Sunlight Controlled Solar Dump Water Heater

The Problem

I live in the Southern part of the UK. A few years ago, I installed a Hybrid solar panel system with Lithium storage batteries. Our house runs on the batteries during the evening and overnight. The batteries are fully charged by about midday the following day. I needed to find a way of using the excess solar power to heat my hot water tank.

The first problem is that the UK has many "partly cloudy" days. The sun is often obscured by cloud for a few minutes and then re-appears. What I needed was a sun-controlled system that switches the water tank heater off when the sun is obscured and then back on when the sun re-appears. This prevents the heater from taking power from the batteries when the sun clouds over.

The second problem is that the amount of solar power varies dependant on the time of year. During the summer (when the sun is high) I have about 2.5kw of spare power available but when the sun is lower in the winter, I only have bout 1.2kw. I needed a way of adjusting the immersion heater load dependant on available solar power.

The Solutions

Warning

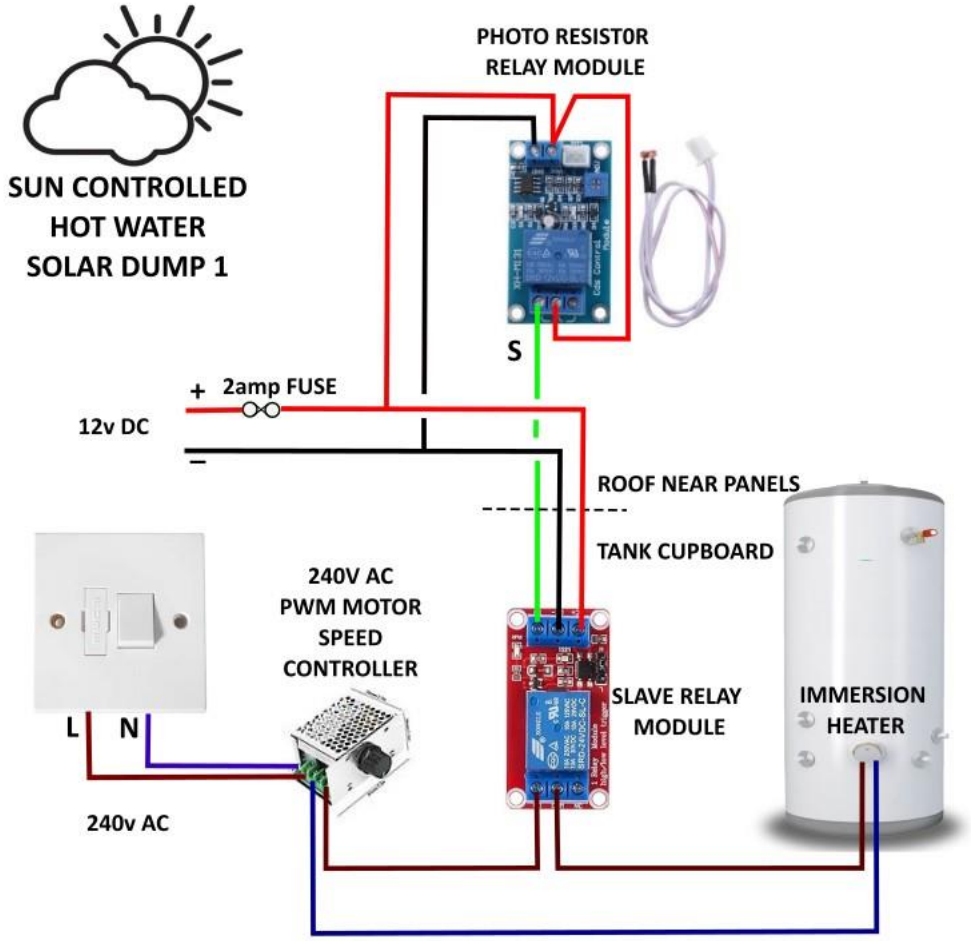
The systems described use domestic voltages at high current loads. If not installed properly there is a risk of electrocution and fire. All connections must be made properly and to a high standard. Electrical cabling used must be of the correct type and current rating. The domestic voltage parts of the system must be enclosed, properly insulated and earthed. The components used are **C**ommercially **O**ff of **T**he **S**helf but may not comply to the electrical standards in your country. If you are unsure about the safety of your installation, please have it checked by a qualified electrician. The systems are experimental and I take no responsibility for accidents or malfunctions.

1. DC Voltage Detection Control Relay

Initially I tried a battery voltage-controlled solution. The problem is that in LiFePO4 batteries the voltage band between 70% and 100% charged is very small. The batteries discharge when the sun is obscured. The heater switches on when the batteries are charged and off at a set lower voltage. I found that I could be left with a low battery by the end of the day if sunset is at the

lower part of this cycle. The voltage-controlled system worked to a point but was not quite good enough.

2. Electro Mechanical Slave Relay Control



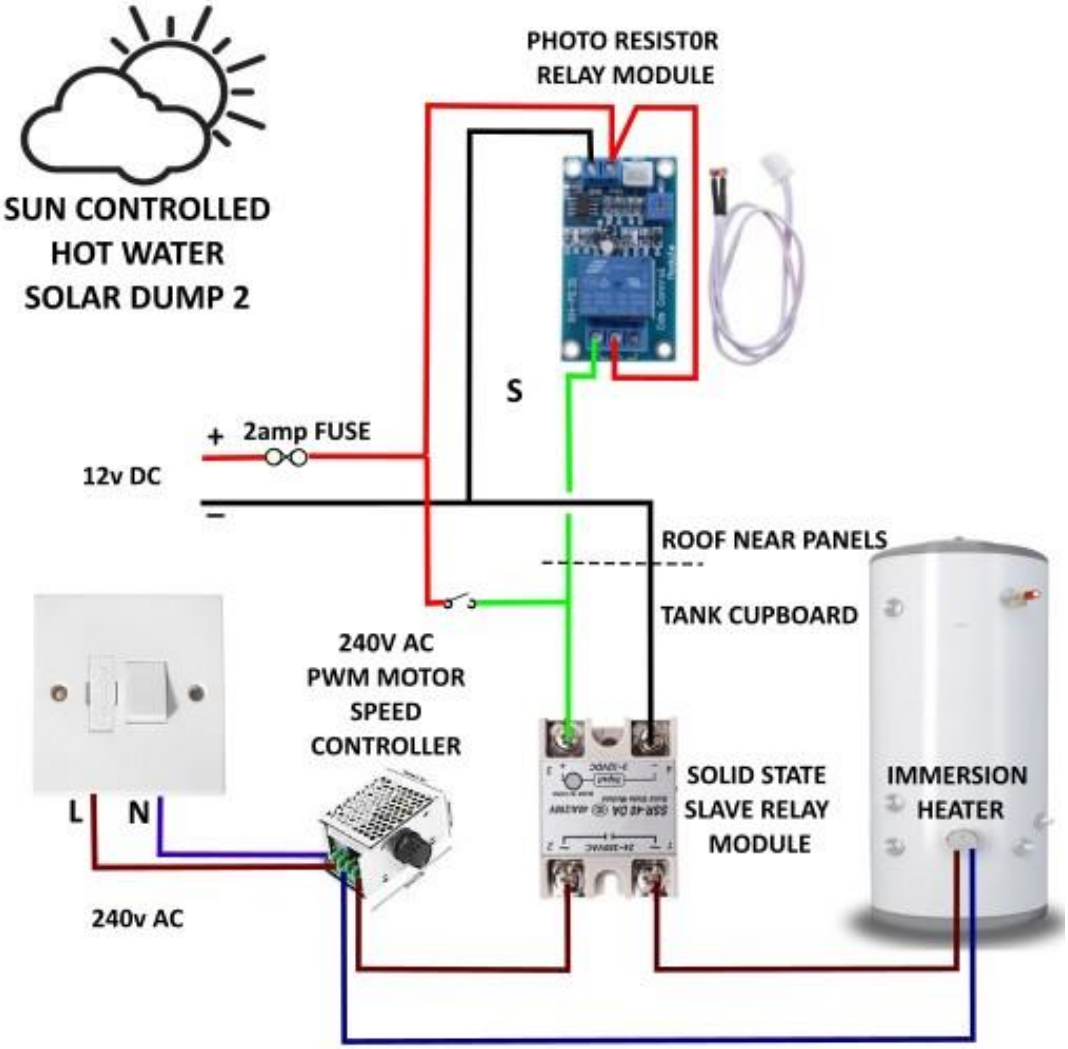
An automatic lighting control unit is used to switch the heater on and off. In this system the adjustable light sensitive photo resistor control until sends a 12v signal to a electro mechanical slave relay module. A 240v, 3kw PWM (Pulse Width Modulation) motor speed controller allows the heater load to be set dependant on available solar power. Both the slave relay module and light sensitive control unit need a 12v operating supply. 12v positive is feed from the light sensitive control units power input to it's relay common connection. Output from the relay's terminal is connected to the signal input of the slave relay. The "Normally Open" terminal is used because it is working opposite to a lighting control application. The photo resistor control unit is located near to the solar panels and connected to the slave relay using a 3-core cable. I used security system alarm cable left over from another project. The PWM motor controller, slave relay module and immersion heater are connected using the correct current capacity cable.

The sensitivity of the light photo resistor control unit is adjustable by a pot onboard the circuit board. The sensitivity was adjusted so that the relay energises when the sun is not

obscured and de-energies when the sun clouds over. I started with the PWM motor controller set to its lowest setting. When the slave relay is switched on (the sun is out), I monitored the solar systems battery load and increased the current on the motor controller until the battery is just charging (150w). This set point can be adjusted as seasons change.

The results were very good. On one partly cloudy day in March I manage to put 6.4 kwh into my hot water tank and still have full battery by the end of the day. The PWM controller was set to 1.5kw load to the tank heater.

3. 30amp SOLID STATE RELAY



I was never very happy with the electro mechanical relay module. It was only rated at 10amps and I was concerned about the number of cycles it was doing in a day. Would the contacts burn out over time? Although the relay should have been able to cope with this duty, I installed a 240v 12v operated 40amp solid state relay. The relay is mounted on an aluminium heat sink inside the enclosure box. To allow cooling airflow I drilled holes in the top and bottom of the enclosure box. In addition to this modification, I added a toggle switch which feeds 12v into the relay signal terminal. This allows the light sensitive photo resistor controller to be overridden and the heater switched on manually.

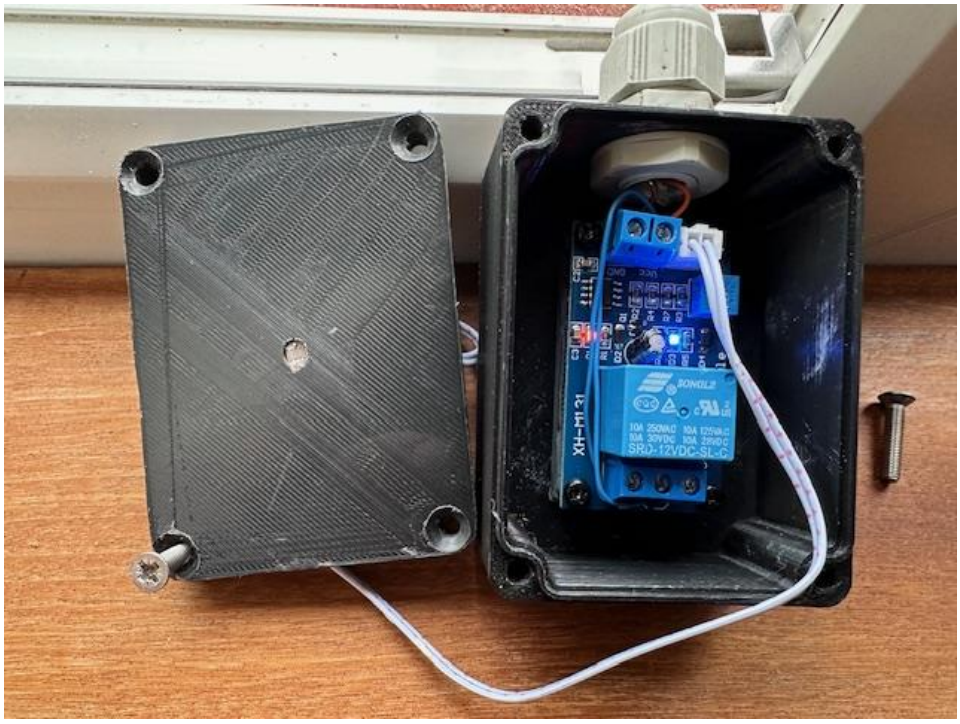
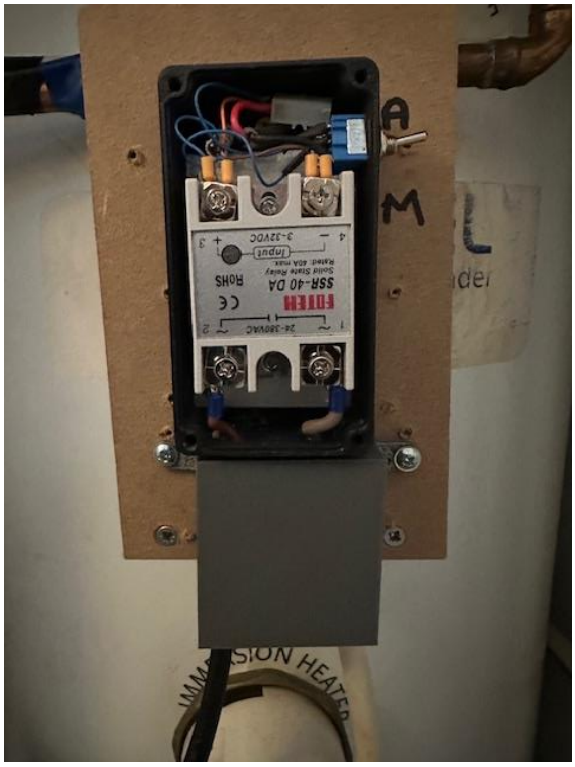
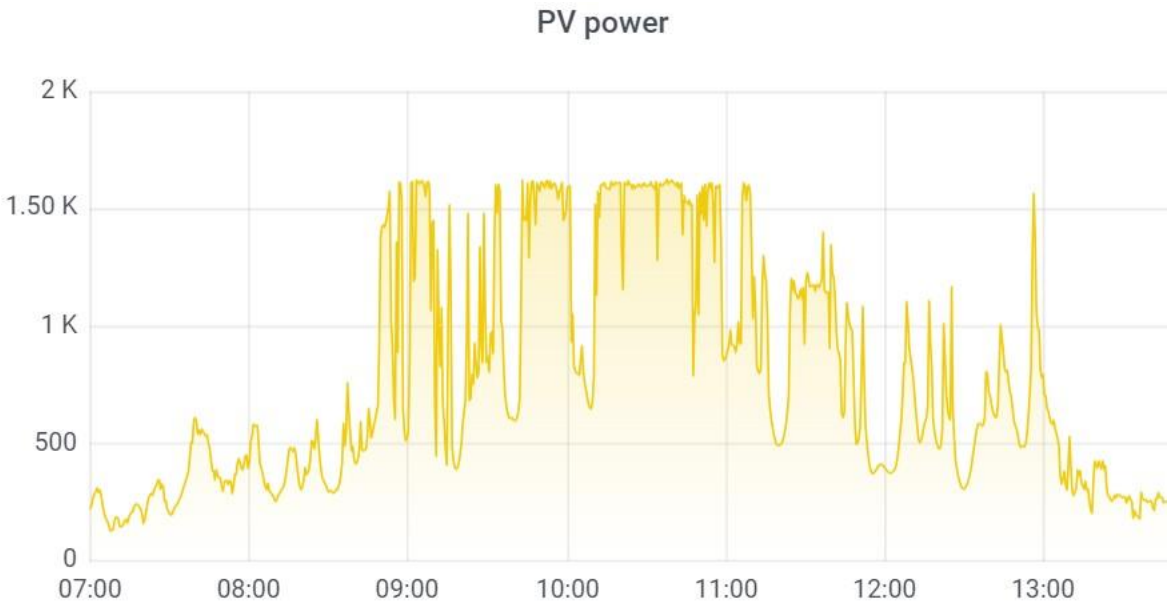


Photo resistor control unit being setup on a windowsill before installation on the roof.



Slave relay in the tank cupboard. The grey box under covers a terminal block and cable clips.



A Typical British Spring Day. The peaks above 1.5kw are when the solar dump is switched on.

4. Components

1x Hilitand DC-AC Single Phase Solid State Relay, SSR-40DA 40A Input Voltage 3-32V DC Output Voltage 24-380V AC.

1x 12V Light Control Switch Photoresistor Relay Module Detection Sensor XH-M131 Brightness Automatic Control Module Light Control Relay Light Switch.

1x Yalati Electronic Voltage Motor Regulator AC 220V 4000W High Power Motor Thermostat Regulator with AC SCR Speed Controller Power Heat Control Dimmer Thyristor

All 3 items above were purchased from Amazon.

2x 3D printed waterproof encloses download from the Thingiverse.