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Comparative Review of the Factors Affecting the Performance of Solar Photovolatic System

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***Abstract*—**The increasing trend in the photvoltaic technology ask not only for efficient photvoltaic technology but also requires the best utilization of the solar power. As many factor effecting the performance of photvoltaic system such as Temperature, Dust depositon, Humidity, Tilt angle, wind speed. So a qualitative study is carried out to summarize the effect of these factors. Among all these temperature is the main culprit in degrading the performance of the Photovoltaic System. Due to dust deposition slightly reduce the open circuit voltage of the system while it significantly reduce the short circuit current and hence affecting the performance. Humidity has also negative impact on the performace of the PV system. Similar with increase in tilt angle the ability of the system to receive maximum irradiance decrease but it has the advantage of reducing the dust deposited on the photvolataic panel. Among all the parameters wind speed has positive impact on the performance of the system as it reduce temperature, dust deposition, humidity and hence improve the performance of the system

***Keywords*—** Photovoltaic System (PV), Temperature, Dust, Humidity, Tilt angle, Wind Speed

I. INTRODUCTION

The world is striving to look for energy resources which are environmental friendly, sustainable, efficient and reliable . Renewable energy is an option but its environmental dependency and low efficiency is one of the dishearting factor in using it. Among all Renewable Energy Resources, it has been seen that people have increased interest in solar energy due to their abundance and availability everywhere.In addition to the abundance and availability, it is also neeccessory to unitlize the solar energy efficiently which not only required the efficient photvolataic technology but also requires to take into account the factor which degrade the performance of solar photovoaltaic system.As photovoltaic system is exposed to many environmental paranmeter such as hot weather coniditon, dusty environment, humid weather condition, windy condition. The study of the these factor is essential to utilize the solar energy efficiently and increase the life of photvolatic system. In this paper a qualitative study is carried out to analys and study the effect of these parameter and give the users a qualitative knowledge of these parameter to use their photovoltaic system efficiently.

II. BACKGROUND

Photo voltaic technology is based on the conversion of light energy of sun to electrical energy. Its working principle is based on the famous Einstein's Photoelectric effect. Material mostly used in the Photovoltaic Technology is Silicon. The improvement in the conversion efficiency of silicon is noted up to 23% [1], which has result in the reduction of the solar photovoltaic technology cost and size; the material required for the 100-watt panel is less than that of the low efficiency, is one of the main reason of the increasing interest in PV technology along with other important reasons [2]. The output of the PV technology is not only based on the material conversion efficiency but also depends on the incident radiation, Temperature, Humidity, accumulated dust and the wind speed surrounding the PV panel [3].

The output generated by the PV panel is directly dependent on the solar irradiance absorbed by the PV panel in addition several other environmental parameter besides the internal conversion parameters [4]. As the PV plant is long run system and exposed to changing environmental conditions and different factors which influence the solar PV output and performance directly or indirectly and the life of the PV plant. The most important factors are temperature, humidity, amount of dust deposited on PV panel, and air speed surrounding the PV plant [5].

III. FACTOR AFFECTING THE PERFORMANCE OF THE PV SYSTEM

A. Temperature

The most important factor affecting the performance and life of the PV plant is temperature. The power output of the PV plant is reduced with the rise in temperature and it contribute more to the degradation of the PV plant than any other parameter and hence is the main cause of the reduced life of the PV plant [6]. With the increase in temperature the current of the PV plant increases along with the increase in voltage drop. The increase in voltage drop is more than the increase in current and hence the power, which is the product of current and voltage, get

reduced and hence decreasing the efficiency of the PV panel. In [7] a relationship between the PV panel efficiency and temperature is given as:

$$\eta = -0.05Tm + 12.75 \quad (1)$$

Where

$$Tm = Tamb + (NOCT - 20)E/800 \quad (1.1)$$

Tm= module temperature, NOCT= normal cell operating temperature; can be calculated according to the IEC standard method from equation (1) Based on the equation (1.1) characteristic of an arbitrary PV module is given in the figure. Which shows the variation of efficiency of pv module with the increase in temperature.

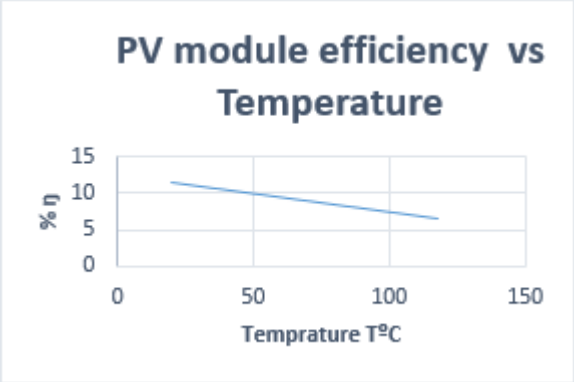

Figure III-1 Photovoltaic efficiency vs temperature

It was calculated that for every degree rise in temperature the efficiency of PV module will decreased by 0.006%. which is also an indicator of the degradation of the pv module.

In addition to this, with the rise in temperature there may be uneven distribution of temperature which may create hot spots in the PV panel and destroy some cells which enormously effect the panel and sometime the panel needs to be replaced and hence one can say the main culprit behind the degradation of the PV panel is temperature [8].

B. Humidity

The effect of humidity on the performance of PV panels in [9] by considering two cases: one is the effect of water vapors on the irradiance level and second is the ingression of humidity into the solar cell enclosure. The light may reflect, refract or diffract when it hit the water droplet due to which reduction in the direct component of solar irradiance may occur. The irradiance level is changed non linearly due to humidity. open circuit voltage (V_{oc}) of the panel is slightly affected by the irradiance level but significantly affect the short circuit current $I_{sc.}$ Due to humidity the power output of the PV plant and hence the efficiency drops [9]. In fig.1 and 2 the effect of humidity on irradiance and of the irradiance on the V_{oc} and I_{sc} is elaborated which is based on the case study carried out in Nigerian tropical climate.

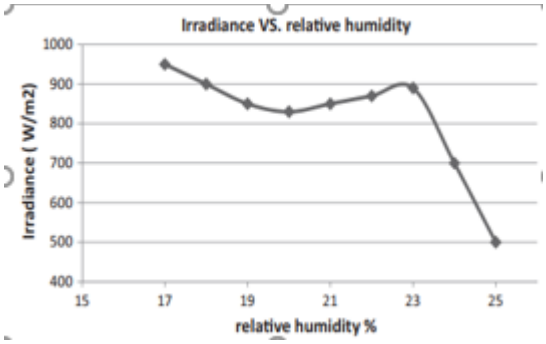

Figure III-2 Irradiance absorpotion vs relative humidity

In second case the water molecule may ingress into the cover of the pv panel and may not let the escaping out of the heat or reflect radiation in addition to the reduction in the irradiance level which increases the temperature and hence degrading the power output and efficiency of the panel [10].

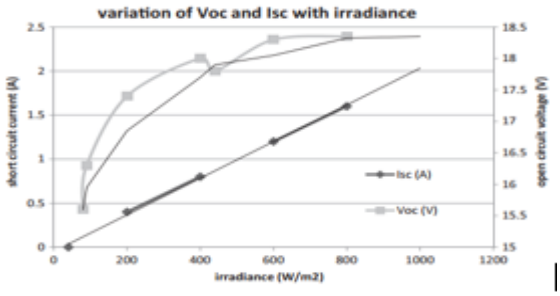

Figure III-3 variotion of Voc and Isc vs irradiance

C. Dust Depostion on Photovoltaic Panel

The amount of dust deposited on the PV panel significantly reduces the panel output power. The power loss is different for different amount of dust, different dust particle composition, dust particle optical properties, and uniformity and non-uniformity of the accumulated dust [11]. Non uniform dust deposition is more dangerous than the uniform dust deposition as it introduces the partial shading which adversely affect the PV performance [12].

In [13] it is observed that the transmittance of the PV panel cover is affected by dust deposition and transmission loss of around 0.05% was observed for every increase of $1g/m^2$ dust deposited, resulting in optical power loss and hence reduction in output current of the panel; as current is directly related to the received radiation, and hence the output power is reduced.

D. Tilt Angle

In [14] the effect of different tilt angle of the PV panel on dust deposition on the pv panel was investigated. It was noted that with the increase in tilt angle the amount of dust deposited reduces due to the gravity pull on the dust particle and hence reduction in the power loss due to reduction in dust deposition was noted but increasing tilt angle can reduce the irradiance absorption area of the panel which again lead to reduction in power of the panel. Therefore, the panels should be so placed that the dust accumulation is reduced and the irradiance absorption is not affected.

It is followed from the above discussion that the dust deposition has adverse effect on the PV performance. However, the only aiding effect of the dust deposited on the panel can be seen if the dust is uniformly deposited and composed of a material which absorb Infra-red radiation and heat, which could happen very rarely [15]. Therefor dust particle composition and their thermal and optical properties needs to be considered while studying the effect of dust deposition on the pv panels performance.

The reduction in output is also observed with the increase in tilt angle of the photovoltaic panel as it reduces the absorption of the irradiance, therefore it is necessary to find the best optimum tilt angle for the PV system. Increase in tilt angle have the advantage of reducing the soiling on the surface of panels.

E. Air Speed (Wind Speed)

In [16] the effects of air speed surrounding the PV plant has been studied. It was observed that The increase in wind speed within limit have a positive impact on the performance of the PV panel and counteract some of the harmful effects of the above discussed parameters such as temperature, humidity and dust deposition. As the humidity is inversely related to the wind speed so the humidity in the surroundings reduces and hence minimizing its adverse effect on the performance of PV panel. It is also observed that with the increase in air speed the dust deposition is also reduced and the rate of heat evacuation is also increased; reducing temperature of the pv panel and hence increasing the efficiency and output of the panel.

CONCUSLION

It is found that temperature greatly degrade the performance of PV plant by lowering the voltage and increasing the current, but the increase in current is less than the decrease in voltage so result in reduction of the output. It was also found that efficiency of the Photovoltaic plant doesn't remain constant but greatly depended on environmental factors and greatly reduced due to temperature.

It was found that dust deposition also lowers the output of the panel by lowering the voltage up to 5% and greatly reduce the panel current. 20 to 30% reduction is noted in the current depending on the amount of dust deposited on the panel.

Humidity also affects the performance of the panel and reducing the photovoltaic plant output by reducing the absorption of solar irradiance by the solar panel and if ingress into the panel may result in increase in temperature which again reducing the output of the PV.

The reduction in output is also observed with the increase in tilt angle of the photovoltaic panel as it reduces the absorption of the irradiance, therefore it is necessary to find the best optimum tilt angle for the PV system. Increase in tilt angle have the advantage of reducing the soiling on the surface of panels.

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