Installation Guide

Renewable Energy Systems
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>PV Array — General</td>
<td>2</td>
</tr>
<tr>
<td>Ground Mounted Array</td>
<td>10</td>
</tr>
<tr>
<td>Roof Mounted Array</td>
<td>14</td>
</tr>
<tr>
<td>Marshalling Boxes</td>
<td>16</td>
</tr>
<tr>
<td>Lightning Protection</td>
<td>18</td>
</tr>
<tr>
<td>Fencing</td>
<td>20</td>
</tr>
<tr>
<td>Shed Specifications</td>
<td>22</td>
</tr>
<tr>
<td>Battery Bank</td>
<td>30</td>
</tr>
<tr>
<td>Equipment Enclosure</td>
<td>38</td>
</tr>
<tr>
<td>Energy Management Unit or Energy Meter</td>
<td>42</td>
</tr>
<tr>
<td>Diesel Generator</td>
<td>46</td>
</tr>
<tr>
<td>Diesel Fuel Tank</td>
<td>48</td>
</tr>
<tr>
<td>Reticulation</td>
<td>50</td>
</tr>
<tr>
<td>General Purpose Outlets</td>
<td>52</td>
</tr>
<tr>
<td>Demand Side Management</td>
<td>53</td>
</tr>
<tr>
<td>Pre Commissioning</td>
<td>54</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>58</td>
</tr>
</tbody>
</table>
This guide is intended as a visual reference for Bushlight installation contractors, and should be read in conjunction with Bushlight’s Technical Specification.

The illustrations and text highlight important installation requirements and identify common installation errors and defects.

For detailed installation specifications please refer directly to the Bushlight Technical Specification.

All Bushlight renewable energy systems are designed and installed in accordance with specifications developed by Bushlight which meet or exceed the requirements of all relevant Australian Standards including, but not limited to:

- AS 4509  Stand-alone power systems, (Part 1, 2 and 3)
- AS 5033  Installation of photovoltaic (PV) arrays
- AS 4086  Secondary batteries for use with stand-alone power systems (Part 1 and 2)
- AS 3000  Electrical installations (Australian Wiring Rules)
- AS 1768  Lightning protection.

Please note that although Bushlight renewable energy systems generally demonstrate current best practice in the installation of stand-alone power systems, Bushlight does not suggest or warrant that every image in this publication meets all aspects of every possible standard. Installers should always specifically refer to relevant standards when carrying out renewable energy or electrical installations.
Fixings

• PV modules shall be fixed to the array frame with tamper proof fixings and aluminium bonded washers.

Fixings

• Aluminium bonded washers provide separation between modules and support structure to prevent corrosion.

Fixings

• Tamper proof bolts installed nut side up to ensure security.

Refer to Technical Specification Chapters on *PV Modules and Fixings*
Fixings

- Hexagonal bolts fixing PV modules to the array frame are not tamperproof.

Fixings

- No separation between array frame and PV module. Increased risk of dissimilar metals corrosion.

Fixings

- Tamper proof bolts installed nut side down make it easier to remove the bolts with a spanner.

Refer to Technical Specification Chapters on PV Modules and Fixings
Module Junction Box

- All cable entry to junction box sealed to maintain IP rating.

Module Connections

- Inter-module wiring enclosed in conduit.
- Rigid conduit used where possible.

Refer to Technical Specification Chapters on PV Modules, PV Array Wiring and Cabling
Module Junction Box

- Entry points to junction box not sealed, IP rating is compromised.

- Entry points to junction box is not sealed, IP rating compromised.

- Inappropriate junction box for flying lead modules.

Module Connections

- Poor conduit termination.
- Conduit is damaged.
- Cable damaged.

Refer to Technical Specification Chapters on PV Modules, PV Array Wiring and Cabling
Module Flying Leads

- Flying leads to be mechanically supported and protected in cable ducting sections.
- Cable ducting to be covered with removable face plate and end caps.

Cable Ducting

- Exposed flying lead length to be minimised via top entry into cable ducting.
- Flying lead entry into ductwork to be sealed with appropriate grommets.

Refer to Technical Specification Chapters on PV Modules, PV Array Wiring and Cabling
Module Flying Leads

- Flying leads not mechanically protected, potential for the leads to be damaged and electrically compromised.

Cable Ducting

- Cable ducting not sealed with ductwork end caps.

Cable Ducting

- Flying lead entry into cable ducting not orientated so as to minimise length of exposed flying leads.

Refer to Technical Specification Chapters on PV Modules, PV Array Wiring and Cabling
Cable Protection

- Array cables mechanically protected.

Array Cabling

- Neat array cabling.
- Array cabling protected by UV stabilised conduit.
- Conduit not in direct sunlight.

Array Cabling

- Array wiring securely fastened.

Refer to Technical Specification Chapters on PV Modules, PV Array Wiring and Cabling
Cable Protection

• Array cable not appropriately secured and mechanically protected.

Array Cabling

• Array cable is exposed to direct sunlight.
  • All array cable is to be run in UV stable conduit.

• Too much conduit.
  • Array cabling not run in rigid conduit where possible.

Refer to Technical Specification Chapters on PV Modules, PV Array Wiring and Cabling
Ground Mount PV Array

- Installed in accordance with Technical Specification Chapter on PV Array Mounting Frames

Array Frames

- Array mounting frames constructed to engineer certified specifications.

- Front edge between 1200 mm & 1300 mm above ground level.

NOTE: Structures are required to be cyclone rated in northern locations.

Black Plastic, Weed Matting and Aggregate

- Black plastic and weed matting with minimum 50 mm aggregate cover laid to a radius of 2 m from the edge of the array.

- Covers entire fenced-in area.

Refer to Technical Specification Chapters on PV Array Mounting Frames, and Fire Protection
Array Frames

- Minimum 1200 mm clearance required between ground and lowest edge of the PV array.

Sub Array Spacing

- Sub Arrays installed too closely together will shade each other.

Black Plastic, Weed Matting and Aggregate

- Aggregate is laid too thin.
- Aggregate is not covering the entire fenced in area.

Refer to Technical Specification Chapters on *PV Array Mounting Frames, and Fire Protection*
Array Frames

- Z section purlins preferred over C section to improve access to tamper proof fasteners for maintenance.
- Bolts installed tamperproof end down.

Cabling

- Neat cabling appropriately secured to the array frame.
Cabling

- Excessive conduits, poor layout.
- Conduits not appropriately secured.

Cabling

- External conduit not UV stabilised.

Refer to Technical Specification Chapters on *PV Array Mounting Frames and Cabling*
Roof Mount PV Array

- Installed in accordance with Technical Specification Section chapter on PV Array Mounting Frames.

Dektite Boot Protection

- Roof penetrations protected from the weather by Dektite boots.

Array Cabling

- Neat array cabling secured by saddle clips where required.

Refer to Technical Specification Chapters on PV Array Mounting Frames and Cabling
Roof Mount PV Array

- PV modules located too close to one another and resulting in shading problems.

Dektite Boot Protection

- Roof penetrations not protected by Dektite boots.

Array Cabling

- Poorly secured conduit.

Refer to Technical Specification Chapters on *PV Array Mounting Frames and Cabling*
Marshalling Box

• Neat cabling appropriately secured to the array frame.
• Internal cabling is a perfect solution.

Marshalling Box

• Marshalling box installed in a protected position under array.
• Marshalling box correctly labelled.

Note: Bushlight provides marshalling box labels in the spare parts kit supplied with the Equipment Enclosure.

Marshalling Box

• Neat internal wiring.
• Correct use of positive, negative and earth busbar.
• MOV’s neatly installed.

Refer to Technical Specification Chapters on PV Array Marshalling Boxes and Cabling
Marshalling Box

- Excessive conduits, poor layout.
- Conduits not appropriately secured.

Marshalling Box

- Array marshalling box exposed to direct sunlight.

Marshalling Box

- Untidy internal wiring resulting in a confusing layout.
- Main cables joined in BP connectors instead of using busbars provided.

Refer to Technical Specification Chapters on *PV Array Marshalling Boxes and Cabling*
Air Termination

- Air termination minimum of 500 mm above the highest point of the array.
- Sufficient space between the air termination and the array to avoid shading.

Air Termination

- Single pole with air termination high enough to give full radius of protection.

Earth Stakes

- Earth cable well secured and painted to prevent corrosion.
- Ground resistivity improvement material utilised.
- Inspection pits preferred.

Refer to Technical Specification Chapters on Lighting Protection, and Earthing
Air Termination

- The air termination is shading the array as it is too close and high and is leaning northwards.

**NOTE:** As can be seen from the array shadow the sun will be south of vertical in summer (where installations are above the tropic of Capricorn).

Air Termination

- Excessively high air termination causing shading.
- Shading can be avoided by replacing the high air termination with several shorter ones.

Refer to Technical Specification Chapters on *Lighting Protection, and Earthing*
Fencing

✔ Security Mesh Fence

- Fence must be constructed as per tender specification.
- Sufficient space between the array and the fence ensures the fence does not shade the array.

✔ Stranded Wire Cattle Fence

- Wire appropriately tensioned.
- Sufficient number of posts to adequately support wire.

✔ Fencing

- Gates to have suitable locking mechanism.
- Padlocks for gates and buildings are provided by Bushlight at the time of commissioning.

Refer to Technical Specification Chapters on Fencing
Fencing

- Installation of fences to be complete at time of commissioning.

- Chain held in place by a piece of wire not considered satisfactory locking mechanism.

Refer to Technical Specification Chapters on Fencing
Shed Specifications

✅ Shed - Front View
Shed features include:
• 600 mm eaves.
• Ventilation at highest point of shed roof.

✅ Shed - Side View
Shed features include:
• Neat finish.
• Air vents fitted with insect screens and dust filter material in Central region.

✅ Finish
Coloured surfaces of the shed are standard ‘Colorbond’ colours.
• Walls: Dune.
• Roof: Surf mist.

Refer to Technical Specification Chapters on Shed Specifications
Finish

• Poorly cut and untidy sheet metalwork.

• Exposed insulation.

• Missing flashing.

Refer to Technical Specification Chapters on *Shed Specifications*
False Wall

• False wall or ‘second skin’ installed on the east facing wall.
• Second skin mounted on vertically running top-hat sections to ensure vertical ventilation path
• Sisilation installed between skins
• False wall starts 300 mm above the ground to allow air ventilation.

Finish

Flashings installed to provide neat finish.

Black Plastic, Weed Matting and Aggregate

• Weed matting with 50 mm aggregate cover surrounding shed to a 2 m radius.
Shed Specifications

Finish

- Poor sheet metalwork, potential OH&S issue.

Black Plastic, Weed Matting and Aggregate

- Corrugated iron not acceptable substitute for weed matt.
- No black plastic installed.

Refer to Technical Specification Chapters on Shed Specifications
Shed Security

• 150 mm (minimum) pad bolt required to accommodate padlock provided by Bushlight.
• Pad bolt and catch appropriately secured.

Shed Security

• Bushlight provide appropriately keyed shed and gate locks.

Tropical Roof

• When specified by Bushlight a Tropical Roof is installed to provide additional shading.
• Tropical Roof includes wing walls.
• Tropical Roof to stand above the underlying shed roof by 300 mm.

Refer to Technical Specification Chapters on Shed Specifications
Shed Security

• Locking mechanism insecure due to reliance on thin flashing.

• Pad bolt secured by screws that are easily removed (pop rivets or welding acceptable).

Refer to Technical Specification Chapters on Shed Specifications
Finish

- Vented ridge cap insect and weather proof.

Finish

- Insulation appropriately secured by internal ceiling.

Finish

- Air vent covered by fine gauze insect screening.

Refer to Technical Specification Chapters on *Shed Specifications*
Finish

• Poorly finished vented ridge cap.
• Ventilation obstructed by roof sheeting.

Finish

• Insulation to be appropriately installed and supported as per manufacturer’s specifications.
• Foil on the outside in tropical regions, foil on the inside in temperate regions.

Finish

• Insect screening not installed over air vent.

Refer to Technical Specification Chapters on Shed Specifications
Battery Bank

- Min 900 mm access in front of battery bank
- Min 100 mm clearance between battery bank and wall.

Temperature Sensors

- Temperature sensor fixed at centre of string, adjacent to positive terminal.
- All sensors on same cell.
- Sensor wiring neat.

Battery Spacing

- Batteries have close and even spacing (10 mm).

Refer to Technical Specification Chapters on Battery Bank Installation
Temperature Sensor

- Temperature sensors located adjacent to the negative terminal.

Temperature Sensor

- Temperature sensor hanging between batteries.

Refer to Technical Specification Chapters on Battery Bank Installation
Battery Numbering

- Each Battery cell to be numbered, starting with cell 1 at the positive lead terminal.
- Additional strings numbered identically.

Battery Isolator

- Battery isolator to have solid mounting.
- Cable shrouds to be installed on top and bottom of isolator
- Fuses appropriately rated to protect cable.
Battery Cabling

- Battery Cables untidy and poorly secured.

Battery Isolator

- Battery isolator not securely mounted.
- Shrouds missing.
- Cable penetrations through wall without bushes or glands.

Refer to Technical Specification Chapters on *Battery Bank Installation and Cabling*
Battery Stands

- Batteries supported by galvanised or painted steel stands.
- Battery stands fixed to the floor.
- Batteries elevated minimum 100 mm from the floor.

Battery Cabling

- Cables installed in conduit and fixed to ladder or cable tray.
- Battery cables of identical size and length when installing parallel battery banks.

Battery Cabling

- Double insulated cables neatly fixed to ladder or cable tray.
- Wall penetrations via glands to protect cables.

Refer to Technical Specification Chapters on Battery Bank Installation and Cabling
Battery Location

- Spacing between battery bank and wall not minimum 100 mm.

Refer to Technical Specification Chapters on Battery Bank Installation and Cabling
Battery Box

48 Volt Single String System

- Configured as one Equipment Enclosure and two Battery Boxes.

Battery Box

48 Volt Dual String System

- Configured as one Equipment Enclosure and four Battery Boxes.

Battery Spacing

- Batteries evenly spaced approximately 10 mm apart.

Refer to Technical Specification Chapters on Battery Bank Installation
Battery Terminals

- Battery terminals are missing caps posing a safety risk.

Battery Spacing

- Irregular battery spacing places mechanical strain on interconnections.

Refer to Technical Specification Chapters on *Battery Bank Installation*
Enclosure Location

Appropriate clearance around the enclosure is:

- 750 mm in front.
- 500 mm to the right hand side.
- 75 mm to the rear.

Cabling

- Cables in conduit are neatly laid out and secured to ladder or cable tray.

Refer to Technical Specification Chapters on *Bushlight Equipment Enclosure and Cabling*
Cabling

- Cables tied to one another not appropriately supported.

Cabling

- Conduit not correctly fitted into glands and inappropriate glands used.
- Cables joined in conduit
- Unnecessary hole drilled through bottom of enclosure.

Cabling

- Timber used as backing support for cable susceptible to termite damage (Metal cable tray and covering required).

Refer to Technical Specification Chapters on *Bushlight Equipment Enclosure and Cabling*
Enclosure with Battery Box Location

- Equipment and Battery Enclosures installed in either an existing building or a purpose built shelter.
- Enclosures fully protected from direct sunlight.

Cabling

- Cables installed in conduit supported by cable tray and protected by metal cover.

Enclosure with Battery Box Location

Appropriate clearance around the enclosure is:

- 750 mm in front.
- 500 mm to the right hand side.
- 75 mm to the rear.
Enclosure with Battery Box Location

- The equipment enclosure must be protected from direct sunlight at all times.

Refer to Technical Specification Chapters on *Bushlight Equipment Enclosure with Battery Box*
EMU Display Module

- Where possible, wires enter EMU display through rear of enclosure.
- EMU display installed at a convenient height for visibility while out of reach of children.

EMU Switchboard

- Where possible cables enter through the back of the EMU switchboard.
- Cable connecting the EMU switchboard to the EMU display is 16 core, 0.75 mm minimum.

EMU Switchboard

- EMU switchboard installed at appropriate height.
- Cable entry through rear of switchboard.

Refer to Technical Specification Chapters on Bushlight EMU and EM, and Cabling
Fixings
- Untidy cabling and fixing, use ladder or cable tray.

Fixings
- Poor fixing of EMU.

Cabling
- Hole requires sealing.
- Conduits require mechanical protection and fixing.

Refer to Technical Specification Chapters on *Bushlight EMU and EM, and Cabling*
**EMU Switchboard**

- Switch board installed in a shaded location protected from the weather.

---

**Energy Meter (EM)**

- Energy Meter securely fixed.
- All entry points ganged appropriately.

Refer to Technical Specification Chapters on *Bushlight EMU and EM*
EMU Switchboard

- EMU switchboard should be installed in a shaded position where possible.

EMU Display

- Unfinished work left unattended by installation contractor.

Refer to Technical Specification Chapters on Bushlight EMU and EM
Generator Mounting

- Engine and alternator units mounted onto a common structural frame.
- Removable drip trays under engine. Drip tray capacity at least 1.5 times engine sump oil capacity.

Engine Air Intake

- Engine air intake ducted to weatherproof louvre in shed wall.
- Flexible flashing between air intake duct and generator.

Generator Exhaust

- Insulation wrapped around exhaust pipe and secured in place.
- Exhaust penetration in side wall (not roof) of shed.
- Vibration isolator connection between exhaust and shed roof.

Refer to Technical Specification Chapters on Diesel Generator
Start Battery

- Generator start battery to be housed in lockable housing which prevents access to battery terminals.
- Housing secured to generator shed floor.

Solar Charger

- 20 W solar panel installed on roof of generator shed.
- Suitable rated charge controller installed in generator shed, and connected to start battery.

Generator Control

- Generator control board with automatic and manual operation modes.
- All control functions labelled and operational instructions provided.

Refer to Technical Specification Chapters on Diesel Generator
Fuel Tank

- Welded construction double skin fuel tank.
- Tank installed on tank stand with bunding for fuel spillage.

Fuel Delivery Pipes

- Fuel delivery pipes are mechanically supported and protected.

Fuel Tank Filling Pipe

- Filling pipe reaches outside compound fence.
- Filling pipe fitted with a non-return valve, stop valve and cam lock cover connected on a chain.

Refer to Technical Specification Chapters on Diesel Fuel Tank
Fuel Meter and Filter
- Low flow mechanical fuel meter, and water trap filter, suitable for diesel fuel installed inside generator shed.
- Flexible fuel pipe connections to generator engine.

Sump Oil Removal
- Self priming hand pump.
- 200 L waste oil drum outside shed on concrete pad.
- Pump and all pipework mechanically supported and wall penetrations sealed.

Warning and Safety Signs
- All warning signs installed in accordance with Australian Standards.

Refer to Technical Specification Chapters on Diesel Fuel Tank
Pillar Junction Boxes

- Pillar type electrical junction boxes for all underground cable junctions.
- Pillar mechanically protected by bollards in accordance with the specification.

Cable Junctions

- Cable junctions including appropriately sized circuit breakers to protect the cable.
- Fuses may be approved when there is a possibility of insect infestation.

Underground Reticulation

- All reticulation works to Australian Standards.
- Reticulation installed in orange conduit with buried cable marking tape.

Refer to Technical Specification Chapters on Reticulation
Reticulation

✅ **Overhead Reticulation**
- All reticulation works to Australian Standards, and to local Electrical Utility requirements for potential future handover.

✅ **Building Connections**
- “Hockey Stick” pole used to connect reticulation to buildings.

✅ **Streetlight**
- Installed to technical specification.
- PE cell operated fluorescent streetlight with weatherproof manual switch.

Refer to Technical Specification Chapters on Reticulation
General Purpose Outlets

✓ Genset Only GPO
- GPO labels are provided by Bushlight and found in the Equipment Enclosure spare parts kit.
- Labels to be attached by the installer by the time of commissioning.

✓ Fridge/Freezer Only GPO
- Essential GPO for fridge/freezer only.

✓ Power Card Only GPO
- Power card only GPO labels are provided by Bushlight and used with Hybrid Systems only.

Refer to Technical Specification Chapters on GPO Labels
Electronic Timer Switches

- Individual electronic device timers to switch off loads after pre-determined period.

Sunset Switches

- PE cells (sunset switches) are used to control outdoor lighting circuits.
Bushlight provides installers with commissioning forms and test procedures. These can be found in the Equipment Enclosure O&M Manual and should be completed by the installer prior to Bushlight commissioning and site hand over. This reduces the time taken to commission and also likelihood of defects being identified.

Test Procedures

- Test procedure forms to be completed in detail.

PV Serial Numbers and String Voltages/Currents

- All PV serial numbers to be recorded.
- All PV string voltages and currents to be recorded.
Equipment Enclosure Circuit Configuration

- Final reticulation circuits configuration recorded.

Reticulation Diagram

- Ensure a reticulation diagram is provided and that it is detailed and clear.

Battery Serial Numbers and Cell Voltages

- All battery serial numbers and cell voltages to be recorded.
Post Installation Clean Up

- Bushlight equipment wiped down and left clean.

Post Installation Clean Up

- Leftover building materials removed and rubbish cleared.
Site Mess

• Left over building materials to be removed unless specifically requested by the community and approved by Bushlight.

Site Mess

• Rubbish is to be disposed of and not left on the community.
Images showing high quality installation work have been taken from selected sites completed by the following renewable energy system installation contractors:

- Gully’s Electrical Services, WA
- Delta Electrics, NT
- Eco Energy, NT
- Inland Electrical, NT
- K & F Constructions, NT
- NF Electrical, NT
- Ogden Power, NT
- Australian Solar Industries, QLD
- Ergon Energy, QLD
- PJ Electrical Services, QLD
- Planetary Power, QLD
- Solar Works, QLD
- Eris McCarthy, NSW

Defects illustrated in this manual were brought to the attention of the installers and rectified prior to final payment for the work.