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Review Article

Hybrid Solar/Electric Oven with Smart Switch and Smart Phone

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Abstract

Author during last forty years designed, constructed, studied and published various models of cookers like conventional, hybrid solar electric, solar Electric Microwave and Multipurpose Solar Electric oven including dryer etc. These models have been disseminated at different communities in and out of Costa Rica in the form of publications, lectures, newspaper, TV program and workshops etc. During last few years electrical measuring and controlling devices have been added to measure the electrical energy consumed during cooking and control the device from office or outside using smart switch and smart phone. In this short communication, these devices will be mentioned in detail. With these hybrid gadgets, one cook, bake and roast meal using solar and electricity if required during cloudy period. This will help in reducing conventional fuel and cooling the only planet we have.

Keywords: Solar Cooker; Solar Oven; Solar Hybrid Oven; Hybrid Multipurpose Solar Oven; Energy Saving; Smart Electrical Devices

Introduction

At present Costa Rica is generating 99 percent of electricity from Renewable sources, mainly hydro, geothermal, wind, biomass and sol and rest from imported oil. Even in 1978, when I was invited to here to work on Solar Energy, about 70 % of electricity was generated by Hydro and most of the population was using Electricity for cooking. Due to electric rationing imposed by National Electricity company, two days a week from 7 am to 5 pm, in Feb. 1979, summer/dry season I decided to make simple Solar Oven/warmer just for heating domestic meal, cooked and stored in freeze previous night [1,2].

Looking into the performance and necessity I designed, studied, published, promoted various models, like conventional solar oven, Solar Electric Microwave oven, Solar oven including water heater and, dryer etc.as shown in photo 1 [3-8] and hybrid Solar Electric ovens [9-11]. Since 1979, family is still using conventional solar oven (1980) and hybrid Electric- Solar Oven (Photos 2, 3 and 4) for cooking and warming meal, whenever the climate permits, about 7-8 months for cooking and about 11 months per year for warming etc.

The hybrid Solar Oven is in fact similar to conventional Solar oven with two changes, the normal metallic plate is replaced by electric 1500 electric grill plate with thermostat included. In this way switching from Solar to Electrical energy (in the period of cloud) and vice versa is automatic.

To best of my knowledge Hybrid Solar Electric oven was presented first time by this author at ISES conference at Hamburg/ Germany in 1987 and also published in 1988. The detailed performance results are published in different papers [9-11], however in the present communication, some practical information, not published before are mentioned.

Photo 1: Some of the Solar Oven at author house (1979).

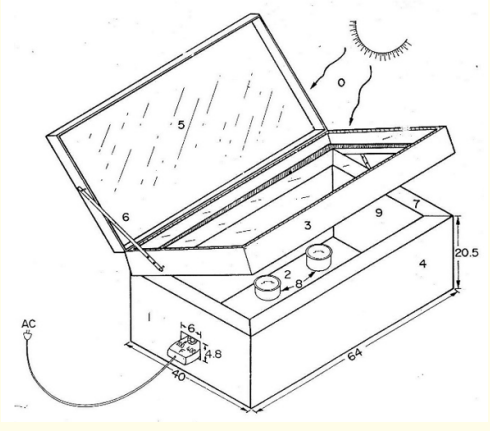

Photo 2: Hybrid Electric Cum Solar Oven (1987).

Main Components: AC Alternating Current 0. Solar Radiation 1. Thermostat 2. Electric Black Plate 3. Transparent Glass Cover 4. Outer Wooden Box. 5. Reflector 6. Arrangement to adjust the angle of reflector 7. Glass Wool 8. Cooking Pots 9. Inner Wooden Box. All dimensions are in cm.

Photo 3

Photo 4

Hybrid Electric cum Solar Oven at authors house (Photo 3) and Hybrid Oven in working mode at exhibition in Costa Rica (Photo 4).

Practical aspects-energy measuring devices

Although the meal can be cooked in any climate, with minimum use of electrical energy, depending on climate and also other advantages, however the researcher and users want to know the energy used/saved. The simplest way could be observing the switching on/off the LED light in the thermostat. Adding this light time (hr.) and multiplying with average Wattage of electrical plate (1.2 kW), one can calculate the electrical energy used (kWh) for cooking.

After one year, (1988) I could find in the physics laboratory the electric timer used by photographers (Photo 5), which when connected in the circuit, can accumulate the time for electrical energy consumption and thus can calculate automatically electrical Energy used for cooking (Energy, kWh = Time (hr) X plate power (kW).

Photo 5: Photographic Timer for use with Hybrid Oven.

In beginning of 2013, I retired from my university and thus I could not use this photographer timer at my house. Had to find some watch with similar characteristics. Tried different watches, digital and analogic. With some difficulties finally I found the proper watch to measure the accumulated electric time.

It was observed that analogic watch like photo 6 (not commonly available) worked very well and tells you the total time when the electricity was used for cooking/baking.

Photo 6: Conventional Analogic Watch to be used with Hybrid Oven.

Few years later found practical and reasonable low cost device, Watt hour meter (Kill a Watt), as shown in photo 7.

Photo 7: Energy Meter KILL A WATT to measure the electric energy used for cooking meal.

This will measure many data, like voltage of electricity, power of electrical plate (1200-1250 W), Current passed (Amp.), total Electrical energy used (kWh) and total time (hour) of the experiment. Now I use Hybrid solar device combined with Watt meter for my experiments and to know the electricity used for solar cooking at house and also show to public for demonstration etc.

Practical aspects-energy controlling devices

Conventional Solar Oven, in addition to save conventional fuel, also has another big advantage. One can cook unattended, it means, user can keep the meal and go for shopping and even to office, the SUN will be doing his job to cook, nutritious and delicious food. The food will not burn as solar is slow and low temperature cooking (80-100 ^{0}C). But using Hybrid Oven, it cannot be done always. Someone has to disconnect electricity after 2-3 hours, depending on climate and quantity of meal etc. Being a promotor of Solar Energy/Cooking, now I had to find some mean. Some programable timers are available for switching off the devices like Electric water heater, TV or other appliances. However only Six months ago I found Smart Switch (Photo 8) which combined with Smart Cell phone (Photo 9) can switch (ON/OFF) the Solar/Electric oven whenever you want, even you are in the office, market or even out of country. I found it very useful.

Photo 8: Smart Switch (8) and Smart Cell phone (9), to control Hybrid Solar Oven, via Wi-Fi.

Photo 9: Smart Switch (8) and Smart Cell phone (9), to control Hybrid Solar Oven, via Wi-Fi.

Experimental Results

Although more technical results have been published about 30 years ago, however now with new measuring device Kill a Watt meter, I did the experiments recently, on Sunday, June 26, 2022 and Tuesday, June 28, 2022 for cooking about 350 g of potatoes and heating pasteurizing 950 ml of water (weight excluding containers) (Photo 10). The days were cloudy, especially June,26. We measured oven, potato and water temperature, solar radiation on horizontal surface and Electric energy consumed, with time.

The oven (thermostat) temperature was set around 100^0C. Both days same quantity of potatoes and water were used. During two hours of study (8:30 am to 10:30 am) the results are:

June 26, 2022, Very cloudy day, Integrated Solar energy was 50.3 Wh and Integrated Electric energy was 0.60 Wh.

June 28, 2022, Cloudy but less than previous day, Integrated Solar energy was 96 Wh and Integrated Electric energy was 0.27 Wh.

Both days potatoes temperature reached about 90^0C and were well cooked, and water was pasteurized (above 70^0C). First day Electric consumption was high due to low solar radiation. No stirring of potato was required as with conventional electric range.

Photo 10: Cooking Potatoes and Pasteurizing Water (Left) in Hybrid Oven and Monitoring the temperature and energy data (Right).

Conclusions

In this communication Hybrid Solar Electric Oven was studied again. It can be used for cooking, baking and pasteurizing water even on cloudy climate, using solar energy and electric energy if required. The switching from solar to electric energy and vice versa is automatic. However in this work new measuring and controlling devices are added recently and not published earlier. With these electric gadgets one can measure the electrical energy used for these cooking which is useful for research purpose as well for consumer to observe their savings. As is well known, with the use of conventional Solar Oven, due to comparatively low temperature cooking, your meal can be cooked unattended. Author have done this when wife was going to India for 2-3 months during summer. Keep food in the morning and come home for hot lunch.

Just for comparison similar experiments were done on two days, cooking potatoes and pasteurizing water. First day was more sunny and other day was more cloudy. Both days the objective was done, but on first day it consumed more electric energy as compared to second day, when the day was more sunny. The use of smart switch to control de device from the street and from office will avoid the burning of meal.

Finally cooking and other applications like water heating, drying, water purification etc. using Solar energy, free, abundant, and cableless, is very much necessary in developing as well as in developed countries. We do not need any war to understand this. Let the politicians THINK GLOBALLY, however we researchers, promotors and users have to ACT LOCALLY, for personal savings and for the health of only planet we have.

Acknowledgement

I am thankful to my university collaborators for 35 years, I am also very thankful to Mrs. Renu, my wife and main user of solar ovens at home for last 43 years, and finding the defects and inconveniences. These forced me to improve the device.

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