GERMI's Innovative research in Solar PV installations in Gandhinagar, Gujarat

T.Harinarayana, Director, GERMI, Gandhinagar, Gujarat

Among the various renewable sources, solar photovoltaic (PV) is growing at a much faster rate. There are many countries planning to initiate PV installations with different targets. China is planning to generate 40 GW of electricity by 2015 using solar PV. In 2009, the cumuative PV power installed in the world is close to 22 GW. This is nearly 70 % increase compared to the previous year 2008. Among all the countries, European Union (EU) is dominant and contribute close to 7.2 GW during the year 2009. Among this, 5.6 GW of electricity is coming from Germany alone. From the above trend, it is clear that electricity generation from solar PV will be increasing many folds in the coming years. In India, 20GW is kept as target by Jawaharlal Nehru National Solar Mission (JNNSM) for grid connected solar power for the year 2022 and it is 200 GW by 2050. These are all large and ambitious targets. To reach these targets, one requires several innovative ideas with new concepts. Gujarat Energy Research and Management Institute (GERMI) has been working in solar PV installations in several locations and also published the reserach results with new ideas.

In recent years, GERMI Scientists have proposed a novel method to enhance electricity generation using limited land area [1]. The new idea is to use two arrays of panels with one above the other. In general, more power generation requires more number of PV modules and additional land to place them. In a previous report [1], GERMI scientists suggested that instead of using a single layer of PV panel, stacking two layers of PV panels one above the other, separated by a small distance, say 5 m, generate about 60 % more energy. It is shown here with another innovative concept that stacking up of PV panels with mirrors near the bottom panel, as shown in the figure-1, produces more power compared to the panels without mirror. This requires a new configuration of the panels. The bottom array of panels are connected to mirrors on all the four sides with one plain mirror below the top array of panels as shown in the figure 1.

Herein, we have studied the effects of additional mirrors fixed at four sides of bottom panels with a total refletion coefficient value assumed as 0.9. In figure 2 the energy generation for the panels shown in figure 1 are presented. The curve A presents the solar power generation for a botoom layer panels

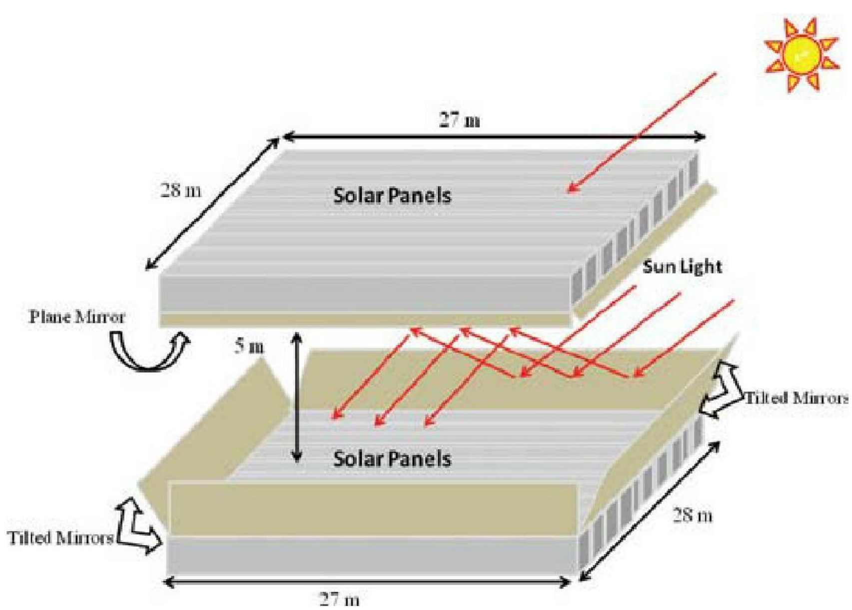

Figure 1: Two-layer solar panels with mirror arrangements in the bottom-layer panels.

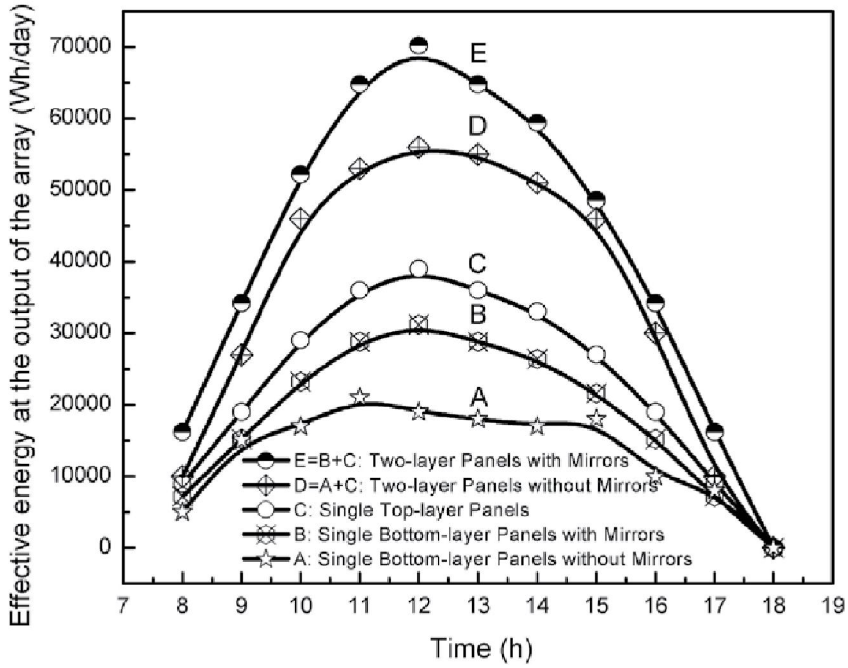

Figure 2: Effective energy generation from two and single-layer solar panels with and without mirror arrangements.

alone in a system of two layer panels exist. The curve B presents the power generation for the bottom layer panels alone in a system of two layer panesl with mirros. The curve C shows the top layer solar panels alone in a system of two layer panels. The curve D is the addition of solar power from a system of two layer solar panels without mirros. Finally, the curve E is the addition of solar power from a system of two layer solar panels with mirror arrangements as shown in figure 1. It is clear that two-layer solar panels with mirrors have shown about 25 % increase in generation as compared to two-layer solar panels without mirrors. This study has clearly brought out that this innovative concept can be extended to n number of solar panels stacking with mirror arrangements in proper orientations to enhance the energy generation.

In short, the outcome of the above work can be summarised as follows. Developing a commercial solar power station using PV modules requires a lot of land area. As the cost of the land has gone up five to ten times in the last 10 years in India demands innovative concepts to optimise the land use. The rationale behind this study is to save the land cost and get maximum output from the solar power plant in a limited area. According to the GERMI scientists, the concept of stacked PV panels can open up new avenues towards large scale generation even for the small scale solar power plant. The two-layer PV system with mirror arrangements can be implemented in all the roof top installations and also in small power plants around the world.

In another research study [2], GERMI scientists have shown increase in efficiency of solar panels with new materials. In this research work, GERMI scientists in collaboration with researchers from Pandit Deendayal Petroleum University (PDPU), Gandhinagar and CSIR-Central Electronics Engineering Research Institute (CEERI, a laboratory of the Council of Scientific and Industrial Research, Govt. of India), Pilani have demonstrated a model-based calculation of the effect of indium composition on the open-circuit voltages of indium-gallium nitride (InGaN) Schottky junction solar cell (SJSC) under monochromatic light illumination. InGaN is a very novel semiconductor material system, which has the potential to achieve solar cell efficiencies of over 50 % in comparison to the present efficiency of 7.12 %. By changing the indium and gallium fractional composition in InGaN, the band gap of this semiconductor can be adjusted to span 90 % of the solar spectrum in comparison to a fixed band gap solar cell, thus efficiently converting photons of different energy into electricity. The current world record efficiency for solar cells is 43.5 %, which is achieved by researchers at Japan. InGaN is already being used commercially for bright light-emitting diodes (LEDs), and now researchers worldwide are exploring into InGaN for solar cell applications.

On the other hand, SJSC is the simplest of all the existing solar cells, which consists of metal-semiconductor junction exposed to the incident sunlight. In the present work, four different metals namely, gold, palladium, nickel and platinum were used to make Schottky contacts with n-InGaN semiconductor. The open-circuit voltages have been calculated using the analytical model. This analytical model is developed by the same scientists and already published [3]. Among four different systems, Pt/ n-InGaN/ Al system resulted in the highest open-circuit voltage, due to the catalytic property of platinum, which helps in reducing the surface recombination at the Schottky interface. The schematic of the system used for simulation is given in figure 3. Now-a-days, model-based studies are important to explore the details of the devices before carrying out the practical experiments.

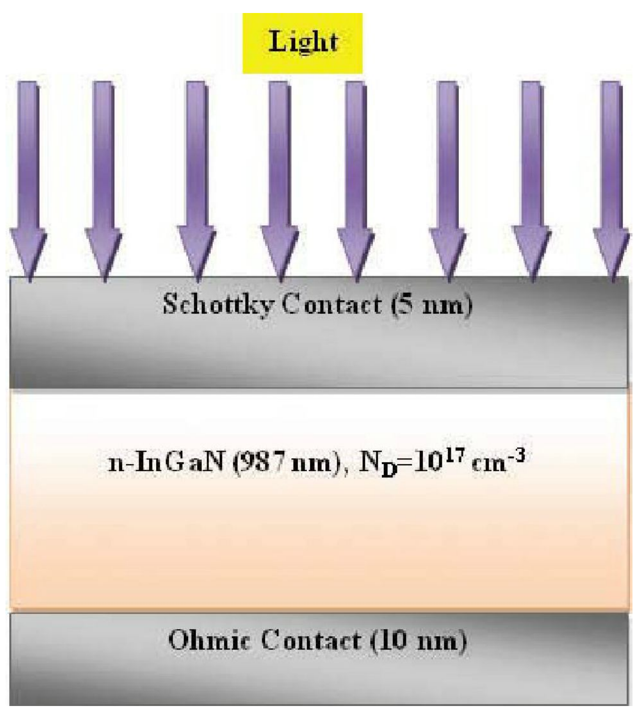

Figure 3: InGaN solar cell device structure used for the simulation.