

Electric Solar Hybrid Cooker

Background

Some of the challenges preventing wider adoption of solar cooking are:

- a) The inability to cook on cloudy days and in the evenings when the sun is not shining
- b) Unable to cook indoors using Solar Energy

Design process

Having been cooking for some time with a Solar Box Oven we decided to adopt this to take a heating element driven from a 12V battery and a power rating of less than 100 watts. At this low power rating it was possible to use a solar panel and battery arrangement and avoid having to use 230V (or 110V) mains voltages.

The first task was to find a suitable heating element and was surprised to find one quickly on E-Bay. It was priced at £15 (\$22). All one had to do was to connect it directly to a 12V supply and it was waterproof – an essential requirement inside a cooker. In air they will settle at a temperature of approx 160 to 170C. The waterproof covering can handle a maximum temperature of approx 220C.



After some experimentation we settled on the 90 watt one. This seemed to take around 7 amps of current from a 12V battery and seemed similar in operation to a solar cooker of power between 40 to 60 watts.



- LED display
- All necessary protections equipped
- Adjustable controlling parameter of the system
- PWM battery charging

Then we invested in a 100W solar panel (£100) and a 10 Amp charge controller (£10). When connecting up a solar panel to a battery and a load using a charge controller is essential.

They are easy to wire up and prevent the battery from over charging. They also prevent the battery from discharging through the panel at night. Finally when driving a load, the charge controller prevents batteries from going completely flat as this can damage it. The image above shows how easy it is to wire this up.

The last investment was a 75 Ah leisure battery at a cost of £55. Leisure batteries are different from car batteries in that they are meant to be charged and discharged many times. The main precaution to take with batteries is to prevent accidental shorting as this can result in a fire. The best way to avoid this is to fit a fuse very close to the positive terminal.

Now for some maths

A fully charged 75Ah battery can supply 7 amps for just over 10 hours. The Ah stands for Ampere Hours ie current multiplied by time in hours. The heating pad takes 7 Amps and with a 12V battery the power is 84 watts ie current multiplied by voltage. Our experiments showed that not all this power ended up in cooking the food – only about 40 to 60 watts.

A 100 W solar panel can provide a peak power of 70 to 80 Watts. If it is in a fixed orientation (and does not track the sun) then my estimate was 50 watts average power over a 6 hour period. 50 watts means a current of around 4 Amps going into a 12 V battery. So to fully charge a 75 Ah battery is going to take around 20 hours – or just over 3 days.

So 3 days of charging will provide 10 hours of cooking. This seemed fine to me. The battery acts as a reservoir charging from the sun and discharging into the heating pad as required so it's never fully charged or fully discharged (unless we have many days without sun).

Trials

The store of energy in the battery meant we could switch this ON when required to BOOST any solar cooking. As well as the cooking power from direct solar, we would have another 40 to 60 watts from the solar panel, via the battery and heating pad. This results in faster cooking due to extra (Photo Voltaic) surface area exposed to the sun. One can now also cook in the evenings after sunset using the same set up.



Here are some images of the cooker in action. On the left you can see the solar panel and the solar box oven facing the sun. The middle image shows the heating pad. Later experimentation showed that it worked better when in contact with the pan. The right hand side image shows the battery with the charge controller stuck on top. The terminals are insulated to prevent accidental shorting and there is a 10 Amp fuse in series with the positive terminal of the battery.

We have successfully cooked rice, biscuits, bread and stews with this set up on cloudy days as well as in the evenings.

Note:

We have not detailed the build plans for a solar box oven here as there are many different designs available on the internet. Ours is made of wood (chipboard, MDF and ply) with 70 mm of insulation and a DIY double glazed glass and Perspex. It has a door at the back to place the food in and take it out and all round reflectors.

Solar Cooked Raisin and Oat Cookies

Ingredients

60g wholemeal plain flour
65g plain flour
1 teaspoon baking powder
30 mls oil
120g dark brown sugar
1 teaspoon vanilla essence
80g rolled oats
75g raisins
1 Egg – if using
Milk or almond milk or similar

Method

Preheat a small baking tray in the box.

(To make vegan omit egg, add a little more oil and almond milk or similar.)

Mix flours and baking powder

Add all other ingredients and make into dough with milk as necessary

Shape into small balls and place on heated tray and flatten slightly.

Bake checking carefully for burning underneath. Turn when browning.