Basic Micro EG Connection Technical Requirements

Standard Number: HPC-9DJ-13-0001-2019

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1	7/06/2019	Initial document incorporating ENA National Connection Guidelines. This document supersedes standard HPC-9FJ-12-0001-2012.
1.1	25/06/2019	Minor update to include Schedule 5 System Parameters
1.2	11/10/2019	Minor update to Appendix F – Summary of Inverter Settings

STAKEHOLDERS *The following positions shall be consulted if an update or review is required:*	
Manager Pilbara	Manager Goldfields Esperance
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Manager Kimberley	Manager System Operations
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1 INTRODUCTION

The purpose of this document is to provide Proponents of basic micro embedded generation (EG) connections, information about their obligations for connection to and interfacing with Horizon Power's low voltage (LV) distribution network.

This includes all customer connected EG, regardless of whether such systems export electricity into the electricity system or not.

1.1 Scope – Inclusions

The Electricity Networks Australia (ENA) Framework and Principles guideline outlines five categories of embedded generation connection, as outlined in Table 1.

This technical requirements document applies to new connections of **basic micro EG systems** or modifications to existing basic micro EG systems, where the basic micro EG system consists of inverter energy system (IES), energy storage system (ESS) or a combination of both.

Table 1: Connection Types

Connection Type	Connection Voltage	Technology Type	Capacity	Relevant Standard
Basic micro EG connection	**Up to 1kV**	**Micro EG (inverter based)**	**≤30kVA three phase,** **≤10kVA single phase**	**Basic Micro EG Connection Technical Requirements** ***(This Document)***
Low voltage EG connection	Up to 1kV	Inverter Based	>30kVA and ≤1MVA three phase	Low Voltage EG Connection Technical Requirements
		Non- inverter based	>30kVA and ≤1MVA three phase ≤10kVA single phase	
Medium voltage connection	1kV to 35kV	Any	Any size up to 10MW	Horizon Power Technical Rules
High voltage connection	>35kV	Any	Any size up to 10MW	Horizon Power Technical Rules
Registered generator connection	>35kV	Any	>10MW	Horizon Power Technical Rules

A basic micro EG connection, consistent with the definition provided within the ENA Framework and Principles guideline is:

A micro EG system with a total system capacity less than or equal to 10 kVA for a single-phase IES (excluding ESS[1]) network connection, and a total system capacity less than or equal to 30 kVA for a three-phase IES (excluding ESS) network connection that is:

a) intended to be connected to and capable of operating in parallel with any part of the LV distribution network

b) involving minimal or no augmentation of the distribution network

c) meeting all other technical requirements set out in this document

This Document is applicable to all basic micro EG connections that are inverter connected to Horizon Power's LV distribution network which may include renewable energy sources such as solar PV, wind and mini hydro. The Proponent's connection application shall identify each type of renewable energy source per connection.

This Document is applicable to single phase and three phase supply arrangements. For key criteria of single and three phase connections, refer to the Western Australian Electrical Requirements (WAER) and Western Australian Distribution Connections Manual (WADCM).

1.2 Scope – Exclusions

The technical requirements do NOT apply to the following system types:

a) EG units covered by Horizon Power's LV EG Connection Technical Requirements

b) EG units covered by the technical requirements for medium or high voltage (MV/HV) connected EG's

c) Non IES systems

d) Electric vehicles, unless the on-board battery storage system is capable of exporting to the LV network (in which case the requirements shall apply)

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

f) Off-grid systems such as Standalone Power Systems (SPS).

1.3 Proponent Responsibilities

The Proponent shall comply with all 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.

b) The obligation to not connect additional inverters, make modifications or install additional micro EG units, including ESS, without prior written agreement from Horizon Power.

c) The obligation to comply with Horizon Power's model standing offer.

[1] Note that ESS are permitted within Basic Micro EG connections. However the ESS capacity is not included in the total system capacity definition of the Basic Micro EG connection.

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

e) The obligation to procure equipment and to arrange for its installation in compliance with these technical requirements as well as all other applicable Australian Standards and Regulations.

f) All design and installation works for LV EG connections with renewable energy sources shall be undertaken by a CEC accredited persons, with certification appropriate to installation type.

Horizon Power may, at its absolute discretion and without limiting any of its other rights, reject an application or disconnect the EG system from the grid if the Proponent's EG system does not comply, or, no longer complies with all the requirements of this Document through modification being made to the Proponent's EG system.

Should the Proponent's total EG connection capacity exceed that of existing supply arrangement, then the additional electrical capacity requirement may call for the network to be modified to facilitate the EG connection. The costs associated with providing that additional capacity shall be charged to the Proponent. The Proponent may choose to retract or modify their presented EG connection application. If the Proponent modifies their application it may be treated as a new EG Connection application by Horizon Power and therefore associated fees and charges shall apply.

The size of the Basic Micro EG system may necessitate upgrading of the Proponent's connection.

1.4 Horizon Power Obligations

Horizon Power acknowledges its obligations to ensure the safe and reliable operation of the distribution system for operating personnel, customers and the general public.

The technical requirements comply with the National DER Connection Guidelines for Basic Micro EG Connections, with the exception of the deviations presented in Appendix A: Deviations from the National DER Connection Guidelines.

1.5 Hosting Capacity

Horizon Power presently allows connection of a fixed total amount of customer EG capacity to its electricity system. This amount of embedded generation is known as the Hosting Capacity and varies from town to town. Hosting Capacity is set at a level that allows Horizon Power to technically and contractually deliver safe and reliable electricity.

Refer to Horizon Power's website for nominated Hosting Capacity for each of its systems and the available capacity.

1.6 Existing EG Connections

All existing Basic Micro EG connections already approved to connect to Horizon Power's systems shall comply with the version of the Technical Requirements at the time of their connection.

Where Proponents modify or upgrade their existing system, their full basic micro EG system will be required to comply with the Basic Micro EG Connection Technical Requirements and meet their obligations outlined in Section 1.3, and they are required to submit an application to Horizon Power.

Where a new system is added to a premises with an existing approved EG system, the existing EG system does not need to meet the latest Technical Requirements. However, the new system must fully comply with the requirements set out in this Document. Where the total system capacity exceeds the Basic Micro EG threshold, the new system shall comply with the requirements of HPC-9DJ-13-0002-2019 Low Voltage EG Connection Technical Requirements.

2 DEFINITIONS AND ABBREVIATIONS

2.1 Definitions

This section provides a list of definitions for technical or industry terms used throughout this document.

In addition to those terms listed in the relevant Australian Standards (including AS/NZS 3000 and AS/NZS 4777), WAER and Electrical Licensing Regulation E(L)R, the following definitions apply:

Table 2: 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 or an equivalent model offer is in place in jurisdictions not subject to Chapter 5A of the National Electricity Rules
Battery Energy Storage System	A device used to store energy in the form of chemical energy.
Break before make switch	A switch that opens a connection prior to closing the new connection.
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
Completion Notice	An electrical contractor, who carries a notifiable work, shall provide notice of completion within the period of 3 days after its completion. Refer to Electricity (Licensing) Regulations 1991 for details.
Connection Point	That point defined in an access contract or, where there is no specific access contract, the upstream terminals of the customer's main switch or downstream of the meter.
Current Transformer	A current transformer is used for measurement of alternating electric currents.
Customer Final Loads	All electrical loads on the Customer's premises not part of the Renewable Energy Installation
Distributed Energy Resources	Power generation or storage units that are connected directly to the distribution network.
Document	This document and any annexed schedules, together with any document referred to, or incorporated into, this document.

Term	Definition
Electrical Installation	As defined in AS/NZS 3000
Electricity System	The electricity grid owned and operated by Horizon Power and connected to the Premises.
Embedded generating system	A system comprising of multiple embedded generating units
Embedded generating unit	A generating unit connected within a distribution network and not having direct access to the transmission network
Energy Storage Device	A generic device that stores energy in the form of electrical, mechanical or chemical energy.
Energy storage system	A system comprising one or more batteries that store electricity generated by distributed energy resources or directly from the grid, and that can discharge the electricity to loads
ESS Capacity	The energy storage system capacity (kVA) Note ESS Capacity does not refer to the *energy* capacity (i.e. kWh) it refers to the IES capacity directly associated to the ESS (kVA)
Extended Ramp Rate Smoothing	A type of Renewable Energy Smoothing requirement to facilitate DER connections in towns where Hosting Capacities are reached. It is subject to case-by-case assessment by Horizon Power.
Feed-In Management	A type of Generation Control, where the EG output is curtailed to prevent system instability.
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
Generation Control	Includes the utilisation of technologies such as inverter control, energy storage or feed-in management to control the output profile of the embedded generator.
Generator	A person who owns, operates or controls a generating unit
Grid	Shall have the same meaning as defined in AS/NZS 4777.
Hosting Capacity	The capacity of the Electricity System to accept or manage the output of Renewable Source Electricity from a Customer's System whether because of a technical limitation, insufficient reserve generating capacity or contractual constraint.

Term	Definition
Inverter	The device forming part of a System which: a) limits the Renewable Source Electricity exported to the Electricity System; b) complies with the Technical Requirements; c) may convert direct current generated electrical energy into alternating current electrical energy; and d) relates to the AS/NZS 4777 definition.
Inverter energy system	A system comprising of one or more inverters that convert direct current to alternating current
IES Capacity	The inverter energy system nameplate rating (kVA)
Low voltage	The mains voltages as most commonly used in any given network by domestic and light industrial and commercial consumers (typically 240V)
Market generating unit	A generating unit whose generation is not purchased in its entirety by a retailer (and receives payment for generation through the National Electricity Market or Wholesale Electricity Market)
Medium voltage/ High voltage	Any voltage greater than 1kVAC
Metering Equipment	As applicable, the import, export, bi-directional, parallel and revenue meters installed at the Premises to measure the import and export of electricity to the Installation under the Electricity Supply Agreement and the Renewable Electricity Exported by the Customer.
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
Mini Hydro	A renewable generation source less than 1MW that creates electrical energy as a result of harnessing moving water.
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. This definition also applies to an equivalent model offer for jurisdictions not subject to Chapter 5A of the National Electricity Rules. For Horizon Power this refers to the contractual agreement between Horizon Power and the Proponent for the connection of the EG system.

Term	Definition
Multiple–mode inverter	An inverter that operates in more than one mode; for example, having grid-interactive functionality when mains voltage is present, and stand-alone functionality when disconnected from mains supply. A stand-alone inverter that can inject energy into the grid would be considered a multiple-mode inverter.
Off-grid system	A property which does not have Horizon Power's tariff meter on their premises and / or is not connected to Horizon Power's distribution network; this document is not applicable to an off-grid system.
Point of Connection	Same as Connection Point
Power Conversion Equipment	An electrical device that converts one kind of electrical power from a voltage or current source into another kind of electrical power with respect to voltage, current and frequency. This category is for devices which are not inverters, but are connected between a renewable energy generator and an application circuit. Examples include DC/DC converters and charge controllers. Shall have the same meaning as defined in AS/NZS 4777
Preliminary Notice	The preliminary notice for notifiable works shall be provided as per the Electricity (Licensing) Regulations 1991.
Premises	The premises nominated in the Application Documents, owned or occupied by the Customer, which must be the same Customer supplied at that premises in accordance with an Electricity Supply Agreement.
Proponent	A person proposing to become a Generator (the relevant owner, operator or controller of the generating unit (or their agent))
Prosumer	A Horizon Power customer that installs a renewable energy system to offset their energy consumption.
Photo Voltaic	A renewable energy generation device that creates electrical energy as a result of harnessing energy from the sun collected on photovoltaic cells.
Registered generator	A person who owns, operates or controls a generating unit that is connected to, or who otherwise supplies electricity to, a transmission or distribution system and who is registered by the Australian Energy Market Operator as a Generator under Chapter 2 of the National Electricity Rules For Horizon Power this means a generator greater than 10 MW.
Renewable Energy Producer	An entity whose primary purpose is to generate and sell renewable source electricity to Horizon Power.

Term	Definition
Renewable Energy Smoothing	Participating customers to install Renewable Energy Smoothing Devices that mitigate system instability risks. For example; energy storage, load control or any other method that meets the required ramp rates.
Renewable Energy System	a) a system of photovoltaic arrays; b) a system of wind turbines; c) a hydropower system; or another system for the generation of electricity from a renewable energy source, that has a generating capacity exceeding 1.5 kW but not exceeding 1 MW unless otherwise agreed in writing by Horizon Power.
Renewable Energy System Installation Size	The nominal output rating in kW of the grid connected inverter.
Secure Gateway Device	This is the control interface between the Proponent's EG system and Horizon Power's communications system. This device is for the purposes of feed-in management control of the EG system.
Single Wire Earth Return	Parts of the electrical distribution network that use a single live conductor to supply single-phase or split-phase electric power with higher network impedances, and with distribution supplying low voltages to premises
System Capacity	The total installed nameplate rating (kVA)
System Impact Study	A system study to assess the impact of renewable energy connection on Horizon Power's generation and transmission & distribution network.
Site generation limit	The generation threshold that the embedded generation system cannot exceed, measured downstream of the connection point
Small generation aggregator	A person who has classified one or more small generating units as a market generating unit
Small registered generator	A generator who elects to register a generator with the Australian Energy Market Operator as a market generating unit who would otherwise be entitled to an exemption to register based on size
Solar Thermal	A renewable energy generation device that creates electrical energy as a result of harnessing the sun's energy focused on thermal collectors.
Spinning Reserve	The amount of standby generation synchronised to the grid and available for immediate use.

Term	Definition
Stand-alone inverter	An inverter that is not designed to inject power into the grid, and is used for the supply of extra-low (ELV) and/or low voltage (LV) electric power to a single load, or an electrical installation via batteries or a renewable resource, PV, wind, hydro etc. The inverter may or may not contain a charging function.
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
SunSpec Protocol	A protocol facilitating the interoperability of distributed energy resources
System Diagram	A conceptual diagram that illustrates the relationships between separate subsystems using lines.
System Instability	A disturbance to the Electricity System that affects the reliability and quality of power to customers.
Technical Requirements	This refers to the provisions set out in this Document. These requirements may be in addition to the Horizon Power Technical Rules HPC-9DJ-01-0001-2012
Wind	A renewable energy generation device that creates electrical energy as a result of harnessing moving air.
Zero Export Response Time	Is the time spanning from the renewable energy export event detection to its effective reduction to a net zero export situation.

2.2 Abbreviations

This section provides a list of all abbreviations used throughout the technical requirements document.

Term	Definition
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AS/NZS	A jointly developed Australian and New Zealand Standard
BESS	Battery Energy Storage System
CBD	Central Business District

Term	Definition
CEC	Clean Energy Council
CT	Current Transformer
DER	Distributed Energy Resources
DNP3	Communication protocol. Distribution Network Protocol
DNSP	Distribution Network Service Provider
DRM	Demand Response Mode
EG	Embedded Generation or Embedded Generating
ENA	Energy Networks Australia
ESS	Energy Storage System
FiM	Feed-In Management
GM	Generation Management
HV	High Voltage
IEC	International Electrotechnical Commission
IES	Inverter Energy System
LV	Low Voltage
MEN	Multiple Earthed Neutral
MV	Medium Voltage
NEM	National Electricity Market
NER	National Engineering Register
NER	National Electricity Rules
NIA	Network Impact Assessment
NMI	National Metering Identifier
NWIS	North West Interconnected System
PCE	Power Conversion Equipment
PLC	Programmable Logic Controller
PV	Photo Voltaic

Term	Definition
REBS	Renewable Energy Buyback Scheme
SCADA	Supervisory Control and Data Acquisition
SGD	Secure Gateway Device
SIS	System Impact Study
SWER	Single Wire Earth Return
SWIS	South West Interconnected System
TCP/IP	Transmission Control Protocol/Internet Protocol
WAER	Western Australian Electrical Requirements
WADCM	Western Australian Distribution Connections Manual
WEM	Wholesale Electricity Market servicing the SWIS

2.3 Terminology

The following instructional terms are to be interpreted as follows:

1. The word ‘shall’ indicates a mandatory requirement
2. The word ‘may’ indicates a requirement that may be mandatorily imposed on the Proponent
3. The word ‘should’ indicates a recommendation that will not be mandatorily imposed on the Proponent.

2.3.1 Subcategories

The following subcategories apply for basic micro EG connections:

1. **Single-phase basic micro EG connection** – Any basic micro EG system with a system capacity less than or equal to 10 kVA for a single-phase IES (excluding ESS) network connection meeting all technical requirements for basic micro EG connections set out in this Document.
2. **Three-phase basic micro EG connection** – Any basic micro EG system with a system capacity less than or equal to 30 kVA for a three-phase IES (excluding ESS) network connection meeting all technical requirements for basic micro EG connections set out in this Document.
3. **Non-standard network areas** – Basic Micro EG connections shall be initially classified as either (1) or (2), plus additional requirements apply to any basic micro EG system connecting to a non-standard part of the network including (but not limited to) SWER networks, isolated networks, and CBD networks.

The Technical Requirements apply to all of the above subcategories of basic micro EG connections. Each of these subcategories has differing technical settings and requirements.

Horizon Power currently identifies the NWIS as a standard network and all non-NWIS systems as non-standard networks in the application of this guideline. Refer to Horizon Power's service area map in Appendix H.

For all enquiries please contact Renewables@Horizonpower.com.au.

3 RELEVANT RULES, REGULATIONS, STANDARDS AND CODES

Unless otherwise stated within this Document, the Proponent shall comply with the current versions of all relevant legislation, technical requirements, Australian Standards, and applicable industry guidelines, whether explicitly identified or not, in Section 3.

3.1 Standards and Codes

This section lists of all the Australian and International standards and industry codes which shall apply to the design, manufacture, installation, testing and commissioning, and operation and maintenance of all plant and equipment for basic micro EG connections to the distribution network.

In the event of any inconsistency between Australian and International standards and industry codes and Horizon Power's technical requirements, the Horizon Power technical requirements shall prevail.

Table 3: Reference Documentation – Standards and Codes

Horizon Power and Other Documents	
WA Distribution Connections Manual (WADCM)	
HPC-9DJ-01-0001-2012	Horizon Power Technical Rules
Australian and International Standards	
AS/NZS 3000	Electrical Installations (Wiring Rules)
AS/NZS 3011	Electrical Installations – Secondary batteries installed in buildings
AS/NZS 3017	Electrical installations — Verification guidelines
AS/NZS 3100	Approval and Test Specification – General Requirements for Electrical Equipment
AS/NZS 4777 (all parts)	Grid Connection of Energy Systems via Inverters
AS/NZS 5033	Installation and Safety Requirements for Photovoltaic Arrays
Guideline	Battery Energy Storage Systems: A guide for Electrical Contractor
DR AS/NZS 5139 (Draft)	Electrical Installations – Safety of Battery Systems for use with Power Conversion Equipment
AS IEC 62619:2017	Safety Requirements for lithium cells and batteries
IEC 62109 (all parts)	Safety of Power Converters for use in Photovoltaic Power Systems

IEC 62116	Utility-Interconnected Photovoltaic Inverters – Test Procedure of Islanding Prevention Measures
Codes	
WA Electricity Industry (Code of Conduct) Regulations 2005	
WA Electricity Industry (Metering) Code 2012	

3.2 Legislation and Regulation

This section provides a list of all the relevant legislation and regulations which shall apply to the design, manufacture, installation, testing and commissioning, and operations and maintenance of all plant and equipment for basic micro EG connections.

In the event of any inconsistency between legislation and regulations and the Horizon Power technical requirements, the legislation and regulation shall prevail.

Table 4: Reference Documentation – Legislation and Regulation

Legislation
WA Electricity Licensing Regulation 1991
WA Electricity Act 1945
WA Electrical Requirements (WAER)

3.3 Order of Precedence

In the event of a conflict arising between the reference documents listed in Table 4, the following order of precedence shall apply:

Table 5: Order of Precedence (Highest to Lowest)

Order	**Reference Document**
1	Legislation
2	Technical Requirements
3	Australian Standards

The Proponent shall notify Horizon Power of any such conflict prior to undertaking work in relation to this Document.

3.4 Useful Links

Table 6: Useful Links

Name	**Link**
Clean Energy Council	http://www.cleanenergycouncil.org.au

Horizon Power	http://www.horizonpower.com.au
Clean Energy Council Approved Inverters	http://www.solaraccreditation.com.au
State Law Publisher (SLP)	https://www.slp.wa.gov.au/Index.html

4 TECHNICAL REQUIREMENTS

This section outlines the technical requirements and system diagram to be used for different subcategories of basic micro EG connections.

The following table summarises the key technical requirements and considerations for different subcategories of basic micro EG connections:

Table 7: Summary of Technical Requirements

Basic Micro EG Connection Subcategory		Hosting Capacity Required?	Feed in Management Required?	Renewable Smoothing Required?	System Diagram	Horizon Power Assessments	
						Network Impact Assessment	System Impact Study
Standard Network Areas	Single Phase	Y	N	N	Diagram A	Y	N
	Three Phase	Y	N	N	Diagram A	Y	N
Non Standard Network Areas	Single Phase	Y	Y – FiM Ready	N	Diagram E	Y	N
	Three Phase	Y	Y – FiM Ready	N	Diagram E	Y	N

Notes:

1 A basic micro EG system is defined in Section 1.1.

2 Available Hosting Capacity: The Proponent is required to check if sufficient hosting capacity is available for the EG connection in accordance with Section 1.5.

3 Feed in Management is mandatory for all non-standard basic micro EG connections: Refer Section 4.3.6.

4 Renewable energy smoothing is not required for basic micro EG connections.

5 System Diagrams: Refer to Appendix B for applicable system diagrams and connection arrangement for each subcategory of system.

6 System Impact Study: Refer to Section 4.14.

4.1 Labelling and Signage

Labels and signs on the installation, including cables, shall be as per AS/NZS 4777.1, AS/NZS 3000 and AS/NZS 5033.

Labels shall be of the type and location specified in Section 6 of AS/NZS 4777.1.

Other labelling shall be as per AS/NZS 3000 and AS/NZS 5033.

For installations that are required to be FIM Ready, also refer to labelling requirements in Section 4.11.2.

4.2 Maximum System Capacity

The maximum system capacity of basic micro EG connections for each subcategory shall be as follows:

1. Single-phase basic micro EG connection – For single-phase basic micro EG connections of IES (excluding ESS), the maximum system capacity shall be set to less than or equal to 10 kVA
2. Three-phase basic micro EG connection – For three-phase basic micro EG connections of IES (excluding ESS), the maximum system capacity at the same connection point shall be set to less than or equal to 10 kVA per phase
3. Non-standard basic micro EG connection – For non-standard networks the above Single-phase and Three-phase basic micro EG connection maximum system capacities apply.

The maximum EG system capacity allowed for a single-phase connection is 10 kVA and is subject to individual technical assessment and power quality checks.

The system capacity for low voltage EG connections on different strata titles, but at the same network connection point (e.g. retirement villages), is to be defined by the capacity at the connection point.

4.3 Generation Control

Basic micro EG connections require generation control in accordance with the following.

4.3.1 Export Limits at Connection Point

The following export limits apply for each subcategory of basic micro EG connections:

1. Single-phase basic micro EG connection – For single-phase basic micro EG connections of IES (excluding ESS), the export limit shall be set to equal 5 kVA at the connection point
2. Three-phase basic micro EG connection – For three-phase basic micro EG connections of IES (excluding ESS), the export limit shall be set to equal 5 kVA per phase with a balanced output with respect to its rating and a tolerance of no more than 2.5 kVA unbalance between any phases as per AS/NZS 4777.1 at the connection point
3. Non-standard basic micro EG connection – For non-standard networks the above Single-phase and Three-phase basic micro EG connection export limits and unbalance limits apply.

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

This export limit is to be interpreted by the Proponent as a maximum. The ability of the Proponent’s basic micro 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 a basic micro EG system may need to be constrained for various scenarios including, but not limited to scenarios where power quality response modes are in operation.

4.3.1.1 *Additional Export Limit Requirements*

In the event of network or contractual constraints, Horizon Power may nominate an additional requirement for certain Proponents (or for certain towns) to install generation control devices that limit or prevents the export of energy onto the Horizon Power Electricity System.

In cases where a Proponent adds an energy storage system (ESS) to an existing basic micro EG connection, the total inverter capacity may increase beyond the maximum system capacity and export limits specified in this document, and a new application is required.

Note that irrespective of how much ESS capacity is added, the site export limits in Section 4.3.1 shall remain applicable for such installations. The Proponent shall provide the certification from the inverter manufacturer and installer that this requirement has been incorporated as a part of their design prior to approval.

Horizon Power may review the compliance of this requirement as a part of its ongoing post approval compliance checks.

4.3.1.2 *Zero Export Limit Requirements*

In the event of network or contractual constraints, Horizon Power may nominate that the basic micro EG connection must not export any energy.

In such circumstances, the maximum power spillage (power exported to Horizon Power's grid) from the zero export systems shall not exceed 100W.

4.3.1.3 *Equipment*

Generation control subsystems for export limiting may include but are not limited to:

- Inverter Disconnect Systems that disconnect the EG if the instantaneous generation exceeds the nominated export limit.
- Inverter Output Reducer Systems that control the instantaneous generation to ensure it does not exceed the nominated export limit.
- Energy storage devices that store the excess of energy (separate or integral of the inverter).

The generation control subsystems for export limiting shall:

- Limit the export of active power to Horizon Power's Electricity System in accordance with the nominated export limit.
- Use communication media, interfaces and protocols ensuring inter-operability of components in the subsystem.
- Meet the service life of the EG for the conditions under which it will be installed and operating.
- Be tamper-proof and settings are password protected.

4.3.2 Site Generation Limit Downstream of Connection Point

A site generation limit is not required for basic micro EG connections.

4.3.3 Balanced Generation

The nominal inverter output rating of a multi-phase EG connection, or systems connected to multi-phase supply connections, shall not differ by more than 2.5 kVA between phases.

Therefore, the following maximum inverter sizes may be connected to a three phase supply:

- Up to 2.5 kVA as a single-phase inverter.
- 2.5 kVA to 5.0 kVA as two single-phase inverters with no greater than 2.5 kVA imbalance between any two phases or one balanced two phase inverter.
- Greater than 5.0 kVA as three single phase inverters with no greater than 2.5 kVA imbalance between any two phases or one balanced three phase inverter in compliance with AS/NZS 4777.2.

Where multiple single-phase inverters are used, they must be operated in accordance with AS/NZS 4777.2 Section 8.2.

4.3.4 Renewable Energy Smoothing Requirements

Renewable Energy Smoothing is not required for basic micro EG connections.

4.3.5 Extended Ramp Rate Smoothing Requirements

Extended Ramp Rate Smoothing is not required for basic micro EG connections.

4.3.6 Feed in Management Requirements

Feed-in Management is a temporary control signal applied by Horizon Power to the IES to lower and then raise the IES output power.

Feed in management is not required for standard basic micro EG connections, unless specifically nominated by Horizon Power at the time of application. This could be due to local network constraints or conditions determined at the time of application.

Feed-in Management is a requirement for basic micro EG connections in non-standard network areas. Proponents in these areas must be feed-in management ready ('FIM Ready'), which includes the following:

- provision of single phase 240 V AC power supply, adjacent to the basic micro EG system, for the secure gateway device in accordance with Section 4.11 – Communications Systems; and
- provision of an inverter communications termination box, adjacent to the basic micro EG system, Section 4.11 – Communications Systems.

Each of these requirements, including the required equipment, obligations of the proponent, and details of the communications interface is outlined in Section 4.11 – Communications Systems. Horizon Power may choose to install a secure gateway device at the time of installation, or at a later date.

The generation control or management of a customer's basic micro EG connection may be initiated by Horizon Power, where a risk exists to power system reliability, due to network or communications outages, due to contractual obligations, or as required for system operational efficiencies.

In certain circumstances, isolation of a customer's basic micro EG connection may be required by Horizon Power where there is a threat to the safety of personnel or the public, or a threat to power system plant and equipment.

4.4 Inverter Energy System

The following requirements apply to inverter energy systems:

1. The Proponent shall ensure that the basic micro EG connection is compatible with the characteristics of Horizon Power's supply as defined in Section 2 of the Horizon Power Technical Rules.
2. The Proponent must ensure that the basic micro EG connection complies with AS/NZS 4777, AS/NZS 3100 and IEC 62109.
3. IES shall comprise of inverters installed in compliance with AS/NZS 4777.1
4. IES shall be tested by an authorised testing laboratory and be certified as being compliant with AS/NZS 4777.2 with an accreditation number
5. IES shall comprise of inverters that are registered with CEC as approved grid connect inverters. The CEC inverter certificate must not have expired at the time of connection application.
6. 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
7. IES shall comprise of inverters that have both volt-var and volt-watt response modes available.
8. Horizon Power may require the Proponent to update inverter settings upon request.

4.5 Network Connection and Isolation

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

Network connection and isolation requirements for IES shall include but not be limited to:

1. As a minimum, mechanical isolation shall be as per 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.
3. For PV systems, isolation requirements shall be as per AS/NZS 5033.

4.6 Earthing

The earthing requirements for basic micro EG connections shall include:

1. For IES, earthing requirements shall be as per AS/NZS 4777.1 and AS/NZS 3000
2. For ESS, earthing requirements shall be as per AS/NZS 3011.
3. For PV systems, earthing requirements shall be as per AS/NZS 5033.

4.7 Protection

4.7.1 Inverter Integrated Protection

Inverter integrated protection requirements shall be as per AS/NZS 4777.1 and AS/NZS 4777.2 for basic micro EG connections.

Passive anti-islanding requirements and settings shall be as per Table 13 in AS/NZS 4777.2, with any variations to AS/NZS 4777.2 marked with (*) and shown in the following table:

Table 8: Passive Anti-Islanding Settings

Protective Function	Protective function limit	Trip delay time	Maximum disconnection time
Undervoltage (V<)	180 V	1 s	2 s
Overvoltage 1 (V>)	265 V*	1 s	2 s
Overvoltage 2 (V>>)	265 V	-	0.2 s
Under-frequency (F<)	45 Hz*	1 s	2 s
Over-frequency (F>)	53 Hz*	-	0.2 s

Active anti-islanding protection requirements shall be as per AS/NZS 4777.2 and IEC 62116.

4.7.2 Central Protection

Where central protection is required, the Proponent shall comply with the requirements as per Table 1 of AS/NZS 4777.1.

Phase balance protection, where required, shall comply with the unbalance limits specified in this Document instead of AS/NZS 4777.

4.7.3 Interlocking

Where multiple single-phase inverters are connected to more than one phase, phase balance protection as per Clause 3.4.4 of AS/NZS 4777.1 is required, with exceptions outlined within Clause 5.4.4 in AS/NZS 4777.1.

4.8 Operating Voltage and Frequency

Horizon Power's supply characteristics are defined in Section 2 of the Horizon Power Technical Rules.

The maximum voltage set point V_{nom_max} is 258 V.

The Proponent shall be responsible for ensuring that the maximum voltage rise within the Premises complies with AS/NZS 4777.1 and shall submit evidence for Horizon Power's record keeping in the form of Schedule 4 Cable Data.

4.9 Metering

This section refers to the Horizon Power's revenue metering at the Proponent's connection point to Horizon Power's network.

4.9.1 Approved Meters

Only Horizon Power approved meters in accordance with Horizon Power Metering Standards and the WA Metering Code shall be used. If the Proponent has existing non-conforming meters, then they shall be replaced as a part of the EG installation at the Proponent's cost.

4.9.2 Approved Installers

The meter shall be installed by Horizon Power or its approved contractor.

4.9.3 Upgrading of Enclosure

In order to meet the meter installation requirements of Section 11 of the WA Distribution Connections Manual, the Proponent may be required to upgrade the enclosure where the meters are housed.

4.9.4 Measurement of Meters

Horizon Power shall perform measurements in accordance with the Metering Code and Horizon Power Metrology Procedures.

4.9.5 Cost of Metering

If meter replacement is required, the cost of materials and installation of meters shall be borne by the Proponent in accordance with the customer's Buyback Contract. This includes the cost of upgrading of enclosures and switchboard if required.

4.10 Power Quality

4.10.1 Quality of Supply

All grid-connected inverters shall comply with the settings specified in this section. These settings may be pre-set or programmable. A summary of these settings are provided in Appendix F.

The programming of the setting shall not be easily changed and preferably be done internally within the inverter or protected by a password.

Horizon Power may request changes to the above settings prior to energisation in specific circumstances.

4.10.2 IES Power Quality Response Modes

The following inverter power quality response modes as per AS/NZS 4777.2 are required:

1. Volt-Watt
2. Power Factor
3. Fixed Power Factor
4. Volt-VAr
5. Voltage Balance
6. Hz-Watt
7. Power Rate Limit

4.10.3 Volt-Watt Response Mode

All inverters are required to have Volt-Watt capabilities, with these capabilities **enabled by default** with settings as given in Appendix F, and shown in Figure 1.

Volt-Watt settings shall be as per AS/NZS 4777.2, with the following variations to AS/NZS 4777.2 marked with (*) and shown in the following table:

Table 9: Volt-Watt Response Reference and Maximum Set-Point Values

Reference	Value	Maximum value (P/P_{rated})
V_1	207	100%
V_2	220	100%
V_3	254*	100%
V_4	265	20%

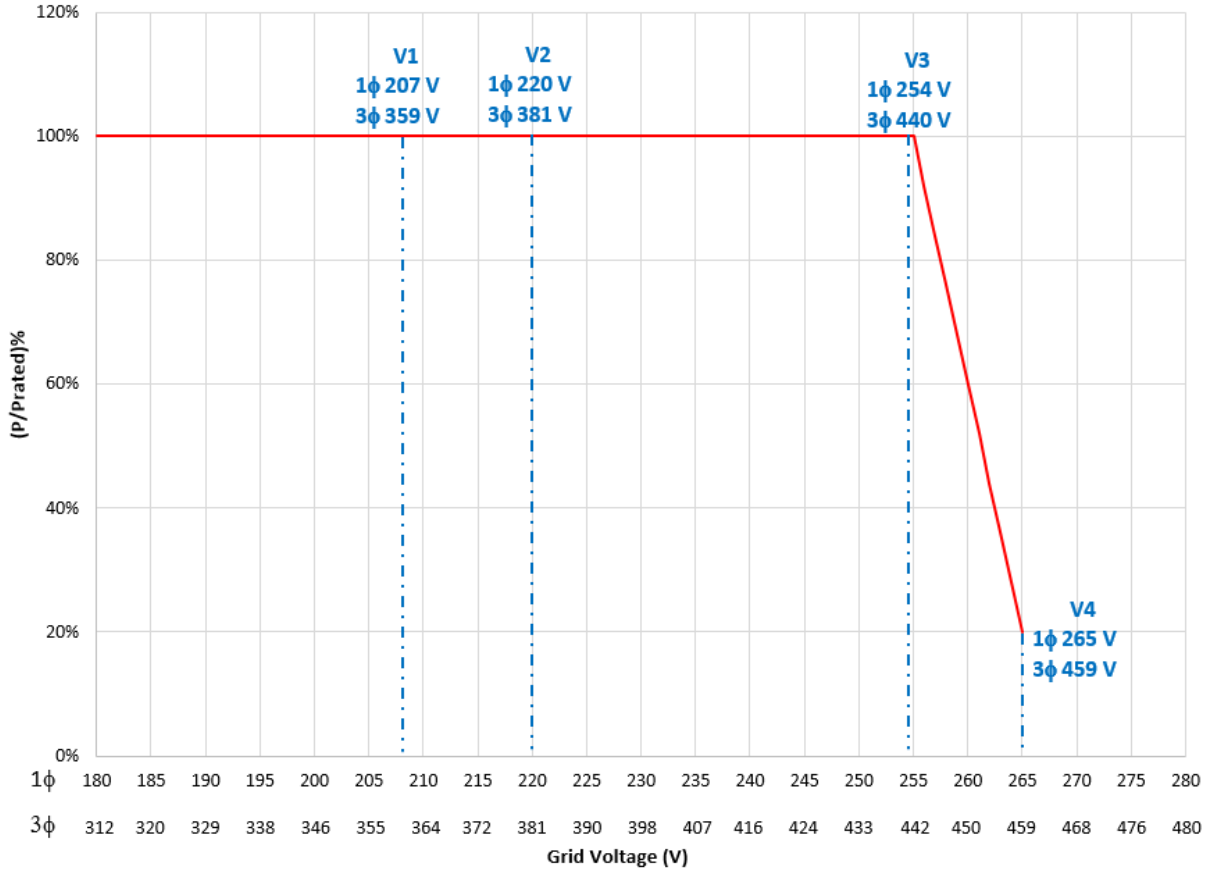


Figure 1: Volt-Watt response curve

Horizon Power may at any time direct the enabling or disabling of Volt-Watt Response Mode or a change to the default settings.

4.10.4 Power Factor Requirements

At all times during normal operation, inverters shall be capable of operating with a power factor within the range of 0.8 leading to 0.8 lagging as shown in Figure 2. The Proponent shall consider the maximum site design temperature when determining the operating ability of the inverter.

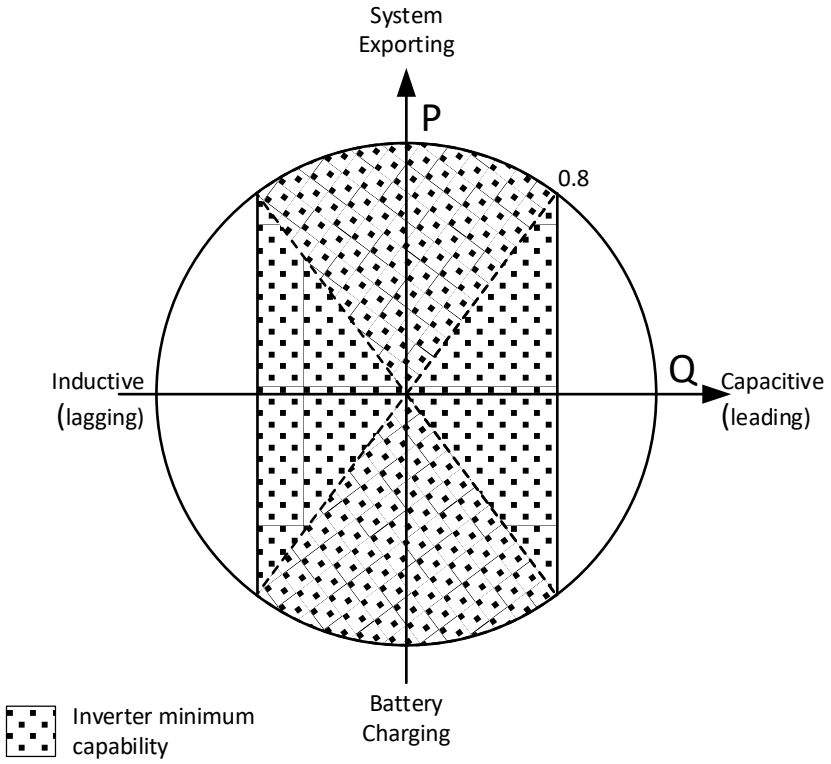


Figure 2: Power factor operational requirements for normal operation

4.10.5 Fixed Power Factor Mode

All inverters are required to be capable of operating in fixed power factor mode, with these capabilities **disabled by default**. Refer to Appendix F, for required settings.

Horizon Power may, at any time, direct the inverter to operate in fixed power factor mode, with settings as required by Horizon Power.

4.10.6 Volt-VAr Response Mode

All inverters are required to have Volt-VAr capabilities, with these capabilities **enabled by default** with settings as given in Appendix F, and shown in Figure 3.

Volt-VAr settings shall be as per AS/NZS 4777.2, with the following variations to AS/NZS 4777.2 marked with (*) and shown in the following table:

Table 10: Volt-VAr Response Reference and Set-Point Values

Reference	Reference Voltage	Set-Point Value (var % rated VA)
V_1	207	60% leading*
V_2	230*	0%
V_3	240*	0%
V_4	265	60% lagging*

Figure 3: Volt-VAr response curve

Horizon Power, may at any time, direct the enabling or disabling of Volt-VAr Response Mode, or a change to the default settings.

4.10.7 Voltage Balance Mode

All three-phase inverters, or single-phase inverters used in a three-phase system, are required to have Voltage Balance capabilities, with these capabilities **disabled by default.**

Horizon Power, may at any time, direct the enabling or disabling of Voltage Balance Mode, with settings as required by Horizon Power.

4.10.8 Hz-Watt Response Mode

All inverters are required to have Hz-Watt capabilities **enabled by default** with settings as given in Appendix F.

The relevant settings are in relation to the Over-Frequency Power Reduction response as described in Clause 7.5.3.1 of AS/NZS 4777.2, and include:

- *Activation Frequency* – this is the frequency level at which over-frequency power reduction is activated.
- *Deactivation Frequency* – this is the frequency level below which the over-frequency power reduction is deactivated (after a suitable delay – see the *Deactivation Time*) and the power level may be increased in accordance with the power rate limit.
- *Deactivation Time* – this is the period of time for which frequency must be below the *Deactivation Frequency* before the over-frequency power reduction is deactivated and the power level may be increased in accordance with the power rate limit.
- F_{stop} – this is the point on the Over-Frequency Power Reduction curve where the output of the system reaches zero.

The following settings are required for the Over-Frequency Power Reduction settings in non-standard network areas (i.e. outside the NWIS), in accordance with Appendix F:

- Activation Frequency: 50.6 Hz
- Deactivation Frequency: 50.5 Hz
- Deactivation Time: 20 sec
- F_{stop}: 53.0 Hz

Settings for standard network areas (i.e. NWIS) shall be as per Clause 7.5.3.1 of AS/NZS 4777.2.

The following figure is indicative of the Over-Frequency Power Reduction response characteristic (AS/NZS 4777.2 settings shown):

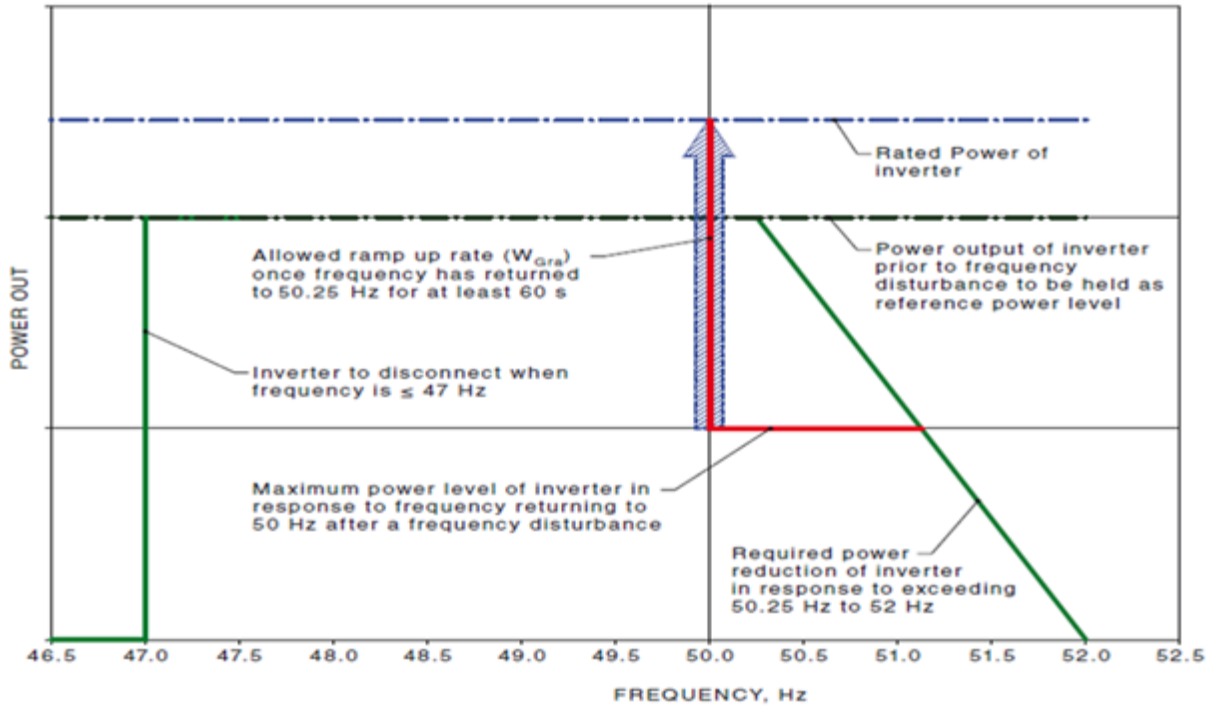


Figure 4: Over frequency response (Indicative)

For systems with energy storage, additional settings are also required to enable Under-Frequency Charge Rate Limits in accordance with Clause 7.5.3.2 of AS/NZS 4777.2.

The following settings are required for the Under-Frequency Charge Rate Limit settings in non-standard network areas (i.e. outside the NWIS), in accordance with Appendix F:

- Under-Frequency Activation Frequency: 49.4 Hz
- Under-Frequency Deactivation Frequency: 49.5 Hz
- Under-Frequency Deactivation Time: 20 sec
- $F_{stop-CH}$: 45.0 Hz

Settings for standard network areas (i.e. NWIS) shall be as per Clause 7.5.3.2 of AS/NZS 4777.2.

The following figure is indicative of the Under-Frequency response characteristic (AS/NZS 4777.2 settings shown):

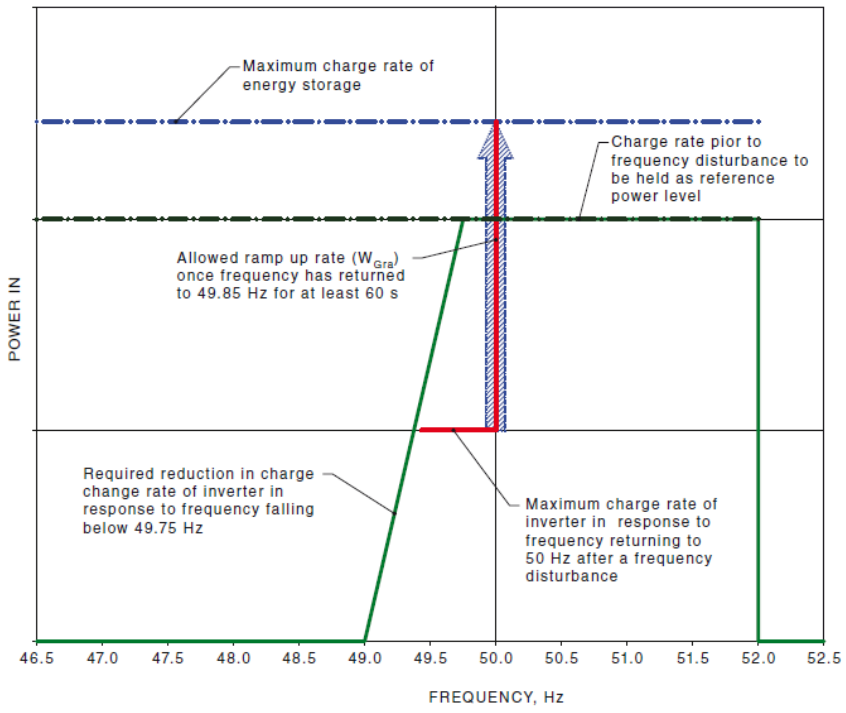


Figure 5: Under frequency response (Indicative)

4.10.9 Power Rate Limit Modes

All inverters are required to have a Soft Ramp Up after Connect or Reconnect mode as per AS/NZS 4777.2 Section 6.3.5.2.

Horizon Power only requires for soft ramp up to be applied to reconnection (i.e. ramp up / soft start).

The ramp up power rate limit shall be:

W_{Gra}+=16.67% of rated power per minute.

4.11 Communications Systems

This section identifies the communications systems requirements for basic micro EG connections.

Communications is not required for standard basic micro EG connections, unless specifically nominated by Horizon Power at the time of application. This could be due to local network constraints or conditions determined at the time of application.

Communications is a requirement for basic micro EG connections in non-standard network areas. Proponents in these areas must be feed-in management ready ('FIM Ready'), which includes the provision of a power supply and communications termination box, in accordance with the requirements of Section 4.11.2.

The provision of the power supply and communications enclosure are required as a prerequisite to enable the installation of a secure gateway device for communications between Horizon Power and the Proponent.

Horizon Power may choose to install a secure gateway device at the time of installation, or at a later date.

4.11.1 Communications – Horizon Power Obligations

Horizon Power shall undertake the following in relation to the communications subsystem:

- Supply and install a preconfigured secure gateway device, which will be owned by the Proponent.
- Own and maintain the communications channel (upstream of the gateway device) and any SIM card associated with the communications subsystem.
- Commission the communications subsystem.
- Perform control and monitoring of the renewable energy installation output.

4.11.2 Communications – Proponent Obligations

Where communications is required, the Proponent shall:

- Allow Horizon Power to remotely monitor and control the basic micro EG connection.
- Provide a labelled general power outlet (GPO) within 1m of the inverter, for the Horizon Power provided secure gateway device. The Label should read: 'SGD Power'.
- Provide an approximate 200 mm x 200 mm x 200 mm or larger enclosure (rated minimum IP24 suitable to the installation location) mounted adjacent to the GPO, for termination of the inverter communications.
    - The box opening may be screw sealed or hinged lockable.
    - The box shall be installed at a minimum height of 1200 mm from the finished ground or floor level.
    - The box shall be located in a safe and accessible location near the inverter.
    - The box should be labelled 'Inverter Comms'.
    - The box shall be suitably UV rated and non-transparent.

- Refer to Appendix I for indicative diagrams of installation requirements.

- Ensure that all communications from the inverter(s) shall be terminated inside, including DRED and MODBUS TCP connections. The installer shall also ensure any AS/NZS 4777 DRED adapters required are installed either inside the inverter or in the enclosure, with final DRED connections terminated inside the box.

  If the Proponent intends to also connect the inverter directly to their LAN, the Proponent shall ensure this is done only if a suitable additional network port or Wi-Fi connection is available. The primary inverter Ethernet connection must be connected to a terminated socket inside the Inverter Comms enclosure.

  Where the Proponent installs multiple inverters, all of the communications from each inverter shall be brought back and terminated within the box.

- Where multiple inverters are located at distances greater than 2m apart, a separate GPO and enclosure shall be provided for each inverter.

- Liaise with Horizon Power as required for commissioning of the Horizon Power provided secure gateway device.

- Own and maintain the Horizon Power provided secure gateway device and any associated wiring and accessories. The Proponent is responsible for all costs associated with replacement of the secure gateway device.

- Provide Horizon Power with full and unrestricted access to the basic micro EG connection, main switchboard, and any power supply, network connection, or secure gateway device installed as part of the basic micro EG connection, to perform any up front and ongoing works.

- Configure the inverter to provide suitable control and monitoring inputs to Horizon Power's secure gateway device. Horizon Power requires that all basic micro EG connections (including all inverters that make up the EG system) have Modbus TCP protocol capabilities. The inverters must comply with the Modbus mapping table in Appendix G.

4.11.3 Equipment

The communication subsystem shall comprise the following components:

- An approved gateway device with hardwired connection to the inverter system, including provision of single phase 240 V AC power for the secure gateway device.

- One or more enclosures (as specified in Section 4.11.2) to house the above components. Installation shall be away from direct sunlight.

- Installation shall be robust, as reasonably practicable, to discourage the people from tampering with the approved gateway device and its connection to the inverter.

- The Proponent shall declare to Horizon Power the name and model of CEC approved inverters that it proposes to monitor and control (Supported Inverters).

4.11.4 Gateways

The following requirements apply for gateways utilised as part of the communications system:

1. Only Horizon Power supplied gateway devices shall be used.

2. Horizon Power shall supply the approved gateway device.
3. The gateway device shall be pre-programmed by Horizon Power.
4. The gateway device shall be installed by Horizon Power.

4.12 Data and Information

4.12.1 Static Data and Information

The Proponent is to provide static data and information to Horizon Power as per Appendix D.

4.12.1.1 *Summary of Documentation to be Submitted*

The following documentation shall be supplied by the Proponent as part of their application:

- Completed Application Form;
- Compliance Checklist (Schedule 1);
- System Diagram (Schedule 2);
- Circuit Diagrams (Schedule 3);
- Cable Data (Schedule 4);
- System Parameters (Schedule 5);
- Static Data and Information as per Appendix D

Upon receipt of the application and all required information, Horizon Power shall undertake a Network Impact Assessment (NIA) for all applications.

Examples of the Schedules to be submitted are included in the Appendices and Schedules.

4.12.1.2 *Schedules to be submitted*

Schedule 1: Compliance Checklist

A checklist comprising the key elements that needs to be satisfied in order to comply with this Document.

Schedule 2: System Diagram

A conceptual diagram that illustrates the functional relationships between key subsystems using solid lines. The Proponent's System Diagram shall be in accordance with Appendix B of this Document.

Schedule 3: Circuit Diagram

One or more diagrams detailing the electrical connections **from the point of connection through to the EG energy source**. The Proponent's Circuit Diagram shall be in accordance with the Standards in Section 3.1 and the other requirements of this Document. The circuit diagram submitted to Horizon Power for reference shall include:

- Electrical connections for all phases.
- Neutral and earth connections (AC & DC).
- Switchboard electrical connections (depiction of Proponent final loads not required).
- Electrical interconnection of all electrical elements of the EG including inverters, energy storage devices, chargers, renewable energy sources, DC and AC protection devices etc.

Schedule 4: Cable Data

Data associated with power cables connecting the Proponent's grid connected inverter to Horizon Power's electricity distribution system. **This includes the consumer mains cable.** Cable data to be provided includes:

- Location of cable in installation
- Number of cores
- Cross sectional area and insulation type
- Cable Length
- Method of installation (e.g. underground in conduit)

The cables shall be depicted via one or more concept diagrams. Refer to the example at end of this Document.

Schedule 5: System Parameters

The Proponent is to capture the key parameters (including power quality response modes and protective functions) that will be implemented for their system.

4.12.2 Dynamic Data and Information

No dynamic data and information requirements apply for basic micro EG systems, beyond those requirements in Section 4.11 – Communications.

4.13 Cybersecurity

Where communications is required, Horizon Power shall notify the proponent of any cybersecurity requirements, which may include:

1. Monitoring and communications devices shall be in screw sealed or lockable enclosures
2. Protection and control from the network systems (firewalls)
3. Privilege settings and password protection
4. Limiting access to only that which is required to monitor the generating unit.
5. Communications shall be over secured channels or Modbus TCP.
6. No unauthorised changes to the SGD

4.14 Technical Studies

System Impact Studies (SIS) are generally not required for basic micro EG connections. Where a SIS is required, this will be undertaken at Horizon Power's cost. Note however should the SIS identify the requirement for any generation or network augmentation, or augmentation of the proponent's EG system to facilitate the EG connection then this will be at the customer's cost.

4.15 Systems with Energy Storage

Energy Storage Systems may be installed by the Proponent and shall comply with the requirements in this section.

4.15.1 Charging of Energy Storage Devices from the Grid

Horizon Power will permit limited charging of energy storage devices from the grid exclusively for the purposes of maintaining battery health.

Horizon Power will allow one cycle of the energy storage device per month (in aggregate) for the purposes of battery health cycling.

Horizon Power does not permit arbitrage. Any Proponent found to be charging Energy Storage Devices from the grid not in accordance with these requirements, may have their Basic Micro EG system disconnected from the grid until the system is shown to have been modified to meet these requirements.

Where charging of Energy Storage Devices from the grid is permitted by Horizon Power, this shall be in accordance with AS/NZS 4777.2, Sections 6.3.5, 6.4.3 and 7.5.3.2, with voltage and frequency setpoints provided in Appendix F.

Horizon Power may at any time direct the enabling or disabling of energy storage system charging, with settings as required by Horizon Power.

5 FEES AND CHARGES

Horizon Power's fees and charges for Basic micro EG connections are shown in Table 11 below.

Table 11: Horizon Power Fees and Charges for Basic Micro EG Connections

Type of Application	Technical Assessment	Required Information	Horizon Power Fees
Basic Micro EG Connection – Standard	Network Impact Assessment	Application form with Schedule 1,2,3,4 and 5	N/A
Basic Micro EG Connection – Non Standard	Network Impact Assessment	Application form with Schedule 1,2,3,4 and 5	N/A

Note however additional costs may be incurred in the event the Network Impact Assessment identifies the requirement for any generation or network augmentation, communications, or augmentation of the Proponent's EG system required to facilitate the EG connection.

6 TESTING AND COMMISSIONING

Testing and commissioning shall be undertaken 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 Horizon Power's Technical Requirements to demonstrate that the Basic Micro EG system meets the requirements of the connection agreement.

If requested, the Proponent will provide to Horizon Power a list of step-by-step energizing and commissioning procedures prior to Basic Micro EG system commissioning.

The Proponent shall retain a complete set of manuals, installation drawings; permits, inspection and verification test reports and make them available to Horizon Power if requested.

The tests shall be installation tests and functional tests, not type tests.

6.1 EG System Commissioning

Commissioning and verification shall be in accordance with section 8 of AS/NZS 3000, AS/NZS 5033 (if applicable), WADCM, WA Electrical Requirements and manufacturer specifications.

Prior to completion of the Basic Micro EG system commissioning, or whenever the system is modified, a verification test shall be performed as recommended by the equipment manufacturer and required by the relevant standard. Testing of the Basic Micro EG system shall include procedures to functionally test all protective elements including verification of inverter trip timing.

Horizon Power reserves the right to witness commissioning or request evidence of commissioning results.

Commissioning of the feed in management system by Horizon Power may require the Proponent's involvement as part of the commissioning process.

7 OPERATIONS AND MAINTENANCE

Basic micro EG systems should be operated and maintained to ensure compliance with their connection agreement and all legislation, codes, and/or other regulatory instruments at all times.

Horizon Power may inspect the Proponent's basic micro EG system at any time. This inspection will be at Horizon Power's cost.

Operations and maintenance requirements for basic micro EG systems shall include, but not be limited to:

1. Maintaining the electrical installation at the supply address in a safe condition.
2. 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.
3. The Proponent shall seek Horizon Power 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.

7.1 Compliance Audits

The EG system shall comply with the Technical Requirements at all times, until it is permanently disconnected. The Proponent shall notify Horizon Power when the EG is permanently disconnected.

Horizon Power may undertake audits of the EG system for compliance with the requirements of this Document.

Note that compliance audits of existing EG systems connected prior to this version of the Technical Requirements may also be undertaken; these systems shall be assessed against the version of the Technical Requirements at the time the system was approved to connect to the grid.

Horizon Power will contact the Proponent to arrange for an audit of the EG system at their Premises. The Proponent shall provide full unrestricted access to the EG system to the Horizon Power personnel or authorised Horizon Power contractor undertaking the audit.

The results of the audit will be recorded on Horizon Power's system for future reference.

Should the audit identify non-compliance with the Technical Requirements, a Fault Note will be placed on the installation, with the EG system disconnected from Horizon Power's network. The EG system will not be reconnected to the grid until Horizon Power is satisfied that the non-compliance has been resolved. Rectification of non-compliance issues shall be at the Proponent's cost.

The frequency for audits will not be more than once per year, with exceptions where non-compliance has previously been identified for the EG connection at the same Premises.

APPENDIX A. DEVIATIONS FROM THE NATIONAL DER CONNECTION GUIDELINES

All deviations from the National DER Connection Guidelines are shown in Table 12.

Table 12: Table of Deviations from National DER Connection Guidelines

Section	Description of Deviation	Type of Deviation	Justification
4.3.1 Export Limits at Connection Point	Reduction of unbalance limits at Connection Point for Three-phase basic micro EG IES connections from 5 kVA per phase to 2.5 kVA per phase.	Jurisdictional	N/A
4.3.3 Balanced Generation	Reduction of unbalance limits for multiple single-phase inverters connected to more than one phase from 5 kVA between phases to 2.5 kVA between phases.	Jurisdictional	N/A
4.7.2 Central Protection	Where required, phase balance protection is set to greater than 2.5 kVA between phases instead of 5 kVA as specified in AS/NZS 4777.1	Jurisdictional	N/A

Note that, consistent with provisions under the Energy Networks Australia National DER Connection Guidelines, Horizon Power has the following additional requirements:

- Alternative inverter settings are required in accordance with Appendix F to cater for voltage and frequency fluctuation characteristics of Horizon Power's systems (ref Appendix F); and
- Additional Communications requirements in non-standard network areas to cater for power station constraints in Horizon Power's systems (ref sections 4.3.6 and 4.11).

APPENDIX B. CONNECTION ARRANGEMENT REQUIREMENTS

A system diagram illustrates the functional relationships between key subsystems using solid lines. The lines do not represent wiring, rather energy flows between subsystems. Details such as intermediary protection devices, chargers, internal device connections, switches and links are not displayed on the provided system diagrams.

The Proponent's Electrical Installation shall be in accordance with the following system diagrams:

- System Diagram A (Basic micro EG system without **communications**);
- System Diagram E (Basic micro EG system with **communications**);

(**Note that System Diagrams B, C and D are not applicable and have been removed from this document.**)

Common elements to the system diagrams include, but are not limited to:

- A single point of connection between the Proponent's Electrical Installation and Horizon Power's Low Voltage Grid.
- Splitting of the Proponent's Electrical Installation into the following elements:
    - EG
    - Proponent Final Loads
    - One or more switchboards
    - Tariff Meter and sub meters
- The EG may include, but is not limited to the following devices:
    - Renewable Energy Sources (e.g. photovoltaic cells, wind turbine)
    - Grid Connected Inverter
    - Other Inverters (if required)
    - Chargers
    - Grid Protection Devices
    - Energy Storage Devices (e.g. battery bank)
    - Feed-in Management Devices
    - Associated control, monitoring, protection and auxiliary equipment (e.g. gateway devices)
- Final Proponent Loads
    - Final Proponent Loads requiring energy
    - Associated control, monitoring, protection and auxiliary equipment

System Diagram A: Basic micro EG Connections without Communications

System Diagram A is represented in Figure 7 below:

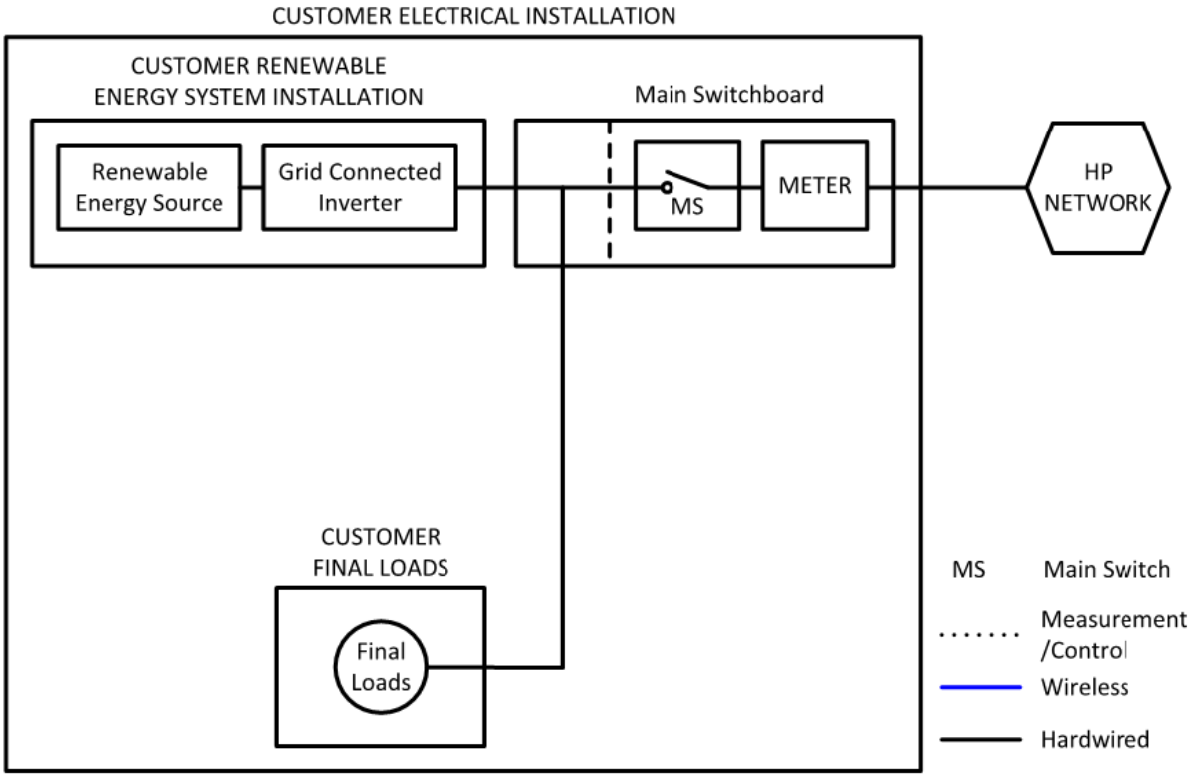


Figure 6: System Diagram A – Basic micro EG Connections without Communications

Key elements of System Diagram A are:

- No Communications is required
- The energy storage device or renewable energy smoothing is not a mandatory requirement. It may be added by the Proponent as long as the export limit requirements in Section 4.3.1 are addressed.
- No direct connection is permitted between the Proponent's EG Installation and Proponent Final Loads. Connection must be made via the switchboard.

System Diagram E: Basic micro EG Connections with Communications

System Diagram E is represented in Figure 7 below:

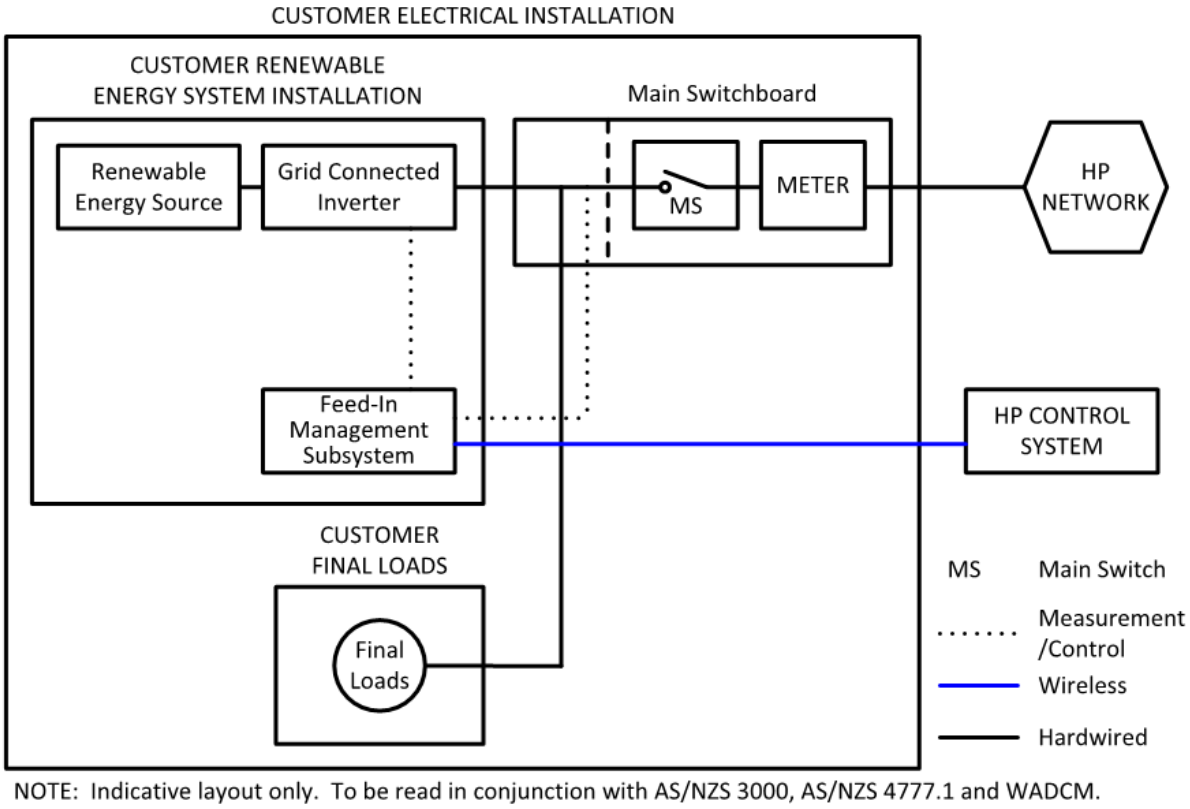


Figure 7: System Diagram E – Basic micro EG Connections with Communications

Key elements of System Diagram E are:

- Use of Communications (Feed in management subsystem, where required) (see Section 4.3.6).
- The energy storage device or renewable energy smoothing is not a mandatory requirement. It may be added by the Proponent as long as the export limit requirements in Section 4.3.1 are addressed.
- No direct connection is permitted between the Proponent's EG Installation and Proponent Final Loads. Connection must be made via the switchboard.

APPENDIX C. MODEL STANDING OFFER (CONNECTION AGREEMENT)

The REBS product is offered on a ‘net export’ basis. Please refer to Horizon Power’s website for Eligibility Calculator and associated ‘Terms and Conditions’ for REBS product details.

APPENDIX D. STATIC DATA AND INFORMATION

This appendix includes the static data and information that is required to be provided by the Proponent to Horizon Power, including as a minimum:

1. NMI meter numbers (10 digit)

2. DER Devices
    a) Fuel source – primary {renewable/biomass/waste; fossil; hydro; geothermal; solar; wave; wind; tidal; storage}
    b) Fuel source – descriptor
    c) Make, model and manufacturer
    d) Maximum capacity (kW or MW)
    e) Storage capacity (kWh/MWh of available storage)
    f) Installer
    g) Whether the device is remotely controllable (Y/N)
    h) Compliance with Australian Standards

3. Inverter
    a) Make, model and manufacture
    b) Whether the installer has changed the inverter default manufacturer settings (Y/N) with details of any changes
    c) Maximum capacity (kW and kVA)
    d) Date of installation
    e) Compliance with Australian Standards

4. Inverter enabled modes of operation
    a) Demand response modes enabled and enablement method
    b) Power quality modes {power response (frequency control); voltage response (voltage-watt or voltage-var); Q (reactive power), PF (power factor)}

5. Trip settings
    a) Frequency trip settings {over-frequency, under frequency}
    b) Voltage trip settings {over-voltage, under-voltage}
    c) Other protection functions and settings

APPENDIX E. LIST OF AMENDMENTS TO PREVIOUS VERSION

This document includes the following amendments since the previous version:

Section	Affected Clause	Type of Change
	Note Initial document incorporating ENA National connection Guidelines. This document supersedes standard HPC-9FJ-12-0001-2012.	

Notes:
[1] 'New addition' refers to the addition of a new clause not available in previous version of document
[2] 'Amendment to Existing' refers to modifications made to a clause in previous version of document
[3] The table above is not an exhaustive list of all changes made to this document

APPENDIX F. SUMMARY OF INVERTER SETTINGS

The following settings are required for inverters connected to Horizon Power's systems The settings are in accordance with AS/NZS 4777.2:2015, with any variations to the standard settings marked with (*).

Table 13: Summary of Required Inverter Settings

AS/NZS 4777.2: 2015 Clause	Description	AS/NZS 4777.2:2015 Default setting	Horizon Power required settings
6.2	Inverter demand response modes	DRM 0 Disconnect - required. DRM 1 to DRM 8 - optional.	*DRM 0 implemented as required by Horizon Power*. DRM 1 to DRM 8 - not required.
6.3	**Power quality response modes**		
6.3.2.2	Volt-Watt response mode	Default - **enabled**.	Required by all inverters. Enabled for all inverters. Settings: 1Ø / 3Ø V1 = 207 / 359 V2 = 220 / 381 V3 = 254* / 440* V4 = 265 / 459 Volt-watt response active power setpoints in accordance with Table 10 of AS/NZS 4777.2.
6.3.2.3	Volt-VAr response mode	Default - **enabled.**	Required by all inverters. Enabled for all inverters. Settings: 1Ø / 3Ø V1 = 207 / 359 V2 = 230* / 398 V3 = 240* / 415 V4 = 265 / 459 Volt-var response reactive power setpoints as follows: Setpoints (VAr % rated VA) V1 | 60% leading* V2 | 0 V3 | 0 V4 | 60% lagging*
6.3.2.4	Voltage balance mode	Default - disabled.	Disabled for standard connections. As directed by Horizon Power, enabling of this mode may be requested.

AS/NZS 4777.2: 2015 Clause	Description	AS/NZS 4777.2:2015 Default setting	Horizon Power required settings
6.3.3	Fixed power factor mode and reactive power mode	Default - disabled.	Disabled for standard connections. As directed by Horizon Power, enabling of this mode may be requested.
6.3.4	Power factor curve -Cos φ (P)	Default - disabled.	Disabled for standard connections. As directed by Horizon Power, enabling of this mode may be requested.
6.3.5 (6.3.5.3.2) 6.3.5.3.2	Power rate limit (Ramp Rate) Modes: (a) Soft Ramp Up after connect or reconnect Note: This will be applied to reconnection (i.e. ramp up/soft start)	**Required**.	Required. As per this Document Ramp Up: W_{Gra}+= 16.67% of rated power per minute
Protective functions for connection to electrical installations and the grid			
7.3	Active anti-islanding protection	**Required**.	Test method to IEC 62116 is required
7.4	Passive anti-islanding protection	R**equired**	Frequency: f_{min} = 45 Hz f_{max} = 53 Hz Voltage: 1Ø / 3Ø Vmin= 180 / 312 V Vmax= 265 / 459 V
7.5.2	Sustained operation for voltage variations	**Required.**	Required. 1Ø / 3Ø Vnom-max = 258 V* / 447 V

AS/NZS 4777.2: 2015 Clause	Description	AS/NZS 4777.2:2015 Default setting	Horizon Power required settings
7.5.3.1	Sustained operation for frequency variations – Response to an increase in frequency	**Required**.	The following settings are required for Over-Frequency Power Reduction[2] in non-standard network areas (i.e. outside the NWIS): Activation Frequency = 50.6 Hz* Deactivation Frequency = 50.5 Hz* Deactivation Time = 20 sec* F_{stop} = 53 Hz* Settings for standard network areas (i.e. NWIS) shall be as per Clause 7.5.3.1 of AS/NZS 4777.2.
7.6	Disconnection by external signal.	**Required**.	Required. Implemented as directed by Horizon Power for individual connections.
7.7	Connection and reconnection procedure	**Required**.	Required. Frequency to be maintained within 47.5 Hz to 50.5 Hz*
Additional requirements for multiple mode inverters			
6.3.5.3.4	Power rate limit (Ramp Rate) (c) Changes in energy source operation. Note: This will be applicable to multiple mode (hybrid) inverters with energy storage .	.	Enabled. Ramp Down:. W_{Gra} – = 8.33% of rated power per minute (12 min ramp down rate) Ramp Up: W_{Gra}+= 16.67% of rated power per minute (6 min ramp up rate)

[2] The relevant settings in relation to the Over-Frequency Power Reduction settings as described in Clause 7.5.3.1 of AS/NZS 4777.2, include:

- Activation Frequency – this is the frequency level at which over-frequency power reduction is activated.
- Deactivation Frequency – this is the frequency level below which the over-frequency power reduction is deactivated (after a suitable delay – see the Deactivation Time) and the power level may be increased in accordance with the power rate limit.
- Deactivation Time – this is the period of time for which frequency must be below the Deactivation Frequency before the over-frequency power reduction is deactivated and the power level may be increased in accordance with the power rate limit.
- F_{stop} – this is the point on the Over-Frequency Power Reduction curve where the output of the system reaches zero.

AS/NZS 4777.2: 2015 Clause	Description	AS/NZS 4777.2:2015 Default setting	Horizon Power required settings
6.4.3	Volt watt response mode for **charging of energy storage**	**Required**.	Required. Settings: 1Ø / 3Ø V1= 180 / 312 V V2= 220 / 381 V V3= 254* / 440 V* V4= 265 / 459 V Volt-watt response active power setpoints in accordance with Table 12 of AS/NZS 4777.2.
7.5.3.2	Sustained operation for frequency variations – Response to a decrease in frequency **(charging of energy storage)**	**Required**	The following settings are required for Under-Frequency Charge Rate Limits in non-standard network areas (i.e. outside the NWIS): Activation Frequency = 49.4 Hz* Deactivation Frequency = 49.5 Hz* Deactivation Time = 20 sec* $F_{stop\text{-}CH}$ = 45 Hz* Settings for standard network areas (i.e. NWIS) shall be as per Clause 7.5.3.2 of AS/NZS 4777.2.

APPENDIX G. REQUIRED MODBUS PARAMETERS

Horizon Power requires that basic micro EG connections (including all inverters that make up the EG system) have Modbus TCP protocol capabilities.

As a minimum, the following Modbus parameters are required for all inverters, unless otherwise agreed by Horizon Power.

Required Functionality	Variable Name/ID	Unit	Data Type	Size	Read / Write	Variable Description	Mandatory (Y/N)
Inverter Nameplate Ratings	WRtg	W	uint16	1	R	Continuous power output capability of the inverter.	Y
	WRtg_SF	-	sunssf	1	R	Scale factor	Y
Control of inverter active power output	WMaxLimPct	% WMax	uint16	1	RW	Set power output to specified level.	Y
	WMaxLimPct_RmpTms	secs	uint16	1	RW	Ramp time for moving from current setpoint to new setpoint.	Y
	WMaxLim_Ena	-	enum16	1	RW	Enumerated valued. Throttle enable/disable control: 0: DISABLED 1: ENABLED	Y
Control of inverter reactive power output	VArMaxPct	-	sunssf	1	RW	Reactive power as a % of VArMax	N
Monitoring of the following data	ChaState	% AhrRtg	uint16	1	R	Currently available energy as a percent of the capacity rating.	Y
	InBatV	V	uint16	1	R	Internal battery voltage.	Y
	InBatV_SF		sunssf	1	R	Scale factor for battery voltage.	Y
	A	A	uint16t	1	R	AC Current	Y
	A_SF		sunssf	1	R	Current scale factor	Y
	PhV	V	int16	1	R	Line to Neutral AC Voltage (per phase or average of active phases)	Y
	V_SF		sunssf	1	R	Voltage scale factor	Y
	Hz	Hz	int16	1	R	Frequency	N
	Hz_SF		sunssf	1	R	Frequency scale factor	N
	W	W	int16	1	R	AC Power	Y
	W_SF		sunssf	1	R	Active Power scale factor	Y
	VAr	VAr	int16	1	R	AC Reactive Power	Y
	VAR_SF		sunssf	1	R	Reactive Power scale factor	Y
	VA	VA	int16	1	R	AC Apparent Power	N
	VA_SF		sunssf	1	R	Apparent Power scale factor	N
	PF	PF	int16	1	R	Power Factor	N
	PF_SF		sunssf	1	R	Power Factor scale factor	N
	PPVphAB	V	int16	1	R	Phase Voltage AB	N
	PhVphA	V	int16	1	R	Phase Voltage AN	Y
	TotWhExp	Wh	acc32	2	R	Total Energy Exported	N

Required Functionality	Variable Name/ID	Unit	Data Type	Size	Read / Write	Variable Description	Mandatory (Y/N)
	TotWhImp	Wh	acc32	2	R	Total Energy Imported	N
	TotWh_SF		sunssf	1	R	Energy scale factor	N
Control and monitoring of inverter isolation circuit breaker (or electronic isolator) • Control of Isolation Circuit Breaker (open/close) • Monitor status of Isolation Circuit Breaker (open/closed)	Conn	-	enum16	1	RW	Enumerated value. Connection control: 0: DISCONNECT 1: CONNECT	Y
Monitoring of inverter status and relevant fault/alarm indications	St	-	enum16	1	R	Enumerated value. Operating state: 1: OFF (Device is not operating) 2: SLEEPING (Device is sleeping / auto-shutdown) 3: STARTING (Device is starting up) 4: MPPT (Device is auto tracking maximum power point) 5: THROTTLED (Device is operating at reduced power output) 6: SHUTTING DOWN (Device is shutting down) 7: FAULT (One or more faults exist) 8: STANDBY (Device is in standby mode)	N
	Evt1	-	bitfield32	2	R	Bitmask value. Event fields: 0: GROUND_FAULT 1: DC_OVER_VOLT 2: AC_DISCONNECT 3: DC_DISCONNECT 4: GRID_DISCONNECT 5: CABINET_OPEN 6: MANUAL_SHUTDOWN 7: OVER_TEMP 8: OVER_FREQUENCY 9: UNDER_FREQUENCY 10: AC_OVER_VOLT 11: AC_UNDER_VOLT 12: BLOWN_STRING_FUSE 13: UNDER_TEMP 14: MEMORY_LOSS 15: HW_TEST_FAILURE	N

APPENDIX H. HORIZON POWER SERVICE AREA

Horizon Power's service area is shown in the figure below. The NWIS covers the area between Karratha and Port Hedland and surrounding suburbs.

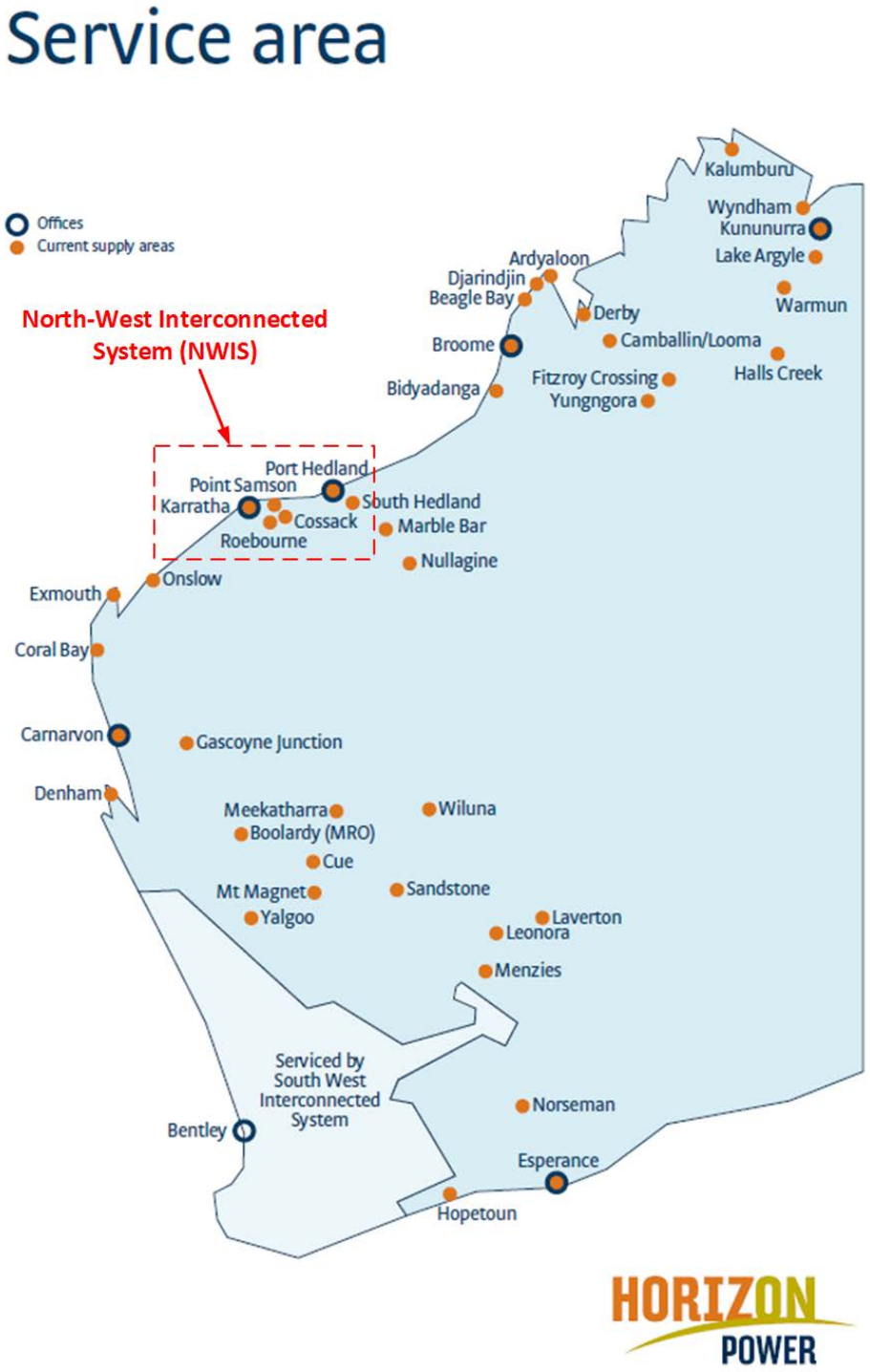


Figure 8: Horizon Power Service Area map showing NWIS

APPENDIX I. SGD ENCLOSURE INSTALLATION DIAGRAM

An indicative diagram for FIM ready SGD enclosure installation requirements is shown in the figure below.

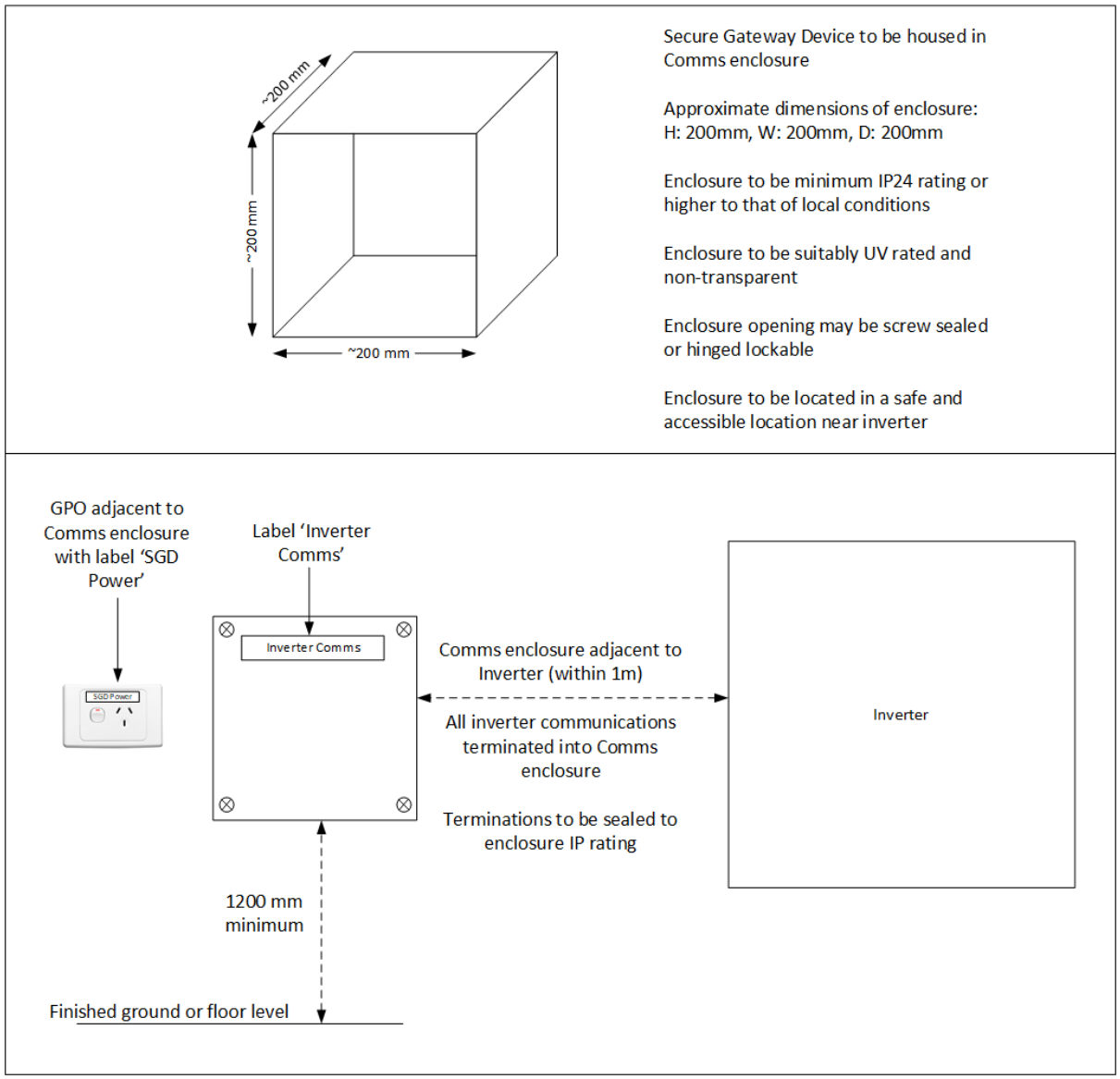


Figure 9: SGD Enclosure Installation Diagram (Indicative)

SCHEDULES

The following Schedules shall be submitted to Horizon Power by the Proponent as part of their application:

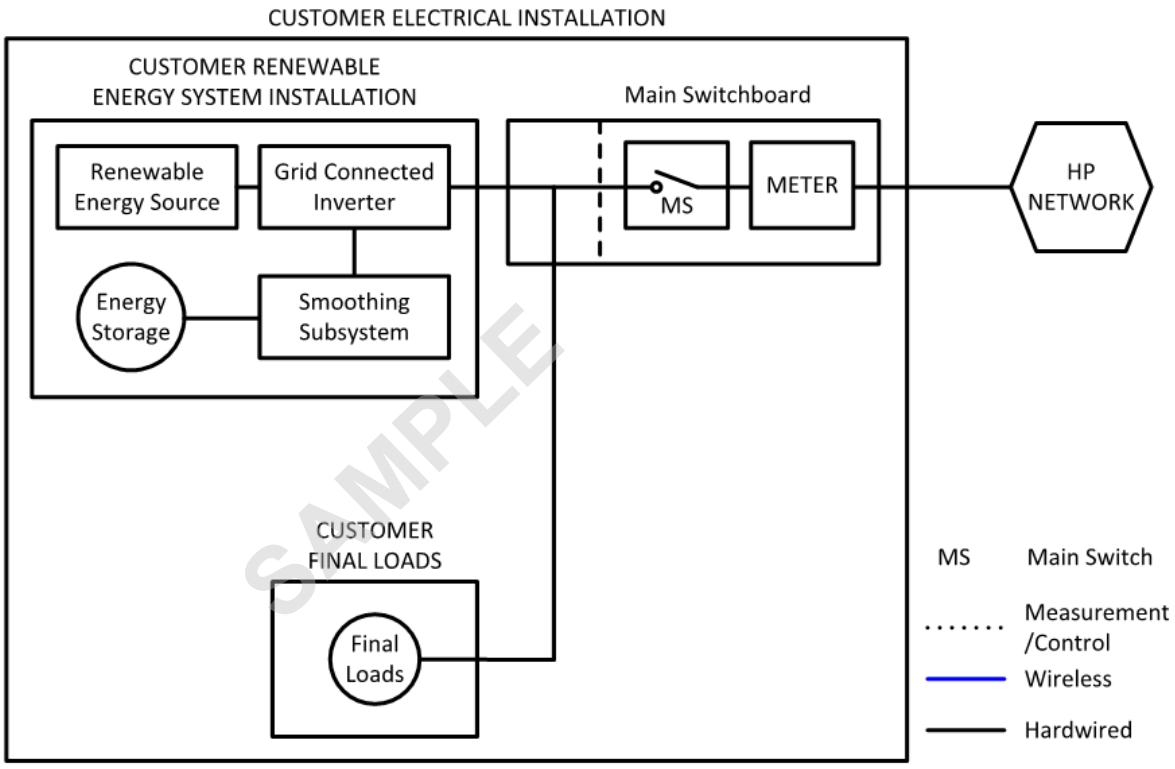
- Schedule 1 Proponent Compliance Checklist
- Schedule 2 System Diagram (example included below)
- Schedule 3 Circuit Diagram (example included below)
- Schedule 4 Cable Data (example included below)
- Schedule 5 System Parameters

SCHEDULE 1. PROPONENT COMPLIANCE CHECKLIST

System Type:		Basic Micro	**Comments**
System Diagram: (A or E)			
Description	**Clause**	**Complies**	
Export Limit	4.3.1	□	
Balanced Generation	4.3.3	□	
Feed in Management	4.3.6	□	
Inverter Energy System	4.4	□	
Network Connection and Isolation	4.5	□	
Earthing	4.6	□	
Protection Requirements	4.7	□	
Passive anti-islanding	4.7.1	□	
Horizon Power Meter at Property	4.9	□	
Volt-Watt Response	4.10.3	□	
Power Factor Requirements	4.10.4	□	
Volt-VAR Response	4.10.6	□	
Volt-Hz Response	4.10.8	□	
Communications Systems	4.11	□	
Schedule 2	4.12.1.2	□	
Schedule 3	4.12.1.2	□	
Schedule 4	4.12.1.2	□	
Schedule 5	4.10	□	
Cybersecurity	4.13	□	
Systems with Energy Storage	4.15	□	
Testing and Commissioning	6	□	
Operations and Maintenance	7	□	

SCHEDULE 2. SYSTEM DIAGRAM

*******SAMPLE ONLY******

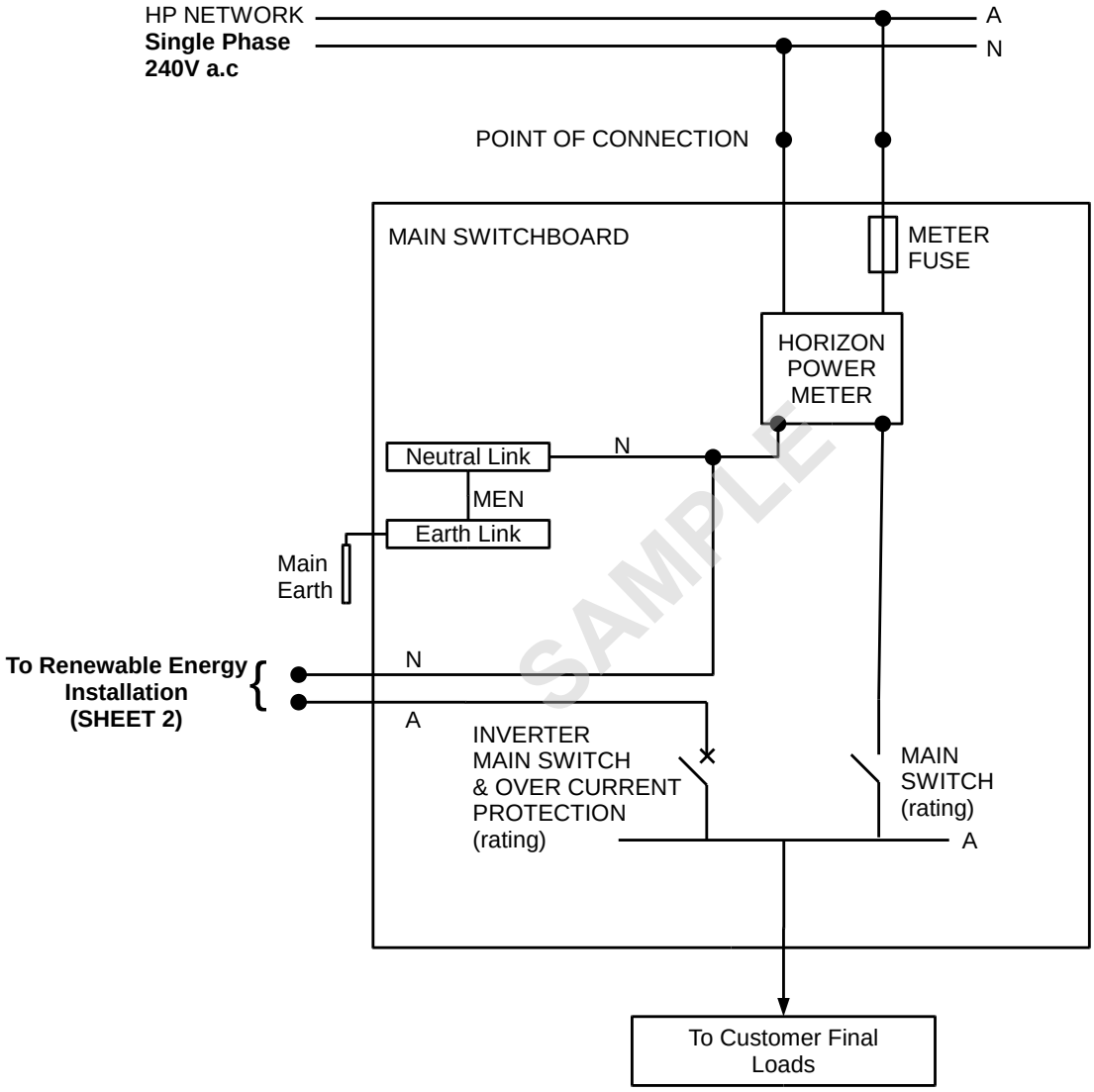


NOTE: Indicative layout only. To be read in conjunction with AS/NZS 3000, AS/NZS 4777.1 and WADCM.

SCHEDULE 3. CIRCUIT DIAGRAM

*******SAMPLE ONLY******

SHEET 1

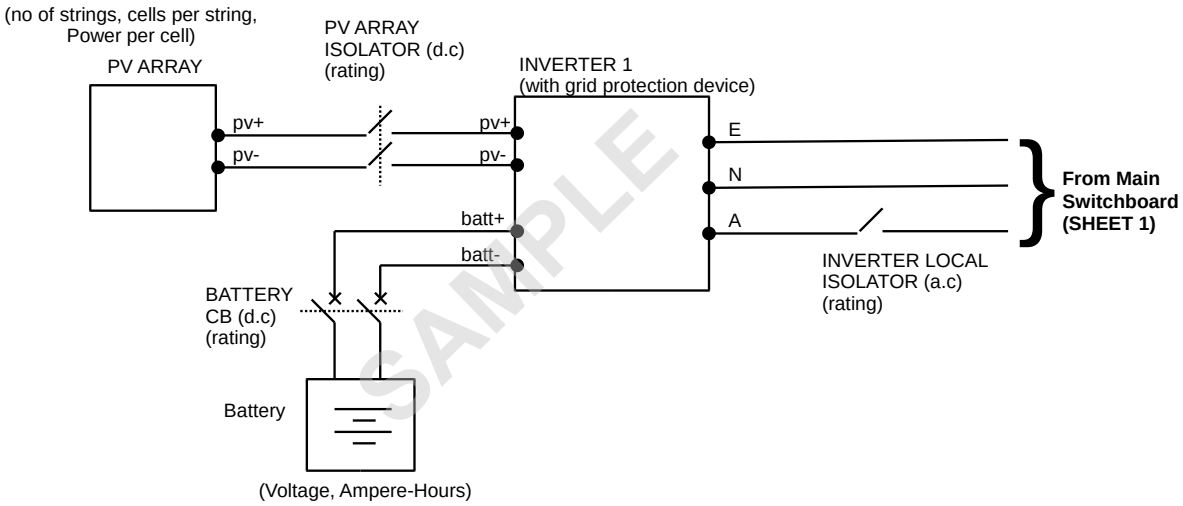


Note: For indicative purposes only **-** the Proponent shall rely on the other requirements of this Document together with AS/NZS 4777.1, AS/NZS 3000, AS/NZS 5033 (PV only) and other applicable documents to connect the internal components of Renewable Energy Installation correctly

(Schedule 3 continued)

*******SAMPLE ONLY******

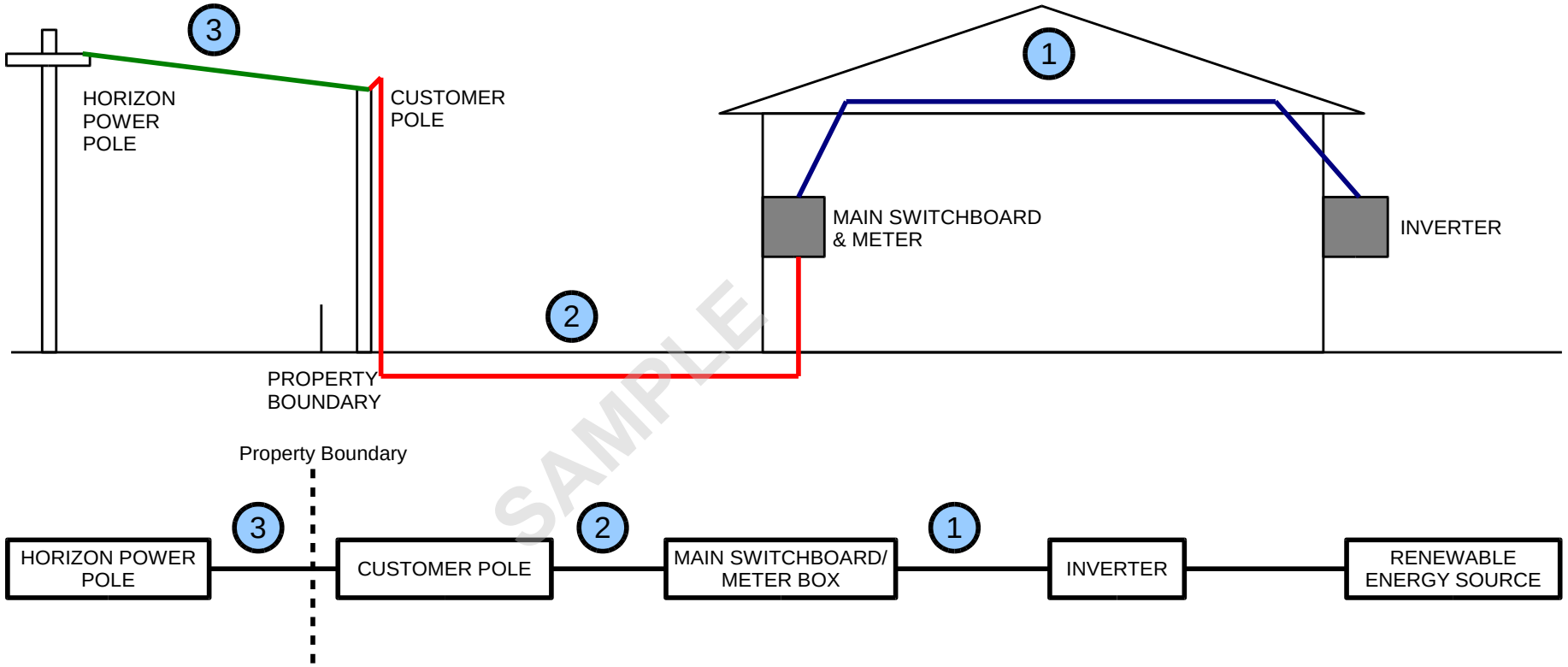
SHEET 2



SCHEDULE 4. CABLE DATA

*******SAMPLE ONLY******

Concept Drawings (Sample):



(Schedule 4 continued)

******NOTE: Include cable information for all power cables between Inverter and Point of Supply******

Concept Drawing Item	Cable Length	Cable Type	Installation type
1	10m	6mm^2 , 2 Core + Earth, PVC/PVC, Copper	In Roof Space
2	20m	6mm^2 , 2 Core, PVC/PVC, Copper	Underground
3	30m	6mm^2 , 2 Core, Bare, Copper	Overhead

SCHEDULE 5. SYSTEM PARAMETERS

Site Export Limit			
Total site export limit to Horizon Power Grid		kVA	
Power Quality Response Mode			
Voltage balance mode		***Enabled*** *or* ***Disabled ?*** *; Default = Disabled*	
Fixed power factor mode and reactive power mode		*Refer to Basic Micro EG Connection and LV EG connection Technical Requirements - Appendix F: Voltage balance mode, Fixed power factor and reactive power mode and Power factor*	
Power factor curve -Cos ϕ (P)			
Volt- Watt Response			
V1		Volts	*Refer to Basic Micro EG Connection Technical Requirements - Appendix F: Volt-Watt response mode*
V2		Volts	
V3		Volts	
V4		Volts	
Volt- VAr Response			
V1		Volts	*Refer to Basic Micro EG Connection Technical Requirements - Appendix F: Volt-VAr response mode*
V2		Volts	
V3		Volts	
V4		Volts	
Setpoints (VAr % rated VA)			
V1		leading	*Refer to Basic Micro EG Connection Technical Requirements - Appendix F: Volt-VAr response mode*
V2	0		
V3	0		
V4		lagging	
Protective function			
Passive anti-islanding protection			
Fmin		Hz	*Refer to Basic Micro EG connection Technical Requirements - Appendix F: Passive anti-islanding protection*
Fmax		Hz	
Vmin		Volts	
Vmax		Volts	
Sustained operation for voltage and frequency variations			
Vnom-max		Volts	*Refer to Basic Micro EG Connection - Appendix F: Sustained operation for voltage variation*
Fstop		Hz	*Refer to Basic Micro EG Connection Technical Requirements - Appendix F: Sustained operation for frequency variation*
Fstop-CH		Hz	
Notes			