

A Review on Solar Power Generation and Controlling

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ABSTRACT

Solar Power has become prominent source of energy as it provides most of the clean and renewable energy. Moreover, it is cost effective and has become the best option in the field of electricity production as grid-connection or distributed modes. Solar Power generation is now the most sustainable as well as also proved to be the tough competitor for fossil-fuel power generation. The ability to harness sunlight and use that energy to get electricity is achieved through a spread of methods. In order to use the energy from the Sun to get electricity, there must be some method of harnessing the radiation. Since there's no fuel to burn to get electricity like there's in fuel power plants or atomic power plants, different methods are wont to capture or concentrate sunlight.

KEYWORDS: Solar Power, electricity production, concentrate sunlight

I. INTRODUCTION

Solar power is energy from the sun that's converted into thermal or electricity by excitation of the electrons on the solar panels. Solar energy is that the cleanest and most abundant renewable energy source available. Solar technologies can harness this energy for a widespread use, including generating electricity, providing light for domestic, commercial, or industrial use. Solar energy may be a very flexible energy technology: it is often located at or near the purpose of use or as a central-station, utility-scale solar power plant. All those applications depend upon supportive policy frameworks at the local, state, and federal level to make sure consumers and businesses have fair access to clean energy technologies like solar. The need for electric energy has moved closer to the primary needs of some people or groups, as well as in national issues. Various efforts doing by Indonesia in meeting the needs of various energy sources, the improvement of all aspects for each source of energy. Renewable energy sources are one of the energy sources that

currently occupy the first position as an alternative energy. This Paper is organized as (i) Introduction which gives a glimpse of present necessity of Solar Power followed by (ii) Aim of the Study which includes the aim and motto of the study. (iii) Methods of Generating and Controlling Solar Power which flashes out the two basic methods by which solar energy is captured and further modified as per the field of requirement like electricity generation or solar cooking etc. led by advantages and disadvantages of these methods. (iv) Applications of Solar Power, here various fields of applications of solar power are highlighted. (v) Conclusion which shows the final concluded points we can perceive from this paper.

II. THE AIM OF THE PRESENT STUDY

The aim of this research was to generate knowledge about Solar Power and to learn advantages of using natural energy. The objectives of this study are:

- (1) a demonstration of state-of-the-art technologies for the generation of electricity from solar technology.
- (2) the creation of an informative and academic tool for the County citizens and visitors with regard to the advantages of generating energy, including reduced greenhouse emission emissions, reduced reliance on foreign oil, and cost savings.
- (3) an impetus for the County to supply a nexus for future facilities energized with solar energy, demonstrating leadership in sustainable and environmentally friendly practices while at an equivalent time encouraging operational efficiency and long-term operational cost reductions.

III. METHODS FOR GENERATING AND CONTROLLING SOLAR POWER

There are two main methods of generating and controlling Solar Thermal Powerplant and Photovoltaic Cells/Panels.

a) SOLAR THERMAL POWER PLANT:
Thermal systems capture the Sun's heat (infra-red radiation) in some sort of solar dish and use it to mostly to supply predicament or for space heating, but the heat also can generate electricity by heating the working fluid in engine which successively drives a generator.
Thermal Powerplant system consists of two parts: Solar Collectors and Solar Unit (including HTF and generator)

1. Solar Collectors:
A solar dish is just a heat collecting surface which intercepts the Sun's radiated energy and heats up a thermal working fluid. In practical thermal systems it's usually more convenient to focus the Sun's heat on to a little receiver to get a better temperature rise of the working fluid. Such collectors are called concentrators. The units employed by the solar

concentrator community to precise the degree of concentration of the mirror system, almost like the magnification factor of a lens are called 'Suns'. Note that this unit isn't a precisely defined quantity. Typical concentrators are constructed from parabolic mirrors which reflect the Sun's parallel rays on to one spot at the main target of the mirror. Concentrators are of different types:

• Parabolic Dish

A parabolic dish will capture the energy intercepted by the dish and concentrate it on an appropriate heat absorber located at the main target as shown in Fig.1. The amount of energy captured and hence the temperature rise of the absorber are going to be proportional to the world of the dish. Size limitations of the dish limit its application to small systems of from 10kW to 50kW.

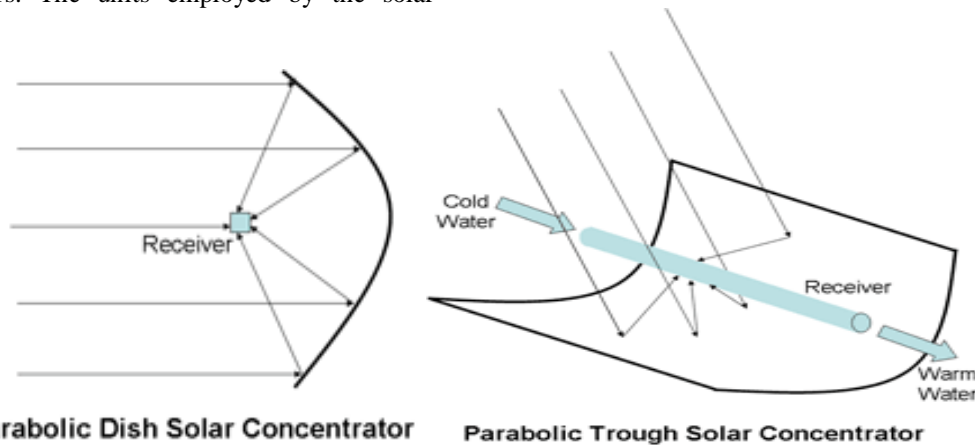


Fig. 1 Parabolic Dish Solar Concentrator

• Parabolic Trough

Larger systems use arrays of parabolic trough shaped mirrors oriented north-south to concentrate the radiation as shown in Fig. 2. They usually also include a tracking system to trace the Sun's path throughout the day.



Fig. 2 Parabolic Trough arrays

The thermal absorber, a tube located at along the focal line of the mirror, contains the working fluid which is heated by the radiation to a heat and used to drive a heat engine.

• **Power Tower**

An alternative concentrator arrangement is the Power Tower as shown in Fig. 3 which uses an outsized array of parabolic mirrors focused on a solar dish mounted on the highest of a tower. Due to long focal distance, the mirrors are almost flat.

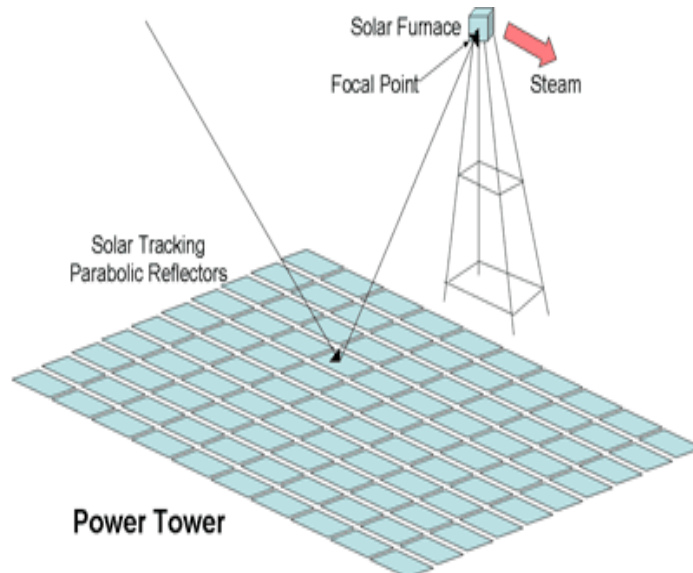


Fig. 3 Power Tower

2. **Solar Unit:**

Solar Thermal generating plants typically use an array of water filled panels or a little array of parabolic trough concentrators to capture the Sun's thermal energy. Very small system like those utilized in space applications may simply use a parabolic dish to capture the energy.

This makes the system very expensive. Grid connected systems also need power conditioners and control systems if surplus energy is to be sold back to the utility company. Efficiencies achieved with small scale systems range from 18% to 23%.

Advantages of Solar Thermal Powerplant:

No Fuel Cost – Solar Thermal Energy doesn't require any fuel like most other sources of renewable energy. This is an enormous advantage over other fossil fuels whose costs are increasing at a drastic rate per annum. Electricity prices are increasingly rapidly in most parts of the planet much faster than general inflation. Price shocks thanks to high fuel costs are an enormous risk with fuel energy lately.

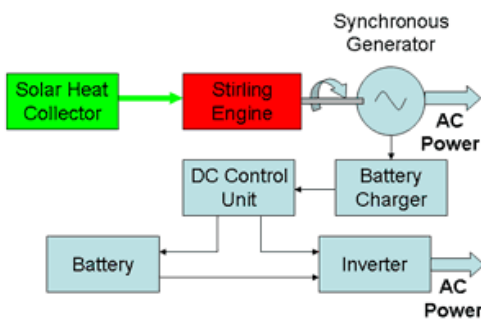


Fig. 4 Block diagram of Solar Unit

The working fluid is then used because the external heat source for powering the Stirling engine which successively drives a rotary generator. A solar electric system must have batteries supported by Balance-of-System (BOS) components including chargers, inverters and controllers to manage the energy flows in order to provide power on demand. The block diagram of the system is shown in Fig.4.

Predictable, 24/7 Power – Solar Thermal Energy can generate power 24 hours each day. This is made possible as solar thermal power plants store the energy within the sort of molten salts etc. Other sorts of Renewable Energy like Solar PV and Wind Energy are intermittent in nature. The electricity supply is far more uniform and reliable.

No Pollution and heating Effects – Solar Thermal Energy doesn't cause pollution which is one among the most important advantages.

Using Existing Industrial Base – Solar Thermal Energy uses equipment like solar thermal

mirrors and turbines which is formed in large scale at low cost by the prevailing Industrial Base and requires no major changes in equipment and materials unlike new technologies like CIGs Panels.

Disadvantages of Solar Thermal Powerplant:

Water Issue – Solar Thermal Plants uses water which is Major Problem in Desert Areas. Using non-water-cooling system raises the cost too much. While using Sea Water has been proposed it remains to be seen if it possible to implement this solution as this is able to imply building Plants very near the Coastline.

Ecological and Cultural Issues – The Usage of Massive Arrays of Mirrors is noted to heavily impact the Desert Wildlife endangering the species. California has already seen a huge fight on this issue with Project Developers curtailing the dimensions of their Plants and pocket money to maneuver the wildlife.

Limited Locations and Size Limitations – Solar Thermal Energy can only be inbuilt places which have the high amount of radiation. They can be inbuilt deserts mostly and need an outsized acreage. This means it's impossible to create them in populated areas. Solar Thermal Energy can also only be inbuilt large sizes which are a minimum of 50 MW in size to be economical.

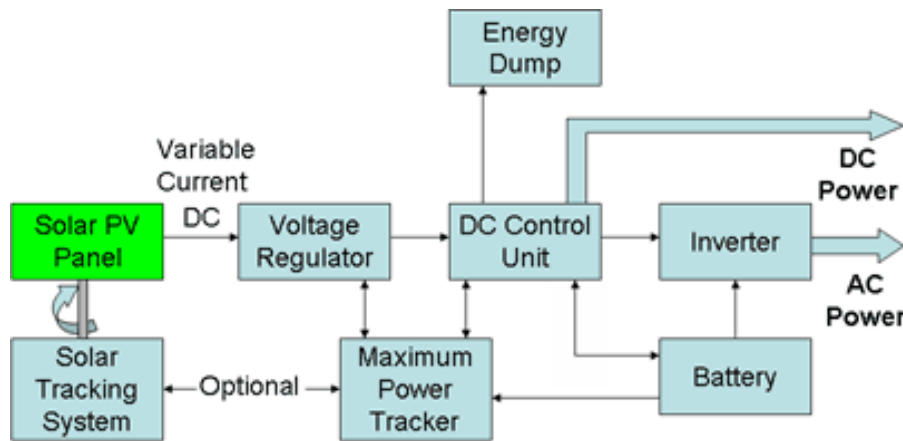
Financing – is the biggest problem in developing projects particularly for little solar thermal developers during this industry.

b) PHOTOVOLTAIC SYSTEMS

Photovoltaic systems capture the sun's higher frequency radiation (visible and ultraviolet) in an array of semiconductor, photovoltaic cells which convert the energy directly into electricity. The actual solar power reaching a solar dish or array depends on its position on the world, its orientation and it also varies continuously with time also as weather. The amount of energy captured is directly proportional to the world of the Sun's energy front intercepted by the collector. Solar cells are usually sold in modules built up from variety of cells arranged serial and / or parallel to supply convenient or commonly used voltages and power ratings. Modules are often similarly interconnected to make larger arrays with the specified peak DC voltage and current. As with thermal collectors, concentration of the incident energy on to a smaller surface is feasible. For very small applications, optical mirrors and lenses are used.

Working:

When a photon with sufficient energy impinges upon a semiconductor it can transfer enough energy to an electron to free it from the bonds of the semiconductor's valence band so that it's liberal to move and thus carry an electrical current. The junction during a diode provides the required field to cause the present to flow in an external circuit. Fig.5 shows the essential building blocks of a little stand-alone off-grid PV power generating system. A grid connected system wouldn't need the battery and MPPT power tracking system. They do however need alternative capacity to return on stream to hold the load during the hours of darkness.



Photovoltaic Electric Power Generation

Fig. 5 Stand-alone off-grid PV power generating system

IV. TYPES OF SOLAR PHOTOVOLTAIC CELLS/PANELS

Several sorts of solar cells are developed with the aims of reducing costs and improving efficiencies.

a) Crystalline Silicon Solar Cells

Benefiting from the manufacturing experience of the semiconductor industry, crystalline silicon is that the leading photovoltaic cell material, though still relatively expensive. Monocrystalline cells are from crystals of high purity electronics grade silicon. These cells are about 25 percent efficient at the best. Using the easier to manufacture polycrystalline silicon cut from from a block of crystals or less pure, so called "solar grade" silicon, efficiencies may be only about 15% or 16% because of grain boundaries or impurities but they cost a fraction of single crystal electronics grade cells.

b) Amorphous Silicon Solar Cells

Amorphous Silicon has been employed for several years within the manufacture the solar cells used for powering electronic calculators and watches and promises the likelihood of low cost, higher power cells. Amorphous material seems like a solid but has no regular space lattice structure. such as glass. The presence of controlled quantities of certain "impurity" elements like hydrogen and therefore the random space lattice formation enhance the otherwise very low conversion efficiency. Typical cell efficiencies range from 5% to 10%. Manufacturing yield remains a drag and therefore the cells suffer from degradation when exposed to the sun.

c) Thin Film Silicon Solar Cells

Thin film cells are made by depositing the active photovoltaic material, like amorphous silicon or other semiconductor onto a glass or other substrate alongside the required current collecting contacts. The cell construction is far less expensive than using semiconductor wafers and therefore the manufacturing process is additionally simpler also as being suitable for creating cells with a way larger area and hence current carrying capability. Efficiencies of 11% to 14% have been achieved with this construction. PV systems on flexible polymer substrates have also been made using Copper Indium Gallium Selenide (CIGS) active material with efficiency of 10%.

d) Organic PV Solar Cells

Intensive research is being administered by various teams on the utilization of organic semiconductors within the construction of PV cells. Devices are often fabricated by means of a printing from single- or double-layer organic polymer films sandwiched between a pair of electrodes. Manufacturing doesn't involve the high energy consumption related to crystalline semiconductors and brings the likelihood

of high volume and low-cost products printed onto flexible films. Currently, conversion efficiencies are rather low at around 12% but this is expected to improve.

e) Multi-Layer (Tandem) Solar Cells

Better conversion efficiencies are possible by using multiple layers of differing semiconductor materials, optimized for various wavelengths, during a single device. This can raise the theoretical efficiency limit, currently about 30% for a single junction device, to about 45% for a three-junction cell. Efficiencies of over 33% have already been achieved in practical devices.

f) Exotic Materials

Materials like Gallium Arsenide, Copper Indium Di selenide, Cadmium Telluride and Indium Nitride are employed to supply characteristics to optimize solar cells for specific applications. Gallium Arsenide is used for military and aerospace applications in a variety of cells because of its suitability for capturing high energy photons (ultraviolet radiation), high potential conversion efficiency and its ability to face up to high temperatures. It is however harder to manufacture and cells using Gallium Arsenide which are often 100 times costlier than commercial silicon-based cells. Copper Indium Di selenide and Cadmium Telluride are utilized in polycrystalline form in low-cost thin film cells due to their simple manufacture and reasonable yields. Efficiencies are however low starting from 8% to 14% Indium Nitride is suitable for capturing low energy photons (infra-red radiation).

Advantages of Photovoltaic cells/panels:

- a) It is very easy to operate power sources of renewable type.
- b) It does not produce any noise as it does not have any moving parts.
- c) It does not generate emissions or radiations.
- d) Solar cells have longer life, about 30 years.

Disadvantages of Photovoltaic cells/panels:

- a) It cannot be used in absence of the light from any source.
- b) It incurs very high initial cost for installation.
- c) During cloudy weather, less power is being generated.
- d) Off grid applications require energy storage.
- e) Very large geographical area is needed to deploy solar panels or cells.

V. APPLICATIONS OF SOLAR POWER

1. Solar Water Heating:

A solar water heating unit comprises a blackened flat plate metal collector with a metal tubing facing the overall direction of the sun. The plate collector

features a transparent glass cover above and a layer of thermal insulation beneath it. The metal tubing of the collector is connected by a pipe to an insulated tank that stores predicament during cloudy days. The collector absorbs solar radiations and transfers the warmth to the water circulating through the tubing either by gravity or by a pump.

This predicament is supplied to the tank via the associated metal tubing. This system of water heating is usually utilized in hotels, guest houses, tourist bungalows, hospitals, canteens also as domestic and industrial units.

2. Solar Heating of Buildings:

Solar energies are often used for space heating of buildings in some ways namely:

(a) Collecting the radiation by some element of the building itself.

(b) Using separate solar collectors or storage devices which can accumulate the collected solar power to be used in the dark and through inclement days.

When the building requires heat then from these collectors or storage devices, the warmth is transferred by conventional equipment like fan, ducts, air outlets, radiators, and hot air registers etc. to warm up the spaces of a building.

When the building doesn't require heat, the warm air or water from the collector are often moved to the heat memory device like well insulated cistern or other heat holding material. For inclement days, an auxiliary heating plant using gas, oil or electricity is required as a backup system.

3. Solar-distillation:

In arid semi and or coastal areas there's scarcity of potable water. The abundant sunlight in these areas is often used for converting saline water into potable water by the tactic of solar distillation. In this method, radiation is admitted through a transparent airtight glass cover into a shallow blackened basin containing saline water. Solar radiation passes through the covers and is absorbed and converted into heat within the blackened surface causing the water to evaporate from the brine (impure saline water). The vapors produced get condensed to make purified water within the cool interior of the roof. The condensed water flows down the roof and is collected in the troughs placed at the bottom and from there into a water storage tank to supply potable distilled water in areas of scarcity, in colleges, and many more. Per liter water cost obtained by this technique is cheaper than water obtained by other electrical energy-based processes.

4. Solar pumping:

In solar pumping, the facility generated by solar energy is employed for pumping water for irrigation purposes. The requirement for water pumping is greatest within the hot summer months which

coincide with the increased solar radiations during this era then this method is most appropriate for irrigation purpose. During periods of inclement weather when solar radiations are low then the need for water pumping is additionally relatively less because the transpiration losses from the crops also are low.

5. Solar Furnaces:

In a solar dish, heat is obtained by concentrating the solar radiations onto a specimen employing several heliostats (turn-able mirrors) arranged on a sloping surface. The solar dish is used for studying the properties of ceramics at extremely high temperatures above the range measurable in laboratories with flames and electric currents.

Heating is often accomplished with no contamination and temperature are often easily controlled by changing the position of the fabric focused. This is especially useful for metallurgical and chemical operations. An important future application of solar furnaces is that the production of fertilizers from air.

6. Solar Cooking:

A variety of fuel like coal, cooking gas, and many more are used for cooking purposes. This necessitated the utilization of solar power for cooking purposes and therefore the development of solar cookers. A simple solar cooker is that the flat plate box type solar cooker. It consists of a well-insulated metal or wooden box which is blackened from the inner side. The re-radiation from the blackened interior to outside the box through the 2 glass covers is minimized, thereby minimizing the heat loss. The heat loss thanks to convection is minimized by making the box airtight. This is achieved by providing a rubber strip between the upper lid and therefore the box for minimizing the warmth loss thanks to conduction, the space between the blackened tray and outer cover of the box is crammed with an insulating material like insulator, saw-dust, paddy husk etc. When placed in sunlight, the solar rays penetrate the glass covers and are absorbed by the blackened surface thereby leading to a rise in temperature inside the box. Cooking pots blackened from outside are placed within the solar box. The uncooked food gets cooked with the warm energy produced due to increased temperature of the solar box. Collector area of such a solar cooker is often increased by providing a plane reflector mirror. When this reflector is adjusted to reflect the sun rays into the box, then temperature rises from 15°C to 25°C inside the cooker box.

7. Solar Electric Power Generation:

Electric energy or electricity are often produced directly from solar power by means of photovoltaic

cells. The solar cell is an energy conversion device which is employed to convert photons of sunlight directly into electricity. It is made from semiconductors which absorb the photons received from the sun, creating free electrons with high energies. These high energy free electrons are induced by an electrical field, to effuse of the semiconductor to try to to useful work. This field in photovoltaic cells is typically provided by a contact of materials which have different electrical properties. There are different fabrication techniques to enable these cells to realize maximum efficiency. These cells are arranged in parallel or series combination to make cell modules. Some of the special features of those modules are high reliability, no expenditure on fuel, minimum cost of maintenance, long life, portability, modularity, pollution free working etc. Photovoltaic cells are wont to operate irrigation pumps, railroad crossing warnings, navigational signals, highway emergency call systems, automatic meteorological stations etc. in areas where it's difficult to get power lines.

VI. CONCLUSION

Solar power is an immense source of directly useable energy and ultimately creates other energy resources: biomass, wind, hydropower, and wave energy. Most of the surface receives sufficient solar power to allow low-grade heating of water and buildings, although there are large variations with latitude and season. At low latitudes, simple mirror devices can concentrate solar power sufficiently for cooking and even for driving steam turbines.

The energy of sunshine shifts electrons in some semiconducting materials. This photovoltaic effect is capable of large-scale electricity generation. However, this low efficiency of solar PV cells demands very large areas to provide electricity demands.

Direct use of solar power is that the only renewable means capable of ultimately supplanting current global energy supply. According to scientists, sunlight energy may be a complete solution of present energy crisis because the quantity of solar power incident on Earth in 1 hour is like the total amount of energy consumed by humans annually. Moreover, solar power is extremely environment friendly because it can reduce 40 million plenty of CO₂ emissions annually with the inception of solar grids that meet just one of electric energy demand around world. Currently, solar cells, solar power plants and solar collectors are some of the practical applications of harvesting solar energy to fulfil clean energy demand of world

For solar power to be considered as major renewable energy contributor, the devices utilized in

its generation must be improved in terms of their performance because the revolutionary developments in this field are possible if conversion, storage and utilization are done effectively. In coming years, it's expected that devices for solar power harvest would be radically simpler and efficient than today and therefore the dream of solar economy would become a reality.

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