BUSHLIGHT

Renewable Energy Systems

Preface

Since 2002, Bushlight has managed the installation of more than 140 renewable energy (RE) systems in remote Indigenous communities across Central and Northern Australia. Systems generally provide electricity to meet the domestic needs of residents, including lighting, refrigeration, cooling (fans), communication and entertainment.

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.

This publication contains detailed images of RE systems installed by Bushlight contractors, and is intended to demonstrate and showcase the work of the renewable energy industry in Australia. It is also intended to act as a handy reference guide for people working with or in the RE industry in Australia, showing examples of appropriate RE system installation standards applied in the field.

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.

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Bushlight Renewable Energy Systems:

Desert Peoples Centre, South Stuart Highway,
Alice Springs, Northern Territory, Australia

Contents

Photovoltaic Array

Wiring

- Array wiring protected by UV stabilised conduit and mounted in protected locations
- Conduits/wiring in an orderly layout and appropriately fastened to support structure
- Use of appropriate glands to maintain IP rating of junction and marshalling boxes
- Flying lead cables, if used, need to be mechanically protected in sealed metal cable ducting and secured with cable saddles
- Mechanical protection provided where cables enter the ground
- Roof penetrations minimised and Dektite™ boots or similar used to provide a weather proof seal
- Mid-string isolators installed where open circuit array voltage is greater than 120 volts to reduce segment voltages to extra-low voltage (ELV)

Photovoltaic Array

Array Structure

- Support structures manufactured to engineer certified specifications with appropriate wind loading capacity
- Ensure structure materials are suitable for environmental conditions - hot dipped galvanised in coastal areas
- Weed matting with a minimum 50 mm aggregate cover to reduce weed growth under array (fire and vermin hazard)
- Tamper-proof fasteners (if appropriate) to prevent theft of modules
- Ensure separation of dissimilar metals – use aluminium bonded washers or flashing tape to separate aluminium from steel structures or roof cladding
- Ensure a minimum 100 mm air gap when mounting on a roof structure to allow air flow across the underside of modules
- Array orientation and tilt mounting angle to designer specifications – minimum 10° tilt to allow self cleaning
- Array modules should be a minimum of 1.2m off the ground and have a maximum height that allows for easy access for maintenance and cleaning

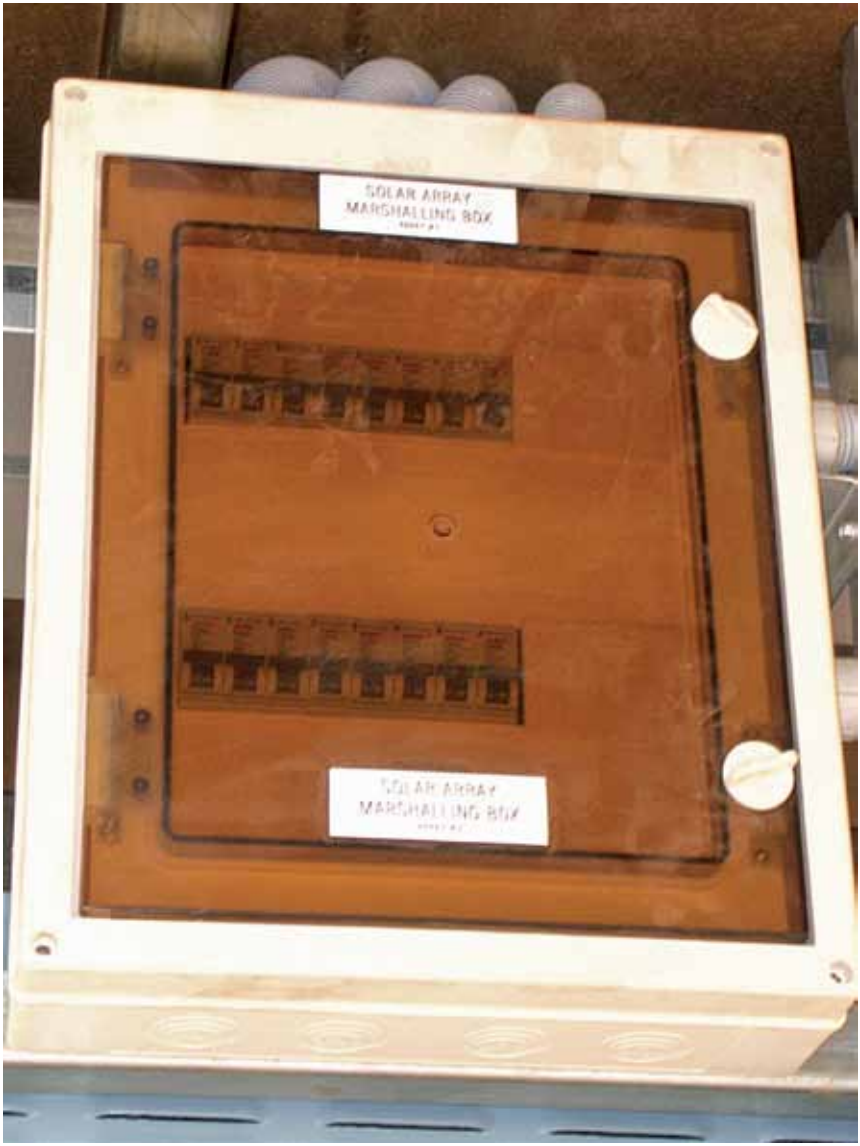
Photovoltaic Array

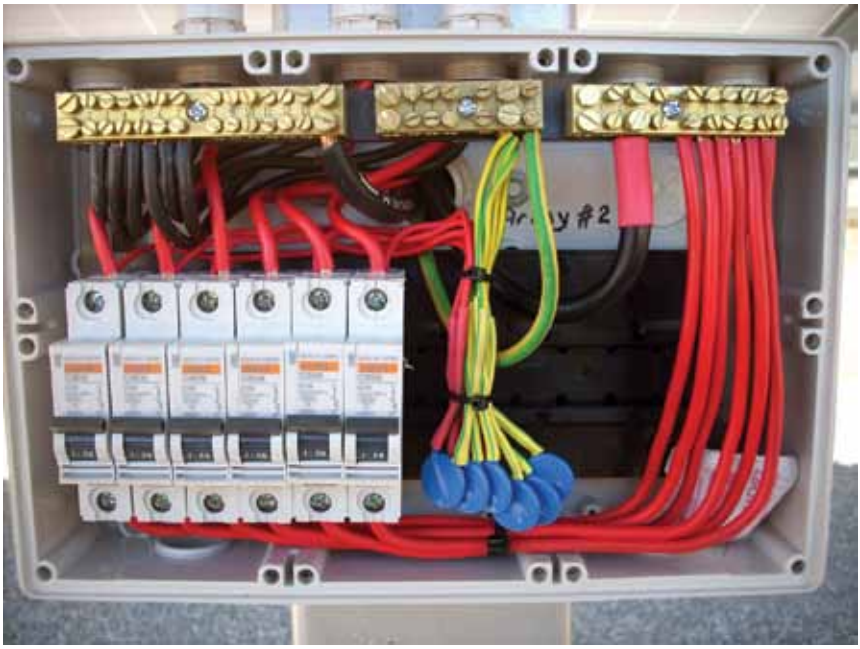
Photovoltaic Array

Marshalling Boxes

- Installed in protected location under array or other shaded location (not on roof or in direct sunlight)
- Conduits securely fastened – wiring inside array frame preferable
- Maintain IP rating by using appropriate glands
- Neat internal wiring with sufficient length to enable string currents to be measured ('tonged') during maintenance
- Install Metal Oxide Varistors (MOVs) on each array string to protect against transient over-voltages
- One circuit breaker per array string
- Use only circuit breakers with appropriate DC rating for PV string voltage
- Avoid connecting multiple cables in single or double screw (BP) connectors – use earth and neutral bars – insulate bars or cover appropriately
- Apply appropriate labelling


SOLAR DC ARRAY
MARSHALLING BOX


SOLAR ARRAY
MARSHALLING BOX


#2

Lightning protection

- Install lightning protection to AS 1768 where installation is susceptible to lightning strike
- Air termination installed high enough above highest point of array to provide radius of protection to the full array
- Ensure no shading of array from air termination/s
- Earth mat constructed in crows-foot configuration
- Conductors to be electrically isolated from house or array structure
- Earth connections painted with galvanised paint to prevent corrosion
- Array earth mat electrically connected to installation main earth where distance is less than 10 m

Photovoltaic Array

Batteries

Layout

- Minimum 900 mm clearance in front of battery bank to allow access to battery strings
- Minimum 100 mm clearance between battery bank and wall
- Even spacing between batteries – minimum 10 mm – to allow adequate ventilation
- Battery stands able to withstand full load of batteries without significant deformation
- Battery trays installed if wet cell batteries used
- All cells numbered starting at the lead positive terminal
- Adequate cross flow ventilation provided – low inlet and high outlet – to ensure air flow across batteries
- No spark producing equipment in battery room or enclosure


Century
Enersun Series
1300 362 297

Connections

- Flexible links to minimise stress on battery terminals
- Fully enclosed and insulated links
- Corrosion inhibiting grease applied to terminals to battery manufacturer specifications
- String end connections fitted with protective covers where necessary
- Temperature sensors attached in the centre of string; adjacent to, or on, the positive terminal
- Battery cables installed neatly and securely fastened and fixed – do not exceed cable minimum bending radius
- Ensure identical cable lengths if using parallel strings
- Use double insulated cable or install main battery cables in conduit

Batteries


603
04/05

Protection

- Each battery string must be fused and isolated separately
- Appropriately rated battery isolator installed as close as practical to battery terminals
- Provide spare fuses
- Provide mid-string isolation on 120 volt systems to allow reduction to extra-low voltage (ELV)
- Battery safety and maintenance equipment supplied, including insulated tools for removing cell connectors
- Battery cables must be rated to carry current to the full rating of the protective device
- Main battery isolator marked appropriately


AND SMOKING
PROHIBITED
SAFETY
GOGGLES
MUST BE WORN
CAUTION
ISOLATE SOLAR ARRAY
CIRCUIT BREAKERS
PRIOR TO OPENING
MAIN BATTERY
ISOLATOR


FIRE NAKED FLAME
AND SMOKING
PROHIBITED
SAFETY
GOGGLES
MUST BE WORN
CAUTION
ISOLATE SOLAR ARRAY
CIRCUIT BREAKERS
PRIOR TO OPENING
MAIN BATTERY
ISOLATOR
DANGER
NO


Battery Isolation Point
NHP
XLP 00


Scotch-Brite
HEAVY DUTY

Control Equipment

Location

- Control equipment installed in ventilated, vermin proof, lockable enclosures
- Enclosures installed on flat, level surface – preferably a concrete plinth
- Equipment and enclosures installed in a shaded and well ventilated location
- Clearance on all sides and to the rear of enclosures to allow air flow
- A fixed, solid divider should be installed between all equipment and the battery area
- Prevent battery gas entering equipment area

Wiring and layout

- External control wiring installed in conduit and protected with metal ducts or covers where appropriate
- All wiring neat and tidy and securely fastened
- Wiring terminated in appropriate size terminals
- Crimp lugs used to terminate cables greater than 10 mm^2 – use only approved crimping tools
- Ensure no exposed live terminals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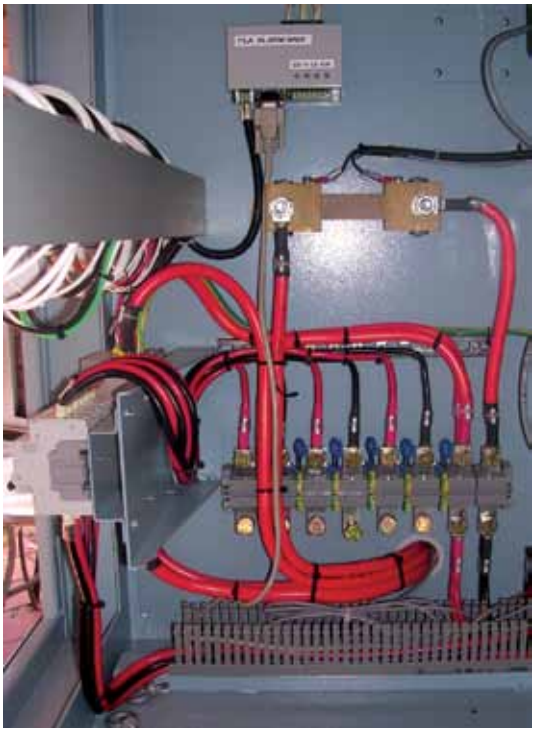
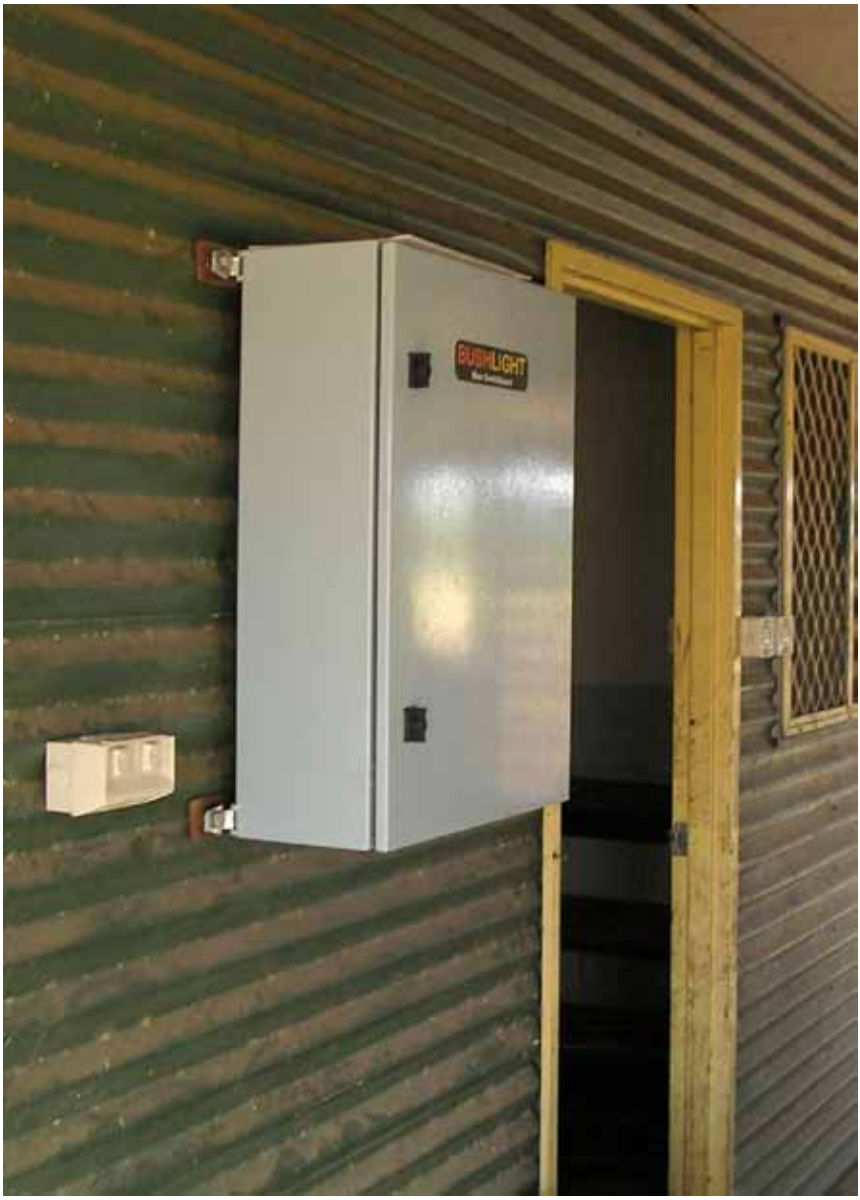
BUSHLIGHT



Demand Side Management

Energy Management Units (EMUs)

- Agreed household energy budget is provided each day and resets at midday
- Supply to discretionary circuits is disconnected if agreed daily energy budget is exceeded within a 24 hour period; power remains to essential circuits
- Display module is mounted in accessible location within house to provide a visual indication of energy consumption
- Operation of community diesel generating set provides supply to generator only, discretionary and essential circuits and suspends energy budget countdown
- EMU switchboard takes the place of normal consumer switchboard
- Multiple EMUs can be installed within a community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BUSHLIGHT
Energy Use Meter
Power available when lights are on
Press Buttons for Power
Power Use


WARNING–MULTIPLE SOURCES OF SUPPLY

Timers and fixtures

- Generator only supply provided to enable use of high power equipment such as welders, air-conditioners, pumps and compressors
- Individual device timers to switch off loads after pre-determined period
- Circuit timers to switch power, light or fan circuits off after pre-determined period
- PE cells (daylight switches) to control outside lighting circuits
- Solar hot water fitted with one shot boosters on generator only supply
- Compact fluorescent lighting (CFL) preferred due to low energy use, availability, and ease of changing bulbs


WATER TEMP. HOT
WATER TEMP. COLD
(BOOST TO HEAT)
BOOST
POWER ON
PRESS TO BOOST


GENSET SUPPLY ONLY


FRIDGE/FREEZER ONLY

Sheds and Fencing

Sheds

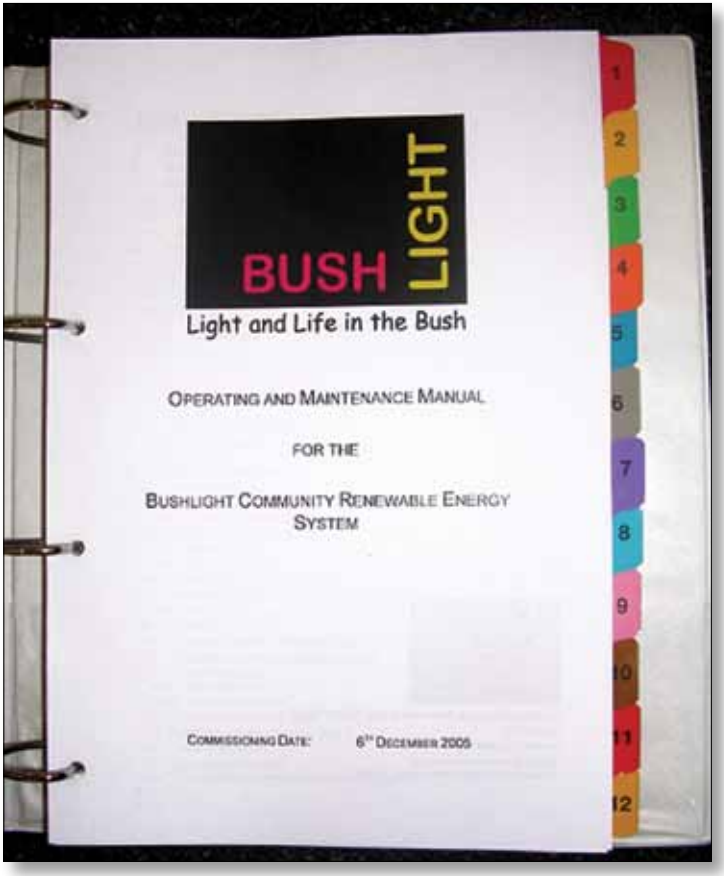
- Light coloured (including roof) to reflect heat
- Orientation of shed to take into account passive thermal features of shed
- Eaves to provide shade to reduce heat load
- Insulation of walls in battery room to stabilise temperature
- Ventilation in battery room as per battery standards
- High level exhaust ventilation to allow exit of warm air
- Louvres and vents fitted with insect screens to prevent vermin ingress, and dust filters where required
- Second cladding or ‘false wall’ on eastern facing wall to provide additional insulation from heat (reflective foil installed between walls)
- Internal flashings installed to provide neat finish
- Optional tropical roof to provide additional shading

Fences

- Fences installed where appropriate to prevent access by animals and unauthorised people
- Barbed wire cattle fence installed around array to prevent damage by stock
- 2.4 m highsecurity cyclone fence with 3 strands of barbed wire to prevent access by unauthorised people
- Personnel and vehicle access gates provided in appropriate locations for future works
- Fence installed far enough away from array to prevent shading

Documentation

- Operation and maintenance manual to contain:
  I. List of equipment supplied and installed
  II. System performance estimate/guarantee
  III. System and component operating instructions
  IV. Shutdown and isolation procedure for emergency and maintenance
  V. Maintenance procedure and timetable
  VI. Commissioning records and installation checklist
  VII. Warranty information
  VIII. Original energy usage estimate
  IX. System connection diagram
  X. Equipment manufacturers' documentation and handbooks
- Maintenance logbook
- Battery logbook
- Generator logbook as required for hybrid systems


BUSH LIGHT
Light and Life in the Bush
OPERATING AND MAINTENANCE MANUAL
FOR THE
BUSHLIGHT COMMUNITY RENEWABLE ENERGY SYSTEM
COMMISSIONING DATE: 6TH DECEMBER 2005
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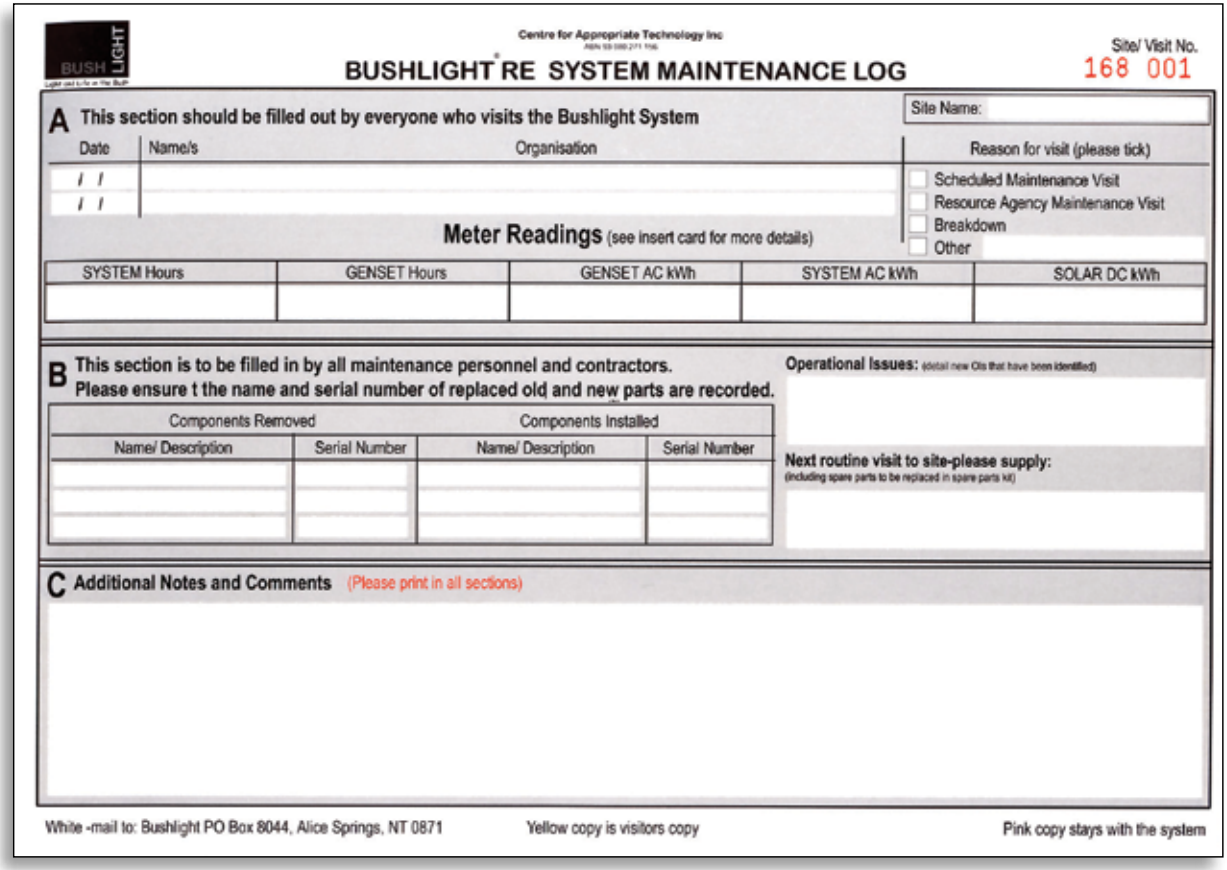


BUSH LIGHT

Centre for Appropriate Technology Inc

BUSHLIGHT RE SYSTEM MAINTENANCE LOG

Site/ Visit No. 168 001

A This section should be filled out by everyone who visits the Bushlight System

Site Name:

Date	Name/s	Organisation
/ /		
/ /		

Reason for visit (please tick)

- ☐ Scheduled Maintenance Visit
- ☐ Resource Agency Maintenance Visit
- ☐ Breakdown
- ☐ Other

Meter Readings (see insert card for more details)

SYSTEM Hours	GENSET Hours	GENSET AC kWh	SYSTEM AC kWh	SOLAR DC kWh

B This section is to be filled in by all maintenance personnel and contractors.
Please ensure t the name and serial number of replaced old and new parts are recorded.

Components Removed		Components Installed	
Name/ Description	Serial Number	Name/ Description	Serial Number

Operational Issues: (detail new OIs that have been identified)

Next routine visit to site-please supply:
(including spare parts to be replaced in spare parts kit)

C Additional Notes and Comments (Please print in all sections)

White -mail to: Bushlight PO Box 8044, Alice Springs, NT 0871

Yellow copy is visitors copy

Pink copy stays with the system

BUSH LIGHT

Centre for Appropriate Technology Inc
ABN 93 090 271 156

BUSHLIGHT® RE SYSTEM BATTERY LOG

Site/Visit No.
302 001

Battery cell voltages should be recorded at least annually or more often as required

Company:		Name:		Community:		Time:		Date:	
Telephone:				House:					

(Complete a separate sheet for the second string if applicable)

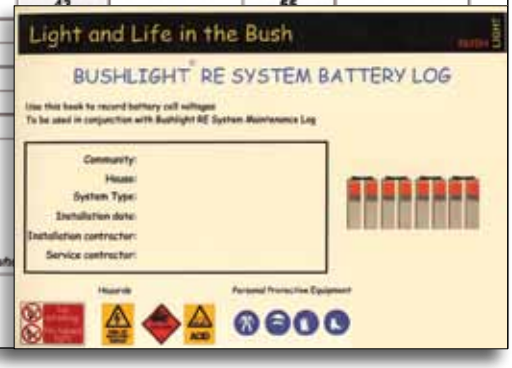
Battery Type - Brand/Model			Model			AH_{C100}			
Battery String Number:									
Cell N°	*Cell Voltage*	*Cell N°*	*Cell Voltage*	*Cell N°*	*Cell Voltage*	*Cell N°*	*Cell Voltage*	*Cell N°*	*Cell Voltage*
1		13		25		37		49	
2		14		26		38		50	
3		15		27		39		51	
4		16		28		40		52	
5		17		29		41		53	
6		18		30		42		54	
7		19		31					
8		20		32					
9		21		33					
10		22		34					
11		23		35					
12		24		36					

Comments:

(Document any irregularities and take photographs wh

White copy: mail to Bushlight,
PO Box 8044, Alice Springs, NT 0871

Yellow is contractor's copy



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Bushlight Hybrid System Users Manual

This book is for families who live in a community with a Bushlight Hybrid System.

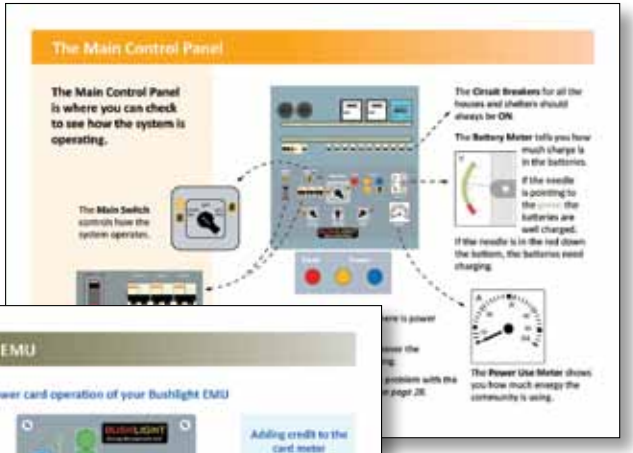
It has information about how the System works and how to use it.

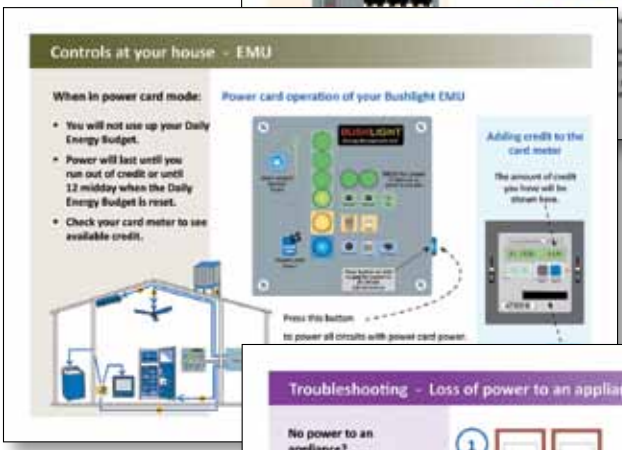
Parts of the Bushlight Hybrid System

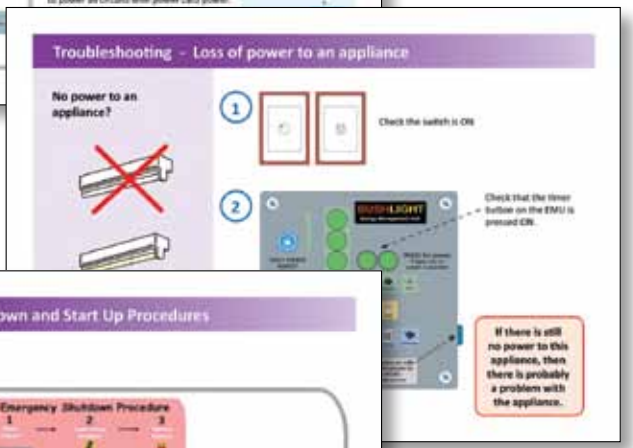
The Bushlight Hybrid System uses both solar energy and energy from a Generator to meet the energy needs of your community.

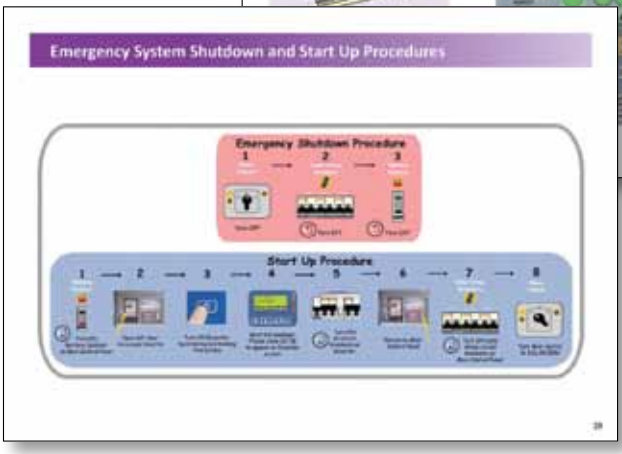
The **Solar Panels** in the **Solar Array** absorb light energy from the sun and change it into electrical energy.

The **Generator** runs on diesel to make the extra energy needed to power the community. The generator will start automatically when the batteries need charging.

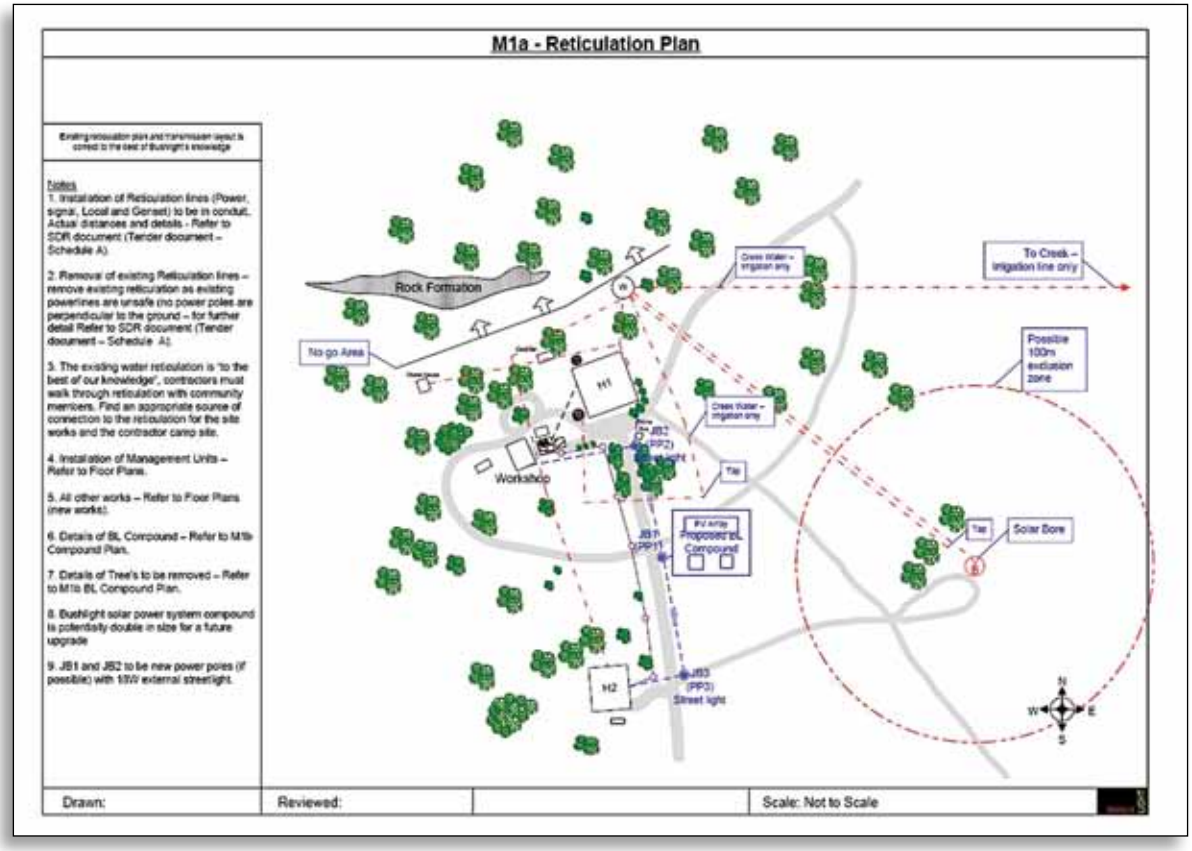

The Main Control Panel
The Main Control Panel is where you can check to see how the system is operating.
The Main Switch controls how the system operates.
The Circuit Breakers for all the houses and shelters should always be ON
The Battery Meter tells you how much charge is in the batteries.
If the needle is pointing to the green the batteries are well charged.
If the needle is in the red down the bottom, the batteries need charging.
The Power Use Meter shows you how much energy the community is using.


Controls at your house - EMU
When in power card mode:
You will not use up your Daily Energy Budget.
Power will last until you run out of credit or until 12 midday when the Daily Energy Budget is reset.
Check your card meter to see available credit.
Power card operation of your Bushlight EMU
Adding credit to the card meter
Press this button
to power all circuits with power card power


Troubleshooting - Loss of power to an appliance
No power to an appliance?
Check the switch is ON
Check that the timer button on the EMU is pressed ON.
If there is still no power to this appliance, then there is probably a problem with the appliance.


Emergency System Shutdown and Start Up Procedures
Emergency Shutdown Procedure
Start Up Procedure


BUSHLIGHT
Installation Guide
Community
Renewable Energy Systems
Shed based installations


M1a - Reticulation Plan
Notes
1. Installation of Reticulation lines (Power, signal, Local and Genset) to be in conduit. Actual distances and details - Refer to SDR document (Tender document – Schedule A).
2. Removal of existing Reticulation lines – remove existing reticulation as existing powerlines are unsafe (no power poles are perpendicular to the ground – for further detail Refer to SDR document (Tender document – Schedule A).
3. The existing water reticulation is 'to the best of our knowledge', contractors must walk through reticulation with community members. Find an appropriate source of connection to the reticulation for the site works and the contractor camp site.
4. Installation of Management Units – Refer to Floor Plans.
5. All other works – Refer to Floor Plans (new works).
6. Details of BL Compound – Refer to M1b Compound Plan.
7. Details of Tree's to be removed – Refer to M1b BL Compound Plan.
8. Bushlight solar power system compound is potentially double in size for a future upgrade
9. JB1 and JB2 to be new power poles (if possible) with 1/W external streetlight.
Rock Formation
No go Area
To Creek – Irrigation line only
Possible 100m exclusion zone
Workshop
H1
H2
Proposed BL Compound
Solar Bore
JB3 (PP3) Street light
N
S
E
W
Drawn:
Reviewed:
Scale: Not to Scale


WARNING
Circuits
1 2

Images in this publication have been taken from selected sites completed by the following renewable energy system installation contractors:

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

BUSHLIGHT

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