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Impact of Shading, Soiling and Temperature on Solar Photovoltaic System

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ABSTRACT

The main objective of this research paper is to study the effect due to shading, temperature, dust accumulation, snow, birddropping. The power output of the solar panels dependent upon the amount of sun radiation which reaches the solar cells and converts it into electrical energy through inverters. A various types of solar cells are used to manufacture the solar panels like Mono crystalline and polycrystalline. Many factors affect the performance of solar panels and efficiency of PV cells. Experiment was done by using some particles of sand(15g,20g), coal(30g) , impact of building trees shading at 10m and 20m and at different temperature (cold and hot).The power output of both clean and soiling ,without shading or with shading, at high or low temperature is included. The paper will also include the methods by which we can reduce the impact of dust, shading, high or too low temperature and improving the efficiency of solar panels.

KEYWORDS: *Shading, soiling, temperature, monitoring*

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INTRODUCTION

Solar panels lose a significant amount of power if they are in shadow .Solar panels create energy by using Photons to release Electrons. Photon is a charge of energy which is the basic unit of light when it strikes a solar panel the photon energy knocks electrons loose allowing them to fill freely this produces electricity if it is a light then there are photons however their activity varies with light strength which is dependent on the angle of the earth to the Sun. Light intensity is greatest when sun is highest in the sky which in the Northern hemisphere is at the mid day on the midsummer day .Light intensity is off course affected by shadowing. So shadowing cuts down the production of electricity from solar panels light is weak for example; in winter or in the early morning but it will matter greatly when it is strong then shadow on solar panels will significantly reduce the output and can also cause damage overheating of the panels section of a solar panel is shaded. For example when I place a hand on the solar cell there is a very significant drop in the power output from the panel this is because PV panel is made up of string of solar cells connected in series with one another electrical output from the whole panel is limited about parking to the weakest link cell is a typical panel if 1 cell out of 60 in that panel is completely the power output from the panel can fall by third a very significant draw but the effect of shading does not stop there typically a domestic solar panel installation will comprise an inverter and one or two strings of panels wired in series As shown in figure below.

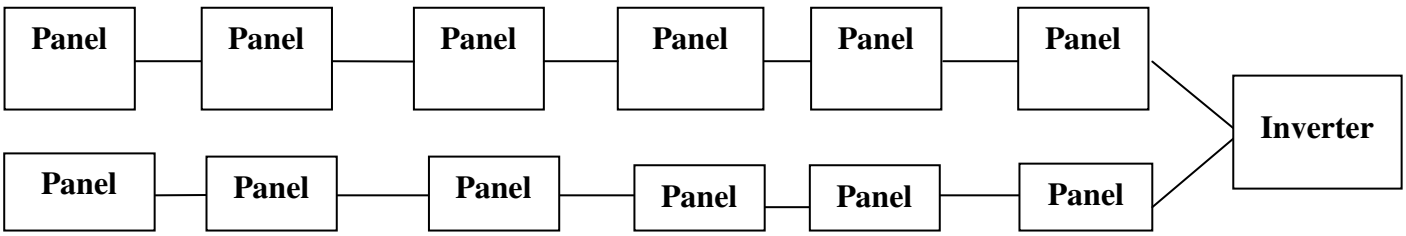

Figure 1: Two strings of solar panels wired in series into an inverter

The inverter takes the direct electrical current produced by the panels and converted it to alternating current which is what is used domestically just as a shading on a single cell of a panel will pull down the performance of that panel. The underperformance of that panel will pull down the performance of the whole string. Large disproportionate power losses can be caused by a tiny amount of shading.

Temperature is one of factor which affects the output of solar panels. Solar PV system does produce the most energy in hotter months like May to August this isn't because of the temperature. It's simply because the days are longer. It's because of the amount of sunshine a panel is exposed to each day. In fact excessive heat reduces the amount of power a system can produce.

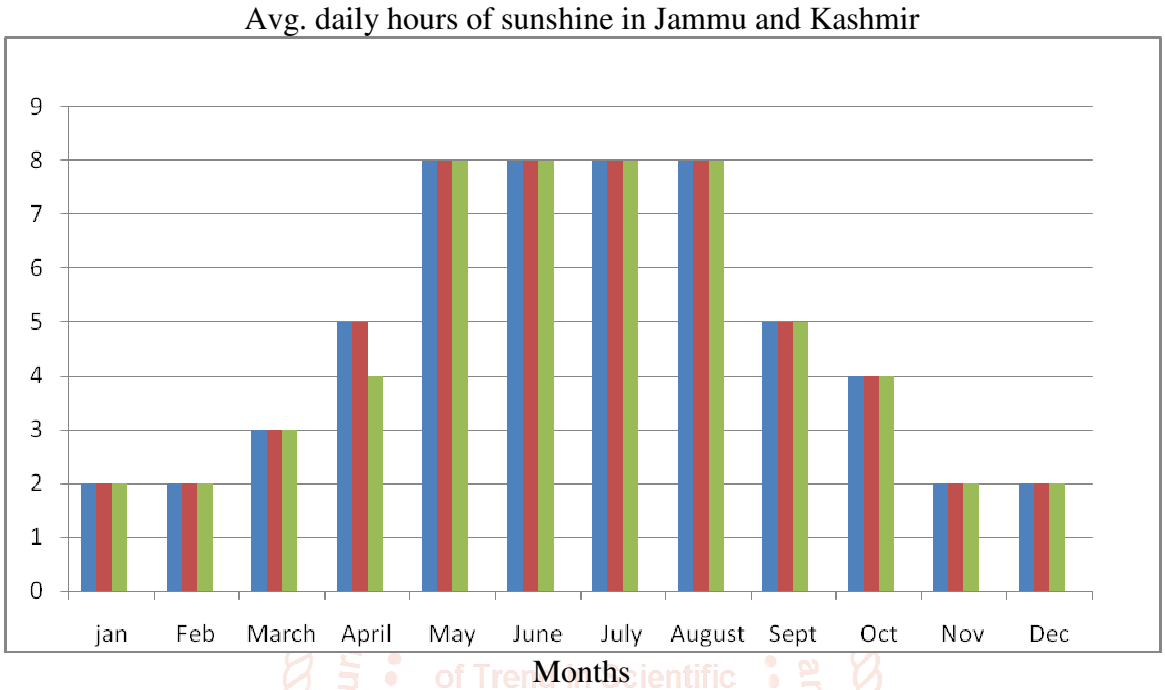

Figure 2: Bar graph of daily sunshine

The power and energy produced by panels begins to decrease once the cell temperature of the panel goes above 25ºC.The solar panels lose efficiency when overheated. It is not too concerned when you are living in tropical environment. Typically a panel will experience only 0.5 decrease in power for every degree above 25ºC.This is called the temperature coefficient and will change depending on the quality and type of panel. It is quite difficult to measure the cell temperature of your solar panels at any time because it won't be the same as the temperature of the ambient air. Cell temperature is determined by conditions like solar irradiations air temperature the space between the roof and panel. e,g if 30ºC at mid day the sun is high in the sky, there isn't a single cloud we would expect the panel temperature to be about 60ºC there will be loss of around 14% in efficiency for a standard 300W.Due to this loss the panel will produce less than 260W at optimal angle an direction. Increase in temperature causes reduction in band gap and fill factor will also decrease slightly with temperature.

Some solar panels will change angle to get the most direct sunlight. These single access or dual access trackers simply adjust the angle for the time of year to maximize output. This typically means the panel need to shift about 25ºC between winter and summer. Some system use solar trackers that continuously adjust solar panels angle throughout the day. PV system are more efficient in cooler weather i,e higher temperature means longer exposure to the sun and causes increase in loss. Snow can also have negative effect on their efficiency. However PV system will continue to work during a light snowfall. If snow accumulates on tha PV system they won't work even when the sun is out however on the bright and sunny side melting snow can clean the PV system making them more efficient and if there is snow on the ground reflecting the sun well TV's can really crank out the electricity.

We all know that the soiling loss is nothing but the dust decomposition on solar panel's surface. Apart from dust, bird dropping, pollen are also a part of it. The accumulation of soil on the PV module can lead to a significant decrease in energy produced by a PV module. In other words, the amount of sunlight that is blocked by dirt and debris that accumulate on solar panels. The accumulation of dust depends on some major factors and this is not the same globally it varies from region to region. e.g. soil loss will not same in Rajasthan and jammu and Kashmir. In Rajasthan due to nearby desert land, dust particle in air is much much higher than that of Jammu

and Kashmir. Next factor for obvious reason is the air pollution .It is not everywhere it also varies from region to region. Industrial areas have lot of dust and air pollutants. So it is obvious in such area that the percentage loss due to dust decomposition will be higher than other places. If the moisture content is high in air, then it makes the dust decomposition on PV surface sticky. Bird dropping is a serious problem because they are not usually removed by rain but their impact is reported as relatively small, less than 2% of total soiling loss so to reduce soiling loss. The only option is to clean the PV surface regularly. For large scale solar panels, a 15 days to 30 days cycle of cleaning normally followed. For smaller system one can follow 60 days to 90 days water based cleaning cycle.

How to reduce impact of shading on solar panels

- First thing is that installer should be of good idea and have competent system designer.
- **Uses of diodes;** Diode is an electrical component that only allows current to flow in one direction. This does not cell an effort on the system designer part as diodes are fitted as standard by the panel manufactures most panels have three diodes when apparently is partially shaded. The current from the unshaded part of the panel passes to a diode which bypasses a shaded group of cells while some power is lost as heat in the diode due to the voltage drop the overall power generation of the partially shaded panel is better than it would be without the diodes and the diodes also protect the shaded cells from overheating. We can use more diodes for reduction in power loss and panels wiil suffer small power loss. Keep away from shadow this is not always possible it is possible if installed on the roof projections
- **Use of micro inverters:**

Micro inverters are small inverters one of which is fitted to each panel e.g if we install 20 panels we would not have 1 inverter but 21 fitted to the underside of each panel .Micro inverters have some advantages ,they eliminate a whole string of panel been affected by just 1 or 2 panels in shadow they have online monitoring system they have also disadvantages too. They are expensive than a single inverter solution. They require connection to a router broadband. They have online monitoring system that means they needs to be internet access all the time because of this more components to fail rooter PC exits were in the installation where we used them where the shadowing was heavy. We use three repeaters to get the signal from loft down to the rooter. The inverter are normally located under the panel where they are harder to access in case of problem.

EXPERIMENTAL SETUP AND METHODOLOGY:

In this experiment there were used different types of solar PV technologies one was mono-crystalline and other was polycrystalline. Both the panels were exposed to different environment conditionsat the same time to get the comparison. Before performing the experiment to get the different observations the panels were manually cleaned and got results at clean and unaffected conditions. The environmental parameters that are taken into account are shading, dust and temperature.

Testing when solar panel is accumulated by Sand to measure current Each panel is with 150W:

Figure no 3: Sample of sand for testing

No of solar panel plates	Without sand	With sand
Plate no. 1	6.20 A	4.21 A
Plate no. 2	4.10 A	2.50 A
Plate no. 3	3.35 A	2.05 A
Plate no. 4	5.65 A	4.28 A

Table no 1

Testing on Monocrytaline solar panel with power of 440 W effect by partial shading:

Parameters calculated	Without shading	Partial shading	Full shading
Voltage	46.8 V	43.6 V	40.1 V
Current	7.27 A	1.58 A	0.92 A

Table no 2

- If minimum 3 cells of each module are shaded it means that each module in array has minimum 2 strings not working.

Testing on Monocrytalline and Polycrystalline solar panels with power of 440 W effects by cloudy weather:

Serial No.	Monocrytalline		Polycrystalline	
01)	Voc	45.60 V	Voc	45.60 V
02)	Isc	9.40 A	Isc	9.15 A
03)	Max.power voltage(Vmp)	36.55 V	Max.power voltage(Vmp)	37.65 V
04)	Max. Power current(Imp)	9.03 A	Max. Power current(Imp)	8.50 A
05)	Max. System voltage	1000 V	Max. System voltage	1000 V

Table no 3

Testing on solar panels with high temperature and low and with system voltage =600 V

For high temperature

Temp.	Month	Day timing	Voltage(volts)
31ºC	June	12 am	19.5V

Table no 4

For low temperature

Temp.	Month	Day timing	Voltage(volts)
-6ºC	January	12 am	22.9 V

Table no 5

After analysis i have seen that when temperature is high voltage decrease and when temperature is low voltage increases.

Rated Max. Power(Pmax)	30 W
Current at Pmax (Imp)	1.67 A
Voltage at Pmax (Vmp)	15.0 V
Short circuit current(Vmax)	1.82 A
Open circuit voltage (Voc)	22.3 V

Table no 6

When you are planning your system and you should know how many solar panels you are going to connect in series in a string to increase the voltage. We need to take temperature Compensation into account.

CONCLUSION:

A comparative study of two dust particles, partial shading, full shading and different temperature (high or low) has been carried out. Due to shading, Dust accumulation on the surface and temperature the output of the power is reduced to a large extend. It is concluded that these parameters decrease the efficiency of the solar panels. It is confirmed that small particles blocks more sunlight and decreases the efficiency of solar panels and modules. It is also be concluded that in desert areas the dust accumulation is high where probability of sunlight is maximum and power can be reduced by 60%.

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