

Transparent Solar Cells and Solar Thermal Hybrid Power Plant

E. Sandeep

Abstract— In this paper I present the concept of maximizing the use of solar radiations by combining the technology of using a thin film photovoltaic module with transparent electrodes as solar cells and concentrated solar power (CSP) system. This can be done by building a transparent solar cell and solar thermal hybrid power plant. We also discuss about the advantages and disadvantages of transparent solar cell and solar thermal hybrid power plant.

Keywords- *Transparent solar cells, Solar thermal energy, Beamdown tower, Albedo, heliostat.*

I. Introduction

Earth has abundant source of solar radiations. But most of the solar radiation is not being used. In this transparent solar cells and solar thermal hybrid power plant we can use both solar cells and solar thermal energy. This increases the usage of solar radiations. The transparent solar cells will use the solar radiations for photovoltaic purpose (generation of electricity) and then the radiations are left out. These solar radiations which are left out buy the transparent solar cells can be reflected to the CSP system using heliostat mirrors. That reflected radiations can be used to produce electricity by the solar thermal power plant. Therefore we can get electricity from both solar cells and CSP system.

II. Transparent Solar Cells

Photovoltaic cells of the prior art have typically been opaque, extending from a first, light-incident surface having a transparent conductive electrode to a second, back surface covered by a metallic electrode film. Metallic back electrodes have been favored because they are both conductive and reflective, enhancing collection efficiency of the device and reflecting unused light back through the semi conductive layer for use in generating electricity. Thin film photovoltaic module is used because it absorbs less radiation. Replacing the conventional solar cells with this transparent solar cell has many advantages. In this hybrid power plant transparent solar cells will be more efficient than the conventional solar cells.

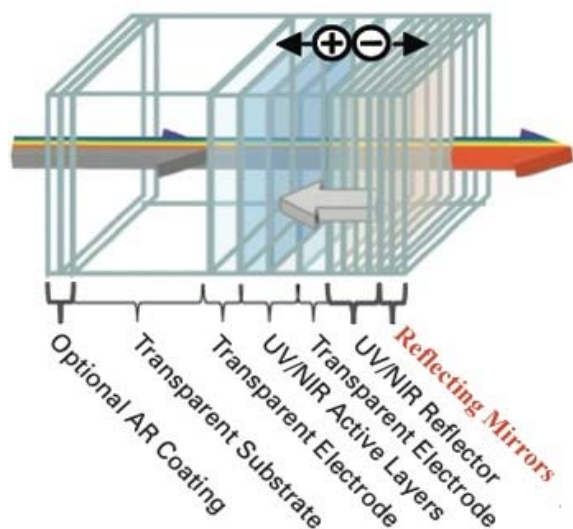


Fig 1. Transparent solar cells.

A. Albedo:

The average reflection coefficient of a surface is called albedo. Albedo of earth is between 0.30 to 0.35. That means earth reflects 30% to 35% of the solar radiations which falls on the earth's surface.

B. How much radiations do Solar cells and Transparent solar cells absorb?

Photovoltaic panels range from blue to black but they are smooth and have an albedo around 0.30. But the transparent solar cells do not absorb much of the radiations. So the radiations which come out of the transparent solar cells can be used for generating electricity by concentrated solar power technology.

Absorption of light in a solar cell is governed by the optical properties of the semiconductor materials used to form the active layers of the cell. Optical absorption in the active layers imposes constraints on the minimum thickness of the semiconductor materials used to form the cell. These transparent thin film solar cells have very low thickness. So the amount of radiations absorbed will be less.

III. Solar Thermal

In this technology the sun's radiation is used to vaporize the water and the steam is used to generate electricity by running turbines. In this hybrid power plant the solar radiations reflected from the solar cells are used to vaporize the water. So that the reflected radiations from the solar cells are not wasted and they are used to generate electricity again.

A. Beam down tower

In all the solar thermal towers the receiver will be kept on the top of the tower because of which there is some loss. But in beam down tower the receiver will be kept in the ground level and heliostat mirrors will be kept on the central tower. This will decrease the energy loss.

Unlike other plants, The beam down tower reflects sunlight twice, once from the heliostats to the central tower and once from the tower down to a collection platform at the system's base. The working of the beam down tower is given below.

1) Concentrate the Sun:

Heliostats mirrors arranged in the shape of a parabola circle. Motors adjust the elevation and angle of the heliostats throughout the day to track the sun and direct the reflected light toward the underside of the tower.

2) Beam It down:

An array of mirrors made to reflect as much solar radiation as possible, also arranged in concentric circles and lines the underside of the central tower. Each ring corresponds to a specific ring of heliostats. When the reflected sun from the heliostats reaches the tower array, the mirrors redirect the light down toward the base of the tower

3) Generate power:

A ceramic receiver at the base of the tower absorbs the radiation. The radiation heats a tank filled with molten salt, air, or water. The medium then heats water to produce steam and drive a turbine.

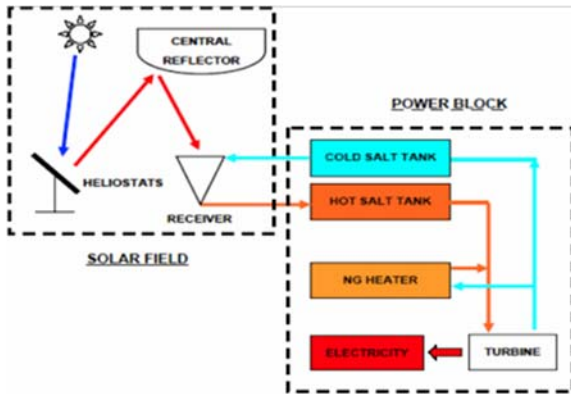


Fig 2. Beam down tower energy flow diagram

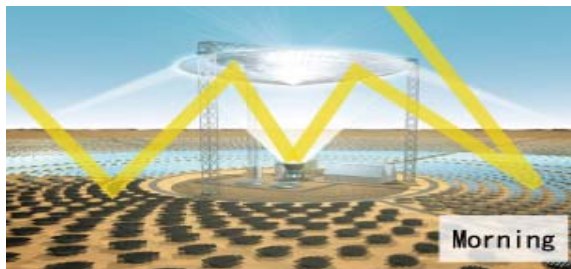


Fig 3. Morning

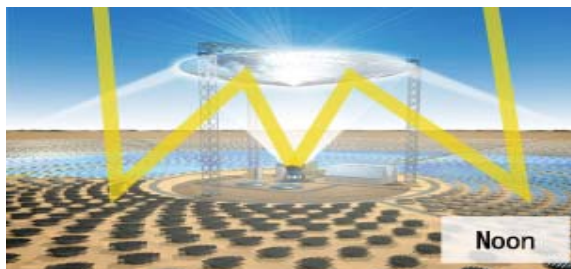


Fig 4. Noon

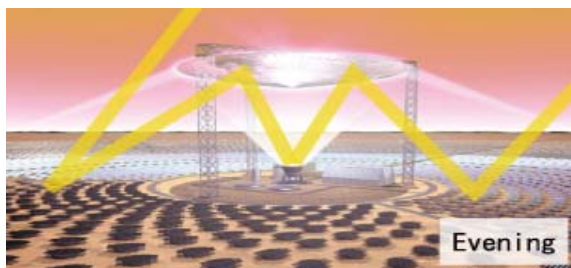


Fig 5. Evening

IV. Hybrid Power Plant

The transparent solar cell and solar thermal hybrid power plant uses the solar energy almost completely. The solar radiations which pass through the transparent photovoltaic cells generate electricity by photovoltaic effect. Then the radiations which come out unabsorbed will be directed to the beam down tower of the CSP system using the heliostat mirrors which are placed below the transparent solar cells. This is then redirected to the ground receiver. Where the radiations are concentrated to a small area. Thus it generates more heat than the normal concentrated solar power systems. Transparent photovoltaic cells have thin transparent electrodes and photovoltaic material.

A conventional solar panel having 14% efficiency will generate 1KWh of energy when 7KWh of energy is incident on the panel. The rest of the energy is being wasted. By implementing the hybrid power plant sun's energy can be efficiently used.

V. Components

Major components which are used in the transparent solar cell and solar thermal hybrid power plant are transparent photovoltaic cells, heliostat mirrors, beam down tower and ground receiver.

A. Transparent photovoltaic cells

Transparent photovoltaic cells have thin transparent electrodes and photovoltaic material. In this hybrid power plant the transparent solar cells should not have UV reflectors. Instead heliostat mirrors are used.

B. Heliostat mirrors

Heliostat mirrors are used to reflect the radiations to ground receiver. Multilayers of thin film can be used to obtain maximum reflection. Heliostat mirrors can track the sun's radiations and get aligned to the maximum efficiency.

C. Beam down tower

Beam down tower is used to hold the heliostat array of mirrors. So that the radiations will get reflected from the heliostat mirrors to the ground receiver.

D. Ground receiver

The ground receiver must be in a vacuum glass container to reduce the heat loss. The receiver holds the liquid which is to be heated.

VI. Advantages and Disadvantages:

A. Advantages of transparent solar cells:

- Transparent solar cells are very small in size. So they occupy less space.
- They absorb less heat. So the efficiency of the CSP can be increased.

B. Advantages of Hybrid power plant:

- Efficiency will be high.
- Less amount of solar energy is wasted.
- As the solar energy is a green energy, it is eco-friendly.

VII. Conclusion:

The concept of transparent solar cell and solar thermal hybrid power plant is presented and its advantages and disadvantages were discussed. This concept

will maximize the use of solar energy. Even in future solar energy will not get depleted. But other conventional sources will be depleted one day. Also solar energy is a green energy. So developments should be made in this field.

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