# National Distributed Energy Resources Grid Connection Guidelines

## Technical Guidelines for Low Voltage EG Connections

ENA DOC 040-2019

Energy Networks Australia

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# Key Information

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# Documents of Energy Networks Australia

## History of Energy Networks Australia

Energy Networks Australia is the peak national body representing Australia's gas distribution and electricity transmission and distribution companies. Established in its current form in 2004 it has a long history of industry representation, operating under different names over the years to reflect the sector transformation.

With more than 16 million customer connections across the nation, Australia's energy networks provide the final step in the safe, reliable delivery of gas and electricity to virtually every home, business and industry in the country.

## Documents

Part of the role of Energy Networks Australia is the development and management of support material such as codes, specifications, guidelines and handbooks to support the energy industry and members of the public in the interpretation and application of legislation and standards. All documents are written in collaboration with the industry through working groups and general consultation with the members of Energy Networks Australia.

It should be noted that legislation and standards may alter between editions of Energy Networks Australia documents, and they will always take precedence. As such, all document users must be aware of the current regulatory environment.

# Definitions[1]

| | |
|---|---|
| ***Basic micro embedded generation connection*** | *A connection between a distribution network and a retail customer's premises for a micro embedded generating unit, for which a model standing offer is in place* or an equivalent model offer is in place in jurisdictions not subject to Chapter 5A of the National Electricity Rules |
| **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 |
| ***Embedded generating unit*** | *A generating unit connected within a distribution network and not having direct access to the transmission network* |
| **Embedded generating system** | A system comprising of multiple embedded generating units |
| **Distributed Energy Resources** | Power generation or storage units that are connected directly to the distribution network |
| **Energy storage system** | A system comprising one or more batteries that store electricity generated by distributed energy resources or directly from the grid, and that can discharge the electricity to loads |
| ***Generating system*** | *A system comprising one or more generating units* |
| ***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* |
| **Inverter energy system** | A system consisting of one or more inverters that convert direct current to alternating current |
| **Low voltage** | The mains voltage as most commonly used in any given network by domestic and light industrial and commercial consumers (typically 230V) |
| **Medium voltage/ High voltage** | Any voltage greater than 1kVAC |

[1] Definitions in italics are consistent with the definitions under the National Electricity Rules

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| ***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)* currently up to 200 kVA |
| ***Market generating unit*** | *A generating unit whose generation is not purchased in its entirety by a retailer (and which 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.* This definition also applies to an equivalent model offer for jurisdictions not subject to Chapter 5A of the National Electricity Rules |
| **Model connection agreement** | A document that is a model standing offer or a document used to provide low voltage embedded generation connection services which contains (amongst other things) the safety and technical requirements to be complied with by the proponent |
| ***Negotiated connection*** | *A connection of an embedded generating unit which is neither a basic micro embedded generation connection nor a standard connection for which technical requirements are negotiated between the Distribution Network Service Provider and the proponent* |
| **Non-inverter energy system** | A system consisting of one or more synchronous or asynchronous generators |
| **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 the Australian Energy Market Operator as a Generator under Chapter 2 of the National Electricity Rules* |
| **Site generation limit** | The generation threshold that the embedded generation system cannot exceed, measured downstream of the connection point |
| ***Small generation aggregator*** | *A person who has classified one or more small generating units as a market generating unit* |
| ***Small registered generator*** | *A generator who elects to register a generator with the Australian Energy Market Operator as a market generating unit who would otherwise be entitled to an exemption to register based on size* |
| ***Standard connection*** | *A connection service (other than a basic micro embedded generation connection service) for a particular class (or sub-class) of connection applicant and for which an Australian Energy Regulator approved model standing offer is in place* or for which an equivalent model offer is in place in jurisdictions not subject to Chapter 5A of the National Electricity Rules |

| | |
|---|---|
| **Technical requirements document** | The document produced by each Distribution Network Service Provider setting out their requirements for proponents to enable a gird connection, to which these guidelines apply |

# Abbreviations

| | |
|---|---|
| AEMC | Australian Energy Market Commission |
| AEMO | Australian Energy Market Operator |
| AER | Australian Energy Regulator |
| AS/NZS | A jointly developed Australian and New Zealand Standard |
| AS | Australian Standard |
| CEC | Clean Energy Council |
| CPEng | Chartered Professional Engineer of Engineers Australia |
| DC | Direct Current |
| DER | Distributed Energy Resources |
| DNSP | Distribution Network Service Provider |
| EG | Embedded Generation or Embedded Generating |
| ESS | Energy Storage System |
| GDL | Generation Dispatch Limiter |
| HV | High voltage |
| IEC | International Electrotechnical Commission |
| IES | Inverter Energy System |
| LV | Low voltage |
| MV | Medium voltage |
| NBN | National Broadband Network |
| NEM | National Electricity Market |

| | |
|---|---|
| NER | National Electricity Rules |
| NMI | National Metering Identifier |
| RPEQ | Registered Professional Engineer of Professionals Australia |
| SWIS | South West Interconnected System |
| WEM | Wholesale Electricity Market servicing the SWIS |
| xDSL | X Digital Subscriber Line |

# Foreword

The electricity industry in Australia is undergoing a transformation from a centralised system of generation transmission and distribution, dominated by relatively few participants, to a system of increasing decentralisation. The transformation is being largely driven by technological change in renewables and DER, enabling a broader range of stakeholders, including retail customers, to connect to and participate in existing and emerging energy markets.

As a result, network businesses are transforming from network service providers, facilitating one-way flow, to a customer connection provider, facilitating two-way flows between multiple distributed generating units and loads. The rate of transformation varies between networks due to the rate of uptake of DER and differing characteristics of network types.

Each network has responded to these challenges independently, resulting in a range of technical requirements and connection processes which, although consistent with regulatory requirements, result in some inconsistencies between networks and a lack of clarity for proponents. These issues have been identified as a major concern by stakeholders in numerous industry reports and reviews including the CSIRO/Energy Networks Australia's Energy Network Transformation Roadmap[2], and the Clean Energy Council's Future Proofing Australia's Distribution Networks[3].

These National DER Connection Guidelines have been developed in response to the needs identified in the abovementioned studies.

Energy Networks Australia, in partnership with the AEMO, is separately undertaking consultation on its '*Open Energy Networks*' project. Open Energy Networks proposes options for improving the electricity system to ensure household solar PV and ESS work in harmony and deliver the most value for all customers. The consultation has identified the need for common standards and protocols for active DER but is yet to develop specific technical requirements. It is envisaged that the outcomes of the Open Energy Networks consultation will be incorporated in future iterations of these National DER Connection Guidelines.

[2] http://www.energynetworks.com.au/electricity-network-transformation-roadmap
[3] http://fpdi.cleanenergycouncil.org.au/reports/grid-connection-standards-scoping-study.html

# About the National DER Connection Guidelines

The National DER Connection Guidelines set out the framework, principles, approach and technical settings for Australian DNSPs to adopt in the development and application of their technical requirements for grid connection of DER. The ultimate aim of the guidelines is to facilitate the efficient integration of DER into the grid from the perspective of networks, renewable energy proponents and Australia's electricity system more generally.

In preparing these guidelines, Energy Networks Australia has consulted broadly with industry including: the AEMO, the AEMC, state and federal governments and the Clean Energy Council as well as each of the fourteen DNSPs across Australia, who are our member organisations.

## Objectives of the Guidelines

The objectives of the guidelines are to:

1. Give rise to clear, complete and accessible technical requirements for grid connection for each DNSP
2. Provide for a level of consistency between DNSPs' technical requirements for grid connection in terms of both structure of presentation and the requirements themselves
3. Ensure that DNSPs' technical requirements give regard to the long-term interest of consumers by appropriately balancing the economic benefits, costs and risks that the requirements impose upon their network, proponents and Australia's electricity system more generally; consistent with the National Electricity Objective to:

   "Promote efficient investment in, and efficient operation and use of, electricity services for the long-term interests of consumers of electricity with respect to: price, quality, safety and reliability and security of supply of electricity and; the reliability, safety and security of the national electricity system"
4. Establish a platform for DNSPs to develop common standards and protocols for future management of active DER.

## Structure of the Guidelines

The guidelines are separated into four distinct documents:

1. **Framework and Principles guideline** – Specifies the number, scope and structure of the technical requirements documents which all DNSPs shall develop as well as the principles DNSPs shall adopt in setting technical requirements
2. **Basic micro EG connection technical guidelines** – Specifies how DNSPs shall develop and apply technical requirements for the connection of a micro EG unit with a total system capacity greater than or equal to 5 kVA for single-phase IES (excluding ESS), and less than or equal to a total system capacity of 30 kVA for three-phase IES (excluding ESS) to an LV distribution network

3. **LV EG connection technical guidelines (this document)** – Specifies how DNSPs shall develop and apply technical requirements for the connection of an EG unit (which is not a basic micro EG unit) to a LV distribution network
4. **MV/HV EG connection technical guidelines** – Specifies how DNSPs shall develop and apply technical requirements for the connection of an EG unit (which is not a basic micro EG unit or an LV EG unit) to a MV/HV distribution network, for which the generator is not required to be registered in the NEM (≤5MVA) or WEM (≤10MVA) or is within other jurisdictions and is ≤5MVA[4].

## How to Comply with the Guidelines

Compliance to the Energy Networks Australia DER Connection Guidelines is not legally required by DNSPs, however, all DNSPs have communicated an intention to adopt the requirements of the guidelines. To be deemed to comply with the guidelines, DNSPs shall:

- Structure their technical requirements documents consistent with the framework and principles set out in the Framework and Principles guideline
- Develop and apply technical requirements set out in the technical guidelines as relevant.

Where DNSPs choose to adopt an alternative setting, structure or approach, they shall still be deemed to comply so long as the deviation is set out and justified.

Justification shall include:

- That the alternative setting is required to respond to a jurisdictional legislative or regulatory requirement and/or
- That the alternative setting promotes improved benefits to Australia's electricity system (in terms of both network and proponent benefits, risks and costs).

Each deviation shall be listed in a table within the appendix of the DNSPs' technical requirements document, consistent with the format provided in Appendix A: Deviations from the National DER Connection Guidelines. The full justification shall be published separately on the DNSP's website and hyperlinked from the deviation table where appropriate.

## Terminology

In these guidelines the following terminology is used:

- The word *shall* indicates that adopting the setting or approach is mandatory in order for DNSPs to be deemed to comply with these guidelines
- The word *may* indicates an optional setting or approach that DNSPs shall consider. DNSPs will still be deemed to comply with the guidelines if they do not adopt that setting.

[4] Note that the guidelines still apply to generators who elect to register with AEMO as either a small registered generator or a small generation aggregator operating individual generating units of less than 5MW.

## Relationship to Other Documents

The guidelines are intended to be consistent with and to complement existing legislation and regulations.

To the extent that the application of these guidelines results in any inconsistency between existing legislation and regulations and DNSPs' technical requirements, existing legislation and regulations shall prevail. The implications of any inconsistency on DNSP's ability to comply with these guidelines shall be set out within a table of deviations as per Appendix A: Deviations from the National DER Connection Guidelines.

These guidelines are also intended to be consistent with relevant Australian/International Standards and Industry Codes. In some cases, these guidelines require DNSPs to apply additional requirements or additional specificity beyond Australian/International Standards and Industry Codes. Any inconsistency shall be interpreted as deliberate and shall not be used as justification for a deviation.

# Preparing LV EG Connection Technical Requirements

DNSPs shall produce a technical requirements document for LV EG connections that shall follow the structure and content detailed in these guidelines. The DNSP shall include the terms "Low Voltage or LV EG Connection Technical Requirements" in their key search terminology for their technical requirements document. The DNSP document title shall include the terms "*Low Voltage EG Connection Technical Requirements*". The document title may include other terms where required for consistency with the DNSP's document classification system.

# 1 Introduction

This section shall include an introduction to the DNSP's technical requirements document that provides proponents with an overview of the technical requirements for the equipment and installation of LV EG connections to the DNSP's LV network.

The introduction shall include:

1. The definition of an LV EG connection, consistent with the definition provided within the Framework and Principles guideline being:

   "*an LV EG system with a total system capacity less than or equal to {insert maximum indicative LV network capacity in kVA} for a single-phase or three-phase IES (excluding ESS) network connection, that is:*

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

   b. *meeting all other technical requirements set out in this document"*

   *OR*

   "*an LV EG system with a total system capacity of greater than 0 kVA and less than or equal to {insert maximum indicative LV network capacity in kVA} for a*

*single-phase or three-phase non-IES (synchronous or asynchronous) network connection, that is:*

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

b. *meeting all other technical requirements set out in this document*"

2. The purpose of the DNSP's technical requirements document, being:

   "*to provide proponents of LV EG connections information about their obligations for connection to and interfacing with the LV distribution network*"

3. An outline of the scope of connections to which the technical requirements document applies, being new connections of LV EG systems or modifications to existing LV EG systems, where the LV EG system consists of IES, ESS or a combination of both

4. An outline of the scope of systems to which the technical requirements document does NOT apply, being:

   a. EG units covered by the DNSP's Basic Micro EG Connection Technical Requirements

   b. EG units covered by the DNSP's MV/HV EG Connection Technical Requirements

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

   d. DER systems that do not generate electricity including demand response/demand management systems, unless they impact on the ability of the LV EG system to meet the technical requirements

5. The general obligations of proponents, including:

   a. The obligation to comply with the technical requirements as well as relevant national standards, industry codes, legislation and regulations. The instrument that shall prevail in the event of any inconsistency shall be the legislation and regulations, followed by the technical requirements, followed by national standards and industry codes

   b. The obligation to not add additional inverters, make modifications or install additional LV EG units, including ESS, without prior written agreement from the DNSP

   c. The obligation to comply with the DNSP's model connection agreement

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

   e. The obligation to meet the connection and commissioning requirements to the LV distribution network

6. A statement of acknowledgement from the DNSP of their obligations to ensure the safe and reliable operation of the distribution system for operating personnel, customers and the general public

7. A statement that the technical requirements comply with the National DER Connection Guidelines for LV EG Connections, with the exception of the deviations presented in Appendix A: Deviations from the National DER Connection Guidelines.

# 2 Definitions and Abbreviations

## 2.1 Definitions

This section shall provide a tabulated list of definitions for any technical or industry terms used throughout the technical requirements document. The definitions shall be consistent with the definitions provided within the National DER Connections Guidelines (including these technical guidelines and the Framework and Principles Guideline) as relevant.

## 2.2 Abbreviations

This section shall provide a tabulated list of all abbreviations used throughout the technical requirements document.

## 2.3 Terminology

This section shall outline how instructional terms are to be interpreted, being:

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

### 2.3.1 Subcategories

This section shall state the subcategories for which different technical settings may apply, being:

1. LV EG IES (excluding ESS) connection ≤200 kVA – Any LV EG system, that is not a basic micro EG system, with a total system capacity less than or equal to 200 kVA for a single-phase or three-phase IES (excluding ESS) network connection, meeting all relevant technical requirements for LV EG connections set out in the DNSP's technical requirements document. Further subcategorised by:
    a. Exporting
    b. Non-exporting
2. LV EG IES (excluding ESS) connection >200 kVA – Any LV EG system, with a total system capacity greater than 200 kVA and less than or equal to {*insert maximum indicative LV network capacity in kVA*} for a three-phase IES (excluding ESS) network connection, meeting all relevant technical requirements for LV EG connections set out in the DNSP's technical requirements document. Further subcategorised by:
    a. Exporting
    b. Non-exporting
3. LV EG non-IES connection – Any LV EG system, that is synchronous or asynchronous, with a total system capacity greater than 0 kVA and less than or equal to {*insert maximum indicative LV network capacity in kVA*} for a single-phase or three-phase network connection, meeting all relevant technical

requirements for LV EG connections set out in the DNSP's technical requirements document. Further subcategorised by:

a. Exporting

b. Non-exporting.

Where:

1. The maximum LV system capacity allowed for connection to the LV network may be specified as an indicative level or range above which the proponent would likely require a connection to the MV/HV networks. Where this is the case, this section shall state that proponents wishing to connect a system at or near this size contact the DNSP to determine whether an LV EG connection is appropriate
2. Exporting systems shall be considered to be LV EG systems operating in parallel with the LV distribution network and exporting electricity either via partial-export or full-export into the LV distribution network, where:
    a. Partial-export LV EG systems limit the amount of export into the LV distribution network to an agreed export threshold defined in the connection agreement
    b. Full-export LV EG systems can export into the LV distribution network to the full LV EG nameplate capacity (full AC rating).
3. Non-exporting systems shall be considered to be LV EG systems operating in parallel with the LV distribution network that are not approved to and limited to ensure they cannot export electricity into the LV distribution network.

This section shall also provide contact details in case there is any doubt as to which subcategory applies.

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

# 3 Relevant Rules, Regulations, Standards and Codes

## 3.1 Standards and Codes

This section shall provide a list of all the Australian and international standards and industry codes which shall apply to the design, manufacture, installation, testing and commissioning, and operation and maintenance of all plant and equipment for LV EG connections to the distribution network.

This section shall be consistent with the standards provided within the Framework and Principles guideline and shall only include those relevant to the DNSP's jurisdiction.

This section shall also state that in the event of any inconsistency between Australian and international standards and industry codes and the DNSP technical requirements, the DNSP technical requirements shall prevail.

## 3.2 Legislation and Regulation

This section shall provide a list of all the relevant legislation and regulations which shall apply to the design, manufacture, installation, testing and commissioning, and operation and maintenance of all plant and equipment for LV EG connections to the distribution network.

This section shall be consistent with the legislation and regulation provided within the Framework and Principles guideline and shall only include those relevant to the DNSP's jurisdiction.

This section shall also state that in the event of any inconsistency between legislation and regulations and the DNSP technical requirements, the legislation and regulation shall prevail.

# 4 Technical Requirements

## 4.1 Labelling and Signage

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

In addition, this section may provide further specificity, including but not limited to:

1. Additional descriptors of the generating unit
2. Details as to where within the installation and/or the DNSP's equipment the labelling and signage should be placed.

Any requirements which are additional to AS/NZS 4777.1, AS/NZS 3000 and AS/NZS 5033 shall be clearly stated as such.

## 4.2 Maximum System Capacity

This section shall specify maximum system capacity of the LV EG connections for each subcategory consistent with the below:

1. LV EG IES (excluding ESS) connection ≤200 kVA – For LV EG connections of IES (excluding ESS), the maximum system capacity at the same connection point shall be set to less than or equal to 200 kVA
2. LV EG IES (excluding ESS) connection >200 kVA – For LV EG connections of IES (excluding ESS), the maximum system capacity at the same connection point shall be determined at the time of application but shall typically be greater than 200 kVA and less than or equal to {*insert maximum indicative LV network capacity in kVA*}
3. LV EG non-IES connection – For LV EG connections of non-IES, the maximum system capacity shall be determined at the time of application but shall typically be greater than 0 kVA and less than or equal to {*insert maximum indicative LV network capacity in kVA*}.

## 4.3 Generation Control

This section shall specify that LV EG connections require generation control.

### 4.3.1 Export Limits at Connection Point

This section shall specify that the export limits at the connection point of LV EG connections will be assessed as to whether it is required. Where an export limit is required or requested by the proponent, it shall be determined at the time of application.

This section shall also specify those factors that are to be considered in determining the export limit including, but not limited to:

1. Existing asset ratings
2. Existing power quality at the relevant network location
3. Existing and forecast DER penetration at the relevant network location.

This section may also specify that an indicative export limit will be provided at the enquiry stage.

This section shall state that any export limit is to be interpreted as “soft”, a limit that will cause the IES or non-IES to reduce its output, preventing ongoing export greater than the limit.

This section shall specify that the export limit is to be interpreted by the proponent as a maximum. The ability of the proponent’s LV EG system to export at the export limit is not guaranteed, but rather, it will depend upon network characteristics which change over time. This section shall describe those scenarios where output may need to be constrained, including, but not limited to, power output where power quality response modes are in operation.

This section may recommend generation control requirements.

This section may also state that an estimate of the likelihood of constraints occurring and the impact on the proponent’s overall export volumes are to be provided at the time of connection application.

### 4.3.2 Site Generation Limit Downstream of Connection Point

Where the DNSP adopts a site generation limit, this section shall specify that the site generation limits downstream of the connection point of the LV EG connections shall be determined at the time of application.

This section shall also specify those factors that shall be considered in determining the site generation limit, including, but not limited to:

1. Retail and market operations
2. Existing asset ratings
3. Existing power quality at the relevant network location
4. Existing and forecast DER penetration at the relevant network location.

This section may recommend generation control requirements.

Where the DNSP does not have any site generation limit requirements for LV EG connections, this section shall be retained, but noted as intentionally blank.

## 4.4 Inverter Energy Systems

This section shall state the requirements that apply to IES, including that:

1. IES shall be tested by an authorised testing laboratory and be certified as being compliant with AS/NZS 4777.2 with an accreditation number
2. IES shall comprise of inverters that are registered with CEC as approved grid connect inverters
3. IES shall comprise of inverters that are tested by an authorised testing laboratory and be certified as being compliant with IEC 62116 for active anti-islanding protection as per AS/NZS4777.2
4. IES shall comprise of inverters installed in compliance with AS/NZS 4777.1
5. IES shall comprise of inverters that have *both* volt-var and volt-watt response modes available.

## 4.5 Network Connection and Isolation

This section shall specify that network connection and isolation requirements for IES shall be as per AS/NZS 4777.1 and AS/NZS 3000 for LV EG connections less than or equal to 200 kVA, LV EG IES connections greater than 200 kVA and LV EG non-IES connections (although AS/NZS 4777.1 currently only applies to IES systems less than or equal to 200 kVA). In addition, this section may provide further specificity, including but not limited to:

1. As a minimum, mechanical isolation shall be as per AS/NZS 3000 in that the isolator must always be readily accessible
2. Any means of isolation (where lockable) shall be able to be locked in the open position only
3. Requirements for multiple mode IES.

Any requirements that are additional to AS/NZS 4777.1 or AS/NSZ 3000 shall be clearly stated as such.

This section shall further specify the network connection and isolation requirements for Non-IES connections or that they shall be determined by the DNSP in the connection application stage.

## 4.6 Earthing

This section shall specify the earthing requirements of the LV EG systems consistent with the below:

1. IES less than or equal to 200 kVA have earthing requirements as per AS/NZS 4777.1 and AS/NZS 3000.
2. IES greater than 200kVA have earthing requirements as per AS/NZS 4777.1 and AS/NZS 3000 (although AS/NZS 4777.1 currently only applies to IES systems less than or equal to 200 kVA).
3. Non-IES have earthing requirements as per AS/NZS 3000 and AS/NZS 3010 and any requirements which are additional shall be clearly stated as such.
4. ESS have earthing requirements as per AS 3011.

## 4.7 Protection

### 4.7.1 Inverter Integrated Protection

This section shall specify that the inverter integrated protection requirements that apply will be as per AS/NZS 4777.1 and AS/NZS 4777.2 for LV EG IES connections less than or equal to 200 kVA and LV EG IES connections greater than 200 kVA (although AS/NZS 4777.1 currently only applies to IES systems less than or equal to 200 kVA).

This section shall specify passive anti-islanding requirements using voltage and frequency limits as per AS/NZS 4777.2 and shall reproduce Table 13 of AS/NZS 4777.2. DNSPs may depart from the set point values included in Table 13 of AS/NZS 4777.2 but should clearly nominate where this is the case.

This section shall specify the active anti-islanding protection requirements, including, but not limited to, a table of set point values, where relevant.

### 4.7.2 Central Protection

This section shall specify that central protection requirements that apply will be as per AS/NZS 4777.1 for LV EG IES connections less than or equal to 200 kVA, LV EG IES connections greater than 200 kVA and LV EG non-IES connections (although AS/NZS 4777.1 currently only applies to IES systems less than or equal to 200 kVA).

This section shall also specify the circumstances in which central protection is necessary and shall reproduce the voltage and frequency set points as per Table 2 of AS/NZS 4777.1.

This section shall reproduce Table 1 below with further details provided as per sections 4.7.2.1 to 4.7.2.5 of this guideline.

*Table 1 – Central Protection requirements*

| Protection Requirements | LV EG IES | | | | LV EG Non-IES | |
|---|---|---|---|---|---|---|
| | ≤200 kVA | | >200 kVA | | | |
| | Exporting | Non-Exporting | Exporting | Non-Exporting | Exporting | Non-Exporting |
| Grid reverse power (32R) | ✓ | – | ✓ | – | – | – |
| Generator circuit Phase balance protection (46/47) | – | – | – | – | ✓ | ✓ |

| Protection Requirements | LV EG IES | | | | LV EG Non-IES | |
|---|---|---|---|---|---|---|
| | ≤200 kVA | | >200 kVA | | | |
| | Exporting | Non-Exporting | Exporting | Non-Exporting | Exporting | Non-Exporting |
| Overcurrent facility fault, grid fault and earth fault protection (50/51) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Passive anti-islanding protection (27U/O, 59U/O, 81U/O, 81R) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Inter-tripping | ✗ | ✗ | – | ✗ | – | – |

Symbols are used to denote protection requirements, where:

- ✓ Represents that the protection shall be required
- – Represents that the protection may be required
- ✗ Represents that the protection shall not be required

#### 4.7.2.1 Grid Reverse Power Protection

This section shall specify the grid reverse power protection requirements which shall include:

1. That reverse power protection shall be set as low as practicable with consideration of protection relay, CT accuracy and generating system synchronisation characteristics
2. That design of control systems shall minimise reverse power flow immediately following synchronisation.

This section shall specify that the specific settings for grid reverse power protection shall be determined via a connection specific technical assessment.

#### 4.7.2.2 Phase Balance Protection

This section shall specify that LV EG connections shall have phase balance protection in place where not inverter integrated.

This section shall also specify that all Non-IES shall require both current unbalance and voltage unbalance protection.

This section shall specify that three-phase IES are exempt from this requirement.

#### 4.7.2.2.1 Current Unbalance Protection

This section may specify the current unbalance requirements for the generator at the connection point where not inverter integrated, and shall include but not be limited to:

1. Threshold of current unbalance: maximum difference between any of the phase currents and the average value of phase currents (%)
2. Minimum limit of measured current as a percentage of nominal current, from which the current unbalance protection is enabled (%)
3. Delay of current unbalance protection (sec).

This section shall further specify that the specific settings for current unbalance protection shall be determined via a connection specific technical assessment.

Where DNSPs do not adopt this requirement, this section shall state that there are no current unbalance protection requirements.

#### 4.7.2.2.2 Voltage Unbalance Protection

This section may specify the voltage unbalance requirements where not inverter integrated, and shall include but not be limited to:

1. Threshold of voltage unbalance, i.e. amplitude asymmetry (%)
2. Undervoltage limit of the positive sequence (%)
3. Overvoltage limit of the negative sequence (%)
4. Delay of the voltage unbalance (amplitude asymmetry) protection (sec)
5. Direction of correct phase rotation (clockwise, counter-clockwise, any).

This section shall specify that the specific settings for voltage unbalance protection may be determined via a connection-specific technical assessment.

Where DNSPs do not adopt this requirement, this section shall state that there are no voltage unbalance protection requirements.

### 4.7.2.3 Overcurrent Facility Fault, Overcurrent Grid Fault and Earth Fault Protection

This section shall specify that the requirements for overcurrent facility fault, overcurrent grid fault and earth fault protection shall be determined via a connection-specific technical assessment.

### 4.7.2.4 Passive Anti-islanding Protection

This section shall specify passive anti-islanding requirements as per Table 2 of AS/NZS 4777.1 using voltage and frequency limits for LV EG IES connections greater than 30 kVA and a separate table for LV EG Non-IES connections.

This section shall include the passive anti-islanding table with set point values as per Table 2 of AS/NZS 4777.1. DNSPs may depart from the set point values included in Table 2 of AS/NZS 4777.1 but should clearly nominate where this is the case.

#### 4.7.2.5 Inter-tripping

This section shall specify the inter-trip protection function(s) and requirements for LV EG connections, if any, as per Table 1, including but not limited to:

1. Inter-trip protection is to be applied in addition to the distribution network protection requirements set out in the DNSP's technical requirements document
2. Responsibilities for the set-up and monitoring of the communication link between an EG system (specifically connecting to an interface panel on the customer's site) and the DNSP's data collection system
3. Interface requirements
4. Responsibilities for tripping the circuit breaker upon receiving the inter-trip signal
5. Actions that shall be taken by the DNSP should the communication link fail until such time when the link is restored
6. Responsibilities for including a tripping function of the generating system in the case where the DC supply to the protection scheme is lost.

This section shall further specify that:

1. For LV EG connections inter-tripping may be required depending on the outcomes of technical studies
2. For LV EG Non-IES non-exporting connections, inter-tripping may not be required provided that minimum import protection is installed
3. Where there is an inter-trip, reverse power protection may not be required.

### 4.7.3 Interlocking

This section shall specify that where multiple single-phase inverters are connected to more than one phase, either of following requirements will apply:

1. Single-phase inverters are to be interlocked and configured to operate as an integrated multi-phase inverter providing a balanced output that is no more than 5 kVA between any phases as per AS/NZS 4777.1

   OR

2. Phase balance protection is required and shall reference that this information can be found within the DNSP's technical requirements document in the section containing the Phase Balance Protection requirements.

### 4.7.4 Power Factor Control

Where power factor control is required, this section shall specify the allowable range for power factor control of IES and for non-IES measured at the connection point.

### 4.7.5 Synchronisation

This section shall specify the automatic synchronising and synchronisation check requirements for LV EG connections where it is intended that parallel operation of a generating unit will occur.

### 4.7.6 Additional Requirements for LV EG Non-IES

This section shall specify additional protection functions that may be required for EG Non-IES beyond those specified within Table 1 to allow for the differences between synchronous and asynchronous generator technology and applications on the LV network.

Where DNSPs do not adopt this requirement, this section shall state that there are no additional protection requirements.

## 4.8 Operating Voltage and Frequency

This section shall specify that the operating voltage and frequency requirements can be found within the DNSP's technical requirements document in the section containing Inverter Integrated Protection requirements.

This section shall specify the nominated maximum voltage set point, $V_{nom\_max}$ as per AS/NZS 4777.2.

This section shall also specify the voltage rise requirement as per Appendix F.2 (i) of AS/NZS 4777.1 and any jurisdictional requirements for voltage rise calculation.

## 4.9 Metering

This section shall not include any requirements for metering and shall be retained but noted as intentionally blank for DNSPs in jurisdictions subject to Chapter 7 of the NER.

This section may include requirements for jurisdictional metering for DNSPs in jurisdictions which are not subject to Chapter 7 of the NER.

## 4.10 Power Quality

### 4.10.1 Quality of Supply

This section shall specify that the LV EG connections shall comply with the applicable power quality requirements of the AS/NZS 61000 series as well as relevant state-based regulations and licence conditions, including but not limited to:

1. Network voltage control
2. Voltage fluctuations
3. Harmonics
4. Voltage balance.

### 4.10.2 LV EG IES Power Quality Response Modes

This section shall specify either of the following inverter power quality response modes as per AS/NZS 4777.2 as being required:

1. Volt-watt and volt-var response modes specified in Clause 6.3.2.2 and Clause 6.3.2.3 of AS/NZS 4777.2 shall be enabled. This section shall provide additional specificity for the required response modes in terms of the volt response reference values, the volt-watt response set-point values and the volt-var response set-point values consistent with the format in Tables 9 to 11 of AS/NZS 4777.2.

OR

2. Fixed power factor mode and/or volt-var response modes specified in Clause 6.3.3 and Clause 6.3.2.3 of AS/NZS 4777.2 shall be enabled. If applicable, this section shall also specify the circumstances under which power factor mode and/or reactive power mode shall be required. Further to this, this section shall provide additional specificity where applicable for the volt response reference values and the volt-var response set-point values consistent with the format in Tables 9 and 11 of AS/NZS 4777.2.

Where volt-var response mode is required to be available and enabled, this section shall specify the ratio of reactive power to apparent power or the required fixed constant reactive power.

This section may specify that where an additional LV EG unit is being added to a site with an existing LV EG connection that has legacy power quality settings, the DNSP may provide site-specific voltage response mode settings.

This section shall specify whether there are ramping requirements of the IES as per AS/NZS 4777.2, where a site generation limit is applied for generation control.

### 4.10.3 LV EG Non-IES Synchronous Power Quality Response

This section shall specify that synchronous LV EG Non-IES connections shall be designed and operated to adequately control real and reactive power output through either of the following power quality response modes:

1. Voltage control mode

   OR

2. Fixed power factor mode that shall require achieving a power factor operating window at the connection point of {*insert power factor setting*} lagging and not leading unless otherwise agreed to by the DNSP.

This section shall specify that the power quality response mode and settings shall be determined depending on the outcomes of technical studies.

## 4.11 Communications Systems

This section shall set out the communications systems requirements for LV EG connections as per the subcategories.

### 4.11.1 LV EG IES Excluding ESS ≤200 kVA Communications Systems

For LV EG IES (excluding ESS) systems less than or equal to 200 kVA, where DNSPs have communications systems requirements, this section shall recommend the communications systems requirements that proponents should adopt with reference to other requirements. That is, communications systems requirements may be recommended, but not imposed by the DNSP.

Where the DNSP does not yet have any communications systems requirements for LV EG connections, this section shall be retained, but noted as intentionally blank.

### 4.11.2 LV EG IES Excluding ESS >200 kVA Communications Systems

For LV EG IES (excluding ESS) systems greater than 200 kVA, this section may specify:

1. For non-exporting systems that there are no requirements
2. For exporting systems
    a) That continuous monitoring of current per phase, active power flow and reactive power flow shall be required
    b) The options for communication technology that may be adopted and may include the DNSP's private communications network (e.g. radio optical fibre or third-party networks such as mobile cellular carrier, xDSL, broadband, NBN, etc.)
    c) The responsibilities for the set-up and monitoring of the communication link between the EG system and the DNSP's data collection system
    d) The interface signal requirements for digital outputs and analogue outputs from the DNSP to the EG system and digital inputs and analogue inputs required from the EG system to the DNSP
    e) The communication signal fail-safe scheme requirements for remote monitoring (telemetry) and control functionality. Details shall include timing and expected outcome (e.g. reduce GDL or cease exporting)
    f) The communications equipment DC supply requirements and associated fail-safe schemes
    g) Any inter-trip communications requirements (if applicable) and the associated signal fail-safe scheme requirements. These requirements may include details such as availability, integrity monitoring and maximum latency.

### 4.11.3 LV EG Non-IES Communications Systems

For LV EG non-IES systems, this section may specify:

1. For non-exporting systems that there are no requirements for communications
2. For exporting systems
    a) That continuous monitoring of current per phase, active power flow and reactive power flow shall be required
    b) The options for communication technology that may be adopted and may include the DNSP's private communications network (e.g. radio optical fibre or third-party networks such as mobile cellular carrier, xDSL, broadband, NBN, etc.)
    c) The responsibilities for the set-up and monitoring of the communication link between the EG system and the DNSP's data collection system
    d) The interface signal requirements for digital outputs and analogue outputs from the DNSP to the EG system and digital inputs and analogue inputs required from the EG system to the DNSP

e) The communication signal fail-safe scheme requirements for remote monitoring (telemetry) and control functionality. Details shall include timing and expected outcome (e.g. reduce GDL or cease exporting)

f) The communications equipment DC supply requirements and associated fail-safe schemes

g) Any inter-trip communications requirements (if applicable) and the associated signal fail-safe scheme requirements. These requirements may include details such as availability, integrity monitoring and maximum latency.

## 4.12 Data and Information

### 4.12.1 Static Data and Information

This section shall specify the static data and information that is required to be provided by the proponent to the DNSP as per Appendix D: Static Data and Information.

This section may specify the format and method for transmitting static data but shall not impose any additional communications systems requirements.

### 4.12.2 Dynamic Data and Information

This section shall specify the data format and protocol requirements for transmitting dynamic data and information to the DNSP and any other bodies, which proponents shall adopt where communications systems are in place.

## 4.13 Cybersecurity

This section shall set out the cybersecurity requirements for the subcategories of LV EG connections for which a communication link between the DNSP's data collection system and the LV EG system is required.

Cybersecurity requirements shall include but not be limited to:

1. Ensuring monitoring and communications devices are in lockable enclosures
2. Protection and control from the network systems (firewalls)
3. Privilege settings and password protection
4. Limiting access to only that which is required to monitor the generating unit.

This section may specify the relevant standards and documents relating to cybersecurity (e.g. compliance to Australian Signals Directorate Essential 8 and Federal Government's Critical Infrastructure Centre for Operational Cyber Security).

Where the DNSP does not yet have any communications systems requirements for any LV EG connections, this section shall be retained, but noted as intentionally blank.

## 4.14 Technical Studies

This section shall state the technical studies required to be completed as part of the connection application as per Table 2 and as per jurisdictional requirements.

*Table 2 – Technical Studies Required for LV EG Connections.*

| Technical Studies | LV EG IES | | | | LV EG Non-IES | |
|---|---|---|---|---|---|---|
| | ≤200 kVA | | >200 kVA | | | |
| | Exporting | Non-Exporting | Exporting | Non-Exporting | Exporting | Non-Exporting |
| Voltage level (incl. power factor) | – | – | ✓ | – | ✓ | ✓ |
| Power flow | – | – | ✓ | – | ✓ | ✓ |
| Fault level | – | – | ✓ | – | ✓ | ✓ |
| Protection grading | – | – | ✓ | – | ✓ | ✓ |

Symbols are used to denote technical studies' requirements, where:

- ✓ Represents that technical studies shall be required
- – Represents that technical studies may be required
- ✘ Represents that technical studies shall not be required

This section shall also state which technical studies shall be completed by the DNSP, which technical studies shall be completed by the proponent and which technical studies may be completed by either the proponent or the DNSP.

For each technical study that shall or may be undertaken by the proponent, this section shall state the following and may be presented in a separate schedule or reference document that is to be appropriately linked in this section:

1. The relevant inputs to be provided by the DNSP
2. The outputs required from the proponent
3. The criteria against which the study shall be assessed by the DNSP.

For each technical study that shall or may be undertaken by the DNSP, the DNSP shall outline the following and may present this in a separate schedule or reference document that is to be appropriately linked in this section:

1. The relevant inputs to be provided by the proponent
2. The estimated time and cost to complete the study
3. The outputs provided
4. The criteria against which the study shall be assessed by the DNSP.

This section shall also state that where one or more of the technical studies does not meet the assessment criteria, the DNSP shall provide the proponent with an alternative option which may include:

1. Alternative configurations of the generating systems (e.g. lower generation control limits)
2. Network augmentation (and associated cost of network augmentation).

# 5 Fees and Charges

This section shall specify fees and charges applicable to proponents and any jurisdictional requirements including, but not limited to:

1. The types of connection fees that shall be applied
2. Any ongoing charges applicable regarding the installation and operation of the generating unit while maintaining the connection to the distribution network and how these are determined
3. The fee payable and/or how the fees are determined
4. How the fees are to be paid by the proponent.

This section may provide hyperlinked website addresses with short descriptions where information is published separately on the DNSP's website.

# 6 Testing and Commissioning

This section shall state the testing and commissioning requirements for LV EG connections as per Table 3 including the requirements that:

1. Testing and commissioning plans shall be produced by the proponent and may be required to be signed off by the DNSP prior to finalising the connection agreement
2. Testing and commissioning acceptance shall be signed off either by a CPEng, RPEQ (only in Queensland) or by a DNSP-approved suitably qualified person
3. Testing and commissioning acceptance may require the DNSP to carry out witnessing at the DNSP's expense
4. For IES, this section shall specify that testing and commissioning requirements shall be in accordance with AS/NZS 4777.1, AS/NZS 3000 and AS/NZS 5033 (where applicable), the equipment manufacturer's specifications and the DNSP's technical requirements to demonstrate that the LV EG IES system meets the requirements of the connection agreement. This section may further specify that compliance to AS/NZS 3000 and AS/NZS 5033 (where applicable) may be tested by suitably qualified local electrical authorities
5. For Non-IES, this section shall specify that testing and commissioning requirements shall be in accordance with the equipment manufacturer's specifications and the DNSP's technical requirements to demonstrate that the LV EG non-IES system meets the requirements of the connection agreement. This section shall also specify the technical settings that will be required to be

tested, including: protection settings, power quality settings, export limits, communications settings and shutdown procedures.

*Table 3 – Testing and Commissioning Requirements for LV EG Connections*

| Testing and commissioning requirements | LV EG IES | | | | LV EG Non-IES | |
|---|---|---|---|---|---|---|
| | ≤200 kVA | | >200 kVA | | | |
| | Exporting | Non-Exporting | Exporting | Non-Exporting | Exporting | Non-Exporting |
| Protection settings and performance | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Power quality settings and performance | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Export limits settings and performance | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Communications settings and performance | – | – | ✓ | – | ✓ | ✓ |
| Shutdown Procedures | ✘ | ✘ | ✓ | – | ✓ | ✓ |
| Confirm system is as per specifications | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Confirm SLD is located on site | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

Symbols are used to denote testing and commissioning requirements, where:

- ✓ Represents that testing and commissioning shall be required
- – Represents that testing and commissioning may be required
- ✘ Represents that testing and commissioning shall not be required

This section shall specify that the tests shall be installation tests not type tests.

# 7 Operations and Maintenance

This section shall state the operations and maintenance requirements for LV EG connections, including that:

1. An operation and maintenance plan shall be produced and the DNSP may require for it to be signed off prior to forming a connection agreement
2. The LV 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
3. Operation and maintenance reports may be submitted to the DNSP at a specified interval no more frequently than annually
4. The DNSP may inspect the LV EG system at any time at the DNSP's expense.

This section may also describe the general expectations for operating and maintaining the LV EG system, including, but not limited to:

1. Maintaining the electrical installation at the supply address in a safe condition
2. Ensuring that any changes to the electrical installation at the supply address are performed by an electrician lawfully permitted to do the work and that the customer holds a Certificate of Compliance issued in respect of any of the changes
3. Seeking DNSP approval prior to altering the connection in terms of an addition, upgrade, extension, expansion, augmentation or any other kind of alteration, including changing inverter settings
4. How the DNSP proposes to respond to non-complying LV EG systems.

# Appendix A: Deviations from the National DER Connection Guidelines

This appendix shall include a register of all deviations from these technical guidelines in the format provided in Table 4.

*Table 4 - Table of Deviations from National DER Connection Guidelines*

| Section | Description of deviation | Type of deviation | Justification |
|---|---|---|---|
| *{Section of this technical guideline document to which the deviation applies}* | *{High level description of the deviation}* | *{Nominates whether the deviation is to meet a jurisdictional requirement or is to promote improved benefits to Australia's electricity system}* | *Justification {Either N/A where the deviation is to meet a jurisdictional requirement or provides link to justification documentation}* |

# Appendix B: Connection Arrangement Requirements

This appendix shall include:

1. Single line diagrams of the DNSP's preferred connection arrangements, and a range of other possible connection arrangements for integration of a LV EG connection, showing:
    a) the connection point
    b) the point of common coupling
    c) the EG unit(s)
    d) load(s)
    e) meter(s)
    f) circuit breaker(s)
    g) isolator(s)
2. A sample schematic diagram of the protection system and control system relevant to the connection of an EG unit to the distribution network, showing the protection system and control system, and including:
    a) All relevant current circuits
    b) Relay potential circuits
    c) Alarm and monitoring circuits
    d) Back-up systems
    e) Parameters of protection and control system elements.

# Appendix C: Model Connection Agreement

In jurisdictions subject to Chapter 5 of the National Electricity Rules, this section may include the AER approved model standing offer for any LV EG connections where they exist.

In jurisdictions not subject to Chapter 5 of the National Electricity Rules, and for DNSPs without a model standing offer, this section may include an equivalent document used as the basis to form a connection agreement with proponents of LV EG connections.

The model connection agreement shall be entirely consistent with the technical requirements document.

This section may provide hyperlinked website addresses with short descriptions where information is published separately on the DNSP's website.

# Appendix D: Static Data and Information

This appendix shall include the static data and information that is required to be provided by the proponent to the DNSP and shall include as a minimum:

1. NMI meter numbers (10 digit)
2. DER Devices
    a) Fuel source – primary {renewable/biomass/waste; fossil; hydro; geothermal; solar; wave; wind; tidal; storage}
    b) Fuel source – descriptor {as per appendix 8 of the NEM Generator registration guide}
    c) Make, model and manufacturer
    d) Maximum capacity (kW or MW)
    e) Storage capacity (kWh/MWh of available storage)
    f) Installer
    g) Whether the device is registered for ancillary service provision (Y/N)
    h) Whether the device is part of an aggregated control (Y/N)
    i) Whether the device is remotely controllable (Y/N)
    j) Compliance with Australian Standards
3. Inverter
    a) Make, model and manufacture
    b) Whether the installer has changed the inverter default manufacturer settings (Y/N)
    c) Maximum capacity (kW and kVA)
    d) Date of installation
    e) Compliance with Australian Standards
4. Inverter enabled modes of operation
    a) Demand response modes enabled and enablement method
    b) Power quality modes {power response (frequency control); voltage response (voltage-watt or voltage-var); Q (reactive power), PF (power factor); standalone}
5. Trip settings
    a) Frequency trip settings {none, over-frequency, under frequency}
    b) Voltage trip settings {none, over-voltage, under-voltage}

Energy Networks Australia