Review Paper on Solar Energy and Its Applications

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Abstract— The sun, which is the largest member of solar system, radiates solar energy which is a clean, inexhaustible and universally available renewable energy source. The energy transmitted by sun in each hour can meet the energy demand for the whole year. Nowadays, energy needs is increasing day by day. The application of solar energy is everywhere like in industrial, residencial and commercial purposes. This energy can be easily available and convertible nowadays. So it is very efficient and environmental friendly. In this article, we have reviewed about the Solar Energy from Sunlight and discussed about their future trends and aspects. This article also tried to discuss the working, types of solar panel; emphasize the various applications and methods to promote the benefits of solar energy.

Keywords: Renewable energy, Solar panel, Photovoltaic cell, Modelling of PV Panel, Characteristics of PV cells, Heliostat

I. Introduction

Solar energy is a type of renewable energy which comes directly from the sun. This energy drives the climate and weather and supports virtually all life on Earth.

Solar Energy technologies harness the sun's energy for practical ends. These technologies date from the time of the early Greeks, Native Americans and Chinese, who warmed their buildings by orienting them towards the sun. Modern solar technologies provide heating, lightning, electricity and even flight.

Solar power is used synonymously with solar energy or more specifically to refer to the conversion of sunlight into electricity. This can be done either through the photovoltaic effect or by heating a transfer fluid to produce steam to run a generator.

Sun emits solar energy of 3.86 x 10^{26} watts. But only about 1.74 x 10^{17} watts strikes the earth.

II. Solar Energy

Amount of energy in the form of heat and radiations called solar energy. It is radiant light and heat from sun that is natural source of energy using a range of ever changing and developing of technology such as solar thermal energy, solar architecture, solar heating, molten salt power plant and artificial photosynthesis. The large magnitude of solar power available makes highly appealing source of electricity. 30% (approx.) solar radiation is back to space while the rest is absorbed by ocean, clouds and land masses.[1]

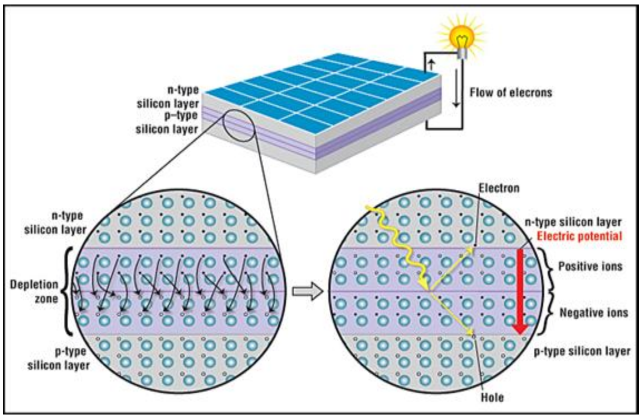

Fig. 1: Internal of Reaction of Solar energy

III. Working of Solar Cell

Solar PV system convert solar energy directly into electrical energy. Basic conversion device is known as a photovoltaic cell or a solar cell. PV cells Convert Sunlight to Direct Current (DC) electricity. Charge Controller work as control the power from solar panel, which reverse, back to solar panel get cause of panel damage. Battery System act as storage of electric power is used when sunlight not available (i.e. night).From this system connected to inverter for convert Direct Current (DC) into Alternating Current (AC).[3]

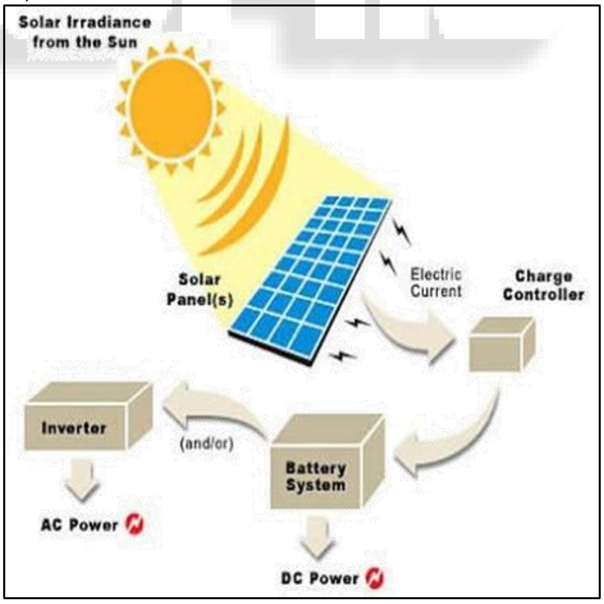

Fig. 2: Working Of Solar Cell

IV. Modelling of PV Panel

A. Solar Cell (PV Cell)

The basic cell structure of a typical N-on-P, bulk silicon cell. The bulk material is P-type silicon with thickness 100 to 350 microns, depending on the technology used. A thin layer of N-type silicon is formed at the top surface by diffusing an impurity from Vth group to get a PN junction. The top active surface of the N layer has an ohmic contact with metallic grid structure to collect the current produced by impinging photons. The grid covers minimum possible top surface area to leave enough uncovered surface area for incoming photos. Similarly, the bottom inactive surface has an ohmic metallic contact over the entire area. These two metallic contacts on P and N layers respectively form the positive and negative terminal of the solar cell.[3]

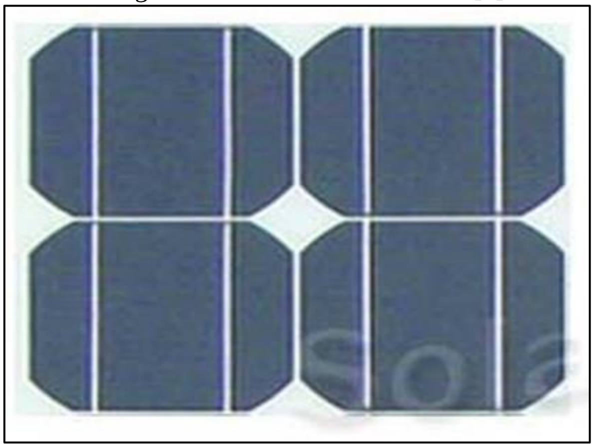

Fig. 3: Photovoltaic Cell (4 cell)

B. *Photovoltaic Module*

A PV module consists of solar cell circuits sealed in an environmentally protective laminate and are the fundament building blocks of PV system. Generally sizes from 60W to 170W. Usually a number of PV modules are arranged in series and parallel to meet the energy requirement.[1]

Fig. 4: Photovoltaic Module (Multiple cell)

C. *Photovoltaic Panel*

It includes one or more PV modules assembled as a pre-wind, field instable unit. In this panel PV cell is series connections. Solar panels are made up of individual PV cells connected together. [1]

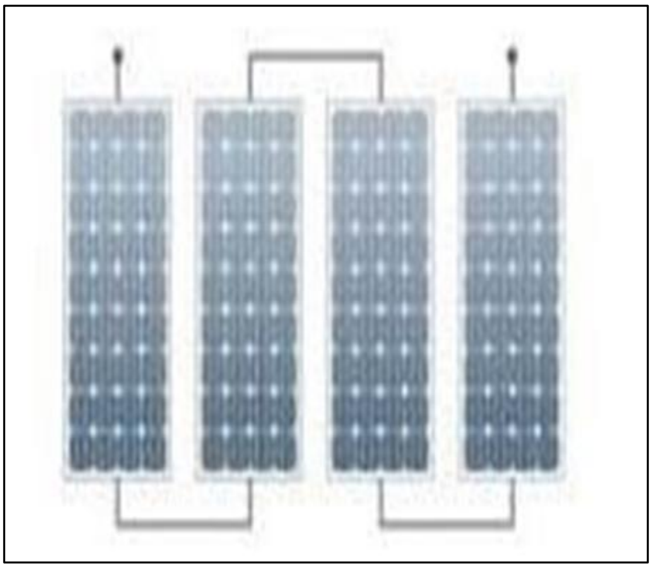

Fig. 5: Photovoltaic Panel

D. *Photovoltaic Array*

It is contain of several amount of PV cells in series and parallel connections. Series connections are responsible for increasing the voltage of the module whereas the parallel connection is responsible for increasing the current in the array. It generates maximum 180W in full sunshine. Large the total surface area of the area of the array, more solar electricity it will produce.[3]

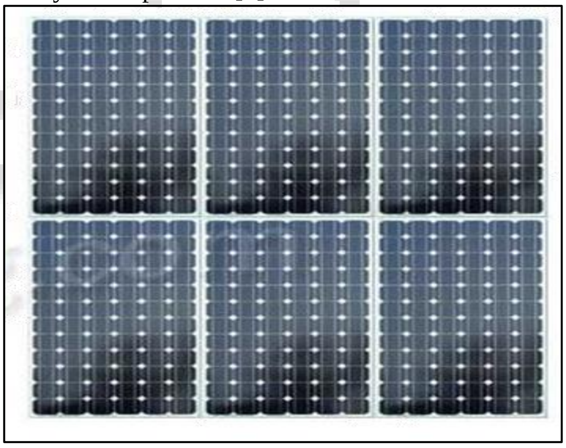

Fig. 6: Photovoltaic Arrays (Multiple Modules)

V. SOLAR COLLECTOR

Solar power has low density per unit area (1 kw/sq.m. to 0.1 kw/sq. m.). Hence, it is to be collected by convering large ground area by solar thermal collectors. Solar thermal collector absorbs solar energy as heat and then transfers it ot heat transport fluid efficiently. The heat transport fluid delivers this heat to thermal storage tank / boiler / heat exchanger, etc., to be utilized in the subsequent stages of the system. [3]

A. *Flat Plate Collector*

The flat plate solar collector is a type of solar thermal panel whose objective is to transform solar radiation into thermal energy. It consists of a flat absorber plate. Flat plate collector have concentration ratio as 1. This type of solar collector has a good cost / effectiveness ratio in moderate climates and adapts correctly to a large number of applications of solar thermal energy (heating of sanitary water, heating of swimming pools, support for heating, preheating industrial fluids , etc.[4]

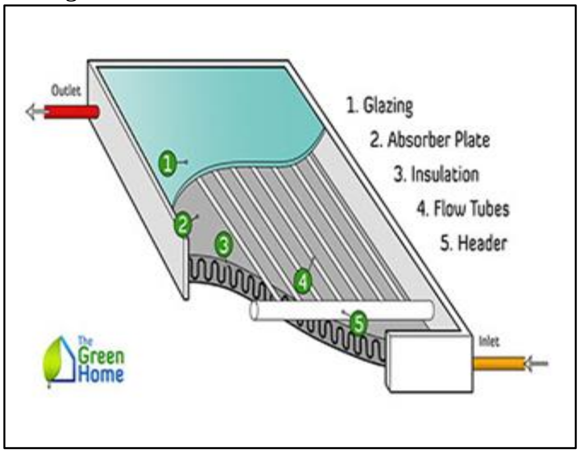

Fig. 7: Flat Plate Collector

B. *Parabolic Trough Collector*

This collector consists of a parabolic trough reflector and a metal tube receiver at its focal line. The receiver tube is blackened at the outside surface to increase absorption. It is rotated about one axis to track the sun. The heat transfer fluid flows through the receiver tube, carrying the thermal energy to the next stage of the system. The concentration ratio in the range of 5-30 may be achieved from these collectors.[3]

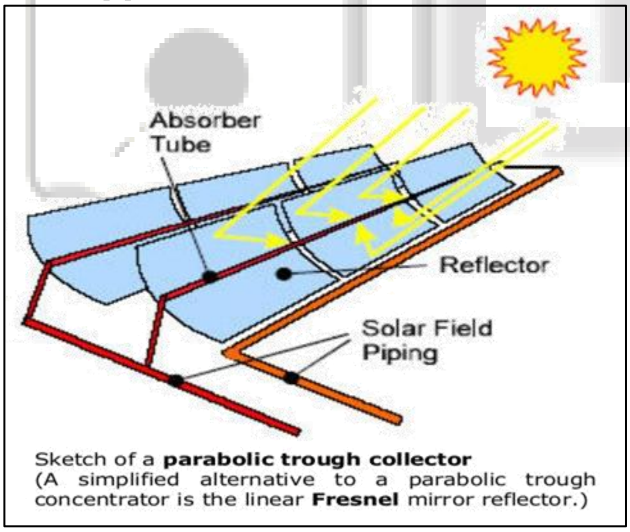

Fig. 8: Parabolic Trough Collector

C. *Compound Parabolic Collector*

Compound parabolic concentrator consists of two parabolic mirror segments, attached to a flat receiver. The segments are oriented such that focus of one is located at the bottom end point of the other in contact with receiver. It has a large acceptance angle and needs to be adjusted intermittently. The concentration ratio of this collector is in the range of 3-7. [3]

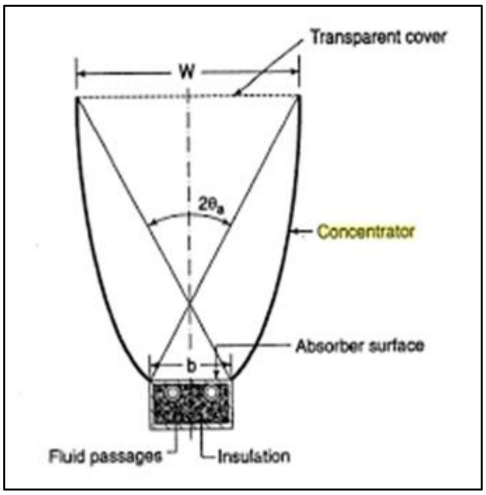

Fig. 9: Compound Parabolic Collector

D. *Linear Fresnel Lens Collector*

In this collector a Fresnel lens, which consists of fine, linear grooves on the surface of refracting material on one side and flat on the other side, is used. The angle of each groove is designed to make the optical behavior similar to a spherical lens. The beam radiation, which is incident normally, converges on focal line, where a receiver tube is provided to absorb the radiation. A concentration ratio of 10 to 30 may be realized which yields temperature between 150°C and 300°C. [3]

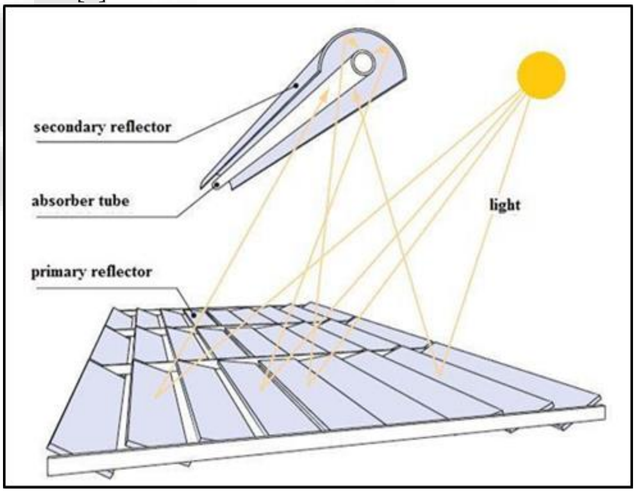

Fig. 9: Linear Fresnel lens Collector

E. *Central Tower Receiver (Heliostat)*

In central tower receiver collector, the receiver is located at the top of a tower. Beam radiation is reflected on it from a large number of independently controlled; almost flat mirrors, known as heliostats, spread over a large area on the ground, surrounding the tower. Thousands of such heliostats track the sun to direct the beam radiation on the receiver from all sides. Concentration ratio of as high value as 3000 can be obtained.[3]

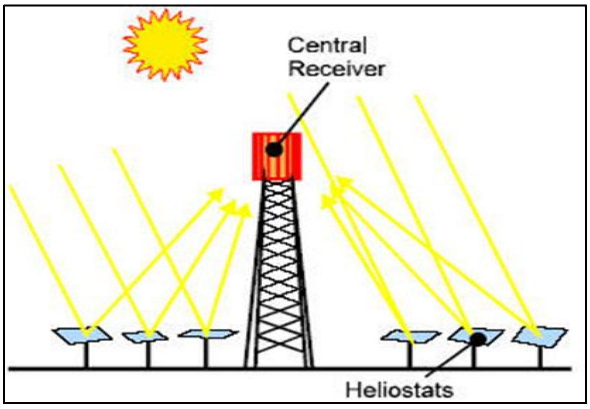

Fig. 10: Central Tower Receiver

F. Scheffler Solar Concentrator

When a parabola is rotated about its optical axis a paraboloidal shape is produced. Beam radiation is focused at a point in the paraboloid. This requires two axis tracking. It can have concentration ratio ranging from 10 to few thousands and can yield temperature up to 3000°C. [3]

Fig. 11: Scheffler Solar Concentrator

VI. MERITS OF SOLAR ENERGY

- It is save up to 20% of energy costs.
- It can use in Remote Locations.
- Easy Installation (i.e. does not required any wires, cords etc.).
- Rooftop which means no new space is needed & every domestic or commercials user can generate their own electricity.
- It is widely available of sunlight with free of cost, eco-friendly, renewable resource.
- It has no moving parts and not required any additional fuel, other than sunlight, to produce power.
- No need of water and fuel.

VII. DEMERITS OF SOLAR ENERGY

- No generation of energy, when the sun is not shining.
- Initial cost is high.
- More area needed for large amount power.
- For alternating Current (AC) application required of inverter and also storage at night.
- Production PV systems single silicon crystals is technically challenging, energy, time consuming.

VIII. APPLICATIONS OF SOLAR ENERGY

It is used in many applications including

- electricity,
- evaporation,
- heating water,
- heating ,
- cooling of buildings,
- cooking of food,
- water pumping etc.

IX. FUTURE ASPECTS

1) Costs will continue to drop, likely to a little more than the current price of wind energy (which will drop itself). This will bring solar into grid parity with new coal, new nuclear and new hydro projects if all market distortions for all forms of energy were stripped off.
2) Most jurisdictions that have low penetration of solar will have some market mechanism that supports greater rollout of solar to enable the technology to overcome startup timeframes and to overcome market distortions favouring fossil fuel and other 'traditional' energy sources.
3) Solar will continue to be a very effective source of stable energy at peak times for cooling demand. This makes it advantageous at its current price point regardless.
4) Solar will continue to use virtually no water during operation. This is a major advantage over thermal plants which require hundreds of times the water, and require it to be at reasonably low temperatures to allow heat transfer. Thermal plant demand for water is challenged at present by global warming-enhanced drought in many areas, and increases in surface water and shallow sea water temperatures preventing use of the water as a cooling agent. Many major thermal coal and nuclear plants are being shut-down or put on reduced cycles world-wide due to this concern. Wind energy, of course, shares this advantage. This is also advantageous for the strategic hydroelectric generation units with their multi-use water asset; it allows the asset to be better prioritized.
5) Solar will continue to have very low full-lifecycle CO2e emissions, comparable with wind energy at around 8 grams per KWh. Nuclear is slightly higher at 11 grams per KWh, natural gas is 50 times higher and coal is 100 times higher. This is a valid reason why governments concerned with negative externalities of fossil fuel generation will fund market distortions favouring solar and wind.
6) Solar will continue to be a very safe technology. During major solar spills, people have to apply more SPF. During major oil spills, there is the potential for species extinction and extensive habitat destruction. During nuclear failures, there is the potential for large areas of land to remain uninhabitable and unusable by humans for generations (note that deaths per TWh for nuclear are currently around the same as for solar and wind however, so despite fears, the nuclear industry has maintained a very good safety

record.) By comparison, normal use of coal will continue to kill thousands or tens of thousands world-wide. It will continue to cause asthma in millions world-wide. It will continue to cause emphysema and other cardiovascular challenges in millions world-wide. Wind energy shares this massive safety value, of course.

This is yet another reason why governments will provide market distortions favouring solar and wind.

7) Solar will continue to be environmentally benign, causing very little to no damage to ecosystems and wildlife where it is installed. Wind shares this advantage. Coal, of course, will continue to require the destruction of mountain tops and significant environmental and wildlife issues in normal use. Obviously, this is another reason for rational governments to support market distortions favouring solar and wind energy.
8) Finally, should the price of silicon rise, there are significant technologies on the shelf to maintain the cost of solar energy. As an example, Solyndra's intellectual capital is preserved and available for licensing. While Solyndra bet on silicon prices increasing and lost, this is likely a matter of timing, not a failure of insight into the long term price of raw materials. Of course, Solyndra is only one of the technologies that have been developed for effective and efficient solar capture.

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