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# The Efficiency of Solar Panel: Case Study of Cross River State University of Technology, Nigeria

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## *Abstract*

*We use two solar panels; mono-crystalline and poly-crystalline solar panel, to determine how ambient temperature affects the efficiency of photovoltaic solar panels in Cross River State University of Technology within Calabar south metropolis. This shows that the efficiency of the solar planes actually decreases with increase in temperature and which also depends on the time interval.*

***Keywords:*** *Mono-crystalline solar panel, polycrystalline solar panel, ambient temperature, Photovoltaic modules, global warming, relative humidity, rainfall, insulation levels*

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## INTRODUCTION

Energy is one of man's crucial needs. The biological processes, the food chain, the industrial processes are all dependent on energy. The development of man has been greatly influenced on how his use of energy has evolved. It is on this premise that the nations of the world are categorized as developed, developing, and under-developed nations. Since, Nigeria is a developing nation, energy is a very vital tool that is requisite for her economical developmental goals [1].

Nigeria is among the countries with abundance of natural resources such as fossil fuel and biomass. The utilization of these resources has given rise to the conventional means of power production such as hydro-power plant and fossil fuel burning. These means of power production have not been able tackle the power dilemma in the country which in turn have created quandary such as a global warming and other environmental issues [2]. It is now pertinent that we find an adequate alternative of energy generation that will both improve our present power condition and have minimal adverse effect to our environment.

Solar power comes to the earth in the form of light (sun) or radiation. The amount of radiation reaching the earth's surface can be measured as per square meter and which can provide enough energy for the nation [3]. Solar energy through the use of solar panel (PV module) has been found as an adequate alternative due to its cheap availability in the market. Photovoltaic modules are classified on the basis of the materials used in producing them. The materials presently used for photovoltaic include mono-crystalline silicon, polycrystalline silicon, amorphous silicon, and cadmium telluride and cooper indium gallium selenide/sulfide. The crystalline silicon modules (mono-crystalline and polycrystalline module) were chosen in the research because of their high commercialization, environmental friendliness and efficiency, with a sample of mon-crystalline solar cell as shown in Figure 1 [4, 5]. The aim of this study is to provide a solar mapping within the location and to investigate how temperatures as an environmental parameter influence the output performance of a crystalline silicon photovoltaic module.

## MATERIALS AND METHODS

### Materials

The materials used include: solar panels (mono-crystalline and polycrystalline module), a deep cycle lead-acid battery with 100Amps, charge controller (regulator), digital multimeter, digital thermometer, and digital photometer.

### Experimental Setup

The two solar panels (mono-crystalline and polycrystalline module) were placed at an elevated position of equal heights and which is at 180° to the horizontal surface of the earth. The solar panel terminals are left unconnected while the battery terminals are connected to the output terminal of the charge regulator. The charge regulator has an input terminal which is connected to the solar panel terminal when taking measurement for short-circuits current (Isc). The load is also connected to the terminal of the battery. To obtain the open-circuit voltage (Voc), the solar panel terminals are connected to the probes of the multimeter from which the reading was obtained as shown in Figure 2.

The isolation level measurement was obtained by focusing the photometer's sensor to the sun and placing it at the same angle and height as the solar panels. Ambient temperature was obtained using the digital thermometer and the solar panel temperature is obtained by placing the probes of the digital thermometer on each panel and decoding the value.

For each day, solar panel was exposed to irradiation for a period of 12 h. The open circuit voltage (Voc), short-circuit current, ambient temperature, solar panel temperature and irradiation level measurement were taken after 15 min interval. From the measured values, the efficiency of the solar panel can be calculated by the equation:

$$\eta = \frac{P_{max}}{P_{in}} = \frac{V_{max} \times I_{max}}{I(t) \times A} = \frac{Voc \times Isc}{I(t) \times A} \quad (1)$$

$P_{in}$ is the input power, I(t) is the light intensity which may be defined as irradiance (E), that is, the power of electromagnetic radiation per unit area incident on a surface and A is the surface area of silicon solar cell.

***Fig. 1:*** *Mono-Crystalline Solar Cell.*

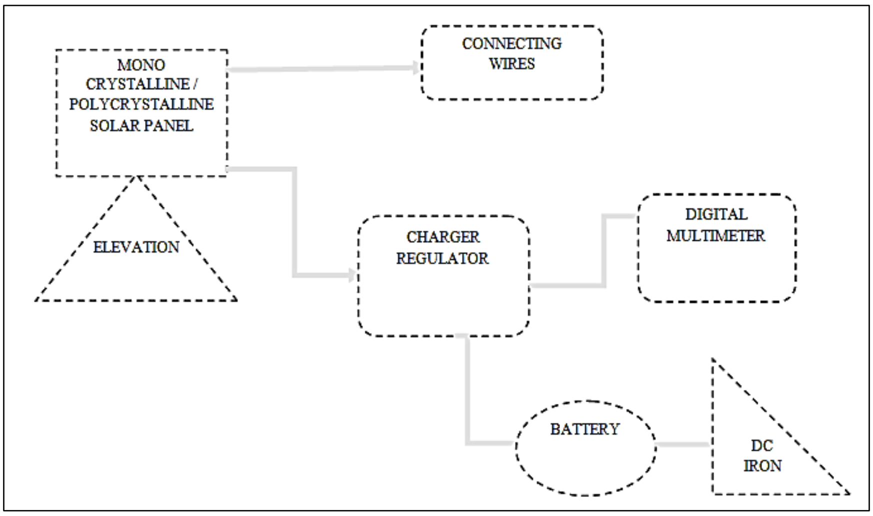


***Fig. 2:*** *Schematics Structure of the Experimental Setup of the Photovoltaic Modules.*

## RESULTS AND DISCUSSION

The following parameter such as solar radiation (W/M$^2$), open circuit voltage (Voc), short circuit current (Isc), relative humidity (%), solar panel temperature (°C) and the outputs of the mono-crystalline and polycrystalline solar panels at different meteorological condition were taken between the morning and evening session at the interval of 15 min each day.

The relationship between temperature and electrical parameter in an open environment is non-linear which is due to the fact that in an open environment, conditions are constantly changing which results in the low or high performance of the mono-crystalline or polycrystalline solar panels. Modulus performance varies with location of uses and actual environmental condition such as temperature and rainfall and relative humidity.

Mono-crystalline and polycrystalline solar panels are presented in Figures 3 and 4 and Figures 5 and 6 respectively. The figures make it apparent that there is a decline in current generation of both mono-crystalline and polycrystalline solar panels during the

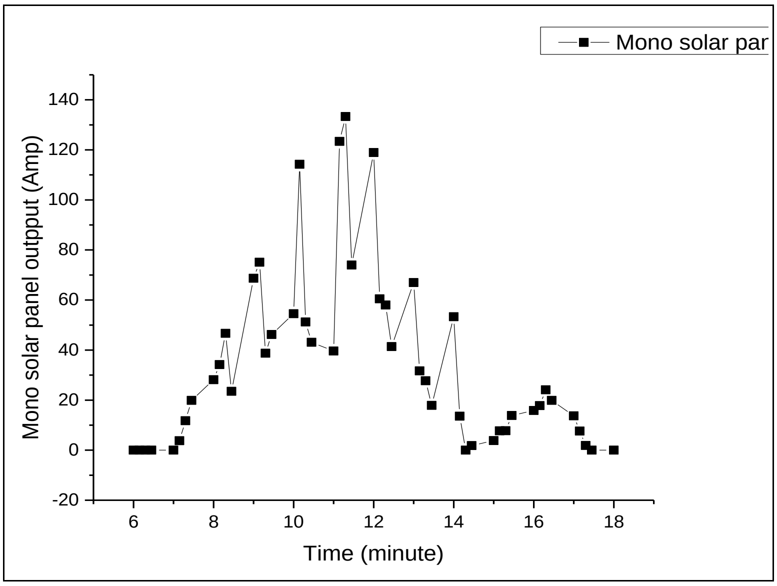


***Fig. 3:*** *Performance Graph for Mono-Crystalline.*

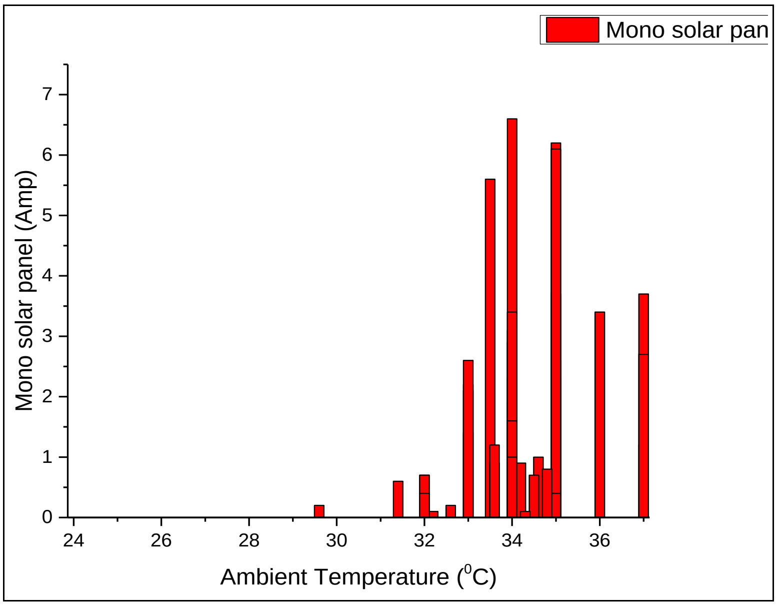


***Fig. 4:*** *Histogram of Mono-Crystalline.*

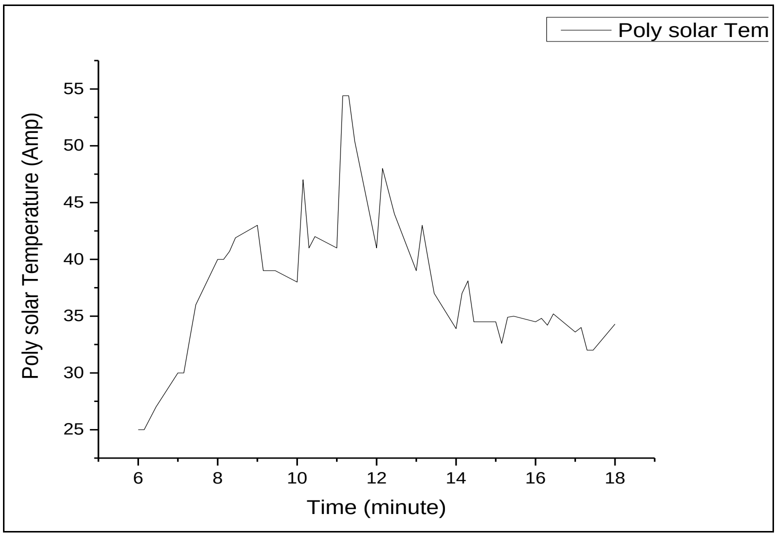


***Fig. 5:*** *Performance Graph for Polycrystalline.*

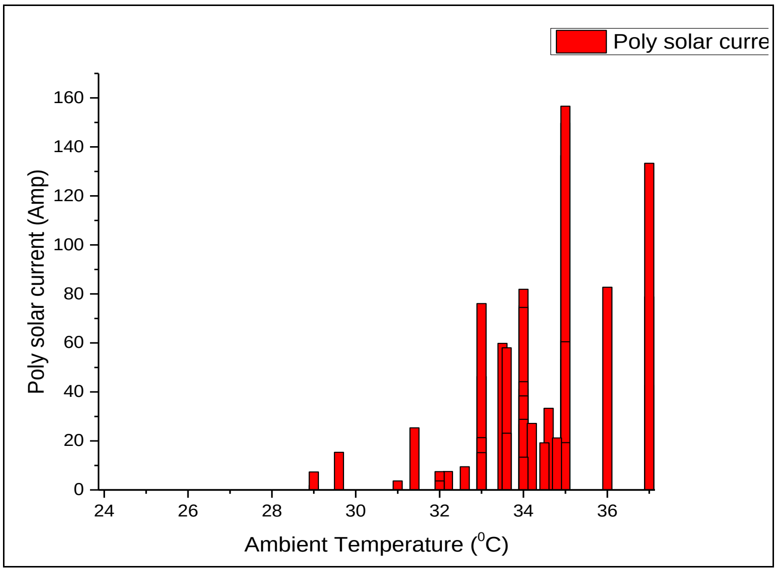


***Fig. 6:*** *Histogram of Polycrystalline*.

morning session with the rime interval of 6am to 11am, but while during the afternoon session, there is an increase in the generation of energy from both solar panels due to the increase in the amount of the solar radiation from earth's atmosphere reaching the solar panel within the temperature range of 35 and 37°C.

The solar noon time (12pm) has the highest insulation level which leads to good accurate efficiency performance of the mono-crystalline and polycrystalline solar panel.

## CONCLUSION

The study adopted the photovoltaic technologies to investigate the mono-crystalline and polycrystalline solar panels in order to determine the efficiency in energy generation during the two sessions, using the data obtained from the measuring instrument at Cross River State University of Technology.


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