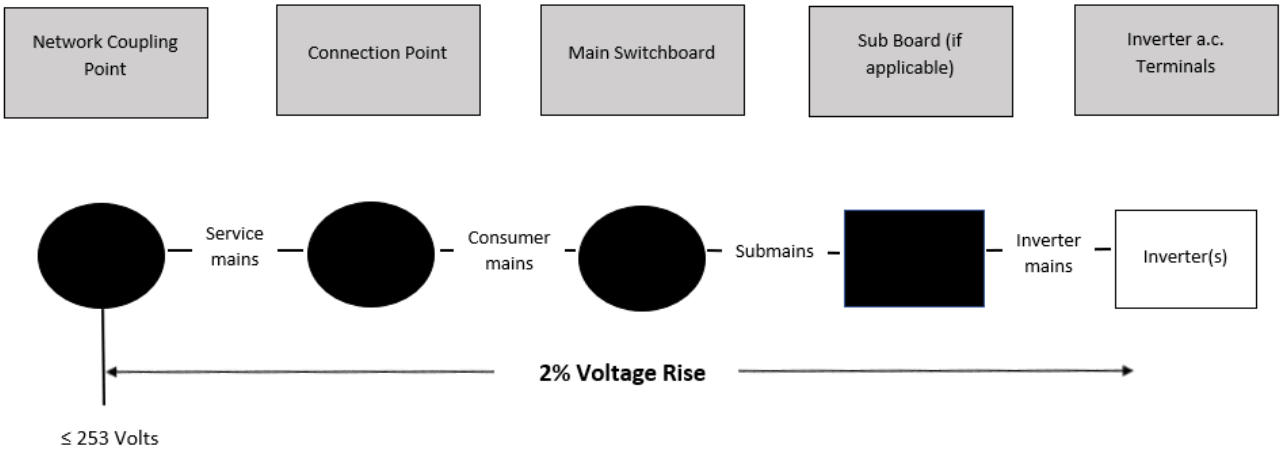

Figure 2 Voltage Rise Calculation Diagram

Table 11 Calculated Voltage Rise

Voltage Rise	Service mains	Consumer mains	Submains	Inverter Mains	Total Voltage Rise
Calculated (V)					
Percentage (%)					

Joint Standard Document between Energex and Ergon Energy
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Annex B Assessment Criteria for Applications (informative)

B.1. Assessment Tests

Where a technical assessment is indicated as being required in Table 1 of Section 4 of this Standard, the following tests may be performed by the DNSP. The Table 9 shows how Ergon Energy and Energex are applying these test criteria:

Table 12 Application of Assessment Tests

	Energex	Ergon	Isolated Networks
Test 1	✓		
Test 2	✓		
Test 3	✓		
Test 4A/4B	✓	✓	✓
Test 5			✓

Test 1 – Transformer Penetration Test for LV Voltage Regulation

That the addition of the proposed micro EG's will not cause the total installed PV capacity off a shared transformer to exceed 25% of the transformer nameplate rating, reducing the probability of the transformer entering net export mode back onto the HV feeder.

Test 2 – Maximum Single Phase Inverter Test (Unbalance)

That the maximum single phase inverter size does not exceed 10% of the transformer nameplate rating for single phase transformers, or 8% of the nameplate rating for three phase transformers. There also shall not be an unbalance of any more than 5kVA between phases at any one connection, as per Clause 6.5 of this standard. This test is not applicable to three phase balanced inverters.

Test 3 – HV Feeder Voltage Fluctuation and Distortion Test

To minimise voltage disturbance to customers on the same HV network.

Ratio $\sum \frac{S_i}{S_{schv}} \leq 0.1\%$

Where:

S_i Three phase inverter rating (kVA)

S_{schv} Three phase fault level at network coupling point – HV (kVA)

Test 4 – LV Feeder Voltage Regulation, Fluctuation and Distortion Test

To minimise voltage disturbance to customers on the same LV network.

Test 4A

Ratio $\frac{S_i}{S_{sclv}} \leq 1.0\%$

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Where:

S_i Three phase inverter rating (kVA)

S_{sclv} Three phase fault level at point of common coupling – low voltage (kVA)

OR

Test 4B

Conduct a voltage rise test based on **all** micro EG units connected to low voltage network. If the voltage rise does not exceed **1.0%** at the most distant micro EG units with the addition of the proposed micro EG units, then the system will pass Test 4.

Test 5 – Isolated Networks Only – Micro EG Unit Hosting Capacity Test

As the Ergon Energy's isolated networks' load is supplied via diesel generation, finite hosting capacity is available for connection of micro EG units. Hosting capacity is determined on a network-by-network basis, in order to ensure that the diesel generators:

- are able to respond to a sudden loss of generation from micro EG units, to maintain network stability; and
- do not operate below minimum loading for extended periods of time, to avoid irreversible damage to the diesel generators.

B.2. Technical Considerations – Assessment and Mitigation Options

Where the proposed system fails to meet the five criteria outlined above, the Proponent may have the following options:

Fails Test 1 (Over supply of micro EG's on LV network)

- Reduce size of proposed micro EG's
- Install an approved power limiting device, as per Section 5.9.1 of this Standard.
- Install a dedicated transformer.

Fails Test 2 (Over supply of micro EG's on single phase of LV transformer)

- Reduce size of proposed micro EG's
- Install a larger transformer
- Upgrade service connection to two phase or three phase

Fails Test 3 and 4 (Voltage rise on the HV or LV network)

- Reduce size of proposed system
- Install a three phase micro EG's in lieu of single phase
- Installing a dedicated low voltage circuit from the transformer (where Test 5 fails only)
- Installing a dedicated transformer (where Test 5 fails only)
- Install a four quadrant inverter with variable power factor setting and modify the power factor setting to reduce voltage rise to acceptable limits, as per Section 5.12 of this Standard.
- Having additional reactive compensation to reduce voltage rise in combination with inverter shedding
- Augmentation of dedicated and shared assets to facilitate connection

Fails Test 5 (Isolated Networks – Micro EG Unit Hosting Capacity Test)

- Reduce the total inverter capacity of the micro EG unit (Note this option does not apply if the hosting capacity for the isolated network has been reached).
  Install an ESS for intermittent generation output ramp rate control. Note that this option is negotiated on a case-by-case basis and the ESS must meet additional requirements specific to operation on the isolated networks. Depending on the location of the proposed installation, this option may not be available due to technical limitations of the isolated networks.