Requirements for Connection of Embedded Generators up to 5MW to the Evoenergy Network

VERSION 3.2
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1. INTRODUCTION

Under National Electricity Rules (NER) Chapter 5A, Evoenergy has an obligation to review and process applications to connect or modify a connection, which are submitted to it and must enter into a connection contract with the applicant. This requirement applies to both customer load and embedded generation plant.

Embedded generation technologies are broad and diverse and can include the following:

- Gas Turbines
- Diesel Engines
- Hydro
- Wind Turbines
- Photovoltaic Generation (Solar)
- Battery Storage
- Fuel Cells
- Landfill Generation
- Tri/Co-Generation

Embedded generating units, have the ability to impact the operating conditions, voltage profile, power quality and loading on Evoenergy’s distribution network.

Evoenergy has minimum technical requirements that must be met in the design and installation of embedded generation facilities to ensure that these impacts can be controlled to maintain a safe and reliable operation of the distribution network.

These requirements outline the technical parameters for the installation of embedded generating units connecting to and operating in parallel with Evoenergy’s distribution network for installations up to 5MW in size.

This document does not relate to eligibility for any feed-in-tariff or any other tariff. There may be additional requirements for installations in unique situations. These requirements will be identified by Evoenergy on a case by case basis.
This document applies to the following embedded generating units connecting to and operating in parallel with Evoenergy’s distribution network:

- Single-phase LV installations up to and including 5kW
- Three-phase installations up to and including 5MW
- Those generators involved in short term paralleling with the Evoenergy network (greater than 400ms)

This document applies to installations connected via inverters, such as energy storage devices as well as non-inverter connections, such as alternating current (A.C.) rotating machines.

The requirements outlined in this document do not apply to embedded generating units greater than 5MW and ‘break-before-make’ (backup) generating units.

For connection of systems larger than 5MW Evoenergy will consider the inquiry on a case by case basis and provide the customer with the appropriate requirements.

It must be noted that approval for connection for embedded generating units greater than 30kW will be based on the results of the Network Technical Studies as outlined in this document.

### 2.1 Types of Embedded generating Systems

For the purpose of this document, all proposed generating units designed to connect to Evoenergy’s network are either export or non-export embedded generating units as described below.

#### 2.1.1 Export embedded generation

An export embedded generation unit is one designed to export electricity that is in excess to the site load (Demand) to Evoenergy’s network. Evoenergy encourages proponents of export embedded generation to support its Network Demand Management initiatives.

A direct connected unit is directly connected to Evoenergy’s network.

Exporting embedded generation units may require communication links installed between Evoenergy and the embedded generating unit installation to provide SCADA monitoring and control. This will be determined by Evoenergy in accordance with Section 8.

#### 2.1.2 Non-Export Generation

A non-export embedded generating unit is an embedded generating unit within a Customer’s installation that does not exceed the Customer’s electricity demand.

Where the embedded generating unit does not have an agreement to export electricity to Evoenergy, reverse power flow protection (towards the network) must be installed to disconnect the embedded generating unit from Evoenergy’s network in the event that the minimum import electricity buffer is encroached upon.
3. OBJECTIVE

Evoenergy is committed to connecting renewable generation to its distribution network while ensuring at all times that power supply to its customers is delivered in accordance with Evoenergy and Industry standards.

Evoenergy’s prime objectives are:

a. The safety of personnel who work on the distribution network and to the general public;

b. To minimise asset loss-of-life, reduced performance and to prevent damage to distribution network assets;

c. To minimise disruption to all customers (quality of supply) inclusive of the customer’s own site; and

d. To not intentionally cause harm to the environment and to encourage development that supports the environments ability to satisfy the needs of future generations.

This document outlines Evoenergy’s requirements for the connection to, and parallel operation with, Evoenergy’s distribution network in relation to customer connected embedded generation units.

This guideline should be read in conjunction with AS/NZS 4777 and the Evoenergy Service & Installation Rules.

The Evoenergy Service & Installation Rules can be accessed on the Evoenergy website at:

Evoenergy Service & Installation Rules
4. DEFINITIONS & REFERENCES

4.1 Definition of Terms in this Document

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Evoenergy</strong></td>
<td>Evoenergy is the ACT’s principal Distribution Network Service Provider</td>
</tr>
<tr>
<td></td>
<td>(DNSP) and is responsible for the distribution of electricity to all</td>
</tr>
<tr>
<td></td>
<td>distribution network connected customers within the ACT under a regulatory</td>
</tr>
<tr>
<td></td>
<td>framework. Evoenergy designs, installs, upgrades, repairs and maintains</td>
</tr>
<tr>
<td></td>
<td>the infrastructure which makes up the distribution network carrying</td>
</tr>
<tr>
<td></td>
<td>electrical energy to ACT homes and businesses.</td>
</tr>
<tr>
<td></td>
<td>An agreement made with Evoenergy does not constitute an agreement</td>
</tr>
<tr>
<td></td>
<td>with a Retailer. Nor does an agreement made with a Retailer constitute</td>
</tr>
<tr>
<td></td>
<td>an agreement with Evoenergy</td>
</tr>
<tr>
<td><strong>ACT Government – Electrical Inspectorate</strong></td>
<td>The ACT Government Electrical Inspectorate is the inspecting authority</td>
</tr>
<tr>
<td></td>
<td>in the ACT and is responsible for inspecting and approving the customer’s</td>
</tr>
<tr>
<td></td>
<td>electrical installation.</td>
</tr>
<tr>
<td></td>
<td>Contact number is (02) 6207 7775 Email: <a href="mailto:electrical.inspections@act.gov.au">electrical.inspections@act.gov.au</a></td>
</tr>
<tr>
<td><strong>Amp (A)</strong></td>
<td>A unit of electrical current</td>
</tr>
<tr>
<td><strong>Anti-Islanding Protection (Loss of Mains)</strong></td>
<td>A protection system to detect islanded conditions and disconnect the</td>
</tr>
<tr>
<td></td>
<td>embedded generating unit from the distribution network.</td>
</tr>
<tr>
<td><strong>Bi-Directional Metering</strong></td>
<td>A meter capable of registering energy supplied to the premises and</td>
</tr>
<tr>
<td></td>
<td>energy exported from the premises as separate data streams.</td>
</tr>
<tr>
<td><strong>Battery Energy Storage System (BESS)</strong></td>
<td>A system consisting of one or more electromechanical cells connected in a</td>
</tr>
<tr>
<td></td>
<td>series, parallel or series-parallel arrangement that can be charged</td>
</tr>
<tr>
<td></td>
<td>electrically to provide stored electrical charge when needed.</td>
</tr>
<tr>
<td></td>
<td>The battery cells can consist of various chemistries – such as lead,</td>
</tr>
<tr>
<td></td>
<td>nickel or lithium, and depending on the operating requirements of that</td>
</tr>
<tr>
<td></td>
<td>chemistry, the system may or may not include a battery management system</td>
</tr>
<tr>
<td></td>
<td>for monitoring, controlling and protecting the individual cells and</td>
</tr>
<tr>
<td></td>
<td>complete system.</td>
</tr>
</tbody>
</table>
For the purposes of these requirements, embedded generating units have been classified according to their nameplate rating as shown in the table below.

<table>
<thead>
<tr>
<th>CLASS</th>
<th>NAME PLATE RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Up to and including 5kW Single-phase or up to and including 30kW Three-phase</td>
</tr>
<tr>
<td>2</td>
<td>Exceeding 30kW up to and less than 60kW Three-phase</td>
</tr>
<tr>
<td>3</td>
<td>From 60kW up to and less than 120kW Three-phase</td>
</tr>
<tr>
<td>4</td>
<td>From 120kW up to and less than 200kW Three-phase</td>
</tr>
<tr>
<td>5</td>
<td>From 200kW up to and less than 1500kW Three-phase</td>
</tr>
<tr>
<td>6</td>
<td>From 1500kW up to 5000kW Three-phase</td>
</tr>
</tbody>
</table>

For inverter connected systems, the rating is defined as the maximum inverter AC output of the system. If more than one inverter is installed, the rating is then the combined output of all inverters.

**Current Transformer (CT)**

A current transformer is an electrical device that produces a current in its secondary winding that is proportional to its primary winding.

**Customer**

Customer has the definition given to it by the regulatory documents outlined in Section 5 of the National Electricity Rules. For the purposes of this document the word customer also includes proponents of embedded generating units planned to be connected to the distribution network, their agents and representatives where appropriate.

**Demand Response**

The automated alteration of an electrical product's normal mode of operation in response to an initiating signal originating from or defined by a remote agent.

**DRED**

Demand Response Enabling Device. A device, integral or external to an electrical product, which provides the functionalities and capabilities to achieve demand response.

**Embedded Generating Unit**

A generating unit that is connected directly to and operating in parallel with the distribution network without direct access to the transmission network.

**Embedded Generator**

A person that owns controls or operates an embedded generating unit

**Energy Storage System (ESS)**

Energy storage systems are the set of methods and technologies used to store various forms of energy.

**Export Embedded Generation**

An embedded generating unit that is designed to export electricity that is in excess to the site load (demand) to the distribution network.

**External Protection**

For the purposes of these requirements, external protection means a protection device that is not part of the generating unit’s internal protection.

**Generating Unit**

The actual hardware, equipment and systems which produce electricity and all related equipment essential to their functioning as a single entity.
Generator Connection Cubicle (GCC)  A standardised enclosure designed to provide backup protection, SCADA and communication for the embedded generating unit. Refer to Appendix C for the requirements of the GCC.

Gross Metering  For the purpose of these requirements, Gross Metering means a revenue metering arrangement in which both the total amount of energy created and the total amount of energy consumed by a customer are recorded separately.

This is achieved either by a separate meter or by a second element within the meter.

High Voltage (HV)  High Voltage nominally above 1000 Volts AC or 1500 Volts DC.

Installer  For Inverter systems: A person who possesses both a Clean Energy Council (CEC) accreditation and holds an unrestricted electricians licence.

For Non-Inverter systems: an engineering consultant body or a licenced electrical contractor with relevant knowledge, expertise and experience.

Internal Protection  For the purpose of these requirements, internal protection means a protection device that is part of the generating unit.

Inverter  A device that uses semiconductor devices to transfer power between a D.C. source or load and an A.C. source or load.

Inverter Energy Systems (IES)  A system comprising one or more inverters together with one or more energy sources (which may include batteries for energy storage), controls and one or more grid protection devices.

Islanding  Any situation where the electrical supply from the distribution network is disrupted and one or more inverters maintains any form of electrical supply, be it stable or not, to any section of that distribution network.

kVA  kilo Volt Amp; the measure of Total Power.

kVAr  kilo Volt Amp Reactive; the measure of Reactive Power.

kW  kilo Watt; the measure of Real Power.

kWh  kilo Watt Hour;

Lockable Switch  A switch or circuit breaker that has provision for insertion of a mechanical device to prevent the switch being closed.

Low Voltage (LV)  Low Voltage nominally up to 1000 Volts AC or 1500 Volts DC.

Micro-Embedded Generator  Shall have the meaning defined in the National Electricity Rules (NER) Chapter 5A.

Main Switchboard (MSB)  A switchboard from which the supply to the whole electrical installation can be controlled.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter Protection Device (MPD)</td>
<td>A fuse or other protection and isolation device (which complies with Clause 5.8 of the service and installation rules) located on the unmetered side of the installation, intended for the isolation and protection of the meter and its associated customer installation.</td>
</tr>
<tr>
<td>‘Must’ and ‘Shall’</td>
<td>For the purposes of these requirements, the words ‘must’ and ‘shall’ indicate a mandatory requirement.</td>
</tr>
<tr>
<td>Net Metering</td>
<td>For the purpose of these requirements, ‘net metering’ occurs when an embedded generating unit is connected on the customer (load) side of the revenue meter. This can be used and billed as Period of Billing Net metering or Instantaneous Net metering.</td>
</tr>
<tr>
<td>Maximum Point Power Tracker (MPPT)</td>
<td>A device, typically located within an inverter, which regulates incoming D.C. power to the inverter and optimises solar panel performance.</td>
</tr>
<tr>
<td>Network Connection Breaker (NCB)</td>
<td>A customer owned circuit breaker which defines the demarcation between the distribution network and the customer’s installation. The NCB provides the disconnection point of the embedded generating unit. Evoenergy requires control over the NCB as described in this document.</td>
</tr>
<tr>
<td>National Electricity Rules (NER)</td>
<td>The Rules made under the National Electricity Law to control the operation of the National Electricity Market.</td>
</tr>
<tr>
<td>National Energy Customer Framework (NECF)</td>
<td>The National Energy Customer Framework (NECF) was introduced in the ACT on 1 July 2012. The NECF introduces a new set of national laws, rules and regulations governing the retail sale and distribution of energy to customers and provides protection for energy users.</td>
</tr>
<tr>
<td>Network</td>
<td>Evoenergy’s electrical distribution system</td>
</tr>
<tr>
<td>Network Charges</td>
<td>For the purpose of these requirements, ‘Network Charges’ shall refer to the costs invoked by Evoenergy for the use or augmentation of the distribution network. See Appendix B for details.</td>
</tr>
<tr>
<td>Network Technical Study (NTS)</td>
<td>The connection of an embedded generating unit to the distribution network will inevitably result in some local changes to the characteristics of the distribution network. To evaluate the possible consequences of these changes Evoenergy will carry out a NTS with the installation included in the network model. This involves the use of detailed databases describing the electrical characteristics of the network and can be used to analyse how the network will behave under different loading conditions or in the event of particular faults.</td>
</tr>
<tr>
<td>Non-Export Embedded Generation</td>
<td>An embedded generating unit that is paralleled with Evoenergy’s network and is designed not to exceed the site load (demand). Where the customer does not have an agreement to export electricity directly to the distribution network, duplicate reverse power flow protection must be installed.</td>
</tr>
<tr>
<td>Point of Common Coupling (PCC)</td>
<td>The closest electrical point to where the generating unit connects to either the customer load or the distribution network.</td>
</tr>
</tbody>
</table>
Remote Terminal Unit (RTU)

An electronic device that is controlled by a microprocessor. The device interfaces with physical objects to a Distributed Control System (DCS) or Supervisory Control and Data Acquisition (SCADA) system by transmitting telemetry data to the system.

Supervisory Control and Data Acquisition (SCADA)

A control system that remotely monitors and is capable of switching the embedded generating unit connected to the distribution network.

Service Protection Device (SPD)

The first protection device located on the network side or forming part of the Connection Point.

Uninterruptable Power Supply (UPS)

A power system comprising inverters, switches, control circuitry and a means of energy storage (e.g. batteries) for maintaining continuity of electrical supply to a load in the case of a disruption of power supply from the distribution network.

V or kV

Volt or kilovolt; the measure of Electrical Potential.

Voltage Transformer (VT)

A voltage transformer is an electrical device that produces a voltage in its secondary winding that is proportional to its primary winding.
### 4.2 List of References

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<th>Description</th>
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<td>AS/NZS 2467</td>
<td>Maintenance of Electrical Switchgear</td>
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<td>AS/NZS 3000</td>
<td>Electrical Installations (known as the Australia/New Zealand Wiring Rules)</td>
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<tr>
<td>AS 4086</td>
<td>Secondary Batteries for use with stand-alone systems</td>
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<tr>
<td>AS 4777.1</td>
<td>Grid Connection of Energy Systems via Inverters Part 1 – Installation Requirements</td>
</tr>
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<td>AS/NZS 4777.2</td>
<td>Grid Connection of Energy Systems via Inverters Part 2 – Inverter Requirements</td>
</tr>
<tr>
<td>AS/NZS 4755.1</td>
<td>Demand Response capabilities and supporting technologies for electrical products – Part 1: Demand Response Framework and requirements for Demand Response Enabling Devices (DREDs)</td>
</tr>
<tr>
<td>AS/NZS 5033</td>
<td>Installation of Photovoltaic Arrays</td>
</tr>
<tr>
<td>AS/NZS 60034.1</td>
<td>Rotating electrical machines - Rating and performance</td>
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<td>AS/NZS 6100-3.2</td>
<td>Electromagnetic Compatibility – Limits for Harmonic Current Emissions</td>
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</tr>
<tr>
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<td>Uninterruptible Power Systems</td>
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<tr>
<td>AS 60038</td>
<td>Standard voltages</td>
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<tr>
<td>AS/NZS 7000</td>
<td>Overhead line design</td>
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<td>IEC 62109-1, 2</td>
<td>Safety of power converters for use in photovoltaic power systems</td>
</tr>
<tr>
<td>IEC 60255</td>
<td>Series Protection Relays</td>
</tr>
<tr>
<td>IEC 62116</td>
<td>Utility-interconnected photovoltaic inverters – Test procedure of islanding prevention measures</td>
</tr>
<tr>
<td>ISO/IEC 27002</td>
<td>Information Technology - Security techniques</td>
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<td>ENA EG-0</td>
<td>Power system earthing guide: Part 1: management principles</td>
</tr>
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<td>HB 264 – 2003</td>
<td>Power Quality- Recommendations for the application of AS/NZS 61000.3.6 and AS/NZS 61000.3.7</td>
</tr>
<tr>
<td>ENA Guidelines</td>
<td>ENA Guideline for the preparation for connection of Embedded Generation within Low Voltage Distribution Networks</td>
</tr>
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**National Electricity Rules**

**Evoenergy Service & Installation Rules**
5. GENERAL REQUIREMENTS

5.1 Regulatory
The embedded generation connection process shall adhere to the regulatory requirements and recommendations of:

- The National Electricity Rules – NER
- All other relevant laws, rules and regulations

5.2 Embedded Generator Connection Contract
Customers proposing to become an embedded generator are required to enter into a connection contract with Evoenergy.

In accordance with the applicable regulations listed above in Clause 5.1, a customer proposing the installation of a Class 1 embedded generating unit is offered Evoenergy’s model standing offer for basic connection services to retail customers who are embedded generators.

The model standing offer sets out the terms of connection of the embedded generating unit to the distribution network. An embedded generator may request Evoenergy’s terms and conditions for non-standard connections.

In accordance with the applicable regulations listed in Clause 5.1, a customer proposing the installation of Class 2 – 6 embedded generating units will be provided with Evoenergy’s terms and conditions for non-standard connections.

The terms and conditions for non-standard connections are subject to commercial negotiations between the parties and will encompass both the technical and commercial aspects of the connection, address the access standards and specify the terms and conditions, including the connection charge. The process regarding the formation of connection contracts contained in Chapter 5A of the NER will apply for non-standard connections.

The terms and conditions for non-standard connections also require the customer to indemnify Evoenergy against any liability resulting from the customer’s use of the distribution network in a manner prejudicial to the safety and efficiency of the distribution network.

Non-standard connection offers have a twenty (20) business day expiry date where the terms and conditions must be finalised and signed by the authorised representatives of both parties.

Where required, Evoenergy will prepare and forward Evoenergy’s terms and conditions for non-standard connections following the receipt of the Customer’s full and complete connection application.

Commissioning and connection of the embedded generating unit to the network will not be permitted until this contract is executed by both parties and associated charges paid.

Customers seeking to be a registered participant should contact Evoenergy as different terms, conditions and processes may apply.

Contractual queries surrounding incentive schemes for generation, including feed-in tariffs, should be directed towards the customer’s energy retailer.

5.3 Compliance with the National Electricity Rules (NER)
The National Electricity Rules, (NER), regulate access to the distribution network for embedded generators subject to the generating unit’s attributes.

Chapter 5A of the NER provides the framework for this access and aims to:

- Establish the process to be followed;
- Detail the guidelines and principles governing the connection application and access to the distribution network;
- Address the customer’s reasonable expectations of the level of standard of power transfer capability; and
Establish the process to ensure ongoing compliance with the technical requirements of the connection with the distribution network.

5.4 Connection limits

Since existing Evoenergy’s network and substations were designed and constructed without consideration for embedded generation, additional sources of supply may affect the fault level of the Evoenergy network. As the penetration level of embedded generation continues, a point may be reached where additional sources of supply will result in the fault level being greater than the switchgear and equipment ratings.

Evoenergy thus reserves the right to inhibit the output of a generator to ensure that the system is not compromised under high fault or abnormal conditions. This may be provided via a control signal from Evoenergy such that the generating unit is either taken off-line (i.e. soft trip) or inhibited from starting up.

Upon assessment of the proposed connection, Evoenergy will advise the customer if any fault level exists whereby scheduling may be required as part of the installation.

5.5 NER Negotiated Access Standards

Evoenergy will give appropriate consideration to negotiated access standards that are proposed by the embedded generator. It should be noted that, in the case of embedded generator negotiated access performance standards that impact on system security, Evoenergy is required to seek technical advice from AEMO.

In preparing and submitting embedded generator negotiated access standards, generator customers should provide the technical rationale, together with supporting information for assessment by Evoenergy.

5.6 NER Minimum Access Standards

The acceptance of minimum access standards will depend on a number of factors, including the proposed generation capacity, and technology to be utilised. Consideration will also be given to the connection location and existing customer supply issues.
6. INSTALLATION & TECHNICAL REQUIREMENTS

Unless agreed otherwise, the inverter shall comply with the requirements of AS/NZS 4777. As noted in AS/NZS 4777, although this standard does not apply to inverters larger than 200 kVA, similar principles may be used for the installation of larger systems.

Only inverters that are either included in the list of approved inverters published by the Clean Energy Council (CEC) or have been tested by an authorised testing laboratory and certified as being in compliance with AS/NZS 4777 will be accepted for connection to the Evoenergy distribution network.

Where systems employ inverters greater than 30kW approval to connect these inverters will be determined on a case by case basis. This may require the customer to have the inverter evaluated by an engineering consultant body with relevant knowledge, expertise and experience.

Refer to Appendix A2 for the requirements regarding approval of non CEC listed inverters.

Rotating generating units can either be synchronous or asynchronous generators. Synchronous generators can operate either in isolation from or connected to the distribution network. When connected to the distribution network, a synchronous generator is “locked into” the distribution network, i.e. operating at the same frequency.

Asynchronous generators draw their magnetising current from the distribution network during operation and are generally not capable of isolated operation. The provision of magnetising current for the operation of asynchronous generators can place additional demands on the distribution network.

Evoenergy prefers the use of synchronous generators for rotating generator units; however consideration for asynchronous or induction generators will be given on a case by case basis.

6.1 Safety

The embedded generation unit shall not impose a safety hazard to personnel working on the distribution network, Evoenergy customers and members of the public as stipulated in AS/NZS 4777.2 and the Evoenergy Service and Installation Rules.

Inverters for use in inverter energy systems with photovoltaic arrays shall also comply with the appropriate electrical safety requirements of IEC 62109-1, 2. Inverters for use in inverter energy systems that have energy storage batteries as the only possible energy source shall also comply with the appropriate electrical safety requirements of AS 62040.1.1.

6.2 Connection Arrangement

The maximum value for the rating of a generating unit allowed for single phase installations at any time is 5kW. Single phase generating units in three-phase configuration are permitted.

Where an energy storage system is installed, the storage system will not contribute to the overall available exporting generation capacity.

Where there is an existing single phase embedded generation unit greater than 5kW in size, the addition of an energy storage system will be approved. However, Evoenergy may require the existing embedded generation unit to have power limiting devices installed.

Generating units with a capacity greater than 5kW must be balanced evenly over three-phases with a tolerance of no greater than 5 percent of the inverter output between any two phases.

Generating units with a capacity greater than 30kW must be three-phase systems with generation balanced equally amongst the three-phases.

Unless specifically stated by Evoenergy, the rating limit for a single-phase IES in an individual installation shall be equal to 5 kVA, and a multi-phase IES shall have a balanced output with respect to its rating, with a tolerance of no greater than 5 kVA unbalance between any phases.
6.3 Network Connection Requirements

Embedded generating units shall be connected by fixed wiring to a dedicated circuit at the customers MSB that is accessible to Evoenergy personnel at all times. If this requirement cannot be achieved, special approval for the connection of the embedded generating unit may be provided as detailed in section 6.3.3.

For embedded generating units (Class 4 and above) that connect directly to an Evoenergy substation, the circuit breaker shall be rated at full load breaking capacity and have remote operation capability.

6.3.1 Embedded Generating Unit Isolation Switch

There shall be a visible and accessible method of ensuring the embedded generating unit is disconnected from the distribution network and disconnected from the customer’s installation.

Where more than one form of an embedded generating system, is installed, each system shall have a separate AC main switch installed. Where embedded generation systems share an inverter, (e.g. PV and Energy Storage System), only one AC main switch is required. Refer to Appendix H for additional information.

The embedded generating units A.C. main isolation switch shall be located at the MSB of the customer’s installation, and shall be a lockable switch in the OFF position, which operates in all live conductors. The operation of this switch shall isolate the embedded generation system at that switchboard.

This isolation switch is to provide isolation of the embedded generating unit for persons working on other parts of the electrical installation and to provide Evoenergy personnel working on the distribution network a means of isolation. The isolation switch shall be installed to the requirements governing main switches in AS/NZS 3000, irrespective of where the embedded generation system originates from.

6.3.2 Existing Residential Premises with Common Metering Location

In the case where existing residential premises, such as townhouse complexes are supplied by the same service cable; with the service fuses, links and metering equipment located at the point of common coupling (PCC), the embedded generating unit isolation switch may be installed at the customer’s residence.

This isolation switch must be located in an accessible location at all times that is external to the residence in a lockable enclosure approved by Evoenergy to allow field personnel to isolate the embedded generating unit.

The enclosure and common metering point shall be labelled in accordance with AS/NZS4777.

6.3.3 Special Approval

In cases that are unable to comply with the defined requirements in this document, special approval may be granted, however; any special approval outcome must still meet the essential requirements of the Evoenergy Service & Installation Rules. The installer shall notify Evoenergy of the particular installation that does not fully comply with the requirements set out in this document.

An Evoenergy service and installation officer will then attend the site in order to make an informed decision. Further advice may need to be sought from Evoenergy engineering personnel to come to a final decision. The installer will be notified of the final decision in writing within ten (10) business days from the initial special approval request.

6.3.4 Issues that may require further investigation by Evoenergy

The following items are seen as potential issues for the connection of small embedded generation installations in Evoenergy’s network and may require further investigation.

- Network load balance for distribution feeders
- Network thermal overload conditions
- Harmonic saturation

Evoenergy sees that the control and recording of small embedded generation installations is essential in managing quality of supply. In the future limits may need to be enforced on the total kVA of small embedded generator installations connected per distribution transformer, with lower limits applying on LV networks to minimise the impact of harmonic saturation.
6.4 Energy Storage Systems

An Energy Storage System (ESS) provides an independent source of supply from the distribution network. An ESS is defined as having the ability to operate in parallel with the grid via an inverter, regardless of whether it is charged directly from the distribution network or through energy produced from an inverter energy source.

For parallel connected embedded generating units with an inverter that includes the capability to charge the ESS from a mains supply, the charging can be supplied from the distribution network through a number of available tariffs, including both residential and commercial/business tariffs. The customer shall be aware of the cost structures for each tariff and their hours of operation when making any decision regarding circuits to charge the ESS.

Evoenergy does allow customers to connect an ESS to an existing embedded generating system. A new special connection request and single line diagram shall be submitted by the installer showing sufficient detail as to how the proposed ESS will integrate with the existing embedded generating system. ESS applications for connection to the Evoenergy network and are only permitted through a parallel operating AS/NZS 4777 compliant inverter.

6.5 Electric Vehicles

Electric vehicles that are only capable of charging from the grid are not considered an embedded generating unit, but rather only a load, and are subject to the requirements outlined in chapter 6 of the Evoenergy Service and Installation Rules.

An electric vehicle will however be considered an embedded generating unit and therefore subject to these requirements, where it is:

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

6.6 Maximum Permitted Embedded Generating Unit Capacity

Evoenergy has limits on the maximum generation capacity that can be connected to a local distribution network. This is largely driven by the thermal capacity of the supplying HV feeder, potential voltage rise of that HV feeder, the distribution transformer rating and the combined effect of the connected generation plant on Evoenergy’s network performance, operation and safety requirements.

For export embedded generation of Class 2 and above, a Network Technical Study (NTS) will determine the maximum embedded generating unit capacity that may be connected.

For class 6 embedded generating units, the customer is required to have a Network Technical Study prepared by an engineering consultant with relevant knowledge, expertise and experience.

There may also be cases where the proposed installation may be required to connect at a reduced capacity or where no connection is allowed. In some instances, depending on the location of the proposed installation, network augmentation and or additional protection and control functions (for either or both the distribution network and the embedded generating unit) may be required to ensure network safety and performance standards are not compromised. Evoenergy will identify these as part of the NTS and advise the applicant if additional work is required. The cost for some or all of this work will be attributed to the customer. Applications will be processed strictly in the order in which they are received.

For the purposes of these requirements, Evoenergy has classified embedded generating units by the nameplate rating of the generating unit. Please refer to Section 4 for details.

6.7 Demand Response Management

Inverters compliant with the latest versions of AS/NZS 4777 have additional inverter functionality including demand response modes. This allows for the dispatch of stored energy from grid –connected Electrical Energy Storage (ESS) systems and other dispatchable types of energy in a variety of ways.
The minimum functionality required for all grid connected inverters is DRM0 i.e. operate the automatic disconnection device (must occur within 2 seconds). The inverter should support the other demand responses of Table 5 of AS/NZS 4777.2. All supported demand response commands shall be detected and a response initiated within 2 seconds. A Demand Response Enabling Device (DRED) acts to provide the interface between the remote agent (i.e. the grid) and the demand controller built into the inverter.

### 6.8 Alteration of Approved Design

The customer must not modify the approved design of the embedded generating unit without receiving prior written authorisation from Evoenergy. Settings of protection relays and control equipment must not be modified without receiving prior written authorisation from Evoenergy.

Upon receipt of a written request to modify the approved design and/or settings, Evoenergy will advise the customer if it is considered necessary to undertake a new assessment on the impact on the distribution network, the associated costs involved and the timeframe expected to complete the study and associated report.

### 6.9 Power Supply Quality and Reliability

The NER in Schedule 5.1 specifies “Network Performance Requirements” placing certain responsibilities on Evoenergy for quality of supply. The embedded generator must not impact adversely on Evoenergy’s ability to meet these requirements and cause undue interference with the supply to other customers. Mitigation actions may be included as part of the connection agreement.

The installation shall comply with the requirements of:

- AS/NZS 4777.2 Clause 5.4 Compatibility with electrical installation
- AS/NZS 4777.2 Clause 5.5 Power Factor
- AS/NZS 4777.2 Clause 5.6 Harmonic currents
- AS/NZS 4777.2 Clause 5.7 Voltage fluctuations and flicker
- AS/NZS 4777.2 Clause 5.8 Transient voltage limits
- AS/NZS 4777.2 Clause 5.9 D.C. current injection
- AS/NZS 4777.2 Clause 5.10 Current balance for three-phase inverters
- IEC 61000.3.6:2012 AS 1359.101 and IEC 60034-1 Harmonic Voltage Distortion (for rotating electrical machines)
- NER Schedule S5.2.5

The voltage range for the Evoenergy LV network is 230/400 Volts (+10 %, -6%) in accordance with AS 60038 – Standard Voltages and the Evoenergy Service & Installation Rules.

Connection of an embedded generating unit to the Evoenergy network shall not create a situation where the reliability of the distribution network is degraded. Refer also to NER Chapter 5 Clause S5.2.5.2 for additional information detailing the requirements for quality of electricity generated regarding voltage fluctuations, harmonics and voltage unbalance.

#### 6.9.1 Storage and PV Connection arrangement

For combined battery storage and PV systems controlled for the purpose of load/generation levelling, where the charge/discharge of the batteries in relation to PV output is ramped directly proportional to the PV output, that control loop lag may cause a delay in the battery charger ramping down in synchronism with the PV ramp down rate. This difference may cause a point of common coupling import spike directly proportional to the charge rate before the PV step change. Such step changes of demand are known to cause significant power quality issues on the network, such as flicker, with the impact magnified on weak networks due to their high source impedance.
6.9.2 Inverter Power Quality Response modes

The inverter may be capable of providing support to the grid by working outside the typical operating characteristics of an inverter or by contributing to maintaining the power quality at the point of connection to the customer installation.

These various operating modes may be enabled or disabled in the inverter and may include the following:

i. Volt response mode (responds to voltage changes at the inverter terminals)
ii. Fixed power factor or reactive power mode (may help to meet local grid requirements.)
iii. Power response mode
iv. Power rate limit (limits changes in power generation through grid interactive mode.)

If these power quality response modes are available in the inverter, the inverter must comply with the relevant requirements of clauses 5 and 6 and all of the requirements of clauses 7 and 8 of AS/NZS 4777.2 when these modes are enabled or disabled.

Note: These operational settings as well as the Demand Response modes in Clause 6.7 shall be secured against inadvertent or unauthorised tampering. Refer to Clause 6.5 of AS/NZS 4777.2 for further details.

6.10 Voltage Rise

The voltage rise on the service, consumer’s mains and the conductors between the main switchboard and the inverter terminals must be calculated prior to installation.

Evoenergy aims to keep its network steady state low voltage at 230V (+10 %, -6%) and although these ranges can be exceeded at some locations, Evoenergy aims to limit the duration of such events under 1 minute.

Regardless of the connection method applied, the voltage rise for an embedded generation system shall be calculated based on the maximum current imbalance permitted by the inverter control in accordance with AS/NZS 4777.1 C3.

6.10.1 Conductor Size Requirements

The combined impedance of the service cable, consumer main and submains must be low enough to ensure the embedded generation system can operate effectively inside the customer’s installation with no more than a 2% voltage rise from the point of supply to the inverter.

6.11 Steady State Voltage

Embedded generating systems must be equipped with controls that enable satisfactory operation over a variation in network voltage. Installations must be designed so that the combined impedance of the customer mains and the service cable is low enough to ensure that the generation system can export to the connection point while the voltage limits and/or voltage rise limits are met.

Additional details and requirements are referenced in the AS 61000.3 series of documents.

6.12 Power Frequency

The performance standards for power frequency variations are defined by the NER and the Frequency Operating Standards published by the AEMC. These standards cover normal conditions as well as period immediately following critical events when frequency may be disturbed.

The AEMC standards state that “The frequency operating standards require that, during periods where there are no contingency events or load events, the frequency be maintained within the normal operating frequency band (48.85Hz to 50.15Hz) for 99% of the time, with larger deviations permitted within the normal frequency excursion band (49.75 Hz to 50.25Hz) for no more than 1% of the time.”
6.13 Network Disturbance Limits

The distortion, fluctuation and unbalance limits specified for the customer supply network shall be assessed at the connection point. The following standards can be referred to for further details:

- TR IEC 61000 series
- HB 264 – 2003 “Power Quality- Recommendations for the application of AS/NZS 61000.3.6 and AS/NZS 61000.3.7

Network disturbances can be broadly categorised into the following:

- i. Rapid/Step Voltage change
- ii. Voltage Flicker
- iii. Harmonics
- iv. Voltage Unbalance

6.14 Low Voltage Network Overvoltage

Embedded generating units may experience ongoing automatic disconnection and reconnection of the generating unit as its internal overvoltage protection system is activated.

This is primarily caused by:

- The impedance between the generating unit and the distribution network
- The interaction of multiple generating units in close proximity (clustering)

It is the customer’s responsibility to ensure their generating unit operates in a manner which fulfils the quality of supply requirements. A voltage rise calculation shall be completed for each installation in accordance with AS/NZS4777 and provided to Evoenergy.

However; Evoenergy can provide some assistance with the following possible solutions (upon investigating and validating the experienced issue):

- Customer installing higher capacity cabling between the generating unit and the MSB to decrease impedance.
- Evoenergy connecting class 1 systems on nearby properties to different phases (possible for single-phase systems only) to decrease interaction.
- Evoenergy reducing the overall supply voltage level for the area.

6.15 Technical Information to be provided by the Customer

The customer shall ensure the design and construction of the installation shall only be carried out by an engineering consultant body or an electrical contractor with relevant knowledge, expertise and experience. In the case of inverter based installations, CEC accreditation is also required.

The customer shall submit the following technical information as applicable as part of their connection enquiry.

Sufficient detail must be provided to enable Evoenergy to:

- Assess compliance with the minimum requirements outlined in this document.
- Conduct an NTS to assess the impact on the embedded generating units fault ratings, protection scheme requirements and power export limits of existing infrastructure. (Systems over 1500kW require the customer to complete the NTS)
- Assess the generating unit power factor and voltage limits compliance requirements.

Table 1 provides an overview of the technical information to be provided by the customer.
### EMBEDDED GENERATING UNIT REQUIRED TECHNICAL INFORMATION

<table>
<thead>
<tr>
<th>REQUIREMENT</th>
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**TABLE 1.** EMBEDDED GENERATING UNIT REQUIRED TECHNICAL INFORMATION
6.15.1 Special Connection Request Form

A special connection request form is required for all generator proposals and can be accessed on the Evoenergy website.

Evoenergy Forms, Connection Applications & Publications

6.15.2 Generator Description

A description of the proposed embedded generating unit using the list below where applicable shall be provided:

- Proposed operating mode(s) for systems; for example, peak lopping control regime, demand response regime, any storage strategies.
- Proposed interaction with the Evoenergy distribution network under abnormal network conditions for example, network support operation and or customer islanded mode operation.
- Details of any voltage control or power factor control strategies proposed
- Details of any energy storage capability
- Proposed local customer loads to be supplied from the embedded generating unit where applicable.
- Known future staging/development of the embedded generating system and/or local customer loads.

6.15.3 Generator Data – Non-Inverter Installations

Generator data required for each generator proposed as listed in Appendix A.1.

6.15.4 Generator Data – Inverter Installations

Please see Appendix A.2 for inverter data required for inverters outside the scope of AS/NZS 4777.

6.15.5 Single Line Diagram

Detailed electrical single line diagram(s) showing the configuration of all embedded generating unit(s) /customer equipment with circuits between the generating unit(s) and the network connection point; including as a minimum:

- All primary circuit equipment such as main switchboards, other switchboards, circuit breakers and isolators/load break switches. In particular, all points where the customer embedded generating unit and the Evoenergy distribution network can be connected /disconnected must be clearly identified
- All secondary protection and control equipment associated with the embedded generating unit's connection and parallel operation with the Evoenergy distribution network including, current transformers, voltage transformers, protection and control elements and sensing points.
- Local customer load connections including any interconnections with other parts of the customer’s installation. In particular, where interconnection with other parts of the customer’s installation is proposed the means to prevent paralleling of Evoenergy substations / transformers and/or unsynchronised connection to the distribution network shall be clearly identified.
- All metering equipment associated with the embedded generating unit and the import and export of power from/to the Evoenergy distribution network
- All proposed power factor correction equipment that will be installed within the part of the customer’s installation that is supplied directly from the embedded generating unit.
6.15.6 Protection Information

Detailed functional block/schematic diagram of the protection and control systems relevant to the embedded generating unit’s connection to the Evoenergy distribution network which includes an in-depth technical philosophy of the protection and control systems including:

- All relevant relay current circuits,
- Relay potential circuits,
- Alarm and monitoring circuits,
- Back-up systems,
- Auxiliary power supply systems and;
- Proposed parameters/settings of all protection and control system elements.

6.15.7 SCADA Information

Data required for SCADA

- A drawing indicating all SCADA connections.
- An index / schedule of I/O points, as listed in these requirements – Section 8.
- Contact information for customer’s SCADA programmer (email and phone).
- Contact person for site access (email and phone).
- Anticipated commissioning date.

Data required for MODBUS

- Modbus address or index number
- IP address
- Slave number
- Port Number

Data required for DNP3

- Slave Profile of Relay
- Device Profile
- IP Address
- Slave Number
- Port Number

6.15.8 Load Profiles

The following load profiles are required:

- Anticipated 24 hour local customer load profiles (both summer and winter) for the local customer loads that are to be normally supplied from the embedded generating unit. The profiles shall include apparent power (S), active power (P) and reactive power (Q) for both lightly loaded and maximum demand scenarios.

- Anticipated 24-hour power import/export profiles (both summer and winter) at the network connection point. The profiles shall include apparent power (S), active power (P) and reactive power (Q) for both lightly loaded and maximum demand scenarios.

6.15.9 Site Plan

Site plan showing the physical location of the
6.15.10 Earthing of Embedded Generating Units

The customer is required to ensure that the embedded generating unit has an earthing system that has been designed to limit any step, touch and transferred potentials to safe values using principles detailed in AS/NZS 3000 and AS/NZS 4777.

Generation schemes working in parallel with Evoenergy’s network in effect become an integral part of the Evoenergy Network. Therefore neutral earthing arrangements for the private generators and any interconnection transformers must be designed to suit the requirements of Evoenergy and the customer’s generation installation and details provided to Evoenergy.

Embedded generating units connecting to Evoenergy’s LV network via delta-star transformers, with the delta on the network side, may have their neutral directly connected to earth via an MEN link in accordance with AS/NZS 3000.

Effective isolation of this neutral may be required to inhibit the flow of harmonics through the neutral and the generator’s method to limit harmonics must be discussed and agreed to by Evoenergy.

All metallic equipment, housing and fixtures shall be connected to an earth point in accordance with AS/NZS 3000.

Embedded generating units connecting to Evoenergy’s HV network shall ensure the star point is effectively isolated from earth (i.e. isolated or earthed via a high impedance) to avoid any earth fault contributions flowing into the Evoenergy system in accordance with AS 2067, and to limit any step and touch potential as described in AS/NZS 7000 and ENA EG-0. This should also inhibit the flow of harmonic currents through the neutral. Each case shall be discussed with the customer on its merit.

The customer must submit a detailed earthing schematic diagram of the proposed earthing system arrangements for the embedded generating unit and associated customer’s electrical installation including all proposed earth connections, MEN connections and relevant switchboard earthing arrangements.

6.15.11 Power Factor Correction Equipment Details

The customer shall operate with a target power factor at the Connection Point which meets the requirements of the NER. For power export, at rated power output and target network voltage as determined in accordance with Clause S5.1a.4 of the system standards when measured at the connection point of the customer, the embedded generator must be capable of operation in the range from a lagging power factor of 0.9 to a leading power factor of 0.95. For power import, the power factor must satisfy the requirements of the NER Clause S5.3.5.

Full details of any proposed power factor correction equipment including:
- A drawing indicating all SCADA connections.
- Rating of capacitors – individual stages and total installation (kVAR).
- Rating of switching reactors (kVAR).
- Capacitor Bank capacitance (microfarads, μF).
- Inductance of switching reactor (millihenries, mH).
- Resistance of the capacitors and the reactors (Ohms, Ω).
- Method of switching including capacitor bank stage sizes.
- Description of the automatic control of the power factor correction unit such that its operating characteristics can be determined.
6.16 Wiring of the Embedded Generating Unit

The embedded generating unit shall meet the wiring requirements of AS/NZS 3000 and AS/NZS 4777.1. It shall also meet the requirements of the Evoenergy Service & Installation Rules.

However, it must be noted that Evoenergy is not an inspecting authority and cannot connect a new installation to the distribution network until that work has been inspected and approved for connection by the ACT Government Electrical Inspectorate.

6.17 Labelling of the Embedded Generating Unit

The embedded generating unit shall meet the labelling requirements outlined in AS/NZS 4777.1. It shall also meet the requirements of the Evoenergy Service & Installation Rules.

7. PROTECTION

Protection equipment must comply with the relevant Australian and International Standards. All equipment must be tested and commissioned by a competent commissioning technician, to the agreed settings and supplied with a certificate of compliance for the complete generating unit prior to connection to the distribution network.

The operating time of Evoenergy’s feeder protection may not clear faults fast enough to prevent transient instability of embedded synchronous generation. In this scenario, faults on adjacent feeders, that are not the interconnecting feeder, may be cleared too slowly for the embedded generating unit to maintain synchronism.

The protection shall be designed to withstand, without damage, the maximum currents, which may occur under fault conditions such as a short circuit as described in the Evoenergy Service & Installation Rules – Section 2 Supply Arrangements.

The make and model of protection relay intended for installation must be provided to Evoenergy at the project design stage in order to investigate its configuration parameters and to validate that particular device integrates with Evoenergy’s SCADA system.

Evoenergy prefers the use of Schneider MiCOM and Schweitzer SEL relays, and these device families have been proven to Evoenergy’s SCADA system.

Evoenergy personnel may also request the customer provide the intended relay for bench testing purposes should the need arise. The customer will be advised if the proposed protection device is approved prior to installation commencing.

All protection relay settings shall be provided to Evoenergy prior to the generating units commissioning to review and approval.

Protection shall include sufficient redundancy to ensure that a faulted element within the protected zone is disconnected from the distribution network within the required fault clearance time.

The factors to be considered when designing a suitable protection scheme are:

- Switchgear configuration and customer single line diagram
- Islanding requirements as described in Section 7.1.
- Availability of protection signalling quality communication links
- Probability of particular faults occurring
- Regulatory and contractual constraints
- Load characteristics

Table 2 and Table 3 detail the required Protection and SCADA settings at the embedded generating unit and the GCC in order to operate in parallel with the distribution network.
<table>
<thead>
<tr>
<th>REQUIREMENT</th>
<th>EMBEDDED GENERATING UNIT</th>
<th>Type</th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
<th>Class 4</th>
<th>Class 5</th>
<th>Class 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISOLATION POINT</td>
<td></td>
<td>All</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Phase lockable isolation switch at the customer connection point in a location that is accessible at all times to Evoenergy personnel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GENERATOR CONNECTION CUBICLE (GCC)</td>
<td></td>
<td>NA</td>
<td>NA</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>MAIN PROTECTION</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ANTI-ISLANDING</td>
<td></td>
<td>All</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>SYNCHRONISATION LOSS OF MAINS</td>
<td></td>
<td>Inverter</td>
<td>MNC</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>UNDER/OVER VOLTAGE</td>
<td></td>
<td>Non-Inverter</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>UNDER/OVER FREQUENCY (UF/OF)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OVERCURRENT AND EARTH FAULT</td>
<td></td>
<td>All</td>
<td>NA</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>NEUTRAL VOLTAGE DISPLACEMENT (NVD)</td>
<td></td>
<td>All</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>REVERSE POWER</td>
<td></td>
<td>All</td>
<td>NA</td>
<td>NA</td>
<td>MNE</td>
<td>MNE</td>
<td>MNE</td>
<td>MNE</td>
</tr>
<tr>
<td>INTER-TRIP</td>
<td></td>
<td>All</td>
<td>NA</td>
<td>NTS</td>
<td>NTS</td>
<td>NTS</td>
<td>NTS</td>
<td>NTS</td>
</tr>
<tr>
<td>SCADA</td>
<td></td>
<td>All</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>DISCONNECTION AND RECONNECTION (&lt;2 second Trip &amp; &gt;60 second Reconnect)</td>
<td></td>
<td>All</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
</tbody>
</table>

**TABLE 2. MAIN PROTECTION AND SCADA REQUIREMENTS FOR EMBEDDED GENERATION SYSTEMS OPERATING IN PARALLEL WITH THE EVOENERGY DISTRIBUTION NETWORK**

- **M** Mandatory
- **MNE** Mandatory where Not Exporting
- **MNC** Mandatory where Not Compliant to AS/NZS 4777
NTS  Determined from Network Technical Study
NA   Non Applicable
<table>
<thead>
<tr>
<th>REQUIREMENT</th>
<th>EMBEDDED GENERATING UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type</td>
</tr>
<tr>
<td>BACKUP PROTECTION</td>
<td></td>
</tr>
<tr>
<td>BACKUP REVERSE POWER</td>
<td>All</td>
</tr>
<tr>
<td>BACKUP LOSS OF MAINS</td>
<td>All</td>
</tr>
<tr>
<td>BACKUP UNDER/OVER VOLTAGE</td>
<td>All</td>
</tr>
<tr>
<td>BACKUP UNDER/OVER FREQUENCY</td>
<td>All</td>
</tr>
<tr>
<td>BACKUP OVERCURRENT AND EARTH FAULT</td>
<td>All</td>
</tr>
<tr>
<td>ROCOF</td>
<td>All</td>
</tr>
<tr>
<td>VECTOR SHIFT</td>
<td>All</td>
</tr>
<tr>
<td>NEGATIVE SEQUENCE VOLTAGE</td>
<td>Inverter</td>
</tr>
<tr>
<td>NEGATIVE SEQUENCE CURRENT</td>
<td>Non-Inverter</td>
</tr>
<tr>
<td>REACTIVE POWER CONTROL (1 AND 3 PHASE) OR POWER FACTOR CONTROL</td>
<td>Inverters</td>
</tr>
</tbody>
</table>

**TABLE 3.** BACK-UP PROTECTION REQUIREMENTS FOR EMBEDDED GENERATION SYSTEMS OPERATING IN PARALLEL WITH THE EVOENERGY DISTRIBUTION NETWORK

- **M** Mandatory
- **MNE** Mandatory where Not Exporting
- **MNC** Mandatory where Not Compliant to AS/NZS 4777
- **NA** Non Applicable
7.1 Anti-Islanding

Anti-islanding protection is an important requirement of embedded generation protection systems. Islanding creates serious safety issues for personnel working on the distribution network or on an embedded generating unit during an outage. It also interferes with the quality of supply to other customers and can damage equipment.

All protection equipment associated with an embedded generating unit must be designed, installed and tested to ensure islanding does not occur. Evoenergy may require its officers to witness such testing on site.

7.1.1 Network Islanded Mode

An embedded generating unit must not be able to operate in network islanded mode.

Network islanded mode occurs when the embedded generating unit is the only source of supply into a section of the distribution network. This situation could arise when a distribution network fault occurs and the Evoenergy source circuit breaker trips but the generating unit NCB does not trip. Similarly, this situation could also occur when the section of the distribution network containing the network connection point is de-energised for planned works but the generating unit NCB does not trip.

Operation of an embedded generating unit in network islanded mode creates significant risks for both the customer and Evoenergy. Therefore, the embedded generating unit must be automatically disconnected from the distribution network if the distribution network at the network connection point is de-energised for any reason. The major risks associated with an embedded generating unit operating in network islanded mode are as follows.

- The significant safety risk to Evoenergy electricity network personnel and members of the general public, and
- The significant risk that when the network supply is restored, through either auto-reclose or manual control, the generating unit will not be synchronised with the network supply at the network connection point resulting in damage to the generating unit, and/or distribution network equipment.

7.1.2 Customer Islanded Mode

Operation of embedded generating units in customer islanded mode is permitted provided that the generating unit is first disconnected, either manually or as the result of a loss of supply, from the distribution network, AND reconnection of the customer island to the distribution network does not occur until the network supply has previously been fully restored and is stable so that synchronisation from within the customer’s installation can occur as mentioned in Section 7.5.

Customer islanded mode occurs when the embedded generating unit is only supplying into the customer’s installation or a section of the customer’s installation. The section being supplied must have been electrically disconnected from the distribution network.

Approval will need to be sought from Evoenergy for customer islanded mode of operation. Anti-Islanding protection systems must be installed by the customer.

Embedded generating units must automatically disconnect from the distribution network and must not connect to the distribution network in the event that one or more phases of the distribution network are not energised. The protection system must ensure the installation is disconnected from the distribution network within two (2) seconds and must not reconnect for at least sixty (60) seconds after the network supply has been restored.

The protection system installed by the customer shall do the following.

- Prevent the generating unit connecting to the distribution network unless all phases of the network are energised, there is correct phase rotation and no unbalance at the network connection point.
- Prevent the generating unit connecting to the distribution network unless the generating unit supply is synchronised with the distribution network.
- Disconnect the generating unit from the distribution network in the event that one or more phases of the distribution network at the network connection point are lost.
- Disconnect the generating unit from the distribution network in the event that a network abnormality causes unacceptable voltage and/or frequency deviations at the network connection point.
Disconnect the generating unit from the distribution network in the event that the generating unit output becomes unstable causing unacceptable voltage and/or frequency deviations at the network connection point.

Prevent the generating unit connecting with, or disconnect the generating unit from, the distribution network in the event of failure of the electrical supplies to protection and/or control system equipment.

Prevent the generating unit connecting with, or disconnect the generating unit from, the distribution network in the event of failure of inter-trip (if installed), SCADA communication links or loss of D.C. supply.

Prevent the export of power unless this has been approved by Evoenergy; or limit the export of power where Evoenergy has established a power export limit due to constraints associated with the existing distribution network infrastructure.

Inverters which have been tested and deemed compliant against AS/NZS 4777 and have been approved by the Clean Energy Council are known to incorporate the above protection and are approved to export power to the distribution network.

Table 4 provides an overview of the typical anti-islanding protection methodologies required for both inverter and non-inverter based generating units.

<table>
<thead>
<tr>
<th>INVERTER SYSTEMS</th>
<th>ALL SYSTEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIN SCHEME</td>
<td>Loss of Mains – frequency and voltage based.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BACKUP SCHEME</th>
<th>Active anti-islanding protection through</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Frequency Instability</td>
</tr>
<tr>
<td></td>
<td>• Vector Shift</td>
</tr>
<tr>
<td></td>
<td>• Impedance Change Detection (current injection)</td>
</tr>
<tr>
<td></td>
<td>• Power Variation OR Power Factor.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NON–INVERTER SYSTEMS</th>
<th>GENERATOR EXPORTING</th>
<th>GENERATOR NOT EXPORTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIN SCHEME</td>
<td>Loss of Mains – frequency and voltage based</td>
<td></td>
</tr>
<tr>
<td>BACKUP SCHEME</td>
<td>• Negative Sequence Voltage and Current</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Neutral Voltage Displacement (NVD)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Negative Sequence Voltage and Current</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Neutral Voltage Displacement (NVD)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Reverse Power Limit</td>
<td></td>
</tr>
</tbody>
</table>

**Table 4. Typical Anti-Islanding Protection Methodologies**
7.2 Protection Requirements – Systems ≤ 30kW

Embedded generating units connect to the distribution via inverters shall be compliant to AS/NZS 4777. The inverter settings shall be set to the values given in Table 2 from AS/NZS 4777.1 reproduced below.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>PROTECTION SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vnom-max (10 min average)</td>
<td>255 V</td>
</tr>
<tr>
<td>OVERVOLTAGE 1 (V &gt;)</td>
<td>260 V</td>
</tr>
<tr>
<td>OVERVOLTAGE 2 (V &gt;)</td>
<td>265 V</td>
</tr>
<tr>
<td>UNDERVOLTAGE (V &lt;)</td>
<td>180 V</td>
</tr>
<tr>
<td>OVER FREQUENCY (F &gt;)</td>
<td>52 Hz</td>
</tr>
<tr>
<td>UNDER FREQUENCY (&lt; F)</td>
<td>47 Hz</td>
</tr>
<tr>
<td>DISCONNECT TIME</td>
<td>2 seconds (max)</td>
</tr>
<tr>
<td>RECONNECT TIME</td>
<td>60 seconds (min)</td>
</tr>
</tbody>
</table>

**TABLE 5** PRESCRIBED INVERTER SETTINGS FOR SYSTEMS ≤ 30kW

Notes:

1. These settings apply to inverters certified with AS/NZS.4777.2.
2. Where inverters do not have the two stage overvoltage setting, the Vmax setting for a 2 second trip shall be set to 255V.
3. These settings shall not be used when determining voltage rise, refer to AS/NZS 4777.1

**7.2.1 Phase – balance protection**

For IES Systems >15kVA, then AS/NZS 4777.2 requires phase –balance protection. The protection shall operate in response to a current imbalance at the IES connection point caused by an IES (or multiple IES) between phases greater than 21.7A (5kVA at 230V) by disconnecting all IES from the installation by automatic operation of a disconnection device located adjacent to the main switch, or adjacent to the inverters and/or the internal disconnection device by asserting DRM 0 to the inverter.

The disconnection device shall operate when there is a loss of power to the central protection, loss of control signal from the central protection or an internal fault in the central protection. A semiconductor (solid state) device shall not be used for this purpose. Phase balance protection shall operate within 30 seconds.
7.3 Protection Requirements – Systems ≥ 30kW

7.3.1 Loss of Mains Protection (LoM) / Anti-Islanding Protection

Where parallel operation of the generating unit is intended, loss of mains/anti-islanding protection shall be installed at the network connection point to disconnect the whole of the embedded generation unit from the distribution network on loss or partial loss of network supply at the network connection point.

Loss of Mains/Anti-Islanding will be the primary protection scheme against network islanded operation of the embedded generating unit by either Rate-of-Change of Frequency (ROCOF) or Vector Shift protection.

ROCOF detects a change of frequency over a time period and Vector Shift protection detects a change in load impedance to the generating unit by sensing the change in the voltage vectors.

The required ROCOF and Vector Shift settings determined by Evoenergy are:

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>PROTECTION SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>RATE-OF-CHANGE OF FREQUENCY (ROCOF)</td>
<td>1.0 Hz / 1 sec</td>
</tr>
<tr>
<td></td>
<td>2 second definite time delay</td>
</tr>
<tr>
<td>VECTOR SHIFT</td>
<td>12 Degrees</td>
</tr>
</tbody>
</table>

7.3.2 Synchronisation

Automatic synchronising and synchronisation check closing protection shall be installed at all locations where it is intended that parallel operation of a generating unit will occur, to prevent non-synchronised connection to the distribution network.

Connection of the generating unit in parallel with the distribution network shall be prevented unless all phases of the distribution network at the network connection point are energised.

The network connection circuit breaker, NCB, shall not be able to close onto a de-energised distribution network.

Evoenergy circuit breakers are not fitted with synchronising facilities and therefore all synchronising facilities must be provided within the customer’s installation.

7.3.3 Over / Under Voltage Protection

Under and over voltage protection shall be installed at the network connection point and the generating unit.

It shall be set to operate if the phase to neutral voltage on any phase at the network connection point varies outside predetermined values, which will be based on the embedded generators proposed network connection arrangement and operating requirements.

The required over/under voltage protection settings determined by Evoenergy are:

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>PROTECTION SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>LV CONNECTED OVER VOLTAGE</td>
<td>Stage 1: 255V for 10 minute average</td>
</tr>
<tr>
<td></td>
<td>Stage 2: 260V for 2 seconds</td>
</tr>
<tr>
<td>LV CONNECTED UNDER VOLTAGE</td>
<td>Stage 1: 216V for 10 minute average</td>
</tr>
<tr>
<td></td>
<td>Stage 2: 204V for 2 seconds</td>
</tr>
</tbody>
</table>
7.3.4  Over / Under Frequency Protection

Under and over frequency protection shall be installed at the network connection point and the generating unit. During and following a power system disturbance, the frequency of the network will fluctuate until it is stabilised and recovers back within the normal operating range.

Embedded generating units should be able to operate within the expected frequency range for the duration of the disturbance without sustaining damage or disconnecting.

The required over/under frequency protection settings determined by Evoenergy are:

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>PROTECTION SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>OVER FREQUENCY</td>
<td>52Hz for 2 seconds</td>
</tr>
<tr>
<td>UNDER FREQUENCY</td>
<td>47Hz for 2 seconds</td>
</tr>
</tbody>
</table>

7.3.5  Negative Sequence Voltage & Current Protection

Negative sequence voltage and current protection shall be installed at the generating unit to protect against voltage and current imbalance from the generating unit source, which together with Neutral Voltage Displacement, NVD, protection also provides back-up protection to the loss of mains protection.

The required over/under frequency protection settings determined by Evoenergy are:

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>PROTECTION SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEGATIVE SEQUENCE VOLTAGE</td>
<td>8V for 5 seconds</td>
</tr>
<tr>
<td>NEGATIVE SEQUENCE CURRENT</td>
<td>&gt; 10% of full load rated current for 5 seconds</td>
</tr>
</tbody>
</table>

7.3.6  Overcurrent & Earth Fault Protection

Bi-directional overcurrent and earth fault protection to detect faults on the distribution network and within the customer’s installation shall be provided at the NCB. This protection shall be set to grade with Evoenergy’s network protection schemes.

Overcurrent and earth fault protection shall also be provided at the generating unit and this shall provide back-up to the protection installed at the network connection point.

This protection shall be set to detect faults within the customer’s installation and the distribution network (back-up to the network connection CB overcurrent and earth fault protection).

Generating unit overcurrent and earth fault protection relays should have compensation for under voltage field weakening unless the customer can demonstrate that voltage depression at the generating unit during fault events will not adversely impact on protection scheme operation.

These settings are to be provided to Evoenergy by the customer for review and advice will be provided to customer once the NTS has been completed should the need arise.

7.3.7  Reactive Power Control

The connection of embedded generating units to the distribution network may impact on Evoenergy’s ability to regulate network voltages. Because of this, Evoenergy requires the embedded generating unit to control reactive power output, within their capability, to maintain the connection point voltage to Evoenergy’s required range.

The embedded generating unit would typically be expected to be capable of continuously supplying or absorbing reactive power to achieve a power factor of +0.95 to -0.90 as measured at the connection point. Subject to the appropriate network technical studies, generating systems not able to meet these typical reactive power capabilities may still be considered acceptable.
The required Reactive Power Control protection settings determined by Evoenergy are:

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>PROTECTION SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>REVERSE VAr</td>
<td>$0.33 \times P_{\text{RATED}}$ for 5 seconds</td>
</tr>
<tr>
<td>OVER VAr</td>
<td>$0.48 \times P_{\text{RATED}}$ for 5 seconds</td>
</tr>
</tbody>
</table>

NOTE: Reactive Power Control OR Power Factor Protection only to be implemented where applicable.

### 7.3.8 Power Factor Control

The operating strategy for the embedded generating unit needs to ensure the power factor falls within the range specified by the Evoenergy Service and Installations Rules Clause 6.4.1 which states “the customer shall maintain such power factor at a value not less than 0.9 lagging”. Rotating machines, as a default, should be set to maintain the power factor at the point of connection, within the limits specified by the service and installation rules.

When measured at the connection point of the customer, the required reactive power protection requirements are:

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>PROTECTION SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>POWER FACTOR</td>
<td>0.95 leading pf for 5 seconds</td>
</tr>
<tr>
<td></td>
<td>0.90 lagging pf for 5 seconds</td>
</tr>
</tbody>
</table>

NOTE: Reactive Power Control OR Power Factor Protection only to be implemented where applicable.

### 7.3.9 Reverse Power & Power Limit Protection

The customer shall install duplicate reverse power protection where the export of power has not been approved by Evoenergy for Class 3 and above systems.

In the event the reverse power protection fails to operate, the proponent shall disconnect the generator to prevent exporting power into the distribution network.

Once the reverse power protection scheme has been repaired and proved fit for service, as witnessed by Evoenergy personnel, the generator may be re-energised.

Any power limit protection will be advised by Evoenergy after the NTS has been completed.

An indicative reverse power value is given below:

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>PROTECTION SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>REVERSE POWER</td>
<td>5% of Generator Rating</td>
</tr>
<tr>
<td></td>
<td>Trip within 2 secs</td>
</tr>
</tbody>
</table>

### 7.3.10 Neutral Voltage Displacement (NVD)

Neutral voltage displacement shall be installed for generating systems rated at class 5 and above, regardless if the generator is an exporting or non-exporting installation.

Generation units paralleling with Evoenergy network for greater than 400ms are still electrically connected to the Evoenergy network and will contribute to the fault level in the event of an unsymmetrical fault condition. In an unsymmetrical fault condition, reverse power protection will not trip as this scheme operates on steady state conditions.

As this protection scheme will require the installation of voltage transformer(s) on the Evoenergy HV distribution network near the network connection point; the voltage transformer(s) will be supplied and installed by Evoenergy.
The total cost of this VT and associated equipment will be borne by the customer.

The voltage transformer(s) required for this protection scheme may be either three single-phase voltage transformers or a single three-phase 5 limb voltage transformer, with the primary winding star point connected to earth and the secondary winding connected in broken delta supplying a NVD protection relay.

Evoenergy will provide the VT secondary wiring to the generating unit interface cubicle. The customer will be required to supply and install the NVD protection relay and associated equipment/wiring within the embedded generation facility.

7.3.11 Inter-Trip

Evoenergy will advise the customer if an inter-trip is required as a back up to loss of mains protection once the NTS has been completed.

7.3.12 Phase Balance Protection

See Clause 7.2.1 for details.

7.4 Battery/Battery Charger and/or UPS Integrity Protection

To ensure all protection and control systems are capable of operation, the generating unit must be automatically disconnected from the distribution network in the event of a failure of the D.C. supply to the protection and control systems.

All primary and secondary protection system equipment installed by the customer in order to comply with the requirements outlined in this document must comply with the relevant Australian Standards and/or IEC Standards.

7.5 Disconnection & Reconnection

Many of Evoenergy’s distribution feeders incorporate automatic reclosing. The customer shall ensure that the design of protection and control schemes adequately accommodate this functionality.

An embedded generating unit shall have primary protection set to trip at two seconds and shall be prevented from attempting to automatically synchronise and reconnect to the distribution network for at least sixty (60) seconds after the network supply has been restored.

Typical Evoenergy feeder automatic reclosing practices (where installed) are as follows;

- The typical de-energised time period before automatic reclose (reclose time) varies between 2.5 seconds and 10 seconds.
- The typical time before resetting on restoration of supply (reclaim time) is 15 seconds.
- The number of automatic “reclose” attempts to restore supply before lock-out occurs varies between 1 and 3 attempts.

**NOTE: For Class 5 and above generating units the customer will need to confirm the specific settings with Evoenergy.**

The customer shall ensure that the protection systems to prevent network islanding operate before automatic reclose can occur.

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISCONNECTION</td>
<td>&lt; 2 seconds</td>
</tr>
<tr>
<td>RECONNECTION</td>
<td>&gt; 60 seconds</td>
</tr>
</tbody>
</table>
7.6 Functional in-Service test of Inverter Protection

In service tests of the Inverter Protection shall be carried out by a licensed electrician every five (5) years to the satisfaction of Evoenergy. as per Clause 7.7 of the Evoenergy Service and Installation Rules. The results must be sent to Evoenergy.

Evoenergy reserves the right to witness the testing.

7.7 Security of Protection for Export Limit Settings

Where the inverter energy system has protection or export limit settings that may be changed via a keypad or switches, adequate security must be employed to prevent any tampering / inadvertent / unauthorised changes to these settings.

A suitable lock or password system shall be used. Evoenergy must approve any setting changes.
8. SCADA

8.1 SCADA Requirements

SCADA is required for Class 5 and above generating units. Evoenergy does not monitor alarms or status of generating units but does record them for network performance analysis. For additional details refer to NER Chapter 5, Clauses S 5.2.6.1 and S 5.6.1.2

Evoenergy will provide, install and maintain the communication equipment and Remote Terminal Unit (RTU) at the customer’s expense for sites requiring SCADA. Evoenergy requires a control point to trip the generating unit under emergency conditions.

The customer has the following options:

- Monitor the alarms and take appropriate actions using their local system such as BMS; or
- Formulate a service agreement with Evoenergy to monitor the generating unit alarms and status.

The SCADA requirement I/O list for embedded generating units is provided in section 8.2.

These I/O points shall be sent to the Evoenergy RTU which may be part of the GCC or a separate generator interface cubicle, (GIC), located in the substation the generating unit connects to.

In the instance where the RTU is located within the GCC, the GCC manufacturer shall install and terminate all wiring (including I/O cabling/wiring) within the cubicle. Where the RTU is located separately to the GCC, Evoenergy shall terminate the customer supplied I/O cabling/wiring at the SCADA Interface Cubicle.

The terminals within the SCADA Interface Cubicle shall be the monitoring and control system interface boundary between Evoenergy’s network and the customer’s embedded generation facility.

The customer will be required to fund the total cost of all Evoenergy remote monitoring and control works.

A typical SCADA arrangement can be found in Figure 1.

(Note: Cybersecurity of SCADA systems has become very important and a number of standards and guidelines have been developed, to support electric utilities and embedded generators in their cyber security efforts. ISO /IEC 27002 looks at organisational countermeasures whilst SCADA specific standards such as NERC CIP-002-1 to CIP009-1 are more focussed on technical countermeasures.)

![Figure 1: Typical SCADA Arrangement](image-url)
## 8.2 SCADA Requirement I/O List

<table>
<thead>
<tr>
<th>I/O FUNCTION</th>
<th>UNIT</th>
<th>SIGNAL TYPE</th>
<th>POWER EXPORT</th>
<th>NO POWER EXPORT</th>
<th>DIGITAL SENSE STATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Network connection CB emergency TRIP (Command by Evoenergy)</td>
<td>-</td>
<td>DI</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>2</td>
<td>Network connection CB CLOSE INHIBIT (Command by Evoenergy)</td>
<td>-</td>
<td>DI</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>3</td>
<td>RTU fail alarm</td>
<td>-</td>
<td>DI</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>4</td>
<td>RTU Maintenance Switch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Trip command acknowledgement</td>
<td>-</td>
<td>DO / Comms</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>6</td>
<td>Enable/Disable close command acknowledgement</td>
<td>-</td>
<td>DO / Comms</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>7</td>
<td>Network connection CB status</td>
<td>-</td>
<td>DO / Comms</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>8</td>
<td>Network connection CB protection operated alarm</td>
<td>-</td>
<td>DO / Comms</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>9</td>
<td>Network connection CB fail alarm</td>
<td>-</td>
<td>DO / Comms</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>10</td>
<td>Network Connection 3 Phase Current</td>
<td>Amps</td>
<td>Comms</td>
<td>R</td>
<td>O</td>
</tr>
<tr>
<td>11</td>
<td>Network Connection 3 Phase Volts</td>
<td>Volts</td>
<td>Comms</td>
<td>R</td>
<td>O</td>
</tr>
<tr>
<td>12</td>
<td>Network Connection Real Power Export</td>
<td>kW</td>
<td>Comms</td>
<td>R</td>
<td>O</td>
</tr>
<tr>
<td>13</td>
<td>Network Connection Reactive Power Export</td>
<td>kVAR</td>
<td>Comms</td>
<td>R</td>
<td>O</td>
</tr>
<tr>
<td>14</td>
<td>Network Connection Power Factor</td>
<td>-</td>
<td>Comms</td>
<td>R</td>
<td>O</td>
</tr>
<tr>
<td>15</td>
<td>Generating unit Real Power Output</td>
<td>kW</td>
<td>Comms</td>
<td>R</td>
<td>O</td>
</tr>
<tr>
<td>16</td>
<td>Generating unit Reactive Power Output</td>
<td>kVAR</td>
<td>Comms</td>
<td>R</td>
<td>O</td>
</tr>
<tr>
<td>17</td>
<td>Generating unit Status</td>
<td>-</td>
<td>DO / Comms</td>
<td>R</td>
<td>O</td>
</tr>
<tr>
<td>18</td>
<td>Generating unit CB Status</td>
<td>-</td>
<td>DO / Comms</td>
<td>R</td>
<td>O</td>
</tr>
</tbody>
</table>
Notes
- DI = digital input, DO = digital output, (Hardwired inputs and outputs)
  Comms = Ethernet TCP/IP.
  The input/output designation is taken from the viewpoint of the generating unit.
- R = Required, O = Optional
- The Network connection CB Emergency Trip and Enable/Disable Close must all be applied to the same CB.
- These signals shall be electrically interlocked with the generating unit controls to prevent the generating unit connecting to Evoenergy’s network without Evoenergy authorisation. The GCC has compatibility with providing and receiving these signals.
- This signal should latch and not reset until the generating unit is reconnected or until the generating unit receives a rising edge of the enable/disable command.
- Applicable for net connected generating unit where the NCB is separate from the GCB.
- This I/O point is an optional point for any additional CB’s that exist between the GCB and the NCB. A group I/O point covering all such intermediate CBs is acceptable where there is more than 1 intermediate CB.
- This signal should latch and not reset until the generating unit is reconnected or until the generator receives a rising edge of the enable/disable command.

8.3 SCADA Communications Link Integrity Protection
To facilitate basic monitoring and control of the embedded generation facility by Evoenergy, a communications link is required between the embedded generation units’ master controller to the Evoenergy interfacing RTU. This communications link shall be continuously monitored for integrity by the generator master controller. In the event that the link fails, the generating unit’s master controller shall automatically inhibit the NCB closing operation to prevent the generating unit reconnecting to the distribution network.
Closing of the NCB shall only be possible if the communications link becomes healthy or the RTU Maintenance switch is in the maintenance position.
If the generating unit is connected to the distribution network and the communications link fails, it is permitted to remain connected to the distribution network.

8.4 RTU Maintenance Switch
An RTU maintenance switch shall be provided and integrated as part of the GCC design.
Evoenergy personnel shall utilise this switch when performing RTU maintenance. The RTU maintenance switch will override all RTU outputs when the switch is in the ON position.
Evoenergy personnel will place the RTU Maintenance switch back into the OFF position at the completion of maintenance. The customer will be notified in writing when the RTU is required to be periodically maintained and when the access to the embedded generating site is required.

8.5 Signal Types & Formats
Internet/Ethernet (TCP/IP) protocol over a fibre optic physical layer is the preferred method for all communication signals.
The customer shall use an application layer of Modbus (standard for Programmable Logic Controls) or DNP3 (standard for relays) where communication signals are used.
Digital inputs and outputs may be accepted / provided by hard wired voltage free contacts or by the above protocols.
Upon application, the customer must provide an index of the required points and other details regarding their SCADA design for Evoenergy review and approval.
9. METERING

9.1 Metering Requirements

The metering standards that apply for load connections to the distribution network also apply for embedded generating units. Active power flow is bi-directional and this requires metering that can accurately measure energy flow in both directions as the standard metering configuration.

Revenue metering shall consist of a bi-directional interval timer with 30-minute import and export real energy data streams as required in the NER chapter 7.

The energy that flows in both directions must be stored in separate registers. The actual metering required will depend on retail tariff selected by the customer.

The customer must pay the costs of the supply and installation of metering equipment and arrange the metering by their chosen energy retailer.

The operational requirements of the customer and National Grid Metering must be addressed, with the appointment of the retailer / metering provider / meter data agent to be decided by the customer.

Customers on a high voltage tariff must provide an appropriate dedicated step-up transformer and high voltage metering panel for an embedded generating unit’s connection to the LV distribution network.

9.2 Net & Gross Metering

Two forms of bi-directional metering are possible, ‘Net’ or ‘Gross’, however depending on the electricity tariffs offered for the particular installation by the retailer, only one form will be offered.
9.2.1 Net Metering

Net meters contain two registers, one to record energy flow into the installation and the other used to record energy flow out of the installation. Net metering will not record the energy consumed within an installation that was produced at the same time by the embedded generating unit within the installation.

Similarly, net metering will not record the energy produced by the embedded generating unit within the installation that was consumed at the same time by the load within the installation.

Figure 2 provides a description of Net Metering

FIGURE 2 EXAMPLE OF NET METERING CONFIGURATION
9.2.2 Gross Metering

Gross meters contain two registers, one to record energy consumed by the load and the other to record the energy produced by the embedded generating unit within the installation.

Gross metering will record the energy consumed by the installation that was simultaneously produced by the embedded generating unit.

Figure 3 provides a description of gross metering.

![Diagram of Gross Metering Configuration](image)

**FIGURE 3 EXAMPLE OF GROSS METERING CONFIGURATION**
9.3 Metering Location

The location of the bi-directional meter must comply with the requirements of the *Evoenergy Electricity Service & Installation Rules* – refer to section 5. The metering point shall be within the customer’s installation and be as close as practical to the network connection point as per Chapter 7 of the NER.

9.4 Metering Services Upgrades

The customer/installer is responsible for ensuring adequate space to accommodate the new metering arrangement in the meter box. Any meter box or metering upgrade work is to be carried out by a licensed electrician/installer at the customer’s expense.

Please refer to the metering provider for further information.

9.5 Metering Provider

The embedded generator is responsible for engaging an accredited metering service provider through their electricity retailer.

For a site of an existing installation with a proposed embedded generating unit, the customer should contact their electricity retailer to arrange for the appropriate metering.

9.6 Current Transformer (CT) Metering

Current metering equipment is required for all embedded generating units connecting to the network that are rated at 60kW or greater.

9.7 High Voltage Metering

Any metering installation unit to be connected to the national grid and to operate under market conditions must have Voltage and Current Transformer National Association of Testing Authorities (NATA) traceable test certificates provided by the installing contractor or manufacturer. All metering must comply with the AEMO national metrology test procedure.

For further details refer to Chapter 7 of the NER.
10. COMMISSIONING & TESTING

10.1 Commissioning Planning

Prior to the connection of the embedded generating unit to the distribution network, Evoenergy personnel will inspect and where necessary, require the customer to test the parts of the embedded generating unit that have a direct effect on the network.

This requirement enables Evoenergy to verify that the embedded generating unit is satisfactory and complies with Evoenergy requirements.

The customer will conduct commissioning tests to demonstrate compliance of the embedded generating unit with Evoenergy’s GCC requirements and NER Schedule 5.2. The tests required in Clause 7.6 of AS/NZS 4777.1 shall also be performed and witnessed by Evoenergy.

The customer must submit to Evoenergy the proposed commissioning program, details of factory and site acceptance testing - including the test procedures with the proposed test equipment to be used in the commissioning for approval.

As per specific contract conditions, Evoenergy will require notice to be given to allow:

- Evoenergy representation during commissioning and all testing that relates to Network and LoM anti-islanding protection
- Access to commissioning test results, test plans, testing methodologies and protection settings.
- Connection to the network during commissioning
- The commissioning does not harmfully affect the security or the quality of supply from the distribution network;
- Minimise the threat of damage to the distribution network, or any other plant connected to the distribution network.
- Testing all protection scheme elements and generating unit systems protection devices.
- Ensure the work as executed is as per submitted design.

Following the successful commissioning of the embedded generating unit, the customer must keep records of the final commissioning test results verifying compliance with the requirements outlined in this document and must provide Evoenergy with a certified copy of the final commissioning test results if requested.

Failure to comply with the testing requirements will result in Evoenergy disconnecting the embedded generating unit from the distribution network.

Note: Evoenergy does not provide any test sets for the required testing. These must be provided by the customer at their own cost.

10.2 Commissioning Clearance

On completion of commissioning testing, Evoenergy will issue the customer with an embedded generation clearance form, for systems that are rated Class 2 and above.

The commissioning technician and Evoenergy representative will sign the commissioning clearance form to acknowledge that all equipment has successfully completed the required commissioning testing.

This commissioning clearance form alone does not allow the system to be energised. It is to prove that Evoenergy personnel have witnessed the commissioning process and are satisfied all requirements within this document have been met.

An example of this form is available at Appendix J.
10.3 System Documentation

At the completion of the installation of the embedded generation system, documentation shall be provided to Evoenergy which should ensure key information is available to Evoenergy designers and inspectors, maintenance service providers and emergency services personnel.

A hardcopy manual as per the requirements of Clause 7.2 of AS/NZS4777.1 shall be stored at an accessible location to Evoenergy.

An electronic copy of the system's documents shall be provided to Evoenergy upon request.
11. OPERATION & MAINTENANCE

11.1 Periodic Maintenance

All protection, control systems and equipment associated with embedded generating units and their connection to the distribution network shall be periodically tested to demonstrate compliance. Embedded generating units shall be tested at least once every 5 years. The periodic test procedure, test declaration and test records forms can be accessed via the Evoenergy website at: Embedded Generation Testing Forms

The customer shall submit periodic test results to Evoenergy. The owner of the embedded generating unit must keep records of all such tests and provide Evoenergy with a certified copy of the test results.

If the generator disconnects due to a fault on the generating unit, the customer shall investigate the cause of the fault and rectify the problem. The customer then shall provide a full report to Evoenergy, carried out by a suitably qualified and experienced person detailing the investigation, cause of the fault, rectification and changes undertaken to prevent reoccurrence.

The customer will also detail any tests carried out to demonstrate any changes made to the system in order to operate as required. The generator will only be allowed to be re-connected once Evoenergy is satisfied the report complies with its requirements.

Where the generating unit fails to disconnect automatically or where nuisance / unexpected operations of the generating unit occur, Evoenergy will disconnect the generating unit. Reconnection will only be permitted once a satisfactory report with associated test results has been submitted and reviewed by Evoenergy. Failure to comply with the testing requirements as stipulated above will result in Evoenergy disconnecting the embedded generator unit from the network.

11.2 Operating Protocol

The customer may be required to have, maintain and use up to date operating protocols, consistent with Evoenergy processes and the generator connection contract for large scale embedded generating systems.

11.3 Trained Operators

The customer shall ensure that appropriately trained operators are available and contactable when operating its facilities or undertaking any work in relation to its facilities covered by the operating protocol and the ACT Government Operating Certificate Framework for medium and large scale embedded generation systems.
12. CONNECTION PROCESS

Customers will be required to enter into contracts as described in Section 5. The processes for enquiring and applying to Evoenergy for connection of an embedded generating unit are subject to the regulatory requirements detailed in NER Chapter 5A.

12.1 Class 1 Generating Units

The connection process for Class 1 installations is outlined on the Evoenergy website.

http://www.evoenergy.com.au

12.2 Class 2 to 6 Generating Units

The connection process for Class 2 to 6 generating units is detailed in Figure 4

---

**FIGURE 4** CLASS 2 TO 6 CONNECTION PROCESS DIAGRAM
Step 1: Connection Enquiry

The customer must advise Evoenergy of the proposed connection by submitting a completed Special Connection Request Form (SCR) ensuring that the following information as per Section 6 is provided:

i. Location of the proposed installation (address and suburb or block and section)
ii. Details of embedded generating unit
iii. Single line diagram showing proposed connection arrangement
iv. Details of protection
v. Typical generation/load profile over a 24-hour period at point of connection
vi. Site plan
vii. Voltage rise calculations
viii. Any specific requirements for supply service levels and connection arrangement • additional information specific to the proposed installation as requested by Evoenergy in order for it to complete the assessment.
ix. Anticipated dates for connection.

This shall be done prior to undertaking any detailed design or committing to expenditure or material and resources.

Evoenergy shall address any reasonable request for information that would enable the customer to prepare a connection enquiry that best meets the customer’s technical and commercial considerations.

(Note: Requests for information on distribution network layout and ratings for a specific section of the distribution network are considered reasonable by Evoenergy.)

Step 2: Initial Response

Evoenergy will provide an initial response to the connection enquiry within five (5) business days of receiving the enquiry, advising whether or not the enquiry is complete and also advise of the applicable charges. Appendix B shows the charge code for processing this connection enquiry.

If a customer wishes to proceed with a connection enquiry and pay the charges, Evoenergy will issue a quote/invoice and submit to the customer within ten (10) business days.

Step 3: Preliminary Network Advice

Evoenergy shall process the connection enquiry and respond within twenty (20) business days of payment. This will include advice to the customer on:

i. Technical feasibility of the proposed connection based on the preliminary information provided
ii. Network studies required to determine the impact of the installation on the distribution network
iii. Additional information required from the customer for Evoenergy to carry out the above studies
iv. Preliminary program of works to make the connection; provided that the customer has informed Evoenergy of their schedule to connect
v. NTS charge payable by the customer.
Step 4: Network Technical Study

The customer shall confirm intent to take the connection enquiry to the next stage by submitting to Evoenergy written confirmation to proceed with the Network Technical Study (NTS).

Upon receipt of the written confirmation Evoenergy will raise a quote/invoice for the NTS or for the provision of technical information to conduct the NTS and submit to the customer.

Upon receipt of the payment Evoenergy will commence the study or provide the technical information.

Evoenergy undertakes the NTS for generating units up to 1500kW capacity i.e. Class 2-5. Above this capacity, Evoenergy requires the customer to conduct studies by a qualified engineer with suitable expertise then provide a copy to Evoenergy prior to installation.

The NTS typically includes the following:

i. Load flow studies to check effect on voltage profiles and thermal loading on feeders and transformers.

ii. Fault level study to confirm equipment fault ratings are not exceeded.

iii. Protection co-ordination study, if required, to check effect of generation on operation of Evoenergy’s protection system.

iv. Review of connected generation type and capacity, load type and capacity and inverter specification to evaluate risk of islanded operation.

Appendix D contains the scope of the NTS.

Step 5: Connection Proposal

Evoenergy shall conduct a detailed assessment of the connection enquiry to determine its impact on the safety and operation of the network.

The outcome of the above studies and reviews will provide the basis for Evoenergy’s preparation of a connection proposal for submission to the customer.

The connection proposal will include the following:

i. Advice on the maximum embedded generation capacity and the details of the connection arrangement that can be accepted at the proposed location.

ii. Details of network augmentation or modification, if required, to enable the proposed connection.

iii. A schedule of itemised estimated costs to be funded by the customer, including network augmentation or modification costs if required.

iv. A program of works to complete the connection, including augmentation or modification works if required.

v. Applicable service standards.

vi. Non-refundable design charge.

Evoenergy will provide the customer with the connection proposal with twenty (20) business days of completing or receiving the NTS, providing all necessary information has been provided.

Step 6: Connection Application

On receiving the connection proposal, the customer must decide if the connection conditions are acceptable and if so the customer must advise Evoenergy in writing of the acceptance.

(Note: If the information provided by Evoenergy is more than three (3) months old then the Connection Application may not be accepted)

Where applicable, Evoenergy will require a non-refundable design charge with the application which will be offset against the cost should the customer choose to accept the offer to proceed with the construction.

Upon receipt of the written acceptance Evoenergy will raise a quote/invoice for the design charge and submit to the customer.
Upon receipt of the payment Evoenergy will prepare the connection plans which include the cost to augment the electricity network to enable a connection to occur.

**Step 7: Connection Offer**

Evoenergy shall issue a connection offer within sixty five (65) business days of receiving the connection application and any applicable payment.

The connection offer will be in the form of a Non-Standard Connection Agreement including a quote/invoice for the customer contribution, a works program and the terms and conditions of the connection contract, as described in [Section 5.2](#).

Upon acceptance by the customer of the connection offer and once payment is received for the customer contribution, Evoenergy will proceed with the detailed design, construction and commissioning as per the works program.

**Step 8: Design, Construction and Commissioning**

**Design (if required)**

Evoenergy will undertake a detailed design after the Non-Standard Connection Agreement has been finalised, signed and all necessary requirements have been met.

A project manager may be appointed, depending on the size of the project who will liaise with the customer’s principle contractor. Procurement of long lead equipment will be undertaken once the detailed design and specification has been approved.

**Construction (if required)**

The projects principal contractor and Evoenergy’s project manager will co-ordinate the joint works during the construction stage including the testing, commissioning and project handover as per the schedules within the Non-Standard Connection Agreement.

**Metering**

The customer’s principal contractor or installer must submit a Request for Service Form (RFS) to Evoenergy. This form can be submitted at any time after the connection offer has been received and the contract has been executed by the customer.

It is at this point that Evoenergy becomes aware that the customer has liaised with their selected energy retailer for metering of the embedded generating unit.

**ACT Government Electrical Inspection**

The customer’s principle contractor or installer shall notify ACT Government Electrical Inspectorate that the generating unit installation is ready for inspection through filing the Certificate of Electrical Safety (CES).

ACT Government Electrical Inspectorate may carry out an inspection of all electrical work. If the installation passes the inspection, the electrical inspector will place an approval sticker adjacent to the existing metering installation or in the meter box.

**Commissioning**

The customer’s principal contractor or installer must give Evoenergy at least ten (10) business days’ notice to enable Evoenergy personnel to witness commissioning of the generating unit. Refer to [Section 10](#) – Commissioning and Testing for more detail.

Following the successful commissioning of the generating unit, the customer’s principle contractor is responsible for submitting a detailed commissioning report to Evoenergy for approval. The report must include results of testing all protection schemes (main and backup), control systems (SCADA), all protection settings and the correct operation of safety features.
12.3 SCADA Connection Process

When the embedded generating unit is required to have SCADA, the following steps will require additional actions as outlined below.

At Step 7 (Section 12.2)
The customer is required to provide the SCADA information as detailed in Section 8.1.
The customer shall submit the following:
- Cubicle layout,
- I/O points list,
- Wiring schematic,
- Contact details for their SCADA technician and site access.

Customers proposing a programmable logic controller (PLC) or protection relays, which have not previously been interfaced with Evoenergy’s SCADA system shall be required to provide their equipment to Evoenergy for bench testing to confirm the correct functioning between the customers generating unit and the Evoenergy RTU.

Evoenergy will advise on SCADA costs (including commissioning) in the connection offer.

At Step 8 (Section 12.2)
Evoenergy SCADA technicians will attend site to perform site acceptance testing of the SCADA equipment during the commissioning of the system. The site acceptance test requirements can be made available to customers upon request.

12.4 Alterations to Proposals
The Customer shall apply to Evoenergy with a new Special Connection Request to:
- Relocate a generator proposal
- Alter the installation contractor
- Alter the generator equipment proposed.

Relocations or proposals for equipment materially different from the original proposal may require Evoenergy to reassess the NTS. A special connection request which is an alteration to an existing proposal shall clearly state this on the comments section on the form. The customer or business name should remain unchanged on the new special connection request.

12.5 Removal of an Embedded Generating Unit
The customer shall inform Evoenergy and their selected energy retailer if they wish to remove an embedded generating unit from the distribution network. Evoenergy will remove the generating unit from the register of embedded generators within the ACT.
# APPENDIX A – GENERATOR DATA

## A 1 Non inverter data

The following information shall be provided for each non-inverter generating unit proposed to be installed:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DATA DESCRIPTION</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Type of generator</td>
<td>Text</td>
</tr>
<tr>
<td>2</td>
<td>Connection arrangement (Delta or Star/Wye)</td>
<td>Text</td>
</tr>
<tr>
<td>3</td>
<td>Rotor type (round rotor or salient type)</td>
<td>Text</td>
</tr>
<tr>
<td>4</td>
<td>Nominal rated output</td>
<td>kVA, kW &amp; kVar</td>
</tr>
<tr>
<td>5</td>
<td>Nominal terminal voltage (line to neutral)</td>
<td>V or kV</td>
</tr>
<tr>
<td>6</td>
<td>Highest voltage (line to neutral)</td>
<td>V or kV</td>
</tr>
<tr>
<td>7</td>
<td>Rated lightning impulse withstand voltage</td>
<td>kVp</td>
</tr>
<tr>
<td>8</td>
<td>Rated short duration power frequency withstand voltage</td>
<td>kV</td>
</tr>
<tr>
<td>9</td>
<td>Maximum current</td>
<td>kA</td>
</tr>
<tr>
<td>10</td>
<td>Rated short time withstand current</td>
<td>kA for Seconds</td>
</tr>
<tr>
<td>11</td>
<td>Ambient conditions under which items 9 &amp; 10 currents apply</td>
<td>Text</td>
</tr>
<tr>
<td>12</td>
<td>Synchronous reactance – D Axis ((X_d))</td>
<td>PU</td>
</tr>
<tr>
<td>13</td>
<td>Synchronous reactance – Q Axis ((X_q))</td>
<td>PU</td>
</tr>
<tr>
<td>14</td>
<td>Transient reactance – D Axis ((X'_d))</td>
<td>PU</td>
</tr>
<tr>
<td>15</td>
<td>Transient reactance – Q Axis ((X'_q))</td>
<td>PU</td>
</tr>
<tr>
<td>16</td>
<td>Subtransient reactance – D Axis ((X''_d))</td>
<td>PU</td>
</tr>
<tr>
<td>17</td>
<td>Subtransient reactance – Q Axis ((X''_q))</td>
<td>PU</td>
</tr>
<tr>
<td>18</td>
<td>Open circuit transient time constant – D Axis</td>
<td>Seconds</td>
</tr>
<tr>
<td>19</td>
<td>Open circuit transient time constant – Q Axis</td>
<td>Seconds</td>
</tr>
<tr>
<td>20</td>
<td>Open circuit subtransient time constant – D Axis</td>
<td>Seconds</td>
</tr>
<tr>
<td>21</td>
<td>Open circuit subtransient time constant – Q Axis</td>
<td>Seconds</td>
</tr>
<tr>
<td>22</td>
<td>Armature resistance</td>
<td>PU</td>
</tr>
<tr>
<td>23</td>
<td>Negative sequence resistance</td>
<td>PU</td>
</tr>
<tr>
<td>24</td>
<td>Locked rotor impedance (resistance and reactance)</td>
<td>PU</td>
</tr>
<tr>
<td>25</td>
<td>Zero sequence reactance</td>
<td>PU</td>
</tr>
<tr>
<td>26</td>
<td>Grounding impedance (resistance and reactance)</td>
<td>Ohms</td>
</tr>
<tr>
<td>27</td>
<td>Saturation co-efficient at 1.0PU and 1.2PU</td>
<td>-</td>
</tr>
<tr>
<td>28</td>
<td>Mechanical inertia constant</td>
<td>Seconds</td>
</tr>
<tr>
<td>29</td>
<td>Fault contribution from the generating unit(s) at the network boundary</td>
<td>kA</td>
</tr>
<tr>
<td>30</td>
<td>Description of the proposed voltage, active (P) and reactive power (Q), control system details of the operation and performance of the system under normal fault and network disturbance conditions.</td>
<td>Text</td>
</tr>
</tbody>
</table>

Where the data item unit is identified as PU, it shall be the PU value calculated on a base of the generator nominal terminal voltage and nominal generator kVA rating.
A 2 Inverter Data

If the inverter does not have CEC approval, Evoenergy will require additional information such as, but not limited to compliance standards and manufacturers certification stating the inverter has been tested and passed the requirements outlined in AS/NZS 4777.2.

Evaluation of inverters greater than 30kW must include, but is not limited to the following:

- Testing standards which include the method of testing and expected results, such as:
  - Inverter – type tests and routine tests
  - Protection tests
  - Performance tests
  - Periodic tests
  - Power factor tests
  - Harmonic current limit tests
  - Transient voltage limit tests
  - Quality of supply tests

- An evaluation of the required level of safety and performance of the inverter including, control of real and reactive power and the circuitry used, the power factor, performance degradation over time and lifetime expectancy.

- Inverter data, such as impedances, fault levels and ratings required for network technical studies.

- A risk assessment, including type and failure modes, the probability of failure, impact on personnel and public safety, network assets and quality of supply.

- Information on Australian and overseas experience (safety and operational) with that particular inverter, including details of where it was installed and operating.
Please refer to the Evoenergy Electricity Network Prices for the costs associated with connection to the Evoenergy distribution network. Typical cost codes are shown below.

evoenergy.com.au

B 1 Connection Enquiry Processing Charges

<table>
<thead>
<tr>
<th>EMBEDDED GENERATING UNIT</th>
<th>CONNECTION ENQUIRY PROCESSING CHARGE CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLASS 1</td>
<td>570</td>
</tr>
<tr>
<td>CLASS 2 TO 5</td>
<td>571</td>
</tr>
<tr>
<td>CLASS 6</td>
<td>572</td>
</tr>
</tbody>
</table>

B 2 Network Technical Study Services

<table>
<thead>
<tr>
<th>EMBEDDED GENERATING UNIT</th>
<th>NETWORK TECHNICAL STUDY CHARGE CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LV</td>
</tr>
<tr>
<td>CLASS 1</td>
<td>574</td>
</tr>
<tr>
<td>CLASS 2</td>
<td>575</td>
</tr>
<tr>
<td>CLASS 3</td>
<td>576</td>
</tr>
<tr>
<td>CLASS 4</td>
<td>577</td>
</tr>
<tr>
<td>CLASS 5</td>
<td>578</td>
</tr>
<tr>
<td>CLASS 6 (Provision of Information)</td>
<td>573</td>
</tr>
</tbody>
</table>

NA  Non Applicable

B 3 Network Connection Charges

The customer of the embedded generating unit will be advised of the site specific connection charges after receipt of the application to connect.

Typically, these charges will cover the following items:

- Administration and contract preparation
- Network augmentation and design work
- Project management
- SCADA equipment
- Commissioning
APPENDIX C – GENERATOR CONNECTION CUBICLE (GCC)

The connection of all new embedded generating units greater than 30kW to the distribution network will require the applicant to install a generator connection cubicle (GCC).

The primary purpose of this GCC is to assure Evoenergy that embedded generating units, which are connected to the distribution network, do not operate as islanded generators and to provide a facility to house the relevant equipment, including SCADA as required for Class 5 and above embedded generating units.

The GCC is a standard enclosure containing the backup protective devices to the generating unit’s existing active anti-islanding circuitry within its inverters. This backup arrangement will provide Evoenergy with assurance that reasonable steps have been taken to provide for the following Evoenergy prime directives.

- The safety of personnel who work on the distribution network and to the general public;
- To minimise asset loss-of-life, reduced performance and to prevent damage to distribution network assets;
- Minimise disruption to all customers (quality of supply) inclusive of the applicants site; and
- To not intentionally cause harm to the environment and to encourage sustainable development that supports the environment’s ability to satisfy the needs of future generations.

The applicant has the choice of either forwarding a design proposal to Evoenergy for a GCC that offers anti-islanding backup protection and/or SCADA facility or to install a GCC that has been approved by Evoenergy.

If the customer wishes to design their own GCC then the design needs to comply with the performance specification as outlined below. It must be noted that the GCC belongs to and is the responsibility of the owner and not Evoenergy.

C 1 GCC Performance Specification

The GCC shall be located in a prominent position as close to the MSB as practicable, clearly labelled and accessible to Evoenergy and Emergency Service personnel at all times.

The GCC applies to the following installations:

- Class 2 – Required where future upgrades to class 3 or above is intended
- Class 3 & Class 4 (Cubicle + Circuit Breaker + Protection Relay + UPS)
- Class 5 & Class 6 (Class 4 + SCADA + Communication Link + NVD)
The GCC installation comprises of six (6) main parts as follows:

**CUBICLE**

The cubicle shall be designed to include the following.
- Constructed of steel and have a lockable hinged door that is capable of opening 120°. Locking shall be accessible by Evoenergy staff and property facility manager.
- Wall mounted *(preferred)* or free standing
- Vermin proof, weather proof and secure to IP56.
- Contents must not exceed their normal operating temperature range. It requires anti-condensation heater and cooling fans. If the GCC receives greater than 30 minutes of full sunlight per day during summer it will require double skinned walls.
- Opening the door will automatically activate a light that will enable the internal components and schematic diagram to be viewed clearly.
- An internally mounted power outlet.
- Labelled externally to identify the purpose of the installation.
  Label shall be visible in low light conditions.
- Labelled internally to identify the purpose of all internal components, all secondary wiring labelled/numbered and a generator shutdown procedure viewable.
  A schematic diagram must be shown on the inside of the hinged door.
- All secondary components including wiring shall have no exposed live metal parts.
- An externally mounted ‘**WHITE**’ light to indicate the generator is available to commence operation
- An externally mounted ‘**GREEN**’ light to indicate the generator is energised.
- An externally mounted ‘**RED**’ light to indicate the generator protection has operated.
- Externally mounted, lockable emergency manual trip switch to be located at the GCC.
- Provision for the attachment and safe housing of Evoenergy load survey equipment.
  This includes having sufficient spread on entry and exit cables to allow for easy and safe attachment of split core current transformer (CT) logging equipment.

**GENERATOR CIRCUIT BREAKER (GCB)**

The GCB shall be selected to meet the following:
- Disconnect a three-phase continuous load at the generating units rated output.
- Ganged three pole operations.
- Manual TRIP.
- Manual CLOSE *(only by an authorised person)*.
- Optional Remote TRIP *(by the protection relay under local fault detection conditions or remotely by SCADA when fitted)*.
- Optional Remote CLOSE *(by the protection relay under local fault-free conditions or remotely by SCADA subject to local fault-free conditions when fitted)*.
- Optional electrical interlocking *(to inhibit closing)*
PROTECTION RELAY

The protection relay shall be selected to include the following:
- The protection relay shall have settings approved by Evoenergy.
- The primary purpose of the protection relay is to monitor for a generating unit fault event and to isolate the generator by electrically tripping the GCB.
- The protection relay shall have a self-test capability (watchdog contact). A relay failure shall also trip the GCB.
- The status of the protection relay may also be made available to the building BMS system.
- Easily replaceable.
- Located in a prominent position such that the required display is readable.

For the required protection settings, please refer to section 7.

UNINTERRUPTED POWER SUPPLY (UPS)

The UPS shall be designed to include the following:
- If a protection relay is installed, a UPS shall be installed.
- Rated to provide an uninterruptable D.C. supply to the protection relay, SCADA and communication equipment.
- There shall be sufficient battery capacity for a minimum of two hours without supply from the distribution electricity network.
- Easily replaceable.
- Self-test functionality and status reporting.

SCADA

The SCADA system shall be designed to include the following:
- The primary purpose of the SCADA system is remote tripping of the GCB via the protection relay. The trip command will be initiated by Evoenergy System Control.
- An RTU maintenance switch shall be provided to allow Evoenergy staff to carry out periodic maintenance as per section 8.4.
- The secondary purpose of the SCADA system is to monitor the status of the GCB and protection relay. This information may also be made available to the building management system (BMS) system.
- Evoenergy shall have access to the SCADA equipment at all times. Access shall be in accordance with Evoenergy’s standard lock procedures.
- Easily replaceable.

For the required SCADA I/O point lists, please refer to section 8.

COMMUNICATIONS

The communications system shall be designed to include the following:
- Communications equipment shall be installed when a SCADA system is installed.
- The communications equipment will be provided, installed and maintained by Evoenergy at the customer’s expense.
The scope of the NTS is as follows:

<table>
<thead>
<tr>
<th>TASK</th>
<th>DESCRIPTION</th>
<th>ITEM</th>
<th>ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Review enquiry form</td>
<td>1</td>
<td>Location, capacity, voltage, connection and timing details provided.</td>
</tr>
<tr>
<td>2</td>
<td>Confirm inverter compliance to AS/NZS4777</td>
<td>1</td>
<td>CEC compliance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Manufacturer's certificate available</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>AS/NZS4777.2 compliance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>Witness testing if required</td>
</tr>
<tr>
<td>3</td>
<td>Model LV network</td>
<td>1a</td>
<td>Obtain data on connected load minimum, maximum estimates</td>
</tr>
<tr>
<td></td>
<td>OR</td>
<td>1b</td>
<td>Use ADLD-&gt; Load Per Customer = (0.1059 \times \log\text{Total Customers} + 0.0715)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Confirm network data details feeder and service type, length, substation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>Model LV network including new connection downstream of distribution transformer</td>
</tr>
<tr>
<td>4</td>
<td>Network studies</td>
<td>1</td>
<td>Calculate 11kV feeder loading level (% thermal rating) under minimum load demand conditions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Calculate LV feeder loading level (% thermal rating) under minimum load demand conditions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>Calculate distribution transformer loading level (% thermal rating) under maximum and minimum load demand conditions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>Confirm voltage (% Vn) under minimum load at PCC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>Confirm voltage (%Vn) under maximum load at PCC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>Confirm Fault Level (kA)</td>
</tr>
<tr>
<td>5</td>
<td>Assessment of islanded operation risk level</td>
<td>1</td>
<td>Confirm load generation match ([S_{\text{INV}}]:[S_{\text{LOAD}}] &lt;0.7)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Confirm ([P_{\text{INV}}]:[P_{\text{LOAD}}] &lt;0.8 \text{ or } &gt;1.2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>Confirm ([Q_{\text{INV}}]:[Q_{\text{LOAD}}] &lt;0.8 \text{ or } &gt;1.2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>Number of 3 phase inverters on LV feeder</td>
</tr>
</tbody>
</table>
NOTE: For installations that meet the requirements of a 100 Amp service – the service protection device and meter protection device can be fulfilled by the one physical device provided the Evoenergy Service and Installation Rules is complied with.
APPENDIX F – TYPICAL INVERTER CONNECTION (HV)
APPENDIX G – TYPICAL NON-INVERTER CONNECTION

[Diagram showing typical non-inverter connection]
APPENDIX H – HYBRID ENERGY STORAGE SYSTEM CONNECTIONS

**H 1** ESS – AC Coupling

![Diagram of AC Coupling](image)

*NOTE:* For installations that meet the requirements of a 100 Amp service – the service protection device and meter protection device can be fulfilled by the one physical device provided the Evoenergy Service and Installation Rules is complied with.

**H2** ESS – DC Coupling

![Diagram of DC Coupling](image)

*NOTE:* For installations that meet the requirements of a 100 Amp service – the service protection device and meter protection device can be fulfilled by the one physical device provided the Evoenergy Service and Installation Rules is complied with.
APPENDIX I – SPECIAL CONNECTION REQUEST FORM

Special connection request
For enquiries please phone 13 23 86 or return this form by email to network servicing@evoenergy.com.au. All systems must be approved by EVOenergy and all relevant authorities prior to connection to the evoenergy network.

Customer/proponent details
- Customer or business name:
- Unit number: [ ]
- Floor: [ ]
- Street number: [ ]
- Street name: [ ]
- Block: [ ]
- Section: [ ]
- Suburb: [ ]
- State: [ ]
- Postcode: [ ]
- National meter identifier (NMI):
- Contact phone: [ ]
- Contact email: [ ]
- Check this box if you are amending a special connection request you have previously submitted.

Work site address
- As per customer/proponent details listed above:
- Location descriptor or business name:
- Unit number: [ ]
- Floor: [ ]
- Street number: [ ]
- Street name: [ ]
- Block: [ ]
- Section: [ ]
- Suburb: [ ]
- State: [ ]
- Postcode: [ ]

Generator details
- Manufacturer:
- Model:
- Series:
- Number of generator units (or inverters):
- Total installation nominal rating*:
- kW

Inverter details (where applicable)
- DC power supplied to each inverter:
- Over frequency setting:
- Over voltage setting:
- Phases:
- Under frequency setting:
- Under voltage setting:

Solar panel details (where applicable)
- Total number of panels:
- Rating per panel:
- Watts:
- Panels per inverter:
- Panel manufacturer:
- Panel model:

If different inverters have different numbers of panels, please provide details as an attachment.

Contractor/installer information
- Contractor/installer:
- Phone:
- Business name:
- Email:
- Electrical licence number:
- Clean Energy Council (CEC) accreditation number*:

---

* For Solar PV, enter the sum of the panel ratings. For all other generator units enter the sum of the generator units ratings.
* For all other embedded generator special connection requests, please complete the additional generator details section on page 65.
* Applicable for inverter-based installations.

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JANUARY 2019 • SM3201
### System Information

**Generator type**
- [ ] Inverter
- [ ] Rotating machine
- [ ] Other (please specify)

**Generator energy source**
- [ ] Solar
- [ ] Wind
- [ ] Diesel
- [ ] Hydro
- [ ] Wave
- [ ] Fuel cell
- [ ] Gas
- [ ] Battery
- [ ] Other (please specify)

**Generator mode of operation**
- [ ] Gross metered
- [ ] Net metered
- [ ] Continuous operation
- [ ] Backup supply
- [ ] Peaking plant
- [ ] Other (please specify)

---

### Generator Details

**Nominal AC power**

**Nominal AC current**

---

### Comments and Notes

---

### Customer Declaration

By signing the below I declare and agree that:

- [ ] the information I have provided in this form is accurate and correct. If for any reason this information is incorrect, I will submit a new special connection request form for approval by Evoenergy.
- [ ] I have read, understood, and accept the terms and conditions of the Evoenergy Service and Installations rules.
- [ ] I have attached a line diagram and all other relevant information as per Evoenergy requirements for embedded generator connection to Evoenergy low voltage (LV) network.

**Name of proponent or their agent**:  
**Signature**:  
**Date**: / / 

---

**Evoenergy use only**

**Received date**:  
If Evoenergy approves your special connection request, the approval remains valid for 90 days from the issue date unless a certificate of electrical safety is received from the licensed electrician.
# APPENDIX J – EMBEDDED GENERATION CLEARANCE FORM

## EMBEDDED GENERATION SYSTEM INFORMATION

<table>
<thead>
<tr>
<th>SITE NAME</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE ADDRESS</td>
<td></td>
</tr>
<tr>
<td>BLOCK/SECTION</td>
<td></td>
</tr>
<tr>
<td>SUBSTATION NUMBER</td>
<td></td>
</tr>
<tr>
<td>EMBEDDED GENERATION SYSTEM SIZE</td>
<td></td>
</tr>
<tr>
<td>NUMBER OF INVERTERS AND SIZE</td>
<td></td>
</tr>
<tr>
<td>COMMISSIONING DATE</td>
<td></td>
</tr>
<tr>
<td>SYSTEM INSTALLER (name &amp; contact details)</td>
<td></td>
</tr>
<tr>
<td>COMMISSIONING TECHNICIAN (name &amp; contact details)</td>
<td></td>
</tr>
</tbody>
</table>

### Checkboxes

- [ ] PASS
- [ ] FAIL
- [ ] NA

### Emotions

- ACCESSIBLE PHASE LOCKABLE ISOLATION SWITCH INSTALLED
- GCC INSTALLED AS PER SPECIFICATION
- GCC EXTERNAL TRIP BUTTON (LOCKABLE) IS TESTED
- GCC EXTERNAL INDICATION LIGHTS ARE INSTALLED
- GCC INTERNAL LIGHT OPERATES WHEN THE DOOR IS OPENED
- GCC INTERNAL 240V POWER OUTLET IS FUNCTIONAL
- PROTECTION SETTINGS ARE CONFIRMED AND TESTED
- ANTI-ISLANDING PROTECTION TESTED
- SCADA INTEGRATION TESTED
- ACT GOVERNMENT ELECTRICAL INSPECTORATE APPROVAL

### COMMENTS

<table>
<thead>
<tr>
<th>NAME</th>
<th>TITLE</th>
<th>SIGNATURE</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commissioning Technician</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Evoenergy Representative</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Revision History

<table>
<thead>
<tr>
<th>REV</th>
<th>Date</th>
<th>Change Made</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>September 2016</td>
<td>Original – combined past documents’ requirements</td>
</tr>
<tr>
<td>2</td>
<td>August 2017</td>
<td>Major re-drafting to comply with the revised AS4777 requirements.</td>
</tr>
<tr>
<td>3</td>
<td>November 2017</td>
<td>Major re-drafting to comply with Power of Choice implementation.</td>
</tr>
<tr>
<td>3.1</td>
<td>January 2018</td>
<td>Minor update to reflect the organisation’s rebranding ‘evoenergy’</td>
</tr>
<tr>
<td>3.2</td>
<td>January 2019</td>
<td>Disclaimer and Copyright notes added</td>
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</tbody>
</table>