



Technical Requirements for Renewable Energy Systems Connected to the Low Voltage (LV) Grid via Inverters

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1 INTRODUCTION

The purpose of this Document is to specify the minimum Technical Requirements for customers connecting a Renewable Energy System to Horizon Power's Low Voltage Grid via inverters. This includes all customer Renewable Energy Systems, regardless of whether such systems export electricity into the Electricity System or not. The Document aims to be technology agnostic and therefore allow Customers and the market to come up with the appropriate technology to suit the Renewable Energy Connection application.

1.1 Context

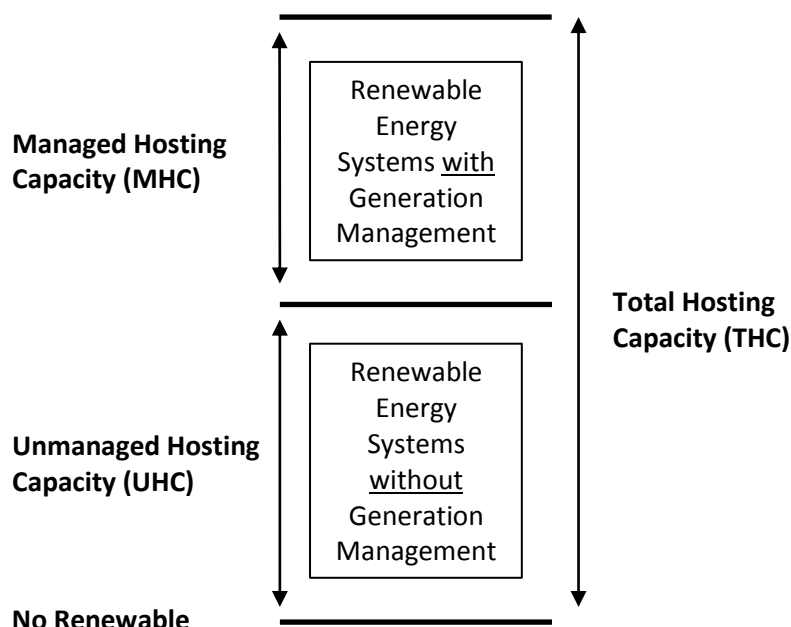
Horizon Power presently allows connection of a fixed total amount of customer generated Renewable Source Electricity capacity to its Electricity System. This target is known as Hosting Capacity and varies from town to town as it is set at a level that allows Horizon Power to technically and commercially deliver safe and reliable electricity.

The Hosting Capacity can be constrained by technical and commercial considerations.

The Total Hosting Capacity (THC) is made up of Unmanaged Hosting Capacity (UHC) plus Managed Hosting Capacity (MHC).

Unmanaged Hosting Capacity refers to the amount of hosting capacity available for renewable energy systems without any form of Generation Management. Managed Hosting Capacity refers to the amount of hosting capacity available for renewable energy systems equipped with Generation Management.

Figure 1: Total, Unmanaged, Managed Hosting Capacity



Generation Management is a method by which the variable output of Renewable Energy Systems is either:

- (a) directly or by remote means controlled, curtailed, suspended, interrupted or in any way reduced; and/or
- (b) managed, either by means of electricity storage, load management or by other electricity generation.

The three types of Generation Management applicable to this Document are described in Table 1.

Table 1: Types of Generation Management

Type of Generation Management	Description
Smoothing	Participating customers to install Energy Smoothing Devices that prevent system instability. For example; energy storage, load control or any other method that meets the required ramp rates.
Feed-in Management	Participating customers to allow Horizon Power to control the customer's generation output to prevent system instability.
Zero-Export	Participating customers to install Energy Control Devices that prevent the export of energy onto the Horizon Power Electricity System.

1.2

Definitions

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
Battery Energy Storage System (BESS)	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.
Current Transformer	A current transformer (CT) 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
DNP3	Communication protocol. Distribution Network Protocol version 3
Document	This document and any annexed schedules, together with any document referred to, or incorporated into, this document.
DER	Distributed Energy Resources – A general description for the range of distributed energy devices such as PV, Battery Storage, etc.
DRM	Demand Response Mode
Electrical Installation	As defined in section 1.4.47 of AS/NZS 3000:2007
Energy Storage Device	A generic device that stores energy in the form of electrical, mechanical or chemical energy.
Energy Analyser	An instrument for measuring various parameters of an electrical power distribution system, such as energy consumption and generation etc.
Electricity System	The electricity grid owned and operated by Horizon Power and connected to the Premises.
Feed-In Management (FiM)	A type of Generation Management. Participating customers to allow Horizon Power to curtail the customer's generation output to prevent system instability.

Term	Definition
Generation Management (GM)	Includes the utilisation of technologies such as energy storage or feed-in management to control the output profile of the renewable energy installation.
Grid	Shall have the same meaning as defined in AS/NZS 4777.
Horizon Power Host Facility	The Horizon Power or third party premises where equipment associated with Feed-in management may be situated.
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.
Managed Hosting Capacity (MHC)	The hosting capacity that can be made available for systems equipped with Generation Management.
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 Customer under the Electricity Supply Agreement and the Renewable Electricity Exported by the Customer.
Mini Hydro	A renewable generation source less than 1MW that creates electrical energy as a result of harnessing moving water.
MEN	Multiple Earthed Neutral
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.
NER	National Engineering Register
NIA	Network Impact Assessment

Term	Definition
Power conversion equipment (PCE)	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.
PLC	Programmable Logic Controller
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.
Prosumer	A Horizon Power customer that installs a renewable energy system to offset their energy consumption.
PV	A renewable energy generation device that creates electrical energy as a result of harnessing energy from the sun collected on photovoltaic cells.
Renewable Energy Producer	An entity whose primary purpose is to generate and sell renewable source electricity to Horizon Power.
Renewable Energy System	<ul style="list-style-type: none"> a) a system of photovoltaic arrays; b) a system of wind turbines; c) a hydropower system; or d) 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 (RESI)	Part of a Customer's Electrical Installation containing the devices listed in Section 5.1.
Renewable Energy Installation Control System	One or more devices that perform control and monitoring of the Renewable Energy System Installation.
Renewable Energy System Installation Size	The nominal output rating in kW of the grid connected inverter.
Renewable Source Electricity	Electricity generated by a Renewable Energy System.
REBS	Renewable Energy Buyback Scheme

Term	Definition
SCADA	Supervisory Control and Data Acquisition
SIS	System Impact Study
Solar Thermal	A renewable energy generation device that creates electrical energy as a result of harnessing the sun's energy focussed on thermal collectors.
Spinning Reserve	The amount of unused generating capacity synchronised to the grid and available for immediate use.
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.
SunSpec Protocol	An open standard protocol facilitating the interoperability of distributed energy resources
System Instability	A disturbance to the Electricity System that affects the reliability and quality of electricity supply to customers.
System Diagram	A conceptual diagram that illustrates the relationships between separate subsystems using lines.
TCP/IP	Transmission Control Protocol/Internet Protocol
Technical Requirements	This refers to the provisions set out in this Document.
Total Hosting Capacity (THC)	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 otherwise or commercial target. The sum of the Unmanaged Hosting Capacity (UHC) and Managed Hosting Capacity (MHC).
Unmanaged Hosting Capacity (UHC)	The target for hosting or renewable energy without Generation Management.
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.

1.3 In Scope

1.3.1 Customers Responsibilities

It is the responsibility of the customer 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.

1.3.2 Installation Size of the Renewable Energy System

This Document is applicable to the following Renewable Energy System Installation (RESI)¹ sizes and general customer type, as defined by this Document:

Table 3: Classes of Renewable Energy Installation

Class	Renewable Energy System Installation Size	Customer Type
Class 1	0 kW < RESI Size ≤ 5 kW	Prosumers only
Class 2	5 kW < RESI Size ≤ 50 kW	Prosumers only
Class 3	50 kW < RESI Size ≤ 1 MW	Prosumers only

1.3.3 Renewable Energy Types

This Document is applicable to the following renewable energy types:

Table 4: Renewable Energy Types

Type	Renewable Energy System Installation Size
Solar (PV, solar thermal)	Class 1, 2 & 3
Wind	
Mini Hydro	

The Customer's RESI shall only generate one type of renewable energy per installation. Other types of Renewable Energy System Installations shall only be used by prior written agreement with Horizon Power only.

1.3.4 Connection Types

This Document is applicable to the following connection types:

¹ Abbreviated and used interchangeably in this Document to "Renewable Energy Installation" (REI)

Table 5: Connection Types

Connection
Single Phase (Two Wire, 240 V a.c)
Two Phase (Three Wire, 240 V a.c. phase to neutral voltage)
Three Phase (Four Wire - LV Connection Point, 415 V a.c phase to phase voltage)

The maximum RESI system size allowed for a single-phase connection is 10 kW and is subject to individual technical assessment.

The size of the RESI may necessitate the upgrading of a Customer's connection. For key criteria of single and three phase connections, refer to the WAER and WA Distribution Connections Manual.

1.3.5 *Balanced Generation*

The nominal inverter output rating of multi-phase Renewable Energy System Installations, or systems connected to multi-phase supply connections, shall not differ by more than 2.5 kW between phases.

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

- Up to 2.5 kW as a single-phase inverter.
- 2.5 kW to 5.0 kW as two single-phase inverters with no greater than 2.5 kW imbalance between any two phases or one balanced two phase inverter.
- Greater than 5.0 kW as three single phase inverters with no greater than 2.5 kW 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 sections 8.3 and 8.4 of AS/NZS 4777.2.

1.3.6 *Eligibility*

This document is applicable to all customers who wish to connect a RESI for Renewable Source Electricity to a Horizon Power Electricity System.

2 REFERENCE DOCUMENTATION

Unless otherwise stated within this Document, the Customer 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 2.

2.1 Reference Documentation

Table 6: Reference Documentation

Legislation	
Electricity Licensing Regulation	
Electricity Act 1945	
WA Electrical Requirements (WAER)	
Horizon Power and Other Documents	
WA Distribution Connections Manual (WADCM)	
Horizon Power Technical Rules	
Australian Standards	
AS/NZS 3000	Electrical Installations (Wiring Rules)
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 of Photovoltaic Arrays ²
Codes	
Electricity Industry Code	
Electricity Industry Metering Code	

2.2 Order of Precedence

In the event of a conflict arising between the reference documents listed in Table 6, the following order of precedence shall apply:

² Only if Renewable Energy Installation contains photovoltaic arrays.

Table 7: Order of Precedence (Highest to Lowest)

Order	Reference Document
1	Legislation
2	Technical Requirements
3	Australian Standards

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

2.3 Useful Links

Table 8: 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 ³

3 RELEVANT SECTIONS FOR EACH CLASS OF RENEWABLE ENERGY SYSTEM INSTALLATION

As described in section 1.3.2, the Customer's RESI is defined as being one of three classes. Depending on the class, different sections of this Document apply, as summarised in the table below.

Table 9: Relevant Sections for Each Class of Renewable Energy System Installation

Class	Relevant Sections of This Document
Class 1	All sections
Class 2	All sections except 5.1.1
Class 3	All sections except 5.1.1

³ Accessed December 2016 (List subject to change)

4 GENERAL REQUIREMENTS

4.1 Compliance with Requirements

The Customer shall comply with all the requirements of this Document.

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

4.2 Offsetting of Imported Energy

The Buyback product is provided on a 'net export' basis. This means the Customer uses the Renewable Source Electricity to first offset the consumption of imported electricity from Horizon Power's Electricity System. Two scenarios to consider:

4.2.1 *Net-Export*

The excess of energy is able to be sold to Horizon Power.

4.2.2 *Zero net-export*

The excess of energy is not able to be sold to Horizon Power if Zero-Export product applies⁴ (see section 5.8).

4.2.3 *Supply Characteristics*

The Customer's Renewable Energy System shall be compatible with the characteristics of Horizon Power's supply as defined in Section 2 of the Horizon Power Technical Rules.

4.3 Labelling

Warning 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.

4.4 Documentation

4.4.1 *Summary*

The following documentation shall be supplied by the Customer as part of its application:

- Completed Application Form;
- Compliance Checklist (Schedule 1);
- System Diagram (Schedule 2);
- Circuit Diagrams (Schedule 3);

⁴ To determine whether you will be Zero-Export constrained, refer to the Horizon Power website (search for "Eligibility to install") or contact Horizon Power directly.

- Cable Data (Schedule 4);
- NER Signoff (Schedule 5); and
- For Class 3 systems refer to Appendix C.

Upon receipt of the application and all required information, Horizon Power shall undertake a Network Impact Assessment (NIA) for all applications (Class 1, 2 and 3). In addition to the NIA, a detailed assessment, System Impact Study (SIS), shall be undertaken for all Class 3 applications. A SIS may also be required for Class 2 applications.

Additional information is required to undertake a SIS, details of which are included in Appendix C. For more information relating to application assessments and associated Horizon Power fees, please refer to Appendix F.

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

4.4.2 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 Customer's System Diagram shall be in accordance with section 5.1 of this Document.

Schedule 3: Circuit Diagram

One or more diagrams detailing the electrical connections **from the point of connection through to the renewable energy source**. The Customer's Circuit Diagram shall be in accordance with section 5.2 and the other requirements of this Document. The circuit diagram submitted to Horizon Power shall include:

- Electrical connections for all phases.
- Neutral and earth connections.
- Switchboard electrical connections (depiction of customer final loads not required).
- Electrical interconnection of all electrical elements of the RESI 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 Customer'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 example at the end of this Document.

Schedule 5: NER Signoff

For Class 1 installations *that require Generation Management* (see Table 1), a NER accredited engineer shall validate that the design is in accordance with this Document. An installer may reuse a NER declaration for multiple installations providing the installations do not differ with the NER validated reference design in the following elements:

- Make and model of inverters
- System Diagram
- Circuit Diagram (changes to protection and cable sizes permitted)
- Electrical arrangement of Renewable Energy System Installation.
- Changes to firmware that affect compliance with this Document.
- Changes to equipment that affect compliance with this Document.
- Changes to the type of technology or methodology used to achieve compliance with this Document.

If a NER declaration is reused, a cover letter shall be supplied stating:

- The project and date of the reference design
- That the new project does not differ from with the NER validated design in the elements described above.

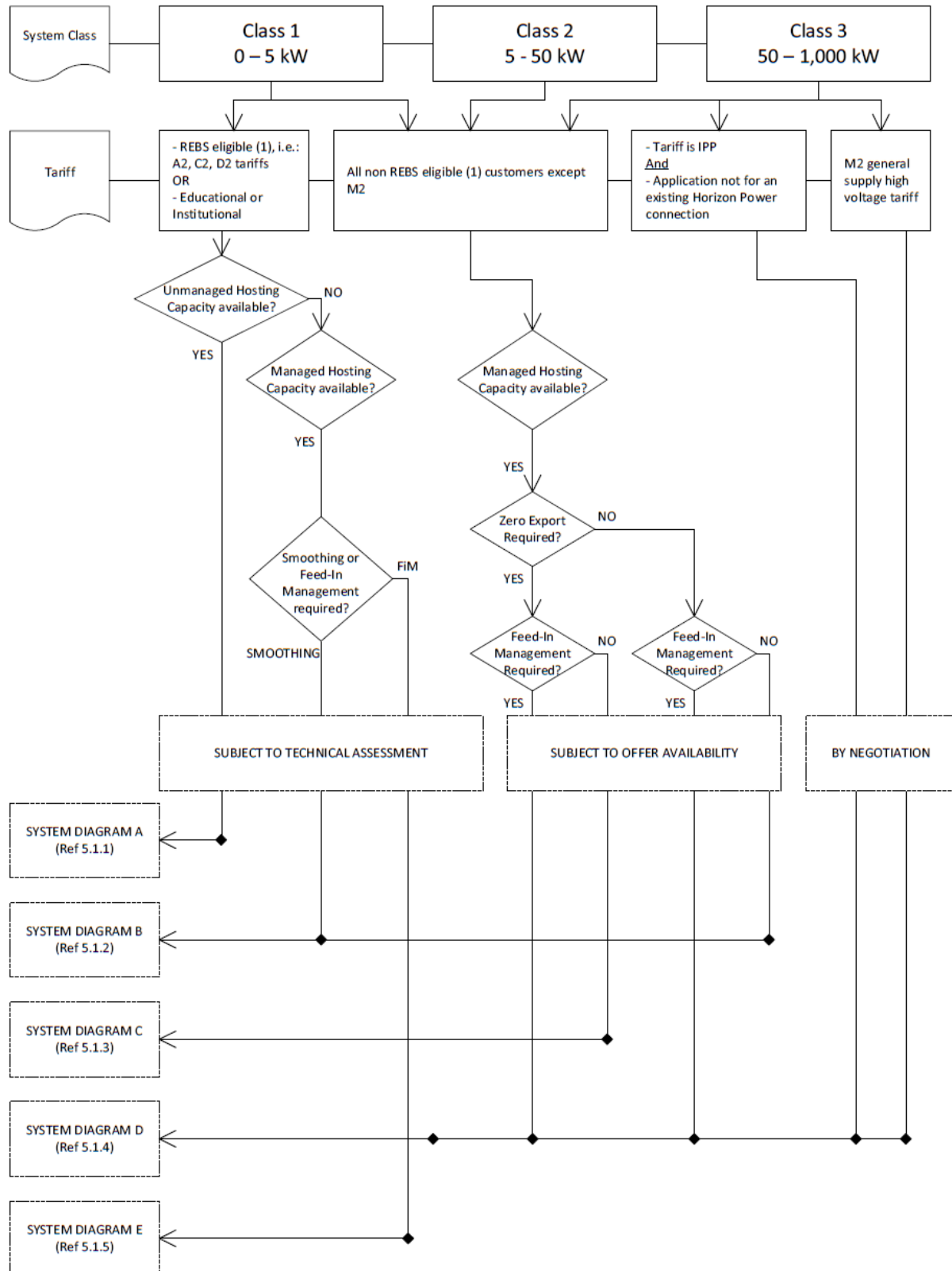
For every Class 2 and Class 3 installation, a NER accredited engineer shall validate that the design is in accordance with this Document and provide supporting documentation. NER accreditation for Class 3 Installations cannot be reused.

Sample letters for NER declaration and declaration reuse are contained in Schedule 5.

5 TECHNICAL REQUIREMENTS FOR EACH CLASS OF RENEWABLE ENERGY SYSTEM INSTALLATION

This section outlines the Technical Requirements and System Diagram to be used for different types of renewable energy systems.

The following criteria shall be employed to determine which System Diagram applies to each type of renewable energy system:



Note (1) Customers on A2, C2, D2 tariffs or an educational institution are REBS eligible.

5.1 System Diagram

A system diagram illustrates the functional relationships between key subsystems using solid lines. The lines do not represent wiring, rather energy flows between subsystems⁵. Details such as intermediary protection devices, chargers, internal device connections, switches and links are not displayed on the provided system diagrams.

The Customer's Electrical Installation shall be in accordance with one of the following system diagrams:

- System Diagram A (not generation managed);
- System Diagram B (generation management via smoothing);
- System Diagram C (generation management via zero-export);
- System Diagram D (generation management via feed-in-management); or
- System Diagram E (class 1 system via feed-in-management);

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

- A single point of connection between the Customer's Electrical Installation and Horizon Power's Low Voltage Grid.
- Splitting of the Customer's Electrical Installation into the following elements:
 - RESI
 - Customer Final Loads
 - One or more switchboards
 - Meters
- The RESI 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. router, DRED)
- Final Customer Loads (if present)
 - Final Customer Loads requiring energy (e.g. washing machine, television, motors, pumps etc)
 - Associated control, monitoring, protection and auxiliary equipment

⁵ Refer to section 5.2 for an acceptable circuit diagram detailing the specific wiring that must be performed.

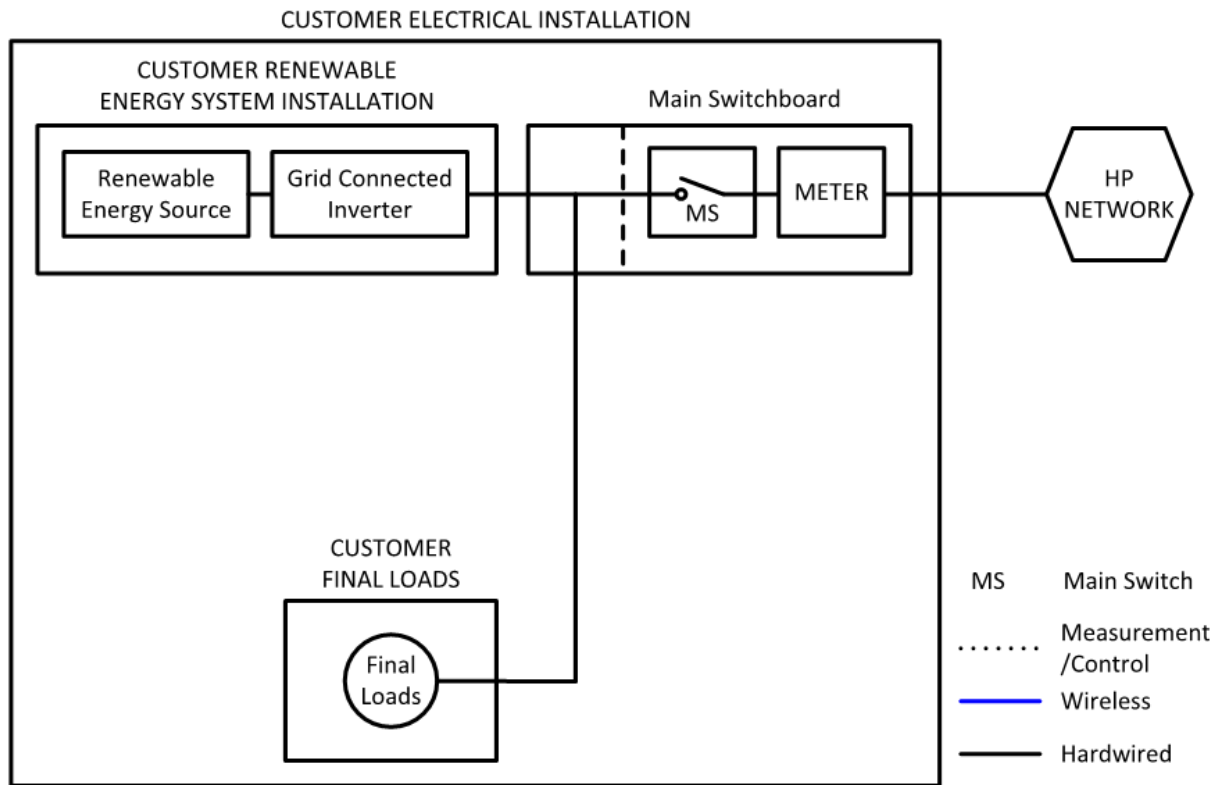
5.1.1 **System Diagram A: Not Generation Managed**

The Customer's Electrical Installation shall be in accordance with System Diagram A (as indicated in Figure 2). All the prerequisites described in Table 10 shall be met.

Table 10: Prerequisites for Using System Diagram A – Not Generation Managed

Class	Tariff	Requirement
Class 1	Customer is on A2, C2, D2 tariff or is an educational institution (i.e. eligible for REBS)	Town has unmanaged hosting capacity ⁶
	Eligible to use System Diagram A	
Class 2	Not eligible to use System Diagram A	
Class 3	Not eligible to use System Diagram A	

⁶ To determine whether your town has Unmanaged Hosting Capacity, refer to the Horizon Power website (search: "Eligibility to install") or contact Horizon Power directly.



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

Figure 2: System Diagram A - Not Generation Managed

Key elements of System Diagram A are:

- No Generation Management measures are required
- No Energy Storage Devices are permitted as part of the Customer's Renewable Energy Installation.
- Use of one meter.

5.1.2 **System Diagram B: Generation Managed via Smoothing**

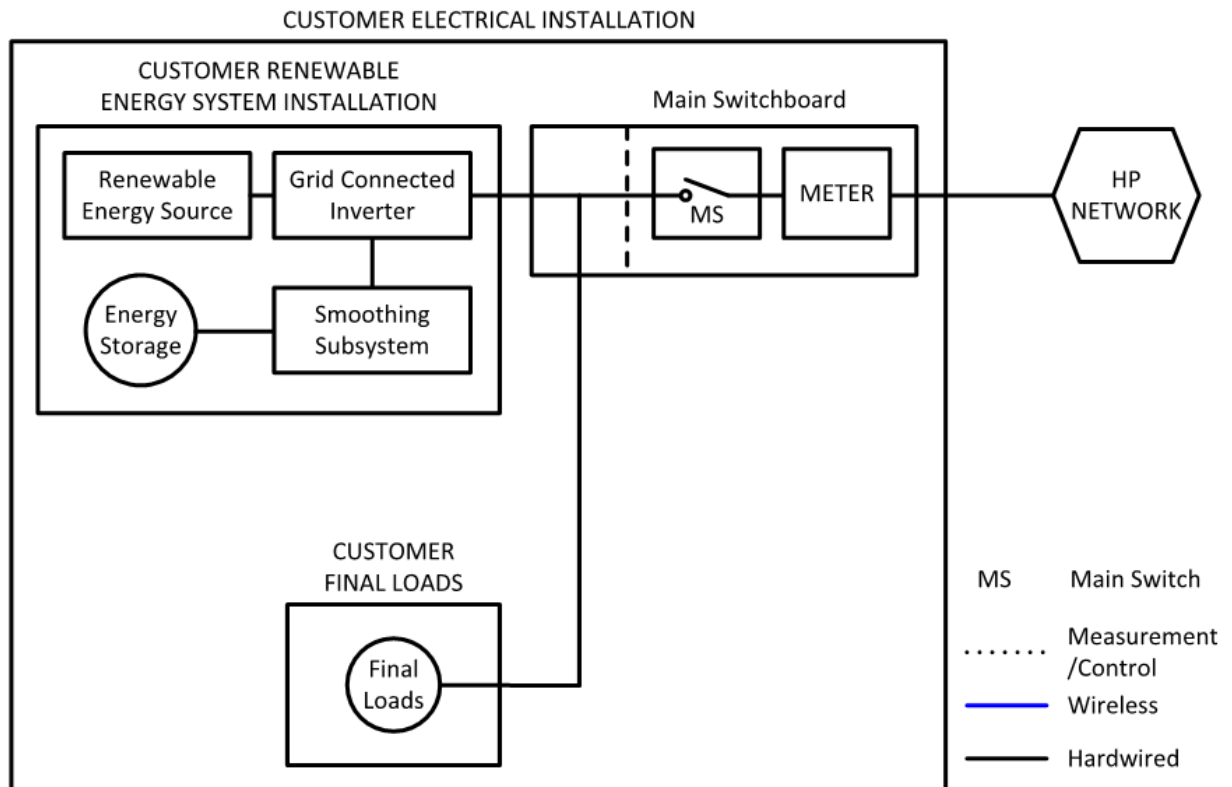
The Customer's Electrical Installation shall be in accordance with System Diagram B (see Figure 3), providing the prerequisites described in Table 11 are met.

Table 11: Prerequisites for Using System Diagram B – Generation Managed via Smoothing

Class	Tariff	Requirement
Class 1	Customer is on A2, C2, D2 tariff or is an educational institution (i.e. eligible for REBS)	Town has Managed Hosting Capacity ⁷ .
	Eligible to use System Diagram B	
	All other customer tariffs – except M2 (i.e. not eligible for REBS)	Subject to offer availability ⁸
	Eligible to use System Diagram B	
Class 2	Any customer tariff – except M2	Subject to offer availability ⁸
	Eligible to use System Diagram B	
Class 3	Any customer tariff – except M2	Subject to offer availability ⁸
	Not Eligible to use System Diagram B	

⁷ To determine whether your town has Managed Hosting Capacity, refer to the Horizon Power website (search: "Eligibility to install") or contact Horizon Power directly.

⁸ To determine the offer availability, contact Horizon Power directly.



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

Figure 3: System Diagram B - Generation Managed via Smoothing

Key elements of System Diagram B (see Figure 3) are:

- Use of Renewable Energy Smoothing (see section 5.6).
- Requirement for Energy Storage device(s).
- No direct connection is permitted between the Customer's RESI and Customer Final Loads. Connection between customer's RESI and load must be made via the Main Switchboard (MSB).
- Use of one meter.

Note: the smoothing subsystem may be integral or separate with the grid connected inverter.

5.1.3 **System Diagram C: Generation Managed via Zero-Export**

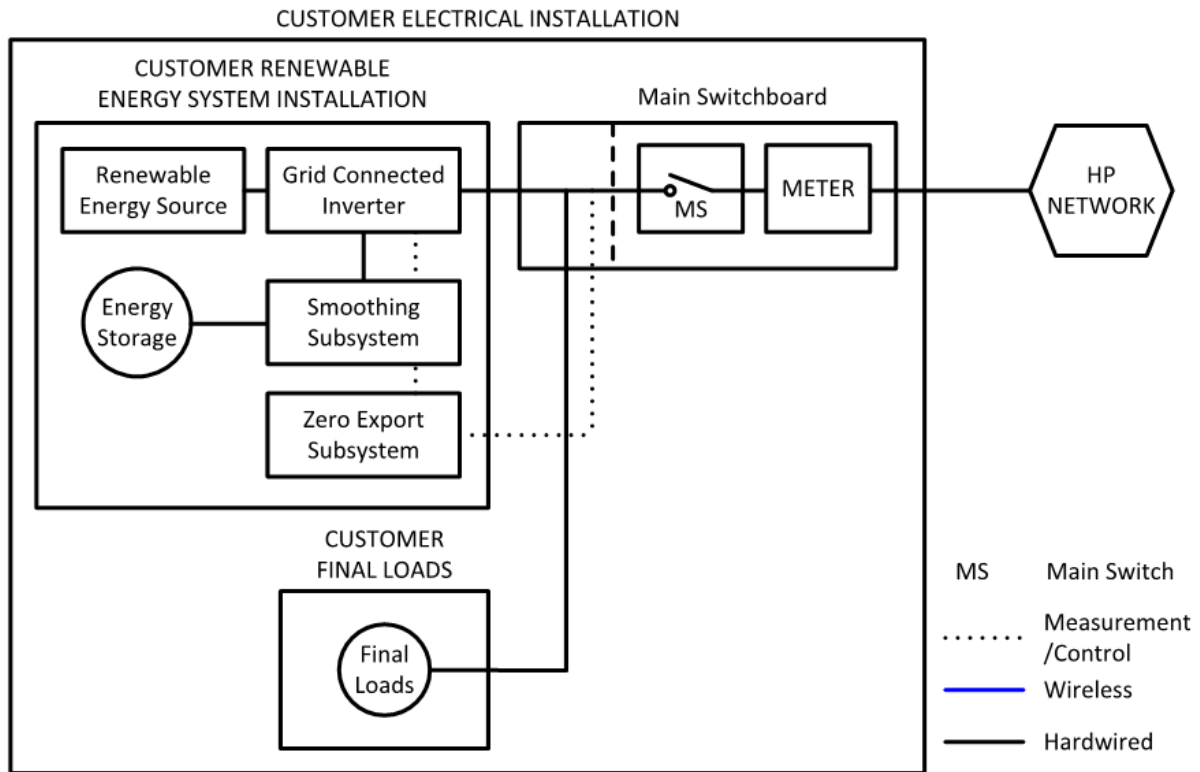
The customer's Electrical Installation shall be in accordance with System Diagram C (Figure 4), providing all the prerequisites described in Table 12 are met.

Table 12: Prerequisites for Using System Diagram C – Generation Managed via Zero-Export

Class	Tariff	Requirement
Class 1	Customer is on A2, C2, D2 tariff or is an educational institution (i.e. eligible for REBS)	Town has managed hosting capacity ⁹ .
	Not eligible to use System Diagram C	
	Any customer tariff – except M2	Subject to offer availability ¹⁰
	Eligible to use System Diagram C	
Class 2	Any customer tariff – except M2	Subject to offer availability ¹⁰
	Eligible to use System Diagram C	
Class 3	Any customer tariff – except M2	
	Not Eligible to use System Diagram C	

⁹ To determine whether your town has Zero Export Managed Hosting Capacity, refer to the Horizon Power website (search: "Eligibility to install") or contact Horizon Power directly.

¹⁰ To determine offer availability contact Horizon Power directly.



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

Figure 4: System Diagram C - Generation Managed via Zero-Export

Key elements of System Diagram C are:

- Use of a Zero Export and Smoothing devices (see sections 5.6 and 5.8).
- Requirement for Energy Storage devices to be installed either on the dc or ac side of the grid connected inverter or other intermediary devices.
- No direct connection is permitted between the Customer's RESI and Customer Final Loads. Connection between customer's RESI and load must be made via the Main Switchboard (MSB).
- Use of one meter.

Note: the Zero Export device and smoothing subsystem might be integral or separate with the grid-connected inverter.

5.1.4 **System Diagram D: Generation Managed with Feed-in Management**

The Customer's Electrical Installation shall be in accordance with System Diagram D (see Figure 5), providing the prerequisites described in Table 13 are met.

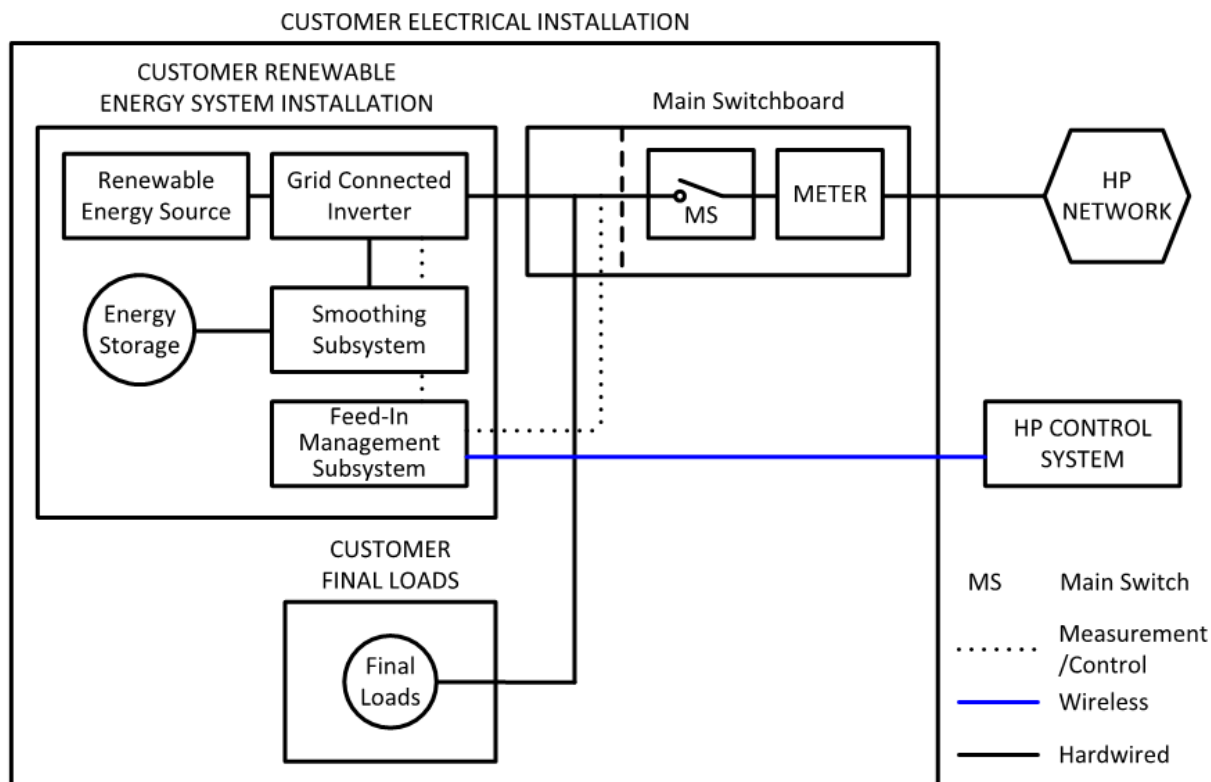
Table 13: Prerequisites for Using System Diagram D – Generation Managed via Feed-in Management

Class	Tariff	Requirement
Class 1	Customer is on A2, C2, D2 tariff or is an educational institution (i.e. eligible for REBS)	NA
	Not Eligible to use System Diagram D	
	All other customer tariffs – except M2 (i.e. not eligible for REBS)	Subject to offer availability ¹¹
	Eligible to use System Diagram D	
Class 2	Any customer tariff – except M2	Subject to offer availability ¹¹
	Eligible to use System Diagram D	
Class 3	Any customer tariff – except M2	Subject to offer availability ¹¹
	'Tariff' is Independent Power Producer (IPP) ¹² application is not for an existing Horizon Power connection	By negotiation ¹³
	Eligible to use System Diagram D	

¹¹ To determine offer availability and if feed-in management applies, contact Horizon Power directly.

¹² Independent Power Producers (IPP) are applicants who wish to install a large renewable energy system (typically greater than 200 kVA) with the intention of supplying the energy they produce back to Horizon Power as a power producer.

¹³ Negotiated Power Purchase Agreement (PPA) Horizon Power directly.



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

Figure 5 System Diagram D - Generation Managed via Feed-in Management

Key elements of System Diagram D are:

- Use of Feed-in Management and Smoothing devices (see sections 5.6 and 5.7).
- Requirement for Energy Storage devices to be installed either on the dc or ac side of the grid connected inverter or other intermediary devices.
- Direct communication required between the Customer's Electrical Installation and Horizon Power's Control System.
- No direct connection is permitted between the Customer's Renewable Energy Installation and Customer Final Loads. Connection must be made via the switchboard.
- Use of one meter.

Note: the feed-in management and/or smoothing subsystems may be integral or separate with the grid-connected inverter.

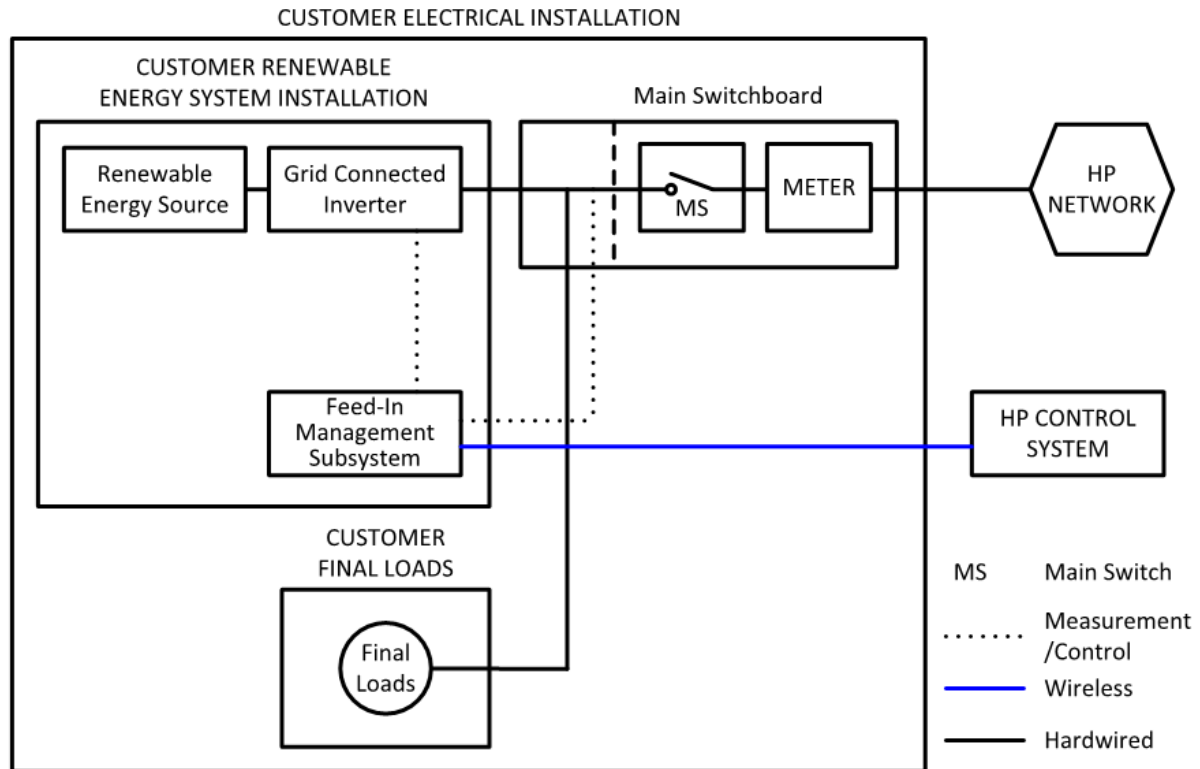
5.1.5 **System Diagram E: Class 1 Systems with Feed in Management Only**

The Customer's Electrical Installation shall be in accordance with System Diagram F (Figure 6), providing all the prerequisites described in Table 14 are met.

Table 14: Prerequisites for Using System Diagram E – Class 1 Systems with Feed in Management Only

Class	Tariff	Requirement
Class 1	Customer is on A2, C2, D2 tariff or is an educational institution (i.e. eligible for REBS)	Town has extended unmanaged hosting capacity ¹⁴
	Eligible to use System Diagram E	
Class 2	Not eligible to use System Diagram E	
Class 3	Not eligible to use System Diagram E	

¹⁴ To determine whether your town has extended Unmanaged Hosting Capacity, refer to the Horizon Power website (search: "Eligibility to install") or contact Horizon Power directly.



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

Figure 6: System Diagram E – Class 1 Systems with Feed in Management Only

Key elements of System Diagram E are:

- Use of Feed-in Management (see section 5.7).
- There is no energy storage device.
- Direct communication required between the Customer's Electrical Installation and Horizon Power's Control System.
- No direct connection is permitted between the Customer's Renewable Energy Installation and Customer Final Loads. Connection must be made via the switchboard.
- Use of one meter.

Note: the feed-in management subsystem may be integral or separate with the grid connected inverter.

5.2 Circuit Configurations

The Customer shall refer to the requirements of this Document together with AS/NZS 4777.1, AS/NZS 3000, AS/NZS 5033 and other applicable documents to connect the internal components of Renewable Energy Installation correctly.

5.2.1 Photovoltaic Installations

Within the Customer's RESI, Photovoltaic installations shall comply with Australian Standard AS/NZS 5033 *Installation of Photovoltaic (PV) Arrays*.

5.3 Metering

5.3.1 Approved Meters

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

5.3.2 Approved Installers

The meter shall be installed by Horizon Power.

5.3.3 Upgrading of Enclosure

In order to meet the meter installation requirements of section 11 of the WA Distribution Connections Manual, the Customer may be required to upgrade the enclosure where the meters are housed, typically due to space constraints.

5.3.4 Measurement of Meters

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

5.3.5 Cost of Metering

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

5.4 Router

5.4.1 Approved Routers

Only Horizon Power approved routers shall be used for each circuit diagram and connection type.

5.4.2 Supply

The router shall be supplied by Horizon Power but purchased by the customer.

The costs for router replacements shall also be borne by the customer.

5.4.3 *Approved Installers*

The router shall be installed by a Clean Energy Council (CEC) accredited installer.

5.4.4 *Programming*

The router shall be pre-programmed by Horizon Power.

5.4.5 *Installation of Routers*

The cost for installation of router(s) shall be borne by the Customer. This includes the cost of the enclosure if required.

5.5 *Inverters*

5.5.1 *Number of Inverters*

Where an installation requires feed in management, the Horizon Power router shall communicate with only one interfacing device to provide the feed-in-management signal to the customer's renewable energy system.

Where an installation consists of multiple inverters, the communications with the router (refer to section 5.4) shall be through a PLC or suitable equivalent device that aggregates the parameters from multiple inverters. The design and installation of the aggregation system is the customer's responsibility.

5.5.2 *Approved Inverters and Power Conversion Equipment*

The customer must demonstrate that the Grid-connected Inverter model and Power Conversion Equipment (PCE) complies with the following standards:

- AS/NZS 4777; and
- AS 3100.

The Grid-connected Inverter model shall be on the CEC's approved list of Inverters.

5.5.3 *Systems with Energy Storage*

Generation Managed Systems shall comply with 5.5.3 (a) and (b).

(a) Only for the purposes of undertaking routine testing of the Energy Storage Device and ramp rates in accordance with section 5.12, as well as for cycling of the Energy Storage Device system to maintain optimal health, it is permissible that the Energy Storage Device system is charged from the grid.

The maximum frequency for which Energy Storage Device charging from the grid is permissible is:

- Two complete Energy Storage Device cycles annually for ramp rate testing; and
- One complete Energy Storage Device cycle monthly for the purpose of battery health cycling.

Charging of Energy Storage Devices shall be in accordance with section 5.5.3.1.

Horizon Power does not permit arbitrage at this present time. Any customers found to be charging Energy Storage Devices from the grid at a frequency greater than that stated in this clause for the purposes of exporting the energy back into the grid, may have their RESI disconnected from the grid until the system is shown to have been modified to prevent charging of Energy Storage Devices from the grid.

- (b) For any other purpose RESI's shall not import power from Horizon Power's Electricity System to charge Energy Storage Devices. The RESI shall be resistant to tampering that enables direct energy importation to charge energy storage devices.

Notwithstanding 5.5.3(a), the RESI shall be prevented from importing power from Horizon Power's Electricity System to charge Energy Storage Devices, by one or more of the following methods:

- A physical device;
- A software interlock; or
- By the nature of the design.

Any method used shall be tamper resistant.

Horizon Power reserves the right to permanently exclude an Inverter make and model from connection to its Electricity System if it considers (in its absolute discretion) that the method used to prevent energy import and re-export is not satisfactory.

5.5.3.1 *Charging of Energy Storage Devices from the Grid*

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 6.4.3 and 7.5.3.2, with voltage and frequency setpoints shown in Table 16

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

5.5.4 *Passive Anti-islanding Protection Settings*

Passive Anti-islanding protection for grid-connected inverters shall comply with the requirements of section 7.4 of AS/NZS 4777.2, with settings as required by Horizon Power and defined in Table 15. These settings shall be installed prior to energisation.

Table 15: Passive Anti-islanding Protection Settings

Parameter	Value		Definition
	1Ø	3Ø	
fmin	46.5 Hz		Refer section 7.4 of AS/NZS 4777.2
fmax	53 Hz		
Vmin	190 V	329 V	

Vmax	265 V	459 V	
------	-------	-------	--

The settings may either be pre-set or programmable.

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.

5.5.5 *Permission to Export*

The grid connected Inverter shall be prevented from exporting power until the Energy Storage Devices have sufficient energy stored to meet the ramp rate requirements described in section 5.6.

For systems fitted with Zero-Export¹⁵, the grid connected Inverter shall not supply power to the local load until the Energy Storage Devices have sufficient energy stored to meet the ramp rate requirements described in section 5.6.

5.5.6 *Power Factor Requirements*

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 7.

¹⁵ To determine whether you are Zero-Export constrained, refer to the Horizon Power website or contact Horizon Power directly.

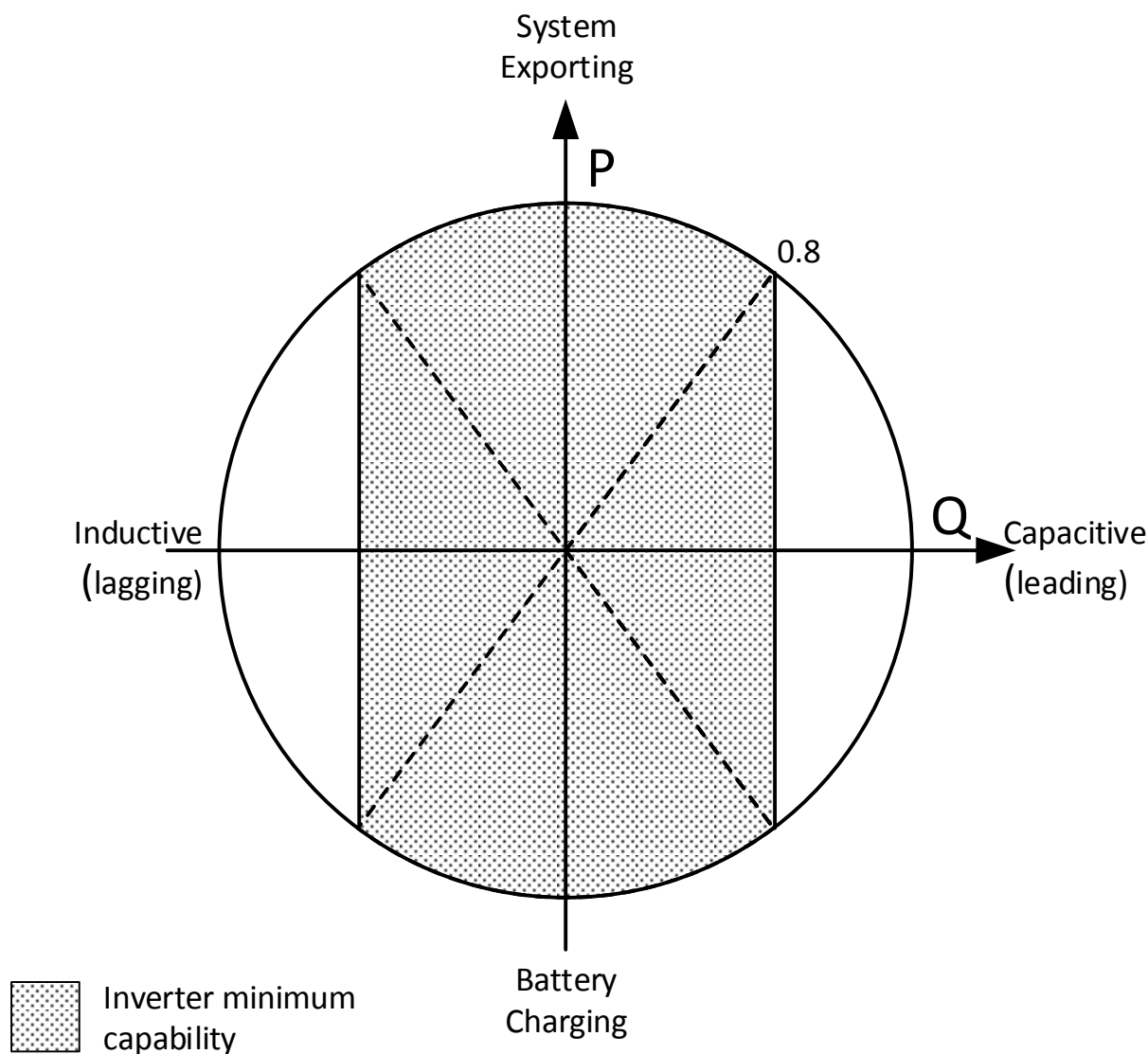


Figure 7: Power factor operational requirements for normal operation

5.5.6.1 **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 Table 16 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.

5.5.7 **Volt-Watt Response Mode**

All inverters are required to have Volt-Watt capabilities, with these capabilities **enabled by default** with settings as given in Table 16 and shown in Figure 8.

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

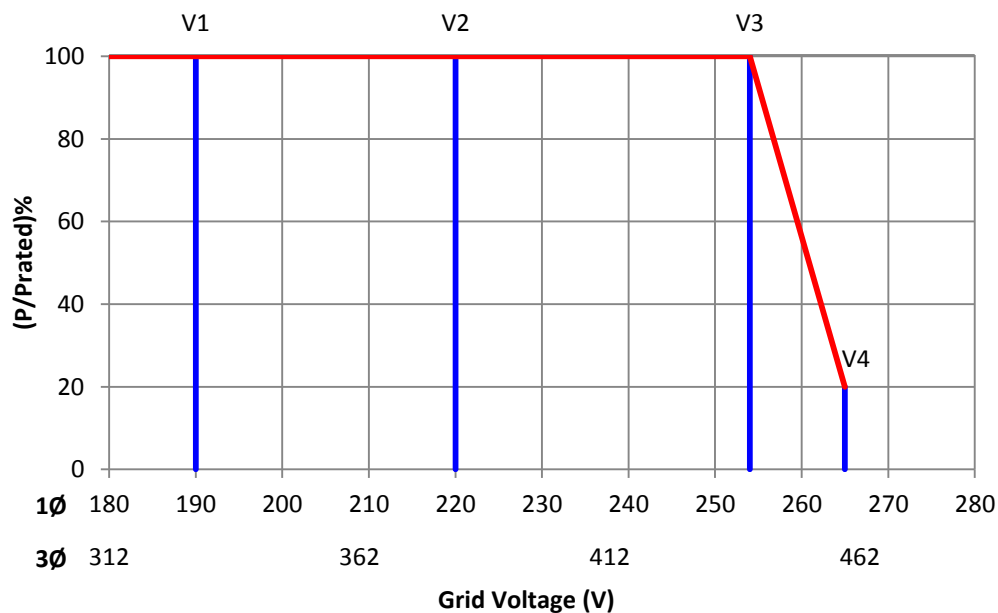


Figure 8: Volt-Watt response curve for default settings

5.5.8 ***Volt-VAr Response Mode***

All inverters are required to have Volt-VAr capabilities, with these capabilities **disabled by default**. Refer to Table 16.

Horizon Power may at any time direct the enabling or disabling of Volt-VAr Response Mode, with settings as required by Horizon Power.

5.5.9 ***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**. Refer to Table 16.

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

5.5.10 Required Settings for AS/NZS 4777.2-2015 Compliant Inverters

Table 16: AS/NZS 4777.2 compliant inverters required 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 = 190 / 329 V2 = 220 / 381 V3 = 254 / 440 V4 = 265 / 459 Volt-watt response active power setpoints in accordance with Table 10.
6.3.2.3	Volt-VAr response mode	Default - disabled.	Disabled for standard inverter usage. As directed by Horizon Power, enabling of this mode may be requested.
6.3.2.4	Voltage balance mode	Default - disabled.	Disabled for standard supplies. As directed by Horizon Power, enabling of this mode may be requested.
6.3.3	Fixed power factor mode and reactive power mode	Default - disabled.	Disabled for standard supplies. As directed by Horizon Power, enabling of this mode may be requested.
6.3.4	Power factor curve -Cos θ (P)	Default - disabled.	Disabled for standard supplies. As directed by Horizon Power, enabling of this mode may be requested.
6.3.5 (6.3.5.3.2 & 6.3.5.3.3)	Power rate limit (Ramp Rate) <u>Note:</u> This will be applied to reconnection (i.e. ramp up/soft start).	Required.	Required. As per HPC-9FJ-12-0001-2012 Section 5.5 Ramp Down. $R_n = -1000 * O_n / T_n$ [W/s] O_n = Nominal rated output [kW] T_n = 720 seconds (12 minutes)

AS/NZS 4777.2: 2015 Clause	Description	AS/NZS 4777.2:2015 Default setting	Horizon Power required settings
			Ramp Up $R_n = 1000 * O_n / T_n$ [W/s] O_n = Nominal rated output T_n = 360 seconds (6 minutes)
Protective functions for connection to electrical installations and the grid			
7.3	Active anti-islanding protection	Either test methods of Appendix F or IEC 62116.	Test method to IEC 62116 is required.
7.5.2	Sustained operation for voltage variations	Required.	Required. Settings as per HPC-9FJ-12-0001-2012 Section 5.4.4 $1\varnothing$ / $3\varnothing$ $V_{nom-max} = 265 \text{ V}$ / 459 V $V_{nom-min} = 190 \text{ V}$ / 329 V
7.5.3	Sustained operation for frequency variations (generation operation).	Required.	Required. Settings as per HPC-9FJ-12-0001-2012 Section 5.4.4 $F_{stop min} = 46.5 \text{ Hz}$ $F_{stop max} = 53 \text{ Hz}$
7.6	Disconnection by external signal.	Required.	Required. Implemented as directed by Horizon Power for individual supplies.
Additional requirements for multiple mode inverters			
6.3.5.3.4	Changes in energy source operation. <u>Note:</u> For multiple mode inverters (i.e. with energy storage) will also apply for changes in energy source operation.	Default - disabled.	Enabled.

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 <u>charging of energy storage</u>	Required.	<p>Required.</p> <p>Settings:</p> <table> <tr> <td></td><td>1Ø</td><td>/</td><td>3Ø</td></tr> <tr> <td>V1=</td><td>190</td><td>/</td><td>329 V</td></tr> <tr> <td>V2=</td><td>220</td><td>/</td><td>381 V</td></tr> <tr> <td>V3=</td><td>254</td><td>/</td><td>440 V</td></tr> <tr> <td>V4=</td><td>265</td><td>/</td><td>459 V</td></tr> </table> <p>Volt-watt response active power setpoints in accordance with Table 12 of AS/NZS 4777.2.</p>		1Ø	/	3Ø	V1=	190	/	329 V	V2=	220	/	381 V	V3=	254	/	440 V	V4=	265	/	459 V
	1Ø	/	3Ø																				
V1=	190	/	329 V																				
V2=	220	/	381 V																				
V3=	254	/	440 V																				
V4=	265	/	459 V																				
7.5.3.2	Sustained operation for frequency variations <u>(charging operations)</u>	Required.	<p>Required.</p> <p>Settings as per HPC-9FJ-12-0001-2012 Section 5.4.4</p> <p>$F_{\text{stop ch}} = 49 \text{ Hz}$</p> <p>$F_{\text{stop}} = 52 \text{ Hz}$</p>																				

5.6 Smoothing Requirements

5.6.1 Concept

Controlling the ramp rate of the Inverter output is a requirement of the Renewable Energy Smoothing type of Generation Management. As described in Table 1, Renewable Energy Smoothing requires the Customer to install an Energy Smoothing Device that provides for a gradual ramp-up or ramp-down over a period of time if the Renewable Source Electricity output changes too suddenly (Figure 9). This allows enough time for Horizon Power and Independent Power Producers to ramp up their generation assets to cover for a loss in Customer generation. The method for achieving the required ramp rate is at the discretion of the customer.

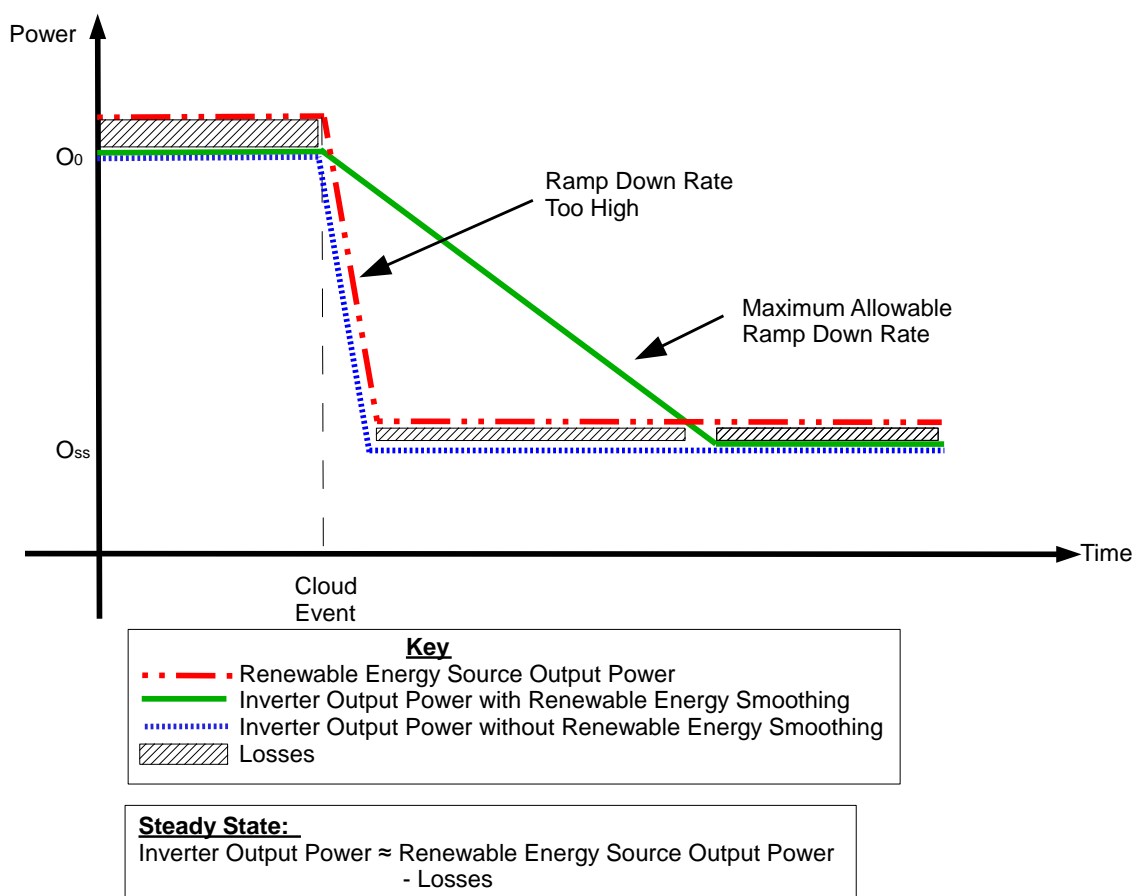


Figure 9: Ramp Down Rate with and without Renewable Energy Smoothing

5.6.2 Characteristic Curve

Figure 10 below plots the characteristic curve of the output power of a grid connected Inverter. The characteristic curve is defined as the desired output behaviour of the grid connected inverter, initially operating at nominal rated output, in response to a step change in renewable energy source output at time $t = 0$ seconds to 0 kW.

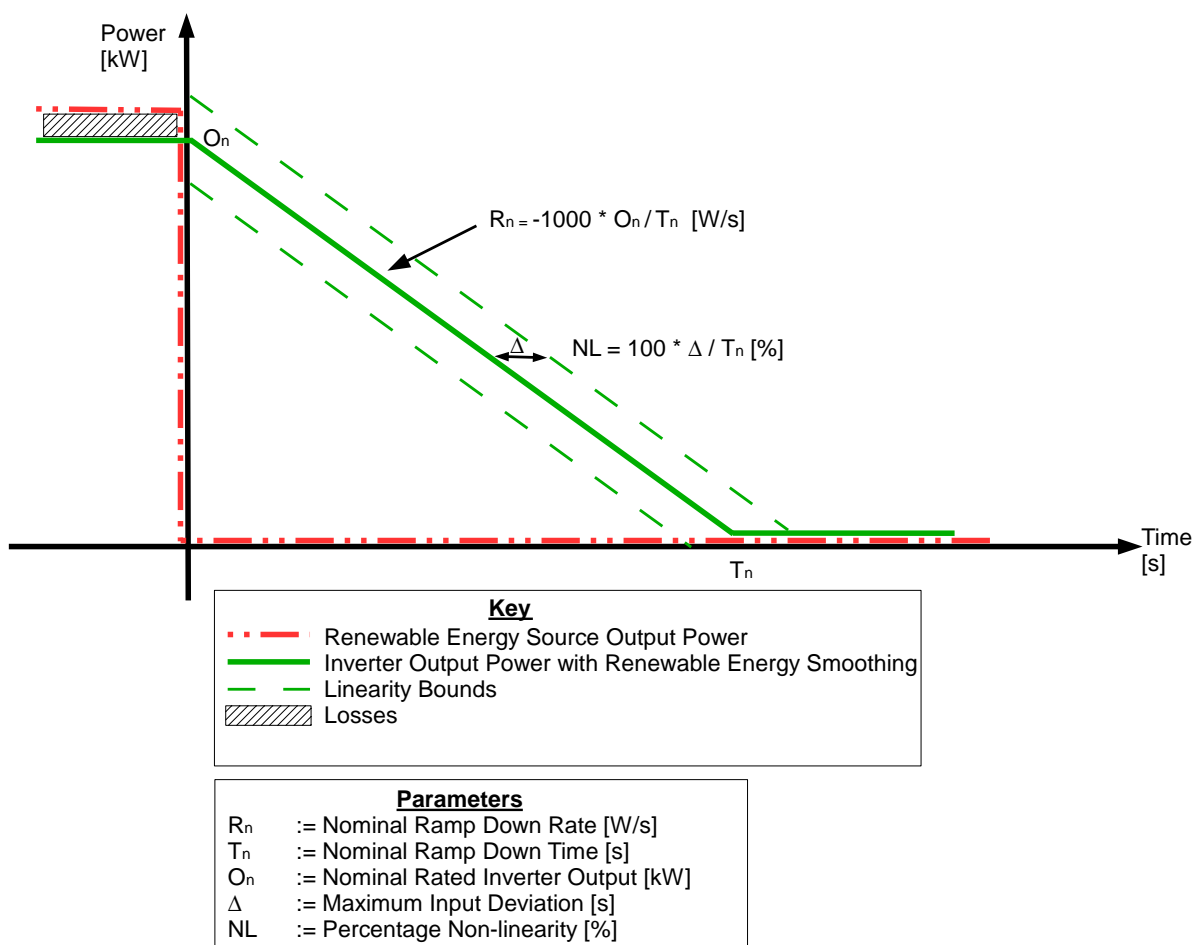


Figure 10: Ramp Down Characteristic Curve

5.6.3 Nominal Ramp Down Times

The nominal ramp down time is depicted Figure 10 and is defined as the time taken for the inverter to ramp down from nominal rated output to 0 kW.

The nominal ramp down rate for each installation size is then derived according to the equation shown in Figure 10.

For systems employing a multi-mode inverter the ramp function shall cover the customers system voluntarily reconnecting to the grid so a sudden change in system load or renewable generation is not observed by the grid.

Control action is required when the ramp down rate of the renewable energy source exceeds R_n in magnitude.

All Renewable Energy System Installations employing System Diagrams B, C or D for towns with available managed hosting capacity greater than the proposed system size shall have a nominal ramp down time T_n of 720 seconds.

5.6.4 Nominal Ramp Up Time

The nominal ramp up time R_p is defined as the time taken for the inverter to ramp up from 0 kW to nominal rated output:

$$R_p = 1000 * O_n / T_p \text{ [W/s]}$$

This covers for a sudden increase in Renewable Source Electricity output. It is expected that during this type of control action that the Energy Storage Devices would be absorbing energy.

Control action is required when the ramp up rate of the renewable energy source exceeds R_p in magnitude.

All Renewable Energy Installations employing System Diagrams B or C for towns with available hosting capacity greater than the proposed system size shall have a nominal ramp up time T_p of 360 seconds.

5.6.5 Non Linearity

The non-linearity of the ramp rate of the inverter output, as defined by the Characteristic Curve depicted in Figure 10 shall be less than 10%.

5.6.6 Method for Achieving Required Ramp Rate

The ramp rate requirements describe the required output behaviour at the point of connection only. The method used for achieving the required ramp rate, such as the type and size of Energy Storage Devices, inverter control method, or load control method used together with the control algorithm, trigger condition and associated devices, is left for the Customer to develop.

5.6.7 Testing

The RESI shall be considered to have met the ramp requirements if it passes both ramp tests described in section 5.11.

5.7 Feed-in Management Requirements

Feed-in Management is a requirement of Renewable Energy Installations that meet the pre-requisites described in Table 13, or as advised by Horizon Power.

The curtailment of a customer's *RESI* may be initiated by the Grid Operator, being a:

- local operator;
- Horizon Power Control Centre (HPCC) operator; or
- regional Contract Manager,

where a risk exists to:

- Reliability, being the continuation of the supply of electricity in line with its legislative requirements;
- Contractual obligations; or
- Performance, being operating efficiencies.

The Isolation of a customer's *RESI* may occur for:

- Threat to the safety of personnel or the public; or
- Threat to Horizon Power's or the IPP's plant and equipment.

Horizon Power requires that all RESI systems (all inverters) have SunSpec protocol capabilities. A summary of the required SunSpec parameters is provided in Appendix B.

5.7.1 Functional Requirements

The Feed-in Management subsystem shall:

- Include active communication between the Renewable Energy System and Horizon Power via a pre-programmed communications router and Horizon Power's communication infrastructure.
- Include direct control and status indication of the inverter.
- Include control over, and regulation of the output of the grid connected inverter including:
 - Instantaneous active power set point control (within 15 s from signal transmission).
 - Reactive power set point control in accordance with settings outlined in Table 16 with 60 s response from signal. Refer to clause 5.5.6.
 - Functionality for automated system ramp down on loss of the communications link. The ramp set-point will be advised by Horizon Power.
 - Instantaneous set point control of energy storage (within 15 s from signal transmission).
- Provide Horizon Power with live access to the Customer's inverter for monitoring purposes in order to maintain system quality, reliability and stability.
- Provide Horizon Power with full unrestricted access to the Router.

5.7.2 Horizon Power Scope

Horizon Power shall:

- Supply, install, own and maintain the Advanced Metering Infrastructure.
- Supply, install, own and maintain the communications channel (upstream of the router) associated with the Feed-in Management subsystem.
- Supply the pre-programmed communications router.
- Confirm commissioning of the Feed-in Management subsystem.
- Perform control and monitoring of the renewable energy installation output.

5.7.3 Customer Scope

The Customer shall:

- Provide suitable control and monitoring inputs using the SunSpec protocol to Horizon Power's communication channel in order to fulfil the functional requirements described in section 5.7.1.
- Install and commission the Horizon Power pre-programmed communications router with hardwired connection to the inverter system, including provision of single phase 240 V AC power for the router.
- Supply, install and commission the feed-in management sub system, liaising with Horizon Power as required.
- Provide Horizon Power with access to the Renewable Energy Installation in order to perform up front and ongoing works.

5.7.4 Equipment

The Customers Renewable Energy Installation Feed-in Management subsystem shall comprise the following components:

- A pre-programmed communications router with hardwired connection to the inverter system, including provision of single Phase 240 V AC power for the router.
- One or more cabinets to house the above components.

Given the functional requirements described in section 5.7.1, the following equipment configurations apply:

Table 17: Equipment Configuration Options

Class	Method of Control	Integral/Discrete	Equipment Configuration
Class 1, 2 & 3	Set Point & On/Off	Integral with Inverter	Figure 11

5.7.4.1 Method of Control for Class 1, 2 & Class 3 systems:



5.8 Zero-Export Requirements

5.8.1 Technical Requirements

- Not export any active power to Horizon Power
- Use communication media, interfaces and protocols ensuring interoperability of components in the subsystem.
- Meet the service life of the renewable energy system for the conditions which it will be installed.
- Be tamper-proof (enclosure and settings).

5.8.2 Equipment

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

5.9 Extended Ramp Rate Systems

Extended Ramp Rate systems will be considered at the discretion of Horizon Power on a case by case basis. If an Extended Ramp Rate system is accepted by Horizon Power, the system must meet the requirements of 5.9.1.

Extended Ramp Rate systems may be considered by Horizon Power for RESI's employing System Diagrams B, C or D for towns where managed hosting capacity has been exhausted, or where insufficient managed hosting capacity is available.

5.9.1 *Technical Requirements*

All Extended Ramp Rate Systems shall have:

- **a nominal ramp down time T_n of 7,200 seconds (2 hours).**
- **a nominal ramp up time T_n of 3,600 seconds (1 hour).**

The Energy Control subsystem shall:

- Have generation management;
- Have feed-in management; and
- Ensure the load seen by the Grid is free from fluctuations.

5.10 Sole Use Transformer

As an outcome of the Network Impact Assessment Horizon Power may require the Customer to be supplied from a sole use transformer in order to maintain the reliability of the Electricity System¹⁶. The Customer shall bear Horizon Power's costs of supplying and installing a sole use transformer.

5.11 Type Testing

For installations where Renewable Energy Smoothing is required, Horizon Power needs to be able to verify whether a Customer's Renewable Energy Installation complies with both the ramp down and ramp up requirements specified in section 5.6. This is achieved by the validation of an NER accredited engineer that the Renewable Energy Smoothing system is in accordance with the ramp testing requirements specified in section 5.12.2.

5.12 Routine Testing of Renewable Energy Smoothing Systems

Annually from the date of commissioning it is a requirement that the results of one of the test methods outlined in Table 18 are provided to the grid operator. The results may be provided manually or be automated from the inverter/battery controller. Validation is achieved by Horizon Power certifying that the ramp rate requirements are being met.

Results are to be sent to renewables@horizonpower.com.au

5.12.1 *Testing Method*

The testing method shall be one of the following:

¹⁶ This is expected to be more of an issue for large Class 3 installations.

Table 18: Types of Test Methods

Test Method	Description
Pushbutton ¹⁷ Self-Test	A pushbutton is pressed which initiates a test sequence that results in a PASS or FAIL.
Battery Health Indicator	An indicator guaranteeing the health of the battery system and showing there is sufficient capacity in the battery system to perform the test sequence

¹⁷ A pushbutton may be a multifunction, accessible by menus or dedicated button

5.12.2 Ramp Testing Procedure

Figure 12 illustrates the test requirements. In addition, an example of test measurements is contained in Appendix A.

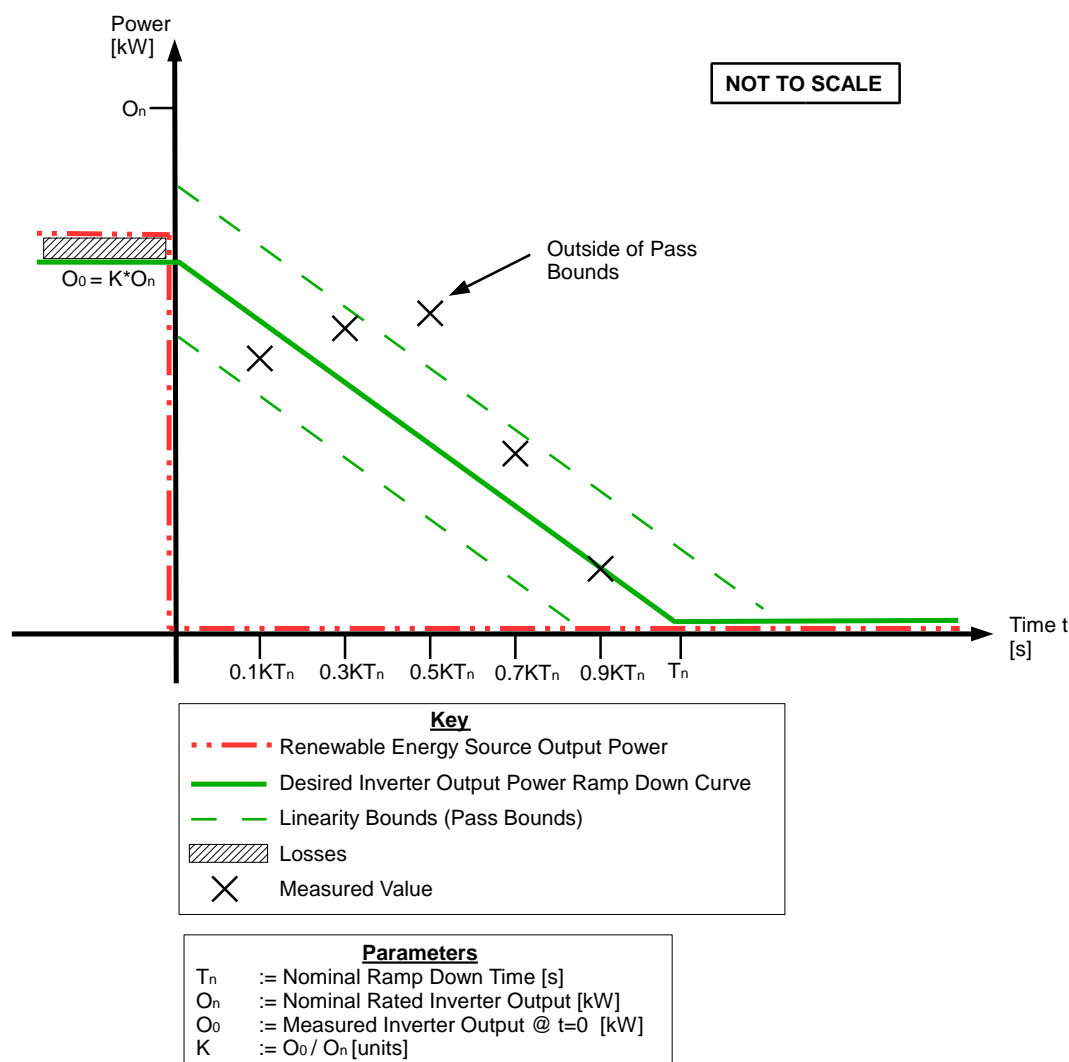


Figure 12: Example of Ramp Down Test Measurements Where Result is TEST FAIL

Procedure:

1. Measure inverter output power prior to commencement of test, O_0
Let O_n be the nominal output rating of the grid connected inverter
Let $K = O_0 / O_n$
If $K < 0.4$ abort test¹⁸
2. Determine 5 test points and the pass bounds for each power measurement

¹⁸ The best time to perform the test is during peak output (typically. 12-2pm)

Table 19: Test Points

Measuring Time	Power Measurement Pass Bounds	
	Lower	Upper
0.1 KTn	0.8 KOn	KOn
0.3 KTn	0.6 KOn	0.8 KOn
0.5 KTn	0.4 KOn	0.6 KOn
0.7 KTn	0.2 KOn	0.4 KOn
0.9 KTn	0	0.2 KOn

3. Electrically isolate the renewable energy source from the rest of the Renewable Energy Installation¹⁹.
4. Start timer.
5. Record measured inverter output value $O_{measured}$ at each test point specified in step 2.
6. If all five measured output values $O_{measured}$ are within the pass bounds specified in step 2 then TEST PASSED, else TEST FAILED
7. Indicate Status
8. If TEST FAILED disconnect inverter from grid according to section 5.12.5.
If TEST PASSED, allow permanent connection to the grid to section 5.12.5.
9. Reconnect the renewable energy source to the rest of the Renewable Energy Installation.
10. Test Complete

5.12.3 Measurement Accuracy

Each measured value shall be accurate to within 4% and with repeatability of 2%.

5.12.4 Recording of Data

Test data shall be stored in an electronic format that guards against tampering.
Data associated with the previous 12 ramp down tests shall be able to be stored.
Data shall include:

- Date and time of test.
- Test result: Pass or Fail.

¹⁹ This could be done by sending an energising signal to a relay that actuates the DC breaker immediately upstream of the renewable energy source.

- Five test measurement values.
- Values of K, T_n, O₀, O_n at the time of the test.

5.12.5 **Action on Test Completion**

If disconnected, the customer shall connect their RESI to Horizon Power's Electricity System for the purposes of conducting the ramp down test. This is a temporary connection only.

The table below describes the action required once a test result is obtained.

Table 20: Action Required Once Test Result Obtained

Method	Action on TEST FAIL	Action on TEST PASS
Pushbutton Self-Test	Automatic Disconnection of Inverter. Permanent Connection of RESI to Horizon Power Grid not allowed and prevented by software interlock.	Permanent Connection of RESI to HP Grid now allowed
Battery Health Indicator	Conduct a Pushbutton Self-Test	NA

5.13 **Commissioning**

Commissioning and verification shall be in accordance with section 8 of AS/NZS 3000, AS/NZS 5033 (if applicable), WA distribution connections manual, WA electrical requirements and manufacturer specifications. **In addition, if applicable, the Customer shall perform a ramp down and/or ramp up test prior to the commencement of use.**

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

RESI's that employ Feed-In Management may require the involvement of Horizon Power personnel as part of the commissioning process.

APPENDIX A. EXAMPLE OF RAMP TESTS

A1. EXAMPLE RAMP DOWN TEST

Table 21: Example Ramp Down Test Parameters

Description	Parameter	Value
Nominal Rated Inverter Output	On	5 kW
Nominal Ramp Down Time	T _n	720 s ²⁰
Initial Inverter Output	O ₀	4.57 kW
Calculated Scaling Constant	K	0.914
Measurement Error	ε	4%

Table 22: Example Ramp Down Test Data

Test Point	Measuring Time (s)	Power Measurement Pass Bounds		P _{measured} (kW)	O _{measured} (%) [error range]	Result
		Lower (%)	Upper (%)			
t1	63	80	100	4.57	91 [87.36-94.64]	PASS
t2	189	60	80	3.43	69 [66.24-71.76]	PASS
t3	315	40	60	1.90	38 [36.48-39.52]	FAIL
t4	441	20	40	1.75	35 [33.6-36.4]	PASS
t5	567	0	20	1.05	21 [20.16-21.84]	PASS

²⁰ Note that AS/NZS 4777.2 specifies a different default nominal ramp down time

Ramp Down Test Results

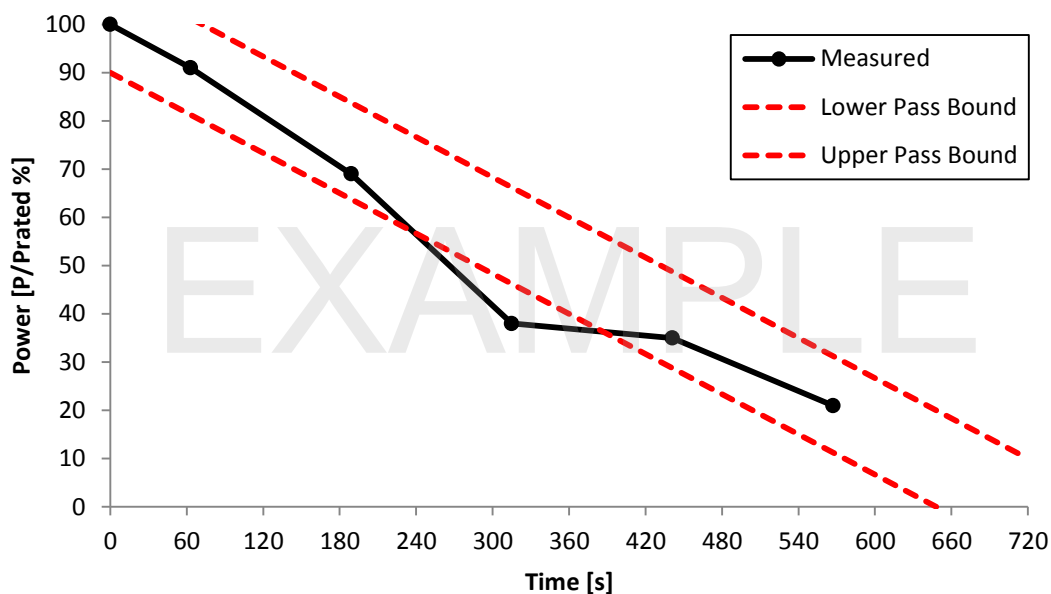


Figure 13: Example Ramp Down Test Results

A2. EXAMPLE RAMP UP TEST

Table 23: Example Ramp Up Test Parameters

Description	Parameter	Value
Nominal Rated Inverter Output	On	100 kW
Nominal Ramp Up Time	T _n	360 s ²¹
Initial Inverter Output	O ₀	0.0 kW
Measurement Error	ε	4%

²¹ Note that this ramp up time is the same as set by default in AS/NZS 4777.2

Table 24: Example Ramp Up Test Data

Test Point	Measuring Time (s)	Power Measurement Pass Bounds		P_{measured} (kW)	O_{measured} (%) [error range]	Result
		Lower (%)	Upper (%)			
t1	27	0	0	0	91 [7.68-8.32]	PASS
t2	88	14.4	34.4	26.0	69 [24.96-27.04]	PASS
t3	142	29.4	49.4	43.0	38 [41.28-44.72]	PASS
t4	208	47.8	67.8	74.0	35 [71.04-76.96]	FAIL
t5	293	71.4	91.4	88.0	21 [84.48-91.52]	PASS

Ramp Up Test Results

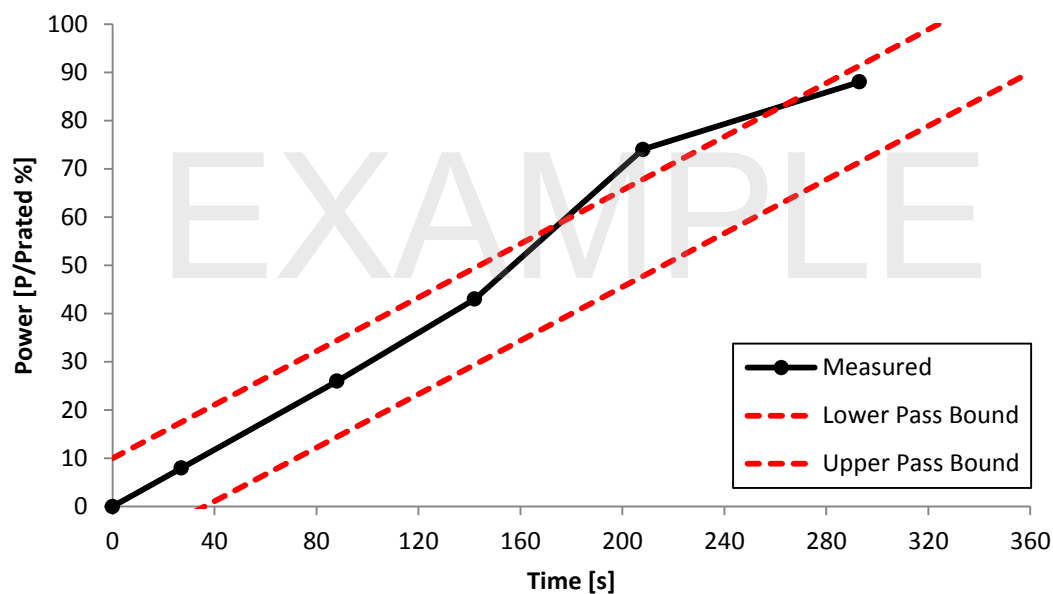


Figure 14: Example Ramp Up Test Results

APPENDIX B. REQUIRED SUNSPEC PARAMETERS

Required Functionality	SunSpec Variable Name/ID	Unit	Data Type	Size	Read/Write	Variable Description
Inverter Controls Nameplate Ratings	WRtg	W	uint16	1	R	Continuous power output capability of the inverter.
	WRtg_SF	-	sunssf	1	R	Scale factor
Control of inverter active power output set point via SCADA	WMax	W	uint16	1	RW	Setting for maximum power output. Default to WRtg.
	WMax_SF	-	sunssf	1	R	Scale factor for real power.
Control of inverter reactive power output set point via SCADA	VArMax	VAr	enum16		R	VAR limit as a % of VArMax
	VArMax_SF	-	sunssf	1	R	Scale factor for reactive power
	VArMaxPct	-	sunssf	1	RW	Reactive power as a % of VArMax
Automated inverter output ramp-down (inverter emergency shutdown)	WMaxLimPct	% WMax	uint16	1	RW	Set power output to specified level.
	WMaxLimPct_RmpTms	secs	uint16	1	RW	Ramp time for moving from current setpoint to new setpoint.
Monitoring of the following on-site generation resource data:	WMaxLim_Ena	-	enum16	1	RW	Enumerated valued. Throttle enable/disable control: 0: DISABLED 1: ENABLED
	ChaState	% AhrRtg	uint16	1	R	Currently available energy as a percent of the capacity rating.
	InBatV	V	uint16	1	R	Internal battery voltage.
	InBatV_SF		sunssf	1	R	Scale factor for battery voltage.
	A	A	uint16t	1	R	AC Current
	A_SF		sunssf	1	R	Current scale factor
	PhV	V	int16	1	R	Line to Neutral AC Voltage (average of active phases)
	V_SF		sunssf	1	R	Voltage scale factor
	Hz	Hz	int16	1	R	Frequency
	Hz_SF		sunssf	1	R	Frequency scale factor
	W	W	int16	1	R	AC Power
	W_SF		sunssf	1	R	Real Power scale factor
	VAr	VAr	int16	1	R	AC Reactive Power
	VAR_SF		sunssf	1	R	Reactive Power scale factor
	W	W	int16	1	R	Total Real Power
	W_SF		sunssf	1	R	Real Power scale factor


Required Functionality	SunSpec Variable Name/ID	Unit	Data Type	Size	Read/Write	Variable Description
	VA	VA	int16	1	R	AC Apparent Power
	VA_SF		sunssf	1	R	Apparent Power scale factor
	VAR	VAR	int16	1	R	Reactive Power
	VAR_SF		sunssf	1	R	Reactive Power scale factor
	PF	PF	int16	1	R	Power Factor
	PF_SF		sunssf	1	R	Power Factor scale factor
	PPVphAB	V	int16	1	R	Phase Voltage AB
	PhVphA	V	int16	1	R	Phase Voltage AN
	TotWhExp	Wh	acc32	2	R	Total Real Energy Exported
	TotWhImp	Wh	acc32	2	R	Total Real Energy Imported
	TotWh_SF		sunssf	1	R	Real Energy scale factor
Control and monitoring of inverter isolation circuit breaker (or electronic isolator) via the local AMI meter <ul style="list-style-type: none"> Control of Isolation Circuit Breaker (open/close) Monitor status of Isolation Circuit Breaker (open/closed) 	Conn	-	enum16	1	RW	Enumerated valued. Connection control: 0: DISCONNECT 1: CONNECT
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 staring 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)

Required Functionality	SunSpec Variable Name/ID	Unit	Data Type	Size	Read/Write	Variable Description
	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

APPENDIX C. SYSTEM IMPACT STUDY DATA REQUIREMENTS

As part of a new or amended PV connection application, Horizon Power may require certain data and documentation to undertake assessment of the application by way of a system impact study in DIgSILENT PowerFactory. This data is required for all Class 3 applications.

The following information is required:

- Computer models of the proposed PV system (including all inverters, energy storage systems, customer side reticulation) in  DigSILENT PowerFactory format suitable for use in the version of PowerFactory currently used by Horizon Power²².
 - The model must be consistent with the information provided as part of connection application.
 - The model must be suitable for load flow studies (balanced and unbalanced), short-circuit studies (balanced and unbalanced) using 'Complete' method, and dynamic studies.
 - The dynamic model, when opened and executed in PowerFactory, must automatically initialise its parameters without warnings or errors and must not result in initialisation or run time warnings or errors.
 - The dynamic model must adequately represent the performance of the PV system over its load range and over the system voltage and frequency operating range described in section 5.5.4 of this document.
 - Inverter active and reactive power ranges must be defined in the model according to the inverter capability, consistent with the requirements of section 5.5.6 of this document.
 - The control mode and droop settings must be configured according to actual equipment operation, for both steady state and dynamic simulations.
 - The model must include all functional controllers and ancillary equipment that affect the performance of the PV system for all possible operating conditions.
 - The model should include relevant protection relays and settings to simulate the performance of the PV system during power system disturbances. This includes, but is not limited to, under and overvoltage protection, under and over-frequency protection etc.
 - Harmonic current and flicker emissions must be included in the inverter model.
- Maximum and minimum load at facility (active power and reactive power / power factor).
- Proposed arrangement and site layout of the installation.
- Single line diagram of PV system.
- Typical 24 hr load power curve measured at 15 minute intervals or less.
- Inverter capability curves
- Inverter harmonic current and flicker emission levels.

²² Contact Horizon Power to confirm version of DIgSILENT PowerFactory currently in use.

APPENDIX D. PRE-COMMISSIONING DATA

This data shall be provided by the customer (Class 2 and Class 3 Systems) at least 4 weeks prior to commissioning date:

- Letter to Horizon Power stating all approval conditions are met;
- Customer's inverter and mains protection settings;
- Inverter's fault ride through capabilities and settings;
- Commissioning Plan; and
- Operation & Maintenance Manual.

APPENDIX E. POST COMMISSIONING DATA

This data shall be provided by the customer (Class 2 and Class 3 Systems) within 6 weeks from commissioning date:

- RESI ramp down and ramp up performance results;
- Confirmation of commissioning of feed-in-management system (if applicable); and
- Flicker and Harmonics assessment results.

APPENDIX F. TECHNICAL ASSESSMENT, APPLICATION AND FEES

Type of Application	Technical Assessment	Required Information	Horizon Power Fees
Class 1 without Generation Management	Network Impact Assessment	Application form with Schedule 1,2,3 and 4	N/A
Class 1 and 2 with Generation Management	Network Impact Assessment	Application form with Schedule 1,2,3, 4 and 5	N/A
Class 3 (and Class 2, where required) with Generation Management	Network Impact Assessment and System Impact Study	Application form with Schedule 1,2,3, 4 and 5, and System Impact Study Data (see Appendix C)	Fees apply

APPENDIX G. LIST OF AMMENDMENTS TO PREVIOUS VERSION OF DOCUMENT

Section	Affected Clause	Type of Change
1 Introduction	1.3.1 Customer Responsibilities	New addition
	1.3.4 Balanced Generation	Amendment to Existing
2 Reference Documentation	2.1 Reference Documentation	Amendment to Existing
	2.3 Useful Links	Amendment to Existing
4 General Requirements	4.4 Documentation	Amendment to Existing
5 Technical Requirements for Each Class of RESI	5.1 System Diagram	Amendment to Existing
	5.1.1 System Diagram A: Not Generation Managed	Amendment to Existing
	5.1.2 System Diagram B: Generation Managed via Smoothing	Amendment to Existing
	5.1.3 System Diagram C: Generation Managed via Zero-Export	Amendment to Existing
	5.1.4 System Diagram D: Generation Managed with Feed-in Management	Amendment to Existing
	5.1.4 System Diagram E: Class 1 Systems with Feed in Management	New addition
	5.2 Circuit Configuration	Amendment to Existing
	5.4 Router	New addition
	5.5.2 Approved Inverters and Power Conversion Equipment	Amendment to Existing
	5.5.3 Systems with Energy Storage	New addition
	5.5.6 Power Factor Requirements	New addition
	5.5.7 Volt-Watt Response Mode	New addition
	5.5.8 Volt-Var Response Mode	New addition
	5.5.9 Voltage Balance Mode	New addition
	5.5.10 Required Settings for AS/NZS 4777.2-2015 Compliant Inverters	New addition
	5.6.3 Nominal Ramp Down Times	Amendment to Existing
	5.6.6 Method for Achieving Required Ramp Rate	New addition
	5.7 Feed-in Management Requirements	Amendment to Existing
	5.7.1 Functional Requirements	Amendment to Existing
	5.7.2 Horizon Power Scope	Amendment to Existing
	5.7.3 Customer Scope	Amendment to Existing
	5.7.4 Equipment	Amendment to Existing

Section	Affected Clause	Type of Change
	5.8 Zero-Export Requirements	Amendment to Existing
	5.9 Extended Ramp Rate Systems	New Addition
	5.12 Routine Testing of Renewable Energy Smoothing Systems	Amendment to Existing

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

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SCHEDULES

(typical shown below)

Schedule 1 Customer Compliance Checklist (typical shown below)

Schedule 2 System Diagram (typical shown below)

Schedule 3 Circuit Diagram (typical shown below)

Schedule 4 Cable Data (typical shown below)

Schedule 5 NER Signoff (typical shown below)

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

SCHEDULE 1. CUSTOMER COMPLIANCE CHECKLIST

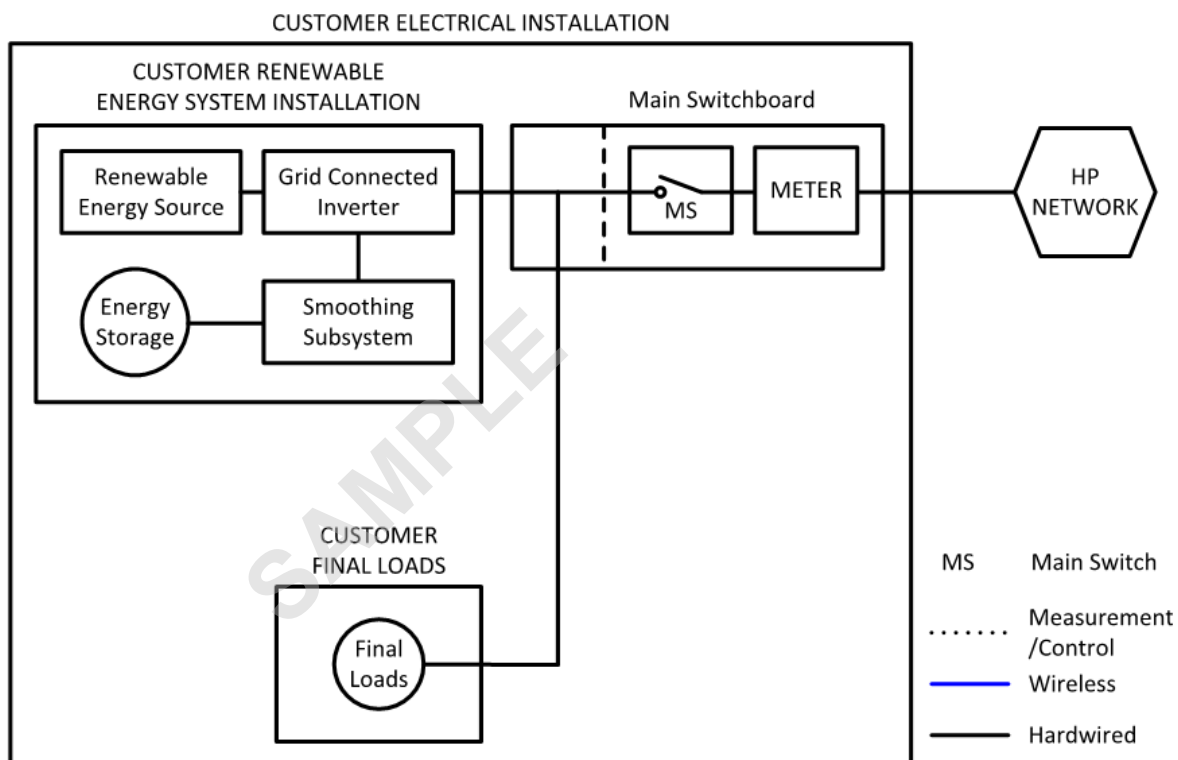
System Diagram:			A	B	C	D	E	
Eligible System Class:			1	1, 2 or 3	1, 2 or 3	1, 2 or 3	1	
Description		Clause	Complies ?					Comments
General Requirements	Customers Responsibilities	1.3.1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Connection Types	1.3.4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Balance Generation	1.3.5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Reference Documentation	2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Compliance with Requirements	4.1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Offsetting of Imported Energy	4.2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Labelling	4.3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Documentation	4.4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	System Diagram	5.1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Circuit Configurations	5.2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Metering	5.3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Router	5.4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Inverters	Number of Inverters	5.5.1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Approved Inverters & Power Conversion Equipment	5.5.2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Systems with Energy Storage	5.5.3	n/a	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	n/a	
	Passive Anti-islanding Protection Settings	5.5.4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Permission to Export	5.5.5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Power Factor Requirements	5.5.6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Volt-Watt Response Mode	5.5.7	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Volt-Var Response Mode	5.5.8	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Voltage Balance Mode	5.5.9	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

	Required Settings for AS4777 Compliant Inverters	5.5.10	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Smoother Requirements	Concept	5.6.1	n/a	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	n/a	
	Characteristic Curve	5.6.2	n/a	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	n/a	
	Nominal Ramp Down Times	5.6.3	n/a	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	n/a	
	Nominal Ramp Up Times	5.6.4	n/a	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	n/a	
	Non-Linearity	5.6.5	n/a	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	n/a	
	Testing	5.6.7	n/a	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	n/a	
Feed in Management	Functional Requirements	5.7.1	n/a	n/a	n/a	<input type="checkbox"/>	<input type="checkbox"/>	
	Customer Scope	5.7.3	n/a	n/a	n/a	<input type="checkbox"/>	<input type="checkbox"/>	
	Method of Control for Class 1, 2 & 3 Systems	5.7.4.1	n/a	n/a	n/a	<input type="checkbox"/>	n/a	
Zero Export	Technical Requirements	5.8.1	n/a	n/a	<input type="checkbox"/>	n/a	n/a	
	Equipment	5.8.2	n/a	n/a	<input type="checkbox"/>	n/a	n/a	
Extended Ramp Rate Systems	Technical Requirements	5.9.1	n/a	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	n/a	
Testing	Type Testing	5.11	n/a	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	n/a	
	Testing Method	5.12.1	n/a	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	n/a	
	Ramp Testing Procedure	5.12.2	n/a	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	n/a	
	Measurement Accuracy	5.12.3	n/a	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	n/a	
	Recording of Data	5.12.4	n/a	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	n/a	
	Action on Test Completion	5.12.5	n/a	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	n/a	

Commissioning	Commissioning Requirements	5.13	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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SCHEDULE 2. SYSTEM DIAGRAM

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

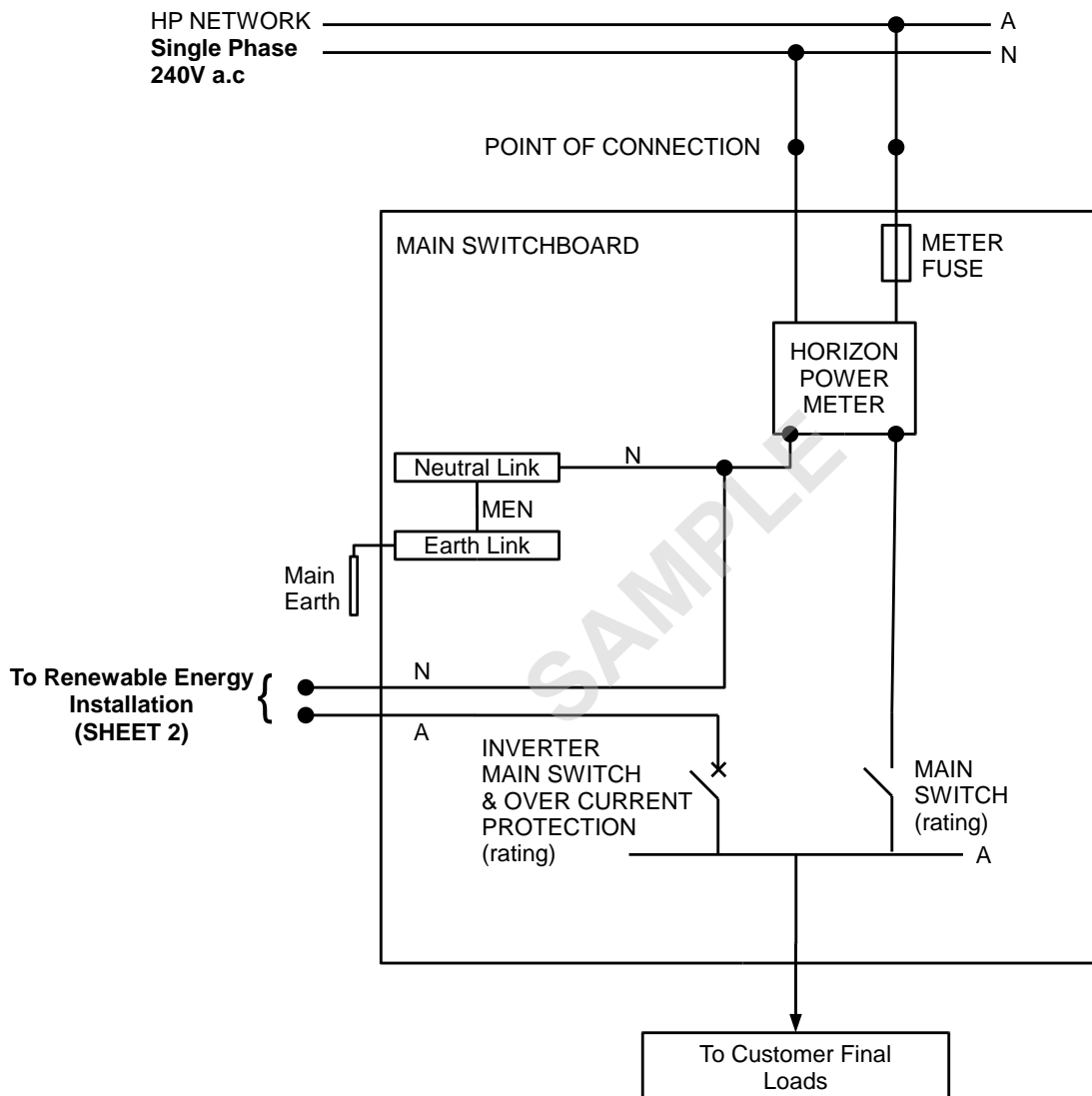


NOTE: Indicative layout only. To be read in conjunction with AS/NZS 3000, AS/NZS 4777.1 and WADCM.

SCHEDULE 3. CIRCUIT DIAGRAM

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

SHEET 1

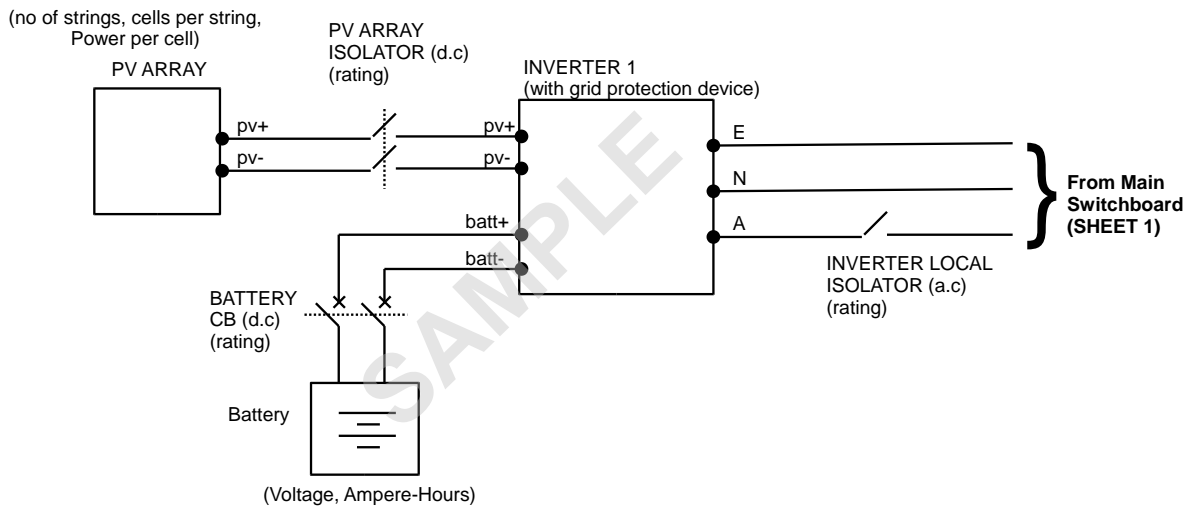


Note: For indicative purposes only - the Customer shall rely on the other requirements of this Document together with AS 4777.1, AS/NZS 3000, AS 5033 (PV only) and other applicable documents to connect the internal components of Renewable Energy Installation correctly

(schedule 3 continued)

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

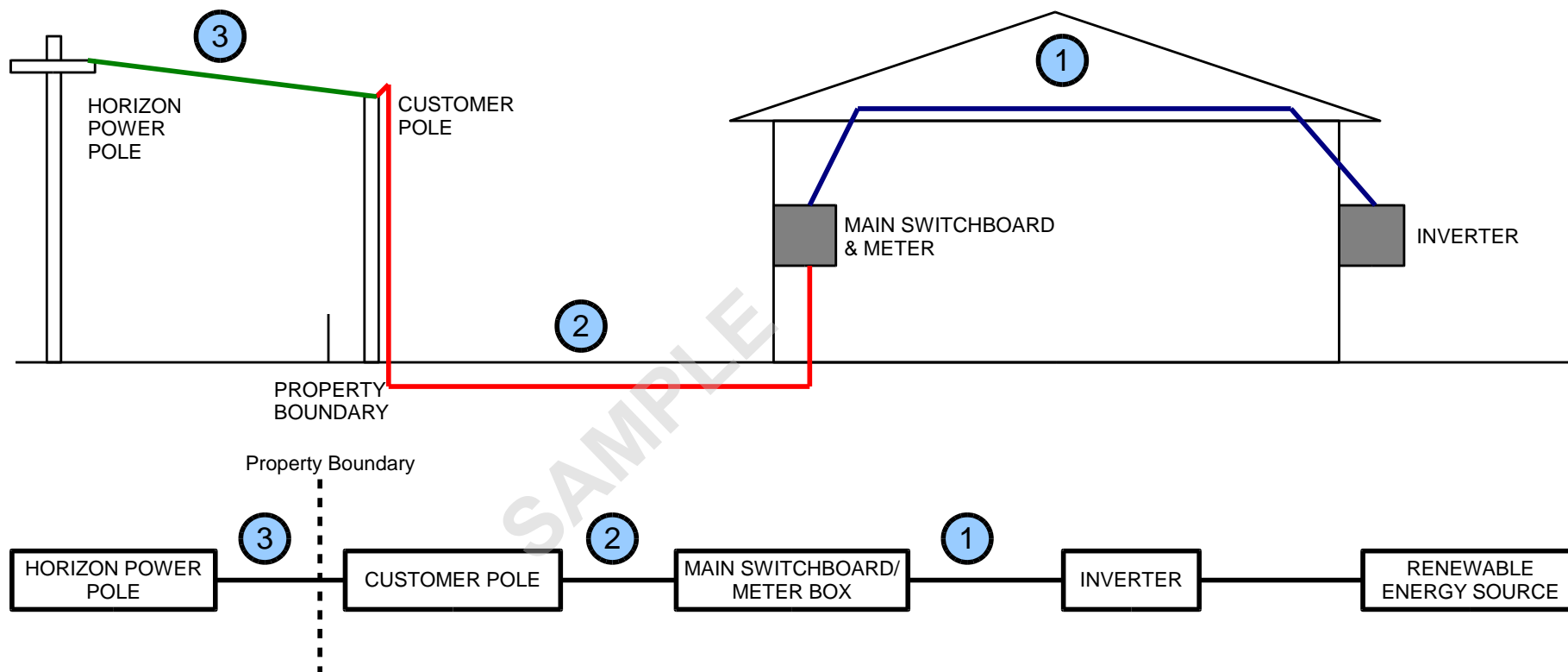
SHEET 2



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	4mm ² , 2 Core + Earth, PVC/PVC, Copper	In Roof Space
2	20m	4mm ² , 2 Core, PVC/PVC, Copper	Underground
3	30m	4mm ² , 2 Core, Bare, Copper	Overhead

SCHEDULE 5. NER SIGNOFF

*****SAMPLE ONLY: NEW REFERENCE DESIGN*****

Horizon Power
18 Brodie Hall Drive
Technology Park
Bentley, WA, 6102

Your Ref: XXXXXX
Our Ref: YYYYYY (if applicable)

DD/MM/YY

Dear Sir/Madam

Subject: Renewable Energy Connection - Project Name, Project Location

Please find attached our submission for the abovementioned project.

This letter is to certify that as a Chartered Professional Engineer and by virtue of my training and experience, the submission documentations issued together with this letter complies with the requirements of the following:

- HPC-9FJ-12-0001-2012 Renewable Energy Systems Connected to the Low Voltage (LV) Grid via Inverters (State latest revision)
- Electricity (Licensing) Regulations 1991
- AS/NZS 3000 (State latest revision)
- Western Australian Electrical Requirements (State latest revision)
- Western Australian Distribution Connections Manual (State latest revision)
- AS 3100 (State latest revision)
- AS/NZS 4777 (State latest revision)
- AS/NZS 5033 (State latest revision)

In addition, the following schedules have been submitted as part of the application:

- Schedule 1: Compliance Checklist
- Schedule 2: System Diagram
- Schedule 3: Circuit Diagrams
- Schedule 4: Cable Data

Should you have any queries, please contact the undersigned.

Yours Sincerely,

Chartered Professional Engineer's Name and NER Number
Professional Title
Company Name
Company Address
Contact Detail

*****SAMPLE ONLY: COVER LETTER FOR REUSED REFERENCE DESIGN*****

Horizon Power
18 Brodie Hall Drive
Technology Park
Bentley, WA, 6102

Your Ref: **XXXXXX**
Our Ref: **YYYYYY (if applicable)**

DD/MM/YY

Dear Sir/Madam

Subject: Renewable Energy Connection - Project Name, Project Location

Please find attached our submission for the abovementioned project. This letter is to declare that the abovementioned project makes use of the reference design for Project (State Project) dated (State Date). An NER accredited chartered professional engineer has checked the reference design and it has been attached to our submission for your consideration.

The abovementioned project does not differ with the NER validated reference design in the key elements described in section 4.4.2 of the Technical Requirements.

In addition, the following schedules have been submitted as part of the application:

- Schedule 1: Compliance Checklist
- Schedule 2: System Diagram
- Schedule 3: Circuit Diagrams
- Schedule 4: Cable Data

Should you have any queries, please contact the undersigned.

Yours Sincerely,

Name
Professional Title
Company Name
Company Address
Contact Detail