CUSTOMER GUIDELINE

CUSTOMER GUIDELINE - High Voltage Distribution Connected Embedded Generation

Version 2

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1. Introduction and Document Information

1.1. Introduction

These guidelines are intended to cover the installation of generating sources typically between two megawatt (2 MW) and ten megawatt (10MW), which existing or new customers wish to connect to the CitiPower/Powercor Distribution Feeder voltage (6.6kV, 11kV or 22kV phase to phase) system that is part of the CitiPower/Powercor distribution system network.

1.2. Purpose

The guidelines have been prepared in order to facilitate generator connection. These Guidelines should be read in conjunction with the National Electricity Rules (NER) and any other relevant standards and regulations.

The aim of these Guidelines is to ensure that:

- Reliability and quality of the grid supply to other customers is not to be adversely affected by operation of the customer's generating plant.
- The safety of other customers and of CitiPower/Powercor employees and contractors is not put at risk.
- The customer's plant is of an accepted design and capable of operating reliably for extended periods.
- The connection complies with the requirements of CitiPower/Powercor.

Prior to the commencement of connection works by CitiPower/Powercor a formal Network Augmentation agreement must be executed. This agreement will contain Schedules which describe all key technical and commercial aspects of the agreement between the two parties.

The installation of a private generating plant must comply with the Electricity Safety Act and its Regulations.

It is also the responsibility of the Customer intending to install a private generating plant to ensure the installation and operation of the plant conforms to the requirements of all other Government and statutory authorities.

1.3. Disclaimer

While CitiPower/Powercor makes every effort to ensure that this information and material is current and accurate, the information and material is provided to you on the understanding that:

- CitiPower/Powercor makes no warranty, guarantee or promise, express or implied, in relation to the content or accuracy of this information and material.
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- CitiPower/Powercor is not liable or responsible in any way for the results of any actions taken on the basis of this information and material.

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2. Definitions

2.1. Regulatory Terms

Term	Description
AER	Australian Energy Regulator. Note: The AER is in progress of taking over from the ESC for Victoria.
AEMO	Australian Energy Market Operator
Agreed Capability	In relation to a connection point, the capability to receive or send out power for that connection point determined in accordance with the relevant augmentation agreement.
Distributor	The owner and operator of the electricity distribution network (grid) to which the customer is connected. The retailer's energy must be delivered to the customer via the distributor's poles and wires (network); the distributor charges for this service. Sometimes referred to as a Distribution Network Service Provider (DSNP).
DNSP	Distribution Network Service Provider.
Embedded Generator	An entity which owns and operates generating units, which are connected within the distribution network and do not have direct access to the transmission network.
ESC	Essential Services Commission.
Generation Dispatch	The process by which Scheduled generating units are directed to start, stop and adjust output by a central controller so that the aggregated generation balances the total customer load.
Generator Technical Requirement (GTR)	In the context of the Victorian System Code, the technical requirements for Large Units which are given in Schedules S5.2.5 and S5.2.6 of the NER.
LNSP	Local Network Service Provider
Market Generator	A Generator which sells all of its sent-out electricity on the national spot market and accepts payments from AEMO.
Market Settlement	The process of producing bills and credit notes as a result of interactions by participants with the National Electricity Market.
NER	National Electricity Rules
Network Service Provider	NSP is the owner and operator of a transmission network or a distribution network.
Non-Market Generator	A Generator which sells all electricity under contract to a retailer, or to a customer at the same connection point.
Non-Scheduled Generator	A Generator whose generating units operate independently of the centralised generation dispatch process.
NSP	Network Service Provider.
Point of Connection	The point on a distribution feeder at which an embedded generator is connected to the distributor's network.
Retailer	The seller of electrical energy (as a market commodity) to customers otherwise than through the wholesale electricity market. Sells energy to any customer independent of location.
Scheduled	A Generator who participates in the centralised generation dispatch

Term	Description
Generator	process managed by AEMO.
TNSP	Transmission Network Service Provider.
Transmission Network	A network within any participating jurisdiction operating at nominal voltages of 220 kV and above plus: (a) any part of a network operating at nominal voltages between 66 kV and 220kV that operates in parallel to and provides support to the higher voltage transmission network; (b) any part of a network operating at nominal voltages between 66 kV and 220kV that is not referred to in paragraph (a) but is deemed by the AER to be part of the transmission network.

Table 1 – Glossary of Regulatory Terms

2.2. Technical Terms

Term	Description
Active Power	The component of an AC electric current which is converted to mechanical power or to heat.
Demand	The power consumed by a customer at any point in time; normally measured by integrating kilowatt hours of energy consumed over a period 15 or 30 minutes, and expressed as an average in kilowatts. May sometimes be defined, measured and expressed in kilovolt-amperes.
Distribution Feeder	An electric line and associated equipment operating at a voltage of 6.6kV, 11kV or 22kV, which a DNSP uses to distribute electricity.
Distribution Network	A network which is not a transmission network.
Distribution System	A distribution network, together with the connection assets associated with the distribution network, which is connected to another transmission or distribution system. Connection assets on their own do not constitute a distribution system.
Fault Level	The maximum electrical current, usually expressed in thousands of amperes (kA), which can flow at a point in the supply network if one phase of the supply is short-circuited to earth or to one or more of the other phases.
Power Factor	A measure of the relative proportions of active power and reactive power in an AC load current; if p.f. = 1, all current is used in producing heat or mechanical power; if p.f. = 0, then all is used in maintaining magnetic or electric fields.
Quality of Supply	(At a point of supply to a customer): The degree to which the voltage of the electricity supply departs from a pure 3-phase sinusoidal waveform of constant magnitude and frequency.
Reliability of Supply	(To a customer) The extent to which power supply is available without interruption or curtailment over a long period of time. Usually quantified as availability (no. hours available/total no. hours).

Term	Description
High Voltage	In this document High Voltage refers to voltages between 1kV and 66kV. Typically in the CitiPower and Powercor networks this will be the voltages that the Distribution Feeders operate at, 6.6kV, 11kV or 22kV phase to phase.
Low Voltage	Refers to voltages less than 1kV. For Victoria typically 230V or 400V.
Zone Substation	The origin of distribution feeders at 6.6, 11 or 22 kV; contains transformers which reduce voltage from sub-transmission level (usually 66kV) to distribution level (6.6, 11 or 22 kV).

Table 2 – Glossary of Technical Terms

3. Standards and Guidelines

The following lists are not necessarily updated and not exhaustive. They are intended as a guide to prospective Embedded Generators. It is incumbent on the proponent and proponents' consultant to ensure that the project complies with appropriate standards, guidelines and rules.

3.1. Australian Standards

Australian Standards are employed by the DNSP's to provide a standard approach for technical requirements. Below is a table that provides a list of relevant Australian Standards.

Australian Standard	Standard Title
AS 1319	Safety signs for occupational environment
AS 1359	General Requirements for Rotating Electrical Machines
AS 1931	High Voltage Test Techniques
AS 2006	Diesel Generators/internal combustion engines
AS 2067	Substations and high voltage installations exceeding 1 kV a.c.
AS 2344	Limits of electromagnetic interference from overhead a.c. powerlines and HV equipment installations in frequency range 0.15 to 1000 MHz
AS 2373	Electric Cables
AS 2374	Power Transformers
AS 2915	Solar Photovoltaic Modules – Performance Requirements
AS/NZS 3000	Electrical Installations (Wiring Rules), 3010 – Electrical Installations – Generating Sets, 3017 – Testing Guidelines
AS/NZS 3008	Electrical installations - Selection of cables - Cables for alternating voltages up to and including 0.6/1 kV
AS 3010	Electrical Installations
AS/NZS 3017	Electrical installations – Testing Guidelines
AS/NZS3100	Approval and test specification – General requirements for electrical equipment
AS 4509	Stand-alone power systems, Parts 1,2,3
AS 4777	Grid Connection of Energy Systems via Inverters, Parts1, 2, 3
AS/NZS 5033	Installation of photovoltaic (PV) arrays
AS 60038	Standard Voltages
AS/NZS 60265.1	High-voltage switches - Switches for rated voltages above 1 kV and less than 52 kV
AN/NZS 61000 Series	Electromagnetic Compatibility
AS 62271 Series	High-voltage switchgear and control gear
AS/NZS 7000	Overhead line design standard

Table 3 – Australian Standards

3.2. Other International Standards

To assist in providing a standard approach for technical requirements below is a table of International standards and guidelines which may be referred to.

The following list is not necessarily updated and not exhaustive. It is intended as a guide to prospective Embedded Generators. It is incumbent on the proponent and proponents' consultant to ensure that the project complies with appropriate standards, guidelines and rules.

Standard	Document Title
IEEE 519	Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
G59[1]	Recommendations for the connection of embedded generating plant to the DNO's distribution systems and the provision of standby generators
ETR 113[2]	Engineering Technical Report No ETR 113

Table 4: Other relevant Standards and Guidelines for reference

3.3. Access Standards and NER Conditions

This document outlines the specific Minimum Access Standards as required by CitiPower/Powercor and should be read in conjunction with the Access Standards as specified in Chapter 5 of the NER with specific reference to Schedules 5.1 and 5.2 (S5.1 and S5.2).

[1] Energy Networks Association (UK)

[2] Energy Networks Association (UK)

4. The CitiPower/Powercor Network

As a general rule, a generating plant of capacity greater than 10 MW cannot be connected to the high voltage distribution system, and must be connected to the 66 kV sub-transmission system. This limit is indicative only, being dependent on the location, the nature of other loads on the relevant network section, and other local factors.

It is sometimes necessary for CitiPower/Powercor to upgrade local networks to and/or modify the operational regime of the network to accommodate a generating plant whilst maintaining the required quality of supply to other customers.

Refer to The CitiPower/Powercor website (www.powercor.com.au) for further information about the distribution network.

The connection process will identify the extent of network extension and augmentation that is required to facilitate a generator connection.

5. Connection Process

Below is a brief summary of the different connection processes and where they are applicable. Further details of the connection process can be found on the 'Connecting Generation' section of the Citipower/Powercor website (www.powercor.com.au).

5.1. NER Chapter 5 Connection Process

The NER Chapter 5 connection process is automatically applicable to registered embedded generators with a generation capacity greater than 5 MW. The process, as defined in the amendments to Chapter 5 of the NER effective as of 1 October 2014, includes defined stages of application and details of the required information exchanges between the two parties and the timeframes applicable to each stage.

Customers wishing to connect generators smaller than 5 MW in capacity may also elect to use this process.

See the Citipower/Powercor website (www.powercor.com.au) for further details of the process.

5.2. Non Registered Embedded Generators

Customers wishing to connect an embedded Generator with capacity less than 5 MW and not electing to go through the NER Chapter 5 process are subject to this process.

See the Citipower/Powercor website (www.powercor.com.au) for further details of the process.

6. Technical Requirements

The technical requirements have been written to provide the generator proponent with details that have to be considered and addressed in the determination of any connection. Technical requirements surrounding the connection of generation to a network are essential and must be addressed to ensure the overall integrity of the network, its impact on public health and safety, existing customers, the network assets and any future connection or network configuration.

Unless otherwise stated, the requirements outlined in this section are applicable to ALL embedded generators connecting to the HV Distribution Network.

6.1. Quality of Supply

The Victorian Electricity Distribution Code (VEDC) requires electricity DNSPs to maintain the quality of electricity supply to its customers in respect of:

- Steady state voltage
- Voltage fluctuations
- Harmonic voltages
- Voltage unbalance

In turn, customers are required by the same code to control the following at their point of connection:

- The power factor of their generation and load.
- The harmonic currents generated by their generators and loads.
- The load balance between phases.
- The magnitude and rate of occurrence of generation fluctuations (which cause corresponding voltage fluctuations to be imposed on other customers).

The regulatory limits applicable to each of the above quality indicators may be found in the Victorian Electricity Distribution Code, which can be viewed on the website of the Essential Services Commission at www.esc.vic.gov.au.

The customer shall comply with these codes and CitiPower/Powercor will nominate any additional requirements.

6.2. Operation of Generators and the effect on network and customers

The stability performance of the generator shall be such as not to impact adversely on existing CitiPower/Powercor customers. CitiPower/Powercor may require stability studies to confirm this.

If required the individual machine model will need to be proven to match the machine specification and designated response.

6.3. Minimum Customer Installation Requirements

Every customer installation which interfaces an embedded generating plant with CitiPower/Powercor's network shall include as a minimum:

- Incomer circuit breaker
- generator circuit breaker
- protection systems as detailed in this document
- metering systems as detailed in this document
- remote control and monitoring facilities as detailed in this document

The customer's installation must be designed/approved by an experienced electrical power engineer. All work must conform to the appropriate Australian Standards. The customer is responsible for arranging all planning and building permits.

6.4. Earthing of Embedded Generators

Embedded LV generators connected to the network via a delta/star transformer with the delta on the network side, may have their neutral directly connected to earth on the star winding. Otherwise, same as for embedded HV generators directly connected at 22kV or 11kV, resistive earthing on the generator star neutral must be used to inhibit the zero sequence earth fault current to the network (i.e. there must be a negligible zero sequence current source). The proponent's method to limit harmonics must be discussed and agreed to by the DNSP. Any earthing of customer transformer HV to allow islanding should be discussed with CitiPower/Powercor.

6.5. Embedded Generator Transformer Requirements

The generator transformer winding vector group must not have a series or ground path to prevent the generator being a source of zero sequence earth fault current to the network (i.e. there must be no zero sequence current source).

6.6. Asset Interface Labelling

Where the generation is connected and synchronised to the network the asset interface must be clearly labelled and defined for ownership and responsibility at the point of supply.

6.7. Fault level Contribution

As per the VEDC an embedded generator must design and operate its embedded generating unit so that it does not cause fault levels in the distribution system to exceed the levels specified in Table 5, below.

Voltage Level kV	System Fault Level MVA	Short Circuit Level kA
66	2500	21.9
22	500	13.1
11	350	18.4
6.6	250	21.9
<1	36	50.0

Table 5: VEDC Fault Level limits

CitiPower/Powercor shall nominate the amount of short circuit fault current the customer’s generator is permitted to contribute. In setting the limit CitiPower/Powercor will consider the requirements of the VEDC fault level limitations as well as organic load growth in the area. The calculation of short circuit currents will be in accordance with the latest version of Australian Standard AS 3851.

Often there is limited fault level capacity in the CBD and urban areas. To ensure that fault level contribution is managed equitably in fault level constrained areas, embedded generators are limited to 2 x rated full load current contribution. Practically this has more relevance to synchronous generators. Proponents should consider series reactors as a means to limit fault level contribution. Other alternatives are available including use of inverters or other devices.

6.8. Phase Rotation

In parts of the network, particularly the Melbourne City, Northcote and Brunswick areas, the phase rotation of the network is not of the same phase rotation as that of the general electricity network. It is important that the generator understand and be aware of network phase rotation prior to project design and commissioning.

6.9. CitiPower/Powercor Network Augmentation

The impact of embedded generation on the existing CitiPower/Powercor network assets needs to be considered. Depending on the connection configuration, augmentation of these assets may be required, especially if the thermal capacities or fault levels are exceeded.

6.10. Auto Reclose

The CitiPower/Powercor system standard is for single shot auto reclose on all overhead HV distribution feeder Circuit Breakers (CB). ACRs on the Powercor overhead lines may be set to three or four operations to lockout and ACRs on CitiPower network are generally set to one or two operations to lockout. Generator manual or automatic restart facilities following a fault and system separation must make allowance for auto reclose operations.

Generation connected to HV feeders downstream of any ACR/sectionalisers may require an additional inter-tripping scheme between ACR and the customer incomer or generator CB or CitiPower/Powercor owned equipment to ensure the customer is disconnected from the Network when such protection operates.

6.11. Synchronisation

All embedded generation synchronism requirements shall be provided within the customer's generation installation.

The customer's synchronism check can be either automatic or manual, although the CitiPower/Powercor preference is for automatic synchronism check.

An out-of-synchronism reconnection can result in:

- Damage to the generator windings, shaft, couplings and prime mover.
- Damage to other synchronous plant in the region.
- Mal-operation of protective relays on other utility feeders.
- Loss of reliability for the general network

6.12. Seamless Transfer (or Make before break)

The connection applicant needs to be aware that if the generator can be paralleled to the network even instantaneously then there may be risks associated with fault level contribution and other technical considerations. Any installation that has "make before break" capability will be considered to be an embedded generator and is required to comply with these guidelines and the standards referred to herein.

6.13. Islanding

Islanding of an embedded generator occurs when a protection or control operation separates the embedded generator connection from the general body of the network and leaves it to supply the local load.

The customer's embedded generation substation protection, generator protection and/or inherent generator design and control system philosophy shall ensure that under all reasonable circumstances, should the customers network separate from the CitiPower/Powercor network, the generator CB's or the customer incoming CB shall trip ensuring that the embedded generation cannot be islanded to the CitiPower/Powercor load.

The generator must be disconnected from the CitiPower/Powercor network if:

- one or more phases of the distribution network at the connection point is lost
- a network abnormality causes unacceptable voltage and/or frequency deviations at the network connection point

Anti-islanding protection operate times shall take into consideration the auto reclose dead time such that the generation is disconnected from the CitiPower/Powercor network before the first reclose attempt.

The customer's generator/s may continue to supply the customer's own load downstream of the network connection point, but must not continue to supply any CitiPower/Powercor customers.

The required methods of detecting islanded scenarios are discussed in the Section 6.15.2 below.

6.14. Remote Control & Monitoring Requirements

The following outlines the local and remote control, plant/equipment status and alarms and metering required by CitiPower/Powercor to operate the system. These requirements are required to enable operational switching to be carried out for both planned and unplanned outage situations and are additional to all other interface requirements specified elsewhere in this document.

The customer shall provide for:

- remote/manual trip control of the customer incoming HV CB
- a close-enable interlock signal to the customer incoming HV CB and/or the Generator CB(s)

The customer may nominate whether the close-enable interlock operates on the customer incomer CB or the Generator CB(s) depending on the mode of operation of their site. *I.e. a customer may wish to have the close-enable interlock operate their generator CB(s) and remain connected to the distribution as a load OR they may wish to have the close-enable interlock operate on their incomer CB and operate as an island supplying their own load from their generation.*

CitiPower/Powercor shall provide the control signals in the form of voltage free normally open contacts available at the secondary interface or via DNP3 over Ethernet. If using voltage free contacts the source voltage for wetting the contact will be provided from within the customer site.

The following remote monitoring signals shall be provided to CitiPower/Powercor SCADA in the form of voltage free normally open contacts available at the secondary interface or via DNP3 over Ethernet.

Condition/Status	Contact Polarity	Comment
Incomer HV CB Open	N.C (closed when breaker open)	Preferably via auxiliary switch in CB
Incomer HV CB Closed	N.O (closed when breaker closed)	
Generator CB Open	N.C (closed when breaker open)	
Generator CB Closed	N.O (closed when breaker closed)	

Table 6: Customer SCADA monitoring requirements

In addition to the above any other relevant alarms or plant status conditions may also be required depending upon the system and generation configuration.

The following SCADA metering quantities at the point of connection and/or at the generator are required by CitiPower/Powercor:

Metering Quantity	No Export	Export
3 phase Amps	✓	✓
3 Phase Volts	×	✓
MWatt	×	✓
MVAR	×	✓

Table 7: Customer SCADA monitoring requirements summary

SCADA metering quantities shall be supplied to CitiPower/Powercor via one of the following methods:

- a communications link utilizing DNP3.0 protocol
- 4-20mA analogue quantities to the CitiPower/Powercor interface terminals
- a CitiPower/Powercor power quality meter that is connected to the customer metering CT's and VT's supplies

A Close-Enable Interlock time expired alarm will to be incorporated in the SCADA Master Station to raise an alarm when generation is not disconnected from the CitiPower/Powercor's network after a Close-Enable Interlock signal has been sent.

In the case where appropriate action is not taken by the customer within an agreed timeframe from sending the Close-Enable Interlock further action will be taken. Action taken may include a trip of the Customer incoming or generator HV CB(s).

6.15. Protection Requirements

The customer protection design shall be based on detecting all faults within the customer's distribution system and operating the customers CB's to isolate the fault without impacting the CitiPower/Powercor system. It is the customer's responsibility to determine all further performance requirements for the generator protection, given that the functionality will depend on the type of machine and its method of electrical coupling.

The protection design should include primary protection and back-up protection. Back-up protection can be via duplicated unit protection schemes with local CB failure schemes or via non-unit protection schemes. The back-up protection must also cover all sections of primary plant and must provide protection for both relay failure and CB failure.

It is recommended to utilise as many unit protection schemes as possible to minimize the number of 'nested' over current schemes.

The protection design shall be carried out to 'best industry practice' and shall include the following principles:

- Adequate CT ratios and performance specifications such that protection mal-operations will not occur under the most severe system fault conditions as a result of CT saturation
- Overlapping protection zones with CT's located such that there are no 'blind spots'

In addition to the detection and clearance of faults the generator shall disconnect from the CitiPower/Powercor network if:

- the generator output becomes unstable causing unacceptable voltage and/or frequency deviations at the connection point
- the AC/DC supplies to protection and/or control system equipment fail
- the CitiPower/Powercor Interconnection Protection operates

The generator may also be required to disconnect from the CitiPower/Powercor network or prevented from connecting if:

- CitiPower/Powercor advises that failure of the inter-trip/interlock communication links has occurred (if deemed appropriate by CitiPower/Powercor)
- a Close-Enable Interlock signal is sent from CitiPower/Powercor to the customer
- directed by a CitiPower/Powercor System Control Centre personnel (for a loss of SCADA communications scenario)

The customer shall submit to CitiPower/Powercor a single line protection diagram of all protection proposed for acceptance at the start of the project. Detailed design and the purchase of any equipment should not proceed until written acceptance is received from CitiPower/Powercor.

6.15.1. Neutral Displacement

Neutral Displacement (ND) protection is required wherever an overhead section of the CitiPower/Powercor network can be back-fed from an unearthed transformer winding or for other unusual system conditions. To facilitate ND protection a 22/11/6.6 kV feeder voltage transformer (VT) is required. The VT shall be supplied and installed by the customer on the customer's HV network. The VT shall be a single three phase 5 limb VT, with the primary winding star point connected to earth and the secondary winding connected in broken delta or fitted with auxiliary VTs connected with an open delta secondary.

In some cases the VT may be supplied by CitiPower/Powercor, in which case CitiPower/Powercor will provide the VT secondary winding to the Generator Interface cubicle.

The customer will be required to supply and install the protection relay performing the ND function along with associated equipment/wiring within the embedded generation facility. This relay shall be suitably located and connected to ensure prompt disconnection of the generator.

ND Protection is generally not required for solar generation or any other generation source that is connected to the network via inverter technology.

6.15.2. Interconnection Protection

The customer shall include interconnection protection at the incomer CB. The interconnection protection functions may be incorporated into a multi-function protection relay along with overcurrent, earth fault and other protection functions required at the connection point.

The interconnection protection shall include over/under frequency and over/under voltage functions and at least one other type of anti-islanding protection.

Other types of anti-islanding protection may include, but are not limited to:

- Rate of Change of Frequency (ROCOF)
- Vector Shift

In addition to the customer interconnection protection on the customer's side a CitiPower/Powercor Interconnection Protection shall be installed either at the CitiPower/Powercor switching station or distribution substation or within the customer switch room. A separate DC supply system will be required.

CitiPower/Powercor's standard interconnection protection functions include, but are not limited to the following elements:

- Rate of Change of Frequency (ROCOF)
- Over/Under Frequency
- Over Voltage

6.15.3. Non-Export or Export Limited Connections

Customer's connecting with no intention of exporting onto CitiPower/Powercor's Distribution Network or subject to an export limit that is less that their installed generation capacity shall install reverse power protection at the point of connection.

6.15.4. CitiPower/Powercor Protection Systems

Augmentation of existing protection schemes at CitiPower/Powercor Zone Substation, existing Distribution Substations or Voltage Regulator sites may be required depending on the functionality of the existing protection schemes, the network configuration and the proposed network connection arrangement. These augmentations may include:

- replacement of existing feeder protection
- duplication of feeder protection
- addition of CB failure protection

As a minimum a protection setting review will be required at adjacent substations.

6.15.5. Intertripping

In cases where CitiPower/Powercor deem that there is sufficient risk that the embedded generator may be capable of operating in an islanded situation that results in the customer's generation supplying other customer load a protection class Intertrip scheme shall be provided. The Intertrip shall be operated by all protection and control schemes that trip the CitiPower/Powercor Zone substation 22/11/6.6kV circuit breakers. An Intertrip may also be required between the customer site and any ACRs or other protection devices on the distribution system.

The communications system utilised for the Intertrip will be continuously monitored for integrity. In the event that the signal fails and the generators are operating and electrically connected in parallel to the CitiPower/Powercor network, one of the following actions may be necessary:

- a SCADA trip signal shall be sent to the Customer Incomer CB or Main Generator CB
- a SCADA Close-Enable Interlock signal sent to the customer
- a reduction in the level of generation may be requested from the customer via SCADA

6.16. Communication Requirements

A continuous SCADA quality communication link between the customer's point of connection and CitiPower/Powercor's SCADA Master Station shall be provided for remote control and monitoring purposes.

Where there is a Voltage Regulating Transformer in CitiPower/Powercor network, SCADA signalling paths shall also be provided between the following:

- the CitiPower/Powercor System Control Centre Master Station and the CitiPower/Powercor regulator
- the CitiPower/Powercor regulator and the customer switch room

A power quality metering communication facility may be required. This communications may consist of a fibre optic cable or a 3G modem to the CitiPower/Powercor network metering hub.

The customer shall make available a telephone link for operational communications with the CitiPower/Powercor System Control Centre.

For some network connection locations communication paths for Protection, SCADA or Power Quality metering may be available via existing CitiPower/Powercor communication networks (point-to-point radio or other communication channels to the master station).

Fibre optic cable is the preferred method of communication for all communication links.

Point-to-point radio or Next G communications system may be utilized for SCADA and/or Power Quality metering. This will require the installation of a small antenna at the customer installation and the running of a communications cable between the CitiPower/Powercor cubicles and this antenna.

6.17. Interface Requirements

The physical interfaces between the customer's plant and CitiPower/Powercor's assets must be clearly defined in regards to ownership and responsibility and appropriately labelled in a clear and unambiguous manner.

The secondary interface will generally be a row or rows of terminals within a CitiPower/Powercor cubicle, rack frame or wall box. Some signalling and control signals may be communicated via a DNP3 over Ethernet link.

Exact details of the secondary interface will depend on the CitiPower/Powercor network and customer embedded generation connection arrangements and will be detailed in a "CitiPower/Powercor Interface Requirements" document that will be prepared after details of the customers system and protection design proposals have been received and accepted by CitiPower/Powercor.

The customer shall be responsible for the supply and installation of all I/O cabling, wiring and other communication circuits between the customer site and the interface cubicle.

Figure 1 below shows a generic secondary systems interface diagram for a HV Generation customer.

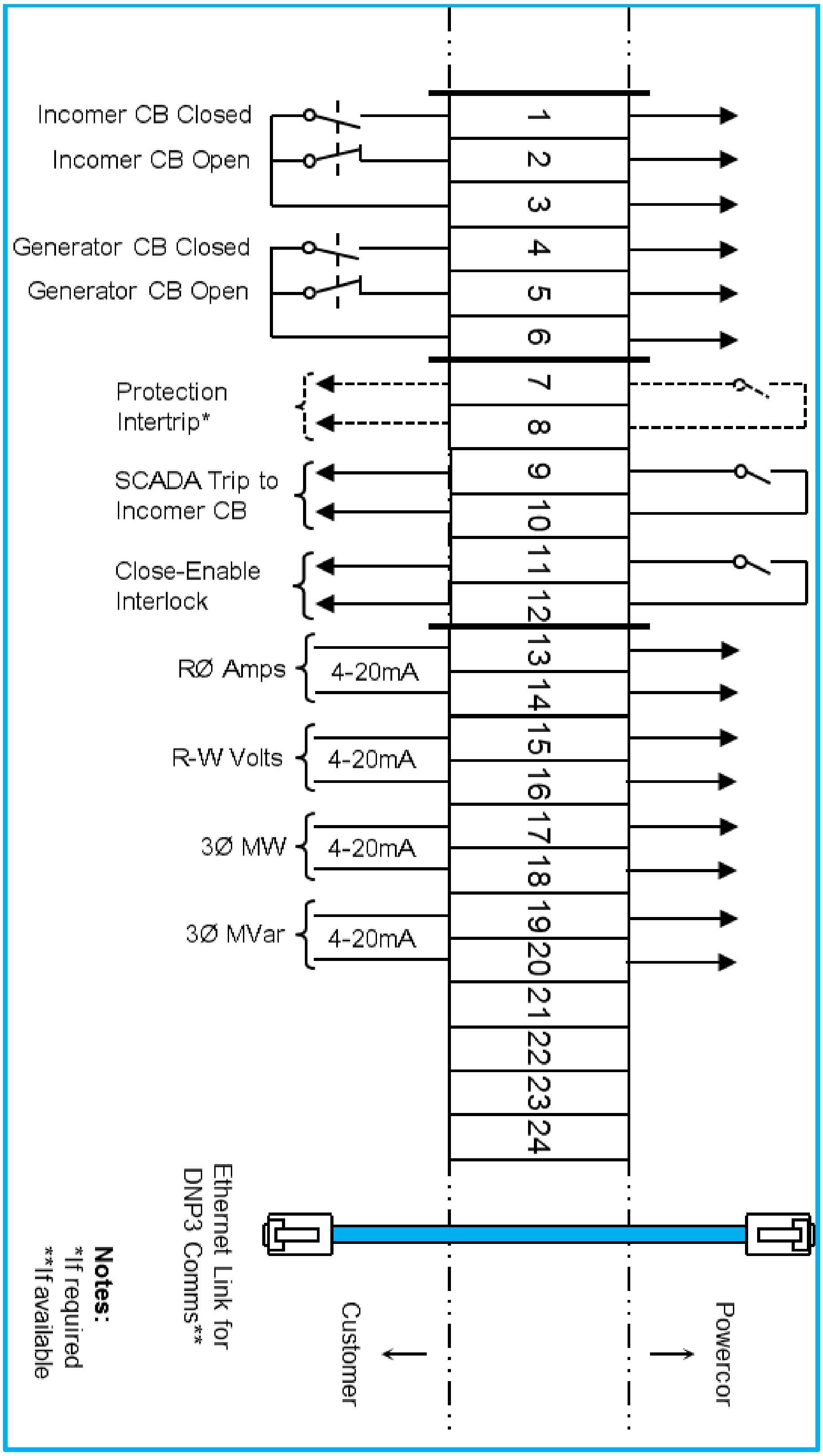

Figure 1: Generic secondary system interface requirements diagram

6.18. CitiPower/ Powercor Cubicle Requirements

As a minimum, the customer shall allocate space in their control room or switch room for 2 off 19” Cubicles suitable to house CitiPower/Powercor Protection equipment, Control & monitoring equipment and communication equipment. The current CitiPower/Powercor standard is a cubicle of dimensions 2300H X 850W X 650D.

The exact space requirements will be negotiated and confirmed in the Interface document.

6.19. CitiPower/ Powercor Distribution Voltage Regulator Requirements

Distribution Voltage Regulators are installed on the HV Distribution system to maintain voltage to within limits specified in the Electricity Distribution Code over the total length of the feeder.

If the customer intends to connect their installation downstream of a CitiPower/Powercor Distribution Voltage Regulator detailed system studies and load flow studies will be required to determine the exact requirements for the connection. Depending on the results of system studies additional SCADA metering, monitoring and control may be required. This may require installation or replacement of existing control systems and associated auxiliary equipment and communications systems.

6.20. Connection Configuration Below is an example of a typical acceptable minimum connection configuration. The example is shown with an ACR and Distribution Voltage Regulator.

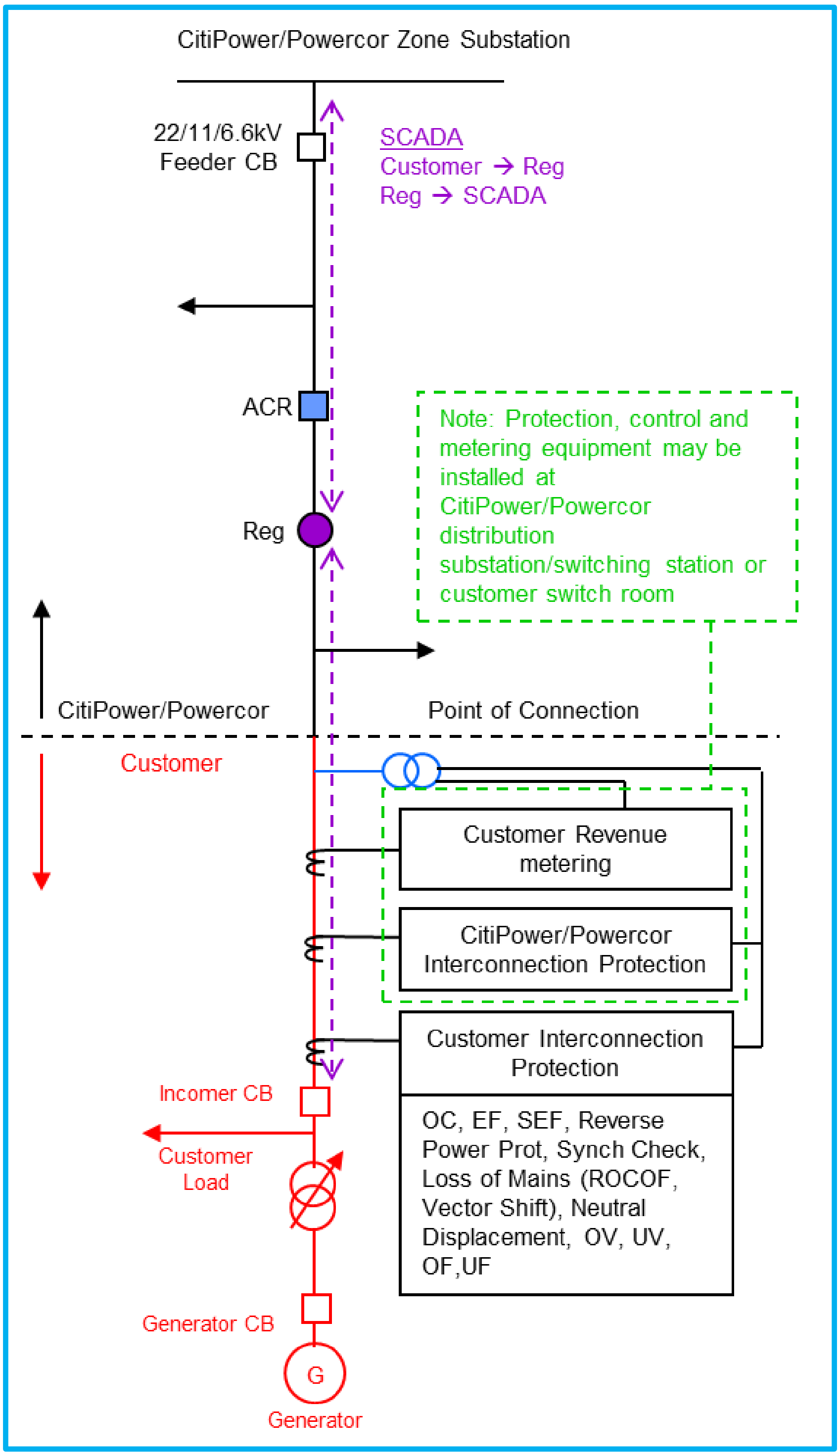

Figure 2 – Typical connection configuration for a HV Embedded Generation Customer connected to a feeder with an ACR and Distribution Voltage Regulator

6.21. Customer Documentation Requirements

If the application is subject to the NER Chapter 5 process the customer shall provide all information set out in Schedule 5.4 of the NER.

Notwithstanding any NER process requirements as discussed above the customer shall provide CitiPower/Powercor with the following documentation for approval:

- A plant electrical single Line diagram of the customer network showing:
  - Supply connection points
  - All relevant switchboards and switchgear and generator
  - All Circuit breaker/s clearly named
  - Synchronizing point/s
  - All protection and control schemes
  - Generator transformer details
- Any other schematic diagrams of protection and control schemes
- Details of primary and secondary interfaces to the CitiPower/Powercor network

The settings of the customer's non-unit protection schemes must be coordinated with the CitiPower/Powercor network protection schemes. The Customer shall provide full details of the protection proposals including the following:

- Protective relay types and configurations
- Protective relay operating characteristics
- Proposed relay settings for non-unit protection

Where coordination with existing CitiPower/Powercor settings is not possible, the customer may propose revised protection settings for CitiPower/Powercor equipment. It may then be necessary for CitiPower/Powercor to revise or upgrade their equipment. It should be noted that the CitiPower/Powercor settings can only be revised within the boundaries of good protection design to ensure HV feeder faults are cleared within an appropriate time. The approved protection design or settings must not be changed without prior approval from CitiPower/Powercor.

7. Testing and Commissioning

A detailed Schedule of pre-commissioning tests will be developed for each embedded generator.

The tests required may vary depending on the size and type of generator and the location, and may include the following:

- Synchronising checks
- Proving correct operation of all protection that may include, but not limited to, loss of mains and neutral overload protection, over-voltage, frequency, reverse power and stator earth fault protection
- Proving functionality of communication systems
- Harmonic testing

The customer will be required to ensure an electrically trained high voltage operator is present at all times during testing and commissioning to receive and execute DNSP operator instructions.

CitiPower/Powercor will not connect an embedded generator which in the opinion of CitiPower/Powercor is unsatisfactory for connection to the supply system.

8. Customer's Embedded Generator Operation and Maintenance

8.1. Operational Interface Requirement

The Operational Interface Requirements will typically include some or all of the following:

- Address of embedded generator
- Size and type of embedded generator
- A description of the upstream network supplying the embedded generator including feeder identification
- System normal operating arrangement
- Operation requirements for failure of incoming HV or LV mains
- Return to mains operating requirements
- Shutdown sequence
- CitiPower/Powercor System Control contact details
- Relevant technical drawings such as:
    - Single Line Diagrams
    - Protection settings
    - Protection curves
    - Remote control and monitoring requirements

8.2. Operating Procedures

The customer will be required to have, maintain and use up to date Operating Procedures, consistent with the Operational Interface Requirements, these Procedures are required to comply with the Code of Practice of Electrical Safety for Work on or near High Voltage Electrical Apparatus (The Blue Book) Victoria 2005.

8.3. Trained Operators

The customer shall ensure that appropriately trained operators are available as required, consistent with the Operational Interface Requirements.

8.4. Installation Maintenance

A customer who operates an embedded generator shall ensure that the electrical installation and generator is maintained in good order to ensure that any malfunction will not create a hazard or cause interference to CitiPower/Powercor's distribution network.

9. Installation Approvals

Prior to the connection of embedded generating plant, the customer shall allow access to the site for CitiPower/Powercor's representative to inspect the electrical switchgear and protection & control equipment. The customer shall also facilitate the presence of CitiPower/Powercor representatives when the plant safety features are being proven.

CitiPower/Powercor may wish to carry out its own tests prior to commissioning of the plant on the CitiPower/Powercor network. The customer shall allow access to equipment as required. In doing such testing, CitiPower/Powercor assumes no liability in respect of the safety of the customer's plant.

Subsequent to commissioning of the plant, CitiPower/Powercor must be consulted prior to any modification of the plant, equipment, protection or control schemes.

10. Revenue Metering

10.1. General Requirements

Revenue or NEM metering is required for connection of all embedded generation or grid connected alternative sources of supply, and is separate to, and in addition to any SCADA and monitoring equipment required by the customer and/or the Network as defined in this document.

Revenue metering is required to comply with the requirements of the National Electricity Market and specifically with:

- The National Electricity Rules chapter 7
- (and in particular Section 7.3.1 (i) Requirements for metering installations for non-market generating units)
- The Victorian Electricity Customer Metering Code
- The National Measurements Act and associated regulations
- The Victorian Service and Installation Rules (and in particular chapters 6, 8 and 9)

HV Revenue Metering can only be installed and maintained by AEMO accredited Meter Providers. HV Revenue Metering shall consist of a bi-directional interval meter with 30 minute import and export real energy data streams as required under the NER chapter 7.

However, in accordance with the NER requirements under section 7.3.1(i), CitiPower/Powercor, as the Local Network Service Provider, specifically requires 4 quadrant real and reactive energy interval metering on all 3 phase HV connected metered sites, as part of its approval for connection of an Embedded Generator to its Network. For all HV connected metering sites, regardless of consumption, tariff or actual demand, that metering shall be 15 minute interval data metering.

HV metering VTs and CTs shall be supplied and maintained by the customer. Metering equipment shall comply with regulatory accuracy and standards and be certified with NATA endorsed test results.

While revenue metering is normally provided by the Responsible Person and their selected Meter Provider, the customer or generation operator must ensure the metering installation design and engagement of appropriate RP/MP will comply with these specific requirements, and ensure Revenue metering is segregated from any remote control, monitoring and measuring equipment.

Where the electrical installation incorporates parallel generation facilities in addition to customer load, the metering installation shall be designed as net metering at the point of supply, unless specifically agreed or approved to be designed as gross metering by CitiPower / Powercor as the LNSP.

Where a multiple occupancy has a landlord operated parallel generation or embedded generation facility, it shall be net metered with the landlord's common area and building services loads, and separate to tenancy metering.

Where a landlord establishes an Embedded Network, any subtractive calculations for export and import at the parent meter will be the responsibility of the Embedded Network Operator and the RP/MP engaged at the Parent Metering.

Where a Generator is the primary purpose of the customer installation, it will be connected as net metering inclusive of its internal own station service, where the generator requires separate LV supply connection for standby/emergency power that may be separately metered at LV.

HV Revenue Metering energy values associated with the settlements in the NEM, or Electricity Retailer transactions, in multiple occupancies and Embedded Networks, may vary significantly from the actual connection point energy and demand loadings applied to the CitiPower and Powercor Distribution Network, and hence Control, Monitoring and Measurement equipment, to be independent to, and segregated from, the Revenue Metering equipment.

10.2. Market Generator Requirements

For Market Generators, the NER assigns primary responsibility for the provision, installation and maintenance of a metering installation to the local Network Service Provider (CitiPower/Powercor) unless otherwise elected by the Market Generator.

CitiPower/Powercor will make an offer for the provision of these services on request and, on acceptance, will provide AEMO with details of the metering installation.

If CitiPower/Powercor's offer is not accepted, the Market Generator assumes responsibility, and must engage a Metering Provider who is registered with the AEMC. The Market Generator must provide AEMO with details of the metering information.

10.3. Non-Market Generator Requirements

For Non-market Generators, i.e. those selling electricity to a retailer, the requirements are detailed in the Victorian Electricity Metering Code, which is available on the ESC website at www.esc.vic.gov.au.

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11. Environmental

There may be environmental issues that are outside the scope of the embedded generator itself that proponents should consider.

Each embedded generator technology will present unique environmental issues that the proponent will need to manage. In addition to these there will be environmental issues associated with the electrical connection itself.

These may include:

- Easements
- Clearances
- Visual amenity
- Electromagnetic compatibility
- Cultural Heritage
- Conservation of Native Vegetation
- Third Party Land User Consent
- Other

The DNSP will likely address many of these issues for the line to the proponent's boundary but there will be a number of environmental issues that will need to be managed and accountability established.

The proponent should also be aware that if there are significant environmental issues with the power connection that could have been addressed or avoided at the site selection stage, there could be significant cost and delays associated with the connection.

12. Safety

Embedded generators should ensure that safety legislation and standards are complied with including any additional conditions that may be applied by the DNSP. These should include consideration of the connection assets and site security.

Where an embedded generator operator is required to undertake works in the vicinity of DNSP assets, the embedded generator is required to use appropriate practices as per the requirements of 'the green book' code of practice and in consultation with the DNSP.

13. Contact

Refer to the '*Connecting generation*' section of the Citipower/Powercor website (www.powercor.com.au) for contact details.