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A Project Report On

DESIGN OF SOLAR COOKER FOR DIFFERENT COOKING APPLICATIONS

Submitted for partial fulfillment of the requirements for the award of the degree of

BACHELOR OFTECHNOLOY IN

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CERTIFICATE

This is to certify that the dissertation entitled to **"Design of solar cooker for different cooking applications"** is a bonafide work carried out by **Mr. MOHAMMED FEROZ (17911A0286), Mr. N SAI KUMAR (17911A0288), Mr.D. MALLIKARJUN (17911A0259)** in partial fulfillment for the award of **BACHEOLER OF TECHNOLOGY IN ELECTRICAL AND ELECTRONICS ENGINEERING** to be awarded by **JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY, HYDERABAD**.

The content in this report has not been submitted to any other university or institute for the award of any degree or diploma.

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DECLARATION

This is certify that the work reported in present project entitled **“Design of solar cooker for different cooking applications”** is a record of work done by us in the department of ELECTRICAL AND ELECTRONICS ENGINEERING, VIDYA JYOTHI INSTITUTEOFTECHNOLOGY(Autonomous),JAWAHARLALNEHRU TECHNOLOGICAL UNIVERSITY, HYDERABAD. The reports are based on the project work done by us and not copied from any other source.

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ABSTRACT

Alternate source of energy is always a green approach of energy consumption, in the time of crises of energy and global warming. Use of solar energy for cooking is better solution, but still not established as user friendliness and economic aspect. Food is the basic need of human being. Food can be cooked with conventional fuels like wood, cow-dung, kerosene, Liquid Petroleum Gas (LPG) and electricity. Solar cooker is clean and eco-friendly energy device for cooking. There are large number of solar cookers designed and developed by the scientists and researchers all over the world but still the utilization of solar cooker is not sufficient. There are many reasons for the insufficient uses of solar cooker like, its bulky size, heavy weight, lack of open place, slow cooking, fixed timing for cooking, less awareness etc. In this paper different solar cookers like solar panel cooker, solar parabolic cooker, solar box type cooker and hybrid solar cooker etc. are discussed in detail. Still lot of modifications are required to make the solar cooker user friendly, lighter in weight, smaller in size and still economic. Development of a photovoltaic and thermal hybrid solar cooker has started a new horizon in the field of solar cookers as the cooking is faster than conventional box type solar cooker and can be used at users convenient time. The cooker was converted into solar dryer by small modification and was used for drying vegetables. Still lots of scopes are there for research in solar cooker especially for small size domestic solar cookers

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CHAPTER 1

Introduction:

Solar energy is an important renewable energy that we get from the Sun. Solar energy is used for different purposes i.e., residential and commercial. Solar energy is one such energy that is available in abundance that too totally free of cost. As said before it is used for various purposes and one of the most essential use of solar energy is for cooking and heating food with the help of a solar cooker. This device uses the rays of the sun and converts it into heat energy for heating the food. The solar cooker uses the energy of the sun directly for preparing food just like the plants that use sunlight to prepare their food. Solar cookers are cheap and use no fuel because of which many people in developed and developing countries make use of it. Solar cookers are mainly used when the food is prepared outdoor and helps in lowering pollution and deforestation.

A solar cooker is a device which utilizes solar energy to cook food. Solar cookers also enable some significant processes such as pasteurization and sterilization. It is a clear fact that there are countless styles of solar cookers in the world and they are continually improved by researchers and manufacturers. Therefore, classification of solar cookers is a hard work. However, it may be asserted that most of the solar cookers today fall within three main categories called solar panel cookers, solar box cookers and solar parabolic cooker

Why Solar Cooking?

Cooking in the developing world. More than half of the world's population rely on dung, wood, crop waste or coal to meet their most basic energy needs1. However, according to the United Nations, about one third of the world – two billion people – now suffer fuel wood shortages, which means it is harder to find and more expensive. Women, and sometimes children, must walk further distances to find fuel for the family. Some urban families spend 30-50% of their income on cooking fuel or must barter away food for fuel to cook the remainder. As a result, families drop the nutritious foods that require lengthy cooking – such as vegetables – from their diet, contributing to malnutrition

Facts:

There are over 100,000 solar cookers being used in both India and China • More than 5000 families in Kenya are using solar cookers because of Solar Cookers International • Developing countries are fuel poor but sun rich • In the Toulouse Refugee Camp in Chad, Africa, 5,000 women have been trained to use solar cookers and about 16,000 have been distributed.

1.1 Background

Cooking is one of the important human activities as food is the basic necessity of life. Commonly used sources of energy for cooking in Nepal are biomass, kerosene, LPG, biogas, and electricity etc. At the national level, biomass is one of the most widely used energy sources for cooking purposes. After biomass, LPG comes second in the list. Similarly, biogas, electricity, and kerosene follow the list in the decreasing order of their use for cooking (WECS, 2014). In case of rural area, people rely exclusively on traditional cooking using biomass specially fuel wood. Their cooking method is very inefficient. The cooking process generates a lot of smoke causing indoor air pollution. Besides, people have to walk for miles to collect fuel woods. They cut trees in the forest, which is one of the main causes of deforestation and environmental hazards in the country. In case of urban area, there is a lot of dependency on LPG for cooking purpose. From time to time there is shortage of LPG in the market. In the conditions like energy crisis, life of urban people becomes extremely hard. In Nepal, there is not any proper quality monitoring in the imported LPG product. Time and often the news of LPG cylinder explosion are heard. Despite knowing about high efficiency and economy of using electric stoves, regular power cutoffs from national grid prevents Nepalese people from using electric stoves for cooking purpose in a reliable way. Even when people managed to cook using solar cooker during the availability of grid electricity, excessive loading of 11 kVA distribution transformers caused its explosion. Clearly an alternative to LPG and load shedding is needed. Being one of the most popular RETs, solar electricity is the most appropriate solution to the problems mentioned above.

Cooking from solar electricity is the simplest, safest,environmental friendly and most convenient way to cook. It can be a blessing for rural people, who cook using firewood or cow dung, who walk for miles to collect wood, who suffer from indoor air pollution. For urban peoples, it can reduce heavy dependence on LPG.Also in unusual conditions like petroleum shortage, energy crisis etc solar electricity cooking might make life of people easier. Thus, cooking from solar electricity might play a major role in solving future energy problems of not only Nepal but also in least developed and developing countries facing energy crisis. Solar PV technology can be used for cooking like it has been used for lighting purposes. With a battery backup as a storage medium, it can be used in a reliable indoor cooking environment so as to overcome the limitation of solar thermal technology. Solar PV technology can be used to implement a single system that can be used for residential cooking as well as lighting. Though the problems exist in both rural and urban area, this research considers only the study of urban area. In this research, a detailed survey for energy consumption profile and solar PV potential has been carried out in the 217 sample households in the selected urban area. Ward number 2 of Lalitpur Sub-Metropolitan City was chosen for this purpose. The testing of a sample existing solar cooker in the market has been completed. The simulation of the functional circuit of the existing solar cooker in the market has been done. The experimental efficiency of the solar cooker has been measured to be 85.56 % while the simulation efficiency has been found to be 87%. With a motivation to switch the LPG users towards solar electricity, a design for solar electricity based solar cooker has been developed. The simulation of design has been completed. The efficiency of the simulated design is 90.10 %. The fabrication of the prototype system has been carried out. The results from the test shows that the system works at relatively low power level confirming solar heating but cannot function well when power level rise. Working of the design above 1 kW could not be achieved. This is primarily because of the fact that the system has to draw about 41 Amperes of current at 24 V system voltage to maintain the output power of 1 kW, which along with transient currents and surges in the circuit is very difficult to handle for the commercially available IGBTs. Besides, the experimental results are not as satisfactory as the simulation is. The author has anticipated the main cause to be the lack of proper hardware.

Components for the realization of the design. Rather than taking the component for the design, authors are obliged to use the available component for design. This has made a lot of inconvenience during the research. Thus, a further research is needed with proper hardware components and research infrastructures.

1.2.Present Scenario of household cooking in India

Three in seven people today lack modern fuel to cook.

Poor and very poor people are still depending on Charcoal and Firewood which is a less efficient heating process and it also creates pollution.

In India Still 49% of fuel used for cooking is from firewood.

Present availability of domestic natural gas is only 23 (million metric cubic meters per day) which is enough to fuel 5 GW of power as against a demand of 120 -60 GW for the whole country

This suggests a better solution in India for fuel to be used for

1.3. Problem Statement

In case of rural area, cooking is heavily dependent on inefficient biomass based cooking. The main problems include the time that is needed to collect the firewood and other biomass by the people, indoor air pollution induced health hazards and various other environmental concerns. In case of urban Nepal, heavy dependence on LPG has made peoples very insecure especially in the conditions like energy crisis, LPG shortage, etc. During the recent energy crisis of Nepal, urban people wished to use solar cooker as an alternative solution to LPG. But regular power cuts prevented them from doing so. And even when people used solar cookers while grid power was available, excessive loading caused faults in 11 kV distribution transformers causing substantial loss for repair and maintenance. So, lots of peoples were interested in running the solar cooker from a battery which required use of costly and over rated inverters. At that stage, people had increasing interests and confusions regarding the use of solar cooker directly from battery using solar panels. Based on the situation the following research question was raised: Can a solar DC based solar cooker be

simulated and fabricated? In order to answer this question, research objectives were formulated. To make life of people easier in the rural areas, an alternative to biomassbased cooking has to be found. Similarly, for the urban area, alternative to LPG has to be found. This study only considers urban areas. From the survey, it has been clear that people are highly willing to use solar cooker and rice cooker if a regular and reliable power supply is provided by the government. In order to fulfill this requirement government needs to construct big hydropower. Hydropower projects have a very long gestation period. On the other hand, there is not even a slightly convincing step from the government and political level towards the development of hydropower in Nepal. Therefore, it can be inferred that this situation will continue for at least a decade. Even when hydropower will be available in the future, it could be
exploited to reduce trade deficit which is increasing year by year while locally available energy sources like solar energy can be used for cooking purpose. The problem will be solved only if the LPG users in the urban areas are switched by RETs. Clearly there is a need for alternative method of cooking in order to solve the aforementioned problems.

1.4. Research Objectives

Main Objective To design, simulate and test a microcontroller and DC power based solar cooker. Specific Objectives

i. To study the energy demand survey for the cooking application in

ii. To test the hardware and simulate functional circuit of selected commercially available Solar cooker.

iii. To design and simulate the DC powered solar cooker. iv. To test design of DC powered solar cooker.

1.5. Rationale

The main purpose of this study has been to carry out the design and testing of the solar cooker using solar electricity. The solar cooker is battery powered and the battery gets its energy from solar PV panel. This type of study is very important because very few literatures exist in the academic world regarding the design of battery powered solar cooker. The thesis report by Weber (2015) claims that the research conducted is first of its kind in context of the design of battery powered solar cooker. Even then the study only gives the design of the circuit but not the hardware realization. It is therefore, this research in context of Nepal with a unique design of solar electricity based solar cooker is expected to be an important value addition to the existing body of knowledge. This study is motivated by the desire to solve the problems experienced by the Nepalese peoples in the urban areas from time to time because of the LPG shortage and ever increasing load shedding problem. The success of this research might have the huge implications in the cooking methods of urban area as well as rural area. However, for the purpose of study, only urban area has been selected.

1.6. Scope of the Work

This study is mainly focused on the residential sector, one of the most energy consuming sector of Nepal (about 80% of the total energy consumption). The scopes of this study have been limited to the energy survey in the sampled number of householdsin the ward number 2 of Lalitpur Sub Metropolitan city, testing of the hardware and simulation of the functional circuit of selected commercially available solar cooker, design and simulation the DC powered solar cooker using quasi resonant topology, and testing of the designed DC powered solar cooker.

1.7. Limitations

i. Higher rating components as required by the design could not be used due to unavailability in the market.
ii. Use of modern equipment with computer friendly facilities like Universal Serial Bus (USB) interfacing feature and data extracting features would have helped even more in the data analysis.
iii.discharge easily

CHAPTER 2

2.1 Literature survey

Reflector Type solar cooker

Solar panel cookers may be considered the most common type available due to their ease of construction and low-cost material. In solar panel cookers, sunlight is concentrated from above [1]. This method of solar cooking is not very desirable since it provides a limited cooking power. On the other hand, this type of solar cookers is highly appreciated by people living or travelling alone. Solar panel cookers utilize reflective equipment in order to direct sun- light to a cooking vessel which is enclosed in a clear plastic bag. Solar panel cooker of Dr. Roger Bernard (CooKit) is one of the most popular designs in this category [3]. Only cardboard and foil shaped was utilized to manufacture the Cookit. It was an afford- able, convenient and effective solar cooker which enabled to preserve nutrients without burning or drying out. Bernard also investigated how the solar cooking technology is taken up by populations [4]. Performance of solar panel cookers highly depend on reflected radiation thus, they do not seem effective under cloudy conditions [5] Another simple concentrating type solar cooker is known as sun basket. The sun basket is basically a parabolic mirror, made from papermache, reinforced by a layer of jute fabric and held in place by a bamboo frame. The reflector lining is an aluminium foil which is glued on the inner side of the basket. This is also known as passive cooker. For fabricating the sun basket a mound of cement concrete of parabolic shape is made on the ground. This is done with the help of a previously fabricated plywood frame of parabolicshape, which is revolved on the masonry work while still soft. A bamboo basket is woven in such a way that it fits exactly over the shape of parboiled mound. At the same time, papermache is prepared from 5kg of shredded waste paper, 2kg of wheat flour, 1kg of fenugreek flour and sufficient quantity of water to make a thick pulp. The ingredients are mixed well and heated to nearly boiling temperature. The mould is then covered with one layer of watersoaked newspapers so that the paper mache would not stick to the mould. The paper mache is then pasted in a layer of about 1.2 cm thick and well-pressed upon the paper covered mould. On top of this, the bamboo basket is then placed and pressed well onto the wet surface. The paper mache is then taken out. silver foil the inside of the paper mache is then pasted with for reflecting solar rays Nine sheets of (40*60 cm.) silver paper are necessary for a basket. For cooking purposes, the sun basket is focused towards the sun and the cooking pot is suspended from a tripod stand. It is claimed the sun basket under clear sky conditions can cook rice in 10 minutes and dal in 20 minutes. One liter of water can be brought to the boiling point in 5 minutes. The sun basket is estimated to be equivalent to 700 Watts electric cooker.

Box type solar cooker

History of solar cooking technology started with the invention of box-type solar cookers. The first solar box cooker was invented by a French–Swiss naturalist named Horace de Saussure in 1767. Especially in the twentieth century, this solar cooker type demonstrated a considerable development in terms of design and performance parameters. A solar box cooker basically consists of an insulated box with a transparent glass cover and reflective surfaces to direct sunlight into the box [7]. The inner part of the box is painted black in order to maximize the sunlight absorption. Maximum 4 cooking vessels are placed inside the box [8, 9]. A detailed description of solar box cookers is illustrated in Fig.

Fig 1 .Old style solar cooker

Advance Solar Cookers

2.2 Cooker with Booster Mirrors

After the 1980s, researchers especially focused on optimization of geometry parameters of solar box cookers since they have a dominant effect on performance. In this context, some researchers analysed the booster mirror effect on efficiency of box-type solar cookers. Dang [10] investigated the concentrators for flat plate collectors and explained that booster mirrors can be utilized in order to increase the efficiency of solar collectors since it provides extra solar radiation. The results indicated that the effectiveness of concentrators highly depends on the angle of mirrors. Garg and Hrishikesan [11] presented a comprehensive analysis of a system consisting of a flat plate collector integrated with two reflectors. They proposed a model which was numerically simulated for conditions prevailing in three different Indian stations for three different months. They found that the enhancement is maximum for the month of December in all the three stations for both horizontal and tilted surfaces. Narasimha et al. [12] comprehensively analyzed the solar cookers augmented with booster mirrors. They provided a single adjustable booster mirror to a solar box cooker and calculated the total energy falling on
the cooking aperture for the latitude of 18 N (Warangal City, India) and for different declinations of the sun. Energy contribution by the booster mirror increase significantly with an increase in latitude of the location.

Fig 2 Advanced solar cooker

2.3 Uses of Phase changing materials (PCM)

Buddhi et al. [13] designed and analyzed a solar cooker augmented with three reflectors and a phase change material storage unit. The experimental results showed that late evening cooking is possible in the solar cooker proposed. Algifri and Al-Towaie [14] carried out a research in order to study the effect of the cooker orientation on its performance.

2.4 Uses of TIM (Transparent insulation material)

Insulation in a solar box cooker should not be limited to the walls of the frame box and absorber tray since a remarkable amount of heat loss occurs through the glazing. In this context, Nahar et al. [15] carried out some studies on utilization of transparent insulation material (TIM) in solar boxcookers. Under an indoor solar simulator, they tested a hot box solar cooker with glazing surface consisting 40 and 100mm thick TIM. The stagnation temperature with the 40 mm TIM was found to be 158 C, compared with 117 C without the TIM. A double reflector hot box solar cooker with TIM was designed, constructed, tested and its performance was compared with a single reflector hot box solar cooker without TIM.

2.5 Different designs of solar cooking systems

Sonune and Philip [16] developed a Fresnel type domestic SPRERI concentrating cooker. The cooker was found capable of cooking food for a family which consisted of 4 or 5 people. The highest plate bottom temperature was calculated 255 C in approximately 40 min while ambient temperature was 30 C and direct solar radiation was 859 W/m2. Prasanna and Umanand [17] developed a hybrid solar cooking system as shown in Fig. 3 where the solar energy was transported to the kitchen. The thermal energy source was used to supplement the Liquefied Petroleum Gas (LPG) which was in common use in kitchens It is a clear fact from the literature that solar cookers are very promising devices in the upcoming future. However, there are some handicaps concerning the solar cooking technology. Perhaps, the most challenging point of solar cookers is that they are not able to serve when the sun goes down. Some researchers performed intensive efforts on solar box cookers in order to allow late evening cooking. PCMs were considered as a solution in most cases. Bushnell [18] designed, constructed and evaluated a solar energy storing heat exchanger as a step toward a solar cooking concept. The methods for describing the system performance were explained and applied to a test system containing a controllable replacement for the solar input power. This first stage of this research work followed by a heatIt is a clear fact from the literature that solar cookers are very promising devices in the upcoming future. However, there are some handicaps concerning the solar cooking technology. Perhaps, the most challenging point of solar cookers is that they are not able to serve when the sun goes down. Some researchers performed intensive efforts on solar box cookers in order to allow late evening cooking. PCMs were considered as a solution in most cases. Bushnell [18] designed, constructed and evaluated a solar energy storing heat exchanger as a step toward a solar cooking concept. The methods for describing the system performance were explained and applied to a test system containing a controllable replacement for the solar input power. This first stage of this research work followed by a heat exchanger, which was connected to a concentrating array of CPC cylindrical troughs. Author also described the size of the solar collector area and mass of PCM mass needed in order to provide adequate energy for several family-size. Different researchers have studied ionic liquid for heat storage in solar energy devices [19-21]. The small scale Photovoltaic and Thermal Hybridized (Casserole type) solar cooker as designed and developed was developed [22] tested for the performance with (a) Thermal Energy Storage materials (TES), sand (b) Ionic liquids (IL) BF4- and PF6- [23-25]. The cooker was modified and made users friendly all time working solar cooker and The maximum utilization of the solar cooker was studied by cooking different dishes in it [26,28]. The hybrid cooker was made more efficient by tracking the solar panel with dual axis solar tracker [29].The hybrid cooker was converted into solar dryer and was used for agricultural applications.

Dis advantage of existing system

The building of the solar cookers could take up to half a day. The testing and cooking needs to be done on a very sunny day and would be well suited to demonstration at a school fete or Green Day. Cooking works best in the hours leading up to midday and immediately after.

2.6. Solar power

Solar Power There are two types of solar power

Photovoltaic solar power: the energy created by converting solar power into electricity using photovoltaic solar cells.

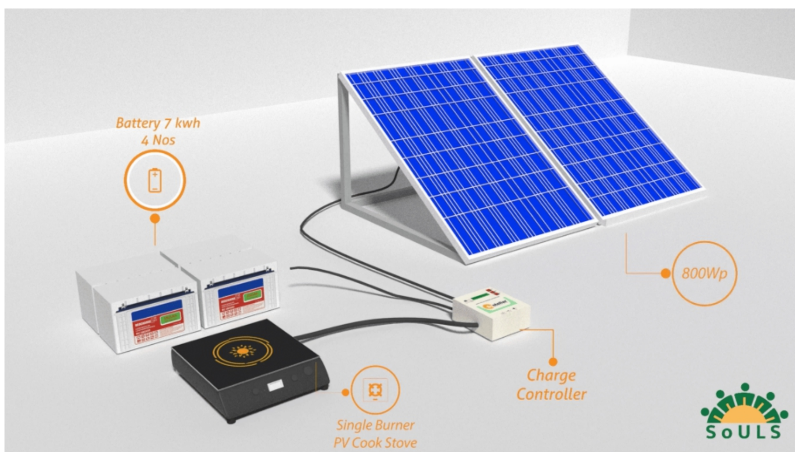


Fig 3

Solar thermal energy, or direct solar power

The energy created by converting solar energy into heat. Solar cooking does not require any electricity but uses solar thermal energy to cook the food. This means that you can use a solar oven anywhere that has lots of sun. Solar Cookers Solar cookers are used to cook food and pasteurize water for safe drinking. They use a free, renewable energy source and do not pollute the environment. There are many benefits to solar cooking, explained later in the pack. They are particularly useful when other sources of fuel are unavailable.

There are different types and variations of solar cookers but the basic principles of all solar cookers are:

1. Concentrating sunlight: A mirror, or reflective metal, is used to reflect the sunlight so that it is

concentrated and the energy is stronger
2. Converting light to heat: Parts of the inside of the cooker are painted black. Black surfaces absorb and retain heat which is important for keeping the cooker hot.
3. Trapping heat: Isolating the air inside the cooker from the air outside the cooker makes an important difference.
A plastic or glass cover creates a greenhouse effect within the oven to make sure that the heat is allowed in but can't escape out.

precautions

• The contents of solar cookers can get very hot.

• Do not put fully sealed jars or bottles inside a cooker as pressure will build up inside it.

• Take extreme care cutting with craft knives.

• If working outdoors, remember sun cream, hats and sunglasses

Types of Solar Panels

If you're thinking of taking the solar route to generate electricity, one of the key items on your list would be deciding between different kinds of solar panels available in the market. A solar energy system's core lies in photovoltaic panels or modules, which are responsible for absorbing sunlight and converting it into a source of energy to generate electricity. Continuous research in the field of solar energy has brought forth a variety of solar panels, and choosing between them
can be a challenge.

Ideally, these solar panels can be classified into the following three generations

• First generation: These are the traditional solar panels made of silicon. Currently, these are the most efficient panels available for residential purposes. However, these panels have a higher risk of losing their efficiency at higher temperatures (scorching and sunny days).

• Second generation: Second generation solar panels are also known as thin-film modules because when compared to the firstgeneration panels, these are made of layers of semiconductor materials only a few micrometers thick. These are cheaper because they use lesser materials than the firstgeneration panels.

• Third generation: Third generation solar modules are still under a lot of research. They're made of a variety of materials besides silicon – including nanotubes, solar inks, silicon wires, organic dyes, and conductive plastics. These solar panels are expected to overhaul the efficiency and reducing the price of commercially available solar panels.

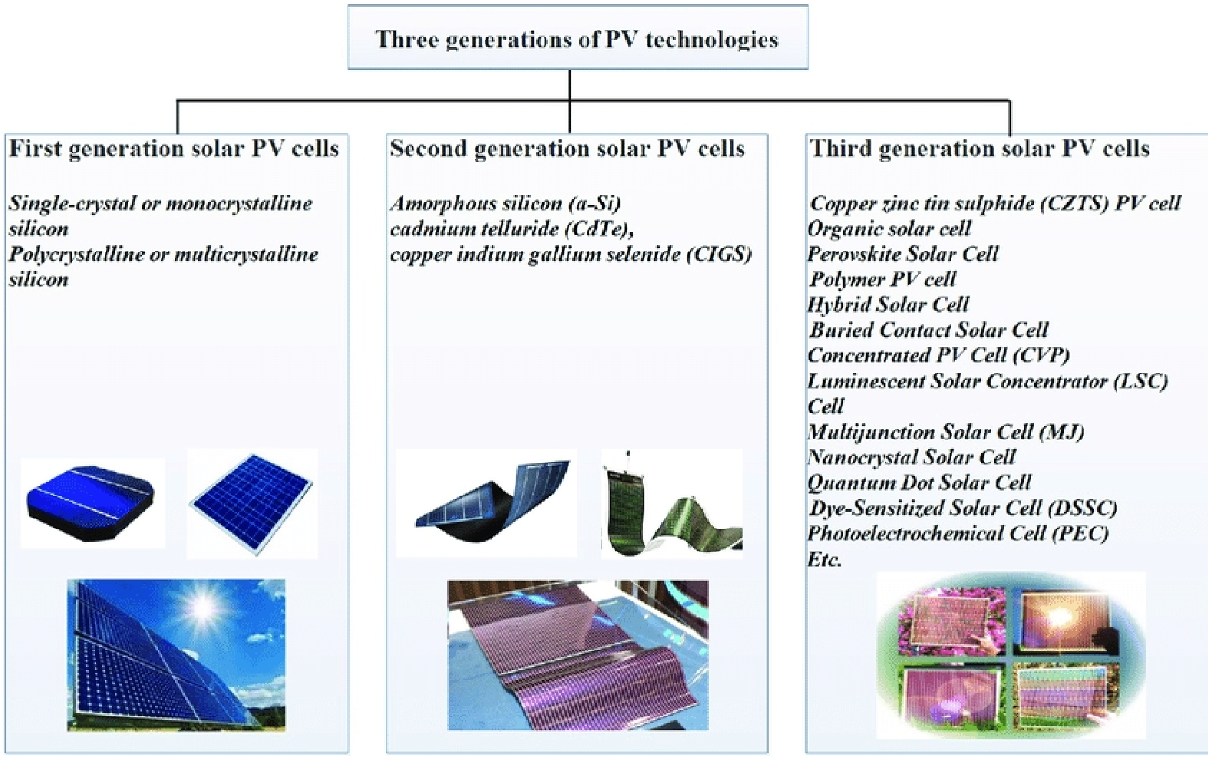


Fig 4

Let's look at some of the commercially available solar panels – including their advantages and disadvantages

1.Monocrystalline Solar Panels

This is the oldest solar technology and is still widely used. These solar panels belong to the first generation and are therefore made of extremely thin wafers of silicon. They're referred to as monocrystalline because the constituent cells are sliced from large single crystals that have been grown under carefully controlled conditions. Compared to the other types, these are up to 20% more efficient. What this means is that you'll generate 20% more electricity from a monocrystalline solar panel than other solar panels of the same area. This is extremely useful if you wish to mount these panels in a limited space or for aesthetic reasons. However, growing large crystals of silicon is an extremely energy-intensive process, hence the production costs for this type of panels are the highest of all the solar panel types. The cost of monocrystalline solar panels in India is around Rs. 60 per watt. Now, let's look at some advantages of disadvantages of the same. Advantages:

1. Highly energy and space-efficient.

2. Live the longest and come with an extended warranty of 25 years.
3. Tend to perform better than similarly rated polycrystalline panels even at low-light conditions.

2.Polycrystalline Solar Panels

Polycrystalline solar panels are made by pouring molten silicon into a cast. This is a cheaper process as it is relatively cost-efficient to produce silicon wafers in molds from various crystals rather than from a single crystal. These solar panels, too, belong to the first generation. Raw silicon is melted and poured into a square mold, which is cooled and cut into perfectly square wafers. Hence, these panels are cheaper but relatively less efficient. These solar panels cost around Rs. 45 per watt. These are ideal for small rooftop like installations spanning 100-1000 Watts.
Let's look at some advantages and disadvantages, advantages:
1. Simpler manufacturing process.
2. Cost-effective.

3) Thin-film Solar Panels

Thin-film solar panels are made of TFSC (thin-film solar cells). These belong to the second generation and are manufactured by depositing one or a few thin layers of photovoltaic material onto a substrate. These solar panels can be categorized as follows depending on the photovoltaic material is deposited onto the substrate:
1. Amorphous silicon (a-Si)
2. Cadmium telluride (CdTe)
3. Copper indium gallium selenide (CIS/CIGS)
4. Organic photovoltaic cells (OPC)
Out of these, only amorphous silicon, cadmium telluride, and copper indium gallium selenide are commercially available in the market. These are easier to produce and hence have seen an increase in their usage. To add to that, they're also cheaper than both the first generation panels.

However, these are less efficient than the other modules we discussed. Advantages:
1. Mass production is extremely simple.
2. Homogeneous in nature, hence they're aesthetically pleasing.
3. Can be made flexible, thus opening the gates for numerous potential applications

Solar water distillation

There is a great need to find ways to supply water for the Earth's population. Many countries are facing water shortages and/or have residents who use and drink contaminated water. Finding different ways to use our renewable resources (for example, solar power) has become an interest. Solar water distillation is the process of using energy from the sunlight to separate freshwater from salts or other contaminants. The untreated water absorbs heat, slowly reaching high temperatures. The heat causes the water to evaporate, cool, and condense into vapour, leaving the contaminants behind. Solar stills can be used for low capacity and self-reliant water supplying systems.

Working

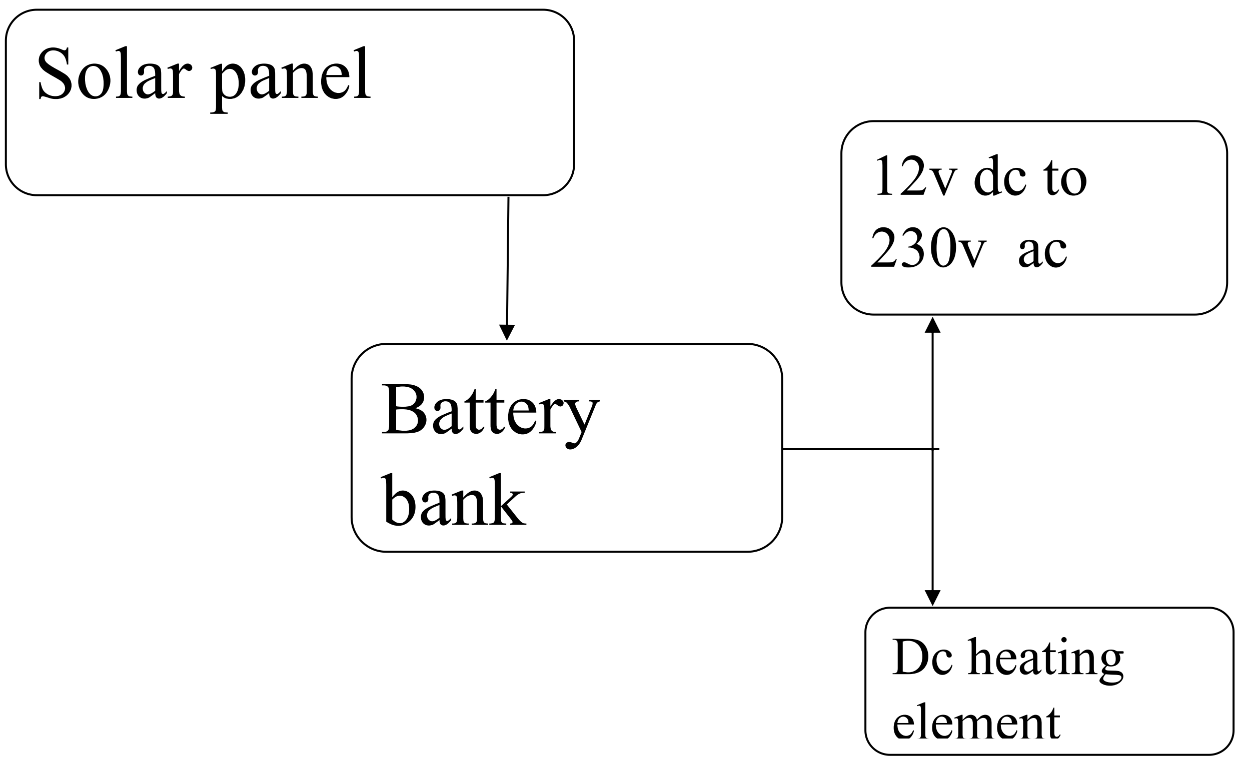
Solar water distillers or solar stills are usually used in remote areas where there is limited access to freshwater. The basic principles of solar water distillation are simple, yet effective, as distillation replicates the way nature makes rain. A solar still works on two scientific principles: evaporation and condensation. The salts and minerals do not evaporate with the water. For example, table salt does not turn into vapour until it gets to a temperature over 1400ºC. However, it still does take a certain amount of energy for water to turn into water vapour. While a certain amount of energy is needed to raise the temperature of a kilogram of water from 0ºC to 100ºC, it takes five and one-half times that much to change it from water at 100ºC to water vapour at 100ºC. Practically all this energy, however, is given back when the water vapour condenses.

Most stills are simple black bottomed vessels filled with water and topped with clear glass or plastic. Sunlight that is absorbed by the black material speeds the rate of evaporation. The evaporation is then trapped by the clear topping and funneled away. Most pollutants do not evaporate, so they are left behind. Most stills need to be about six square meters in size to produce enough water for a single person for a day. Multiple solar distillation systems are required to produce a large quantity of distilled water.

Fig 5

CHAPTER 3

BLOCK DIAGRAM



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CHAPTER 4

Components description

4.1.Heating element

What is a heating element?

A typical heating element is usually a coil, ribbon (straight or corrugated), or strip of wire that gives off heat much like a lamp filament. When an electric current flows through it, it glows red hot and converts the electrical energy passing through it into heat, which it Materials Heating elements are typically either nickel-based or iron-based. The nickelbased ones are usually nichrome, an alloy (a mixture of metals and sometimes other chemical elements) that consists of about 80 percent nickel and 20 percent chromium (other compositions of nichrome are available, but the 80–20 mix is the most common). There are various good reasons why nichrome is the most popular material for heating elements: it has a high melting point (about 1400°C or 2550°F), doesn't oxidize (even at high temperatures), doesn't expand too much when it heats up, and has a reasonable (not too low, not too high, and reasonably constant) resistance (it increases only by about 10 percent between room temperature and its maximum operating temperature). In water heaters, the nichrome element is covered with an outer sheath made of stainless steel, tin-coated copper, or INCOLOY® (an iron-nickel-chromium "superalloy," which is rustproof, long-lasting, and works well in hard-water areas). The sheath is insulated from the heating element by magnesium oxide, an unusual material that's a good heat conductor but a poor electrical conductor, so it allows heat to flow from the nichrome but not electricity.

Fig 6

Types of heating elements

There are lots of different kinds of heating elements. Sometimes the nichrome is used bare, as it is; other times it's embedded in a ceramic material to make it more robust and durable (ceramics are great at coping with high temperatures and don't mind lots of heating and cooling). The size and shape of a heating element is largely governed by the dimensions of the appliance it has to fit inside and the area over which it needs to produce heat. Hair curling tongs have short, coiled elements because they need to produce heat over a thin tube around which hair can be wrapped. Electric radiators have long bar elements because they need to throw heat out across the wide area of a room. Electric stoves have coiled heating elements just the right size to heat cooking pots and pans (often stove elements are covered by metal, glass, or ceramic

Does a heating element need a high or a low resistance?

You might think a heating element would need to have a really high resistance—after all, it's the resistance that allows the material to generate heat. But that's not actually the case. What generates heat is the current flowing through the element, not the amount of resistance it feels. Getting the maximum current flowing through a heating element is much more important than forcing that current through a large resistance. This might seem confusing and counter-intuitive, but it's quite easy to see why it is (and must be) true, both intuitively and mathematically

Approx Amperes to heat a Straight Oxidized wire to given temperature

	Degrees F	400	600	800	1000	1200	1400	1600	1800	2000
	Degrees C	205	315	427	538	649	760	871	982	1093
AWG	INCH DIA.	Amperes								
8	.128	22.4	32	41	52	65	79	95	111	128
9	.114	18.8	26.8	34.5	44	55	67	80	94	108
10	.102	16.2	23.3	29.7	37.5	46	56	68	80	92
11	.091	13.8	19.2	24.8	31.5	39	48	57	67	78
12	.081	11.6	16.1	20.8	26.5	33.5	40.8	48	56	65
13	.072	9.8	13.6	17.6	22.5	28.2	34.2	41	48	55
14	.064	8.4	11.6	15	18.8	23.5	29	34.6	40.5	46
15	.057	7.2	10	12.8	16.1	20	24.5	29.4	34.3	39.2
16	.051	6.4	8.7	10.9	13.7	17	20.9	25.1	29.4	33.6
17	.045	5.5	7.5	9.5	11.7	14.5	17.6	21.1	24.6	28.1
18	.040	4.8	6.5	8.2	10.1	12.2	14.8	17.7	20.7	23.7
19	.036	4.3	5.8	7.2	8.7	10.6	12.7	15.2	17.8	20.5
20	.032	3.8	5.1	6.3	7.6	9.1	11	13	15.2	17.5
21	.0285	3.3	4.3	5.3	6.5	7.8	9.4	11	12.9	14.8
22	.0253	2.9	3.7	4.5	5.6	6.8	8.2	9.6	11	12.5
23	.0226	2.58	3.3	4.0	4.9	5.9	7	8.3	9.6	11
24	.0201	2.21	2.9	3.4	4.2	5.1	6	7.1	8.2	9.4
25	.0179	1.92	2.52	3	3.6	4.3	5.2	6.1	7.1	8
26	.0159	1.67	2.14	2.6	3.2	3.8	4.5	5.3	6.1	6.9
27	.0142	1.44	1.84	2.25	2.73	3.3	3.9	4.6	5.3	6
28	.0126	1.24	1.61	1.95	2.38	2.85	3.4	3.9	4.5	5.1
29	.0113	1.08	1.41	1.73	2.10	2.51	2.95	3.4	3.9	4.4
30	.0100	.92	1.19	1.47	1.78	2.14	2.52	2.9	3.3	3.7

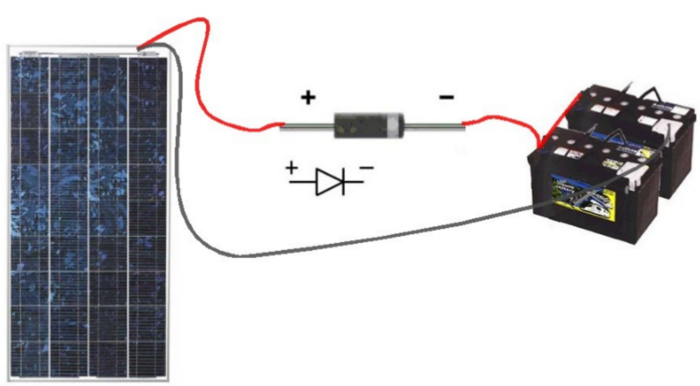
Resistance heating?

We often refer to electrical heating—what heating elements do—as "Joule heating" or "resistance heating," as though resistance is the only factor that matters. But, in fact, as I explained above, there are dozens of interrelated factors to consider in the design of a heating element that works effectively in a particular appliance. The resistance isn't always something you control and determine: it's often determined for you by your choice of material, the dimensions of the heating element, and so on

Solar electrical cooker

The primary criterion in designing the prototype was to keep the power consumption close to. The power of the heating element is kept at such a low value that even small amounts of heat loss can disrupt the function of the design. As already discussed, designing the stove only with proper insulation is not enough to cook at such a low power. The initial design also included insulation for both the stove and the pan. The most challenging part of the design was choice of good quality insulation at an acceptable cost.

Battery charge with solar



[5]

Fig 7

4.2. Solar panel Battery Solar heating element

The solar cells positive terminal is connected through the diode to the positive terminal of the 12V battery. If the voltage of the solar cell drops below 1.4 volts then with the 0.2V the blocking diode takes there won't be enough potential to charge the 1.2V battery. The purpose of the diode is to disallow current dissipating out from the battery to the solar cell when this low voltage situation occurs in the solar cell. Solar energy is the conversion of sunlight into usable energy forms. Solar photovoltaics (PV), solar thermal electricity and solar heating and cooling are all well established solar technologies. These technologies are becoming more common. Although solar power currently accounts for only around 3% of the world's energy generation, its use is growing rapidly.

How does solar charging work?

To catch the energy coming from the sun and to convert it into electrical energy, there are several steps involved. Photons from sunlight carry enough energy to push electrons from their orbit in some elements, especially silicon, the material used in most solar cells. The ability of photons to disentangle electrons is called the photoelectric effect. The first step is creating an imbalance between positively charged and negatively charged particles in the silicon. This is done by adding boron and phosphorus. The imbalance created by adding these impurities creates an electrical field in the silicon. When photons strike the silicon, the electrical field pushes the electrons toward the front of the solar cell, creating a negatively charged side. The protons that are left behind on the other side of the cell surface create a positive charge. When the two sides are connected, using an indirect circuit like the terminals of a solar battery charger, the electrons flow into the load and create electricity. Solar battery chargers don't directly charge the lithium-ion battery in your cell phone or iPad. Instead, they usually charge an internal rechargeable battery. This is charged through the solar modules, and their charge is, then, redistributed to your gadget so that an external electrical source is not required

How Solar Powered Battery Chargers Work and it s principle

• Solar powered battery chargers often work with the assistance of smart and intelligent new modern charge controllers. Here, a sequence of solar cell array plates are individually put in on a roof prime, and are collectively linked to a battery.

• These chargers should not solely used for recharging functions, however can be linked to the mains provide chargers to assist save on energy charges throughout the day. Now you perceive the arrangement of a solar battery charger, you'll undoubtedly surprise how these solar chargers really work at producing electricity from sunlight.

• Basically, free electrons that carry unfavorable charges create motion in present. These free electrons are entangled in an orbit surrounding the atom nucleus manufactured from protons and neutrons. This is the basic facet that happens within the atoms of everything within the universe. • Silicon is the fabric utilized in solar cells. In solar panels, these electrons are knocked unfastened from its orbit by the energy present in photons from sunlight. This photon's expertise in disentangling electrons from its orbit is named photoelectric impact.

How Solar Powered battery Chargers Work with various Cells and Chargers

A solar charger employs solar energy to produce electricity to gadgets or charge batteries. They are typically portable. Solar chargers can charge lead acid or Ni-Cd battery banks as much as 48 V and tons of of ampere-hours (as much as 4000 Ah) capability. Such sort of solar charger setups typically use smart and intelligent new modern charge controller. A sequence of solar cells are put in in a stationary location (ie: rooftops of houses, base-station places on the bottom and so forth.) and will be linked to a battery to retailer energy for off-peak utilization. They can be used along with mains-supply chargers for energy saving throughout the daytime. Most transportable chargers can receive energy from the solar solely. Some, together with the Kinesis K3, and GeNNex Solar Cell 2 can work both approach (recharged by the solar or plugged right into a wall plug to charge up).

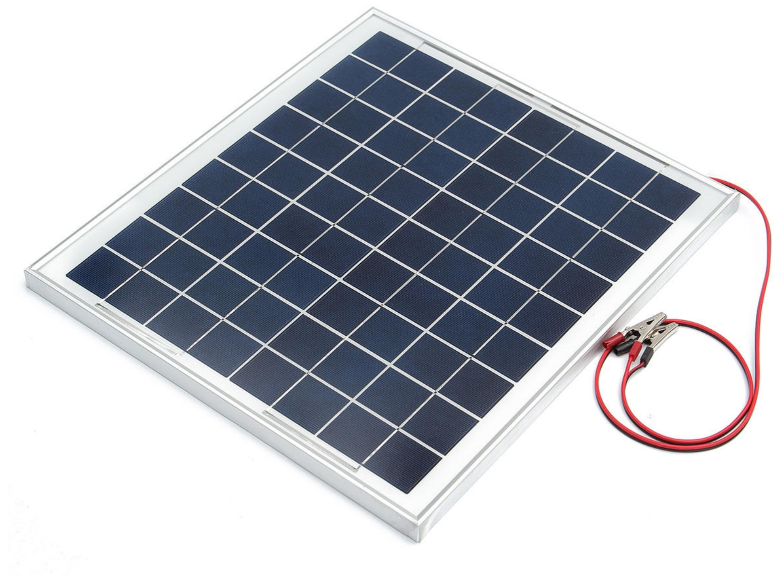


Fig 8

Are solar battery chargers effective?

It is easy to see the benefits of solar battery chargers - they allow you to recharge gadgets and even car batteries without an external electrical source. There are also some subtler benefits. For example, once manufactured, solar cells do not generate any emissions, waste, or byproducts. Although solar chargers function very well, they do have some limitations. Firstly, the power of a solar battery charger cannot be compared to a regular battery charger. These chargers are not as powerful, so it takes more time to charge the batteries. Secondly, a solar charger gives out minimal current, so it is more useful for maintaining a charge rather than charging a completely dead battery. So, you must be careful if you are thinking of relying entirely on a solar battery charger. Using solar battery chargers in smaller devices is still more comfortable than using them in bigger ones. Solartab is an excellent example of such a product. It has a 13,000 mAh battery, which is more than any average smartphone and has an output power which is the minimum amount that a smartphone uses. This advanced solar charger stores enough power to be used later. The device can be carried around easily because it is flat and can easily fit next to an iPad. Moreover, the Solartab solar phone charger is so good that it only takes two hours to charge a fully discharged iPhone 6 completely. However, you'll need to feed the charger with 12 hours of direct sunlight to charge it completely.Solartab is efficient as a solar phone charger, but for charging a 12 Volt battery, things work slightly different. To charge a 12 Volt battery, you require around 10 amps of DC input every time there is an output of 100 watts. A 10 amp charger will need about 6 hours to recharge a completely dead battery. Similarly, the requirements will be higher for a 24 Volt battery. Nevertheless, there are many advantages to solar chargers too. One of the best things about them may be that they are low-powered, so they work well as maintenance chargers. A solar battery charger can also be a lifesaver in case of sudden battery discharge. It can help in prolonging the battery life of a stationary vehicle. And of course, they are also eco-friendly so they can help you reduce your carbon footprint. So, it can be worth the investment, after all. Some of the best 12 Volt battery chargers are DuraVolt 20W Marine Solar Battery Charger, Battery Tender Solar Charger, DuraVolt Magnetic Battery Maintainer, and some others. Other good ones are NOCO Battery Life 2.5-Watt and ALLPowers Portable Solar Battery chargers for cars.

How to choose the right solar charger?

With so many solar chargers available in the market, it can be hard to choose a good one. Some specifics that you should look for when choosing the solar charger for your power requirements are:

Efficiency

An efficient battery charger harnesses the solar energy quickly, so you don’t have to worry even if there is not enough sun. Hence, they are useful in winters as well when you have comparatively less sun.

Size

Solar chargers are available in different sizes. However, the more power you need, the bigger the size of the charger. If you’re looking to charge your car battery, you can go for a 12 Volt battery charger because it is lightweight and usually easy-to-carry. They can be kept easily inside a car, and you can carry it around easily. Moreover, it has enough capacity to sustain bigger things like cars, bikes, boats, etc.

Power

Usually, solar battery chargers have power between 2 to 18 volts. The ones with higher powers can be charged quickly, but the ones with lower powers don't pose a risk to overpower your battery. Small heating circuits find use in many applications. For example, in manufacturing processes, they heat up reactive fluids. The device in this tutorial example consists of an electrically resistive layer deposited on a glass plate. The layer results in Joule heating when a voltage is applied to the circuit, which results in a structural deformation. The layer's properties determine the amount of heat produced. This multiphysics example simulates the electrical heat generation, heat transfer, and mechanical stresses and deformations of a heating circuit device. The model uses the Heat Transfer in Solids interface in combination with the Electric Currents in Layered Shells interface and the Solid Mechanics and Membrane interfaces. The Rigid Motion Suppression condition is automatically applied to a set of suitable constraints based on the geometry model and physics interfaces

4.3.Inverter

A **power inverter**, or **inverter**, is a power electronic device or circuitry that changes direct current (DC) to alternating current (AC).[1] The resulting AC frequency obtained depends on the particular device employed. Inverters do the opposite of "converters" which were originally large electromechanical devices converting AC to DC.[2]

The input voltage, output voltage and frequency, and overall power handling depend on the design of the specific device or circuitry. The inverter does not produce any power; the power is provided by the DC source.

A power inverter can be entirely electronic or may be a combination of mechanical effects (such as a rotary apparatus) and electronic circuitry. **Static inverters** do not use moving parts in the conversion process.

Power inverters are primarily used in electrical power applications where high currents and voltages are present; circuits that perform the same function for electronic signals, which usually have very low currents and voltages, are called oscillators. Circuits that perform the opposite function, converting AC to DC, are called rectifiers.

12v dc to 220 v ac inverter

Fig 9

A DC-AC/DC power inverter is a circuit which modifies an input varying or non-varying direct current (DC) to an alternating current (AC) of a specified voltage and frequency, and a regulated DC voltage. In the case of this project, the input DC voltage source will be a battery, which is being supplied by photovoltaic (PV) panels and a wind turbine. As such, the DC voltage will likely be inconsistent, and considerations will need to be made in order to produce the desired output.

A 200w inverter provides 200 watts of continuous power that can be used to run low power AC electrical devices you may carry with you when you are on the go. They include laptops, cell phones, GPS units, game consoles, blender, small TVs, and DVD players.200W inverters are not made for high power devices such as a hairdryer, electric heaters and curling irons.

How many amps does a 200 watt inverter draw?

The DC amps drawn by a 200W inverter can be calculated as follow:

Watt (Power) = Volts (Voltage) X Amperes (Current)

Current drawn by a 200w inverter (200/110) A = 1.82 amps

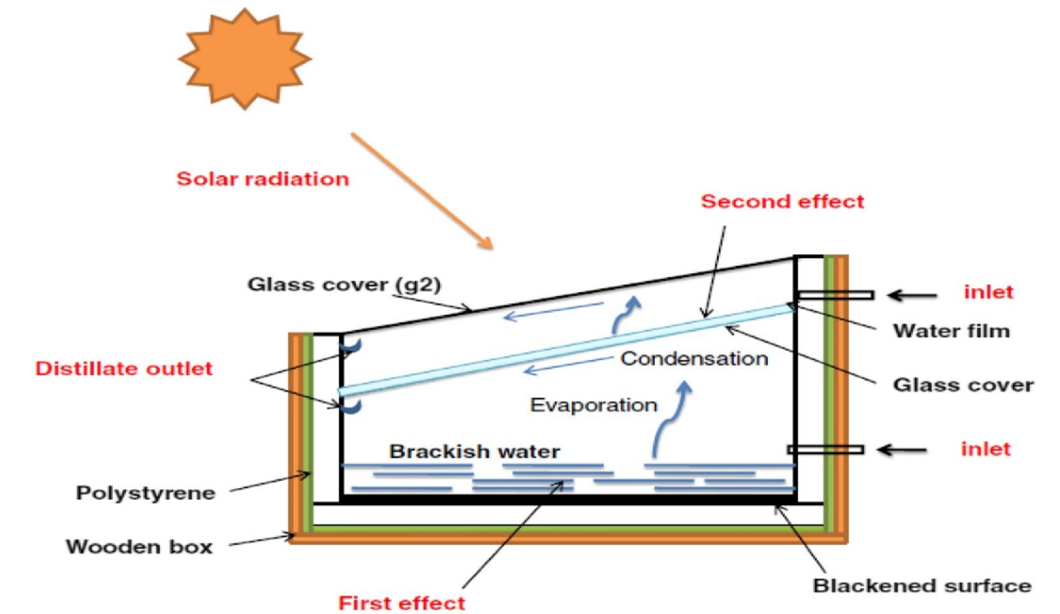
4.4.Battery

The function of the battery is to store electricity in the form of chemical energy and when required to convert it to electrical energy. Electrical energy can be produced from two plates immersed in a chemical solution. Several linked give a higher capacity. Basically, consists of the following parts:

1) Case
2) Terminals
3) Plates
4)Electrol

Fig 10

4.5.Solar disillation unit cum dryer



ouble effect asymmetrical solar still (Adberachid and Abdenacer 2013)

Fig 11

solar distillation systems are suitable for remote, arid, or semiarid regions for small capacities. Simple designs are preferred because they are cost-effective and easier to operate and maintain. Low-cost, locally available materials can be used, taking into consideration safety and lifetime of the installation. Although some solar distillation plants with capacities of 1–40 m^3/day (in Greece, India, the Caribbean islands, and other places) are in operation, the interest currently has turned to solar-driven systems. Solar-driven desalination is suitable for small- to medium-size capacities. As these systems combine, different technologies must be carefully selected and coupled to achieve high efficiencies, simple operation, and easy maintenance. Most plants are pilot plants used to study and improve design, operation, and cost. They do not exceed 0.1% of the capacity of desalination plants driven by conventional energy sources and require further study to improve technologies and lower cost. Table II lists some of the most important solar-driven desalination plants.

Dryer

There are different types of solar dryers, such as direct drying (solar box dryer), indirect drying (solar cabinet dryer), mixed mode drying (solar tunnel dryer) or hybrid drying (hybrid solar/biomass cabinet dryer). Small-scale solar box and cabinet dryers are based on natural air convection, while solar tunnel dryer is based on forced convection (air circulation fan necessary).

Fig 12

CHAPTER 5

5.1 Working

Solar dc cooking

In our present project we are using a battery bank consisting of two 12 v battery with 7.2 ahr output. We have made a dc stove using a ceramic powder and arranging a heating element inside the ceramic construction. We now connect the battery bank to the heating element system with the help of a switch and supply the dc current to the heating element.

The heating element rating depends on the resistivity of the type of heating element we are using.

In here the heating element we are using is an alloy made of nickel and chromium which is called as nichrome wire. the 12v batteries are connected in series which provides us near to 24v output this will help in heating the heating element.

Fig 13

5.2 Solar charging unit using inverter

Here we are using a 12v dc to 230v ac rated at 200w inverter in order to charge a load of upto 150 w by using a 12v battery.

The main objective of inverter in our project is to provide power for basic appliances whose rating is below 200w.

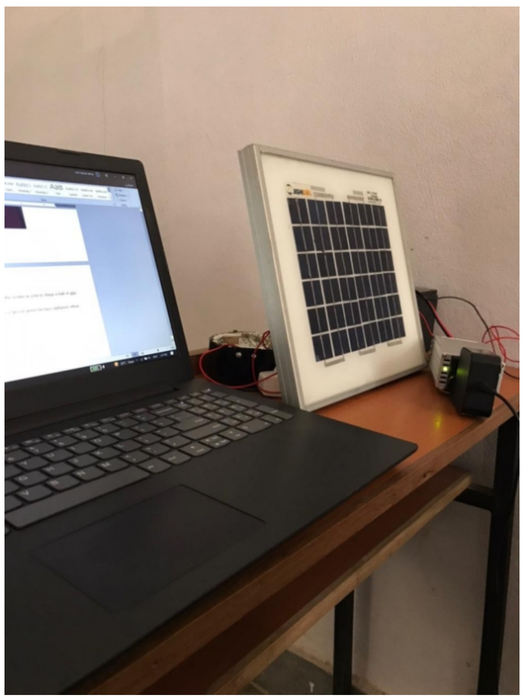


Fig 14

In the above figure we are using inverter to charge a laptop as well we can use other equipments like bulb, tv, dvd, etc.

5.3 Solar dryer cum distillation unit

In here we are using a metal box made up of metal and painted black color in the inner side. here we have made a door opening system on the top of the box and is inclined down side at an angle.

When the temperature is above 30 degree the temperature inside the box increases leading to the vapourisation of the water inside the box.

The water are then collected on the glass in the form of vapour and the flow down the glass and collected in a outlet and collected in the bottle.

As well as the distillation is done and we can use the system as a dryer unit. when there is high sunlight we will be arranging the vegetables by cutting them into pieces. At first the the water capacity in the vegetables is higher than 60 percent. And when the dryer is used the water in the vegetables is decreased to 5 percent.

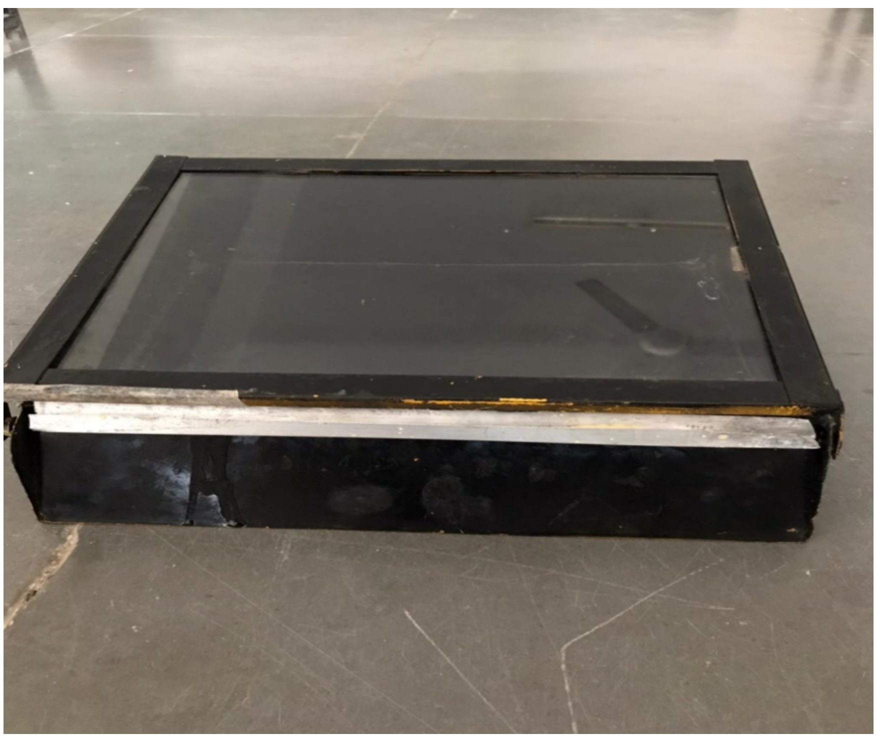


Fig 15

Methodology

The major portion of the work in this is the help of solar power.

The battery bank is charged with the help of a solar panel of its rating and the heating element is heated to a desired temperature.as this is a prototype we will be using a battery bank consisting of two 12 v batteries and heating the heating element to a high temperature.

And the battery bank is connected to a inverter which helps in charging or powering electronic appliances of ratings matching the ratings of the inverter.

And in additional to this we are having solar panels which charge the total battery bank .

Here we are having a solar sitillation cum dryer unit which helps in the distillation and frying of vegetables and water.

CHAPTER-6

6.1 ENVIRONMENTAL ASPECTS

Reduced use of reward for cooking will lead to less deforestation and less emission of carbon dioxide in the atmosphere, responsible in part for global warming. • Normally cooking needs plate/air temperature of the order of 90–100°C, and it is not always possible only with solar energy. Although the food partially uncooked only with solar energy can be cooked with the conventional fuel, this solution may not be practical for many people. The (solar/electric) model with thermostat, can cook the meal always but with the minimum (or none) consumption of conventional fuels. • There are many applications like water pasteurization, water distillation, and dehydrating of agricultural products which need less temperature (even as low as 40°C) and thus this single multipurpose device can be used for more days per year. Earth's atmosphere is caused by a greenhouse effect where carbon dioxide and other gasses emitted from the burning of fossil fuels trap heat in the atmosphere and cause a rise in Earth’s temperatures. The burning of wood, charcoal, or dung releases large amounts of greenhouse gases (GHGs) such as carbon dioxide, which contribute to global warming. The use of solar food makers does not release gases that cause the greenhouse effect.

4.1 Health benefits The indoor air pollution generated largely by inefficient and poorly ventilated stoves burning biomass fuels such as wood, crop residues and dung, or coal is responsible for the global deaths of an estimated 1.6 million people annually according to the World Health Organization (WHO, 2010). The use of solar food makers can reduce the amount of indoor air pollution by 70%, thereby decreasing the risk of disease and death.36

4.2 Social benefits The use of solar food makers can help give women and children more control over their lives. In areas of Uganda, where wood is the primary cooking fuel, it is the traditional duty of women and children to gather wood and cook the food. Often it is these family members who also have the fewest opportunities for education and earning income. Once they have wood and are cooking with it, they often spend a lot of time tending the fire. Considerable savings on firewood and/or charcoal can be made by households using solar food makers and also make substantial monetary savings.

CHAPTER-7

7.1 MERITS AND DEMERITS

Merits

This food maker has low maintenance cost. It doesn't pollute the environment. It helps in Saving fossil fuels. And is a renewable energy source and can be used during night. Saving the Family Budget Depending on the cost of the fuel including transportation cost at the place of use, one can calculate the amount of money saved using solar food processors . Power Generation: Power generation using renewable sources of energy on a large scale is not very feasible due to various reasons, but generation of a small amount of power at every household is a very efficient method of usage of renewable sources of energy and economical when compared to large scale production. The power thus generated can be used to charge a mobile phone, power a radio, etc. Health Aspects Food cooked with little or without water and at low temperature retains most of the nutrients (proteins and vitamins). Studies have also shown children exposed to indoor smoke are affected two or three times more to respiratory infection. The uses of solar food makers (smokeless cooking) will definitely reduce the amount of smoke in the eyes and lungs. Social Aspects: People combining solar food maker with conventional or efficient fuel Stove, especially in rural areas. 1. No attention is needed during cooking as in other devices. 2. No smoke evolution, thus clean. 3. No pollution, thus environment friendly. 4. Vitamins of food are not destroyed; therefore, solar cooked food is with natural taste, aroma and healthier.38 5. No soot accumulation on pots. 6. Available every day, thus renewable. 7. Solar Energy does not contribute to global warming, acid rain or smog. 8. Solar Energy systems are maintenance free and long lasting.

Demerits

1. The biggest disadvantage of using a solar food maker is that it is dependent on sunlight for cooking. As a result, you cannot cook using a solar food maker at night. Besides, rain, low sunlight penetration, cloudy weather, etc. also serve as impediments to cooking on a solar food maker.

2. The solar food maker cannot be used at night and during cloudy weather.

3. It takes more time to cook food. The direction of the solar food maker is to be changed continuously towards the direction of the Sun. Solar energy is not available uniformly all the time and at all places. They don't function in the rainy season; wind can knock them over; they simply won't work for people who are up before dawn or need to cook after dark. When food is left in the sun, it can go bad even faster because the heat can cause foods to enter the temperature danger zone more quickly. Unless you're interested in inviting an angry mob of bacteria into your body, don't leave any of these in the sun for more than an hour—or two if at room temperature. Meat, poultry, and fish are all definitely subject to the two-hour rule—and if we're talking barbecues, be extra cautious

1. Many solar powered food makers are large and bulky to carry.
2. More time is required for the cooking process.
3. Initial cost of an efficient solar cooking system is high.
4. Solar energy concentration is influenced by the presence of clouds or pollution in the air.
5. Food cannot be cooked at night.

CHAPTER-8

8.1 APPLICATIONS

1. Making Jams and Jellies in a Solar Box and Panel style cookers are great due to the fact that solar food makers are great for simmering.
2. Canning fruits and tomatoes in a solar oven (only fruits and highly acidic items like tomatoes can be canned using a solar oven). But you can use a pressure cooker on a large parabolic cooker to pressure it due to the high heat concentration. Of course, you will have to rig your cooker to withstand a large amount of weight.
3. You can also dehydrate food in a solar box style cooker (oven) by ventilating the interior of the oven by leaving the door/lid partially open to prevent excess build-up of heat and to allow for movement of air. Ideally you would have plenty of air movement by natural means, but if not, you can use a slow-moving fan (preferably a solar operated one) to keep the air circulating. I personally prefer to dehydrate food on my own solar drying racks rather than using a solar cooker since it requires constant vigilance of the solar cooker to assure that the heat does not become excessive and it has sufficient ventilation. I prefer using my solar food makers for actual cooking more than dehydrating, but this shows that they can be used for dehydrating. Dehydrating Tomatoes in a Sun Oven.
4. Water Purification and pasteurization is a very common use for solar food makers around much of the world, especially when the water is polluted and needs purification. You can also heat water for bathing, washing clothes and dishes etc. etc. Boiling Water in a Hot Pot. I have a friend who used one of her solar cookers to warm her socks, mittens and other clothing articles in the winter, as well as for drying out wet gloves and socks.
5. Ironing Clothes using the old style hot-irons that were heated on stovetops, or a charcoal iron, with such you can do the same by heating the iron on a Parabolic Cooker which is the only solar cooker that can get hot enough and fast enough. You can pick up charcoal iron online, but most of them are antiques, unless you order a newly manufactured iron from China, Africa or India where they still make and use them.
6. Dying Yarn with natural dyes in a solar cooker.
7. Grain Sterilization can be accomplished in a solar oven to kill weevils and other bugs that may have infested the grain. I had a customer from the Philippines who purchased a solar oven specifically for the purpose of sterilizing the grain he feeds to his pigs.

8.Soil sterilization on a small scale can be accomplished using a solar cooker. Different temperature ranges kill different kinds of pathogens. 140° - 160°: Most weed seeds; all plant pharming bacteria, most plant viruses 157° - 178°: Soil Insects, worms, slugs, mold, and nematode care needs to be taken in order not to overheat the soil and to kill the good components of the soil. Do not exceed 200 F 9-Medical Instrument sterilization. Doctors in third-world countries have used solar ovens and panel style cookers to sterilize their medical instruments, gauze bandages and needles to help reduce and prevent the spread of infections and disease in less-than-ideal fields and normal hospital conditions.

Uses Water Distillation

¬ We use this setup for the distillation of water too with the help of a parabolic cooker along with a distiller setup above the pot receptacle for keeping the water constantly boiling. Solar Smelting

¬ This setup in large scale industries can also achieve high temperatures which are more than 2400 C with the help of a solar concentrator and which can melt iron.

¬ Roasting Coffee and Peanut for commercial purposes:

¬ Usage of the solar food maker can help in efficient use of renewable energy for roasting of consumption items such as coffee beans, peanuts, popcorn

CHAPTER-9

9.1 FUTURE SCOPE

How is the future of solar energy in India?

Climate change is one of the biggest challenges we face today and the Government of India acknowledges the size of the challenge. Moving towards Renewable Energy Sources (RES) such as solar energy is a very important step towards tackling it. We want India to lead in the fight against Climate change and promote the use of Renewable Energy. We want to protect the environment not because someone is telling us to do it but because it is an Article of Faith for every Indian. We want to be a part of this global effort as responsible global citizens, to bring down pollution and address this challenge of climate change

Our aim The Government of India has chalked out a target of 100 GW of solar power plants by 202(40 GW would be from solar roof tops and the balance 60 GW would be from: off the ground,large and medium scale projects.). This is what we aim for the mix of Renewable Energy Sources to look like in 2022: Bar graph

3 Solar parks are an important part of the future plan. The first solar park in the country was established at Charanka solar park in Gujarat. This was closely followed by the Bhadla solar park in Rajasthan. The concept of solar parks has given an impetus for rapid development of solar power projects in the country. More than 34 solar parks in 21 States with an aggregate capacity of 20,000 MW have been approved. Large size projects have a potential to bring down the cost of solar power. Therefore, Ultra Mega Solar power projects having a capacity of 500 MW or above have been planned in India. Large chunks of land are available in some States for solar park development. India is one of the best recipients of solar energy due to its location in the solar belt and has vast solar potential for power generation.

What we have achieved

We have seen the largest ever solar power capacity addition in India of over 5,000 MW in 2016-17. India has reached over 13,000 MW of Solar power capacities as of June 2017 i.e., more than 4 times increase since June 2014. We've surpassed within 6 months of 2017 (4765 MW), the entire solar capacity added in 2016 (4,313 MW). International Solar Alliance (International Solar Alliance). India also jointly launched with France, The International Solar Alliance of sunshine countries (countries which come between Tropic of Cancer and Tropic of Capricorn). The alliance's primary objective is work for efficient exploitation of solar energy to reduce dependence on fossil fuels.44 India is moving towards a sustainable future in terms of energy. But it won't be possible without the support of every citizen. One can make a difference at an individual level, from installing rooftop solar setups to switching off the lights when not in use. Further, here is a list of Indian companies have also started manufacturing solar food makers:

- Solar Energy Systems, Coimbatore
- Shiva Solar Systems, Delhi
- The Bharat Engineering Company, Delhi
- RK Solar Systems, Bangalore
- Aruna Solar Energy Devices, Bangalore
- Cook & Cool, Bhopal
- Classic Solar Devices, Panna
- National Engineering Works, Jabalpur
- Technical Research & Engineering Company, Solapur
- Surya Jyoti Devices India Private Limited, Ropar
- Surya Fibres, Lucknow

CHAPTER 10

EXPERIMENT RESULTS

CHAPTER-11

CONCLUSION

Solar cooking in India has received steady support from the Indian government, non-profit organizations and several international organizations too. This has led to its increased adoption in various cities, communities and villages across India. Community solar food makers are an inexpensive way of cooking hundreds of meals for the whole community. Due to their distinct advantages, Community solar food makers have garnered positive response from most communities of India. Cooking with solar energy remains a fuel-saving technique, which can provide definite help in situations of fuel scarcity. With good sunlight, solar food makers can be used to cook food during emergencies when other fuels and power sources may not be available. This Solar Food Maker can also be used for heating milk, boiling water and making curries. It can also be used even in the absence of power. This innovative product made of high-quality stainless-steel heater boils eggs in just 7 mins, which in effect means that it costs less than 10 paisa for 7 eggs. It boils egg in steam generated by stainless steel heater in 220V/400W Power with 25 ML Water. It is advisable to use drinking water for long life of the heater. Add Water According to the measuring cup, as per the number of eggs you want to cook. The eggs will come out delicious, nutritional and cooked just right. It is easy to peel the shell, and the eggs wont crack. Great Design with Nice Appearance Makes for a Great Gift for Your Family and Friends Salient Features: Food Grade Material, Unbreakable Crystal-Clear Top Cover, New and Improved High-Capacity Design, High Efficiency Stainless Steel Heating Plate, Double Thermal Protection for Safe Application, Easy To Read Operation Indicator Light. Cooking Capacity up to 7 Eggs. Can Be Used as a Food Steamer. Enjoy Different DIY Egg Dishes

CHAPTER 12

REFERENCES

[1]. ars.usda.gov Agriculture Research, May 2002.

[2]. Kate Hilpern (21 September 2018). "9 best multi-cookers". The Independent. Retrieved 10 February 2019. "April 25, 1954: Bell Labs Demonstrates the First Practical Silicon Solar Cell". APS News. American Physical Society. 18 (4). April 2009.

[3]. Christian, M. "The history of the invention of the solar panel summary". Engergymatters.com. Energymatters.com. Retrieved 25 January 2019.

[4]. Adams, William Grylls; Day, R. E. (1 January 1877). "IX. The action of light on selenium". Philosophical Transactions of the Royal Society of London. 167: 313–316. doi:10.1098/rstl.1877.0009. ISSN 0261-0523.

[5]. Meyers, Glenn (31 December 2014). "Photovoltaic Dreaming 1875--1905: First Attempts at Commercializing PV". cleantechnica.com. Sustainable Enterprises Media Inc. Clean Technical. Retrieved 7 September 2018.

[6]. Ohl, Russell (27 May 1941). "Light-sensitive electric device". Google. Retrieved 7 September 2018. The Authoritative Dictionary of IEEE Standards Terms, Seventh Edition, IEEE Press, 2000, ISBN 0-7381-2601-2, page 588.

[7]. "Inverter frequently asked questions". www.powerstream.com. Retrieved 2020-11-13.

[8]. How to Choose an Inverter for an Independent Energy System.

[9]. The importance of total harmonic distortion, retrieved April 19, 2019.

[10]. Jump up to: a b "E project" (PDF). www.wpi.edu. Retrieved 2020-05-19.

[11]. Taylor-Moon, Jonathan (2013). "Alabama Engineering University, Invertors, Prof.Dr.Eng. Jonathan Taylor - Moon | Power Inverter | Photovoltaic System". Scribd. 7 (Convertor and invertor technologies).

[12]. Stefanos Manias, Power Electronics and Motor Drive Systems, Academic Press, 2016, ISBN 0128118148, page 288-289.47

[13]. Stefanos Manias, Power Electronics and Motor Drive Systems, Academic Press, 2016, ISBN 0128118148 page 288.

[14]. Barnes, Malcolm (2003). Practical variable speed drives and power electronics. Oxford: Newnes. p. 97. ISBN 978-0080473918.

[15]. "Inverter Basics and Selecting the Right Model - Northern Arizona Wind & Sun". www.windsun.com. Archived from the original on 2013-03-30. Retrieved 2011-08-16

[16]. Solar cookers—What we are looking for? ISES 2003 conference on solar energy. Goteborg, Sweden, June 14–19, 2003.
[17]. Experimental and theoretical analysis of a simple solar oven in the climate of Costa Rica-I. Sol Wind Technol 1988;5(2):159–70.
[18]. Dinning out on solar cookers—renewable energy 2004, An official publication of the World Renewable Energy Network. (WREN/UNESCO); 2004. p. 101–4.
[19]. Otoniel Fernandez. Experimental study of solar oven cum water heater and solar oven cum drier-II, published in the proceedings, II world conference on solar cookers, use and technology, Universidad Nacional, Herdia, Costa Rica, July 12–15, 1994. p. 273–84.
[20]. Metcalf R. The science of safe water, solar cookers review. Solar cookers international, vol. 8, CA, USA, November 2002