High efficiency solar cell and its system

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Methodology

The working principle of solar cell states that in order to conduct current across the semiconductor junction of solar cell, the photon energy E (of the incident sunlight) should be higher than the band gap energy \( E_g \) of the semiconductor. This can be expressed as:

\[
E = h\nu = \frac{1240}{\lambda} \text{(in nm)} \geq E_g \text{(in eV)}
\]

Therefore, the photons with energy E less than the silicon’s bandgap energy \( E_g \) pass through the cell and are not absorbed and this constitutes the 18% wastage of the incoming solar spectrum. This wastage of solar spectrum contributes to the present low efficiency of solar cells. Thus the focus of this report is to use concentrated photovoltaic cells using Fresnel lens focusing technique to maximize the use of solar spectrum and hence improve the solar cell’s efficiency.

The Fresnel lens as shown in figure 2 has a flat surface on top and have concentric grooves at the bottom. It behaves like a prism and the concentric groves of the Fresnel lens refract different wavelengths of light at different angles (Snell’s refraction law) creating a concentrated focus of incident light rays.

P-V curves for both PV cells. The blue curve shows that the output solar power produced without the use of Fresnel lens focusing is 6.05W at 1.20 V. However, in case of red curve for a solar cell using Fresnel lens the output power is 6.90W at 1.21V. Hence by comparing two curves it can be argued that Fresnel lens focusing technique improves efficiency.

Summary/Conclusions

After analyzing the results of the simulation we concluded that the intensity of the incident light (photons energy) prominently influence the output power and hence efficiency of a given PV cell. The validation of the Simulink modeling we performed can further be investigated experimentally. Further factors including the effect of temperature and type of cell material used must be observed and taken into consideration in order to achieve better results.

Key References


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