Alternative Energy

Edited by

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Performance of PV cells

Chapter 31

Performance of different photovoltaic cells operating under the meteorological conditions of Singapore

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Abstract

Three different types of photovoltaic solar cells were installed and connected in grid-tie inverters to run a blower or pump under the meteorological conditions of Singapore. Experiments were performed over a period of time, where all three types of cells, each type having a rated power of 360W, were exposed to same environmental conditions. For a day with a maximum irradiation of about 760Wm$^{-2}$, analyses of data to determine the performance of solar cells revealed an average efficiency of mono crystalline, poly crystalline and tandem cells of about 10.4%, 9.5% and 8.8%, respectively. The maximum efficiencies recorded were 14.5% for mono-crystalline, 13.5% for polycrystalline and 11% for tandem cells. Although tandem cell has the lowest average efficiency, it shows the highest Solar Fraction (SF) compared to mono and poly crystalline cells. The electricity production of mono crystalline, polycrystalline and tandem cell for 30 consecutive days shows that tandem cell has the highest production with an average value of 1.7KWh. The total production of mono and polycrystalline cell is approximately the same. Both of them have the average daily value of about 1.5 kWh. On a day, with irradiation of about 760Wm$^{-2}$ and without any cooling, the surface temperature of mono-crystalline, polycrystalline and tandem cell were 59°C, 58.4°C and 57.7°C, respectively. On the other hand, the surface temperature has only reached 35.5°C, 35.1°C, 33.6°C, respectively, when the first data was recorded in the early morning, when the irradiation was about 450Wm$^{-2}$. As the efficiency of the cell is dependent upon operating temperature, appropriate measures should be undertaken to maintain low operating temperature, particularly, when the irradiation is high.

Keywords: PV performance; mono-crystalline, polycrystalline, tandem cells; power generation; conversion efficiency; solar fraction.

INTRODUCTION

The sun is an immense source of power emitting a large amount of electromagnetic energy in the form of irradiation. On the average, the Earth’s surface receives approximately $1.2 \times 10^{17}$ W of solar energy. The