Medium Voltage Embedded Generation Technical Requirements

Record Number: R0002006753
Version Number: 1.2
Date: August 2023

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Contents

Disclaimer

While we make 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:

1. This document has been prepared for the sole purpose of advising TasNetworks' access standards for embedded generation systems connecting to the Tasmanian distribution system, as required under Rules 5.3, 5.3A, 5.3AA and Chapter 5A of the National Electricity Rules.
2. Customers will seek verification and/or professional advice from an independent source before relying on or acting upon any of this information and material; and
3. We are not liable or responsible in any way for any actions taken by a proponent based on this document which are not within the purpose described above.

Please note that approval from us to connect a *generating system* to our distribution network is only an acknowledgement that the embedded *generating system* is suitable to be connected to our distribution network at the location requested at the time of your application. Our approval does not in any way indicate, guarantee, or approve that customers are or will be eligible to receive payments, credits or other forms of entitlements from any government or retailer sponsored energy feed-in rebate schemes. Customer eligibility should be determined with the relevant agencies responsible for the payment or provision of such entitlements.

Revisions

Version	Comment
1.0	Original issue following ENA Connection Guideline format
1.1	Minor updates
1.2	Minor update to Section 5.2.5.7 "Neutral voltage displacement" and addition of new NER S5.2 clauses (S5.2.5.15 and S5.2.5.16).

We may amend and expand these requirements from time to time where it may be necessary to meet the requirements of the applicable regulations and to suit the needs of our distribution network.

1 Introduction

Tasmanian Networks Pty Ltd ABN 24 167 357 299 (TasNetworks) is a state government owned network service provider.

The purpose of this technical requirements document is to provide TasNetworks' customers and the designers, consultants and installers of Medium Voltage (**MV**) Embedded Generation (**EG**) systems information about their obligations for connection to and interfacing with the distribution network.

An MV EG connection is a network connection for which the EG system is:

1. Not required to be or is exempt from being registered in the National Electricity Market (**NEM**),
2. A network connection that typically has a system capacity of less than 5 MW,
3. Connected to, and capable of operating in parallel with, any part of the MV distribution network
4. Meeting all other technical requirements set out in this document
5. Is not a Basic Micro Low Voltage (**LV**) EG system as defined in the Basic Micro EG Technical Requirements[1]
6. Is not a LV EG system as defined in the LV EG Technical Requirements

As the licensed Distribution Network Service Provider (**DNSP**) and Transmission Network Service Provider (**TNSP**) in Tasmania, TasNetworks must meet a number of legal and regulatory obligations in relation to the safety, reliability and quality of power supply made available to Network Users.

As part of its obligations, TasNetworks must ensure that the connection of embedded generation within the distribution network does not have an adverse impact on existing Customers or on operation of the network more generally.

To achieve this, TasNetworks requires that embedded generating systems proposing to connect to the distribution network, satisfy certain technical design and performance criteria. The technical requirements to be met by generating systems are called Access Standards. Access standards are provided for a range of technical issues that impact TasNetworks' obligations as a DNSP.

[1] TasNetworks Basic Micro EG Connection Technical Requirements and LV EG Connection Technical Requirements can be found on TasNetworks' website.

1.1 Scope

This technical requirements document applies to:

1. New connections of MV EG systems or modifications to existing MV EG systems, where the MV EG connection consists of Inverter Energy System (**IES**), synchronous rotating generator systems, asynchronous rotating generator systems, Energy Storage System (**ESS**) or any combination of these to TasNetworks' MV distribution network, and
2. Temporary connected MV EG systems

This technical requirements document does NOT apply to:

1. EG units covered by TasNetworks' Basic Micro EG Connection Technical Requirements,
2. EG units covered by TasNetworks' LV EG Connection Technical Requirements,
3. Electric vehicles, unless the on-board battery storage system is capable of exporting to the MV network (in which case the requirements shall apply).
4. DER systems that do not generate electricity including demand response / demand management systems, unless they impact on the ability of the MV EG system to meet these technical requirements
5. EG units that are registered within the NEM
6. EG units directly connected to the transmission network

1.2 Proponent responsibilities

Proponents of EG systems are obliged to:

1. Comply with these technical requirements as well as relevant national standards, industry codes, legislation and regulations. In the event of inconsistency, legislation and regulations shall prevail, followed by the technical requirements, followed by national standards and industry codes. Any apparent conflict between the requirements of this standard and the law, mandatory requirements, industry standards, project specifications, non-statutory standards or guidelines, and any other associated documents should be brought to the immediate attention of TasNetworks, in writing, for resolution.
2. Not to connect additional inverters, make modifications or install additional MV EG units, including ESS, without prior written agreement from TasNetworks.
3. Comply with the TasNetworks' connection agreement (Electricity Supply Contract).
4. To meet the requirements in the design, installation and operation of the MV EG system.
5. To meet the connection, commissioning, operations and maintenance requirements to the MV distribution network
6. Provide documented evidence of compliance with these requirements in accordance with Section 6 of this document.

1.3 TasNetworks' responsibilities

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

As the licenced entity under the *Electricity Supply Industry Act 1995* TasNetworks is responsible for ensuring that generators connected to its distribution system meet the requirements placed upon generators in the Tasmanian Electrify Code (**TEC**) and the NER.

TasNetworks has established procedures in place to process requests for generating unit connections to its distribution network. TasNetworks reserves the right to disconnect any generating system if it is causing a negative impact on other network customers or does not comply with the requirements outlines in these technical requirements.

These technical requirements comply with the National DER Connection Guidelines for MV EG Connections[2], with the exception of the deviations presented in Appendix A: Deviations from the National Distributed Energy Resources (**DER**) Connection Guidelines.

1.4 Responsibilities of Designers, Consultants and Installers

As stated above, the content of this document is also relevant to the designers, consultants and installers of MV EG systems. It is expected that many Proponents will engage designers, consultants and installers to assist them to install MV EG systems, which includes meeting the technical requirements set out in this document.

TasNetworks also notes that designers, consultants and installers of MV EG systems, as people who work on electrical installations, may have other obligations and licensing requirements that they must meet under law in relation to electrical works. This document only sets out TasNetworks' technical requirements for the MV EG system – it is not a comprehensive guide to all legal and technical requirements for electrical work in respect of the system.

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[2] The National DER Connection Guidelines for MV EG Connections can be viewed on the Energy Networks Australia website.

2 Definitions and abbreviations

2.1 Definitions

Access Standard	Has the same meaning given it by the NER.
Basic micro embedded generation connection	A connection between a distribution network and a retail customer's premises for a micro embedded generating unit, for which a model standing offer is in place.
Central protection	Central protection is the protection contemplated by AS/NZS 4777 (grid connection of energy systems via inverters) installed to perform the functions of: coordinating multiple inverter energy system installations at one site, providing protection for the entire inverter energy system installation and islanding protection to the connected grid as well as preserving safety of grid personnel and the general public.
Connection point (this may also sometimes be referred to as the "Point of Supply")	Has the same meaning given it by the NER. The connection point is the agreed point of supply between TasNetworks' distribution network and an electrical installation.
Distributed Energy Resources (**DER**)	Power generation or storage units that are connected directly to the distribution network.
Embedded generating unit	A *generating unit* connected within a distribution network and not having direct access to the transmission network.
Embedded generating system	A *generating system* that is connected to the distribution network referred to in this document also as "EG System".
Energy storage system (**ESS**)	A system comprising one or more batteries that store electricity generated by distributed energy resources or directly from the network, and that can discharge the electricity to loads.
Generating System	A system comprising of one or more *generating units*. A *generating system* includes auxiliary or reactive plant that is located on the *generator's* side of the *Connection Point* which may be necessary for the *generating system* to meet its registered performance standards and/or any other technical requirements included in the G*enerator's Connection agreement*
Generating unit	The plant used in the production of electricity and all related equipment essential to its functioning as a single entity.
Generation	The production of electrical power by converting another form of energy in a generating unit.
Generator	A person who owns, operates or controls a generating unit.
High Voltage	Voltages within the range of 66 kV to 220 kV
Inverter Energy System (IES)	A system comprising one or more inverters that convert direct current to alternating current.
Low voltage	The mains voltages as most commonly used in any given network by domestic and light industrial and commercial consumers (230 V line-neutral or 400 V line-line).
Medium voltage	Voltages within the range of 1 kV to 66 kV.

Micro embedded generation connection	Means a connection between an embedded generating unit and a distribution network of the kind contemplated by Australian Standard AS 4777 (Grid connection of energy systems via inverters).
Market generating unit	A generating unit whose generation is not purchased in its entirety by a retailer (and receives payment for generation through the National Electricity Market or Wholesale Electricity Market).
Model standing offer	A document approved by the Australian Energy Regulator as a model standing offer to provide basic micro embedded generation connection services or standard connection services which contains (amongst other things) the safety and technical requirements to be complied with by the proponent.
Proponent	A person proposing to become a generator (the relevant owner, operator or controller of the generating unit (or their agent)).
Registered generator	A person who owns, operates or controls a generating unit that is connected to, or who otherwise supplies electricity to, a transmission or distribution system and who is registered by Australian Energy Market Operator (**AEMO**) as a Generator under Chapter 2 of the National Electricity Rules.
Registered generator connection	A connection of a generating unit by a registered generator.
Site generation limit	The generation threshold that the embedded generation system cannot exceed, measured downstream of the connection point.
Small generation aggregator	A person who has classified one or more small generating units as a market generating unit.
Standard connection	A connection of embedded generating unit which is not basic and for which a model standing offer is in place.
TasNetworks	Reference to TasNetworks, us, we or our in these requirements is a reference to TasNetworks in its capacity as the owner and operator of the regulated distribution network in Tasmania, unless an alternative meaning is explicitly given in the text.

2.2 Abbreviations

AEMO	Australian Energy Market Operator
AS/NZS	A jointly developed Australian and New Zealand Standard
CEC	Clean Energy Council
DER	Distributed Energy Resources
EG	Embedded Generation or Embedded Generating
EMT	Electromagnetic Transient (simulation model)
ESS	Energy Storage System
HV	High Voltage
IEC	International Electro-technical Commission
IES	Inverter Energy System
JOP	Joint Operating Procedure
LV	Low Voltage
MV	Medium Voltage
NEM	National Electricity Market
NER	National Electricity Rules
NMI	National Metering Identifier
PPC	Power Park Controller
PV	Photovoltaic

2.3 Terminology

The following instructional terms are to be interpreted as follows:

1. The word '**shall**' indicates a mandatory requirement
2. The word '**may**' indicates a requirement that may be mandatorily imposed on the proponent
3. The word '**should**' indicates a recommendation that will not be mandatorily imposed on the proponent.
4.

2.4 Subcategories

The following subcategories apply for MV EG connections:

1. **MV EG IES connection** – Any EG system with a total system capacity less than 5 MW or with a total system capacity greater than 5 MW but has a specific exemption issued by AEMO, meeting all relevant technical requirements set out in TasNetworks technical requirements
2. **MV EG rotating asynchronous connection** – Any EG system that is asynchronous (i.e. uses an induction generator), with a total system capacity less than 5 MW or with a total system capacity greater than 5 MW but has a specific exemption issued by AEMO, meeting all relevant technical requirements set out in TasNetworks technical requirements
3. **MV EG rotating synchronous connection –** Any EG system that is synchronous, with a total system capacity less than 5 MW or with a total system capacity greater than 5 MW but has a specific exemption issued by AEMO, meeting all relevant technical requirements set out in TasNetworks technical requirements

Where:

1. Exporting systems shall be considered to be MV EG systems operating in parallel with the MV distribution network and exporting electricity either via partial-export or full-export into the MV distribution network, where:
    a. Partial-export MV EG systems limit the amount of export into the MV distribution network to an agreed export threshold defined in the connection agreement, and
    b. Full-export MV EG systems can export into the MV distribution network to the full MV EG nameplate capacity (maximum continuous AC rating).
2. Non-exporting systems shall be considered to be MV EG systems operating in parallel with the MV distribution network that are not approved to, and limited to ensure they cannot export electricity into the MV distribution network.

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

For all enquiries relating to network connections please contact:

networkcustomersupply@tasnetworks.com.au, or call our enquiries number on 1300 137 008.

Further information is available on the Embedded Generation page of the TasNetworks website.

3 Relevant rules, regulations, standards and codes

3.1 TasNetworks' standards

R001177235	Embedded Generation Anti-Islanding Standard[3]
R000864164	Distribution Surge Diverters
R000522696	Surge Arrester Standard

3.2 Standards and codes

The following Australian and international standards and industry codes shall apply to the design, manufacture, installation, testing and commissioning, and operation and maintenance of all plant and equipment for MV EG connections to TasNetworks' distribution network:

AS/NZS 4777.1	Grid connection of energy systems via inverters Part 1: Installation requirements
AS/NZS 4777.2	Grid connection of energy systems via inverters Part 2: Inverter requirements
AS/NZS 3000	Electrical Installations (Wiring Rules)
AS/NZS 5139	Electrical Installations – Safety of battery systems for use with power conversion equipment
AS/NZS 5033	Installation and safety requirements for photovoltaic (**PV**) arrays
AS/NZS 61000	Electromagnetic Compatibility
AS/NZS 2373	Electric Cables
AS/NZS 3010	Electrical Installations – Generating sets
AS/NZS 3008	Electrical installations - Selection of cables - Cables for alternating voltages up to and including 0.6/1 kV
AS 60038	Standard Voltages
AS 2067	Substations and high voltage installations exceeding 1 kV
AS 2184	Low voltage switchgear and control gear
AS 2374	Power Transformers
AS 60034.1	Rotating electrical machines, Part 1: Rating and performance

[3] Available online at Embedded generation - TasNetworks

AS 60034.22	Rotating electrical machines, Part 22: AC generators for reciprocating internal combustion (**RIC**) engine driven generating sets
AS 60044	Instrument transformers (multiple parts)
IEC 60255-12	Electrical relays - Part 12: Directional relays and power relays with two input energizing quantities
IEC 60255-26	Electrical relays - Part 26: Electromagnetic compatibility requirements
EC 60255-27	Electrical relays - Part 27: Product safety requirements
IEC 60255-127	Measuring relays and protection equipment - Part 127: Functional requirements for over/under voltage protection
IEC 62109	Safety of power converters for use in photovoltaic power systems
IEC 62116	Utility-interconnected photovoltaic inverters – Test procedure of islanding prevention measures
AS 1359	General Requirements for Rotating Electrical Machines
AS 2006	Diesel Generators/internal combustion engines
AS 4509	Stand-alone power systems, Parts 1,2,3

3.3 Legislation and regulation

The following legislation and regulations shall apply to the technical requirements for design, manufacture, installation, testing and commissioning, and operations and maintenance of all plant and equipment for MV EG connections to the distribution network:

- National Electricity Rules
- National Electricity (Tasmania) Law
- Electricity Supply Industry Act 1995
- Tasmanian Electricity Code

Other legislation also applies in relation to licensing and performance of electrical work, such as the Occupational Licensing Act 2005 (Tas) and regulations. This document deals only with the technical requirements of the MV EG System itself.

3.4 Operating limits

Specific operating limits applicable to the Tasmanian power system that proponents of MV EG Systems should be aware of include the standard operating voltage ranges for MV (and LV) connections as shown in Table 1, and the Tasmanian Frequency Operating Standards as presented in Table 2 and Table 3. Please be aware that various access standards will make reference to these standard operating limits.

3.4.1 Standard Operating Voltages

Table 1: Standard operating voltage ranges for Tasmania as defined by the TEC

Voltage level (kV)	Voltage range for time periods		
	Steady state (average over 10 minute period)	Less than 1 minute	Less than 10 seconds
< 1.0	Refer to: AS 61000.3.100 Section 5.1	± 10 %	Phase to earth 0 % - 150 % Phase to phase 0 % - 130 %
1-6.6 11 22	AS 61000.3.100 Section 5.2	± 10 %	Phase to earth 0 % - 180 % Phase to phase 0 % - 130 %
33 44 66	AS 61000.3.100 Section 5.2	± 15 %	Phase to earth 0 % - 150 % Phase to phase 0 % - 130 %

For the latest version please check the following link:

<http://www.economicregulator.tas.gov.au/electricity/regulatory-framework/codes/tasmanian-electricity-code-downloads>

3.4.1.1 Lighting Protection and Surge Arrestors

The MV EG System shall have appropriate mitigation measures installed to protect their *generating system* and *plant*. The proponent shall install appropriate lightning protection and surge arrestors to prevent damage and/or failure as a result of any system disturbances, as per TasNetworks' requirements established in the relevant standards.

See Section 5.1.7 for further information.

Sr. No.	Parameter	Unit	Value					
1	Nominal system voltage (V_n)	kV	6.6	11	22	33	110	220
2	Rated voltage	kV	7.2	12	24	36	123	240
3	Power frequency withstand voltage	kV_{rms}	20	28	50	70	230	460
4	Lightning impulse withstand voltage	kV_{peak}	60	75	125	170	550	1050
5	Normal voltage variation (criteria for equipment design)	$\%V_n$	± 10					

3.4.2 Standard power system frequency

Table 2: Tasmanian frequency operating standards - interconnected system

CONDITION	CONTAINMENT	STABILISATION	RECOVERY
Accumulated time error (other than multiple contingency events)	15 seconds		
Normal	49.75 to 50.25 Hz, 49.85 to 50.15 Hz 99% of the time	49.85 to 50.15 Hz within 5 minutes	
Load and generation event	48.0 to 52.0 Hz	49.85 to 50.15 Hz within 10 minutes	
Network event	48.0 to 52.0 Hz	49.85 to 50.15 Hz within 10 minutes	
Separation event	47.0 to 55.0 Hz	48.0 to 52.0 Hz within 2 minutes	49.85 to 50.15 Hz within 10 minutes
Multiple contingency event	47.0 to 55.0 Hz	48.0 to 52.0 Hz within 2 minutes	49.85 to 50.15 Hz within 10 minutes

Table 3: Tasmanian frequency operating standards - islanded system

CONDITION	CONTAINMENT	STABILISATION	RECOVERY
Normal	49.0 to 51.0 Hz		
Load and generation event	48.0 to 52.0 Hz	49.0 to 51.0 Hz within 10 minutes	
Network event	48.0 to 52.0 Hz	49.0 to 51.0 Hz within 10 minutes	
Separation event	47.0 to 55.0 Hz	48.0 to 52.0 Hz within 2 minutes	49.0 to 51.0 Hz within 10 minutes
Multiple contingency event	47.0 to 55.0 Hz	48.0 to 52.0 Hz within 2 minutes	49.0 to 51.0 Hz within 10 minutes

Table 3 applies when an electrical island is formed within the Tasmanian power system and **should not** be interpreted as operation of the Tasmanian system operating as an island within the NEM, i.e. during periods of time when the Basslink interconnector is out of service.

4 Classification of generation

4.1 Access standards for generators exempt from registration

The National Electricity Law (**NEL**) requires a person intending to participate in the NEM as a *generator* to register with AEMO. In order to obtain approval to physically connect to the power system, *generation proponents* must follow the connection process as detailed in Chapter 5 of the NER including satisfaction of all technical requirements outlines in Schedule 5.2. In this Schedule, *access standards* for the connection of generation into a distribution or transmission network are defined.

In accordance with AEMO's "Guide to Generator Exemptions and Classification of Generating Units"[4], *generation proponents* may seek a registration exemption from AEMO. AEMO may grant an exemption when it believes that the *generating system* is not likely to have a material impact on the operation of the NEM, or on the activities of other *Market Participants*. AEMO offers standing exemptions to *generating systems* that meet the following criteria:

1. *Generating systems* that have a rated nameplate rating of less than 5 MW.
2. *Generating systems* that have a nameplate rating ≥ 5 MW, but do not have the capability to export more than 5 MW to the network.

Generating systems that have a nameplate rating ≥ 5 MW, but do not export more than 20 GWh per annum to the network, may also be granted exemption upon application.

For *generating systems* in excess of 5 MW that have sought and been granted exemption from registration, TasNetworks generally considers it appropriate to apply the *access standards* provided in Schedule 5.2.5 of the NER. Where the wording of *access standards* preclude their direct application to embedded generation, or are simply not appropriate, alternative descriptions have to be provided. As a result, variations to Schedule 5.2.5 are described in this document.

For *generating systems* that have a rated capacity of less than 5 MW, TasNetworks has defined its own technical standards which are described herein. In some cases, the *access standards* defined in NER Schedule 5.2.5 remain appropriate and continue to be referenced. Where possible, TasNetworks has sought to develop *access standards* that are aligned and compatible with existing policies published for *network users*, as well as various Australian Standards that are relevant for network connections of these types.

4.2 Generation technologies

The performance characteristics of different generation technologies vary widely. While there are a number of specific technologies now commercially available for use in embedded generation applications, they can all be broadly grouped as follows:

1. Network connected rotating synchronous machines.
2. Network connected rotating asynchronous machines.

[4] AEMO's Guide to Generator Exemptions and Classification of Generating Units can be accessed here: External Procedures Template Mar 2015 (aemo.com.au)

3. Inverter Energy Systems (**IES**).

TasNetworks will allow any of the above technologies to be connected to its distribution network noting that the performance characteristics of each demand different considerations (which may also be network dependant). TasNetworks will provide advice to *generation proponents* on the impacts of connecting a nominated generation type at the time a connection application is received and the proposed point of connection is nominated.

4.2.1 Synchronous machines

Synchronous generators are a traditional technology with well-established performance requirements. Examples of embedded generators typically using this type of machine include mini hydro applications, small frame size gas turbines (potentially producing steam or heat as a secondary output in co-gen operation), and reciprocating engine units fired on either diesel or gas.

Being a voltage source that is synchronously coupled to the power system, specific considerations for these types of machines include:

1. Provision of significant fault current with resulting network protection design and coordination requirements (to ensure safe and reliable operation of the machine and the connecting network).
2. Synchronisation requirements, including the management/modification of network controls such as auto reclose schemes.
3. Management of anti-islanding given the potential provision of both voltage and frequency control that may enable stable operation even once disconnected from the main network.

The correct specification of voltage control requirements can be particular important for synchronous machines especially at weak *connection point*s. Utilising the inherent capability of a synchronous machine to control voltage can avoid issues in the network and enable the integration of embedded generation at locations that may otherwise be prohibitive.

4.2.2 Asynchronous (induction) machines

Asynchronous generators are also a very well understood and a relatively common technology. Typical examples for embedded generator applications include use in micro and mini hydro units and wind turbines applications where input power is variable or difficult to control. The ability to operate induction generators at variable speed (slip) makes them ideal for such circumstances, reducing control requirements quite considerably in some situations.

Induction generators require an external source of excitation and always absorb reactive power at their stator terminals (with the exception of doubly fed induction generators which are typically used in larger wind turbine applications). As such, the connection of this type of *generating system* requires consideration of issues which include:

1. Power factor operating range at the *connection point* and the impact on local distribution network voltage profile. The need for local reactive support to be installed with the generator is one potential solution to this issue if not offered as standard. This arrangement is sometimes referred to as a “self-excited” induction generator.

2. Starting arrangements for the generator, i.e.: the use of direct online (**DOL**) starting as an induction motor may not be possible at weak *connection point*s due to the high inrush currents involved. “Soft starting” arrangements may require consideration if not offered as standard.
3. The response of the *generating system* to islanding situations and the possibility of self-excitation. The issue to be managed is the risk of continued operation for a period of time even once disconnected from the main network.

Depending on the size of the generating unit, the provision of transient fault currents may also be a relevant consideration. An induction generator will feed current into a fault until such time that its internal magnetic field has collapsed causing de-excitation of the machine.

While induction generators are typically lower cost and have simpler control and protection arrangements, their connection to the distribution network still requires due consideration of potential issues so that network safety and performance can be managed.

4.2.3 Inverter energy systems

Inverter Energy Systems (IES) use power electronics to convert electrical power from either direct current (**DC**), or a variable frequency alternating current (**AC**) waveform, to a 50 Hz AC supply which allows connection to the main network.

IES EG Systems may either be line commutated or self-commutated technologies. Line commutated inverter systems typically use power electronic devices such as thyristors and rely on the mains voltage signal as a reference for commutation. Self-commutated inverter systems use an internal high frequency reference signal for control of power electronics (IGBT, MOSFET etc.) typically implementing Pulse Width Modulation (**PWM**).

Static generating devices (such as PV panels), as well as rotating plant, can be connected to the grid via an inverter. For the latter, this is generally preferable for small installations because of the additional control that is possible via the inverter, especially in relation to the management of *connection point* power factor and/or voltage.

In terms of *connection point* issues to be considered, the impact on network voltage control and anti-islanding protection is as per the other generation types already mentioned. In addition, inverter connected generating systems can potentially introduce power quality issues including harmonic distortion and flicker, depending on the *generating system’s* size and inverter type being used.

5 Technical requirements

5.1 Generator performance access standards

For MV EG Systems, TasNetworks generally considers it appropriate to apply the *access standards* provided in Schedule 5.2.5 of the NER. Where the wording of access standards preclude their direct application to embedded generation, or are simply not appropriate, alternative descriptions have to be provided. As a result, variations to Schedule 5.2.5 are described in this document.

In a similar manner to that utilised within the NER, the access standards applied by TasNetworks for the connection of EG generally fall into one of three categories:

Automatic Access:	A generating system that meets such a standard would not be unreasonably denied access to the distribution network.
Negotiated Access:	A generating system that can be demonstrated to satisfy defined minimum access standards, but is unable (for whatever reason) capable of satisfying all automatic access standards, may still be granted a network connection subject to technical review and approval by TasNetworks. It should be noted that the size and type of generating system to be connected will be taken into consideration to ensure that negotiated access standards are appropriate and relevant for the connection arrangements being proposed.
Minimum Access:	Failure to meet a described minimum access standard will result in the generation proponent being refused access to the distribution network.

When considering a *negotiated access standard* under these guidelines, the proponent is expected to be as close as practicable to the *automatic access standard*. TasNetworks therefore considers that the automatic access standard is the default starting position for negotiations for connections. Where an *automatic access standard* is not possible or is not required, the proponent must adequately demonstrate why the proposed negotiated access standard is considered adequate (NER Clause **5.3A.9(f)**).

In all cases, TasNetworks will require the submission of suitable information from the generation proponent to enable technical assessments to be undertaken, including the need for any negotiated access arrangements, as well as evidence that all *minimum access standards* have been satisfied (See Section 6). Steady stage and dynamic modelling studies may also be required to be submitted by the generation proponent demonstrating compliance against the NER *access standards*.

The MV EG System (also referred to as the *generating system* where appropriate) is expected to comply with the following (reduced set) of NER generator performance access standards:

- S5.2.5.1 – Reactive Power Capability
- S5.2.5.2 – Quality of electricity generated
- S5.2.5.3 – Generating unit response to frequency disturbances
- S5.2.5.4 – Generating system response to voltage disturbances
- S5.2.5.5 – Generating system response to disturbances following contingency events
- S5.2.5.6 – Quality of electricity generated and continuous uninterrupted operation
- S5.2.5.8 – Protection of generating systems from power system disturbances
- S5.2.5.9 – Protection systems that impact on power system security
- S5.2.5.10 – Protection to trip plant for unstable operation
- S5.2.5.11 – Frequency Control
- S5.2.5.12 – Impact on network capability
- S5.2.5.13 – Voltage and reactive power control
- S5.2.5.14 – Active Power Control
- S5.2.5.15 – Short Circuit Ratio
- S5.2.5.16 – Voltage Phase Angle Shift
- S5.2.8 – Fault Current

5.1.1 Reactive power capability and power factor requirements (S5.2.5.1)

TasNetworks requires that the MV EG System have sufficient reactive capability to maintain voltage at the *connection point* within prescribed limits.

The proponent is expected to provide the reactive power capability of the MV EG System from 0% to 100% active power output over a *connection point* voltage range from 90% to 110% of nominal voltage.

For MV EG Systems that are equal to or larger than 5 MW in capacity, TasNetworks considers the *access standards* defined in S5.2.5.1 of the NER to be appropriate. The MV EG System should ideally be capable of supplying and absorbing reactive power equal to the product of the rated active power and 0.395. This should be possible across the full range of active power outputs that the MV EG System may operate at.

For MV EG Systems that are smaller than 5 MW, operation of the generator at a fixed power factor may be sufficient to maintain distribution network voltages within acceptable limits. For areas of the network where this is achievable, TasNetworks requires that the power factor at the *connection point* be maintained within the ranges provided in Table 4.

Table 4: Power Factor Operational Limits – Tasmanian Electricity Code (TEC), Table 1

Supply Voltage (kV)	Power factor range for customer maximum demand and voltage					
	Up to 100 kVA		Over 100 kVA – 2 MVA		Over 2 MVA	
	Minimum lagging	Minimum leading	Minimum lagging	Minimum leading	Minimum lagging	Minimum leading
<6.6	0.75	0.8	0.8	0.8	0.85	0.85
6.6 11 22	0.8	0.8	0.85	0.85	0.9	0.9
33 44 66	0.85	0.85	0.9	0.9	0.95	0.98

In weak areas of the network, managing *connection point* power factor as embedded generation output varies may not be sufficient to maintain acceptable distribution network voltages.

Under such circumstances, the requirement to regulate network voltages takes precedence. To meet its regulatory obligations, TasNetworks may require that the MV EG System operate at a power factor that is different to that permitted in Table 4, or alternatively, may require that the MV EG System operate in "voltage control mode" so as to provide dynamically controlled voltage support to the *connection point* and surrounding network.

The *generation proponent* must negotiate with TasNetworks to determine the minimum reactive capability of the MV EG System (that is available for use) and the control requirements necessary to support its operation at the proposed *connection point*.

5.1.2 Quality of electricity generated (S5.2.5.2)

The introduction of voltage fluctuations, harmonics or voltage unbalance into the distribution network may result in the maloperation or damage to electrical equipment operated by other *network users*.

The impact of a particular development on the quality of supply is dependent on the current drawn or supplied by the MV EG System and the system impedances at the proposed *connection point*. To ensure that the quality of supply remains consistent with TasNetworks' published planning limits[5], TasNetworks will allocate emission limits to a *generation proponent* at the time a connection application is processed.

Acceptable operation requires the MV EG System to comply with the allocated emission limits, which will always be less than the published planning limits.

To determine these values, TasNetworks requires a *generation proponent* to specify the proposed *connection point* and the rating of the MV EG System at the connection enquiry stage.

[5] Planning limits are published in TasNetworks Annual Planning Report (APR) - www.tasnetworks.com.au

5.1.2.1 Voltage fluctuations

The contribution of an MV EG System to flicker and transient voltage deviations is dependent on the magnitude of change in the current supplied/drawn, and the equivalent impedance at that point in the network.

For MV EG Systems, TasNetworks considers it appropriate to apply the *access standards* defined in S5.2.5.2 of the NER. This clause refers to emission limits (S5.1.5 of the NER) that may be calculated using AS/NZS 61000.3.7:2001 and guidelines published by Standards Australia, i.e. ENA Doc 034-2014 Guideline for Power Quality – Flicker (Recommendation for the application of joint Australian/ New Zealand Technical Report TR IEC 61000.3.7:2012).

Once a *connection application* is received, TasNetworks will determine which assessment stage (as defined in the standard) to apply based on the size of the MV EG System and the short circuit capacity at the proposed connection point.

Unless otherwise stated, TasNetworks requires any rapid voltage changes at the *connection point* to be limited to less than 3% of the nominal voltage.

5.1.2.2 Harmonic injection limits

The impact of an MV EG System on harmonic voltages in the network is dependent on the harmonic currents drawn or supplied through the *connection point* and the equivalent harmonic impedances at that point in the network.

For all MV EG System, TasNetworks considers the *access standards* defined in S5.2.5.2 of the NER to be appropriate. The schedule refers to standard limits that may be calculated using AS/NZS 61000.3.6:2001 and guidelines published by Standards Australia, i.e. ENA Doc 033-2014 Guideline for Power Quality – Harmonics (Recommendation for the application of joint Australian/ New Zealand Technical Report TR IEC 61000.3.6:2012).

Once a *connection application* is received, TasNetworks will determine which assessment stage (as defined in the standard) to apply based on the size of the MV EG System and the short circuit capacity of the proposed connection point.

5.1.2.3 Voltage unbalance

To comply with the requirements of Schedule 5.1a.7 of the NER, TasNetworks must actively manage voltage unbalance in both the distribution and transmission networks.

At distribution level voltages relevant for the connection of MV EG System, TasNetworks considers performance to be adequate if the current in any phase measured across a three phase connection point is not greater than 102 percent or less than 98 percent of the average of the currents in the three phases.

If the *generation proponent* cannot satisfy these requirements, TasNetworks considers it appropriate to determine unbalance requirements in accordance with IEC Technical Report TR IEC 61000.3.13 and the guideline published by Standards Australia (ENA Doc 037-2015 Guideline for Power Quality – Voltage Unbalance (Recommendation for the application of joint Australian/ New Zealand Technical Report TR IEC 61000.3.13:2013).

5.1.2.4 Zero sequence generation

The introduction of zero sequence currents into the MV network may have adverse effects on the balancing of phase loadings and the operation of earth fault protection. Please refer to section 5.10 for further requirements for the physical connection of three phase equipment.

5.1.3 Generating unit response to frequency disturbances (S5.2.5.3)

To prevent the cascading disconnection of embedded generation during and following a network frequency disturbance (with the resulting impacts that this would have on the broader power system), it is expected that MV EG System shall comply with the following performance requirements.

For MV EG Systems that are equal to or larger than 5 MW, TasNetworks will apply the *access standards* as defined in Schedule 5.2.5.3 of the NER.

MV EG Systems that are smaller than 5 MW in capacity shall not disconnect from the network when frequency is within the range 47.0 Hz to 52.0 Hz unless one or more anti-islanding protection schemes has determined that the generator has become electrically separated from the main network supply. Anti-islanding protection is discussed further in Section 5.2.5.9.

In all cases, TasNetworks will review and negotiate the setting of under and over frequency protection so as to ensure coordination with other network protection and control schemes.

5.1.4 Generating unit response to voltage disturbances (S5.2.5.4)

When a voltage disturbance occurs in the power system, the recovery of voltage to the normal operating range is (generally) achieved through the clearance of the network fault that has caused the initial voltage disturbance. To ensure that the power system is robust to system events, it is therefore important that generators remain connected until at least primary protection has operated to clear the fault. Schedule 5 of the NER specifies the maximum clearance time for transmission network fault events to be 120 ms.

Transmission fault events are a critical consideration given that wide areas of the network may suffer from a depressed voltage profile as a result, placing at risk significantly more embedded generating systems (as compared to a local distribution network fault event).

For MV EG Systems that are equal to or larger than 5 MW, TasNetworks will apply the *access standards* defined in Schedule 5.2.5.4 of the NER.

For MV EG Systems that are smaller than 5 MW, the *generating system* shall maintain continuous uninterrupted performance and shall not disconnect from the network within 150 ms for any voltage disturbance. After 150 ms, the *generating system* may disconnect if the voltage remains outside of the operational voltage ranges for the corresponding time periods as defined in Section 8.6.4 of the TEC (refer Section 3.4, Table 1).

The proponent may be asked to provide time domain studies demonstrating the *generating system's* ability to remain in continuous uninterrupted operation for a range of *connection point* voltages and operating conditions for which the *generating system* is expected to ride through.

5.1.5 Generating response to disturbances following contingency events (S5.2.5.5)

When a network contingency event occurs, the recovery of the system to its pre-contingency operating state is (generally) achieved through the automatic control of generators (as well as other network devices) that remain connected to the power system. To ensure that the power system is robust to system events, it is therefore important that *generating systems* perform in a predictable manner in the post contingency period. Furthermore, *generating systems* should not unreasonably withdraw their available capacity for significant periods of time given the power imbalance that is then inflicted on the remainder of the power system.

For MV EG Systems that are equal to or larger than 5 MW, TasNetworks will apply the *access standards* defined in Schedule 5.2.5.5 of the NER.

For MV EG Systems that are smaller than 5 MW, TasNetworks requires that a *generating system* be capable of supplying 95% of its pre-fault power within 500 ms of a fault being cleared by protection systems. If this requirement cannot be met, then the *generation proponent* must enter a process of negotiation with TasNetworks.

Where a MV EG System is capable of providing frequency control capability within this time frame, and does so in response to an over frequency condition, this characteristic shall take precedence over the active power recovery criteria discussed above.

All IES MV EG Systems that operate in parallel with TasNetworks *distribution network,* shall maintain their pre-fault capacitive reactive current during *network* faults.

The proponent may be asked to provide time domain studies demonstrating the *generating system's* ability to remain in continuous uninterrupted operation and fault response for a range of network faults described in Clause S5.2.5.5 of the NER - including multiple faults. The studies are expected to demonstrate performance across a range of active power generation and operating conditions (maximum and minimum reactive output) taking into consideration maximum and minimum fault level at the *connection point.*

5.1.6 Quality of electricity generated and continuous uninterrupted operation (S5.2.5.6)

Generators should recognise that certain parameters within the power system are permitted to vary from ideal under normal system operating conditions. This includes voltage magnitude, frequency, flicker levels, harmonic distortion and voltage unbalance (across phases). *Generating systems* should be robust to variations within permissible limits.

For all *generating systems*, TasNetworks requires evidence of compliance with the *minimum access standard* defined in Schedule 5.2.5.6 of the NER.

It is expected that the proponent provide confirmation that the generating system will remain in continuous uninterrupted operation for the levels specified in clauses S5.1a.5, S5.1a.6 and S5.1a.7 of the NER.

TasNetworks publishes its power quality planning limits in its Annual Planning Report which is available on its website.

5.1.7 Protection of generating systems from power system disturbances (S5.2.5.8)

To maintain network security and reliability, it is important that *generating systems* do not disconnect from the network for operating conditions that remain within their stated capability. All *generating systems* are expected to maintain continuous, uninterrupted operation except when exposed to abnormal power systems conditions that have been accepted to by TasNetworks. The *generating system* shall have sufficient systems in place that disconnect and prevent damage to the *generating system* in the event of any abnormal power system conditions.

For MV EG Systems that are equal to or larger than 5 MW, TasNetworks requires compliance with the *minimum access standard* and general requirements defined in Schedule 5.2.5.8 of the NER.

Refer to Section 5.2 for further information.

5.1.8 Protection systems that impact on power system security (S5.2.5.9)

Refer to Section 5.2 for further information.

5.1.9 Protection to trip plant for unstable operation (S5.2.5.10)

To prevent sustained, unstable behaviour of a *generating system* impacting other *network users*, suitable protection must be installed to disconnect the *generating system* when its operation becomes abnormal.

TasNetworks considers the *access standards* defined in Schedule 5.2.5.10 of the NER to be appropriate for *generating systems* of all sizes.

For synchronous machines refer also to Section 5.2.5.8.

The proponent must provide TasNetworks evidence demonstrating compliance with the performance requirements of Schedule S5.2.5.10 of the NER.

5.1.10 Frequency control (S5.2.5.11)

While AEMO is directly responsible for managing power system frequency, which it does via purchase of Frequency Control Ancillary Services (**FCAS**) from the eight spot markets which exist in the NEM, embedded *generating systems* also have a role to play.

This is especially true in a small power system such as Tasmania, where frequency control has traditionally been more challenging.

For MV EG Systems that are equal to or larger than 5 MW in capacity, TasNetworks will apply the *access standards* defined in Schedule 5.2.5.11 of the NER.

For MV EG Systems smaller than 5 MW, the expectations of TasNetworks are as follows:

1. Where practical to do so, all *generating systems* should provide frequency control capabilities and be responsive to network frequency disturbances. A speed droop characteristic equivalent to 4% (as would be defined for governor control systems installed on synchronous machines) is considered typical and adequate.

   The impact that frequency control capabilities may have on anti-islanding protection arrangements will be considered during the connection application assessment process.
2. Where normal operation of the *generating system* naturally inhibits any increase in active power output to support the system recovery from under frequency events, consideration should still be given to the control of over frequency conditions. For such circumstances, a controlled reduction in active power output proportional to frequency deviation is beneficial.
3. All *generating systems* should comply with the *minimum access standard* defined by Schedule 5.2.5.11 of the NER, taking into account the active power recovery characteristics immediately post fault as defined in Section 5.1.5 (S5.2.5.5) of this guideline.

All frequency control systems installed as part of a *generating system* should be adequately damped as defined by the NER, i.e. the controller's response to a frequency deviation should be tuned to prevent oscillatory behaviours and/or excessive overshoot that may be counterproductive to the stable recovery of system frequency.

5.1.11 Impact on network capability (S5.2.5.12)

To facilitate efficient operation of the energy market in the Tasmanian region, TasNetworks requires that inter-regional and intra-regional power transfer capabilities are not adversely affected by the connection of embedded generation into the distribution network.

For MV EG Systems equal to or larger than 5 MW, TasNetworks will apply the *access standards* defined in Schedule 5.2.5.12 of the NER. This will in most cases require a basic review of perceived risk based on the size of the *generating system* and the connection point to the network. Detailed studies would only be undertaken if deemed necessary based on the initial assessment.

For MV EG Systems smaller than 5 MW, it is considered unlikely that there will be material impacts on power transfer capabilities at the transmission system level. A cursory examination of any potential issues will be undertaken as part of the connection application

5.1.12 Voltage and reactive power control (S5.2.5.13)

To ensure that network voltages can be effectively managed, all *generating systems* comprised of synchronous machines, doubly fed induction generators or inverter interfaced energy sources should be fitted with appropriate control systems that allow voltage, reactive power and power factor at the *generating systems* terminals to be dynamically controlled.

For induction generators, the requirement for independent control of switched capacitor banks or other forms of reactive compensation will be determined as part of the connection application assessment process.

The selection of an appropriate control arrangement will be dependent on the size of the *generating system* and the proposed connection point to the distribution network. The specification of control requirements will occur in conjunction with TasNetworks.

In relation to dynamic response requirements, for MV EG Systems greater than or equal to 5 MW, TasNetworks will apply the *access standards* defined in Schedule 5.2.5.13 of the NER.

For MV EG Systems less than 5 MW, TasNetworks will apply the performance requirements stipulated in Schedules S5.2.5.13 (b)(2B), S5.2.5.13 (b)(3) and S5.2.5.13 (b)(4) of the NER as the appropriate *automatic access standard*. Schedules S5.2.5.13 (d)(2A), S5.2.5.13 (d)(2B) and S5.2.5.13 (d)(3) of the NER will be referenced as the corresponding *minimum access standard*.

The specified sections of the NER are consistent with the general expectations described above and have the intent of providing sufficient control capability such that TasNetworks can continue to manage its regulatory obligations once the *generating system* is connected to the distribution network.

5.1.13 Active power control (S5.2.5.14)

From time to time, EG Systems may be requested by TasNetworks to reduce their active power output or disconnect in response to network maintenance, testing, network overloads, safety, islanding, system security or network stability. To meet the requirements of S5.2.5.14, all MV EG System will be required to automatically reduce their active power output following receipt of such a signal. The active power output will need to be linearly reduced or in 10% steps over a five minute period.

For MV EG Systems less than 5 MW, TasNetworks will apply the performance requirements stipulated in S5.2.5.14(a)(2) of the NER as the appropriate *automatic access standard*. Schedule S5.2.5.14 (b)(2) of the NER will be referenced as the corresponding *minimum access standard* and will only be considered by TasNetworks in circumstances where appropriate communications facilities are not available.

For all *generating systems* that have the ability to export greater than or equal to 5 MW into the HV transmission network, TasNetworks will require that the *generating system* be scheduled/semi-scheduled and will apply the *access standards* defined in Schedule 5.2.5.14 of the NER.

5.1.14 Short Circuit Ratio (S5.2.5.15) and Voltage Phase Angle Shift (S5.2.5.16)

TasNetworks' expectations are that MV EG Systems less than 5 MW comprised of *asynchronous generating units* shall meet the *minimum access standards* as defined in Schedules 5.2.5.15 of the NER. TasNetworks has no requirements for voltage vector shift or similar type of protection to be installed for MV EG systems (Refer to Section 5.2.5), however it is expected the MV EG system meets the *minimum access standard* for Schedule 5.2.5.16.

NOTE: MV EG systems less than 5 MW are not considered “4.6.6 connections” as per AEMO's *System Strength Impact Assessment Guidelines.* MV EG systems with a combined nameplate rating of greater than 5 MW will subject to a *system strength impact assessment* in accordance with AEMO's *System Strength Impact Assessment Guidelines.*

5.2 Protection requirements

5.2.1 General

To ensure safe and reliable operation of the distribution network, appropriate protection must be fitted by MV EG Systems. In the design of protection schemes, consideration must be given to the requirements of the MV EG System, the network in the vicinity of the connection point, and the protection schemes that are already in place within the broader distribution network.

Communication and negotiation with TasNetworks will almost certainly be required to develop protection schemes that grade appropriately and provide adequate coverage (especially in the case of backup protection). It is important that the MV EG System's protection is able to identify and isolate all internal faults, and network faults beyond the *connection point*, as agreed with TasNetworks.

As a general requirement, MV EG System shall have sufficient protection systems that disconnect and prevent damage to the *generating system* in the event of a power system disturbance.

Although all MV EG Systems must meet certain minimum protection requirements, the level of protection required will depend on the specific nature of the MV EG System. This section aims to provide clarification on the specific protection requirements for MV EG Systems of different technologies and sizes.

In general, for MV EG System that are equal to or larger than 5 MW in capacity, TasNetworks will apply the *access standards* defined in Schedule 5.2.5.9 of the NER. For all *generating systems*, the following issues and considerations will be assessed by TasNetworks as part of the connection application process.

5.2.2 Protection system design philosophy

TasNetworks requires MV EG Systems to implement protection systems to ensure that all faults are cleared, even with the failure or maloperation of a single protection element. It is recommended that the relays utilised for main and backup protection are sourced from different manufacturers, and where reasonable to do so, utilise separate CT cores and VT windings as their input signals.

Where the proponent does not believe it practical to install duplicate protection, the design of the protection system will take place through a collaborative process with TasNetworks. TasNetworks' Approval will be required in regards to the provision of backup protection from network installed protection devices, either existing or new.

In all cases, the determination of protection zones and available protection overlap will need to be considered for forward and reverse power flow conditions to ensure that faults of all types can be identified and cleared. A specific consideration is the ability of the MV EG System to detect and respond to earth faults in an unearthed electrical island, as may occur following upstream protection and circuit breaker operations.

5.2.3 Protection operating speed

Failure to clear electrical faults in an appropriate time represents a potential safety risk to *network users* and the general public, can result in damage to equipment, and reduces the quality and reliability of power supply.

Generators should provide TasNetworks with expected protection operating times so that TasNetworks may:

1. Undertake protection coordination studies to assess what discrimination exists between overlapping protection devices. A review of proposed relay settings and expected circuit breaker operating times may be sufficient in many circumstances.
2. Confirm that protection operating times for faults within the *generating system* are consistent with existing network design philosophies.
3. Confirm that protection operating times do not result in a degradation of network reliability that would subsequently affect other *network users*.

As a general design rule, faults within the *generating system* should be cleared as quickly as possible, whereas faults remote from the *generating system* should be cleared in a manner that minimises disruption to other *network users*, i.e. occurs in a coordinated manner taking into account the operation of other network protection.

For faults external to the *generating system*, i.e. in the distribution network, installed protection devices must identify and isolate the fault from both the point of network supply as well as the *generating system* supply point. This applies to faults of any type.

To achieve discrimination between internal and external faults, it is recommended that the main incoming circuit breaker protection devices have directional protection capabilities. The *generation proponent* should consult with TasNetworks to determine the necessity for their particular installation.

Where the upstream protection device is a fast operating device such as a fuse, grading may not be appropriate or practical. In these instances, the *generation proponent* should demonstrate to TasNetworks that all practical steps have been made to grade the installed protection. TasNetworks may consider slowing the upstream protection if it believes it is necessary to prevent internal *generating system* faults from affecting other *network users*. However, if distribution protection must be slowed beyond threshold values that TasNetworks considers acceptable, it may be necessary to implement a blocking scheme to facilitate protection coordination.

5.2.4 Inverter integrated protection

Inverter integration protection shall include the following:

1. Under and over voltage protection
2. Under and over frequency protection
3. Active anti-islanding protection
4. Phase balance protection (where applicable)
5. Synchronisation facilities (where applicable)

Where applicable, inverter integrated protection requirements should preferably be as per AS/NZS 4777.2.

5.2.5 Central protection

The central protection functions that apply to each subcategory of MV EG system are listed in **Table 5** below. Further specification of each element is provided in the subsequent sections.

Table 5: Requirements for central protection for MV EG Systems

Protection Requirements	MV EG IES	MV Rotating Synchronous	MV Rotating Asynchronous
Passive anti-islanding:			
Under-voltage (27) and over-voltage (59)	✓	✓	✓
Under-frequency (81U) and over-frequency (81O)	✓	✓	✓
ROCOF (81R)	×	×	×
Vector Shift (78)	×	×	×
Overcurrent facility fault, grid fault and earth fault (50/51)	✓	✓	✓
Grid reverse power (32R) or grid low forward power (32F)	—	—	—
Synchronisation facilities (25)	×	✓	×
Generator phase balance protection (47)	—	—	—
Generator pole slip	×	✓	×
Neutral voltage displacement (59N)	—	—	—
Anti-islanding inter-trip protection	—	—	—
DC system or UPS integration protection	✓	—	—
Failsafe tripping	—	—	—
Interlocking	—	—	—
Grid isolation device	✓	✓	✓

Where the following symbols are used to denote protection requirements in **Table 5** above:

✓ Represents that the protection shall be required

— Represents that the protection may be required

× Represents that the protection shall not be required

5.2.5.1 Passive anti-islanding protection

TasNetworks requires that all MV EG Systems have the following passive anti-islanding protection:

1. Under and over voltage
2. Under and over frequency limits

TasNetworks requires that no Rate of Change of Frequency (**ROCOF**) or Vector Shift protection be enabled for the purposes of passive anti-islanding as a part of the central protection. Where required, TasNetworks will also require the EG System to implement a communications-based Anti-islanding inter-trip protection.

The protection settings for the passive anti-islanding protection must take into consideration the performance requirements for voltage and frequency as specified in Sections 5.1.3 and 5.1.4. The default recommended passive anti-islanding protection settings are shown in **Table 6** and **Table 8** below. TasNetworks reserves the right to apply variations to the values below following an assessment of each individual EG System.

Table 6: TasNetworks' default Passive Anti-Islanding Protection Settings for IES

Passive Anti-Islanding Protection Setting	Value	Delay (Seconds)
Over Voltage (V>)	115%	10
Over Voltage (V>>)	120%	-
Under Voltage (V<)	80%	5
Under Voltage (V<<)	30%	1.0
Over Frequency (F>)	53 Hz	-
Under Frequency (F<)	45 Hz	1.0

Table 7: TasNetworks' default Passive Anti-Islanding Protection Settings for rotating machines (synchronous and asynchronous)

Passive Anti-Islanding Protection Setting	Value	Delay (Seconds)
Over Voltage (V>)	115%	3.0
Over Voltage (V>>)	130%	0.1
Under Voltage (V<)	90%	20.0
Under Voltage (V<<)	75%	1.0
Over Frequency (F>)	52 Hz	0.1
Under Frequency (F<)	47 Hz	1.0

5.2.5.2 Protection of grid from faults within the generating system

TasNetworks requires that any fault internal to the embedded *generating system* is identified and isolated from the distribution network as fast as is practical. This is to ensure that distribution protection does not operate unnecessarily, resulting in loss of supply to other *network users*. To detect internal faults, any reliable techniques may be used. These may include, but are not limited to:

1. Differential protection
2. Overcurrent protection
3. Earth fault protection (including sensitive earth fault (**SEF**))

MV EG Systems must attempt to grade the *generating system* protection with upstream protection with a clearance margin of 250 ms.

The generator must be capable of identifying and clearing high impedance phase to ground faults, internal to the *generating system*. Where the generator is connected to the network through a step-up transformer, protection of the generator side windings may be achieved through conventional earth fault protection methods and technologies. Discussion on protection of the network side of the transformer (or if the generator is connected directly to the distribution network) is discussed further below.

5.2.5.3 Detection of faults external to the generating system

For synchronous and asynchronous rotating generators, the exact settings will be determined by negotiation with TasNetworks.

IES no requirements.

5.2.5.4 Grid reverse power or grid low forward power protection

Where rotating machines lose their supply of mechanical power, they will naturally transition into motoring mode and begin drawing active power from the network. It is recommended that rotating machines be installed with reverse power flow protection to disconnect under such conditions.

For all non-exporting MV EG Systems, directional flow protection at the point of connection to trip non-exporting machines if they begin to export shall be required to be installed.

5.2.5.5 Synchronisation facilities

The following automatic synchronising and synchronisation check requirements shall be required where it is intended that operation of any EG unit will occur:

1. MV EG IES connections shall comprise inverters with internal synchronisation facilities
2. MV EG rotating synchronous generators shall implement a synchronism check at the generator circuit breaker.
3. MV EG rotating asynchronous generators do not require synchronization facilities.

5.2.5.6 Generator phase balance protection

TasNetworks has no requirements for the implementation of current or voltage unbalance protection.

The proponent must ensure that its *generating system* is capable of meeting the generator *performance standards* outlined in Section 5.1.2.3. It is assumed that all MV EG Systems will be three phase connections.

5.2.5.7 Neutral voltage displacement

Where a direct inter-trip scheme is not implemented or its reliability cannot be guaranteed, the protection design must consider a mechanism to trip the generator for earth faults on the MV distribution network. Neutral voltage displacement protection is the recommended method to trip the generator in this scenario.

5.2.5.8 Pole Slip Protection

Pole slip protection shall be required to be installed for synchronous MV EG Systems to disconnect the generating system upon detection of a loss of synchronism.

5.2.5.9 Anti-islanding Inter-trip protection

Electrical islanding (in the distribution network) is the process where a sub-section of the network is disconnected from other sources of generation (through fault or other network switching events), but remains energised via embedded *generating system(s)* connected in the local area.

Two fundamental conditions must exist if a viable electrical island is to form:

1. The embedded *generating system(s)* can continue to operate as a voltage source without the normal network supply being present.
2. The load and generation in the islanded section of the network can achieve equilibrium such that load demand is balanced by generation capability.

Please refer to TasNetworks' Embedded Generation Anti-Islanding Standard (see Section 3.1) for anti-islanding protection requirements.

5.2.5.10 DC system or UPS integration protection

The EG System shall be automatically disconnected where a failure in the DC system supply or Uninterruptible Power Supply (**UPS**) supply to the central protection and control systems is detected. Where there is a failure in the DC system supply or UPS supply to the High Voltage (**HV**) incomer relay protection, an alarm shall automatically be issued and the EG system should not be disconnected.

5.2.5.11 Failsafe tripping

Failsafe tripping may be determined to be required depending on the outcomes of a site-specific assessment by TasNetworks.

5.2.5.12 EG system grid isolation device

TasNetworks requires a circuit breaker to be installed as close as practical to the *connection point* of the MV EG System. The grid isolation device may therefore be required to disconnect not only the generator, but also any additional primary equipment that may form part of the *generating system*, e.g. a step-up transformer.

The EG System grid isolation device shall be owned by the proponent.

TasNetworks will install its own network isolation device (See Section 5.9) upstream of the *connection point* for operational purposes. TasNetworks' network isolation device shall not be used to provide any central protection capability or services for the MV EG System. A separate disconnect device for the purposes of anti-islanding inter-tripping may be installed by TasNetworks.

5.2.6 Generator connection and disconnection

The connection and disconnection process for MV EG Systems should be performed, as far as practicable, in a way that minimises the impact on other *network users*. The exact requirements for connection and disconnection of a MV EG System to the distribution network will depend on the machine type and size.

For example, a large synchronous machine connected to a weak part of the distribution network may be required to reduce power output below a specified value prior to normal disconnection from the network.

The requirements for the connection of induction generators to the distribution network shall be determined after the impact of the *generating system* on power quality has been considered. As previously mentioned, the initial starting of induction generators direct-online (**DOL**) may not be allowed due to the impact on other *network users*.

5.2.7 Automatic reclose

TasNetworks utilises reclosers as network protection devices to identify and clear transient faults and to prevent the unnecessary operation of permanent protection devices such as fuses. Reclosers will typically attempt three auto close sequences before locking out. In combination with anti-islanding protection, reclosers and distribution feeder circuit breakers will be required to be configured with live-load-blocking to prevent out-of-sync closing onto downstream network elements that may have remained energised from an alternate source. The cost of reconfiguring any upstream reclosers will be borne by the MV EG System proponent.

Embedded generating systems shall only reconnect to the network when the network has been re-energised and has remained within the normal operational voltage and frequency limits for a period of at least five minutes and is approved to do by TasNetworks Operations as per the agreed Joint Operating Procedure (**JOP**). This is to ensure that any reclose event has been successful and to maximise the probability that the embedded *generating system* will maintain operational after reconnecting to the network.

5.3 Fault level requirements (S5.2.8)

Unless otherwise agreed in writing between the *generation proponent* and TasNetworks, the *generation proponent* must design its *generating system* so that it does not cause fault levels in the distribution system to exceed the values specified in **Table 8**. In some areas of the network TasNetworks may require the fault level to be restricted to values below those specified in **Table 8**. TasNetworks will advise the *generation proponent* of any requirements to limit and/or manage fault level contribution coming from the proposed *generating system*, at the time of connection application.

Table 8: Maximum allowable network fault level contribution from the transmission to the distribution system at specified voltages.

Voltage level kV	System fault level MVA	Short circuit level kA
66	1500	13.1
44	1000	13.1
33	750	13.1
22	500	13.1
11	250	13.1
6.6	150	13.1
0.400	36	50.0

5.4 Inverter Energy Systems

The following requirements shall apply to IES MV EG Systems

1. IES EG units connected to MV networks shall comprise of inverters that are:
    a. If used in solar PV systems: type tested and certified as being compliant with an accreditation number or certificate of suitability as evidence of compliance to IEC 62116 for anti-islanding protection
    b. Preferably tested by an authorised testing laboratory and certified as being compliant, with an accreditation number or certificate of suitability as evidence of compliance to AS/NZS 4777.2
    c. Preferably be registered with CEC as approved grid connect inverters
    d. Preferably installed in compliance to AS/NZS 4777.1 (where applicable)
2. IES EG units shall comprise of inverters that have the following inverter power quality response modes available:
    a. Reactive power control mode
    b. Central control mode via a master/slave system (i.e Power Park Controller (**PPC**) or Virtual Plant Controller)

   c. Volt response mode (i.e volt-var and volt-watt)
   d. Fixed power factor or reactive power mode
   e. Power rate limit (i.e ramp rate control)
3. The IES EG system may be required to coordinate the active and reactive power of all inverters through the use of a central PPC. This requirement will be determined during the connection application assessment.

5.5 Monitoring and control requirements

5.5.1 Communications systems

TasNetworks’ preferred communications medium is point-to-point fibre optic for all protection, control and remote monitoring. Where the implementation of fibre is excessively expensive or impractical, it may be appropriate for another communications medium to be used.

Protection schemes that rely on communication links must provide continuous monitoring (of the communication link integrity) and trip the *generating system* in the event of a communications failure.

The communication protocol for remote monitoring will be of a suitable format to allow integration with TasNetworks’ existing SCADA system which is based on DNP 3.0.

5.5.2 Power quality monitoring

A power quality meter may be required to be installed at the *connection point* for some *generating systems* at the proponents cost. This will be determined following the submission of a *connection application.*

5.5.3 Local monitoring and control

Local monitoring and control of the *generating system* is the responsibility of the *generator*.

As outlined in Section 5.9, TasNetworks will install an isolation device on the distribution network that is capable of disconnecting the *generating system* during periods of planned maintenance (on the network), or for abnormal network configurations that may follow faults or emergencies (bush fires, storm events, road accidents etc.). This device may be operated locally or remotely and will not be accessible by the *generator*.

5.5.4 Remote control

With the exception of remote inter-trip functions, TasNetworks will not have direct remote control of any *generating system* functions. The MV EG System will be responsible for following the operational directives (such as active power limit or voltage set point) as communicated from time to time from TasNetworks Control Centre (See also Section 5.1.13).

TasNetworks will work with the proponent to enable this functionality as required.

5.6 Data and information

5.6.1 Static data and information

The static data and information that is required to be provided by the proponent to TasNetworks is as per Appendix D: Static Data and Information.

5.6.2 Dynamic data and information

TasNetworks shall require that the following information be provided via a communication interface for all MV EG Systems greater than 200 kW:

1. Generator and mains incomer circuit breaker status.
2. Analogue measurement of generator real and reactive power output with a measurement accuracy of at least ±2%.
3. Analogue measurement of generator and connection point line-to-line voltage with a measurement accuracy of at least ±0.5%.
4. Analogue measurement of current (amps) on each of the three phases at the connection point. Measurement must be fundamental RMS with an accuracy of ±1%.

The above information shall be provided to TasNetworks at a maximum rate of once every 4 seconds. Power data should have a resolution of 0.1 MW or 0.1% of the generator capacity, whichever is lower, voltage data should have a resolution of 0.1 kV and current data should have a resolution of 1 A. Other performance requirements may be acceptable by negotiation with TasNetworks.

TasNetworks may forgo part of the requirements of this section for the MV EG System to provide some of the information outlined should it be available through TasNetworks' Network Isolation device as per Section 5.9.

5.6.3 Communications availability

The accumulative period of critical outage time must not exceed 24 hours in any 12 month period. It is TasNetworks preference that a highly reliable communications bearer is provided to meet this requirement.

The cost of establishing and maintaining a communications bearer to the Network Isolation device, and/or generator facility, is the responsibility of the proponent. The feasibility of communications to the proposed site can be studied, and dependant on location, a highly reliable communications bearer can be established by the TasNetworks Telecommunication's team.

If the proponent opts to utilise a third party communications barer, TasNetworks recommends that the proponent commission a study to gain confidence that the level of reliability achieved through their proposed telecommunication provider meets the required service level.

5.7 Metering requirements

TasNetworks no longer offers metering services for distribution connections. Refer to your Metering Coordinator for specific metering requirements.

For general metering requirements and NEM specific requirements, please refer to Chapter 7 of the NER.

5.8 Labelling and signage

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

5.9 TasNetworks' network isolation device

For MV EG Systems, TasNetworks will install an isolation device upstream of the *connection point* to allow the *generating system* to be separated from the shared network without need to enter the *generator's* premises. This device may be operated locally and will not be accessible to the *generator*. The device may be operated to disconnect the *generating system* during periods of planned maintenance (on the network), or for abnormal network configurations that may follow faults or emergencies (bush fires, storm events, road accidents etc.).

For all EG Systems, the *generator* shall also provide an isolation device capable of being locked in the 'open' position. The device must be made accessible by TasNetworks upon request.

5.9.1 Live line work and operational switching

Some work performed by TasNetworks on its electrical assets is conducted under live-line operating conditions, which for safety reasons, requires the configuration of specific protection settings in certain network devices, e.g. sensitive earth fault protection. TasNetworks may also at times perform temporary switching operations during planned work resulting in the connection of the generating system to a non-approved distribution feeder.

TasNetworks requires the *generating unit* to be disconnected during such works.

5.10 Earthing

Earth faults in the distribution system result in earth potential rise and present a health and safety hazard for generator and distribution network employees, as well as members of the general public. To ensure that step and touch potentials are maintained within acceptable levels, the earthing system installed as part of a *generating system* development shall be compliant with the relevant standards.

For MV EG Systems earthing shall be independent of the distribution system earthing and be compliant with AS 2067-2008.

TasNetworks requires that *generating system* provide no path for zero sequence currents, and therefore not contribute to an increase in the earth fault level at any point in the distribution network. TasNetworks acknowledges that under some specific circumstances, this requirement may not be achievable. In such cases, the *generation proponent* should negotiate with TasNetworks to determine an acceptable earthing arrangement.

Where a *generating system* can be operated within an electrical island separated from the distribution network, the *generating system* must be installed with an earthing system that can provide adequate earthing independent of that normally provided by the distribution network. An example is an embedded generator that may operate in parallel with the distribution network under normal circumstances, but is capable of maintaining supply to a local load in the case of a separation event.

5.11 Voice and telecommunication systems

A secure operational voice communication system will be required between TasNetworks' *control centre* and the EG System. Timeframes for a response to a directive by TasNetworks Operations will be specified in the agreed JOP. The proponent must provide TasNetworks the name and contact information for at least one person who is responsible for the operation of its *generating unit(s).* It is expected that the contact will be available 24/7.

5.12 Cybersecurity

The Proponent must take reasonable steps, which are in accordance with *good electricity industry practice*, to prevent *cyber security incidents* from affecting the EG System to the extent that such incidents could affect or reasonably be expected to affect TasNetworks' systems.

6 Technical studies

6.1 General Requirements

As a part of its *connection application*, the Proponent shall describe the expected performance of the EG System within the technical requirements specified within Section 5 of this document. The proponent is expected to engage a suitably qualified engineer to undertake these studies on their behalf and present the results to TasNetworks for review as a formal report. Suitable documentary and/or modelling evidence demonstrating the EG Systems compliance with the technical performance requirements specified within Section 5 of this document shall be provided in the report in support of the *connection application*. Any evidence submitted in the formal report must clearly demonstrate how the *generating system* meets the relevant technical performance requirements.

All technical performance standards specified in Section 5 of this document shall be addressed in the formal report. When submitting its proposed performance against these requirements, the proponent is expected to be as close as practicable to the *automatic access standard.*

6.2 Power system modelling requirements

TasNetworks may require the proponent to undertake some steady state modelling as part of their connection application. TasNetworks MV steady state models are in PSS Sincal™.

Depending on the size, type and location of the proposed MV EG System*,* TasNetworks may also require the proponent to provide site-specific dynamic models of the *generating system* for the purposes of demonstrating technical compliance and undertaking a due diligence assessment. If required, the dynamic models provided by the proponent must comply with AEMO's *Power System Model Guidelines*.

The following dynamic models and accompanying model user documentation (Releasable User Guides) are expected to be developed and provided to TasNetworks by the proponent if requested:

- PSS/E™ for the purposes of RMS modelling and validation EG System performance standards[6]
- PSCAD™/EMDTC™ for some IES EG Systems

TasNetworks expects that the PSS/E and PSCAD models will deliver the same performance when exposed to identical disturbances from the same AC system. Clearly, equivalent model performance cannot be validated by applying imbalanced faults. However, TasNetworks expects several validation cases to be made that demonstrate very close performance for equivalent 3-phase faults and voltage step responses, when the AC system model has equal MVA fault levels at the *connection point* and equal AC system inertias.

[6] TasNetworks is unable to accept .dll only files in PSS/e and will require .obj files to be provided in accordance with AEMO's latest *Power System Model Requirements.*

The proponent may be also required to provide a PowerFactory frequency domain model of their *generating system* for the purposes of undertaking a harmonic emission assessment due diligence assessment.

6.2.1 Steady state analysis

The steady state modelling studies that are expected to be undertaken and provided by the proponent as part of the *connection application* are as follows:

- Protection study and settings report
- Harmonics, flicker and unbalance compliance assessment of the EG System
- Impact on network Fault Level due to the connection of the EG System
- Voltage analysis studies
    - Voltage rise due to steady state operation
    - Voltage change due to intermittent generation
    - Voltage change due to plant tripping
- Earthing study

TasNetworks will provide the proponent with modelling input information as required such as source impedances to undertake these steady state studies. TasNetworks will also undertake some basic steady state studies in PSS Sincal™ as part of its enquiry response to determine the suitability of the connecting network to host the EG System.

6.2.2 RMS dynamic studies

The proponent may be required to undertake appropriate dynamic studies (RMS) of their proposed *generating system* as part of their connection application studies demonstrating compliance against the relevant generator performance standards defined Section 5. The studies will include the following where appropriate:

- Transient/step frequency disturbance
- Transient/step voltage fluctuation*
- Fault ride through response*
- Generator stability*
- Generator governor/active power control
- Generator excitation control
- Frequency and voltage control response

The proponent is expected to undertake these dynamic studies taking into consideration the following:

- Maximum and minimum fault level*
- Maximum and minimum system loads
- Nearby *generating systems*

NOTE: Points marked with “*” may also be required to be undertaken within EMT studies for IES EG systems as described below.

6.2.3 EMT modelling requirements

For IES EG systems greater than 1.5 MW, the proponent will be required to provide an EMT PSCAD™/EMDTC™ model of the *generating system* as part of the *connection application* unless specifically exempted by TasNetworks in writing. For proposed EG systems less than 1.5 MW proposing to connect to weak parts of the distribution system, TasNetworks reserves the right to request EMT modelling information.

The proponent shall provide EMT studies against a Single Machine Infinite Bus (**SMIB**) model for studies marked with a “*” above in Section 6.2.2. The Proponent is not expected to undertake any wide area dynamic studies using EMT models outside of that specified in Section 6.2.2 for the purposes of RMS/EMT model benchmarking.

TasNetworks will provide the proponent with further information regarding EMT modelling following receipt of a connection enquiry for the EG System.

7 Fees and charges

Fees and charges applicable to the installation of your generating unit(s) may include:

Application to connect fee:

We may request an application fee from you to investigate:

- connection arrangements at your site - preliminary connection design (which includes as applicable the connection line, substation, provision of any engineering reports, protection, and communications);
- studies of our network to determine if any network construction is required (which may include an any impacts on our transmission network);
- liaising with AEMO to ensure there are no power system impacts; and
- preparation of our offer to connect and connection contract.

Customer contribution

This is a 'once off' cost to cover all reasonable costs incurred by us in undertaking the scope of works as identified within the negotiated offer to connect your generating unit to the distribution network and includes:

- the provision, installation and commissioning of your generating units dedicated connection assets such as transformers; and
- any network extension assets; and
- any network augmentation required to facilitate your generating unit's connection such as reinforcement of the existing network, including any protection; and
- any design, project management and implementation costs incurred to facilitate the connection of your generating unit.

This charge will be calculated in accordance with our Distribution Connection Pricing Policy available on our website.

Avoided TUoS

You may be eligible for payments for avoided Transmission Use of System usage charges (avoided TUoS). Clause 5.5(h) of the NER requires us to pass through to you any avoided charges for the locational component of prescribed transmission use of system services charges arising from your connection. Avoided TUoS is calculated and passed through retrospectively based on actual historic performance of your generation and the application of the published transmission cost allocation methodology and pricing methodology as approved by the Australian Energy Regulator.

TasNetworks does not guarantee that the connection of your generating unit(s) will necessitate the payment of avoided TUoS. Avoided TUoS payments will be confirmed, or otherwise, as part of the negotiations surrounding your connection.

Connection service and management fee (where applicable)

This is an annual fee to cover all reasonable costs incurred by us in undertaking the following:

- routine maintenance and repairs of your connection assets including substation equipment specifically installed for your access to the distribution network (i.e. circuit breaker/recloser, protection equipment including inter-trip/radio communications equipment/telemetry interface relays/ SCADA RTU interface);
- maintenance planning / coordination with you;
- compliance monitoring of any interface protection in accordance with applicable regulations; and

connection contract management including periodic review of the contract to cover changes in industry practice in compliance with the NER and the TEC. Any costs applicable here will be detailed within your connection agreement.

8 Testing and commissioning

The proponent shall provide TasNetworks no less than one months' notice prior to the commencement of energisation, commissioning and testing of the EG system.

TasNetworks will require at least two weeks to review documentation that verifies that the EG system is suitable for connection to our network. Documentation may include;

- Earthing design / performance report
- Protection co-ordination report
- Installation and protection test reports
- Certificate of compliance from your certifying engineer

The proponent shall also provide certification from the relevant regulatory authority that the EG system has been certified as electrically compliant and is safe for energisation. TasNetworks will not energise any connection until the proponent has demonstrated that it is safe to do so.

TasNetworks requires that the proponent demonstrate that the connection is safe to energise by obtaining the required signatures on the Asset Acceptance and Permission to Synchronise Certificate in Appendix F.

The connection process is completed once the required signatures for all fields of the Commissioning Certificate in Appendix G are obtained.

8.1 General requirements

Testing and commissioning shall only commence after the installation of metering, communications and distribution connection equipment required to facilitate the connection of the EG system.

The proponent shall prepare and provide to TasNetworks an appropriate testing and commissioning plan for the EG System. The testing and commissioning plan must be prepared by a suitably qualified engineer and is to be provided no less than one month prior to the commencement of testing and commissioning. Test plan submitted by the proponent must be agreed upon by TasNetworks prior to the commencement of testing and commissioning.

The test and commissioning plan shall include the following:

- The contact number(s) and details (including appropriate qualifications) of the person(s) responsible for undertaking the testing and commissioning
- Confirmation that the single line diagram reflects the installed system
- Confirmation that the EG system and its components are as per specification and have been certified as electrically compliant and safe to energise
- Description of the shutdown procedures for the EG system
- Outline of the communication settings and performance

- Confirmation of the export limit and settings (only for exporting or partially exporting EG systems)
- Confirmation that the power quality settings, control system settings, protection settings, performance and observations are as per TasNetworks' requirements
- Test procedures for validation of protection settings, performance and compliance against relevant standards (e.g anti-islanding, synchronising, tamper-proofing, control system settings, control system firmware and failsafe operation)
- Testing of the earthing connection settings and compliance to AS 2067 and relevant jurisdictional requirements
- Testing of power quality performance as per TasNetworks' requirements including the details of temporary or permanent measurement equipment
- Testing of any site specific requirements relevant for the EG system

8.2 Testing and commissioning for IES EG systems

Testing and commissioning procedures for IES EG Systems should consider the following:

- Preferably meeting the requirements as per AS/NZ 4777.1 Section 7 (where applicable), AS/NZS 3000 (where applicable) and AS/NZS 5033 (where applicable)
- Compliance with the equipment manufacturer's specifications and TasNetworks' technical requirements to demonstrate that the IES EG System meets the requirements of the connection agreement.

8.3 Non-compliance

Should any non-compliance be identified prior to energisation or during final commissioning, the EG system will not be permitted to reconnect until the proponent prepares a rectification plan and provides evidence of corrective actions and/or demonstrates compliance. Depending on the severity of non-compliance TasNetworks may witness the testing at the proponent's expense prior to allowing connection.

9 Operations and maintenance

The following details will be formalised into a document called the JOP. Where there is a conflict between the details of this section and the JOP of a generator, the agreed JOP will take precedence.

The proponent shall provide to TasNetworks the name and contact number of at least one person who is responsible for the maintenance and operation of the MV EG system. TasNetworks' expectation is that this number will be contactable 24/7 (See Section 5.11).

The MV EG system shall be operated and maintained to ensure compliance with the *connection agreement* and all legislation, codes and/or other regulatory instruments at all times. The proponent shall ensure that it documents and undertakes adequate procedures and programs to ensure compliance with the *connection agreement*. It is the responsibility of the proponent to ensure that it implements adequate operations and maintenance plans in accordance with the *connection agreement* and to maintain the electrical installation in a safe condition. All costs associated with the operations and maintenance of the EG system are to be borne by the proponent.

The proponent shall notify TasNetworks of any scheduled and unscheduled primary plant, protection or communication outages or failures.

The proponent must not increase the agreed export capability of the *generating system* or alter the *generating system* in a manner that contravenes the *Connection Agreement* without prior written consent from TasNetworks.

Upon receipt of a written request, TasNetworks will advise the proponent if it is necessary to undertake any new network analysis and produce an engineering report (at the cost of the proponent) in order to ascertain any operational constraints of the *generating system* with the proposed changes.

TasNetworks may require to isolate the *generating system* (EG System) from time to time for distribution system maintenance and testing. TasNetworks will endeavour to coordinate scheduling of planned outages with the proponent were practical to reduce outage periods and operational impacts.

Upon disconnection from the *distribution network,* the proponent must contact TasNetworks' *control centre* prior to reconnection onto the *distribution network.*

Non-complying EG systems shall be curtailed or disconnected, and not be permitted to reconnect until the proponent prepares a rectification plan and provides evidence of corrective actions and/or demonstrates compliance. TasNetworks is not liable for any losses incurred by the proponent for actions in response to non-compliance.

Appendix A – Deviations from the National DER Connection Guidelines

Section	Description of deviation	Type of deviation	Justification
3.1 TasNetworks' Standards	Additional Section included	Jurisdictional requirement	Included new section that provides information on TasNetworks' standards for connections to our LV and MV network
3.4 Operating Limits	Additional Section included	Jurisdictional requirement	Included new section to enable alignment with the Tasmanian Electricity Code and Tasmanian Frequency Operating Standard
4 Classification of Generation	Additional section included	Promote improved benefits to Australia's electricity system	Provided a high level description on the types of technology that may seek to connect to our network
5 Technical Requirements	Structural Change	Jurisdictional requirement	Structure has been changed to align with TasNetworks' established technical requirements for DER
6 Technical Studies	Additional section included	Administrative	"Technical Studies" has been included as its own section in the guidelines to better align with TasNetworks' requirements.
Appendix E, F & G	Additional sections included	Administrative	TasNetworks' Connection Application checklist, Asset Acceptance and Commissioning Certificates included to align with TasNetworks' requirements.

Appendix B – Connection arrangement requirements

Sample single line diagrams are provided below.

TasNetworks' preferred connection arrangement including TasNetworks' network isolation device for an MV EG System that cannot sustain a viable island is shown in Figure 1, and for an MV EG System that requires anti-islanding inter-trip protection is shown in **Figure 2**. These diagrams are provided for general reference only. The specific earthing, switchgear and protection arrangements will be determined by the type of *generating system* to be connected. TasNetworks will require the installation of its own network isolation device for all MV EG Systems.

Figure 1: TasNetworks preferred connection arrangement for MV EG Systems with no viable island

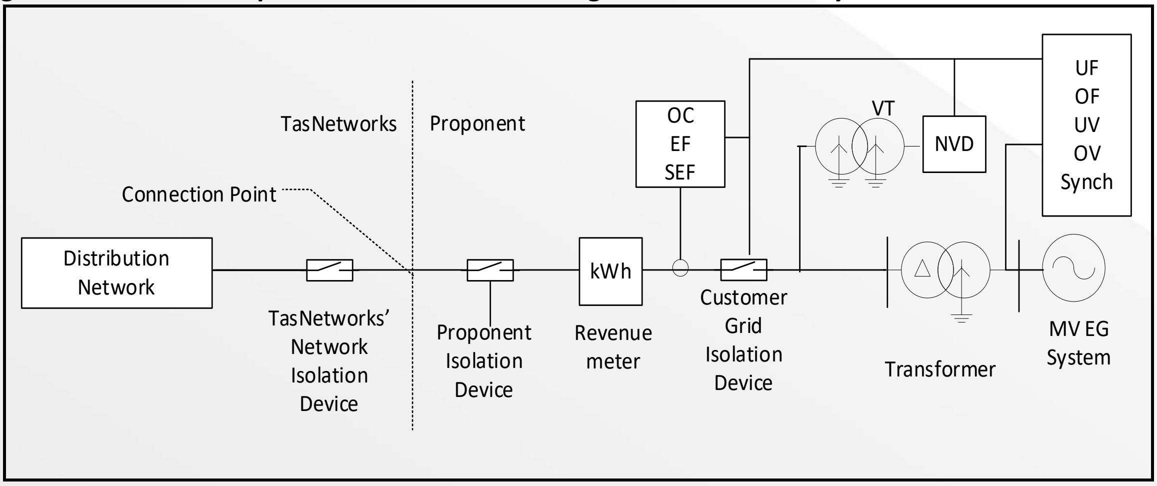
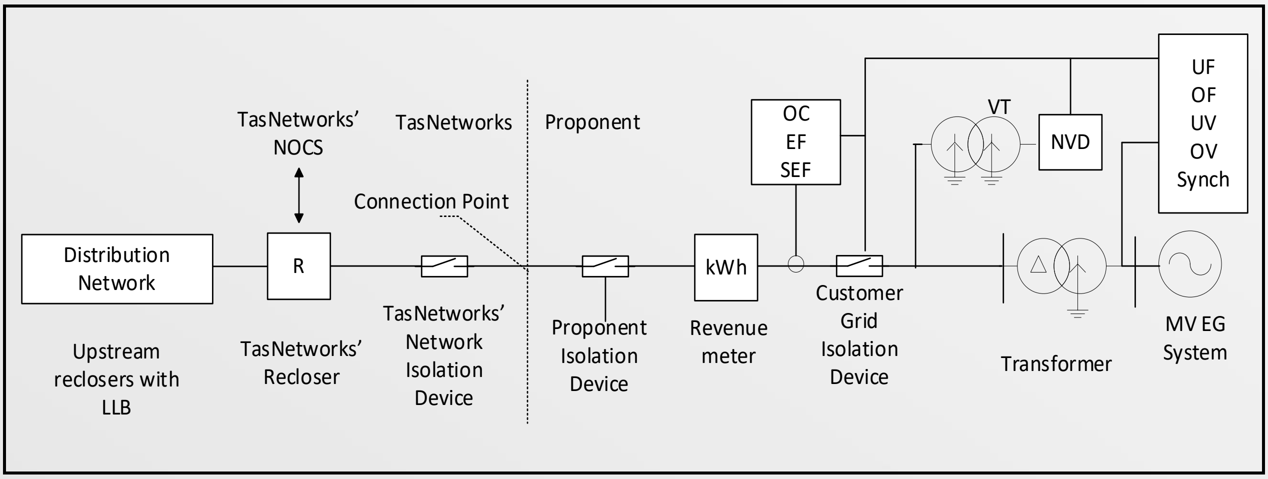


Figure 2: Example of TasNetworks communications based anti-islanding inter-trip protection scheme.



Appendix C – Model connection agreement

TasNetworks' Electricity Connection Contract - Standard Terms & Conditions can be found on our website on our Contracts and policies page.

Appendix D – Static data and information

1) DER Installation at a NMI in aggregate:
    a) NMI
    b) Approved capacity
    c) Installer identification
    d) Connection agreement 'Job number' (provided by DNSP)
    e) Number of phases available
    f) Number of phases with DER installed
    g) Central protection and control
    h) Islandable installation
    i) Protection and control modes
2) AC grid connection of a DER installation:
    a) Number of AC connections
    b) AC equipment type
    c) Inverter/small generating unit manufacturer
    d) Inverter series
    e) Inverter model number
    f) Inverter serial number
    g) Commissioning date
    h) Status of inverter (active, inactive or decommissioned)
    i) Inverter device capacity (kVA)
    j) What standards apply to the inverter
    k) Sustained overvoltage (V)
    l) Over-frequency (Hz)
    m) Under-frequency (Hz)
    n) Inverter – demand response enabled device interaction
    o) Inverter power quality response mode – volt-watt (where enabled)
    p) Inverter power quality response mode – volt-var (where enabled)
    q) Inverter power quality response mode – reactive power mode (where enabled)
    r) Inverter power quality response mode – fixed power factor mode (where enabled)
    s) Inverter power quality response mode – power factor curve/power response mode(where enabled)

- t) Inverter power quality response mode – power rate limit mode (where enabled)
- u) Non-inverter generator – voltage/reactive power regulation
- v) Non-inverter generator ramp rate (where enabled)
- w) Non-inverter generator frequency response mode (where enabled)
- x) Protection and control modes (i.e. ROCOF, vector shift, inter-trip, neutral voltage displacement)
- y) Station services for DER installation (kW)

3) DER energy sources:
   - a) Number of devices
   - b) Manufacturer
   - c) Model number
   - d) Status
   - e) Device type
   - f) Nominal rated capacity (kVA)
   - g) Nominal storage capacity (kVAh).

Appendix E – Generator Connection Application Checklist

The following information is expected to be provided to TasNetworks as part of the Connection Application Package.

Items marked (*) may not be available at the time of submission, however TasNetworks expects to see information within the Connection Application Package outlining how these requirements will be met, e.g. relevant test plans etc.

TasNetworks recommends that *Applicants* submit complete and final design information in their application package wherever possible, however preliminary design information may be accepted by TasNetworks if necessary, at the Applicant's risk. Any assessment or determination made by TasNetworks on the basis of preliminary information is subject to change should the final design or as-constructed *plant* materially change from the original submission. Any preliminary design information must be updated with final design information no later than three months prior to commissioning.

- Connections Study report demonstrating compliance against **5.3 or 5.3A** (where applicable) of the *Rules* and these guidelines including supporting modelling information as discussed in Section 6.
- Single-line diagram with the protection details and asset boundary shown;
- General arrangement locating all the equipment on the site;
- General arrangement for each new or altered *substation* showing all exits and the position of all electrical equipment;
- Specific operational arrangements;
- Information detailing the *protection systems* of the equipment;
- Proposed methods of earthing cables and other equipment to comply with Tasmanian regulations;
- Type test certificates for all new switchgear and *transformers*, including measurement *transformers* to be used for metering purposes in accordance with Chapter 7 of the *Rules*;
- Earthing details;
- *Metering system* design details for any metering equipment being provided by the *Network User*;
- Procedure for the commissioning of the MV EG system;
- *Plant* and earth grid test certificates from approved test authorities*;
- Secondary injection and trip test certificate on all circuit breakers*;
- Certification that all new equipment has been inspected before being *connected* to the *supply**.

Appendix F – Asset Acceptance and Permission to Synchronise Certificate

Project Title			
Customer		Customer Contact	
Customer Phone #		Customer Email	
Connection Date			
Summary of Work performed/Assets being connected to TasNetworks' Network			

CERTIFICATION		(Please tick appropriate boxes)	
1	All offline commissioning tests have been completed and results confirmed to be satisfactory.	Customer Engineer Network Performance (TasNetworks)	☐ ☐
2	CBOS have signed off that the new installation is safe for energisation.	Customer Engineer	☐
3	TasNetworks Distribution Control Room are prepared for the customer plant to be energised for the first time.	Network Operations	☐
4	The equipment complies with appropriate performance standards and connection agreement requirements. Identified defects and /or interim operating limits are documented and have been accepted by TasNetworks along with agreed timeframe for rectification.	Customer Engineer Asset Engineering (TasNetworks)	☐ ☐
5	To the best of the connecting customer's knowledge the equipment is ready for safe connection to the Network.	Customer Engineer	☐

List any limitations to the Equipment

List variances from Performance Standards or Connection Agreement			
Customer	**Name**	**Sign**	**Date**
Engineer			
Project Manager			
TasNetworks	**Name**	**Sign**	**Date**
Network Performance			
Asset Engineering			
Network Operations			

Appendix G – Commissioning Certificate

Project Title				
Customer		Customer Contact		
Customer Phone #		Customer Email		
Connection Date				
Summary of Work performed/Assets being connected to TasNetworks Network				
CERTIFICATION			(Please tick appropriate boxes)	
1	All online commissioning tests have been completed and results confirmed to be satisfactory		Customer Engineer	☐
2	Commissioning test results have been reviewed and accepted by TasNetworks		Network Performance (TasNetworks)	☐
3	The equipment complies with appropriate performance standards and connection agreement requirements. Identified defects and /or interim operating limits are documented and have been accepted by TasNetworks along with agreed timeframe for rectification		Customer Engineer Network Performance (TasNetworks)	☐ ☐
4	All protection and/or auxiliary relays have been tested; final settings applied; SCADA commissioning completed		Customer Engineer Protection and Control (TasNetworks) Network Operations Control Systems (TasNetworks)	☐ ☐ ☐
5	To the best of the connecting customer's knowledge the equipment is ready for safe connection to the Network		Customer Engineer	☐
List any limitations to the Equipment				

List variances from Performance Standards or Connection Agreement			
Customer	**Name**	**Sign**	**Date**
Engineer			
Project Manager			
Tas**Networks**	**Name**	**Sign**	**Date**
Network Performance			
Protection and Control			
Network Operations Control Systems			
Network Operations			