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PHOTOVOLTAIC PERFORMANCE UNDER REAL DESERT CONDITIONS NEAR CAIRO

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Abstract—A photovoltaic panel of polycrystalline silicon solar cells from Solarex was installed with a tilt angle of 30°. The temperatures of the centre and side of the panel were measured by two thermocouples, in addition to the global radiation and ambient temperature measurements. The measurements were analyzed to determine empirical models for the temperature effect and the resultant power. It was found that there is a drop in the voltage and power of the photovoltaic panel at noon during the spring and summer seasons.

INTRODUCTION

A great deal of work is being carried out on solar cells with the aim of obtaining the highest possible power under the influence of the exterior conditions such as solar radiation and temperature, in measuring the two main parameters I and V (short-circuit current and open-circuit voltage) of solar cell systems [1, 2].

In the case of silicon cells in the photovoltaic conversion of solar energy, there is a rapid drop in the efficiency of the semiconductor solar cell with temperature rise and at 160–180°C the silicon cells have zero efficiency. Thus, when photovoltaic assemblies are coupled to solar radiation concentrators, some form of cooling is necessary [3, 4].

The relation between light intensity and short-circuit current I is linear: I increases with increasing light intensity due to the increase in the number of photons generating the photo current in addition to the perceptible improvement in I with increase in temperature, which is the consequence of the improvement in the diffusion lengths and due to the shift of the absorption edge to lower energies [5, 6].

From the following equation:

$$V_{oc} = \frac{AkT}{q} \ln\left[\left(\frac{I_{sc}}{I_o}\right)+1\right]$$

which shows the logarithmic relation between V and light intensity and also shows that V is a function of the light intensity, dark current (I) and the junction perfection factor (A), one can conclude that the dark current (I) decreases and V consequently increases with increasing band gap or decreasing temperature.

Egypt is characterized by a hot desert climate in the summer, where the maximum temperature of the ambient air ranges between 35°C in the North (Cairo) and 42°C in the South (Aswan) on average. This hot climate decreases the output voltage and conversion efficiency of the silicon solar cells, during the optimum time of solar energy utilization [7, 8].

In the present work, the system is employed using normal panels without special attachments for cooling and light concentrating.

MEASUREMENTS

The short-circuit current of solar cells is not strongly temperature dependent. It tends to increase slightly with increasing temperature. This can be attributed to increased light absorption, since semiconductor band gaps generally decrease with temperature. The other cell parameters, the open-circuit voltage and the fill factor, both decrease [9]. For this reason, in the present work, a photovoltaic panel containing 40 polycrystalline solar cells from Solarex of type Sx-110 was installed facing South with tilt angle of 30° (the latitude of Cairo) on the roof top of the building of the National Research Institute of Astronomy and Geophysics (NRIAG) near Helwan at Cairo in the arid desert land area.

The system shown in Fig. 1 was constructed to measure the temperature of the solar cells at the centre