Solar Power V1

I started this project because I wanted to experiment with solar power. I have a south facing conservatory which, in the summer has the sun on it almost all day and can get very hot.

Currently I have the following powered by stored solar power:

1. Conservatory fan
2. Conservatory light
3. Lounge Light

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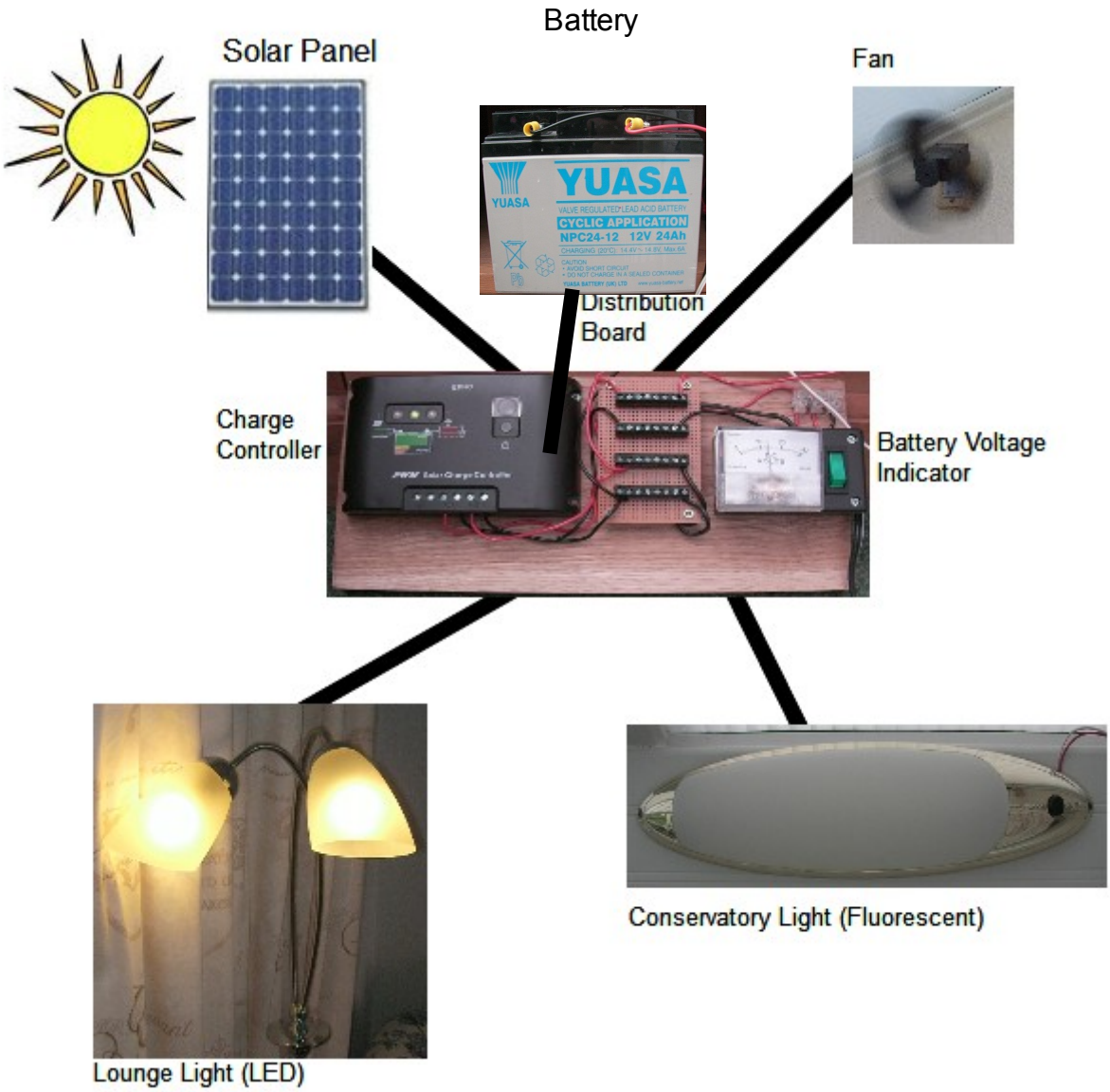
System Components



This is a 12 Volt system and consists of a Solar Panel which charges a Lead Acid battery via a charge controller. I currently have three loads connected to my system (as shown above). The system isn't perfect, but provides enough power for lighting in two rooms and a fan.

The Sun

My location in England is one of the sunniest in the country (Thanet) .

Solar Panel

The solar panel I am using is rated at 20W, nominal output voltage 12V. From measurements, the actual open circuit voltage will vary from 15V to 20V on a clear sunny day. On a clear summers day at mid-day, the maximum load current available is 20W/12V = 1.7Amps.

In practice, the maximum has proven to be about 1 Amp.

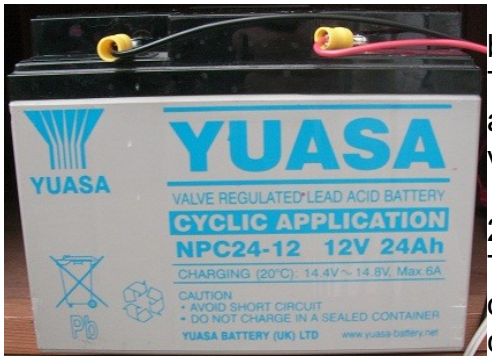
Table 1. Solar Panel Output (Clear summers day in theory)

Time	Output Current (Amps)	Output Power (Watts)	Time	Output Current (Amps)	Output Power (Watts)
06:00	0.1	1	14:00	1.7	20
07:00	0.3	4	15:00	1.4	17
08:00	0.3	4	16:00	1.4	17
09:00	0.7	8	17:00	1.0	12
10:00	1.4	17	18:00	0.7	8
11:00	1.7	20	19:00	0.2	2
12:00	1.7	20	20:00	0.1	1
13:00	1.7	20			

The above data was taken from my panels specification, so is absolute best case. The panel is mounted on a south facing wall at an angle of 30°.

The panel is ideal for charging my 24Amp Hour Lead Acid battery.

Battery



The battery is a 12V, 24 Amp Hours (AH) sealed lead acid battery, which I obtained from an old piece of equipment. The equipment's battery was changed at regular intervals as part of a service, resulting in the battery still being in very good condition.

24 Amp Hours (AH), is the batteries capacity when new. This means that the battery could supply 1 Amp for a period of 24 hours. Or 2 Amps for a period of 12 hours etc. The capacity of the battery will decrease with age and use.

If the current drawn is higher than the batteries capacity (C) divided by 10 (C/10) then the actual rating of the battery will be lower than that stated by the manufacturer.

Therefore up to 2.4 Amps (24/10) can be drawn without affecting the rated capacity of the battery. At a current of 2.4 Amps, the battery should last for 10 hours.

Table 2. State of Battery Charge

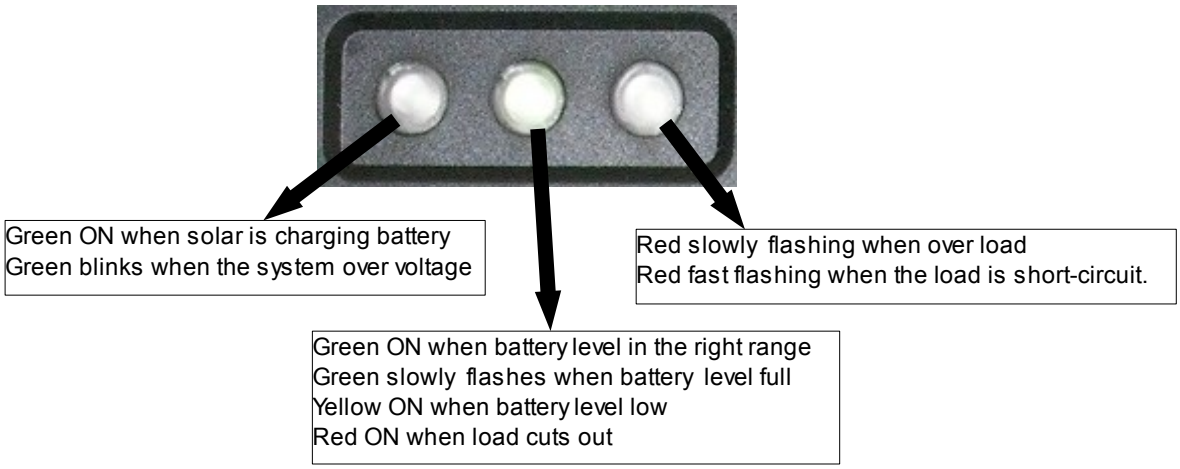
STATE OF CHARGE (%)	VOLTAGE	STATE OF CHARGE (%)	VOLTAGE
100	12.7	40	11.9
90	12.5	30	11.75
80	12.42	20	11.58
70	12.32	10	11.31
60	12.2	0	10.5
50	12.06		

Note. This is with no load and after a period of rest.

Charge / Load Controller

The controller can cope with loads up to 10Amps, which is well within what I need.

- Regulation point: 14.4 Volts – Output won't go above this
- Low voltage disconnect: 11.1 Volt – Turn off the load
- Low voltage Reconnect: 13.1 Volt – Re-connect the load
- Power Consumption : 6mA maximum
- Type of Charging: Series PWM (4stages: Equalization, PWM, Boost and Float)
- Electronic protection: Short circuit and over current(panel and load). Reverse polarity (panel load and battery, Reverse current at night. Limits high voltage to protect load.
- LED indications: Green charging, Green-Yellow-Red battery levels.



The various states of the panel, battery and load are indicated by the three status indicators on the controller as shown above.

The controlled is the heart of the system. It takes the solar panel output and uses it to charge up the battery. During charging, the voltage across the battery will be limited to 14.4 Volts. When the battery is fully charged the controller will reduce the voltage to maintain a float voltage across the battery.

The solar panel, battery and load (via distribution board) are connected to terminals on the charge controller.

Distribution Board

Here you can see the components of my Solar Power system mounted on a board ready for use. As the controller only has one load output, I decided to connect the output to a distribution board. This enabled me to easily connect more than one load to the controller.

Although the load output of the controller is protected against short circuit, I decided to include a 5 Amp in-line fuse on each load connected to the distribution board.

I have also used an Analogue volt meter to monitor the battery voltage.

Conservatory Fan

This fan consists of a 12V DC motor mounted in an ABS plastic box. The 8” blades were taken off an old fan.

Once up to full speed, the fan draws a current of 0.7 Amps. It can be seen from Table 1 that between the hours of 09:00 and 18:00 (on a sunny day in summer) the fan could be powered by the solar panel alone and not need to draw any power from the battery.

The fan is generally only switched on during daylight hours and during hot summer weather

The fan switch has been mounted on the side of the battery voltage indicator box.

Conservatory Light

This uses a low power 4W fluorescent tube which works off a 12Volt supply. This was purchased off the shelf, so no modification was required.

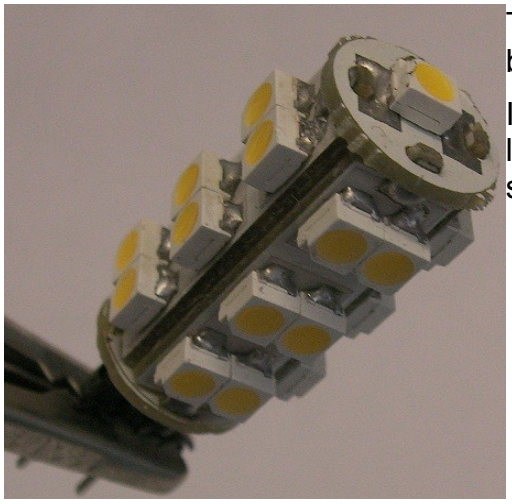
The light draws a current of 0.6 Amps.

As the battery is rated at 24Ah it could (in theory) power the light for over 40 hours.

Lounge Light

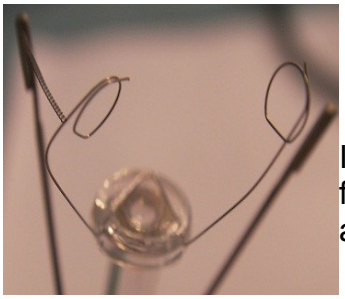
I decided to use LED's for my lounge lights as they have a high light output for a corresponding power output. I chose two LED lamps, each had an output of 95 Lumens at 12V and consisted of 25 surface mounts LED's. Each Lamp drew a current of approx 70mA. This is less than 1Watt each! When used together, the two LED lights provide enough output to light the room in a relaxing way which is idea when watching the TV.

Firstly I removed the mains plug from the lamp cable as the lamp would now be operating at 12V DC rather than 240V AC.

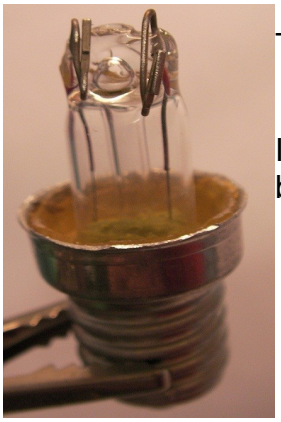


The only problem was that the LED lights came with G4 bases and the lamp stand I had took SES lamps.

I decided to use the bases from a couple of cheap SES lamps so that I could mount my LED lights in the lamp stand.

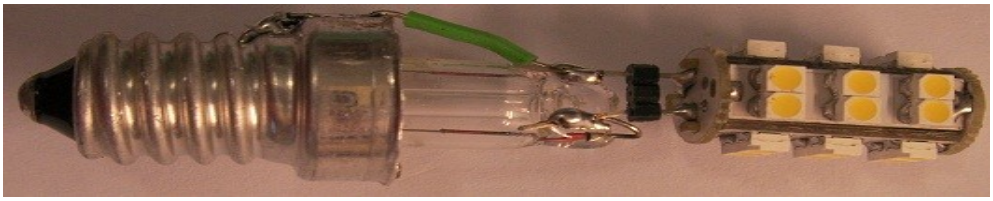


I removed the glass from the SES lamp and then removed the filament. Using a file I made sure there were no rough edges around where the glass had been removed from the SES base



The two wires leading to each filament were bent over as shown.

I then soldered the two pins of the LED light to the two wires on the SES base.



The mains plug was removed from the power cable and what would have been the live (brown) wire connected to the +12V load output on the distribution board. The neutral (blue) wire was connected to the 0V on the distribution board. For safety sake, I included a 5 Amp in-line fuse with the +12V wire.

The finished lamp in operation.

In operation the lamp draws a total of 140mA, this is approximately 1.7W. As the battery is rated at 24Ah it could (in theory) power the light for over 170 hours which is a week of continuous operation. In practice the lamp will only be used for a few hours each evening.

Conclusion

Item	Current
Fan	0.7 Amps
Fluorescent Light	0.6 Amps
Led Lighting	0.14 Amps
TOTAL	**1.44 Amps**

The total current drawn by the devices attached to my solar powered system is 1.44 Amps.

This is worst case. In reality the fan is only on during the day in the summer when we are using the conservatory. On a sunny day in summer, the solar panel will supply at least 1 Amp. As the fan only takes 0.7Amps, the battery will still charge.

The solar panel provides enough power to charge the battery fully during a sunny day, even in the winter. The battery can store enough charge to power the two lights between sunny days.

It Works :-)