THE RELATIONSHIP BETWEEN SOLAR RADIATION AND THE EFFICIENCY OF SOLAR PANELS IN PORT HARCOURT, NIGERIA

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Abstract

Solar Panels have become one of the most promising ways to handle the electrification requirements of numerous isolated consumers worldwide. In this research work, the primary target is to investigate the relationship between solar radiation (flux) and current, voltage, solar radiation and efficiency of solar panel, in Port Harcourt Nigeria. Solar Radiation (flux) measurements as well as formal meteorological data were utilized. Data were recorded from the digital instruments used. Analyses were made between solar radiation (flux) and current, voltage and efficiency. Results obtained show that there is a direct proportionality between solar flux and output current as well as solar flux and efficiency of solar panel. This implies that an increase in solar flux leads to increase in output current which enhances efficiency (performance) of a solar panel.

Keyword: Solar Radiation, Solar Panel, Efficiency

Introduction

Technological dependency of the industrialized world on fossil fuels and the ways in which these fuels have steadily degraded the earth's environment is quite alarming. In our generation climate is receiving unprecedented attention because, human activity on earth during the past couple of hundred years have led to significantly large and rapid changes in environmental conditions. These changes affect health, comfort levels, and ability to grow and distribute food (Parker, 2000). The general public's concern about the environment and the multiplying efforts of environmental activists, along with the fresh way of thinking by scientist and resource managers has led to a new philosophy regarding the handling of the unique natural properties of living on earth (Hutchinson, 2005). Solar radiation (flux) is evidently a determining factor when it comes to studying the natural potential of solar energy as a source of renewable energy. Data shows that the average solar radiation potential for tropical region like Port Harcourt, Nigeria is about 16.4 ± 1.2MJ/m^2 per day (Akpabio and Udoimuk, 2003)Solar flux is described by the visible and near infrared radiation emitted from the sun. The different spectrums are described by their wavelength that range within the broad range of 0.20 to 4.0μ (microns). Terrestrial radiation is a term used to derive infrared radiation emitted from the atmosphere.

Approximately 99% of solar or short wave radiation at the earth's surface is contained in the region from 0.3 to 3.0μm while most of terrestrial or long – wave radiation is contained in the region of 3.5 to 50μm. Outside the earth's atmosphere, solar radiation has an intensity of approximately 1370watts/metre^2 . This is the value at mean earth – sun distance at the top of the atmosphere and is referred to as solar constant. On the surface of the earth on a clear day, at noon, the direct beam radiation will be approximately 1000watts/metre^2 for many locations, at sea level (Rackat, 2005). The availability of energy is affected by location (including latitude, and elevation), season, and time of the day. All of which can be readily determined. However, the biggest factors affecting the availability of energy are cloud and other meteorological conditions which vary with location and time. Solar energy impinging upon a transmitted medium or target is partly reflected and absorbed.

The remainder is transmitted. The relative values are dependent upon the optical properties of the transparent object and the solar spectrum (Dietz, 2002). Solar radiation is partially depleted and attenuated as it traverses the atmospheric layers, preventing a substantial portion of it from reaching the earth's surface. This phenomenon is due to absorption, scattering and reflection in the upper atmosphere (stratosphere), with its thin layer of ozone and the lower atmosphere troposphere within which cloud formations occur and weather conditions manifest themselves. (Brook and Miller, 2005), This research work is aimed at identifying the relationship between solar flux and the production of solar electricity from solar panel. As this will help us maximize the performance (efficiency) of solar panel, in Port Harcourt, Nigeria.

Materials and Methods

Solar panel (silicon) was placed on a horizontal surface about 1.5m high facing the sun. The output terminals were connected to the input terminals of a B.K. Precision compact digital meter (model 615), to measure solar flux in lumens. An Alda Model AV0809Cdigital multimeter was use to determine current and voltage output of the solar panel. From the readings obtained the power of the solar panel was determined from equation (1) and efficiency of the solar panels calculated from equation (2).

Result

The solar panel was of crystalline silicon type with surface area of 0.19m^2 and capacities of 9.0V and 2.5A, respectively.

Power = VI (Watts) (1)

$$\text{Efficiency} = \frac{\text{power of solar panel}}{\text{Area of solar panel} \times 1000\text{W/m}^2} \frac{100}{1}\,\% \quad (2)$$

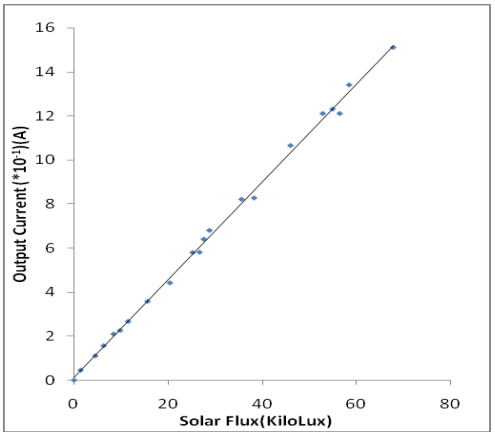

Figure 1. Graph of Output Current against Solar Flux in Port Harcourt

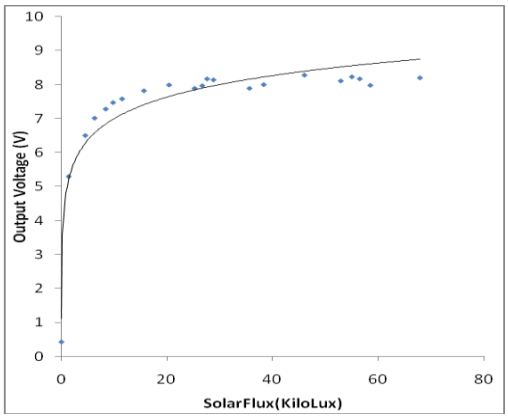

Figure 2: Graph of Output Voltage against Solar Flux in Port Harcourt

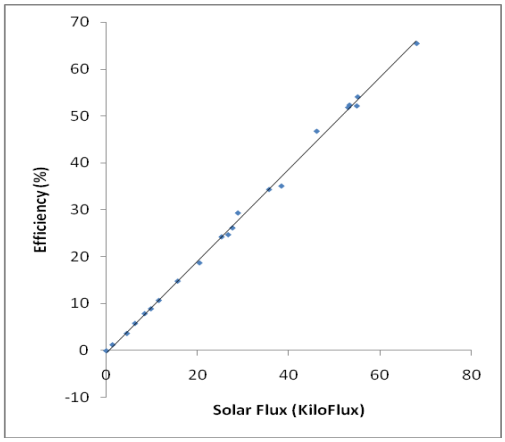

Figure 3: Graph of Efficiency against Solar Flux in Port Harcourt

Discussion

Solar panel output current is directly proportional to solar flux since the graph is a straight line. This means that when solar flux increases solar panel output current increases that is when there is less clouds cover, less dust, haze and low air pollution, fig 4.1 shows that output current of about 10.6 x 101^{-1}A was recorded when solar flux was 46.7 kilolux, 15.1 x 10^{-1}A when solar flux was 67.9 kilolux show and increase of 4.6 x 10^{-1}A.

Increase in solar flux has little effect on output voltage of solar panel, the graph in fig. 2 shows that output voltage is stable despite increase in solar flux, for instance solar flux from 20.4 kilolux to 67.9 kilolux, produced output voltage between 8.0V and 8.2V with a difference of 0.2V which is very small.

Solar flux is directly proportional to output current and also proportional to efficiency, this means that output current is directly proportional to efficiency; therefore output current and solar flux directly determines the efficiency of panel as in fig. (1 and 3)

Conclusion

A direct linear relationship has been observed in this study between solar flux and efficiency fig (1 and 3). However, a rise in solar flux may have little effect on voltage output from the solar panel. A positive linear relationship was found with current, efficiency with solar flux increase.

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