Battery Booster Program – Installer Guide

Department of Energy and Climate

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→ **The Power of Commitment**

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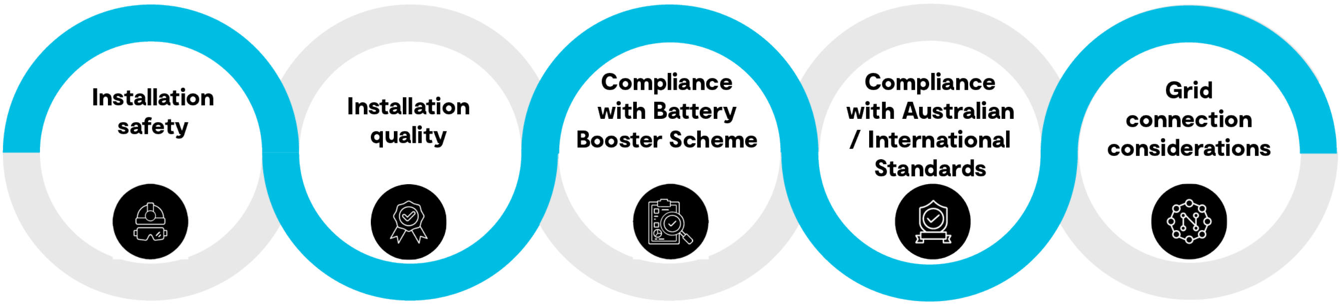
1. Introduction

The Battery Booster Program (the Program) is an initiative under Action 2.2 of the Queensland Energy and Jobs Plan, aimed at helping households to better manage their electricity use and bills. The Program offers rebates to households who purchase and install home battery systems.

As battery energy storage systems are still an emerging technology, the Department of Energy and Climate (DEC) has engaged GHD to develop this guide.

Safety for industry and for households installing batteries is a key priority of the Queensland Government and this guide has been designed to support installers and designers in delivering high quality, safe battery systems that comply with Battery Booster Program requirements.

This document provides guidance in the following five key areas:



Installation safety

In recent years, several safety incidents (e.g., fires) linked to residential battery systems in Australia have arisen. The Installer Guide summarises key hazards and regulatory requirements that must be considered at the time of battery system installation under the Program to reduce the risk of unsafe installations.

Installation quality

The Installer Guide highlights potential issues such as isolation, labelling and signage. It also provides guidance around operations and maintenance, as well as system documentation.

Compliance with the accreditation requirements

From 2024, the Clean Energy Regulator is expected to announce a new national accreditation provider for solar and battery installation. The Battery Booster Program is a rebate for homeowners that will operate in parallel with the CER's new accreditation scheme.

Compliance with Australian/ International Standards

Australian and International Standards have been developed to reduce risks and hazards associated with solar battery installation. The guide identifies Australian and International Standards that must be met under the Battery Booster Program.

Grid connection considerations

The grid connection landscape for batteries is rapidly changing. Therefore, customers may find it challenging to keep up with information surrounding the rights and opportunities a system owner can have when buying and installing a new battery. The Installer Guide describes grid connection considerations such as dynamic connections, virtual power plants and embedded networks to support you in providing your clients with the most up to date information regarding their options.

1.1 Scope and qualifications

The scope of this document is limited to ensure that the five key areas described above can be adequately addressed. As such, while the content of this document may provide useful general information, the following qualifications apply:

1. This document does not form part of a Queensland Government regulatory framework and is a resource for Installers participating in the Battery Booster program.
2. This document describes battery systems (including pre-assembled units) with the following ratings:
   a. A nominal voltage equal to or greater than $12V_{DC}$
   b. Rated capacity between 1kWh and 200 kWh.
3. This document applies to the installation of home battery systems up to the terminals of power conversion equipment (PCE), such as inverters and/or charge controllers. That is, the scope includes the following:
   a. Battery system (including battery enclosure)
   b. Cabling
   c. Switchgear (Protection & Isolation Devices)
   d. Auxiliary equipment such as protective devices and other equipment required by the manufacturer
4. This document covers the installation of pre-assembled integrated battery energy storage systems (BESS) which includes the battery system, cabling, switchgear, power conversion equipment and auxiliary equipment.
5. This document is intended for use by qualified installers of residential batteries who are accredited under the Program in writing.
6. It is assumed that any party reading this document will have existing knowledge of battery systems and general electrical installations in Queensland and relevant training as required to be a Battery Booster Approved Installer. As such, this document does not aim to provide guidance on the fundamentals of battery systems or electrical installations.
7. This document highlights considerations for battery system installation, not battery system design. While design considerations may be addressed, these are a secondary inclusion for reference only.
8. This document primarily concerns grid-connected battery systems. While off-grid capabilities of batteries have been addressed in some sections, these are not the primary focus of this document.
9. This document includes and references content from relevant Australian and international Standards. While limited content from these Standards have been included for reference, this document does not supersede any Standards and does not negate the need to comply with any Standards or other regulatory requirements.

10. Where content from any external documents (including Standards) has been included in this document, these inclusions are incomplete and are intended to act as a reference only.
11. This document must be read in conjunction with any relevant Standards or other referenced documents.
12. This document is intended as an overview and in the event of a conflict between this document and any relevant Standard or regulatory document, the relevant Standard or regulatory document will take precedence over this document.
13. This document references Standards which were current at the date of this document's release. Note that standards may have been updated since this document's release. Where general compliance to a standard is referenced, the standard is addressed as, for example AS5139 but where reference to a specific clause (current at the time of writing) is referred to, the reference will include a year, e.g. AS5139:2021 Cl 4.2.2.2 (b) When the standard is amended or re-issued, this style of reference does not intend to refer to an outdated document but rather a way of finding the original reference in the standard and extrapolating it to the current version which may well have an alternate clause number.
14. Batteries installed under the Program will be Lithium-based technology (i.e., Lithium iron phosphate or LFP, Lithium titanate or LTO, and Lithium nickel manganese cobalt oxides or NMC) chosen from the Approved Battery list. They will be installed by an accredited installer on the Approved Installer list.
15. All batteries will be installed in accordance with Chapter 4 or 5 of AS5139. This means installation of a BESS or a Battery System (BS) in conjunction with an approved inverter and conformance to the provisions of the Best Practice Guide and the many Australian Standards. Systems under Chapter 6 of AS5139 are excluded from this Program.
16. This report has been prepared by GHD for Department of Energy and Climate and may only be used and relied upon by Department of Energy and Climate for the purpose agreed between GHD and Department of Energy and Climate.
17. GHD otherwise disclaims responsibility to any person other than Department of Energy and Climate arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.
18. The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.
19. The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.
20. The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.
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1.2 Standards and guidelines

A variety of Standards and guidelines are referenced throughout this guide. These have been summarised below. Please note that this is not an exhaustive list, and other Standards may be applicable. Also, while this document references the versions of these Standards which were current at the time of this document's creation, the most current version of each Standard must apply at the time of installation.

Table 1 List of relevant Standards

Standard
AS 1170.4 Structural design actions – Earthquake actions in Australia
AS 1319 Safety signs for the occupational environment

Standard
AS 1768 – Lightning Protection
AS 2676.1 Guide to the installation, maintenance, testing and replacement of secondary batteries in buildings – Vented cells
AS 2676.2 Guide to the installation, maintenance, testing and replacement of secondary batteries in buildings – Sealed cells
AS 3011.1 Electrical installations – Secondary batteries installed in buildings – Vented cells
AS 3011.2 Electrical installations – Secondary batteries installed in buildings – Sealed cells
AS 4086 – Secondary batteries for use with stand-alone power systems Installation and maintenance
AS 4086.2 Secondary batteries for use with stand-alone power systems – Installation and maintenance
AS 4509 – Stand-alone power systems
AS 60950.1 Information technology equipment – Safety – General requirements
AS 62040.1.1 Uninterruptible power systems (UPS) – General and safety requirements for UPS used in operator access areas
AS 62040.1.2 Uninterruptible power systems (UPS) – General and safety requirements for UPS used in restricted access locations
AS/ NZS 5000.1 Electric cables – Polymeric insulated – For working voltages up to and including 0.6/1 (1.2) kV
AS/NZS 1170.2 – Wind Loads
AS/NZS 3000 – Electrical Wiring Rules
AS/NZS 3000 Electrical installations (known as the Australian/New Zealand Wiring Rules)
AS/NZS 4509.1 Stand-alone power systems – Safety and installation
AS/NZS 4509.2 Stand-alone power systems – System design
AS/NZS 4777.1 Grid connection of energy systems via inverters – Installation requirements
AS/NZS 4777.2 Grid connection of energy systems via inverters – Inverter requirements
AS/NZS 5000.2 Electric cables – Polymeric insulated – For working voltages up to and including 450/750 V
AS/NZS 5033 – Installation of photovoltaic (PV) arrays
AS/NZS 5139 Electrical installations – Safety of battery systems for use with power conversion equipment.
IEC 62109-1 Safety of Power Converters For Use In Photovoltaic Power Systems – Part 1: General Requirements
IEC 62109-2 Safety of Power Converters For Use In Photovoltaic Power Systems – Part 2: Particular Requirements For Inverters
IEC 62619 Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells and batteries, for use in industrial applications
STNW1170 – Standard for Small IES Connections
STNW1174 – Standard for Low Voltage Embedded Generating Connections
STNW3510 – Dynamic Standard for Small IES Connections
STNW3511 – Dynamic Standard for Low Voltage Embedded Generation Connections
Queensland Electricity Connection Manual V4

1.3 Definitions

Where possible, terms and definitions for this document have been derived from relevant Standards, codes, and/or industry terminology.

Some terms have been adapted in line with industry and market developments or translated into plain language. Other terms are unique to this document.

Table 2 Relevant definitions

Term	Definition
Adjacent	Within three meters, where each item is fully visible from both locations
Arc flash	An electrical explosion or discharge, which occurs between electrified conductors during a fault or short circuit condition
Authorised person	A person in charge of the premises, or the licensed electrician/contractor/accredited person, or other such person appointed or selected by the person in charge of the premises to perform certain duties
Battery	A unit consisting of one or more energy storage cells connected in series, parallel or both.
Battery Cell	A basic functional unit of a battery generally containing electrodes, electrolyte, terminals, etc.
Battery Energy Storage System (BESS)	A system consisting of power conversion equipment (PCE), battery system (s), switchgear, and other such equipment. A BESS may be manufactured as a complete package where all above components are integrated into a single assembly with pre-engineered connections (referred to as a “Pre-assembled BESS” in this document.)
Battery Enclosure	An enclosure containing a battery or batteries suitable for the installation location and associated components.
Battery Management System (BMS)	An electronic device which safely manages a battery/battery system by ensuring it is within its safe operating parameters. Such parameters generally include overcharge, overcurrent, over discharge, overheating, etc.
Best Practice Guide	Means `Best Practice Guide: Battery Storage Equipment – Electrical Safety Requirements’
Inverter	The interface between the electricity grid and the solar and/or battery system. It manages how the system interacts with the grid, including how it behaves under different grid conditions (such as during voltage or frequency disturbances).
Battery Module	One or more batteries linked together, generally incorporating electronics for monitoring, cycling and/or protection.
Battery System	A system comprising one or more cells, modules, or battery systems. It may include a battery management system (BMS), auxiliary equipment and other supporting equipment. It does not include power conversion equipment (PCE).
Bunding/Bund	A physical system for the retention of potentially hazardous substances, e.g. electrolyte.
Combustible material	a material that, in the form in which it is used and under the conditions anticipated, will ignite and burn.
Contact, direct	Contact with a conductor/conductive part that is live in normal service.
Contact, indirect	Contact with a conductor/conductive part that is not normally live but has become live under fault conditions (e.g. due to a breakdown of insulation).
Damp situation	A situation in which moisture is either permanently or intermittently present to the extent that it impairs the effectiveness and safety of an electrical installation
Dwelling, domestic	An Australian building as specified in the National Construction Code (NCC) under Australian building classifications, as follows: Class 1, examples include: Detached house Terrace house Town house Villa unit Boarding house/ guest house/ hostel (subject to specified conditions – refer to clause 1.3.2(b) of the National Construction Code 2015, Volume 2) Class 2, examples include: A building containing 2 or more sole-occupancy units each being a separate dwelling – such as an apartment block Class 10, examples include: A non-habitable building being a private garage, carport, shed, etc. Note that AS/NZS 5033:2014 includes Class 3 as a domestic dwelling. However, this document and AS/NZS 4777.1 does not include Class 3 as a domestic dwelling.

Term	Definition
Dwelling, non-domestic	An Australian building as specified in the National Construction Code (NCC) under Australian building classifications, that is not Class 1, Class 2, or Class 10.
Fire resistance level (FRL)	As defined in the National Construction Code (NCC), is the grading period in minutes for three criteria: structural adequacy, integrity, and insulation.
Inverter Energy System (IES)	A system comprising one or more inverters together with one or more energy sources (which may include a battery) and controls, where the inverter(s) satisfies the requirements of AS/NZS 4777.2.
Material Safety Data Sheet (MSDS)	See Safety Data Sheet (SDS)
Port (of PCE)	Access to a device (e.g. inverter) where electromagnetic energy or signals may be supplied or received
Power conversion Equipment (PCE)	An electrical device that converts one kind of electrical power from a voltage or current source into another with respect to voltage, current and frequency (e.g. inverters, charge controllers, etc.)
Readily available	Capable of being reached for inspection, maintenance, or repairs (without having to dismantle structural parts, cupboards, benches, etc.)
Readily accessible	Capable of being reached quickly without having to remove obstructions, use of elevation equipment (e.g. ladder); and not more than 2m above the ground/ floor/ platform.
Restricted access (to battery system/ pre-assembled BESS)	Access restricted, to authorised persons, to the following: Restricted access (to battery system/ pre-assembled BESS) – Access restricted, to authorised persons, to the following: DC isolation devices DC overcurrent devices DC cabling (between batteries/ battery modules and DC overcurrent devices) Live parts (e.g. PCE input terminals, battery cell terminals, DC busbars, etc.) Access can be restricted: By a barrier, such as: – A perimeter fence/ barrier/ door to a dedicated room with access only via a padlocked/ equivalently secured gate/ door; or, – Enclosure (where the relevant parts are fully enclosed and are only accessible with the use of a tool (e.g. screwdriver, key, etc.) By location (e.g. where there is no ready means of access) Note that restricted access is not required for DC battery cabling between batteries/ battery module overcurrent and PCE. However, the general cable installation requirements of AS/NZS 3000 must apply.
Risk assessment	A risk assessment builds knowledge and understanding about hazards and risks that have been identified so that informed decisions can be taken about controlling them.
Safe work procedures	A part of a risk management process which outlines hazards, risks, and control measures to be applied to ensure an activity is conducted in a way that satisfactorily reduces the risk of injury
Stationary batteries	Stationary batteries – permanently installed batteries, not in use for a portable application.
Safety Data Sheet (SDS)	Safety Data Sheet (SDS) – a document that provides critical information about hazardous materials. Typically, such information includes the chemical's identity and ingredients, health and physical hazards, safe handling and storage procedures, emergency procedures and disposal considerations.

2. Battery System Hazards

Hazards associated with battery systems/pre-assembled BESS can be broadly classified as follows.


Electrical


Chemical


Energy


Toxic and Flammable gas


Fire


Mechanical

Each battery chemistry presents its own combination of hazards under each of these categories. Where hazards are identified, risk reduction methods can often be applied to reduce or eliminate these risks and protect persons, property, and livestock from factors such as electric shock/electrocution, fire, and physical injury. Common hazards for battery systems are described in Section 2.1, and hazard mitigation methods are described in Section 2.2 Hazard classification.

2.1 Hazard overview

2.1.1 Electrical

2.1.1.1 General

The electrical risks associated with battery systems are dependent on the voltage of the battery system and other connected equipment – such as earthing, protection devices, etc. AS/NZS 5139 mandates the completion of two Risk Assessments, firstly the usual WHS risk assessment as undertaken for any electrical work and secondly, a Battery Risk Assessment is detailed as an informative inclusion in Appendix G of AS/NZS 5139.

2.1.1.2 Decisive Voltage Classification (DVC)

Decisive Voltage Classification (DVC), as defined in IEC 62109, informs the level of electric shock hazard. It also informs the designer/installer on safety measures required for electrical protection, enclosures, and interlocks. Table 3 provides a summary of DVC levels.

Table 3 Summary of Decisive Voltage Classification (DVC) ranges

Decisive Voltage Classification (DVC)	Limits of Working Voltage (V)		
	AC Voltage U_{ACL} r.m.s.	AC Voltage U_{ACPL} peak	DC Voltage U_{DCL} mean
A	≤ 25	≤ 35.4	≤ 60
B	≤ 50	≤ 71	≤ 120
C	> 50	> 71	> 120

Notes:

1. Under fault conditions, DVC-A circuits are permitted to have voltages up to the DVC-B limits for a maximum of 0.2s.
2. For DC voltages greater than extra low voltage (120V ripple free) and not exceeding 1,500V, AS/NZS 3000 defines this as low voltage.
3. Where a battery system has a nominal voltage of 48VDC (DVC-A) but exceeds 60VDC (but not exceeding 120VDC) under charging – including boost – conditions, it would be classified as DVC-B.

DVC refers to the voltage level and the degree of separation of the relevant battery port from the grid or other energy source. It is the highest voltage that occurs continuously between two live parts during worst case conditions or between a live part and earth.

Where a battery system is within the DVC A (e.g. 48V) range and is connected to a PCE port also within the DVC A range, it is considered relatively safe with respect to an electric shock hazard (although other types of hazards may be present).

Decisive Voltage Classification splits Extra-low voltage (ELV) into two categories, A and B and DVC C is similar to LV. It should be noted that DVC considers not just the voltage between two terminals but is also dependent on the common mode voltage of either terminal.

However, where a battery system is within the DVC A (e.g. 48V) range and is connected to a PCE port classified as DVC C (for example, a non-separated inverter connected to the grid) the entire battery system would be classified as DVC C.

The applicable DVC is always the highest classification of the equipment within, and connected to, a battery system, which may be greater than the voltage at the battery terminals.

2.1.1.3 Battery system short-circuit current/prospective fault current

The prospective short circuit/fault current may be significant in a battery system. This condition occurs where the impedance between conductors is almost zero and overcurrent protection does not operate.

The short circuit/ prospective fault current should be obtained from the battery system manufacturer.

2.1.2 Energy

A battery has sufficient energy to cause an arc flash if it suffers a short circuit or fault. Generally, higher battery energy storage capacities have a higher risk of arc flash. Arcing faults may cause catastrophic failure of battery cell enclosures unless the fault currents are removed quickly by correctly rated electrical protective devices. An energy, or arc flash, hazard occurs where there is a release of energy caused by electrified conductors when there is insufficient isolation or insulation to withstand the applied voltage. Under such conditions, electrical energy is transferred into other forms of energy including heat, light, and sound.

The arc flash incident energy can be calculated using equation 3.2.4(1) in AS5139:2019 and once known, Table 3.3 of the same standard gives guidance on the PPE required to afford protection.

The severity of any such energy hazard depends on:

– Voltage
– Current
– Duration of event
– Proximity to the hazard
– Obstructions near the hazard

Such a hazard may occur under the following scenarios:

- Accidental contact between battery terminals with a conductive tool – such as an uninsulated socket wrench, spanner, etc.
- A dead short within connected PCEs
- A build-up of conductive material across conductors – such as fluid, metal shavings, etc.
- Damage to cable insulation, resulting in electrical conductivity between copper conductors.

In addition to other risk reduction methods, batteries and associated DC cabling must:

- Be protected from mechanical damage.
- Access to battery systems and pre-assembled BESS must be restricted to authorised persons. (Refer to “Restricted Access” and “Authorised Persons” in *1.3*)

2.1.3 Fire

The manufacturer’s SDS must be assessed to determine if a fire risk is present as per 3.1.2 Safety Data Sheet (SDS).

Note that a fire hazard is distinct from:

- An “energy” hazard as defined in 2.1.2 Energy Hazard
- An “explosive gas” hazard as defined in 2.1.5 Toxic & Flammable Gas Hazard

A fire hazard may be present in any chemistry type.

As per United Nations (UN) 38.3, abuses that may result in fire include:

- Low ambient pressure
- Overheating
- Vibration
- Shock
- External short circuit
- Impact
- Overcharge
- Forced discharge.

2.1.4 Chemical

Home battery systems are made up of a cluster of battery cells in clusters of battery modules, chemical hazard in home battery systems occur at the cell level. The battery cell casings can be degraded or be damaged by impacts if tampered with. They can also rupture as a result of excessive temperatures and excessive pressure generated from a change in chemical reaction from overcharging, forced discharge or following a short circuit. Electrolyte (fluid or gel) can leak from a ruptured casing, resulting in toxic fumes, burns, corrosion, or explosion. Some compounds produced during the failure of a cell can be extremely toxic. The clean-up, decontamination and disposal of damaged equipment require specialised equipment and skills. Disposal of battery systems at the end of their service life usually will require treatment as a hazardous waste because they can still pose a chemical hazard.

There are many types of chemical hazards that a battery system may represent. Such hazards may concern one or more of the following:

- Health (to persons and animals)
- Physical (such as damage to equipment)
- Environment (including soil and water contamination)

2.1.5 Toxic and flammable gases

2.1.5.1 General

When manufactured, installed, and operating properly, home Battery systems made with lithium-ion batteries do not pose a toxic or flammable gas hazard. However, when overcharged or short circuited, lithium-ion battery cells are prone to thermal runaway which is characterised by violent bursting of one or multiple battery cells, hissing and release of toxic, flammable and explosive gases, and an intense, self-sustaining fire that can be difficult to extinguish. This is because the electrolyte in the battery cells generally contain Lithium Hexa-Fluoro-Phosphate ($LiPF_6$) which is flammable and toxic. In the event of overheating during thermal runaway, the electrolyte vaporises to release toxic gases like CO, CO_2, and HF (Hydrogen Fluoride). The reaction of these gases with oxygen in the atmosphere often leads to battery fires and explosions. This is one of the reasons why it is unsafe to extinguish a lithium-ion fire with a traditional fire extinguisher, taking away oxygen with the use of a carbon dioxide fire extinguisher further complicates the issue as the heating of the electrolytes will generate flammable gases, vapours, and smoke that are highly toxic to inhale. The formation of a flammable gas cloud is the precursor to an even worse outcome, an explosion.

As detailed in section 3, before commencing installation, the accredited installer should carry out a risk assessment for each installation in compliance with AS/NZS 5139 and identify any other hazards identified at the site to ensure compliance with AS/NZS 3000 and other relevant Australian standards. This is to ensure that risks of fire, explosion, discharge of flammable gas, rupture, or leakage from the product itself is minimized.

The following general details apply to risks associated with toxic and flammable gas hazards:

Potential sources:

- Battery abuse
- Fault conditions (short circuit, overvoltage, overcharge, or discharge)
- Reactions due to thermal runaway
- Inadvertent release and ignition of flammable gases
- Generation of explosive gases and cloud

Consequences:

- Intense irritation and burns to the eyes and skin
- Burns to airway tissues from corrosive gases
- Poisoning
- Asphyxiation
- Carcinogenicity and cancer promotion

Controls:

- Follow manufacturer’s instructions as per installation and maintenance activities
- Inspect equipment for damage prior to installation
- See AS/NZS 5139 and follow recommended guidelines
- Ensure that all necessary forms of PPE are used during installation/maintenance

2.1.6 Mechanical

All battery systems represent a mechanical hazard. With respect to lithium-ion home battery BESS, this hazard relates to the following:

- Weight
- Sharp edges/corners
- Limited balance points (e.g. tall and thin battery profiles)

Mechanical hazards may be due to:

- Inappropriate battery accommodation and arrangement
- An external force originating from vibrations and abuse of the battery system.

Consequences of mechanical hazards associated with home battery systems can include bump or trip hazards that can lead to a fall or physical injuries.

When installing battery systems, consideration must be given to:

- Type
- Quantity
- Profile
- Size
- Battery enclosure and footing (if any)
- Installation of bollards

For more information on Mechanical protection, refer to section 3.2.6 Mechanical Protection.

2.2 Hazard mitigation

2.2.1 Electrical

2.2.1.1 General

Batteries can be a serious safety risk for occupants and installers if incorrectly installed and operated, potentially leading to electric shock, fire, flash burns, explosion or exposure to hazardous chemicals and released gases.

Where battery systems include accessible live parts and terminals provision must be made to prevent:

- Direct contact; and,
- Indirect contact

Exposed components must be insulated and/ or shrouded and mechanically protected, including:

- Terminals
- Inter battery system cabling.
- Connections (a small hole for testing probes may be provided above each terminal)

Where a battery system voltage exceeds DVC-A, it must:

- Be fitted with isolating switches, plugs or links to separate it into sections not exceeding DVC-A
- Be installed to sectionalise the battery into voltage blocks not exceeding DVC-A.

2.2.1.2 Pre-assembled BESS

Where a battery system is incorporated into a pre-assembled integrated BESS, manufactured as a complete package, and complies AS 62040.1.1 the following clauses need not apply:

– 2.2.1.3 Isolation
– 2.2.1.4 Overcurrent Protection
– 2.2.1.5 Battery System Output Wiring

2.2.1.3 Isolation

2.2.1.3.1 General

An isolation device must be installed between a battery system and PCE; and must meet the following requirements:

– Be capable of being secured in the open position
– Be non-polarised
– If battery voltage is rated DVC A
  - Be rated for voltage and 1.25 x DC current under normal conditions and expected current under fault conditions. (This allows for second harmonic current in the DC cables).
– Be rated for voltage and current under normal conditions and fault conditions
– Be DC rated
– Operate simultaneously on both poles
– Comply with AS/NZS 60947.3
– Comply with the general requirements for isolation and switching in AS/NZS 3000
– Remain in place if the PCE is removed, where the PCE is a grid-connected inverter with battery storage, as per AS/NZS 4777.1, Clause 4.5.

A combined isolation and overcurrent protection device may be used - subject to compliance with all isolation and overcurrent requirements.

2.2.1.3.2 Parallel battery systems

Where multiple battery systems are connected in parallel, each battery system must have an isolator.

2.2.1.3.3 Location

The isolation device must be:

– Installed as close as practicable to the battery system
– Readily available

An isolation device should be adjacent to the PCE to which it is connected, where the PCE is a grid-connected inverter, an isolation device must be adjacent to the inverter port to which it is connected.

Battery systems with inbuilt isolators are not exempt from this rule. The purpose of this Clause is to allow safe isolation to repair or replace the equipment where required. Until such time as AS/NZS 5139 Safety of Battery Systems for use with PCE’s is released and then referenced in AS/NZS 3000, the requirements of the Wiring Rules would apply. AS/NZS 3000 Clause 7.3.4.2 states that where batteries are incorporated in an electricity generation system, a switch capable of interrupting the supply from such batteries must be installed adjacent to the batteries and must be clearly identified to indicate its purpose.

Therefore, on such systems as mentioned, an isolator meeting the requirements of AS/NZS 3000 must be installed between the battery system and the PCE. In compliance with AS/NZS 3000 Cl 2.3.2.2.1, where the battery energy system has an AC output, (such as a Tesla), an AC isolation device complying with the requirements in AS/NZS 3000 must be installed adjacent to the Battery unit. A DC Isolation device must comply with AS/NZS 5033 Cl 4.3.5.

2.2.1.4 Overcurrent protection

2.2.1.4.1 General

Overcurrent protection must be installed between a battery system and PCE; and meet the following requirements:

- Be non-polarised
- Be DC rated
- If battery voltage is rated DVC A
  - Be rated for voltage and 1.25 x DC current under normal conditions and expected current under fault conditions, (this is required practice although not currently a requirement of any Australian standards)
- Be rated for voltage and current under normal conditions and fault conditions
- Be rated to protect battery system cabling
- Comply with the general requirements in AS/NZS 3000
- Meet relevant product standards (e.g. AS 1775, AS 3947.3, etc.)
- Must not be a semi-conductor (solid-state) device

Overcurrent protection should be selected from the following:

- Circuit breakers
- HRC fuses

A battery system which does not have either output conductor connected to earth must have overcurrent protection installed in all live conductors.

2.2.1.4.2 Parallel battery systems

Where multiple battery systems are connected in parallel, each battery system must have separate overcurrent protection in both legs of each string.

2.2.1.4.3 Location

The overcurrent device must be:

- Installed as close as practicable to the battery system (to minimise the length of unprotected cable)
- Readily available

2.2.1.5 Battery system output wiring

2.2.1.5.1 General

Battery system output cables must meet the following requirements:

- Be DC rated
- Have a voltage rating equal to or exceeding the DVC
- Have a fault and normal operating current greater than the overcurrent protection device, including operation time of the device, note requirement to allow a 1.25 multiplying factor for Battery Systems operating at DVC A
- Be multi-stranded
- Be clearly identified (e.g. “BATTERY”) at intervals not exceeding 2m.
- Where cabling is in a wiring enclosure (e.g. conduit), the wiring enclosure must be labelled as above.
- Cable identification must be durable, permanent, legible, indelible, and visible.
- Selected as to minimise the risk of short circuit and earth faults (e.g. double-insulated)
- Be mechanically protected by PVC conduit or equivalent protection (where cabling exceeds 2m)
- Comply with the general requirements of AS/NZS 3000, particularly “Selection and Installation of Wiring Systems”

Battery system output cables should meet the following requirements:

- Be as short as possible.
- Be double insulated.
- Be double insulated where the battery system voltage exceeds DVC-A

Where not installed in conduit, cables should be effectively clamped, and sufficient support should be provided throughout the length of cables to minimise sag and prevent undue strain from being imposed on the cables or on battery terminals or other parts of the installation.

Cables must not be bent through a radius less than the minimum bending radius specified by the cable manufacturer.

Segregation must be provided between the following circuits:

- AC and DC
- DVC-A DC and ≥DVC-B DC

2.2.1.5.2 Parallel battery systems

Where multiple battery systems are connected in parallel, each battery system should have cables connecting strings of equal resistance (e.g. of equal length and cross-sectional area; and conductor material) – except where the charge/ discharge regime is controlled by a BMS or similar (e.g., in a lithium-ion battery system).

2.2.1.5.3 Voltage drop

The maximum voltage drop between the battery system terminals and the PCE:

- Must be less than 5%
- Should be less than 2%

DC voltage drop can be calculated as per:

- AS/NZS 4509.2, Appendix C2
- AS 4086.2, Appendix A5
- AS 2671, clause 2.6

Typically, the current carrying capacity will determine the cross-sectional area of DC cable, rather than voltage drop – especially where voltage levels do not exceed DVC-A.

2.2.1.6 Earthing

2.2.1.6.1 General

There are four categories of earthing arrangements for battery systems:

- Floating/ separated (i.e. Not earthed and not referenced to earth)
- Direct earthed
- Resistive earthed
- Connected to a non-separated inverter (i.e. Reference to the grid and therefore to earth by the inverters internal connections)

The PCE and battery system manufacturer's instructions on earthing arrangements must be followed.

Examples of earthing arrangements are in Figure 1, Figure 2, Figure 3, and Figure 4.

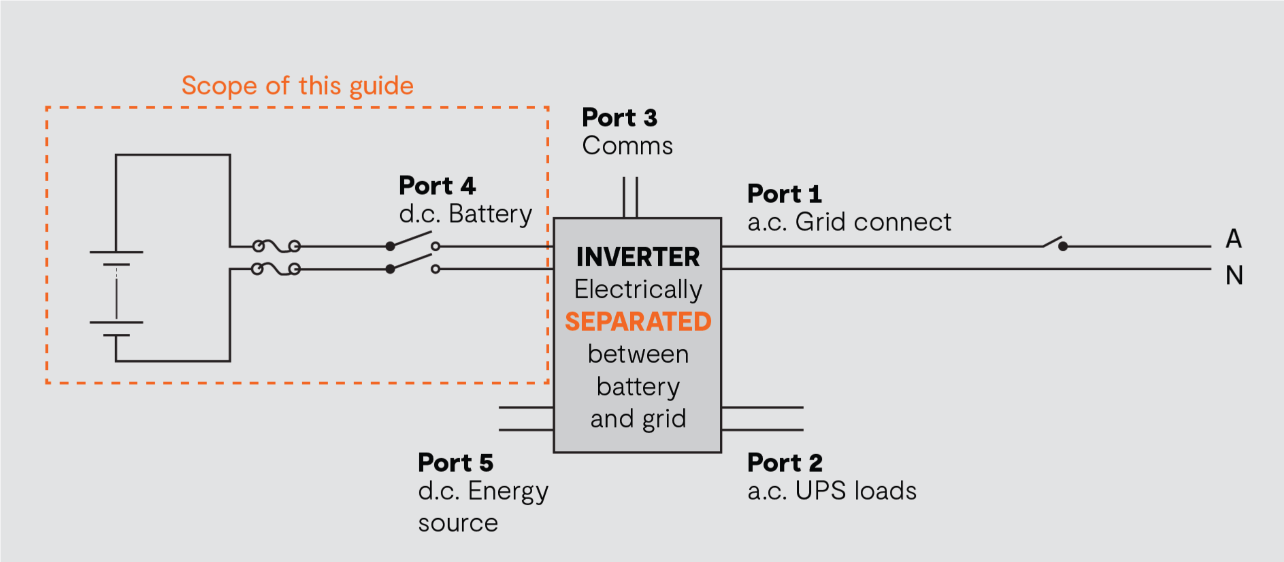


Figure 1 ***Battery connected to an inverter providing separation from the grid***

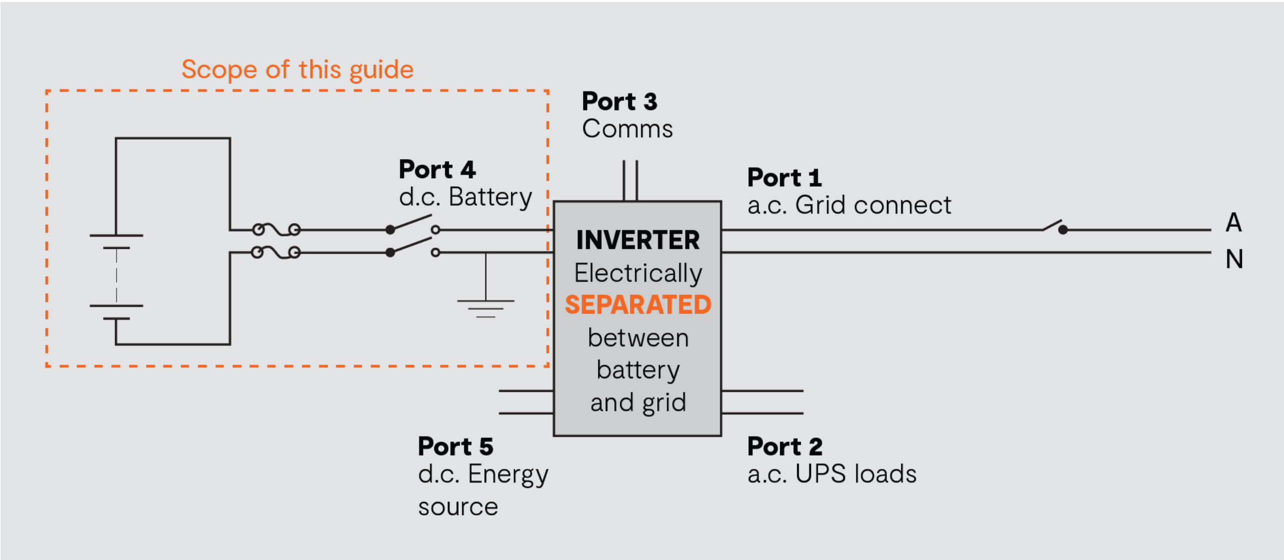


Figure 2 ***Battery connected to an inverter providing separation from the grid with a direct earth connection***

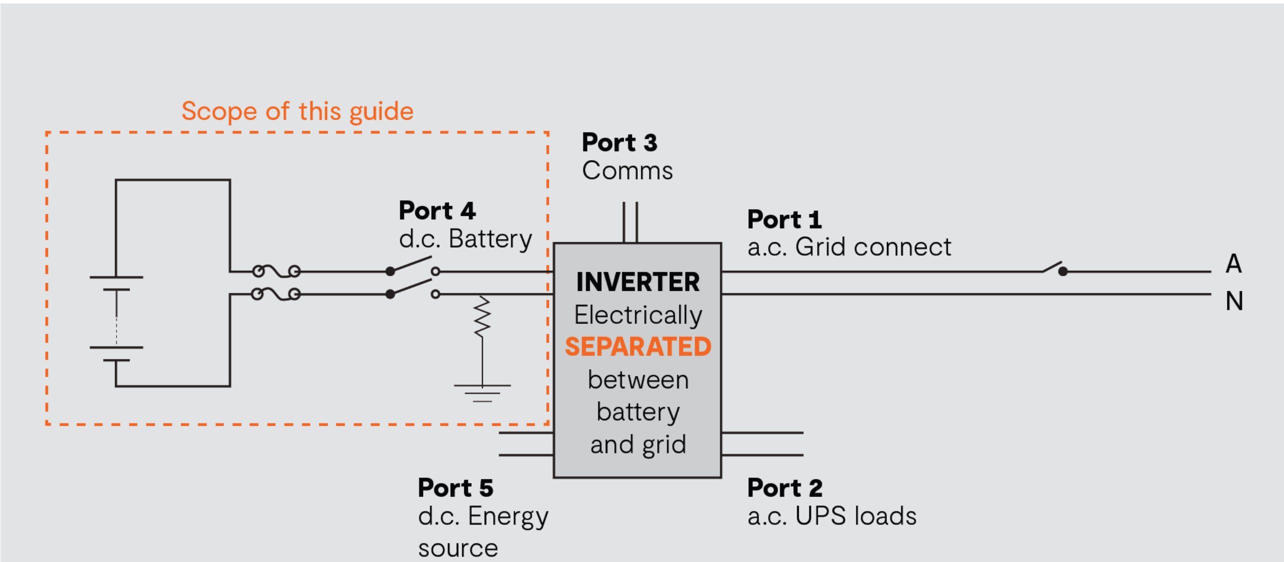


Figure 3 ***Battery connected to an inverter providing separation from the grid with resistive earth connection***

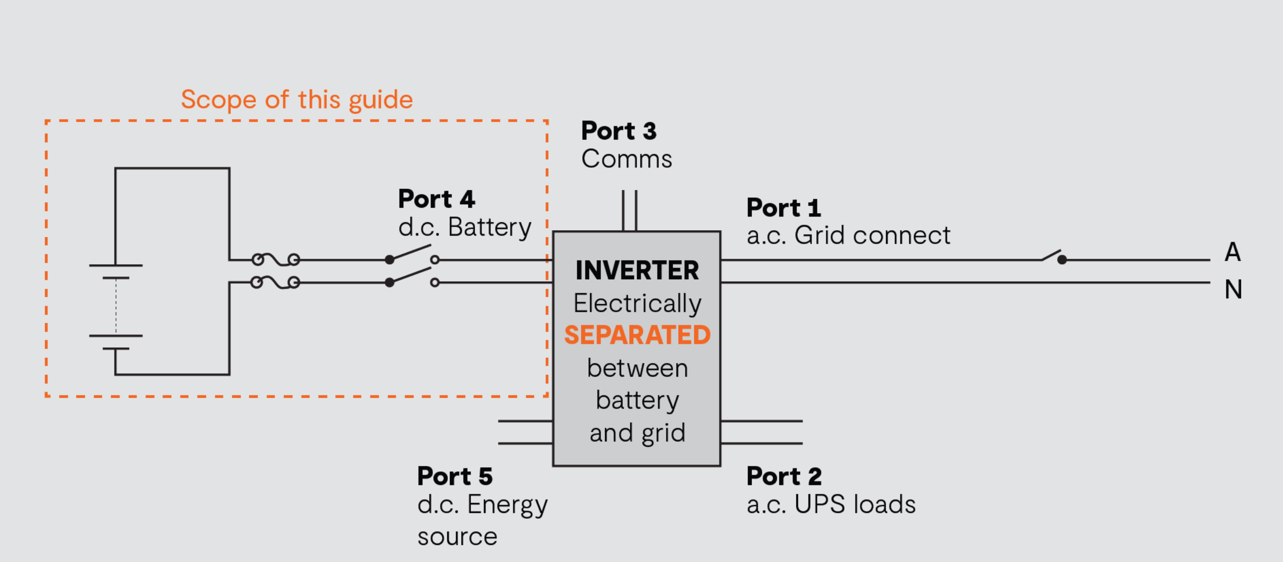


Figure 4 ***Battery connected to a non-separated inverter (i.e. no separation between the battery and the grid)***

2.2.1.6.2 Earth Fault Alarm

Where unearthed battery systems, including pre-assembled BESS, exceed DVC-A an earth fault alarm should be installed which, on an earth fault, causes an action to be initiated to correct the earth fault.

The following conditions should also apply:

– Repeat operation at least at hourly intervals until the earth fault is corrected
– Be placed in an area that must be noticed
– Be reliable (e.g. audible signal and/ or light powered from a constant source)

It may take the form of:

– Visual alarm (e.g. light)
– Audible signal
– SMS
– Email

A set of operational instructions must be provided to the customer that includes the actions to take when the alarm operates.

2.2.1.6.3 Equipotential bonding

If the battery system enclosure and/ or battery system stand is metallic and the battery system is operating at voltages exceeding DVC-A, the enclosure and/ or stand should be earthed in accordance with AS/NZS 3000.

2.2.2 Energy

Battery systems represent an inherent arc flash hazard which cannot be eliminated.

The following measures reduce the risk of an arc flash hazard:

1. Battery output cabling must be selected as to minimise the risk of short circuit faults (e.g. double-insulated), as per 2.2.1.5 Battery System Output Wiring - 2.2.1.5.1 General
2. DC cable must be protected from mechanical damage as per 2.2.1.5 Battery System Output Wiring - 2.2.1.5.1General
3. Terminals and outgoing busbars must be insulated or shrouded as per 2.2 HAZARD MITIGATION - 2.2.1 Electrical Hazard - 2.2.1.1 General.
4. Access to battery systems must be restricted to authorised persons as per 3.1.3 Restricted Access

5. Overcurrent protection must be placed as close as practicable to the battery system as per 2.2.1 Electrical Hazard - 2.2.1.4 Overcurrent Protection - 2.2.1.4.3 Location
6. Isolators must be installed as per 2.2.1 Electrical Hazard - 2.2.1.3 Isolation.
7. Where a battery system voltage exceeds DVC-A, it must be fitted with isolating switches, plugs or links to separate it into sections not greater than DVC-A as per 2.2.1 Electrical Hazard - 2.2.1.1 General
8. Standard operating procedures should be developed to facilitate safe work procedures.
9. Personal Protection Equipment (PPE) should be used when working on battery systems.

2.2.3 Fire

2.2.3.1 General

The manufacturer’s Safety Data Sheet (SDS) must be assessed to determine if a fire risk is present as per 3.1.2 SDS.

Note that a fire hazard is distinct from:

1. An “energy” hazard as defined in 2.1.2 Energy Hazard
2. An “explosive gas” hazard as defined in 2.1.5 Toxic & Flammable Gas Hazard

A fire hazard may be present in any chemistry type. As per United Nations (UN) 38.3, abuses that may result in fire include:

1. Low ambient pressure
2. Overheating
3. Vibration
4. Shock
5. External short circuit
6. Impact
7. Overcharge
8. Forced discharge

2.2.3.2 Requirements for fire extinguishers

Battery fires are often propagated by thermal runaway which is a chemical reaction that occurs within the battery cells and can occur due to manufacturing defects, overcharging, overheating, puncturing, or crushing of the battery system. It is important to note that the thermal runaway reaction cannot be halted once they are initiated therefore battery fires are often left to burn out. For this reason, it is recommended that Fire Extinguishers not be used on Lithium Battery System Fires. Due to the Lithium battery chemistry, in the very unlikely event of the battery igniting, the Lithium battery creates oxygen internally, fuelling the fire therefore a dry extinguisher or fire blanket will not starve the fire of its oxygen source. This is why most battery manufacturers do not require a fire extinguisher to be installed when installing the battery system, manufacturers guidelines are to be followed.

FIRE EXTINGUISHER SELECTION CHART

Class & Type of Fire / Type of Extinguisher	Colours	A: Wood, Paper, Plastic	B: Flammable & Combustible Liquids	C: Flammable Gases	D: Combustible Metals	(E): Electrically Energised Equipment	F: Cooking Oils and Fats	
Water		✓	✗	✗	✗	✗	✗	Dangerous if used on flammable liquid, energised electrical equipment and cooking oil/fat fires.
Carbon Dioxide (C02)		LIMITED	LIMITED	✗	✗	✓	✗	Not suitable for outdoor use or large class A fires.
Dry Chemical Powder (ABE/BE)		✓ AB(E) ✗ B(E)	✓	✓	✗	✓	✗ AB(E) ✓ B(E)	Look carefully at the extinguisher to determine if it is a BE or ABE unit.
Foam		✓	✓	✗	✗	✗	LIMITED	Dangerous if used on energised electrical equipment.
Wet Chemical		✓	✗	✗	✗	✗	✓	Dangerous if used on energised electrical equipment.
Fire Blanket		LIMITED	LIMITED	✗	✗	✗	✓	Fire Blankets effective for oil and fat fires within saucepans and are effective for extinguishing clothes that catch on fire. (Ensure you replace after every use).

FIRE & SAFETY AUSTRALIA

www.fsaus.com.au | 1300 88 55 30
www.nsca.org.au | 1800 65 55 10

This information comes from Australian Standards AS 2444 & AS3745 – This standard requires that personnel who are trained in the use of portable fire extinguishers must refresh this training within a 2 year period

Figure 5 ***Portable fire extinguisher guide***[1]

Despite their inability to stop thermal runaway and quench battery fires, fire extinguishers can be made available at the battery site for protection of surrounding equipment and property in case a battery fire occurs. The fire extinguisher can be used to limit the spread of the fire and damage to life and property at the battery site.

2.2.3.3 Requirements for smoke alarms

Smoke alarms are required by law and new smoke alarm legislation for Class 1a dwellings commenced in Queensland on 1 January 2017 (see **Smoke alarms | Queensland Fire and Emergency Services (qfes.qld.gov.au)** and the QLD Safe installation of smoke alarms guidelines on the WorkSafe QLD website - **https://www.worksafe.qld.gov.au**).

While a manufacturer's SDS may not specify a fire hazard exists with the battery equipment, the Scheme requires smokes alarms as follows:

- A battery system can only be installed in a garage or an acceptable non-habitable room that has a smoke alarm.
- The installer must ensure that the battery site inside a garage or an acceptable non-habitable room has a functioning smoke alarm or request one to be installed, prior to installation of the battery equipment.
- Where the property's existing smoke alarms are interconnected, either wired or wireless, the new smoke alarm shall be interconnected to the existing smoke alarms.
- Where a battery system is installed externally or in an open carport area, installation of a smoke alarm is not a requirement of the Scheme.

[1] https://fireandsafetyaustralia.com.au/resources/free-fire-extinguisher-selection-charts/

A safety checklist (adapted from the same document) for electricians to consider when installing smoke alarms has been presented in Table 4.

Table 4 Smoke detector safety checklist

☑	Turn off electricity at the switchboard before you enter the ceiling space and start any work.
☑	Isolate, lockout, and tag.
☑	Undertake risk assessment.
☑	Confirm conductive foil insulation is energised.
☑	Confirm whether the ceiling sheeting contains asbestos. If it does and the alarm must be installed there, follow safe work procedures for asbestos.
☑	Replace fluids regularly when working in hot conditions.
☑	Always let someone know before heading into the ceiling space and maintain contact with them.
☑	Step carefully on joists and beams and not on the ceiling material.
☑	Issue certificate of testing and safety.

2.2.4 Chemical

2.2.4.1 General

The following general requirements apply to reducing the risk of chemical hazards:

– The battery manufacturer SDS must be consulted, and installation instructions must be followed.
– Where electrolyte is corrosive and vents
– Exhaust air should not pass over battery system terminals or other electrical devices.
– Fumes should be vented outside.

2.2.4.2 Safe work procedures

Safe work procedures should be developed to address potential chemical hazards which may include:

1. Cracked or damaged battery casings
2. Spillage of electrolyte
3. Inhalation of, and physical exposure to, electrolyte
4. What to do in the event of a fire

2.2.4.3 Personal protective equipment

The following equipment may be required for safe handling of battery systems and protection of authorised persons:

1. Hard hats
2. Gloves
3. Safety glasses or goggles
4. Arc rated clothing
5. Insulated gloves
6. Mechanical lifting devices as identified by a WHS risk assessment
7. See also Figure 27 below.

2.2.5 Toxic and flammable gases

Lithium-ion batteries do not produce any exhaust gases during normal operation, but they can produce flammable and toxic gases if there is a fault. These faults could be due to component failure, a short circuit, loose connections, overheating, overcharging, physical abuse, defects etc. When lithium-ion batteries experience these faults, they can undergo thermal runaway which could lead to rupturing of the battery cells and release of toxic, flammable, and explosive gases. The hydrogen content of the released gases from the battery electrolyte can give rise to vapour cloud explosion risks which have the potential to cause significant damage. The gases produced potentially leave toxic deposits on all surfaces and in the atmosphere. Therefore, once the incident is under control, potential hazards remain, and a clean-up will be required.

The chemistry of lithium-ion batteries makes them prone to ‘thermal runaway’ if they are damaged or overheated by overcharging. Battery chemistry and elevated ambient temperatures should be considered by the installer when locating a BESS on a customer premise. Battery chemistries such as Lithium Titanate (LTO) and Lithium iron phosphate (LFP) have higher runaway temperatures than Lithium nickel manganese cobalt oxides (NMC) battery chemistry which has become the most popular choice for solar storage. This higher runaway temperature makes these battery chemistries inherently safer; installers need to be aware of the battery chemistry they are installing and the dangers they could present (this information can be found in the manufacturer’s spec sheet and manual).

2.2.6 Mechanical

Battery system location must comply with the requirements of 5.2 Battery System Location.

For ground mounted battery systems/ pre-assembled BESS, such as those in a dedicated room, the ground structure and type must be designed to withstand the prevailing weight.

For wall-mounted battery systems/pre-assembled BESS, the structural integrity of the wall must be able to withstand the prevailing weight.

The supporting surface of any enclosure must have adequate structural strength to support the battery system/ pre-assembled BESS weight and its support structure.

Battery stands, supports and enclosures should protect battery systems/ pre-assembled BESS from damage due to seismic (earthquake) activity and should comply with AS 1170.4 (Australia) and NZS 4219 (New Zealand).

Battery systems/ pre-assembled BESS should not be installed at a height exceeding 2m above a floor or platform.

Where subject to physical damage, mechanical protection must be provided to the battery system to minimise the risk of such, resulting in electrolyte leakage, including:

– Crushing
– Impact
– Puncturing

Mechanical protection may be achieved via the use of a suitable battery system enclosure and/ or bollards.

Use of mechanical protection must ensure battery systems and pre-assembled BESS are readily available.

It is the installers responsibility to consider likely impact direction & severity and install appropriate protection e.g., heavy-duty core-drilled bollards instead of bolt down bollards which should be determined by the installer based on the risk assessment which the installer must undertake during design

3. Installation

3.1 General

3.1.1 Manufacturer’s instructions

The installation of all home battery systems must be in accordance with the instructions in the manufacturer’s installation manual. In addition, the installation must comply with the relevant standards. In particular, if a “Battery Ready” inverter is found to exist at a site, it is the responsibility of the designer and installer to ensure that the connection of a battery is compliant with both manufacturer’s instructions and current standards and is also approved under the battery booster Program.

3.1.2 Safety Data Sheet (SDS)

The installation of all battery systems must be in accordance with the safety data sheet applicable to the battery chemistry of the home battery system.

3.1.3 Restricted areas

The home battery system must be installed at a location that it complies with AS5139, and particular attention paid to inadvertent operation by un-authorised persons to minimise the possibility of damage while ensuring the ability to isolate in emergencies or for routine maintenance. See below for further details.

3.1.4 Environmental effects

The home battery system must have an IP rating appropriate for the environment in which it will be installed in accordance with AS/NZS 3000.

All equipment exposed to the outdoor environment must be at least IP54 and UV resistant. Higher ratings should be considered for tropical locations.

Connection of wiring, conduit, and glands to IP rated equipment and/or enclosures must be installed so the minimum IP rating is maintained.

3.1.5 External influences

Home battery systems must be able to operate safely and function properly in the conditions in which they are likely to be exposed. Particular situations include:

1. Solar radiation (direct sunlight)
2. Ambient temperature
3. External heat sources
4. Presence of water or high humidity
5. Presence of solid foreign bodies
6. Presence of corrosive or polluting substances
7. Impact
8. Vibration
9. Other mechanical stresses
10. Presence of flora and fauna

3.1.6 Inverter settings

Inverter settings play a vital role in the overall performance of home battery systems. Changes to the Australian Standards for inverters (AS/NZS4777.2), which came into effect in December 2021 are not being followed consistently and this section is to alert installers to the correct application of this standard.

Solar and battery inverters in all states outside Western Australia and Tasmania must be installed with AS/NZS 4777.2 Australia A settings and in addition, any further settings as specified by the distribution network service provider (DNSP).

The protection settings are a condition of connection, and it is your legal obligation to be aware of and to comply with these requirements. Getting inverter settings right is crucial to connecting more solar PV and battery systems, improving grid integration, and maintaining stability in the grid.

How to correctly configure inverter settings

A review by the Australian Energy Market Operator found many inverters are being installed to incorrect inverter settings. To correctly configure solar PV and/or battery inverter settings:

1. Australia A – applies to the configuration of inverter settings in Queensland and all Eastern Australia.
2. Turn on the device.

To commission inverter settings using the default function on your installer app:

1. Go to Menu/Settings
2. Check the Grid Profile is defaulted to AS/NZS 4777.2: Australia A.
3. Note that some inverters still show legacy options in their settings menu. In Queensland, all installations must select the Australia A option.
4. **Do not** select the name of the distribution network (Energex and Ergon Energy Network) in the menu.

The benefits of correctly configuring inverter settings

AS/NZS 4777.2 is about improving grid integration and solar grid hosting capacity while also improving safety.

The changes mean that solar can be relied on to perform as needed, when needed – which means more solar can continue to be installed and stored. Interface changes also simplify commissioning.

About the standard

AS/NZS 4777.2 is the Australian Standard for inverters and applies to the grid connection of both solar PV and battery systems to ensure they respond autonomously in a specified manner to external influences and ensure fault ride through performance to prevent the network collapsing under high penetration of renewables and has significantly changed as compared to requirements a decade or so ago when renewables were a minute proportion of embedded generation and were required to disconnect under many disturbances In addition, installations must comply with:

1. Service and installation rules with your local DNSP
2. Electrical Safety Distribution Codes
3. The National Electricity Rules
4. The Renewable Energy Act (to be eligible for STCs and LGCs)

3.1.7 Generation Signalling Device (GSD)

To ensure Queensland can continue installing solar and working towards its renewable energy targets, new replacement (rooftop solar PV and DC coupled battery storage systems) and upgraded inverter energy systems 10kVA and above must be fitted with a generation signalling device (GSD) that allows Energex and Ergon Energy Network to switch these systems off in case of an emergency.

For sites with multiple inverters, installers have the option of placing a GSD on each inverter or installing a single GSD connected to a Demand Response Controller.

A GSD installation is not required for inverter energy systems where the inverter is solely supplied by a battery, and to any inverter energy systems installed at a location that is not serviced by the audio frequency load control (AFLC) system. The GSD is activated via Energy Queensland's AFLC network.

Specific connection standard requirements for installing a GSD are as follows:

- Installation of the GSD must comply with AS/NZS 3000.
- Connection to a single inverter which is required to have a GSD must satisfy the requirements of the G01 wiring diagrams in Section 4.3 of the Queensland Electricity Connection Manual (QECM) Supplement.
- Connection to multiple inverters which are required to have a GSD must satisfy the requirement of either G02 or G03 in Section 4.3 of the QECM Supplement.
- Should a protective device be required for short-circuit protection of the GSD conductor, the installation must satisfy clause 4.2.2 in the Emergency Backstop Mechanism Installation Requirements of the QECM Supplement.
- The conductor connected between the protective device for the inverter and the GSD must:
  - Be less than three meters in length
  - Be mechanically protected such that there is minimal risk of short-circuit
  - Be installed in a way that minimizes the potential for fires or other hazards
- The location of the GSD must be:
  - At the Main Switchboard; or
  - At the distribution board with a protective device installed for the inverter.
- The control cable of the GSD may be extended as much as is required
- The control cable of the GSD must:
  - Connect to the inverter directly; or
  - Connect to the inverter through an external device which provides demand response mode, if there is no integrated device for the inverter; or
  - If compliant with wiring diagram G03, connect to the inverter through a Demand Response Controller.

To install a GSD on an approved inverter system so that it complies with the new Queensland Emergency Backstop requirements, installers must:

1. Ensure the GSD is mounted either within the main switch board or within the switchboard where the protective device for the inverter supply is located (network protection AC boards can be pre-wired with a GSD on request).
2. Connect the GSD to AC power by wiring it directly to the Main Switch Inverter supply.
3. Connect the inverter's power reduction interface port to the GSD control cable through pins 5 and 6 of the inverter's connector pins (i.e. via the RJ45 adapter supplied with the GSD).

Important points to consider when submitting a Connect Application or generation enquiry are as follows:

- Ensure that the customer information is correct prior to submitting the connection application.
- Ensure that the customer's installation is approved by Energex and Ergon Energy Network.
- Ensure that all sections within the application form have been filled accurately.
- Verify that the equipment intended for installation is selected from the Approved Battery list.

– Certify all details of the application with Energex and Ergon Energy Network and the customer, and keep the customer informed of the status of their application.

3.2 Selecting and preparing the installation site

3.2.1 General guidelines and requirements

The following location requirements apply to the home battery system installation site:

The installation site must comply with the environmental requirements as stated in the manufacturer's specifications – including ambient minimum and maximum temperatures. Refer to Table 5 *as an example.*

Table 5 Example manufacturer's specifications

Environmental Specifications	
Operating Temperature	-20°C to 50°C
Recommended Temperature	0°C to 30°C
Operating Humidity (RH)	Up to 100%, condensing
Storage Conditions	-20°C to 30°C Up to 95% RH, non-condensing State of Energy (SoE): 25% initial
Maximum Elevations	3000m
Environment	Indoor and outdoor rated
Ingress Rating	IP67 (Battery & Power Electronics) IP56 (Wiring Compartment)
Wet Location Rating	Yes
Noise Level @ 1m	< 40 dBA at 30°C

The following must also be considered when selecting an installation site:

– The IP & UV rating of the site is suitable for the environment as per 3 INSTALLATION - 3.1.4 Environmental Effects.
– The battery system is protected against physical damage and other environmental and external factors (e.g. Impact from vehicles, high humidity, etc.)
– The installation location allows for easy access for installation and maintenance.
– The battery system is not near conductive objects capable of falling on the battery system.
– If the battery system is secured to a wall using the manufacturer’s supplied mounting bracket, the installation location must be adjacent to a wall.
– The battery system is not to be installed in locations prohibited and detailed in AS519:2019 section 4.2.2.2 for BESS and 5.2.2.2 for BS.

3.2.2 Site-specific considerations

As with any installation exercise, a WHS risk assessment must be undertaken. In addition, prior to the selection of the battery installation site, a battery risk assessment must be conducted by the installer and or designer, with due consideration for the consequences of a contingency event. Where batteries are planned for installation at locations with extreme temperatures or other climatic concerns, particular consideration should be given to this matter in the risk assessment. A copy of this risk assessment must be provided to the customer as part of the equipment documentation.

Installers must pay due regard to the manufacturer’s recommendations about operating temperature limits, exposure to direct sunlight and avoidance of impact risks. Pre-packaged BESS may include weatherproof enclosures for outdoor mounting and may not need any additional protection.

The location complies with the manufacturer's recommendations to protect the system from weather and extreme heat, light, and temperature, which may reduce the performance or life span of the system, or trigger one of the hazards mentioned above. Most batteries have an optimal operating temperature range to achieve their design life and maintain safety. However, attention should be given to the Queensland context. As an example, Daytime temperatures across northern Queensland are usually warmer than the average temperature therefore locations exposed to north- and west-facing aspects may be undesirable for BESS installations for reasons of high solar radiation.

3.2.3 Restricted locations

The home battery system must not be installed in the following locations:

1. Habitable rooms, as defined by the National Construction Code (NCC) and as listed in AS5139:2019 definition 1.3.42, including, but not limited to:
2. Bedroom
3. Living Room
4. Lounge Room
5. Music Room
6. Television Room
7. Kitchen
8. Dining Room
9. Sewing Room
10. Study
11. Playroom
12. Family Room
13. Home Theatre
14. Sunroom
15. Egress paths
16. Spaces occupied frequently or for extended periods.

Subject to all other requirements in these guideline, suitable locations for installation of the home battery system may include:

1. Garages
2. Basement
3. Battery Rooms
4. Verandas

3.2.4 Clearance

The following minimum clearance requirements must apply for the battery installation:

The minimum of the manufacturers required clearance and those mandated in AS5139 which are 600mm laterally and 90mm vertically.

3.2.5 Residential barrier

The most common rechargeable battery technology used in home battery systems are lithium-ion batteries. Regardless of the battery chemistry, lithium-ion batteries are prone to thermal runaway which leads to battery fires. Many battery systems are installed on concrete slab footing which are non-combustible, so it does not require any additional fire-protection because of its built-in resistance to fire. There are a number of "deemed to comply" materials and if installed on these, no further protection is required. Under AS5139 when the wall and clearances noted above cannot be maintained to a habitable room, the installation of a *non-combustible* barrier must be installed as detailed in AS5139 section 4.2.4.2 or 5.2.4.2.

Examples of walls and clearances required for habitable rooms have been outlined in the following figures.

Figure 6 ***Examples of habitable and non-habitable rooms***

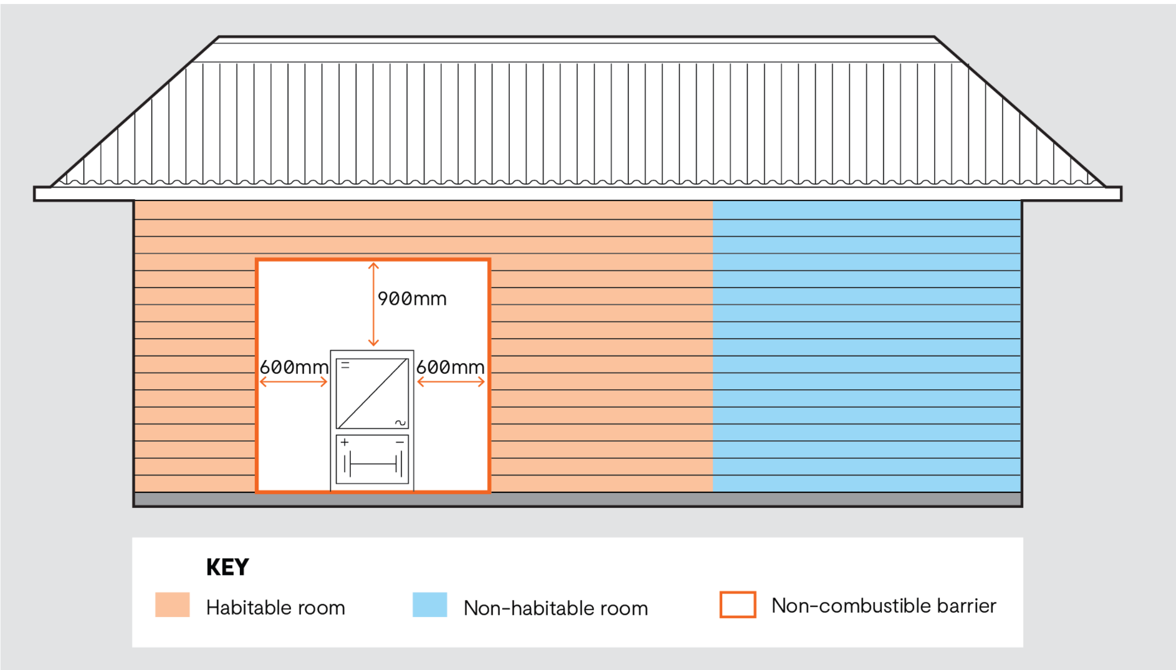


Figure 7 ***Non-combustible barrier requirements for batteries installed to the exterior of habitable rooms***

Figure 8 **Battery installation clearance requirements for sliding doors as per AS/NZS 5139 clause 4.2.2.2 and 5.2.2.2(b)**

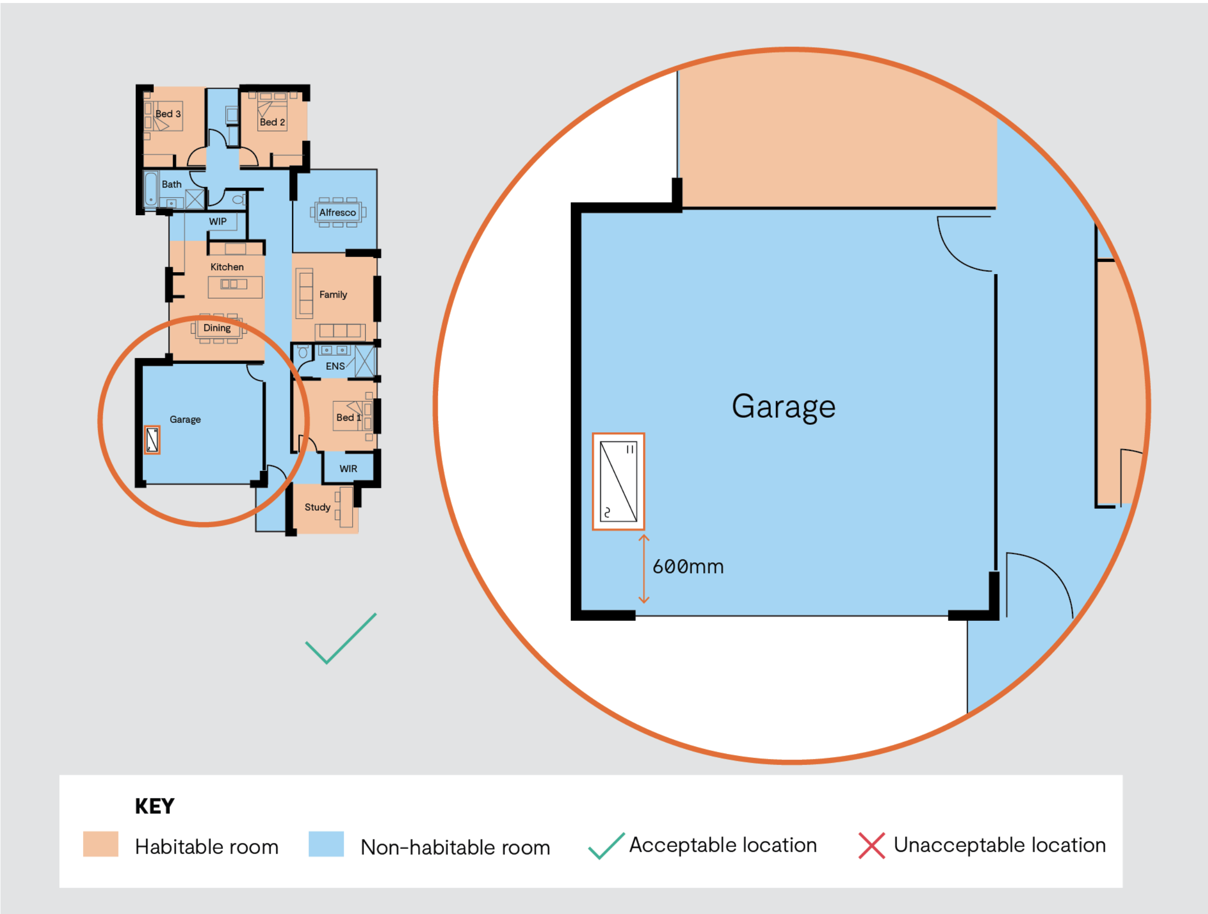


Figure 9 **Battery installation clearance requirements for garage doors**

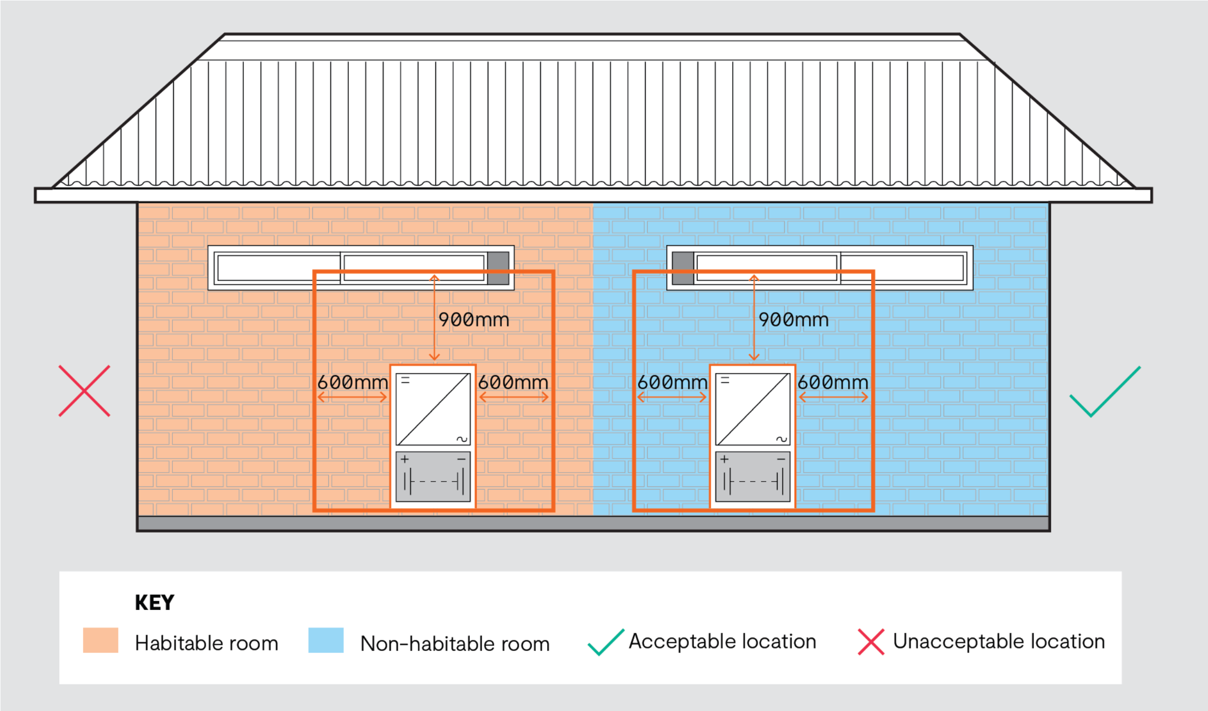


Figure 10 ***Battery installation clearance requirements for windows that can be opened as per AS/NZS 5139 clause 4.2.2.2 and 5.2.2.2(b)***

Figure 11 ***Battery installation clearance requirements for air vents as per AS/NZS 5139 clause 4.2.2.2 and 5.2.2.2(b)***

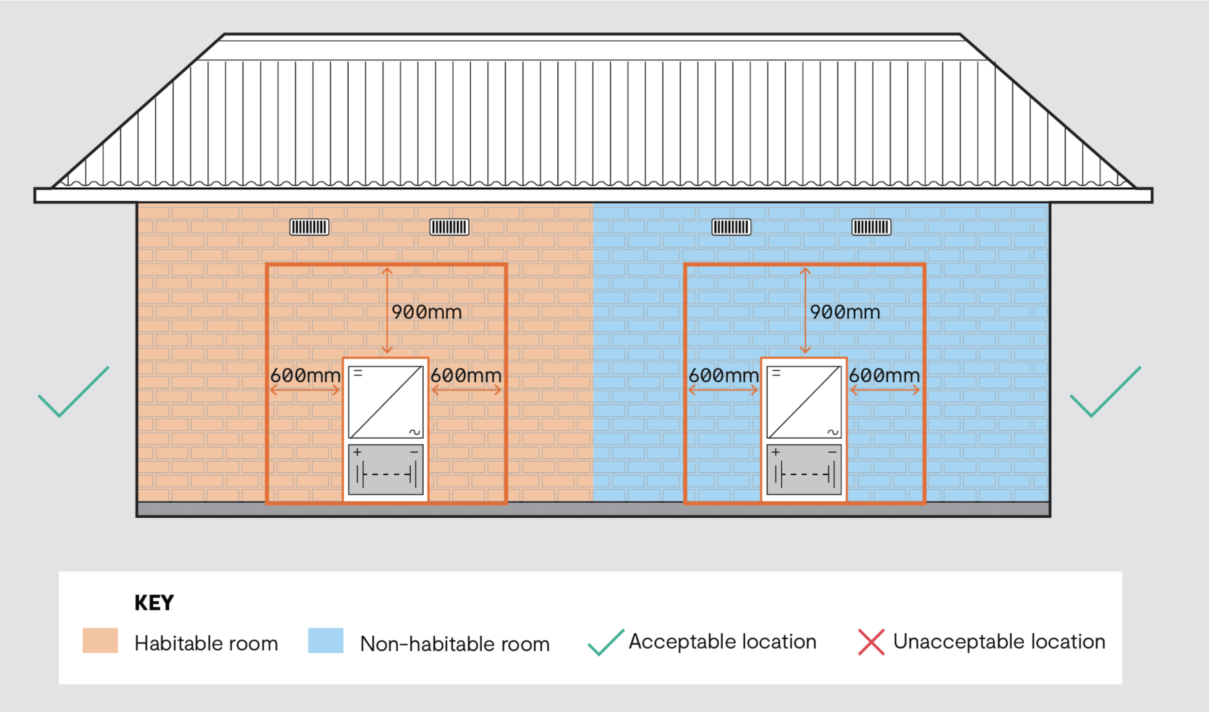


Figure 12 ***Battery installation clearance requirements for fixed vents as per AS/NZS 5139 clause 4.2.2.2 and 5.2.2.2(b)***

Note that batteries may not be included within 600mm of a doorway or egress path. If the battery pack is installed at a distance of 300mm from the wall that isolates the energy storage system from a habitable room, no further protection is required.

3.2.6 Mechanical protection

Many home battery systems in Queensland (and Australia wide) are installed in garages where additional mechanical protection may be required. Additional mechanical protection must be installed at a home battery site when it would reasonably be expected that damage may occur to the battery system or enclosure resulting from impact of a vehicle. While most manufacturers claim their battery system enclosure does not require additional mechanical protection as they have conducted impact testing, AS/NZS 3000 1.5.14 specifies protection against external influences, and Appendix H provides further information on how to achieve adequate mechanical protection, considering the level of impact. Furthermore, Clause 1.7.1 (c) states that electrical equipment must be installed in accordance with the requirements of that standard and the additional requirements as specified in the manufacturer's instructions. To this end, the requirements of AS/NZS 3000 Wiring Rules would apply.

Additional mechanical protection, such as a bollard, must be provided for both rear wall and side wall mounted batteries where there is potential for damage during normal vehicle movement. This includes wall mounted battery systems.

Note: Where the battery system is installed located in the front corner of a standard 6m long garage and is protected by a solid front pillar or wall, it is reasonable to expect vehicle impact could not occur, therefore a bollard would not be required in this location (see Figure 13). However, the zone within 600mm of the opening is a restricted zone under AS5139:2021 Cl 4.2.2.2 (b) however, section 4c(i) of the Electrical Regulatory Authorities Council's (ERAC) Battery Energy Storage System Installation requirements (published on the 2nd of February 2021) exempts it. If the dimensions are greater (see Figure 14), then additional protection would be required.

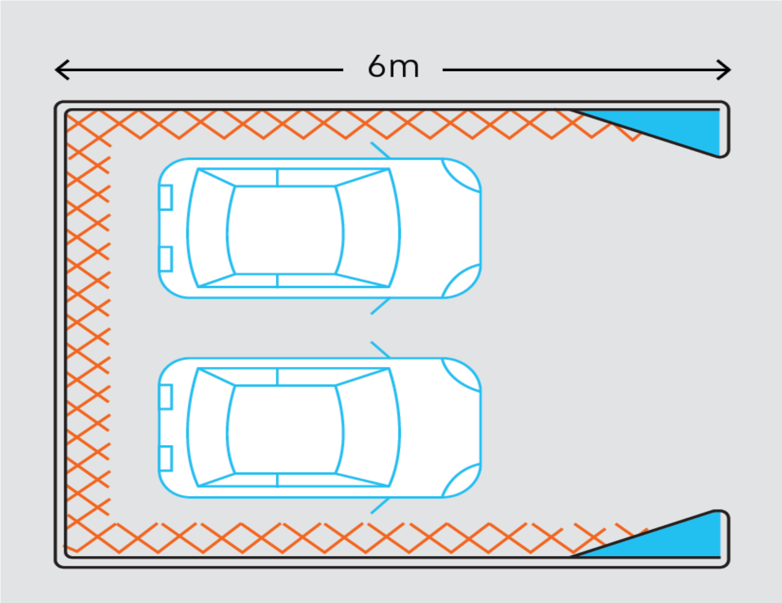


Figure 13 Standard Double Garage 6m x 6m, Standard Single Garage 4m x 6m

Area requiring Additional Mechanical Protection (such as a Bollard)

Area deemed protected by the garage pillar or wall, not requiring additional protection.

As a guide the protected area is calculated at ratio 1:2.5 (e.g. 500mm garage pillar, would allow an area of 1250mm protection along the wall.

Each installation must be assessed for potential hazards and any reduction methods implemented.

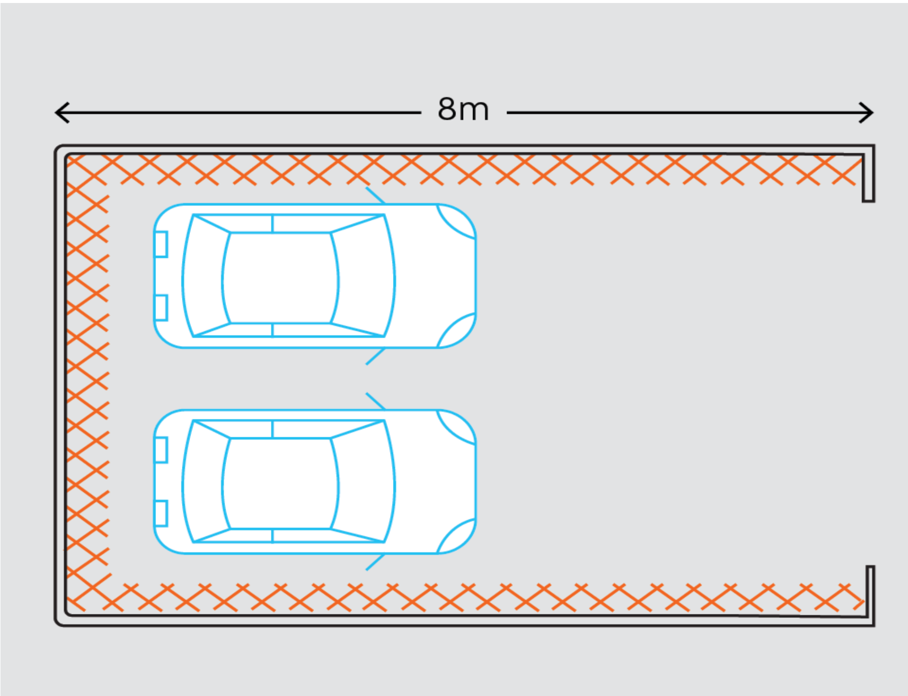


Figure 14 Double Garage 6m x 8m, Single Garage 4m x 8m or other multi car garages of similar sizes or larger

Area requiring Additional Mechanical Protection (such as a Bollard)

As part of the installation battery risk assessment, a decision must be made whether a bolt down bollard might suffice, for example if a glancing impact might be expected as opposed to a full core drilled bollard in the case of a high energy full contact.

4. Inspections and Recent Non-Conformances

An Inspectorate appointed by the Department of Energy and Climate will inspect all home battery installations under the Battery Booster Program for conformance with Australian and other standards. The inspected systems will be categorised as best practice, compliant, adequate, substandard, or unsafe.

The appointed inspectorate will finalise the inspection methodology, which will be communicated to industry. The Overall Assessment classifications for inspections are defined by the following:

a) **Industry Best Practice –** The system complies with all relevant standards and requirements for installation. No safety, performance or documentation issues have been identified. The workmanship and equipment layout are of a high standard. No rectification work is required.

b) **Compliant –** The system complies with almost all of the standards and requirements for installation. No safety or significant performance issues have been identified. There has been some non-safety related low risk documentation and/or minor workmanship that are issues identified. The Inspector to determine if rectification work is required.

c) **Adequate –** The system complies with the majority of standards and requirements for installation. No safety or significant performance issues have been identified. Some medium risk, non-safety related documentation and workmanship issues have been identified. The Inspector to determine if rectification work is required.

d) **Substandard –** The system does not meet key clauses in the standards and requirements for installation and may lead to premature equipment failure or other issues. The installation work and or equipment should be improved. Rectification required. The relevant state or territory regulatory authority has been advised by the Service Provider of the nature and extent of the safety risk.

e) **Unsafe –** The system has a safety hazard which poses an imminent risk to a person or property. Includes electrical safety related non-compliance of the standards and immediate electrical safety risk identified. The system has been shut down or rendered safe by the inspector. The relevant state or territory regulatory authority has been advised by the inspector of the nature and extent of the safety risk. Rectification required.

PV systems will only be inspected minimally to ensure that they are safe to attach a battery system to.

The following section provides some guidance to installers on the wiring and frequency of battery systems and solar PV systems respectively, which have been identified as common non-conformances during national inspections.

4.1 Battery system wiring

These are some battery system wiring considerations that should be noted by Installers:

1. Separate terminals in neutral bars must be used for each outgoing neutral (as per AS/NZS 3000:2018 Cl. 2.10.5.3).
2. Where a wiring system consisting of sheathed cables is installed through metallic structural members, any aperture through which the cable passes through must be bushed or shaped to minimise abrasion of the cable (as per AS/NZS 3000:2018 Cl. 3.10.3.5 (b)).
3. Identify corresponding neutral connections. The Main Switch (ENERGY STORAGE) switches and any other circuits moved at time of installation must be marked or arranged to identify the corresponding active and neutral connections for each circuit (as per AS/NZS 3000:2018 Cl. 2.10.5.4).
4. The short circuit/fault current rating of the battery system is usually specified by the manufacturer, the overcurrent protection device (fuse/circuit breaker) must be adequately sized to cope with such currents.
5. AC and DC circuits must be properly segregated from each other with the DC circuit labelled.

6. Ensure consumer mains cables are protected from overload and short circuit currents by an appropriately rated circuit breaker. Switchboard and load alterations have been conducted therefore requiring the Main Switch to be upgraded accordingly to a correctly rated CB (as per AS/NZS 3000:2018 2.6.2).
7. Battery clearances – e.g. The inverter battery installation manual requires 300mm clearance from all sides of the inverter. At present the battery system has not been installed as per manufactures installation guidelines (as per AS/NZS3000:2018 1.7.1 (c)). For example, LG Chem home batteries should be provided with an equipotential bonding as it has exposed conductive parts (as per AS/NZS3000:2018 Cl.5.4).
8. Clear and accurate labelling is required on the switchboard indicating all switches, circuits and their relationship to the Normal Supply Circuits and the BESS Backed Up Circuits (as per AS/NZS 3000:2018 2.10.5.2).
9. No items should be stored on top of the home battery system, inverter, or its electrical wiring.
10. A protection device should be located as close as practicable to the main output terminals of the battery and any cabling to the location of protective fuses or circuit breakers should be double insulated.
11. Correctly sized DC switches/isolators must be installed to completely isolate the battery from all circuits connected to it during maintenance.

4.2 Solar PV cable management

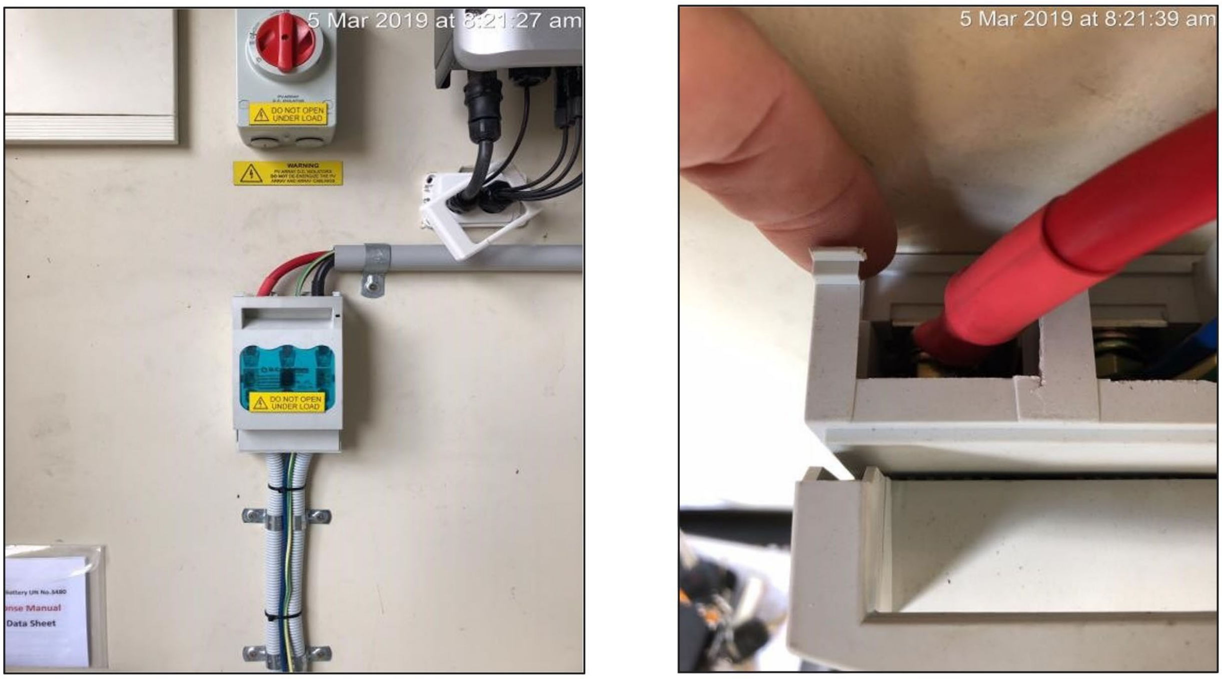
The following solar PV cable management tips were developed based on the top five non-conformances observed in frequency for Solar PV inspections:

1. Identify corresponding neutral connections. The Main Switch (ENERGY STORAGE) and any other circuits moved at time of installation must be marked or arranged to identify the corresponding active and neutral connections for each circuit (as per AS/NZS 3000:2018 Cl. 2.10.5.4)
2. Ensure all cables are secured in place in accordance with the requirements of AS/NZS 3000 & AS/NZS 5033. At times plastic cable ties are installed as a primary means of support, support cables with an appropriate compliant method, secure and fix cables to module frames or/and rails with suitable SS ties or clips (as per AS/NZS5033:2021 Cl. 4.3.2.3.1 (g))
3. Where conduit or other wiring enclosure is used, the wiring enclosure must be visibly labelled ‘SOLAR’ on the exterior surface at an interval not exceeding 2m. If fixed to a surface, the identification must be visible after mounting (as per AS/NZS 5033:2021 Cl 5.3.1 (a))
4. Permanently fix the solar shutdown procedure at the inverter and/or the main switchboard, and - a yellow label with black wording stating “WARNING PV array D.C. isolators do not de-energize the PV array and array cabling” must be included with the shutdown procedure (as per AS/NZS 5033:2021 Cl 5.7)
5. DC connectors need to be mated with those of the same type, from the same manufacturer (as per AS/NZS 5033:2021 Cl 4.3.9.1 (d)).

Queensland Electricity Connection Manual V4 provides obligations regarding cable management for installations in the Energex and Ergon Energy Network.

4.3 Assessment of unsafe installations

This section shows observations from an unsafe battery installation relating to exposed live parts. In this case, LIVE Terminals on a DC ISOLATOR could be accessed by means of touch with a finger through top and bottom entry points (see Figure 15 below).



Exposed LIVE parts **Unsecured panel**

Figure 15 Example of unsafe wiring (exposed live parts and unsecured panel) observed at a battery installation

During the assessment, the attending inspector needed to isolate the PV and Battery System, making the system safe, removing the risk of access to LIVE parts. The installer was required to return to site and install a fixed barrier such as a manufactured cover or similar to provide "Basic Protection" in accordance with AS/NZS 3000:2018 Cl 1.5.4 (see Figure 16 below).

Figure 16 Rectified wiring after compliance and conformance inspection

Another unsafe finding observed at a battery installation was a case where a plug at the battery was damaged, leaving exposed conductors (see Figure 17). In this situation, the attending Inspector needed to isolate the PV and Battery System, making the system safe.

Figure 17 Observation of a battery installation with damaged plug and exposed conductors

Other common electrical wiring problems include open panels, broken receptacles, unguarded parts, open equipment, loose wire connections at switches and outlets, wire connections made with electrical tape, connecting two or more wires under one screw terminal, loose connections on circuit breaker terminals, faulty neutral wire connections at circuit breaker panels, etc.

5. Labels and Safety Signage

The following provides guidance on the safety signs associated with battery systems.

Labelling may also be required in accordance with:

– AS/ NZS 5033 - Installation and safety requirements for photovoltaic (PV) arrays
– AS/ NZS 4777.1 - Grid connection of energy systems via inverters Installation requirements

5.1 Energy storage and battery type UN number

When a battery is installed, a Green Reflective ES disk 80mm in diameter must be affixed to the outside of the main switch board (and metering panel if separate). The sign should be visible to emergency services from the most likely direction of approach. The UN material number informs emergency services of the battery technology, e.g. UN 3480 for Lithium Ion. This is in addition to the PV disk and an example can be seen below in Figure 18 below.

Figure 18 Indicative signage for energy storage and the battery type UN number

5.2 Battery system location

Where a battery system may be difficult to locate within a household, a plan or site map can be placed at the main switchboard for clarity. An example has been provided in Figure 19.

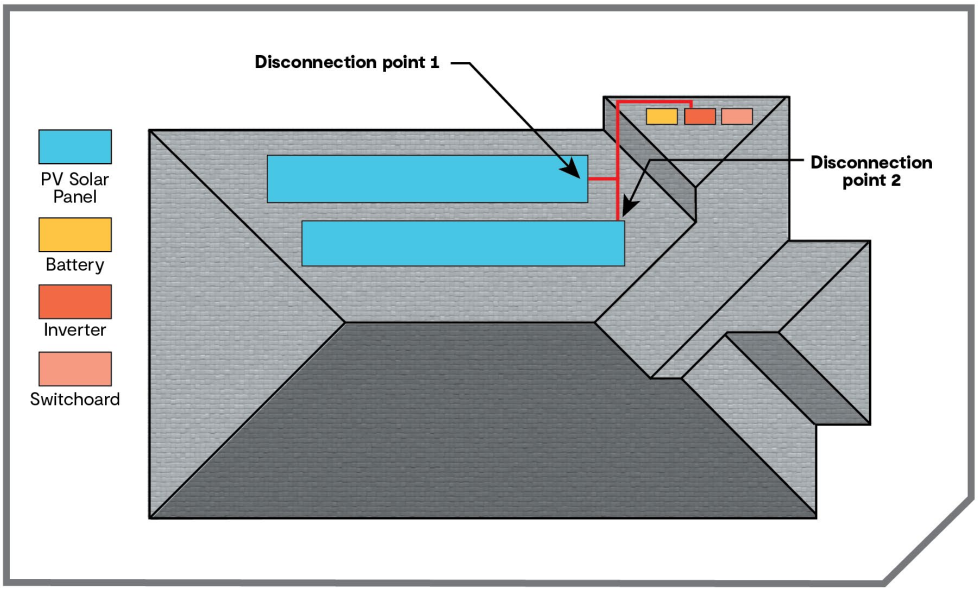


Figure 19 Site layout identifying the battery system location

5.3 Voltage and current

Adjacent to battery enclosures or all doors leading to the room containing the battery, it is required to place a sign which indicates the following (as depicted Figure 20):

– Battery System Location
– Potential short-circuits current rating
– Maximum DC voltage

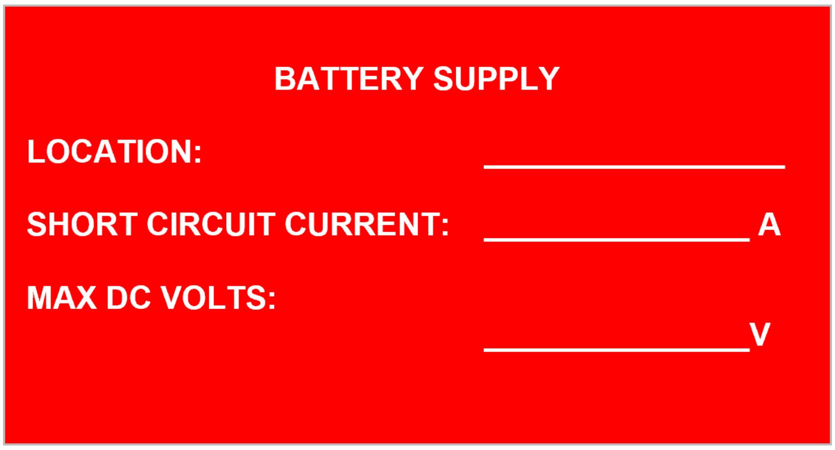


Figure 20 Indicative signage identifying battery voltage and current specifications (not exceeding DVC)

The above sign is to be placed adjacent to the battery system isolator. Where the sign is not adjacent to the isolator, an additional sign is to be installed.

Where battery system voltages exceed DVC A, the above signage must include the words “Hazardous DC Voltage”.

Note that further details can be found in AS/NZS 4777.1, Cl 6.5(a).

5.4 Chemical hazard

A battery system that represents a chemical hazard must include an appropriate sign applicable to the specific risk. For example, this may refer to but is not limited to:

– Electrolyte burns
– Toxic fume emissions

The sign is to be placed adjacent to the battery system enclosure or on all doors to the room housing the battery system. Examples of the aforementioned signage have been provided in Figure 21 and Figure 22.

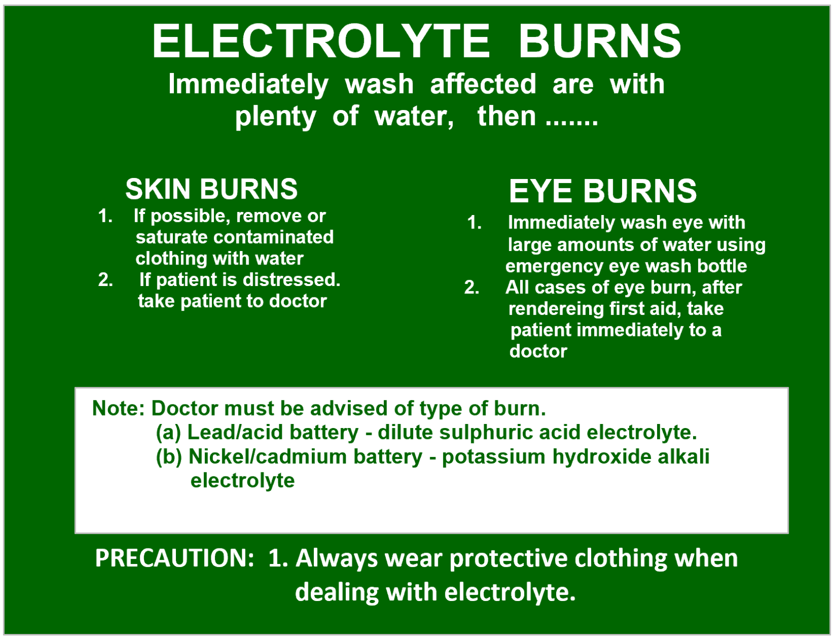


Figure 21 Indicative signage for chemical hazards (electrolyte fumes)

Figure 22 Indicative signage for chemical hazards (toxic fumes)

5.5 Energy hazard

All battery systems contain an inherent energy hazard that cannot be eliminated; therefore it should be ensured that battery systems include a general sign to indicate an energy hazard (i.e. arc flash, shock hazards, etc.), as illustrated in Figure 23. The sign is to be placed adjacent to the battery system enclosure or on all doors to the room housing the battery system.

Figure 23 Indicative signage indicating danger of energy hazards

5.6 Isolation devices

Battery system isolators must be labelled with a sign containing the following words: Battery System Isolator.

Figure 24 Indicative signage used to indicate a battery system isolator

The sign is to be located in a prominent location so that the applicable switchgear can be identified.

5.7 Overcurrent devices

Battery system overcurrent protection devices are required to be labelled with either of the following (as indicated in Figure 25:

- Battery System Circuit Breaker; or
- Battery System Circuit Breaker and isolating switch; or
- Battery System Fuse; or,
- Battery System Switch Fuse and Isolator.

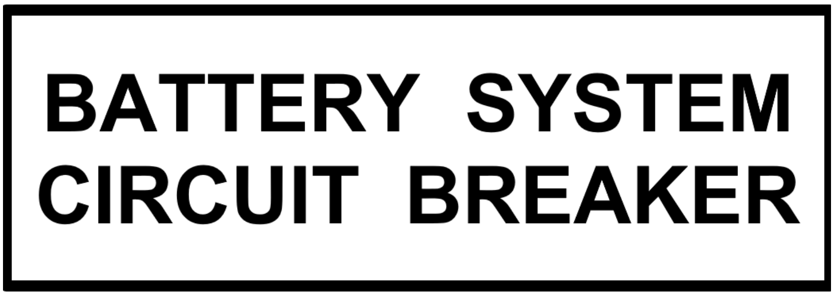


Figure 25 Indicative signage used to indicate battery system overcurrent protection

The sign is to be located in a prominent location so that the applicable switchgear can be identified.

5.8 Battery system cables

Battery system cabling (or conduit where cabling is enclosed), must be labelled "BATTERY" at intervals not exceeding 2m.

See AS 5139:2019 Cl 7.14 Battery System Output Wiring for further details.

5.9 Shutdown procedure

The installer must ensure that site specific shutdown procedure signage labels are installed at the battery installation location and that the signage installed matches the shutdown procedure installed at the battery installation location. All PV and battery systems are required to include a shutdown procedure detailing how to safely switch it off. This procedure must be specific to the PV and Battery Systems that are installed and must be located at all following location:

- Main switchboard
- Distribution board (where a BESS terminates into such); and,
- Adjacent to equipment that will be operated (e.g. battery overcurrent protection)

An example shutdown procedure has been provided in Figure 26.

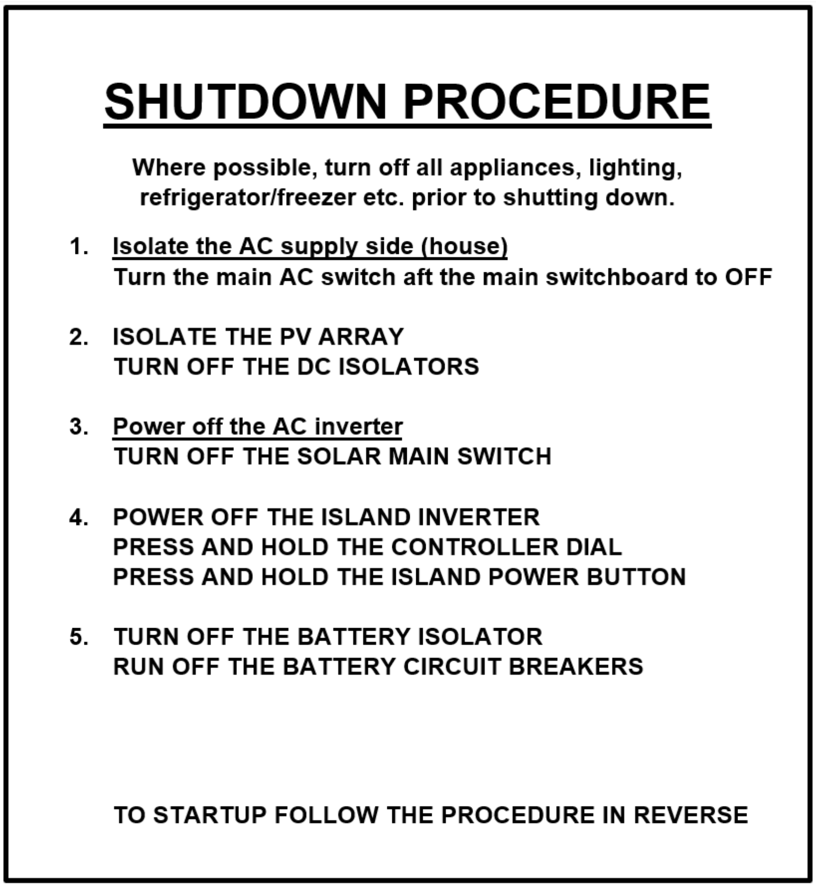


Figure 26 Indicative shutdown procedure sign

All signage labels installed are to be constructed of appropriate materials suitable for the location and be permanently, legibly, and indelibly marked in English. Signage labels requiring details to be filled out by the installer are to be permanently, legibly, and indelibly marked in English as specified in AS/NZS 5033 including amendment 1 & 2 Section 5. Compliant examples of this are etching/engraving and UV resistant premade labels. Using these methods will ensure the details will last the lifetime of the system. The use of a black marker is not permitted as the text will not last the lifetime of the system.

5.10 Personal Protective Equipment (PPE)

Where personal protective equipment is required to access battery systems, a sign should be installed to indicate the following:

- The requirement for personal protective equipment
- The specific type of equipment

Figure 27 illustrates indicative PPE signage.

Figure 27 Indicative signage used to outline PPE required when accessing the battery system enclosure[2]

The sign must be adjacent to the enclosure or on all doors to the room used to enclose the battery system.

5.11 Neutral connections

Grid Connected batteries are designed to be operated while islanded from the grid and during this time, it is important to ensure the neutral connection to earth, the Multiple Earth Neutral (MEN) point integrity is maintained as required by AS4777.1:2016 Cl 5.4.3 – "When operating in stand-alone mode, the stand-alone port must provide an earth referenced A.C. supply." This is extremely important to maintain the electrical integrity of the site. If the MEN connection is not in place, the device may not operate properly thereby making the installation electrically unsafe.

Corresponding neutrals should be identified, e.g. Main Switch Inverter Supply must be marked or arranged to identify corresponding Active and Neutral connections for each circuit (as per AS/NZS 3000:2018 Cl 2.10.5.4) as outlined in Figure 28 below.

[2] https://www.vba.vic.gov.au/news/news/2020/maintaining-health-and-safety-on-construction-sites-and-other-premises

Figure 28 Sample connection showing marked/labelled cables identifying neutral cable connection

6. Commissioning and Testing

Commissioning is the process of verifying both the installed system and its performance against the original design. A formal record of commissioning must be made and supplied to the client at handover as detailed in section 7. It will also form a system baseline which is used as the starting point whenever fault finding of a failed system is required.

After installation, a battery system and pre-assembled BESS must be commissioned in accordance with manufacturer's instructions and the requirements of this section.

The following must occur:

- Confirmation of the installation:
  - Labelling; and,
  - Signage
- Submission of documentation as per section 7 DOCUMENTATION
- Visual inspection including:
  - Basic protection (e.g. cable insulation and conduit integrity, etc.)
  - Fault protection (e.g. installation of switchgear, appropriately insulated cable, etc.)
  - Protection against hazardous parts (e.g. shrouded terminals, battery accommodation restricting access to authorised persons, etc.)
  - Protection against spread of fire, as per 2.2.3 Fire Hazard
  - General condition and integrity of connected electrical equipment
- Check tightness of battery system terminals, links, intercell connections as per manufacturer's specified torque settings
- Ensure operational parameters are correctly set (e.g. charge and discharge settings, communication, etc.)
- Testing, including:
  - Polarity
  - Resistance between active conductors and earth, where relevant
  - Battery system voltage
  - Individual battery voltages, where relevant
  - Other relevant battery parameters, such as specific gravity, state of charge, etc.
- Isolation in accordance with specified shut down procedure.
- Confirmation of functioning charge and discharge cycle
- Note, AS 4086 provides guidance regarding initial charge for traditional chemistries.
- Testing and Confirmation of anti-islanding and emergency power supply mode
- Confirmation of functioning monitoring system(s), where relevant

Commissioning may be conducted in accordance with:

- AS/NZS 4509.1, clause 10
- AS 2676.1 & 2, clause 5.5
- AS 4086.2, Appendices C, D, E & F

7. Documentation

7.1 General

At the completion of the installation of a battery system or pre-assembled BESS, documentation must be provided in accordance with the requirements of this section.

This documentation must ensure that key system information is readily available to customers, inspectors, maintenance service providers and emergency service personnel.

Additional documentation may also be required in accordance with:

- AS/NZS 5033 – Installation and safety requirements for photovoltaic (PV) arrays
- AS/NZS 4777.1 – Grid connection of energy systems via inverters Installation requirements

7.2 System manual

A manual, complete with the following items, re-produced from AS 5139:2019 Cl x.4.1.2, must be provided:

- Battery system information including:
  - Total battery storage capacity
  - Australian/New Zealand address and contact details for the manufacturer representative (or deemed equivalent).
  - UN Number for the battery cell or battery system
  - Commissioning date
  - System provider's contact details
- A complete list of installed equipment, with model description and serial numbers.

  NOTE 1: It is recommended that installers retain records of equipment installed for maintenance and records.
- System performance and operation configuration: system output performance including expected operating response based on programming, expected life of a BESS or battery system, end of life system parameters, and expected operational life.
- Operating instructions (system and components): a short description of the function and operation of all installed equipment.
- Operating instructions for response requirements to battery system alarms that may be required as part of the installation.
- Description and meaning of any state of health measurements, where provided.
- Shutdown and isolation procedure for emergency.
- Start-up procedure and verification checks:
  - Description of how to identify when the system is not operating correctly and what to do in the case of a system failure. Details about alarm systems installed as part of the system and in addition to the system.
- Maintenance procedures and schedule: maintenance procedures, a checklist for the installed equipment and schedule for these tasks including hazard mitigation requirements for maintenance tasks. Including shutdown and isolation procedure for maintenance, this may be different to emergency shutdown procedure above.
- Commissioning records and installation checklist: A record of the initial system settings at system installation, verification records, commissioning checklists for quality assurance and date of installation.
- System connection diagram: A diagram showing the electrical connections of the BESS or battery system with the PCE(s). All diagram labels must match labels provided.

  NOTE 2: In larger installations separate schematic circuit and wiring diagrams should be provided.
- Equipment manufacturer's documentation, data sheets, safety data sheets for BESS or battery systems and handbooks – for all equipment supplied. Where systems have an ethernet or other form of data interface, include all information on connection requirements and system operating manuals.

- A copy of the risk assessment undertaken for AS 5139 Cl x.2.1 including information on specific requirements to address all risks, for example, the action to take when toxic fumes are present.
- List of any spare parts that have been provided (e.g. fuse replacement cartridges).
- Decommissioning information for battery replacement or battery removal including safe handling procedures for the pre-assembled battery system and recommendations for battery recycling.

8. Operation and Maintenance

Battery system and pre-assembled BESS maintenance will promote and prolong:

- Safety
- Reliability
- Performance

Only authorised persons must perform battery system and pre-assembled BESS maintenance.

Maintenance must be conducted in accordance with:

- Manufacturer’s:
  - Instructions
  - Safety Data Sheet
- System Manual, as per section 7.2 SYSTEM MANUAL
  - Recommended maintenance of the system
  - Maintenance procedure and timetable
- Work Health and Safety
  - Standard operating procedures
  - Safe work methods statement

Maintenance may be conducted in accordance with AS 5033:2021 Appendix H and manufacturer’s recommendations.

Examples of battery system/ BESS maintenance include:

- Ensuring electrical terminals are set to correct torque settings.
- Ensuring battery accommodation integrity is maintained (e.g. not damaged, free from debris/ rubbish; and access is not obstructed).
- Ensure proper functioning of overcurrent and isolation devices.
- Check charge and discharge parameters are correctly set.
- Ensure correct ventilation has been provided and is maintained.
- Check cable mechanical support, protection and penetration is maintained.

9. Grid Connection

A new solar battery installation for a premises connected to the distribution network (not "off grid") must be registered with the network provider. The relevant standards for home batteries under 10 kW per phase are either:

1. **STNW1170 (Standard for Small IES Connections)** for a "fixed" connection with static export and import limits.
2. **STNW3510 (Dynamic Standard for Small IES Connections)** for "dynamic" connections. See below for more information about dynamic connections.

For home batteries 30kW or over refer to the following standards:

1. **STNW174 – Standard for Low Voltage Embedded Generating Connections**
2. **STNW3511 – Dynamic Standard for Low Voltage Embedded Generation Connections**

The **Queensland Electricity Connection Manual (QECM) – Version 4** – Effective from 21 February 2024 provides information for proponents of electrical installations about their obligations in respect to connecting to and interfacing with Energex and Ergon Energy Network's distribution system.

9.1 Dynamic connections

A "Dynamic Connection" is a new type of electricity connection which is now available to customers in Queensland. A detailed explanation of dynamic connections and information for installers and suppliers can be found at:

Energex Dynamic Connections for energy exports website

Ergon Energy Network Dynamic Connections for Energy Exports

A dynamic connection offers a number of benefits to households that have solar PV and battery systems. The main benefits are:

1. **More export capacity most of the time:** Static connections have conservative export limits, all the time. A dynamic export limit will maximise the export opportunities at any time when the network is not under stress. This means that a customer will probably be able to sell more electricity back to the grid and reduce their electricity bills. For most customers (customers on a single phase connection) the *maximum* export on a fixed connection is the *minimum* export on a dynamic. This means that a dynamic connection will *only* increase the opportunities to sell electricity back to the grid. The current limits (subject to change) are:

   For a single-phase connection: up to 10 kW dynamically, compared to 1.5 kW on a fixed connection.

   For a multi-phase connection: up to 10 kW per phase dynamically, compared to 5 kW per phase on a fixed connection.
2. **Larger systems are allowed:** Households on single phase connections (most households) are limited to 10 kVA **in total** for PV and BESS. A dynamic connection on a single phase allows for 10 kVA of PV **and another** 10 kVA of batteries (BESS & EV).
3. **Maximised grid efficiency:** Dynamic connections help to optimise the grid. This helps to make the grid more stable and reliable. Importantly, it can also reduce the costs associated with upgrading the grid. These costs are ultimately paid by all electricity consumers.
4. **Contribute to the grid transition:** Dynamic connections form an important part of creating a "smart grid", which can run on 100% renewable energy. By adopting a dynamic connection, Queenslanders can contribute to the government's energy transition away from coal and other fossil fuels.

The dynamic connection enables home energy system components (such as batteries & PV) to receive regular updates to operating parameters (such as export/import limits) from the DNSP. In Australia, dynamic connections will be managed with the Common Smart Inverter Profile – Australia (CSIP-Aus). CSIP-Aus uses the IEEE 2030.5 Smart Energy Profile (SEP 2.0) to manage communications between DNSP servers and home energy system components. IEEE 2030.5 can operate over the internet, and Queensland dynamic connections will be managed over the internet.

Although CSIP-Aus functionality is expected to become a standard functionality for inverters and batteries sold in Australia, implementations of CSIP-Aus might be slightly different for different DNSPs (for example configurations for South Australia may not *necessarily* work in Queensland). Only inverters or communication devices which are listed on the "**Dynamic Connection Compliant Providers**" list have been tested and approved for use with Energex and Ergon Energy Network CSIP-Aus implementations. Some items on this list may be software which is embedded within an inverter. This means that an inverter may be compliant for Energex and Ergon Energy Network dynamic connections even if it is not explicitly listed on the list. Installers are encouraged to contact vendors or OEMs to determine compliance for the Energex and Ergon Energy Network implementation of CSIP-Aus. Equipment OEMs are encouraged to contact Energy Queensland to become compliant providers. A dynamic connection will only be approved if both batteries & PV are either on the list or integrated with a gateway which is on the list.

The full set of dynamic connection technical requirements are defined by Energex and Ergon Energy Network in Standard STNW3510, which is located here: **Standard for Small IES Connections (energex.com.au)**. This standard may be updated from time to time. Installers should consult the latest version of this standard before designing, quoting, or installing systems.

As a general guide, the requirements for a dynamic connection with a home battery are:

- Capacity Limits:
  - Single phase system: the battery & PV each have a capacity of less than 10kW (up to 20 kW in total).
  - Two or three phase: each phase has a capacity of less than 10kW (battery + PV must be less than 10 kVA per phase).
- A battery system which is either:
  - On the "Compliant Suppliers" List, or
  - Integrated with a gateway device on the "Compliant Providers" List
- A PV system which is either:
  - On the "Compliant Suppliers" List, or
  - Integrated with a gateway device on the "Compliant Providers" List, or
  - Not able to export to the distribution network.
- A stable internet connection for inverters and/or gateways (may require home WiFi or LAN configuration).
- Monitoring of export at the point of connection
- Approval and activation from the DNSP.
  - Typical turnaround time from application to approval is approximately 65 days.
- CSIP-Aus settings configured for the customer's equipment and premises.
  - Instructions and settings are issued by Energex and Ergon Energy Network when the dynamic connection is approved.

Note: A PV or battery system which is not able to export to the grid *may* be compliant with the STNW3510 standard, in that it never exceeds the export limit. It may be possible to incorporate a legacy system into a new dynamic connection system on the basis that it does not export.

Customers, or installers on behalf of customers, must apply for a dynamic connection through their DNSP (Energex and Ergon Energy Network). Battery installers are encouraged to create an account in the "Electrical Partners Portal" of either Ergon Energy Network (**Sign In (sparq.com.au)**) or Energex (**Sign In (sparq.com.au)**) as applicable. There is currently a charge for a dynamic connection, which will be listed on the application form. The fee for the year 2023/24 is $196. After a dynamic connection has been approved, Energex or Ergon Energy Network will send out specific configuration data for the relevant address. This data, together with the equipment installation documentation from the OEM, should be used to set up a dynamic connection for the customer.

The basic process to set up a dynamic connection is shown in Figure 29.

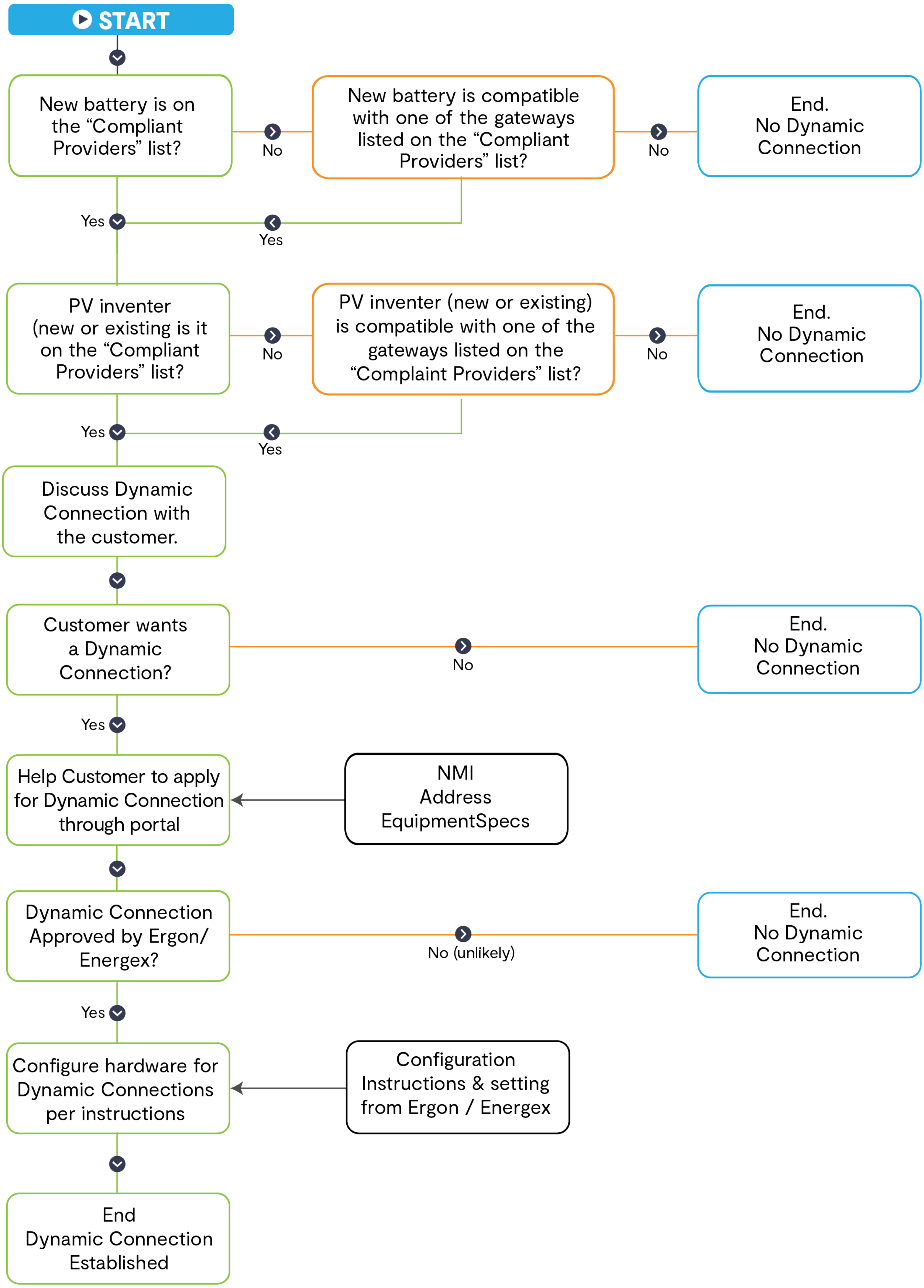


Figure 29 Dynamic connection process

9.2 Virtual Power Plants (VPPs)

Virtual Power Plants (VPPs) provide another opportunity for households with solar battery systems to participate in the next big step of Australia's renewable energy transition. They may also save even more on their energy costs or be paid for access to their household batteries.

Unlike conventional power plants which generate electricity from a single location, Virtual Power Plants (VPPs) can connect lots of smaller PV and solar battery systems in different locations together and act as one single system. This creates a shared energy resource which can generate or store energy like a single power plant or grid battery.

The solar battery systems in a VPP can be clustered together or spread out across the network. VPPs can react quickly to deliver power to where it's needed or absorb excess energy in a region when there is an over-supply. This can help manage strain on the network at the grid or local level, improving the network everyone.

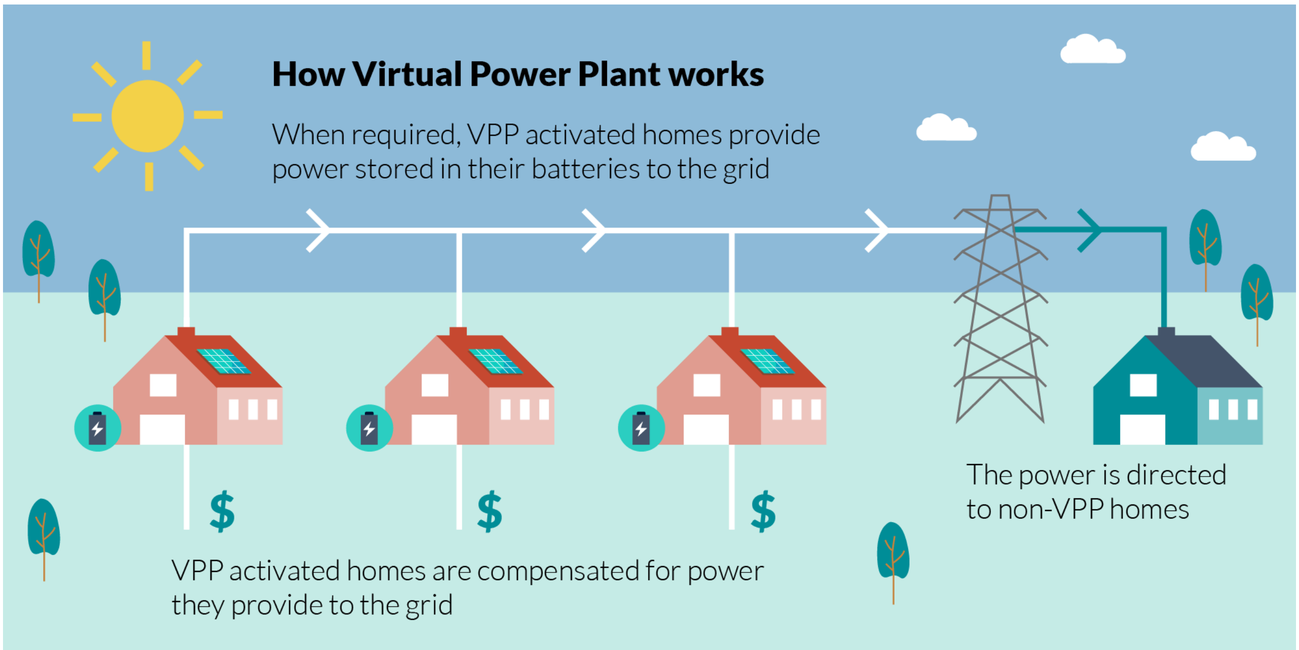


Figure 30 An example showing a number of individual households operating in symphony as a VPP

Some of the possible benefits to a client participating in a VPP program are:

- The client can be paid for letting the VPP network access the excess energy stored in their home battery.
- The client may receive a better rate for their electricity consumption.
- The client has more flexibility on how their excess solar energy is used – to support the grid or other consumers.
- By allowing the VPP to better manage energy supply and demand, the impact of surges on the grid can be reduced.
- VPPs can enable greater solar PV and battery uptake in the community.

VPPs can also have some drawbacks, which are important for clients to consider before participating in a VPP program. Some possible drawbacks could include:

- Reduced control over the client's home energy systems.
- More frequent charging and discharging of your battery, which can affect the lifespan or warranty of the battery.
- Less energy available in the client's battery for use if there is a blackout.
- Less choice in electricity retailers.
- If the VPP is not configured correctly, the VPP may make the battery operate outside the manufacturer's recommendations. This might affect the battery warranty.

A battery system generally requires the following features to be VPP ready:

- **Ability to communicate with VPP control servers –** A secure communications connection (almost always via the internet) will be required for VPP participation. Each VPP operator will have specific communications and networking requirements.
- **Ability to collect and communicate charge status –** A battery system must be able to communicate state of charge data to the VPP operator at regular intervals. Each VPP operator will have specific requirements for how often this data must be updated.
- **Ability to respond to remote battery charge/discharge requests –** A battery system must be able to charge and discharge when the VPP sends an instruction to do so.
- **Ability to communicate additional status or availability data –** The VPP operator may require additional data, such as terminal voltage or operating temperature.
- **Backstop or Failsafe settings –** The VPP operator may require that the battery system revert to certain settings or operations when communications to the VPP servers are lost.

Note: VPPs using home batteries are still an emerging technology in Australia, and globally. The requirements of VPP operators are likely to evolve over time. It is recommended that installers keep up to date with the latest requirements of VPP operators in Queensland as they evolve. It is also likely that VPP operators in Queensland will nominate preferred OEM equipment or technology designs.

9.3 Embedded networks

Embedded Networks are privately owned and operated electricity networks set up within a site or building to supply electricity to multiple buildings or occupants within its network. They could provide mutual financial benefits in the form of passive stream of income to the owners of the network as well as the residents/participants. An example of an embedded network might be an aged care facility with individual dwellings, each with its own PV system and battery.

The overall management of these systems would be undertaken for the mutual benefit of all. The entire site would appear to the grid as a single load with enhanced ability to respond in much the same way as a VPP does – to sink excess energy from the grid or supply energy back to the grid. In this way, benefits can be realised by reducing or increasing demand in a coordinated manner which may enable a deferral of local network infrastructure by the DNSP. A larger example might be an entire suburb consisting of a new housing estate optimised at the design stage. In the latter case, distributed batteries on each house may be supplemented or replaced by much larger community batteries spread at strategic locations throughout the suburb and tapped into the privately owned distribution network.

The downside will be a higher level of grid protection and integration required in order to interface to the grid.

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