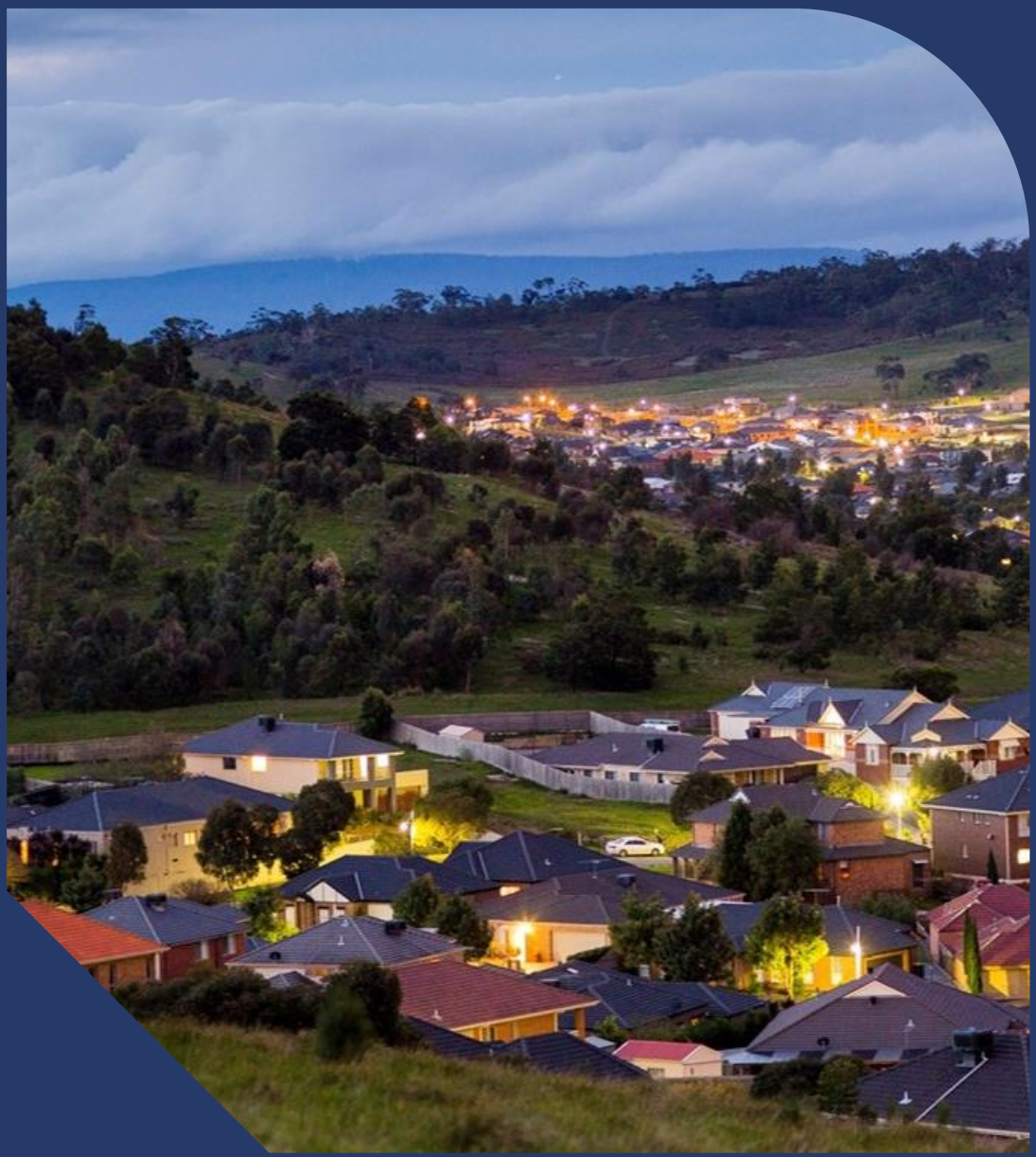
AusNet

Export limits for Embedded Generators up to 200kVA connected at Low Voltage

Standard operating procedure



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1. Purpose

The purpose of this Procedure is to describe the minimum requirements that must be met by the customer to connect an embedded generator with an individual or combined rating up to 200kVA to AusNet Services' low voltage (230V single phase, 400V three phase) electricity distribution network. These requirements including export limits apply at the connection point to the AusNet Services electricity distribution network.

2. Scope

The Procedure applies to existing or proposed embedded generator (EG) systems which require or have a connection to AusNet Services' low voltage electricity distribution network through a single connection point.

The Procedure explains the general and technical requirements that must be met by the customer in order to first form a Connection Agreement with AusNet Services for an EG system. The procedure also sets out the requirement for customers to ensure continuing compliance with the Connection Agreement, and therefore the need for any control schemes that interact with an EG, such as third party aggregation control, to always operate the EG within the agreed Export Limits.

The scope of this Procedure covers both common network connection methods for EG:

- Inverter Energy Systems (IES): applicable to solar photo voltaic (PV), wind power, hydro power, battery storage, fuel cells
- Synchronous or Induction generators: applicable to reciprocating engines (such as gas or diesel fired), wind power, hydro power.

2.1. Limitations of this procedure

This Procedure does not preclude adherence to nor vary any other Regulatory requirements or obligations of the customer including the Electricity Safety Act, Electricity Industry Act, National Electricity Law, the Electricity Distribution Code including Clause 7 and Clause 4.8, other Standards, including AS3000, or any AusNet Services Policy, Procedure or Guideline e.g. Protection Policy.

AusNet do not approve individual products and as a result no list of approved products is published. However, AusNet maintains a whitelist of Software Communication Clients (SCC) which have shown compliance to connecting with AusNet's utility server. It is the customer's responsibility to maintain their system to perform in accordance with their Connection Agreement. Variations from the agreed position could result in the EG system being "locked out" or other action being taken by AusNet Services in accordance with applicable laws to protect the safety of network operators and the public as well as the security of the network.

3. Abbreviations and definitions

Specific terms and abbreviations used in this document are defined in Table 1.

Table 1 Abbreviations and definitions

TERM	DEFINITION
Approved Inverter	An inverter which complies with AS/NZS 4777 and listed in *Tested and Approved Grid Connected Inverters* as in force from time to time and available at http://www.cleanenergycouncil.org.au.
Company Representative	A person authorised by the customer's EG installation company to verify that the limited export system performs as required by this Procedure and complies with the Connection Agreement.
Connection Agreement	An agreement between AusNet Services and an EG customer or owner, by which the EG is or will be connected to the distributor's distribution system.
Connection Point	The agreed point of supply established between AusNet Services and the customer.
CSIP-Aus	Common Smart Inverter Profile Australia
Embedded Generator (EG)	A generator of any type, including a battery storage system that is connected to the AusNet Services distribution network. An EG may be installed behind the meter within a customer's Electrical Installation or connected directly to the distribution network.
Electrical installation	Means any electrical equipment at a customer's supply address that is connected to, but not a part of, the AusNet Services distribution network.
Energy Source	An available energy source either chemical, renewable, potential energy, requiring conversion from one kind of power to another kind suitable for connection to the electricity grid. Examples include wind, hydro, battery energy storage, fuel cell or solar.
Export Limit	Limit on the export of electricity to the AusNet Services distribution network at the connection point.
Installed Capacity	The Rating of one or more EG system installed within an electrical installation. Refer also to Attachment A.
Inverter Energy Systems (IES)	An EG system comprising one or more inverters together with one or more energy sources (which may include energy storage) and controls.
Proponent	Person/Company liaising with AusNet Services. The Proponent will be the customer or their representative (generally this would be the installer although it could be a consultant or designer).
Rating	The continuous or nominal rating of the EG system in kVA**.**
SCC	Software Communication Client

4. General requirements for connection of EG

All EG systems require a Connection Agreement with AusNet Services. Approval to connect an EG system is only granted by AusNet Services after entering into a Connection Agreement (even if the system is limited to zero export). Where approval is being sought for a limited export EG system, and where the total system Installed Capacity is greater than the Export Limits in Table 2, a Commissioning Test Report will be required, and approval to connect will be revoked if the Commissioning Test Report is not provided within a satisfactory timeframe.

The proponent must submit a single line diagram up to the single connection point showing all EG systems and information on proposed protection systems. AusNet Services will review these proposals for inclusion in the Connection Agreement, prior to installation.

The limited export features must not interfere in any way with the normal functions of the EG system, particularly its power quality, electrical safety and protection functions including the anti-island protection as required by AS/NZS 4777.

5. Limited export EG systems

A limited export may be specified by the customer when the proposed EG system Installed Capacity and the connection requirements for the proposed EG system result in breaches in AusNet Services network planning policy, network limitations or the need to upgrade assets in the electricity network. The customer can either agree to limit the export of the EG system or contribute to the cost of upgrading the network to enable export of the required level of generation.

When network limitations exist, a zero export system will normally be recommended, however other proposals for limited or reduced export will be considered. Note that connection of limited export systems usually involves additional cost to the customer for AusNet Services to undertake review of the proposed control mechanism and to provide test reports to AusNet Services to confirm system performance.

Additional requirements may be specified following detailed review of the system proposal.

6. Compliance with export limitations

It is the Proponent's responsibility to ensure that the system is installed and commissioned in accordance with all the appropriate regulations, and it is the ongoing responsibility of the customer to ensure that the export limit is tested and maintained through the life of the installation in accordance with the Connection Agreement. It is important for the customer to ensure that any control schemes that interact with the EG, such as third party aggregation control, only always operate the EG within the agreed Export Limits set by the Connection Agreement.

AusNet Services will monitor compliance with the Connection Agreement conditions via the customers metering data, random audit and other ad hoc information sources, including aerial maps and field inspection reporting. Non-compliance with the Connection Agreement could result in the EG system being "locked out" or other action being taken by AusNet Services in accordance with applicable laws to protect the safety of network operators and the public as well as the security of the network.

7. Technical requirements of EG systems

7.1. Export limits

Unless network constraints exist, AusNet Services allows export of energy from EG systems up to the limits outlined in Table 2. If no export limitation function exists in the EG system, then the installed capacity of the system must be less than the applicable export limit in Table 2. Should the system request an MSL exception in the preapproval stage, a default fallback export limit of 1 kW will be imposed for the entire site.

For small, embedded generation systems where power factor is set to 1.0 by default, the real power rating (measured in kW) is equivalent to the apparent power rating (measured in kVA) and the two units may be used interchangeably.

Limited export systems must comply with the requirements of AS/NZS 4777.1:2024, Clause 3.4.8 for Soft Limit export control (including hybrid and multiple mode connected EG's) and the net export limit at the connection point will not exceed the limits outlined in Table 2.

Note: The transitional period of 18 months for the application of Clause 3.4.8 provided in the Preface to AS4777.1 2016, does not apply to this Procedure, and compliance with the AS4777.1 2016, Clause 3.4.8 is mandatory.

Table 2 Maximum Export limits

CUSTOMER LOAD NUMBER OF PHASES	MAXIMUM EXPORT LIMIT
SYSTEMS CONNECTED BACK TO A SWER TRANSFORMER	
Single Phase 230 V	3.5 kVA
Two Phases 230/460 V	7.0 kVA – Maximum 3.5 kVA per phase
SYSTEMS CONNECTED BACK TO A SINGLE PHASE TRANSFORMER	
Single Phase 230 V	5.0 kVA
Two Phases 230/460 V	10.0 kVA – Maximum 5.0 kVA per phase
SYSTEMS CONNECTED BACK TO A THREE PHASE TRANSFORMER	
Single Phase 230 V	5.0 kVA
Two Phases 230/400 V	10.0 kVA – Maximum 5.0 kVA per phase
Three phases 230/400 V and less than or equal to 15 kVA	Maximum 5.0 kVA per phase
Three phases 230/400 V and greater than 15 kVA	To be reviewed on a case-by-case basis

7.2. Other technical requirements

A range of other technical requirements that the customer must be aware of and comply with are summarised in Table 3 and Figure 1.

Table 3 Technical requirements for EG connections

REQUIREMENT	DETAILS
Load Balance	It is required that the export of power from an inverter system is balanced as required by AS/NZS 4777.2 Clause 5.10 and 8.2. The Soft Export limit must comply with AS/NZS 4777.1:2024 Clause 3.4.8 The settings for Central phase balance protection as required by AS/NZS 4777.1:2024 Appendix C shall comply with SOP 11-16. **DISCONNECTION TIME** / **SETTING** **Phase Balance Protection** — 2 sec — 20 A* *Max imbalance between any two phases, note – negative or zero sequence current protection is not acceptable. The electrical installation load or export must be maintained in accordance with the customer Distribution Code obligation as outlined in Figure 1.
Location of Export Monitoring	Limited export systems must monitor the exported energy electrically adjacent to the customer's meter so as to measure the total current flows for the whole electrical installation.
System Accuracy	Overall system performance export settings must be maintained at +/-4% of the setting except for zero export setting which must incorporate a plus zero accuracy for the export setting. Each phase of a limited export system must be monitored and CTs shall have an Accuracy Class 1 or better as required by AS60044.1 for measuring current transformers.
Maximum Installed Capacity	The Maximum Installed Capacity is measured against the total Rating of Energy Systems as per Appendix A, whether or not the EG system is export limited. The Maximum Installed Capacity for all embedded generation systems connected to the connection point is limited to the agreed supply capacity for the load at that site in accordance with the Deemed Distribution Contract, Tariff conditions, or other agreed capacity. As guidance, typical residential installations have a 40A supply capacity that can support a nominal Maximum Installed Capacity per phase of up to 10 kVA, as long as exports are limited to between 3.5kVA and 5.0kVA as per Table 2. The Maximum Installed Capacity for all embedded generation systems connected to a transformer per phase is also limited to 100% of each phase winding of the transformer. Export limits as per Table 2 must be adhered to, and other criteria which only impact on non-limited export systems are to remain. All connections applications may also be subject to a technical assessment before approval is granted to connect. In some cases this may result in allowable installed capacities and/or export limits being lower than set out in Table 2 and Table 3.

Figure 1 Load Balance requirements[1]

4.7 Load balance

4.7.1 A ***customer*** must ensure that the current in each phase of a three phase ***electrical installation*** does not deviate from the average of the three phase currents:

(a) by more than 5% for a standard nominal ***voltage*** up to 1 kV; and

(b) by more than 2% for a standard nominal ***voltage*** above 1 kV.

4.7.2 Despite clause 4.7.1, deviations are permissible for periods of less than 2 minutes:

(a) up to10% for a standard nominal ***voltage*** up to 1 kV; and

(b) up to 4% for a standard nominal ***voltage*** above 1 kV.

1 Victorian Electricity Distribution Code

7.3. Battery storage systems

The specific connection requirements described in this section for energy storage systems (which in most cases utilise batteries) are in addition to the requirements of Clause 7.1 and 7.2 above.

All grid connected battery storage systems:

(1) are defined as generator connections and as a result must meet all requirements for embedded generators.

(2) will require a Connection Agreement between the Customer and AusNet Services to permit the connection, irrespective of whether the battery system is intended to export to the network or not.

Export from a storage system has traditionally not been considered or even permitted due to the potential to export energy for profit under premium feed-in tariffs intended for solar power only. Feed-in tariffs that are now available for new EG connections do not generally make it economically attractive to export energy from a battery system. The major use of storage in this environment is to enable a customer to maximise their self-consumption from a solar PV system. A storage system may also be designed to charge at cheaper off-peak times and discharge to offset customer load during peak price periods. Some storage systems are able to operate in multiple modes, being grid connected and also operate independent of the electricity grid including backup power supply provision.

Technology and the National Market Rules have moved to enable revenue streams to EG customers for export of energy from small scale generation systems at times when the electricity market requires additional generation or to meet local peak load requirements. This brings about the possibility of storage systems exporting into the AusNet Services network.

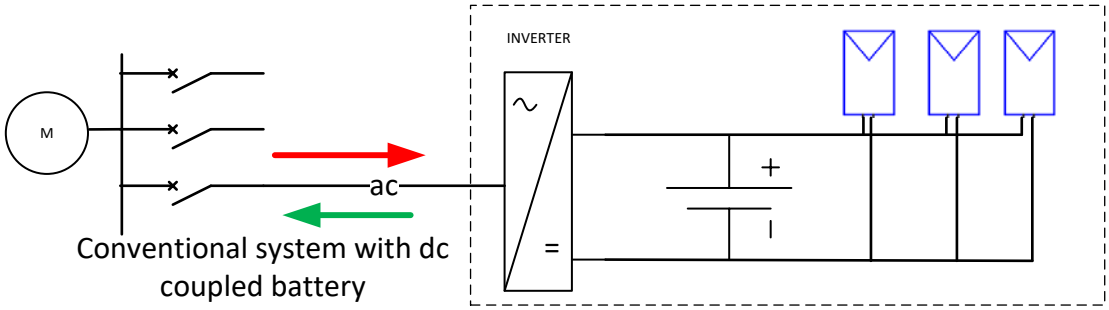
It is therefore important to define the total EG rated capacity at a site, inclusive of battery storage, as well as the agreed Export Limit as per the Connection Agreement.

The following sections are for information and describe the two main categories of EG designs that combine battery storage with solar PV.

7.3.1. DC coupled battery and solar systems

From a network connections perspective these are the simplest battery and solar systems as they utilise only one inverter. The batteries and solar are coupled together on the DC side of the inverter. This design is usually applied in new installations, rather than retrofits of storage onto existing solar PV. The Inverter must comply with AS/NZS 4777 requirements.

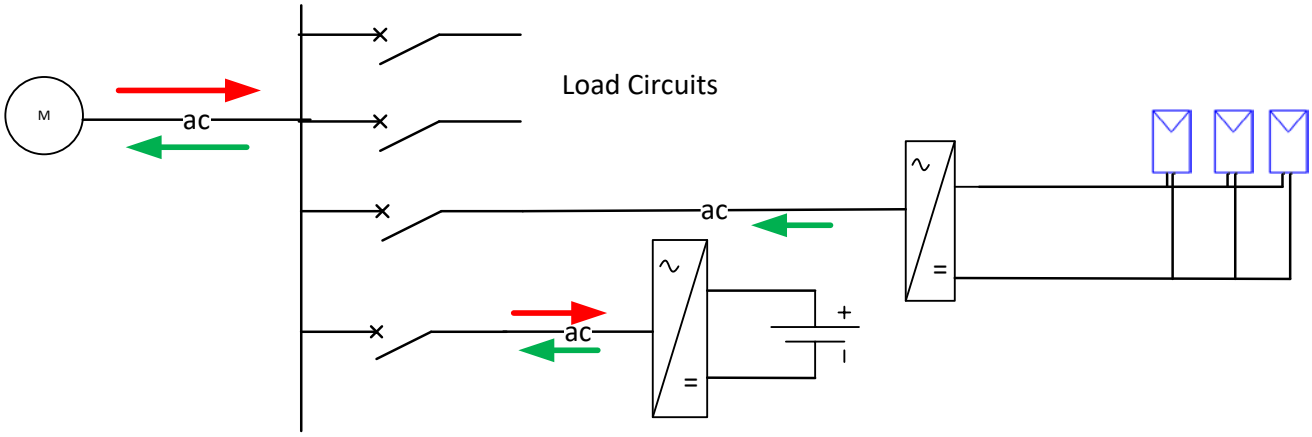
Figure 2 Example of a DC coupled solar and battery storage system



7.3.2. AC coupled battery and solar systems

The following diagram explains simply the concept of AC coupled system, where the battery and solar elements have separate inverters that are coupled together on the AC side. Each grid connected inverter must be compliant with AS/NZS 4777 and disconnect from the electricity network when the grid is not available. This coupling arrangement is often utilised to integrate a battery storage system into an existing conventional solar PV system.

Figure 3 Example of an AC coupled solar and battery storage system



Without limited export control that complies with this Policy, AC coupled systems are able to export the full capacity of the solar inverter plus the battery inverter ratings.

Therefore if the aggregate Rating of the solar PV system and battery system exceeds the Export Limits in Table 2 then the system will need to be designed for connection as a limited export system, where the inverters are automatically controlled to ensure that the agreed Export Limits are not breached.

8. Commissioning tests and settings traceability

Confirmation that the performance of the EG system is compliant with the Connection Agreement, including the agreed Export Limit, must be established by the Proponent at the time of first commissioning and connection to the network and the customer must ensure continued compliance as per Section 6.

8.1. Commissioning test requirements

An EG installation does not require a Commissioning Test Report where the total system Installed Capacity is less than the Export Limits in Table 2, or evidence of Factory Acceptance Testing and security of inverter settings (refer Section 8.2) has been provided. The system must successfully complete the connection and capability test conducted by the utility server following installation in order for the preapproved export limits to be applicable. Should the system fail this test or request an MSL exception in the preapproval stage, a default fallback export limit of 1 kW will be imposed for the entire site.

A Commissioning Test Report is required for approval of a limited export EG system, where the total system Rating is greater than the Export Limits in Table 2. Approval to connect will be revoked if the Commissioning Test Report is not provided within a satisfactory timeframe. The Commissioning Test Report is also required to ensure compliance with AS/NZS 4777.1:2024 Clause 7.2 (r).

A Commissioning Test Report must be completed and returned to AusNet Services before a limited export system is able to be permanently connected to the electricity network. Relevant Commissioning Test results for a limited export system are to be provided in the format shown in Section 9 or similar.

The Commissioning Test should be undertaken by a suitably trained and authorised tester utilising instruments of accuracy commensurate with the test requirement. The test results must be authorised by a Company Representative who is able to accept full responsibility and liability for the test results.

The proponent shall provide an opportunity for AusNet Services to witness any tests if requested. AusNet Services may request any tests to be repeated if the test results do not demonstrate compliance with the agreed performance.

8.2. Factory acceptance testing and type testing

An exception to the above requirement for commissioning tests is granted where the total system control scheme undergoes a similar Factory Acceptance Test (FAT) or Type testing, for compliance with Section 7 above prior to dispatch from the manufacturer, and where inverter settings are secure and cannot be altered during the installation process.

Details:

(1) the FAT must be traceable to the manufacturer or their approved local agent

(2) a copy of the manufacturer's FAT report is to be provided to AusNet Services

(3) for single EG device systems (e.g. solar PV panels, storage and inverter) Type Testing by the Manufacturer is acceptable provided the Manufacturer or their agent takes responsibility for the initial onsite performance of the system and a copy of the full Type Test Laboratory Report is provided to AusNet Services.

9. Limited export commissioning test report

This Limited Export Commissioning Test Report, or equivalent, is to be completed by the Proponent and returned to AusNet Services in order for network connection under a Connection Agreement.

9.1. Standard control settings

Method: Site generation must be greater than the Limited Export Setting. Measure actual export kVA with test load connected. Turn off test load so that the resultant export momentarily exceeds the Limited Export Setting, and record results. Test load is recommended to be at least 1kW.

TEST RESULTS: STANDARD CONTROL SETTINGS				
Contracted Limited Export Setting kVA	**Actual kVA export (+/- 5%) prior to test**	**Time (sec) to return to Export Limit after test load is removed (required to be less than 15 sec)**	**Actual kVA export (+/- 5%) after test load is removed and stabilised**	**Test Result Pass/Fail**
kVA	kVA	sec	kVA	

9.2. Alternate control settings

If the agreed Export Limit is relatively high compared to the Rating of the EG system and the amount of generation is insufficient to reach the Export Limit, it is acceptable to temporarily change the export limit setting in the system controller to an alternate lower setting (such as 1kVA) in order to demonstrate system performance and compliance.

Method: Reprogram Limited Export setting to nominated export Test Value kVA_{test}. Site generation must be greater than the Test Value. Measure actual export kVA with test load connected. Turn off test load so that the resultant site export momentarily exceeds the export Test Value, and record results. Test load is recommended to be at least 1kW. Once test is completed, reprogram the inverter Limited Export setting to the Contracted Limited Export Setting.

Nominated Test Value kVAtest	kVA	Setting altered to Test Value (date and time)

TEST RESULTS: ALTERNATE CONTROL SETTINGS				
Nominated Test Value kVA_{test}	**Actual kVA export (+/- 5%) prior to test**	**Time (sec) to return to Test Value after test load is removed (required to be less than 15 sec)**	**Actual kVA export (+/- 5%) after test load is removed and stabilised**	**Test Result Pass/Fail**
kVA	kVA	sec	kVA	

Contracted Limited Export setting (kVA)	kVA	Setting reset to Contracted Export Limit (date and time)

9.3. Loss of communications

Refer to AS/NZS 4777.1:2024 Clause 3.4.8

Test to perform	**Expected**	**Initial Output kVA** (must be greater than Export Limit)	**Reduced Output kVA** after loss of signal	**Comments**	**Result Pass/Fail**
Loss of signal path from sensing device to Inverter Energy System	Reduce IES output to or below Contracted Export Limit	kVA	kVA		

Test	**Expected**	**Actual time (sec)**	**Comments**	**Result Pass/Fail**
Reconnection Time upon restoration of communications	Min 60 sec	sec		

9.4. Comments

9.5. Test report sign off

TESTED BY	
Signature	
Full Name	
Company	
ACN/ABN	
Date	

10. Legislative references

STATE	REGULATOR	REFERENCE
VIC	Essential Services Commission	Electricity Distribution Code of Practice
VIC	Victorian Service Installation Rules Management Committee	Victorian Service and Installation Rules 2014 (SIRs)
ALL	Standards Australia	AS3000 Wiring Rules
ALL	Clean Energy Regulator (CER)	AS/NZS 4777 Grid connection of energy systems via inverters Parts 1 and 2

11. Resource references

DOCUMENT ID	DOCUMENT TITLE
SOP 11-16	Protection requirements for Embedded Generators
AusNet Services' minimum system requirements	All inverter energy system installations including battery and photovoltaic systems (available on AusNet Services' website)

12. Appendices

Appendix A – Installed capacity

13. Schedule of revisions

ISSUE	DATE	AUTHOR	DETAILS OF CHANGE
1	13/3/2014	M Rankin	Initial document
2	30/9/2015	M Rankin	Updates and addition of section on PV panel oversizing
3	13/10/2015	B Colavizza	Administrative update
4	17/3/2017	M Rankin	Inclusion of Storage Systems and major review
5	3/7/2017	M Rankin	Update export limit per phase and Appendix A
6	17/9/2024	R Muneer	Updated SEB requirements for all system sizes

Appendices

Appendix A – Installed Capacity

Individual Ratings are determined according to the following to reflect the maximum capacity available to the network from the Energy Source.

(1) Inverter Energy Systems (IES): the sum per phase of the total rating of all inverters (including all solar inverters, battery inverters, hydro inverters, wind inverters, fuel cell inverters, etc).

(2) Non IES: total rating of all synchronous or induction generators and alternators (incl all engine driven, wind, hydro, etc).

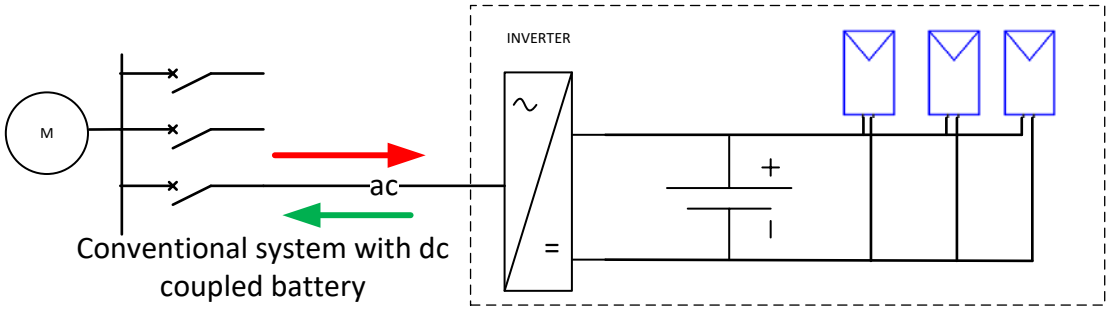
A.1. Solar and battery system examples

Examples of combined or "hybrid" solar and battery system designs are shown below. Many other variations in installation design are possible, but generally installation design can be divided into "AC coupled" and "DC-coupled" approaches.

A.1.1. DC coupled systems

From a network connection perspective, DC coupled systems are the simplest solar and battery systems as they utilise only one inverter. The batteries and solar are coupled together on the DC side of the inverter. This design is usually applied in new installations, rather than retrofits of storage onto existing solar PV.

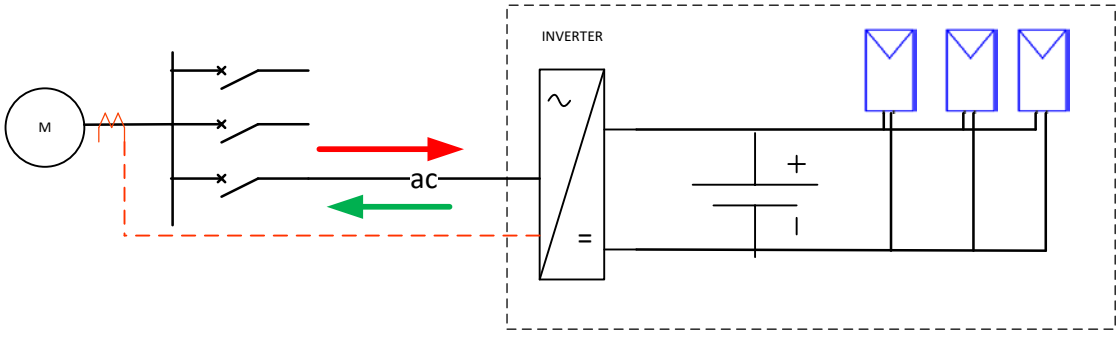
DC coupled and inverter controlled



Installed Capacity = the common inverter rating

Not export limited.

DC coupled with export control



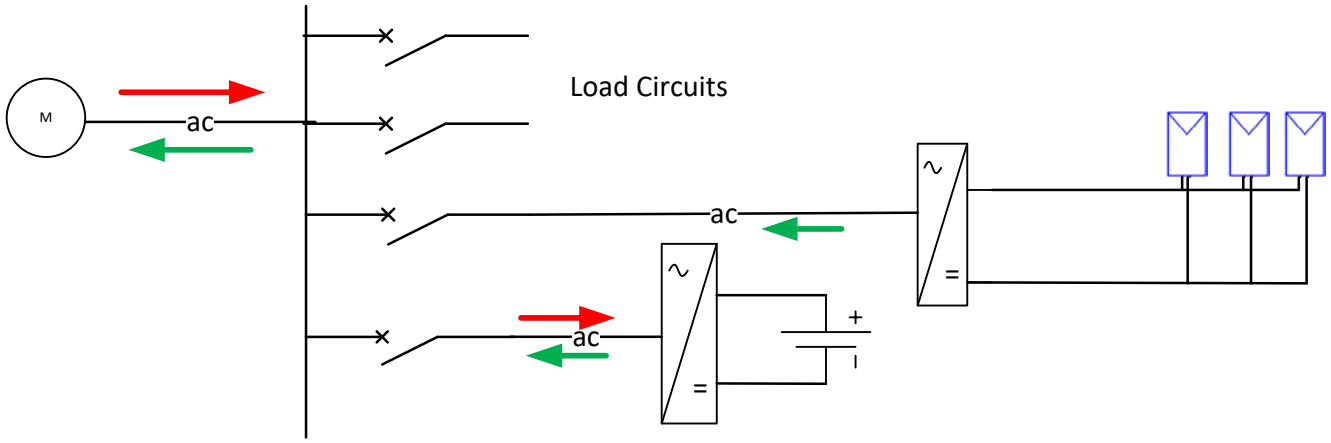
Installed Capacity = the common inverter rating

Export is able to be limited by local measurement of power at connection point, with control of common inverter. Export control can be either achieved within the inverter or controlled via an external controller (not shown).

A.1.2. AC coupled systems

The following diagram explains simply the concept of AC coupled systems. Each grid connected inverter must be compliant with AS/NZS 4777 and disconnect from the electricity network when the grid is not available. This coupling arrangement is most often utilised to integrate a battery storage system into an existing conventional solar PV system.

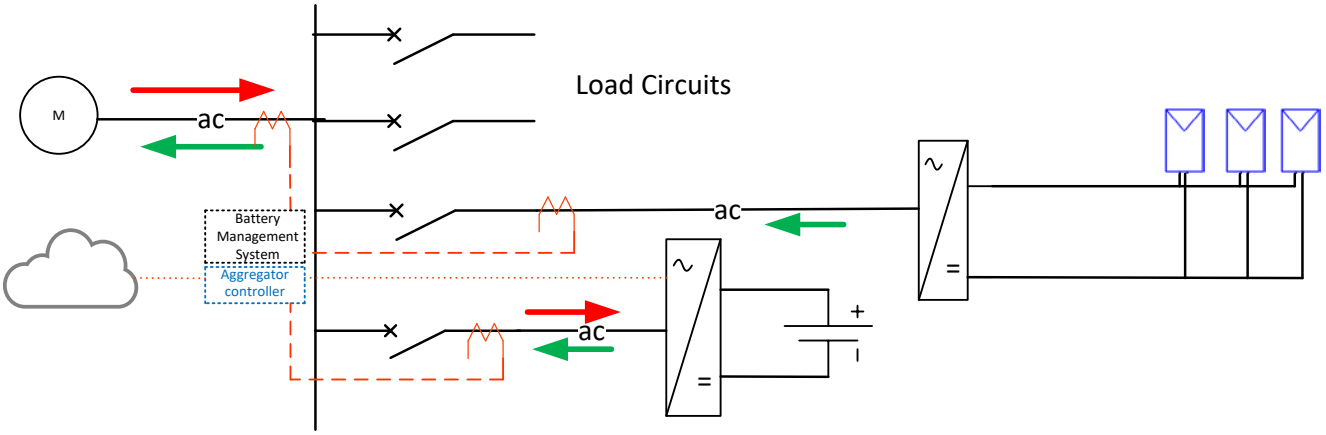
AC coupled and inverter controlled



Installed Capacity = solar inverter rating + battery inverter rating

Not export limited.

AC coupled with export control and remote signalling



Installed Capacity = solar inverter rating + battery inverter rating

Export is able to be limited by local measurement of power at connection point, with control of one or more inverters.

Note: Aggregator Control module is separate and optional but must not interfere in any way with the limited export control or over-ride the export limit as established by the Connection Agreement.

AusNet Services

Level 31
2 Southbank Boulevard
Southbank VIC 3006
T +613 9695 6000
F +613 9695 6666
Locked Bag 14051 Melbourne City Mail Centre Melbourne VIC 8001
www.AusNetservices.com.au

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