# WIND GENERATOR AND SOLAR PANELS

Dr Chris Henderson

## SUMMARY

Previous power supply[1]:

The Mawsons Huts Foundation expeditioners live in insulated accommodation roughly the size of 2x20ft containers. The power supply was from a petrol generator, supplemented by 2x80W solar panels into 2 x 120AH SLA batteries.

The supply circuits are separated into power and lighting, with the lighting sourcing from either the 12v supply via an inverter, or the 240v generator. The power circuits were only supplied from the 240v generator.

The main power consumption is laptop use, which is heavy – all expeditioners use laptops and many use external hard drives. Other use includes fluorescent lights and battery charging for sundry equipment such as cameras.

In 2008-9 a new conservator's laboratory and bunk room were added. The laboratory includes a fume cupboard with a fan motor, fluorescent lighting, and occasional use of a 240v dryer. The bunk room has a fluorescent light.

The existing power system was unable to supply the load, and the generator was run for extended hours. The regulator cut out on numerous occasions.

Future power:

This year (2009-10) there were 10 expeditioners (8 last season), with heavy laptop use. The laboratory was used for the whole of the expedition. This level of use is unlikely to decrease in coming years.

A decision was taken to move toward renewable energy supply. A 24v system was installed initially in parallel with the existing 12v one which will be retained to provide backup and easy transition on arrival and departure. Four solar panels and a wind generator was added and the battery capacity increased from 2 to 6 SLA batteries.

Additional units – either wind or solar – will be added as dictated by future power demands.

[1] The power system has been described in a previous report (2008-9) and the full specifications for the present system are in a document: MAWSONS HUTS FOUNDATION SORENSEN HUT RENEWABLE POWER SUPPLY SPECIFICATIONS by Dr Chris Henderson August 2009.

Operation

The wind and solar power was installed about 2 weeks after arrival. The units operated well, with no recourse to the petrol generator until 26th December when the wind generator failed. Inspection of the unit revealed that a faulty brushes board was responsible. The manufacturers will replace the existing generator and provide a spare. The infrastructure remains for re-installation next season.

Power distribution

An improved power distribution and battery charging system was installed, and the system was earthed.

## SOLAR PANELS

Conergy supplied 4 x 170W 24v solar panels, plus a Tri-Star TS60 regulator. These were installed on a framework off the verandah facing north. They are designed for easy installation and removal, and are hung from plates and are screwed in place by brackets.

The power cable runs to the wall sockets on the E of Sorensen, where it plugs into the system. The regulator is pre-wired, but the cables from the regulator to the battery must be connected.

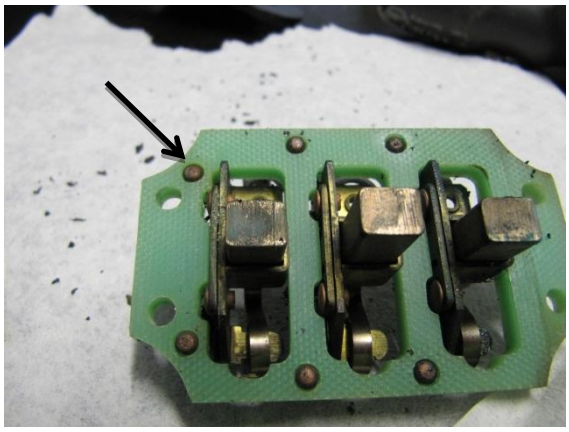
## WIND GENERATOR

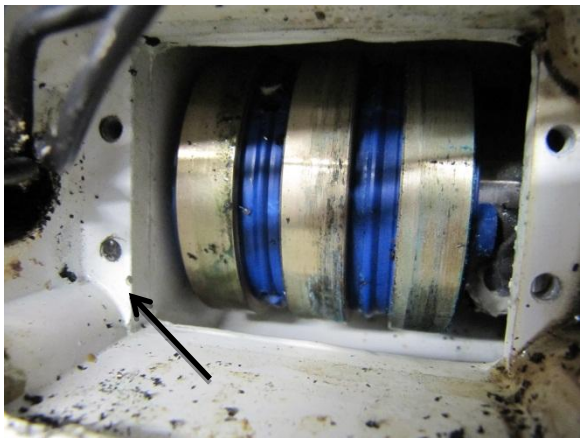
The Ampair 600W 24v wind generator and regulator were supplied by Conergy. It is installed on a mast set in the rocks to the South of Sorensen. During the week it was in operation it supplied more than enough power, with excess being dumped into the regulator load (the blue unit), which got warm.

The downside of the wind generator is the noise – despite being placed 40m from Sorensen (the limit for the cabling before losses become excessive) it was noisy as all wind generators are.

It operated very successfully during the first week, after which one of the stator windings burned out due to a faulty contact in the brushes board (this was apparently a known fault which unfortunately was not rectified before shipping). Ampair UK were of great help over New Year, and by telephone and email the fault was diagnosed as not repairable in the field. Accordingly the unit was RTA.

It clearly supplied enough power for the needs of the expeditioners, and it is suggested that it be re-installed next season. Ampair UK will supply two replacement generators which should have been fully tested in Hobart before shipping to Antarctica.





*This tiny rivet on the brushes board protruded enough to wear a hole in the enamel and short to the case (see arrows). The first winding failed, the other two melted, and the wind generator ceased producing power. The black debris in the brushes case and on the sliprings is burned lubricant.*

# POWER SYSTEM INSTRUCTIONS

## OVERVIEW

### CIRCUITS

The Sorensen has two main circuits, power and light. The light circuit has one power socket over the table, and supplies all the rooms. The power circuit supplies the kitchen, living room and lab.

Both circuits are essentially stand-alone units with 240v plugs on the end. They can each be plugged into any power source.

All external power plugs in through the sockets on the E face of Sorensen.

### BATTERY BANKS

There are two power systems – a 12v system and a 24v system.

12v system

It takes about an hour to set this system up, largely because of the solar panel assembly. The internal set up is only a matter of connecting the batteries.

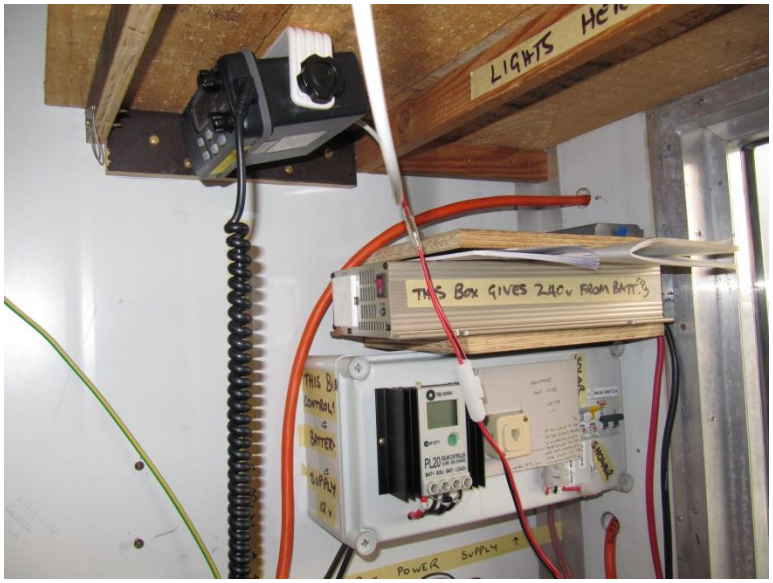
The 12v system is a legacy system, but is useful as a backup and an easy way to get started when moving into and leaving Sorensen. The radio is wired direct to these batteries.

It uses 2 x 12v batteries, and gets power from 2 x 75W solar panels on the outside of Delaneys Dunny. These panels need installing and removing (the winter ice will rip the wires out, or pull the bracket off the hut).

The 12v system also takes a battery charger input which plugs into the red generator socket under the comms table.

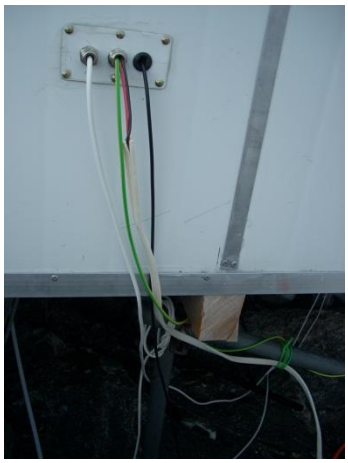
The system has a 12-240v inverter into which you can plug the power or the lights circuit.


This inverter does not have much capacity, and will overload and switch off fairly quickly. The batteries likewise do not last long. The inverter squeals when it the batteries are running out or it is overloaded. Reduce the number of items plugged in, or charge the batteries when this happens.




There is an outside 12v socket (white cable) useful for differential GPS installation etc. The wires come in through one of the penetrations behind the French GPS box.

*this is the 12v system. The PL20 controller and associated fuses are in the panel. The inverter is above the panel. Some of the circuits have been disconnected (eg wind generator) and are labelled as such. The power diagram is available in the 2008-9 report. It is charged by a battery charger and solar panels. The radio is hard-wired to the 12v batteries.*



*The white flat cable is the external 12v supply which is terminated in a polarised 12v socket.*

*The other cables are for the French GPS installation.*

24V SYSTEM

It takes about half an hour to set up the connections for this system.

The 24v battery system consists of 4 x 120 AH 12v batteries wired in series-parallel held in a mobile steel cradle under the comms table. The batteries are labelled 1F(ront) 1R(ear) 2F 2R etc, and the connecting cables are labelled likewise to help installation.

The input is from 3 sources – solar, wind and battery charger.

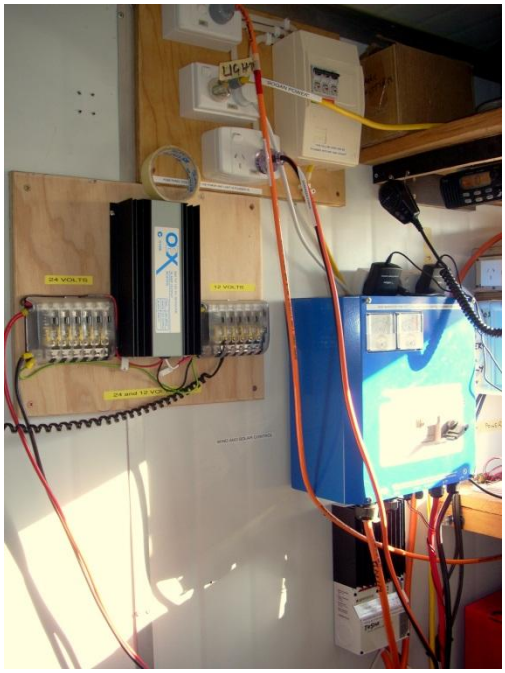

Output is to an inverter which sits on top of the battery bank.

*the battery bank has labelled positions and labelled battery ends to aid installation. The connecting leads are also labelled.*

*All connections to external devices are made from the rear of the cabinet, which is on wheels.*

## Connections to 24v system:


*Solar regulator. This connects to the battery bank using two large +/- cables plus the voltage sense cables. The connection to the solar panels is hard wired to the external socket.*



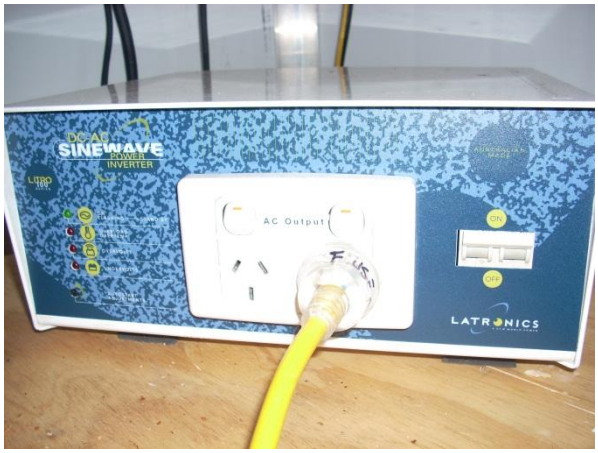
*The wind generator regulator is the blue box on the right. It is hard-wired to the external socket, and sends +/- cables and battery sense cables to the battery bank.*

*It uses the same type of regulator as the solar panels.*

*The control for the wind generator, plus fuses (there are 4 spares) are on the front. To brake the turbine, turn the big switch to "short". Read the manual for further details.*

*The wind generator will supply more than enough power, and excess is dumped to internal loads. The top L of the cabinet will get warm.*


*This is the 24v battery charger. It plugs into the red socket next to it, and the clips attach to the batteries. It has an intelligent interface which charges safely. It is not a rapid charger, and it will take a few hours to bring the batteries up to charge. If you are running the generator, check the lights are lit or else you will simply waste power.*




*This is the Latronics 1600W inverter. This turns 24v into 240v. The cables attach to the battery bank – preferably to their own separate battery lug. It has a 240v generator input, and will automatically switch from the batteries to generator when power is available . If overloaded or overheating it will switch off (wait for it to cool – 15-20 min). If the batteries are low it will switch off.*

# OUTPUT AND INPUT

## OUTPUT:

**FUSE PANEL**

*The fuse panel plugs into any 240v input – for example the 24v inverter, 12v inverter or generator. This is where 240v power is distributed to the hut. The fuses are RCD for protection.*

*Three outputs are available – one light and two power circuits.*

*The light and power circuits each have their own plug and cable and can be thought of as a (big) lamp and a (big) appliance respectively. They should each be plugged into this panel. Spare sockets can be used for example for the comms gear.*

*Fuse panel earth: The fuse panel has a separate earth running to the corner of the hut where it is clamped to 3 of the supporting bolts.*

**12 AND 24 VOLT OUTPUT PANEL**

*this provides a convenient way to access 12v and 24v DC from the battery bank. At present only the shower pump is wired to the 12v outlet. Each outlet is fused, spare fuses being available.*

# INPUT

## GENERATOR


*The generator input is above the comms table. It is fused (R box - the white box on the left is a junction box for the power system).*

*Be careful when starting the generator to switch off the output (at the generator) until it is running. If you don't the generator output will briefly be overloaded and will trip the safety circuit on the generator. This means the generator is running without doing anything. So switch off the generator output, start the generator, switch the output back on.*

*The generator supplies powers to these sockets under the comms table.*

*The one on the right is reserved for the Latronics inverter, and the plug should be left screwed in place. The one on the Left is for general use – usually for battery chargers, but would do for any 240v supply (if the Latronincs inverter fails for instance, you can plug the fuse panel in here).*

*The Latronics inverter switches to generator power automatically.*

## SOLAR PANELS

DO NOT CONNECT OR DISCONNECT THE SOLAR PANELS WHEN THE SUN IS SHINING ON THEM – THEY CAN GENERATE AROUND 100V AT THE TERMINALS. IF YOU DO IT WILL PROBABLY DESTROY THE REGULATOR. WAIT UNTIL LATE EVENING OR EARLY MORNING WHEN THERE IS ONLY A SMALL OUTPUT VOLTAGE AT THE CONNECTORS.

The solar panels supplement the wind generator during the afternoons when commonly the wind drops. Of course if the day is cloudy there is little or no solar input either.

Solar panels work rather like a battery in that they have power available when needed - unlike the wind generator which pushes power into the system which must either use it or dump it.

The regulator controls how much charging the battery gets from the solar panels. If there is excess power because the battery is fully charged, the regulator will dump power into the heat sink – the black fins – which will get warm.

The state of the battery is indicated by the red/yellow/green LEDs on the front of the regulator. The instruction manual shows what the combination of lights means.

## SOLAR PANEL INSTALLATION

Installation and removal of the solar panels takes about 20 minutes.

The solar panels hang from their top frame which sits over brackets on the verandah handrail. The panels hang down touching the frame. Small lugs on the sides of the solar panels allow them to be screwed to the supporting frame.

*This picture shows the solar panel brackets which screw onto the supporting frame.*

SOLAR PANEL INSTALLATION:

1. Ensure the batteries are installed properly
2. Connect the solar regulator cables to the battery bank
3. Connect the solar regulator voltage sense wires to the battery bank
4. Attach solar panels to verandah as shown above.
5. Run the solar panel cable from the Sorensen input to the solar panel frame.
6. Wait till there is no sun on the panels
7. Connect the 4 solar panels using the plug in connectors.

## WIND GENERATOR INSTALLATION:

Installing the wind generator takes about two hours.

First connect the blue wind generator regulator to the battery bank:

1. Ensure the batteries are installed properly.
2. Connect the wind generator cables from the blue regulator box to the battery bank.
3. Connect the thin battery sense wires to the battery bank.
4. Assemble the wind generator.
5. Run the heavy black cable from the hut to the base of the wind generator mast.
6. Install the wind generator on the mast.
7. Erect the mast.
8. Plug in the wind generator cable to Sorensen.
9. Take the rope off the wind generator and let the blades spin.
10. Monitor the wind generator.

**WIND GENERATOR CABLE**

The cabling between the installation and the Sorensen is large, heavy duty flexible cabling in order to minimise power losses.

It will need at least two people to run the cable up to the mast base.

**WIND GENERATOR ASSEMBLY**

Get a large enough area to work on (the blade diameter is 1.7m). Attach each blade using 2 bolts (care with the split ratchet-type washers). Attach the tail fin. The bolts are torqued to 2.6 NM (which is about as hard as you can go without stripping the thread).

**WIND GENERATOR INSTALLATION ON THE MAST**

**How it works:**

MAST CABLING: The wind generator fits into a green nylon bush at the top of the mast, and is held in place by 3 bolts into the central axle. The power wires run through the centre of this axle.

The power wires are terminated in a screw connector. The male end of the connector is the termination of thin power cables attached to the end of the heavy duty black cable. The male connector cannot fit through the mast easily, so has to be attached after the black cable is run up the mast.

There are only 3 wires coming out of the wind generator – they are all active phases, AC at 24v. *There is NO earth wire in the cabling from the wind generator. It has been designed this way. Earthing of the wind generator case is via the mast and rock anchors. The DC rectifier system ensures that the average of the 3 AC phases becomes the negative (ground) line to the battery.*

The heavy black cable would pull the screw connector apart under its own weight, so it has to be supported in the mast. Two U bolts in the top section clamp onto the cable and hold it in place. At the bottom of the mast a dog tail rope around the cable is tied to the mast base. If you don't do this the cable slides back down the hill and pulls on the mast connection.

There is not a lot of room in the top of the mast once the wind generator plus its cable is inserted and the black cable plus its connector is in there too. Therefore the black cable is only inserted to a certain distance, marked by a grey tape band. If the black cable stops there, then the assembly at the top end works OK.

**ERECTING THE WIND GENERATOR AND TOWER**

First unpick the covers at the base and top which are tied and Silasticked to the mast. You will find a green mousing strip running up the centre, going under the U-blot clamps and through the green nylon bush at the end of the mast. Use the wooden mast crutch to hold the end of the mast at a convenient height.

Push the cable into the mast up to the grey tape using the mousing as a guide. Tie off the cable with a dogtail. Tighten the U bolts at the top.

At the top end wire up the plug (to sockets 1, 2, 3 any order). Attach it to the wind generator.

Slide the shaft into the nylon bush and tighten the locking bolts.

Put a rope around the blades to keep the generator under control. Raise the mast and tighten off the chain tensioners.

**WIND GENERATOR MAST**

The wind generator mast is easy to raise and drop. It can be done with a couple of people lifting it and one on the cable tensioners, but you get better control with a block and tackle and the gin pole – especially if there is a wind.

The guy wires are all fixed except for two at the NE corner, which are the 'control guys'. These are used to raise and drop the mast. In order to satisfy the requirements for speedy lowering of the mast, the two guy wires are attached by chain tensioners to the rock bolt. This means that the chain tensioner assemblies must be shackled to the rock bolt and to the cable eyes before raising the mast.

If a block and tackle is used to raise the mast, then this is also shackled to the rock anchor and to the gin pole. The small twig of cable is also shackled to the gin pole, leaving both long ends free to be attached to the chain tensioners when the mast is vertical.

*Short 'twig' of cable attached to the gin pole*

*Raising the mast using the block and tackle*

*Tightening the chain tensioner*

*Guy wires tightened*

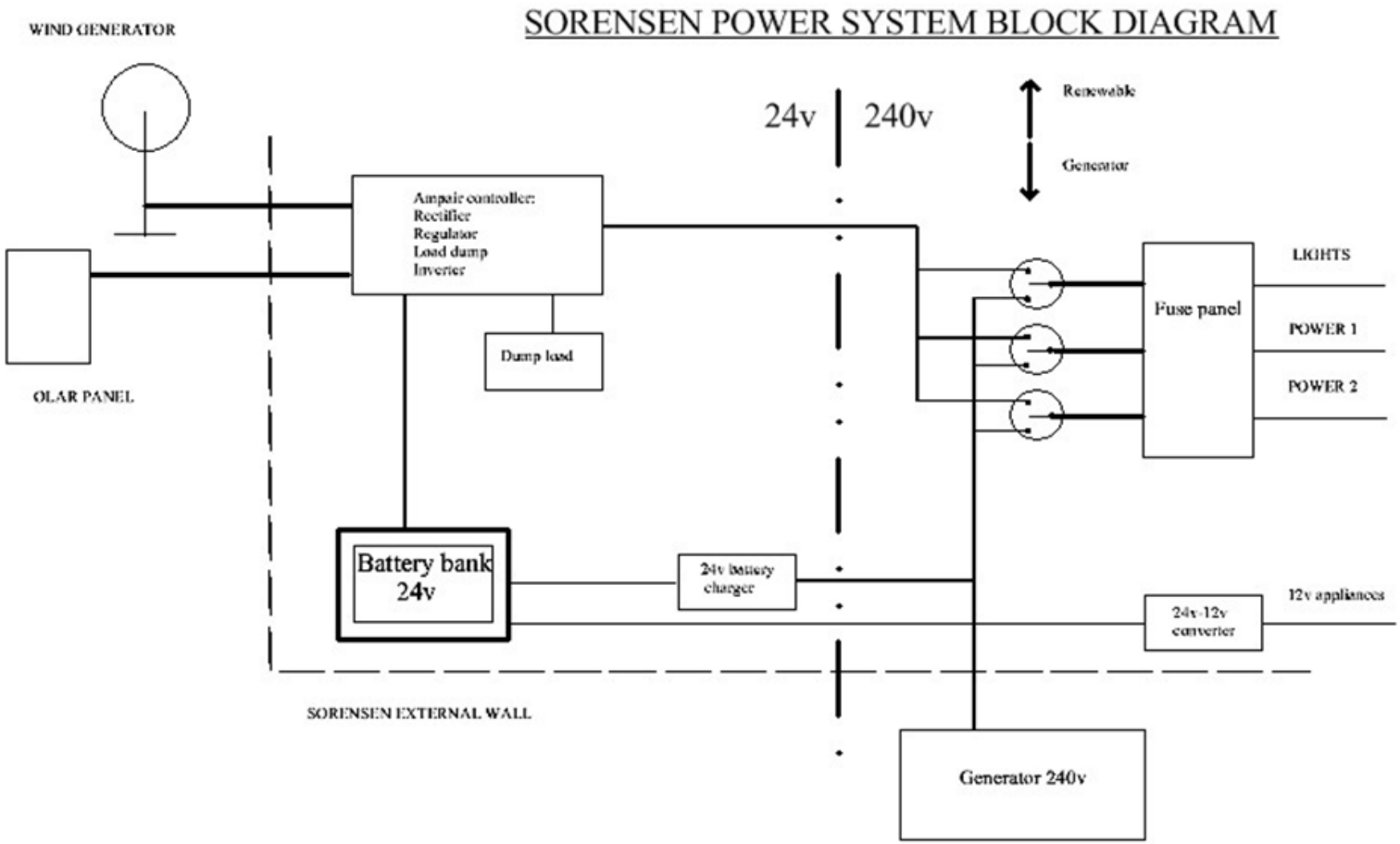
When you are ready, pull the rope away. Check the blades spin freely.

The turbine should produce power into the batteries – the switch at the regulator should be in the RUN position, the voltage should be around 26v, and there should be significant current (5-20 amps) showing on the ammeter.

**TO DROP THE MAST:** Brake the wind turbine using the switch on the regulator ("SHORT"). Wait till the blades are still or slowly turning and throw a rope over them. Tie off the rope. Lower the mast using a reversal of the above procedure.

## SIMPLIFIED POWER SYSTEM OPERATION for those who don't know anything about electricity, or don't want to.

1. There is a 12v system for backup, but it cannot supply much power.
2. The main power source is the 24v battery system, which is turned into 240v by the inverter sitting on the top of the batteries.
3. The lights and power sockets are each like any other appliance (a bit bigger perhaps) – they have a plug on one end.
4. You can plug the lights and power into any 240v socket. It is best to plug them into the fuse board (for safety) then plug the fuse board (yellow cable) into 240v.
5. Don't let the batteries get below 11.2v (which means 22.5v for the 24v system). If you do, you start to destroy them.
6. If you start the generator, disconnect or switch off the power at the generator first. When the generator is running, plug it back in. Check you are getting power into the hut or else you waste the generator (the battery charger will light up if it is connected).
7. If the inverter cuts out it is either overloaded – turn something off – or the batteries are low – recharge them. If it is too hot, let it cool for 15 minutes and it will turn on again.
8. Watch the lights on the wind and solar regulators – they will tell you what the batteries are doing. If they are flashing, read the manual.
9. If you are getting low on battery power, turn off the switches at the fuse panel before you go to bed. This disconnects everything and stops the batteries being drained.


SORENSEN POWER SYSTEM BLOCK DIAGRAM
WIND GENERATOR
24v
240v
Renewable
Generator
Ampaie controller:
Rectifier
Regulator
Load dump
Inverter
Dump load
OLAR PANEL
Fuse panel
LIGHTS
POWER 1
POWER 2
Battery bank
24v
24v battery
charger
24v-12v
converter
12v appliances
SORENSEN EXTERNAL WALL
Generator 240v