Students' Diary

Alternatives to the conventional solar power plant

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Since the invention of the first commercial solar panel in 1881, by Charles Fritts, there has been tremendous development in photovoltaic technology which has reduced cost and increased the efficiency of solar power plants. Solar power is pollution-free and causes no greenhouse gases to be emitted after installation. India has made significant development in generating capacity for solar energy in the last few years. However, factors including lack of financing support, inconsistent government policy, lack of scale and competition from low-priced Chinese imports led to the decrease in India's domestic module manufacturing growth. Indian government introduced certain measures such as the Domestic Content Requirement and the safeguard duty to reduce cheap imports. Later, schemes were launched to reserve 50 percent of the project's bid capacity for solar cells and modules manufactured indigenously, while allowing the remaining 50 percent capacity to be set up using imported modules. But this was challenged in the World Trade Organization by the United States. As a result, the process of reserving capacities in the projects bid for solar cells and modules manufactured domestically was stopped in January 2018.

Need for alternatives to conventional solar power plants:

Although solar power plants are one of the best technologies to produce electrical energy from the sun because of the dependency of solar panel manufacturing on China its availability is questionable. Solar energy is not available throughout the day and conventional solar plant is unable to use other sources for generating electricity except sunlight which creates problem in absence of sun.

The traditional solar power plant also needs high initial capital cost, they are hard to integrate with existing infrastructure and huge land requirements. There is a need to find alternative ways of harvesting this huge amount of energy received on the earth's surface from the sun.

What options do we have?:

There are lots of alternatives for conventional solar power plants for generating clean energy. We are mainly going to focus on the following two alternatives:

1. Transparent solar cells
2. Solar thermal power plants

Transparent solar cells:

Transparent solar cells absorb only infrared and ultraviolet light and Visible light passes through the cells unimpeded. The figure below shows its components and how they work together. The thickest layer (toward the left) is the glass, plastic, or other transparent substrate being coated; the multiple layers of the PV coating are toward the right. At the core of the coating are the two active layers - the absorptive semiconductor materials that get excited by sunlight and interact, creating an electric field that causes current to flow. Sandwiching those layers are electrodes that connect to the external circuit that carries the current out of the device. Since both electrodes must be transparent and not the usual reflective metal a layer on the back of the cell can be added to reflect sunlight of selected wavelengths, sending it back for a second pass through the active layers. Finally, anti-reflective coatings can be used on both outside surfaces to reduce reflections because any light that reflects - potentially as much as 10% of the total - doesn't go through the device.

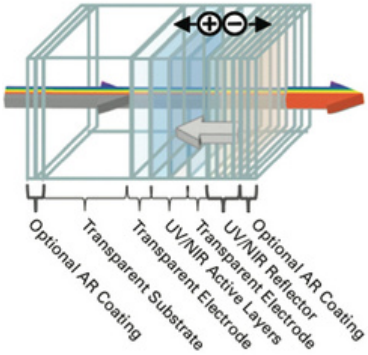

Fig. 15: Sample Transparent Photovoltaic Device

To compare the operation of the transparent solar cells, the researchers measured their absorptive response and then compared it with that of a conventional solar cell. The results appear below. The absorptive response (black curve) of conventional solar cells is superimposed on the solar spectrum (gray curve). In the conventional solar cell (top), the wavelengths at which absorption is relatively high include the visible part of the spectrum that our eyes can detect (the colored section between about 400 and 700 nanometers).

While on other hands transparent solar cell (bottom) absorbs in the infrared and the ultraviolet parts of the spectrum—both above and below the visible range. But in the visible region, absorption drops off, approaching zero.

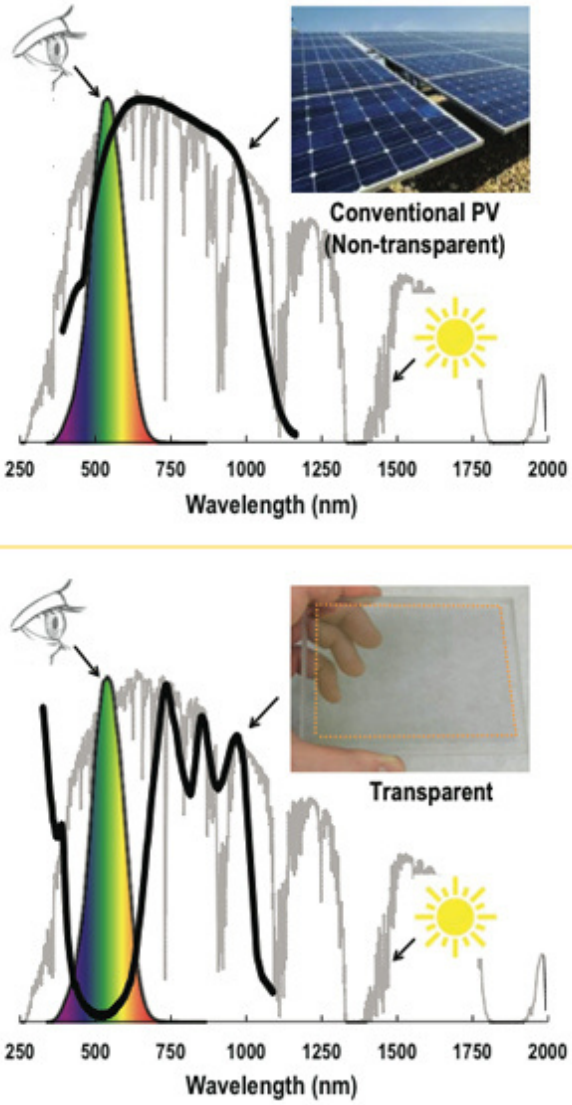

Fig. 16: Spectral response of conventional and transparent PV

Solar thermal power plants:

Most techniques generating electricity need a high temperature to achieve reasonable efficiencies example are coal power plants. The output temperatures of non-concentrating solar collectors are limited to temperatures below 200 ˚C. Therefore, concentrating systems must be used to produce higher temperatures. The reflector, which concentrates the sunlight to a focal line or focal point, has a parabolic shape; needs to be tracked using some motor sensors control system to achieve higher efficiency.

The reflector can be further divided into one-axis and two-axis tracking: one-axis tracking systems concentrate the sunlight onto an absorber tube in the focal line, while two-axis tracking systems do so onto a relatively small absorber surface near the focal point.

The energy collected from the sun is then used for heating water at higher temperatures to produce steam which is feed to the steam turbine which converts the kinetic energy of steam to electrical energy.

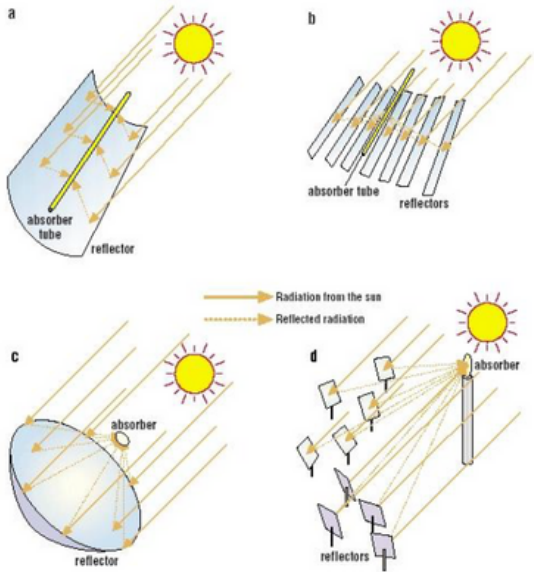

Fig. 17: Concentration of sunlight using (a) parabolic trough collector (b) linear Fresnel collector (c) central receiver system with dish collector and (d) central receiver system with distributed reflectors

Advantage of using Transparent solar cells and solar thermal power plants over conventional solar: Transparent solar cells has the advantage of easy integration with existing infrastructure than conventional solar cells. The coating could easily be deposited on one of the inner surfaces of double-paned windows, along with standard low-emittance or solar-control coatings. Distributing the energy generated by the Transparent solar cell equipped windows could be as simple as placing a wire connection, power electronics, and an outlet at the side of each window or series of windows. Moreover, the Transparent solar cells would block much of the infrared radiation. That effect could cut down on air conditioning needs, further reducing energy use and operating costs in the building. Transparent solar cell use also solves the problem of not being in my backyard as no land is needed for Transparent solar cells. The initial cost of installing a Transparent solar cell is low compared to a conventional solar cell.

Solar thermal power plants have the advantage of guaranteed capacity. During periods of bad weather or during the night, a parallel, fossil fuel burner can produce steam; this parallel burner can also be fired by climate-compatible fuels such as biomass, or hydrogen produced by renewables. With thermal storage, the solar thermal power plant can also generate electricity even if there is no solar energy available.

Conclusion:

Due to the increase in global energy demand, there is an increased need for the development of more such alternatives to conventional solar panels which can produce electricity depending on the requirements of different locations. Further research needs to be carried out to increase the efficiency of already existing technology to make it commercially viable.

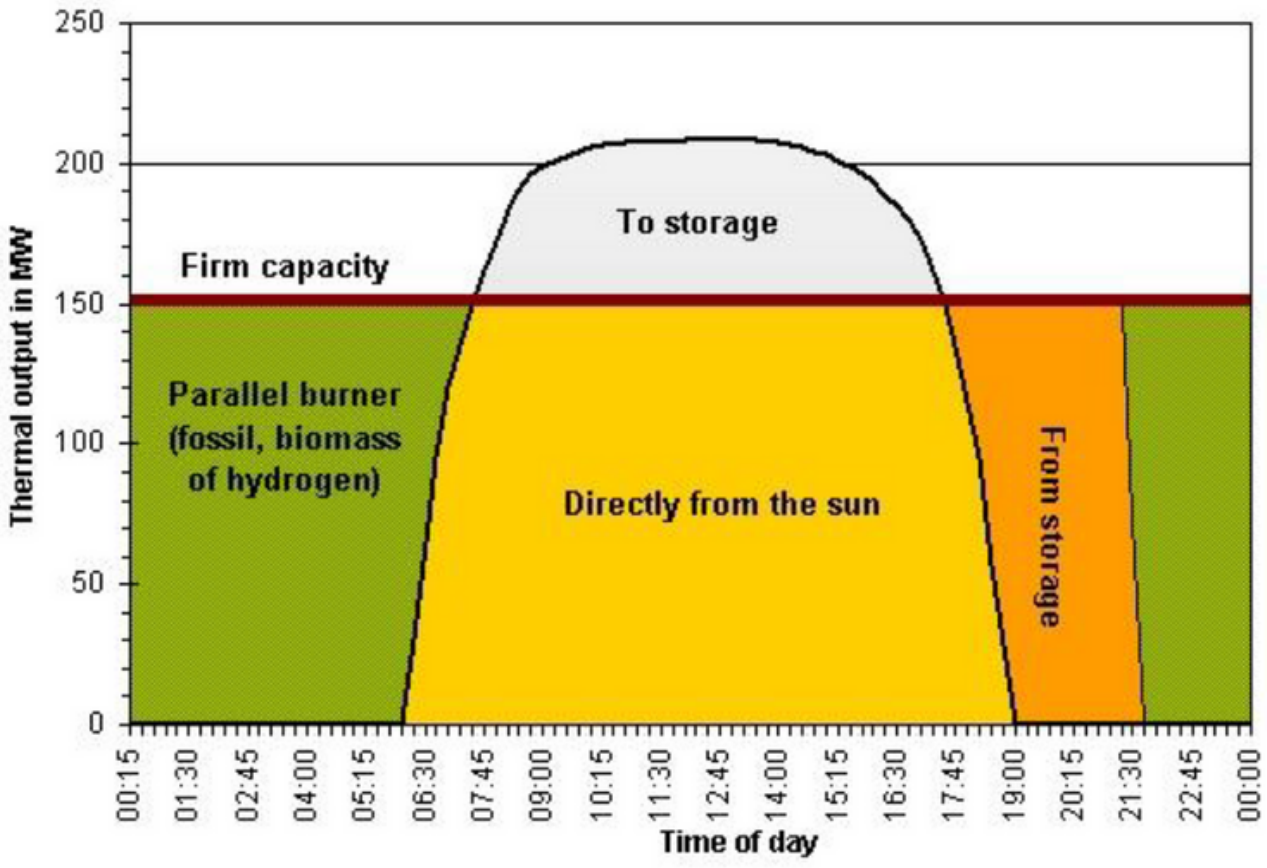

Fig. 18: Typical output of a solar thermal power plant with two-hour thermal storage and backup heater to guarantee capacity