Negotiated EG Connection Technical Requirements Specification

Greater than 30 kVA, less than or equal to 200 kVA

Version 0.1
Draft for consultation August 2020
D2020/380911

PowerWater

Contents

1 Introduction

1.1 Purpose

This technical requirements document provides Proponents of negotiated embedded generation (EG) connections information about their obligations for connection to and interfacing with the Power and Water Corporation (Power and Water) network.

1.2 Scope

This technical requirements document applies to new connections of negotiated EG systems or modifications to existing EG systems, where the EG system consists of an inverter energy system (IES), battery energy storage system (BESS) or a combination of both.

An EG system has a total system capacity less than or equal to 200 kVA in Darwin, and less than or equal to 100 kVA in Alice Springs, Katherine and Tennant Creek, for a three-phase IES (with BESS) network connection, that is:

a. Intended to be connected to and capable of operating in parallel with the Darwin, Alice Springs, Katherine, and Tennant Creek networks[1]

b. Meeting all other technical requirements set out in this document. [2] [3]

The scope of this technical standard does not include:

a. EG units covered by Power and Water's *Basic micro EG technical specification (<30 kVA)*

(Basic Micro EG Connection Technical Requirements)

b. EG units covered by Power and Water's *Large EG technical specification (>200kVA in Darwin and >100kVA in Alice Springs, Katherine and Tennant Creek)*
(Large EG Connection Technical Requirements)

c. Non-IES systems

d. Electric vehicles, unless the onboard battery storage is capable of exporting to the network (in which case the requirements shall apply)

e. Distributed energy resource (DER) systems that do not generate electricity, including demand response/demand management systems, unless they impact on the ability of the EG system to meet the technical requirements.

This technical requirements document complies with the National DER Connection Guidelines for Low Voltage EG Connections, with the exception of the deviations presented in Appendix A: Deviations from the National DER Connection Guidelines.

1.3 Obligations of Proponents

Proponents shall comply with all of the applicable requirements of this document.

The general obligations of Proponents include:

a. The obligation to comply with the technical requirements as well as relevant national standards, industry codes, legislation, and regulations. In the event of inconsistency, an indication of which instrument shall prevail, being legislation and regulations, followed by the technical requirements, followed by national standards and industry codes

[1] For connections to other parts of the network (e.g. remote networks and minor centres) please contact Power and Water as bespoke requirements will apply

[2] Note that BESS are permitted within negotiated EG connections. The total system capacity definition of the negotiated EG connection includes the IES and the AC-coupled BESS battery capacity or battery-inverter capacity.

[3] For single-phase or three-phase connections ≤ 30 kVA that do not meet the requirements of the *Basic micro EG technical requirements* document, the connection shall comply with the technical requirements in this document.

b. The obligation to not connect additional inverters, make modifications or install additional EG units, with BESS, without prior written agreement from Power and Water

c. The obligation to comply with Power and Water's connection agreement

d. The obligation to meet the requirements in the design, installation, and operation of the EG system

e. The obligation to meet the connection and commissioning requirements to the distribution network.

Power and Water's obligations are to ensure the safe and reliable operation of the distribution system for operating personnel, customers, and the general public.

2 Definitions

2.1 Definitions

TABLE 1: DEFINITIONS

Term	Definition
Basic micro embedded generation connection	A connection between a distribution network and a retail customer's premises for a micro embedded generating unit, for which a model standing offer is in place
Central protection	Central protection is the protection contemplated by AS/NZS 4777 (grid connection of energy systems via inverters) installed to perform the functions of: coordinating multiple inverter energy system installations at one site, providing protection for the entire inverter energy system installation and islanding protection to the connected grid as well as preserving safety of grid personnel and the general public
Connection point	An agreed point of supply[4] established between the distribution network service provider and the Proponent
Embedded generating unit	A generating unit connected within a distribution network and not having direct access to the transmission network
Embedded generating system	A system comprising of multiple embedded generating units
Distributed energy resources	Power generation or storage units that are connected directly to the distribution network
Battery energy storage system	A system comprising one or more batteries that store electricity generated by distributed energy resources or directly from the network, and that can discharge the electricity to loads
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
Generator	A person who owns, operates, or controls a generating unit
Inverter energy system	A system comprising one or more inverters that convert direct current to alternating current. For the purposes of maximum system capacity in this document, the term inverter energy system includes the capacity of the sum of the inverter energy system capacity and AC-coupled energy storage system capacity
Lot	A recognised subdivision of land with an owner
Low voltage	The mains voltages as most commonly used in any given network by domestic and light industrial and commercial consumers (typically 230V)
Medium voltage/ High voltage	Any voltage greater than 1kVAC
Micro embedded generation connection	Means a connection between an embedded generating unit and a distribution network of the kind contemplated by Australian Standard AS/NZS 4777 (Grid connection of energy systems via inverters) currently up to 200kVA
Model standing offer	A document approved by the Australian Energy Regulator as a model standing offer to provide basic micro embedded generation connection services or standard connection services which contains (amongst other things) the safety and technical requirements to be complied with by the Proponent
Proponent	A person proposing to become a generator (the relevant owner, operator, or controller of the generating unit (or their agent))

[4] Point of supply has the definition contemplated by the Power and Water Network Policy NP 003 Installation Rules, available from https://www.powerwater.com.au/developers/power/design-and-construction-guidelines

Term	Definition
Site generation limit	The generation threshold that the embedded generation system cannot exceed, measured downstream of the connection point
Standard connection	A connection service (other than a basic micro embedded generation connection service) for a particular class (or sub-class) of connection applicant and for which an Australian Energy Regulator approved model standing offer is in place or for which an equivalent model offer is in place in jurisdictions not subject to Chapter 5A of the National Electricity Rules
Technical requirements document	This document, which sets out requirements for Proponents to enable a grid connection.

2.2 Abbreviations

TABLE 2: ABBREVIATIONS

Abbreviation	Definition
AC	Alternating Current
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
API	Application Programming Interface
AS/NZS	A jointly developed Australian and New Zealand Standard
BESS	Battery Energy Storage System
CEC	Clean Energy Council
CPEng	Chartered Professional Engineer of Engineers Australia
DC	Direct Current
DER	Distributed Energy Resources
DNSP	Distribution Network Service Provider
EG	Embedded Generation or Embedded Generating
HV	High Voltage
IEC	International Electrotechnical Commission
IES	Inverter Energy System
LV	Low Voltage
MV	Medium Voltage
NEM	National Electricity Market
NER	National Electricity Rules
NMI	National Metering Identifier
NT	Northern Territory

2.3 Terminology

Instructional terms are to be interpreted in the following way:

- The words 'shall' or 'must' indicate a mandatory requirement
- The word 'may' indicates a requirement that may be mandatorily imposed on the Proponent
- The word 'should' indicates a recommendation that will not be mandatorily imposed on the Proponent.

2.3.1 Sub-categories

The technical requirements set out in this document shall apply to the following subcategories of negotiated EG systems:

1. **EG IES with BESS connection ≤200 kVA** – An EG system with a system capacity less than or equal to 200 kVA in Darwin for a three-phase IES (with BESS) network connection, meeting all technical requirements for EG connections set out in this technical requirements document. Further subcategorised by:
    - Exporting
    - Non-exporting
2. **EG IES with BESS connection ≤100 kVA** – An EG system with a system capacity less than or equal to 100 kVA in Alice Springs, Katherine, and Tennant Creek, for a three-phase IES (with BESS) network connection, meeting all relevant technical requirements for EG connections set out in this technical requirements document. Further subcategorised by:
    - Exporting
    - Non-exporting

Exporting systems shall be considered to be EG systems operating in parallel with the network and exporting electricity either via partial-export or full-export into the network, where:

- Partial-export EG systems limit the amount of export into the network to an agreed export threshold defined in the connection agreement
- Full-export EG systems can export into the network to the full EG nameplate capacity (full AC rating).

The technical requirements set out in this document should be interpreted as applying to all subcategories of EG connections unless otherwise specified.

For all enquiries, Power and Water can be contacted via email:

connect.me@powerwater.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 requirements, and network standards as set out below.

In the event of any inconsistency between an applicable Australian/international standard or industry code (except for legislated industry codes) and these technical requirements, these technical requirements will prevail.

3.1.1 Australian and International Standards and Industry Codes

The Australian and international standards and industry codes listed in Table 3 shall apply to the design, manufacture, installation, testing and commissioning, and operation and maintenance of all plant and equipment for EG connections to the distribution network.

TABLE 3: APPLICABLE STANDARDS

Document number	Document name	Document type
AS/NZS 3000	Electrical Installations – Wiring Rules	AU/NZ Joint Standard
AS/NZS 4777	Grid connection of energy systems via inverters (multiple parts)	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/NZS 61000	Electromagnetic compatibility (EMC) (multiple parts)	AU/NZ Joint Standard
IEC 62116	Utility-interconnected photovoltaic inverters – Test procedure of islanding prevention measures	International standard

3.1.2 Internal References and Related Documents

Document Tile	Record Number
Embedded Generation Connection Guideline specification	CONTROL0639
Installation rules[5]	NP003
Power networks service rules[6]	NP007
Meter manual[7]	NP010

3.2 Legislation and Regulation

The relevant legislation and regulations listed in Table 4 shall apply to the design, manufacture, installation, testing and commissioning, and operations and maintenance of all plant and equipment for EG connections to the network.

In the event where there is any inconsistency between legislation and regulations and these technical requirements, the legislation and regulations shall prevail.

TABLE 4: REGULATIONS AND LEGISLATIONS

Document name	Document type
National Electricity (NT) Rules	Regulation
Electricity Reform (Safety and Technical) Regulations 2000	Regulation
Network Technical Code	Code produced under Electricity Reform (Administration) Regulations
System Control Code	Code produced under Electricity Reform (Administration) Regulations

[5] Power and Water, NP003 Installation Rules, available from https://www.powerwater.com.au/developers/power/design-and-construction-guidelines
[6] Power and Water, NP007 Power networks service rules, available from https://www.powerwater.com.au/developers/power/design-and-construction-guidelines
[7] Power and Water, NP010 Meter manual, available from https://www.powerwater.com.au/developers/power/design-and-construction-guidelines

4 Technical Requirements

4.1 Labelling and Signage

Labels and signs on the installation, including cables, shall meet the requirements of AS/NZS 4777.1, AS/NZS 3000, AS/NZS 5033 and AS/NZS 5139 as appropriate.

The IES must include warning signage to clearly indicate that the electrical installation has multiple supplies and identify which circuits are affected by these supplies.

Signage shall as a minimum be placed:

a. On the switchboard that has the inverter energy system directly connected to it
b. On all switchboards including main switchboard and distribution board(s) between the main switchboard and the board that has the inverter energy system directly connected to it
c. In all meter boxes containing the distributor's metering equipment

Signage should describe the actual type of generation source installed.

4.2 Maximum System Capacity

The maximum system capacity of the EG connections for each subcategory consistent shall be as per Table 5.

TABLE 5: MAXIMUM SYSTEM CAPACITY

Sub-category	Maximum system capacity
EG IES (with BESS) connection ≤200 kVA	For EG connections of IES (with BESS) in Darwin, the maximum system capacity at the same connection point shall be less than or equal to 200 kVA
EG IES (with BESS) connection ≤100 kVA	For EG connections of IES (with BESS) in Alice Springs, Katherine and Tennant Creek, the maximum system capacity at the same connection point shall be less than or equal to 100 kVA

In circumstances where there are multiple connection points on a single lot, the system capacity will apply on a per lot basis.

4.3 Generation Control

Negotiated EG connections require generation control as specified in the following subsections.

4.3.1 Export Limits at Connection Point

If export is requested by the Proponent, the export limit at the connection point of EG connections will be assessed by Power and Water at the time of application.

Factors that are considered in determining the export limit include, but are not limited to:

a. Existing network asset ratings
b. Existing power quality at the relevant network location
c. Existing and forecast DER penetration at the relevant network location.

In circumstances where there are multiple connection points on a single lot, the export limit will apply on a per lot basis.

The export limit is to be interpreted as "soft", consistent with the definition of soft export limits within AS/NZS 4777.1.

The export limit is to be interpreted by the Proponent as a maximum. The ability of the Proponent's EG system to export at the export limit is not guaranteed, but rather, it will depend upon network characteristics which change over time. The output of an EG system may need to be constrained for various scenarios including, but not limited to scenarios where power quality response modes are in operation.

4.3.2 Additional Export Limit Requirements

The following are additional export limit requirements that shall apply to negotiated EG connections:

a. The Proponent shall ensure the EG system is technically capable of achieving the export limit requirements above at all times through the inverter(s), BESS and/or other export limiting device
b. Certification from the inverter manufacturer shall be provided to Power and Water upon request to confirm that the export limit requirements in this document have been incorporated as a part of their design prior to approval (where applicable) [8] [9]
c. In the event of network or contractual constraints, the Proponent or Power and Water may nominate that the EG connection must not export any energy.

4.4 Inverter Energy System

The following requirements apply to IES comprising of EG inverters:

a. IES shall be tested by an authorised testing laboratory and be certified as being compliant with AS/NZS 4777.2 with an accreditation number
b. IES shall comprise of inverters that are registered with CEC as approved grid connect inverters
c. IES shall comprise of inverters that are tested by an authorised testing laboratory and certified as being compliant with IEC 62116 for active anti-islanding protection as per AS/NZS4777.2
d. IES shall comprise of inverters installed in compliance with AS/NZS 4777.1
e. IES shall comprise of inverters that have both volt-var and volt-watt response modes available.
f. The following requirements apply to IES with BESS:
g. BESS shall comprise of batteries that are AS/NZS 5139 compliant, and be listed in the CEC approved batteries list (currently applies to lithium-based batteries only).

4.5 Network Connection and Isolation

Network connection and isolation requirements shall be as per AS/NZS 4777.1 and AS/NZS 3000.

In addition, the following requirements shall apply:

a. Mechanical isolation shall be as per AS/NZS 3000 in that the isolator must always be readily accessible
b. Any means of isolation (where lockable) shall be able to be locked in the open position only.

4.6 Earthing

The earthing requirements shall include:

a. For IES, earthing requirements shall be as per AS/NZS 4777.1 and AS/NZS 3000
b. For IES with BESS, earthing requirements shall be as per AS/NZS 5139.

4.7 Protection

4.7.1 Inverter Integrated Protection

The inverter integrated protection requirements for inverters connected to the network shall comply with AS/NZS 4777.1 and AS/NZS 4777.2.

Active anti-islanding requirements shall apply as per AS/NZS 4777.2.

Other inverter settings including passive anti-islanding settings shall be as per Table 13 from AS/NZS 4777.2, with the exception of variations marked with an asterisk (*) below in Table 6.

[8] The certification issued by the inverter manufacturer must be an electronic document that includes the following elements as a minimum; the relevant manufacturer's company name and logo, date, confirmation that the inverter has export limitation functionality and any associated equipment that must also be installed for its operation.
[9] Additionally, export limit details are required to be provided by the installer via the Power and Water Embedded generation commissioning form (as per Section 6).

TABLE 6: INVERTER INTEGRATED PASSIVE ANTI-ISLANDING PROTECTION SETTINGS

Parameter	Settings	Trip delay time	Maximum disconnection time
Under-voltage (V<)	180 V	1 s	2 s
Over-voltage 1 (V>)	260 V	1 s	2 s
Over-voltage 2 (V>>)	265 V	—	0.2 s
Under-frequency (F<)	47 Hz	1 s	2 s
Over-frequency (F>)	54 Hz*	—	0.2 s

4.7.2 Central Protection

The central protection requirements are summarised in Table 7, with further details provided in sections 4.7.2.1 to 4.7.2.5 of this document.

TABLE 7: CENTRAL PROTECTION REQUIREMENTS

Protection requirements	EG IES	
	Exporting	Non-exporting
Grid reverse power (32R)	×	–
Generator circuit phase balance protection (46/47)	–	–
Overcurrent facility fault, grid fault and earth fault protection (50/51)	–	–
Passive anti-islanding protection (27U/O, 59U/O, 81U/O, 81R)	✓	✓
Inter-tripping	×	×

Note: Protection requirements consistent with AS/NZS 4777.1 are italicised.

Symbols are used to denote protection requirements, where:

- ✓ Represents that the protection shall be required
- – Represents that the protection may be required
- × Represents that the protection shall not be required

4.7.3 Grid Reverse Power Protection

Grid reverse power protection requirements may be required for non-exporting EG systems, and include:

a. Reverse power protection shall be set as low as practicable with consideration of protection relay, current transformer (CT) accuracy and generating system synchronisation characteristics
b. The design of control systems shall minimise reverse power flow immediately following synchronisation
c. Specific settings for grid reverse power protection shall be determined via a connection specific technical assessment.

4.7.4 Phase Balance Protection

Phase balance protection is required as per Clause 3.4.4.2 of AS/NZS 4777.1 for exporting and non-exporting EG systems where it is not inverter integrated.

Note that three phase IES are exempt from this requirement.

4.7.5 Current Unbalance Protection

Current unbalance protection requirements for the EG system at the connection point shall include:

a. The nominal inverter output rating of EG systems connected to multi-phase supply connections, shall not differ by more than 5 kVA between phases as a result of current unbalance. Phase balance protection shall respond to current unbalance by disconnecting all inverters within the IES automatically within 30 seconds via a method that complies with Clause 3.4.4.2 of AS/NZS 4777.1

b. Where multiple single-phase inverters are used, they must be operated in accordance with Clause 8.2 of AS/NZS 4777.2, which requires that the a.c. output current is generated and injected into the three-phase connection as a three-phase balanced current.

4.7.6 Voltage Unbalance Protection

There are no voltage unbalance requirements for the EG system at the connection point.

4.7.7 Overcurrent Facility Fault, Overcurrent Grid Fault and Earth Fault Protection

Overcurrent facility fault, overcurrent grid fault and earth fault protection may be required for non-exporting EG systems, and include:

a. Overcurrent protection shall be provided at the IES isolating switch in accordance with the equipment rating
b. Specific settings for overcurrent facility fault, overcurrent grid fault and earth fault protection shall be determined via a connection specific technical assessment.

4.7.8 Passive Anti-islanding Protection

Passive anti-islanding protection shall be as per Clause 3.4.4.3 of AS/NZS 4777.1, with the exception of variations marked with an asterisk (*) below in Table 8.

TABLE 8: CENTRAL VOLTAGE AND FREQUENCY PROTECTION SETTINGS

Parameter	Settings	Trip delay time	Maximum disconnection time
Sustained overvoltage ($V_{nom-max}$)	258 V*	-	15 s
Undervoltage (V<)	180 V	3 s*	2 s
Overvoltage (V>)	260 V	3 s*	2 s
Under-frequency (F<)	47 Hz	3 s*	2 s
Over-frequency (F>)	54 Hz*	2 s*	2 s

4.7.9 Inter-tripping

There are no inter-tripping requirements.

4.7.10 Interlocking

The following interlocking requirements shall apply to EG systems:

a. To mitigate unbalance conditions on the network, the IES shall be designed and installed to operate with balanced output across each phase as far as practical, as such a single-phase IES should not be used where the connection to the network is three-phase.
b. Where multiple single-phase inverters are connected to more than one phase, the inverters must be interlocked and configured to operate as an integrated multi-phase inverter providing a balanced output that is no more than 5 kVA between any phases as per AS/NZS 4777.1.
c. Three-phase inverters must be configured to ensure the maximum unbalance between phases is 5 kVA whilst connected to the network
d. All three-phases of the inverters must simultaneously disconnect from, or connect to, the network in response to protection or automatic controls (e.g. anti-islanding trip and subsequent reconnection).
e. Phase balance protection shall be as per 4.7.2.2 where inverters cannot be interlocked by internal controls. In these cases, the installation must be protected by a phase imbalance relay which must immediately isolate the inverter in the absence of reasonable balance between phases of 5 kVA as per Clause 3.4.4.2 of AS/NZS 4777.1. The inverters must be physically prevented from operating independently and all installed inverters must simultaneously disconnect from, or connect to, our distribution network in response to protection or automatic controls (e.g. anti-islanding trip and subsequent reconnection).

4.7.11 Power Factor Control

There are no power factor control requirements.

4.8 Operating Voltage and Frequency

The inverter and customer installation must be designed, installed, and maintained in a manner that ensures that the maximum steady state voltage at any socket outlet or fixed equipment (other than the inverter) within the installation complies at all times with the requirements of AS/NZS 4777.1 and AS/NZS 4777.2.

4.8.1 Voltage Rise

The proposed EG unit installation shall not cause more than 2% voltage rise at the point of supply. Voltage rise is calculated from the a.c. terminals of the inverter(s) to the point of supply as per AS/NZS 4777.1.

From Appendix C2 of AS/NZS 4777.1, the following shall considered:

a. An assessment of the consumer mains is required to ensure that the 2% voltage rise requirements of Clause 3.3.3 are able to be met with the intended IES rating

b. It can be assumed that sizing an IES larger than the existing site load or energy use is likely to require additional work and costs to upgrade switchboards and possibly even the local grid.

Refer to figure C1 of AS/NZS 4777.1 for an example of application of voltage rise requirements for a typical EG installation.

4.8.2 Limits for Sustained Operation

4.8.3 Voltage

For sustained operation[10] for voltage variations, the maximum voltage set point shall be set as per AS/NZS 4777.2 default setting, with any variation to AS/NZS 4777.2 marked with an asterisk (*) below in Table 10.

TABLE 9: LIMITS FOR SUSTAINED OPERATION FOR VOLTAGE VARIATIONS

Reference	Setting
Sustained operation over-voltage limit (V_{nom_max})	258 V*

4.8.4 Frequency

For a grid disturbance that causes an increase in grid frequency (above the upper limit of continuous operation), the inverter(s) shall respond as per AS/NZS 4777.2 default settings as set out in Table 10 below, with any variations to AS/NZS 4777.2 marked with an asterisk (*).

TABLE 10: LIMITS FOR SUSTAINED OPERATION FOR FREQUENCY VARIATIONS (INCREASE IN GRID FREQUENCY), APPLICABLE TO ALL INVERTERS

Reference	Setting
Lower limit of continuous operation for supplying rated power	47 Hz
Upper limit of continuous operation for supplying rated power (above which power output is reduced linearly with an increase in frequency until f_{stop} is reached)	50.25 Hz
f_{stop} (above which power output level is 0 W)	54 Hz*
Frequency value within continuous operation range which must be achieved (for the minimum elapsed time) before power operation may recommence at the nominated ramp rate (W_{GRA}) as set out in Section 4.10.3	50.15 Hz
Minimum elapsed time	60 s

For a grid disturbance that causes a decrease in grid frequency (below the lower limit of continuous operation), the inverter(s) with energy storage shall respond as per AS/NZS 4777.2 default settings as set out in Table 11 below, with any variations to AS/NZS 4777.2 marked with an asterisk (*).

[10] Sustained operation refers to a 10 minute average value which needs to be calculated for the preceding 10 minutes at least every 3 seconds based on measurements at the inverter's terminals or another external measurement position for comparison with the V_{nom_max} to determine when to disconnect.

TABLE 11: LIMITS FOR SUSTAINED OPERATION FOR FREQUENCY VARIATIONS (DECREASE IN GRID FREQUENCY), APPLICABLE TO INVERTERS WITH ENERGY STORAGE

Reference	Setting
Lower limit of continuous operation for charging of energy storage (below which charging of energy storage by the inverter is reduced linearly with a decrease in frequency until $f_{stop-CH}$ is reached)	49.75 Hz
Upper limit of continuous operation for charging of energy storage	54 Hz*
$f_{stop-CH}$ (below which power input for charging of energy storage is 0 W)	49 Hz
Frequency value within continuous operation range which must be achieved (for the minimum elapsed time) before power input may recommence for charging of energy storage at the nominated ramp rate (W_{GRA}+) as set out in Section 4.10.3	49.85 Hz
Minimum elapsed time	60 s

4.9 Metering

The installation shall meet metering requirements as per NT NER Chapter 7A and Power and Water NP010 Meter Manual[11], including replacement or re-configuration of existing meter(s) to bi-directional meter(s).

4.10 Power quality

4.10.1 Quality of supply

EG connections shall comply with the applicable power quality requirements of the AS/NZS 61000 series as well as the Power and Water Network Technical Code and Planning Criteria, including but not limited to:

a. Network voltage control
b. Voltage fluctuations
c. Harmonics
d. Voltage balance.

4.10.2 IES Power Quality Response Modes

The volt–var and volt–watt response modes specified in Clause 6.3.2.2 and Clause 6.3.2.3 of AS/NZS 4777.2 shall both be enabled and shall respond as per AS/NZS 4777.2 default settings, with any variations marked with an asterisk (*) below in Table 12 and Table 13.

TABLE 12: VOLT–VAR RESPONSE MODE SETTINGS

Reference	Voltage	Inverter reactive power level (Var % rated VA)
Volt-var 1 (V_{v1})	207 V	44% leading*
Volt-var 2 (V_{v2})	220 V	0%
Volt-var 3 (V_{v3})	240 V*	0%
Volt-var 4 (V_{v4})	258 V*	60% lagging*

Note: Lagging is when the EG unit absorbs reactive power from the network, and leading is when the EG unit acts as a source of reactive power into the network.

[11] Power and Water Design and construction guidelines, available from https://www.powerwater.com.au/developers/power/design-and-construction-guidelines

TABLE 13: VOLT–WATT RESPONSE MODE SETTINGS

Reference	Voltage	Inverter maximum active power output level (P/ P_{rated}, %)
Volt-watt 1 (V_{w1})	207 V	100%
Volt-watt 2 (V_{w2})	220 V	100%
Volt-watt 3 (V_{w3})	253 V*	100%
Volt-watt 4 (V_{w4})	260 V*	20%

Note: Where P is the output power of the inverter and P_{rated} is the rated output power of the inverter.

4.10.3 Ramping Requirements

Ramping requirements and settings shall be as per AS/NZS 4777.2 default settings, with any variations marked with an asterisk (*) below in Table 14 for inverters capable of use with energy storage (multiple mode operation).

TABLE 14: RAMPING SETTINGS FOR INVERTERS CAPABLE OF USE WITH ENERGY STORAGE

Reference	Ramp rate	Nominal ramp time (Tn)
Rate limit an increase in power (W_{GRA}+)	16.67 % per minute	6 minutes
Rate limit a decrease in power (W_{GRA}-)	8.33 % per minute	12 minutes

4.11 Communications Systems

There are no requirements for communications systems.

For BESS, the following virtual power plant (VPP)-capable requirements should be adopted:

a. Physical communications interface including an ethernet port capable of being used for communications with the system by authorised parties
b. Internet accessibility through at least one method for forming a reliable internet connection accessible by authorised parties
c. Remote registration capability via application programming interface (API) to remote services (e.g. retailer, equipment manufacturer, aggregator)
d. Remote monitoring communication function that is capable of reporting data via an API
e. Remote control capability to respond to remotely-provided commands from authorised parties to charge or discharge the battery
f. Remote configuration capability to respond to remotely-provided commands from authorised parties to alter firmware or operational settings.

4.12 Data and Information

4.12.1 Static Data and Information

Static data and information that is required to be provided by the Proponent to Power and Water is set out within Appendix D: Static Data and Information.

4.12.2 Dynamic Data and Information

There are no requirements for dynamic data and information.

4.13 Cybersecurity

The cybersecurity requirements for VPP-ready EG systems shall ensure security against electronic intrusion and tampering by unauthorised parties through provisions, including:

a. Monitoring and communications devices shall be in screw sealed or lockable enclosures
b. Protection and control from network systems (e.g. firewalls)
c. Privilege settings and password protection

d. Limiting access to only that which is required to monitor the generating unit.

4.14 Technical Studies

Technical studies shall be undertaken and completed by Power and Water as part of the connection application and in accordance with jurisdictional requirements at the Proponent's expense. Technical study requirements are set out below in Table 15.

TABLE 15: TECHNICAL STUDY REQUIREMENTS

Technical study	EG IES	
	Exporting	Non-exporting
Voltage level (including power factor)	–	×
Power flow	–	×
Fault level	–	–
Protection grading	–	–

Symbols are used to denote technical study requirements, where:

- ✓ Represents that the technical study shall be required
- – Represents that the technical study may be required
- × Represents that the technical study shall not be required

Where the technical study does not meet the assessment criteria, Power and Water shall provide the Proponent with an alternative option which may include:

a. Alternative configurations of the generating systems (e.g. lower generation control limits)
b. Network augmentation (and associated cost of network augmentation).

5 Fees and Charges

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

https://www.powerwater.com.au/customers/moving-and-building/power-connections

6 Testing and Commissioning

Testing and commissioning requirements for EG IES connections include the following in addition to requirements provide in Table 16:

a. Testing and commissioning plans shall be produced by the Proponent and are required to be signed off by a CPEng prior to finalising the connection agreement. The signed off testing and commissioning plans shall be provided to Power and Water upon request
b. Testing and commissioning acceptance shall be signed off by the Proponent's suitably qualified engineer. The signed off testing and commissioning acceptance shall be provided to Power and Water upon request
c. Testing and commissioning acceptance may require Power and Water to carry out witnessing and may be charged at the Proponent's expense
d. On-site testing and commissioning shall be undertaken in accordance with AS/NZS 4777.1, AS/NZS 3000, AS/NZS 5033 (where applicable) and AS/NZS 5139 (where applicable), the equipment manufacturer's specifications, and this document to demonstrate that the EG system meets the requirements of the connection agreement
e. The tests shall be installation tests not type tests.

TABLE 16: TESTING AND COMMISSIONING REQUIREMENTS

Testing and commissioning requirements	EG IES	
	Exporting	Non-exporting
Protection settings and performance	✓	✓
Power quality settings and performance	✓	✓
Export limits settings and performance	✓	✓
Communications settings and performance	×	×
Shutdown Procedures	×	×
Confirm system is as per specifications	✓	✓
Confirm SLD is located on site	✓	✓

Symbols are used to denote testing and commissioning requirements, where:

- ✓ Represents that the testing and commissioning shall be required
- – Represents that the testing and commissioning may be required
- × Represents that the testing and commissioning shall not be required

Refer to the Power and Water Embedded generation commissioning form, available at the following link:

https://www.powerwater.com.au/customers/moving-and-building/power-connections

7 Operations and Maintenance

Operations and maintenance requirements for EG connections include:

a. An operation and maintenance plan shall be produced, and signed off by the Proponent's suitably qualified engineer prior to forming a connection agreement. A copy shall be left on site, and the signed off operation and maintenance plan shall be provided to Power and Water upon request
b. The EG system shall be operated and maintained to ensure compliance with the connection agreement and all legislation, codes, and/or other regulatory instruments at all times
c. Operation and maintenance reports shall be submitted to Power and Water upon request, no more frequently than annually
d. Power and Water may inspect and test the Proponent's EG system at any time at Power and Water's cost. Should the inspection identify non-compliance with this technical requirements document, the EG system may be disconnected from Power and Water's network. The EG system will not be reconnected to the network until Power and Water is satisfied that the non-compliance has been resolved. Rectification of non-compliance issues shall be at the Proponent's cost

The general expectations for operating and maintaining the EG systems shall include:

a. Maintaining the electrical installation at the supply address in a safe condition
b. Ensuring 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
c. The Proponent shall seek Power and Water's approval prior to altering the connection in terms of an addition, upgrade, extension, expansion, augmentation or any other kind of alteration, including changing inverter settings.

Appendix A: Deviations from the National DER Connection Guidelines

TABLE 17: TABLE OF DEVIATIONS FROM NATIONAL DER CONNECTION GUIDELINES

Section	ENA National DER Connection Guidelines for LV EG Connections requirements	Description of deviation	Type of deviation	Justification
1.2	Inclusion of non-IES	Exclusion of non-IES	N/A	Consistency with Power and Water requirements
2.3.1, 4.2	Subcategories shall include - LV EG IES (excluding BESS) connection ≤200 kVA, - LV EG IES (excluding BESS) connection >200 kVA, and - LV EG non-IES connection	Subcategories include - EG IES (with BESS) connection ≤200 kVA (Darwin), and - EG IES (with BESS) connection ≤100 kVA (Alice Springs, Katherine, and Tennant Creek)	Jurisdictional requirement	Consistency with Power and Water requirements
4.2, 4.3.1	Applies at the connection point only	In circumstances where there are multiple connection points on a single lot, the system capacity (4.2) and export limit (4.3) will apply on a per lot basis	Jurisdictional requirement	Consistency with Power and Water requirements
4.3.2	Requires a subsection heading to be retained for Site generation limit downstream of connection point	This subheading has been removed from the document (with no impact to subsequent heading numbers)	N/A	Consistency with Power and Water requirements
4.4	There are no requirements specified for BESS.	Compliance requirements for IES with BESS	Promote improved benefits to the electricity system	Increasing the flexibility for customer choice of batteries
4.6	For BESS, earthing requirements shall be as per AS/NZS 3011	For BESS, earthing requirements shall be as per AS/NZS 5139	Compliance with relevant standards	The new standard AS 5139 is directly applicable for use of IES with BESS
4.7.1, 4.7.2.4	As per AS/NZS 4777.2 default settings (i.e. Over-frequency (F>) = 52 Hz)	Over-frequency (F>) = 54 Hz	Promote improved benefits to the electricity system	Consistency with Power and Water requirements
4.7.2, 4.7.2.1	Grid reverse power (32R) shall be required for exporting EG systems	Grid reverse power (32R) is not required for exporting EG systems ≤ 200 kVA	Promote improved benefits to the electricity system	Consistency with Power and Water requirements
4.7.2, 4.7.2.3	Overcurrent facility fault, grid fault and earth fault protection (50/51) shall be required for all EG systems	Overcurrent facility fault, grid fault and earth fault protection (50/51) may be required for all EG systems	Promote improved benefits to the electricity system	Consistency with Power and Water requirements

4.7.6, 4.10.3, 4.11.3	Sections relating to LV EG Non-IES	These sections are excluded from the document	Promote improved benefits to the electricity system	Consistency with Power and Water requirements
4.8.2	Sustained operation for over-voltage (V_{nom_max}) requirements is as per AS/NZS 4777.2 (i.e. V_{nom_max} = 255V)	V_{nom_max} = 258 V	Promote improved benefits to the electricity system	Consistency with Power and Water requirements
4.8.2	Frequency where power output level is 0 W is as per AS/NZS 4777.2 (i.e. f_{stop} = 52 Hz)	f_{stop} = 54 Hz	Promote improved benefits to the electricity system	Improve sustained operation for increase in grid frequency variations
4.8.2	Upper limit of continuous operation for inverters with energy storage is as per AS/NZS 4777.2 (i.e. 52 Hz)	Upper limit of continuous operation for inverters with energy storage = 54 Hz	Promote improved benefits to the electricity system	Improve sustained operation for increase in grid frequency variations
4.10.2	Volt-var settings are as per AS/NZS 4777.2 Vv3 = 250V, 30% leading Vv4 = 265V, 30% lagging	Vv3 = 240V, 44% leading Vv4 = 258V, 60% lagging	Promote improved benefits to the electricity system	Increasing the hosting capacity which reflects Power and Water's commitment to enable more DER penetration
4.10.2	Volt-watt settings are as per AS/NZS 4777.2 Vw3 = 250V Vw4 = 265V	Vw3 = 253V Vw4 = 260V	Promote improved benefits to the electricity system	Increasing the hosting capacity which reflects Power and Water's commitment to enable more DER penetration

Appendix B: Connection Arrangement Requirements

B1 Single Line Diagram

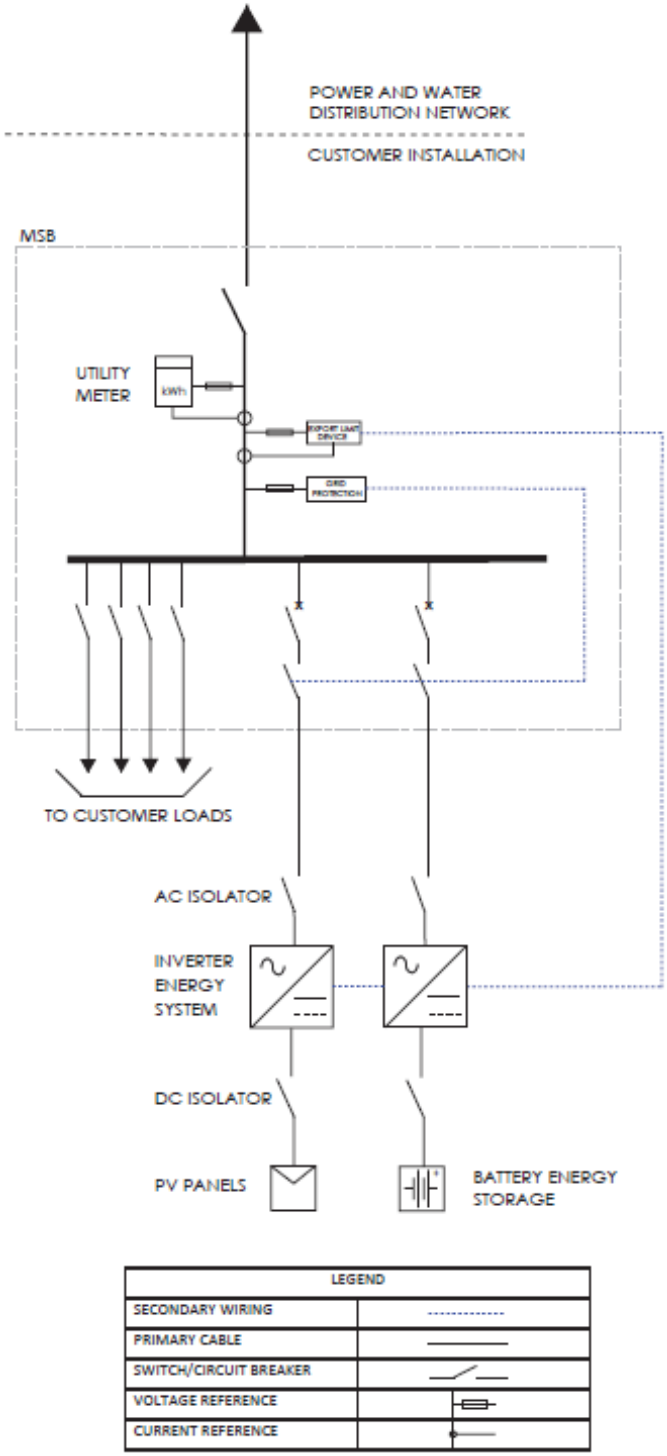

FIGURE 1: TYPICAL SINGLE LINE DIAGRAM FOR AN EG SYSTEM

Appendix C: Connection Agreement

The connection agreement template for negotiated EG connections is available at the following link:

- Negotiated contracts
  https://www.powerwater.com.au/customers/moving-and-building/power-connections

Appendix D: Static Data and Information

The static data and information that is required to be provided by the Proponent to Power and Water is to be provided via the Power and Water Embedded generation commissioning form, available at the following link:

https://www.powerwater.com.au/customers/moving-and-building/power-connections