Automated System for Testing Solar PV Panel

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***Abstract* — A photovoltaic power system (PV system) is a tool that uses solar cells to convert solar energy into electricity. The concept of solar cells the use of P-V semiconductor light fixtures has unique modifications to electronic structural modifications. The performance of a photovoltaic (PV) system is greatly influenced by its shape and angle of inclination. Variations in PV performance and electrical properties with varying degrees of inclination have been investigated experimentally (both internally and externally). There were two methods of testing: 1) adjusting the inclination of the module (Tilt angle) while maintaining a constant level of radiation, and 2) various radiation firmness (irradiation) while maintaining proper fixed slope. Rent of mirrors and cooling system to improve the efficiency of solar panels is a practical solution.**

Keywords:- Photovoltaic; Angle of inclination; Tilt angle; Irradiation; Mirrors; Cooling; Efficiency.

I. INTRODUCTION

Solar energy, which is pv (PV) solar energy, is a promising renewable energy source, especially for mobile systems. PV power has long been used in space systems and calculators. The efficiency of PV solar cells has increased in recent decades as a result of research. The concept of small film technology is still young. In this case, the PV cell is made up of one or more thin layers on the substrate. Thin-film film technology is a novel concept. Solar pv cells are made with one or more layers on the substrates in this example. Additional layers improve the efficiency of using the solar spectrum. The shape and inclination of the pv (PV) system have a significant impact on its performance. The impact of tilt degrees on the performance of PV and electrical structures has been scientifically tested (internally and externally). It has been observed that the rotation angle of the PV modules has a significant effect on their electrical performance. By changing the module angle, the cost of simply using staff or tracker motors can be significantly reduced. As a result, we need to find the right angle for placing PV panels to increase production.[1][2][3]

II. LITERATURE SURVEY

The amount of radiant heat absorbed determines the amount of electron energy produced by the solar panel. Many factors influence the function of solar cells. Light intensity, of course, is the most visible aspect. Is there anything that can change the performance of the solar panel? In this thesis, the causes are studied, and several surprises are revealed. Many studies use a flexible control method to properly evaluate all components. Solar radiation from the sun, which we often call solar light, is the average solar radiation in the earth's crust at 1369w / m2. Because the equatorial diameter of the Earth is 40076 kilometers, we can assume that the planet's carrying capacity is 173000 TW. At sea level, the average peak height is 1kW / m2, while the average annual radiation power from a surface of the Earth is 0.20kW / m2, or up to 102000TW of power. Water heaters are increasingly using a solar power source or electricity. From the earliest of times, living things have relied heavily on the glorious sunshine for survival. During that time, ancient civilization used sunlight to dry food, art supplies, and even food production processes, such as salt extraction and the treatment of salted fish. In the face of declining fuel economy, solar has become increasingly important in the energy sector, making great strides. Solar energy can be used in two ways.[1][3][4][5]

III. SOLAR PV PANEL

The two most common types of photovoltaic power conversion are indirect and direct power conversion systems. The PV effect converts light energy into electrical energy, making direct power conversion possible. When an object is exposed to light, the PV effect is a physiochemical element that generates voltage and energy. Solar PV systems use cells to convert sunlight into energy. PV cells are made of one or two semiconducting materials, usually silicon. The panels produce an electric field where the sun shines on it, allowing electricity to flow here between the layers. Solar cells are made up of semiconducting materials that have been impregnated with various impurities, such as silicon. Over one side of the separation, this results in an unequal distribution of free ions (n-type) and an overflow of hole (p-type) on the other. Sunlight stimulates free ions bound to solar cells designed to flow in only one direction, leading to the formation of two electrons in the same connection and creating energy in the outer circle. [5][6]

IV. TEMPARATURE AND INTENSITY EFFECTS

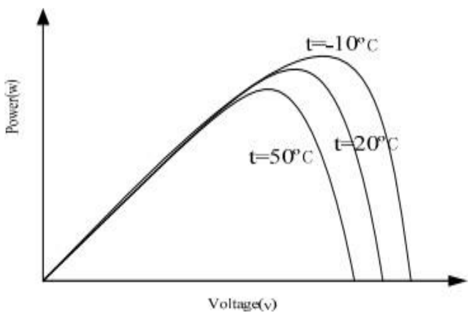

Figure 1. PV power characteristics at various ambient temperatures

Figure 1 shows the PV power production vs voltage curve at different temperatures with continuous irradiation. As the temperature increases, so does the resistance to flow of current. Efficiency is affected by temperature. Solar panels' output performance reduces at high temperatures when compared to lower temperatures.

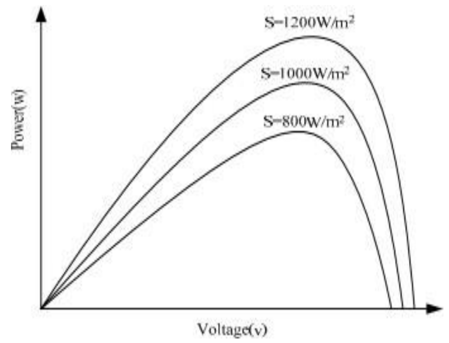

Figure 2. PV power characteristics at various levels of irradiation

Figure 2 shows a plot of PV output vs voltages at different irradiance intensities at a steady ambient temperature. The greater the light intensity, the bigger the electricity flow that can be made.[7][8]

V. TILT ANGLE AND IRRADIATION EFFECTSON PV PANEL PERFORMANCE

Table 1. Panel specifications

Materials	**Mono-crystalline silicon (m-Si)**
Model number	SY-90M
Brand name	Shaiyang
Manufacturing Country	Hebei, China
Number of cells	36 (4 x 9)
Maximum power	90 W
Vmp (V)	18.36
Imp (A)	4.9
Voc(V)	22.03
Isc(A)	5.3
Size of cell (mm)	125 x 125
Size of the module (mm)	1200 x 544 x 35
Weight (kg)	7.0

TEST CONDITIONS:
(i) Maintaining a steady irradiation of 750W/m2
(ii) Changing the tilt angle as well as the irradiation

The tilt angles used in these two trials should be between 0 and (-15°) depending on the location's latitude. Total content was reduced due to this calculation of the ideal tilt arrangement in the range of 15°. (The percentage is less than 5%.) The study looked at the influence of tilt (from 0 to 85 degrees) on Photovoltaic performance and module electrical attributes at a constant irradiance strength of 750 W/m2 and varied irradiance intensity (200 – 1000 W/m2). A solar simulation with 90 halogen lights in series and in parallel combinations provides varied irradiance strengths to the module in the testing environment. [1]

CASE (i): Keeping the irradiation at 750W/m2 and adjusting the tilt angle by 5degrees

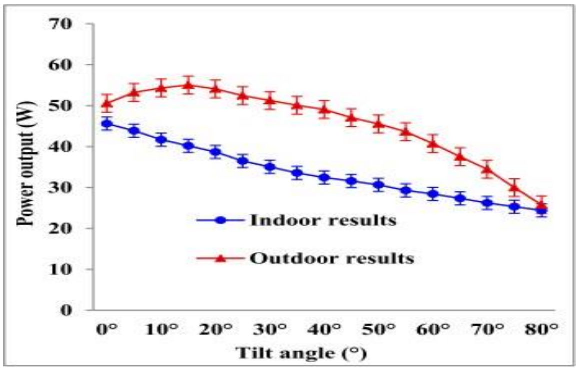

Figure 3. At a 750 W/m2 irradiation intensity, power production against tilt angle

Figures 3 and 4 show the effect of altering modules tilt on energy production and performance at a 750 W/m2 radiation intensity. With increased tilt, both electricity production and performance are expected to decrease. Figure 3 shows that for every 5o increase in tilt, electricity generation drops by 2.09 W inside and 3.45 W outdoors. Indoors, a 5o rise in tilt angle reduces efficiency by 0.54 %, whereas outside, it decreases performance by 0.76 percent. The module tilt affects the temperature dependence of the power output; as the temperature dependence grows, the equivalent value of the ideal inclination angle at the larger values points drops.

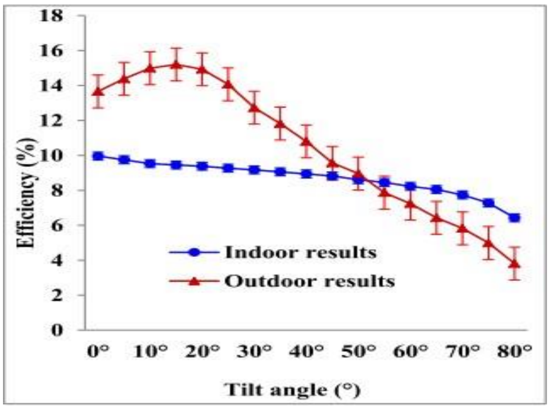

Figure 4. At a 750 W/m2 irradiation intensity, efficiency varies with tilt angle

Figure 5 shows the solar cell temperature as a function of the inclination angle. Increasing the angle of inclination reduces the temperature of the cell in both indoor and outdoor conditions. The maximum temperature of the module decreases due to the failure of the surface area of the PV to block the sun's rays properly when the module is tilted.

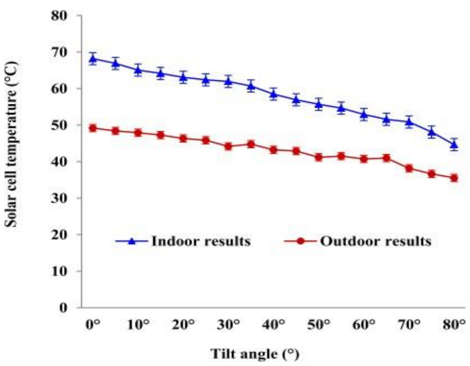

Figure 5. Temperature of solar cells as a function of module tilt at 750 W/m2

PV Electrical parameters output:

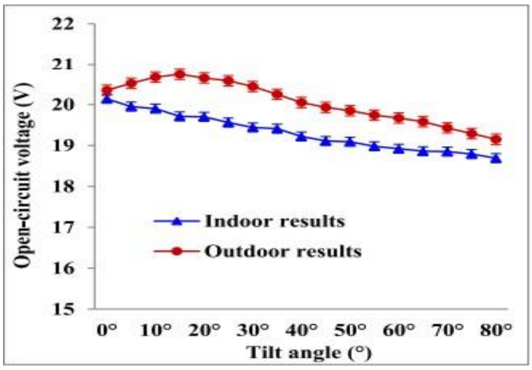

Figure 6. PV electrical characteristics for open-circuit voltage as a function of tilt angle at 750 W/m2 (Voc),

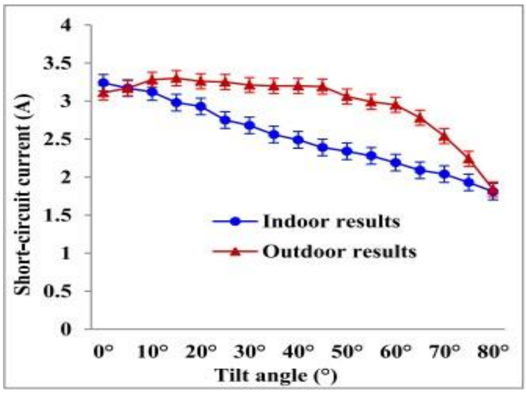

Figure 7. PV electrical characteristics for short-circuit current as a function of tilt angle at 750 W/m2 (Isc)

Case (ii): Changing the tilt angle as well as the irradiation

The spectral distance to measure the intensity of irradiance is between 300 and 1100 nm, and the determining range is between 0 and 1500 W / m2.

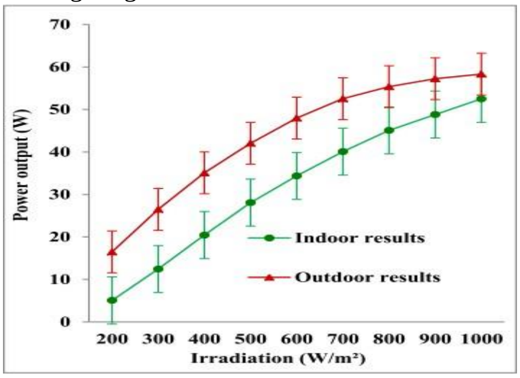

Figure 8. Irradiation intensity vs. power output

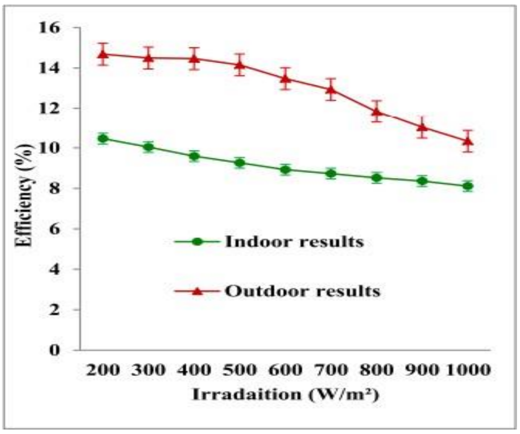

Figure 9. Efficiency versus irradiation intensity

Results and discussion:

■ Power output decreases by 2.09 W indoors and 3.45 W outside of all 5o rises module.

■ When the inclination angle is raised from 0o to 15o, efficiency decreases by 0.54 percent indoor and out by 0.76 percent.

■ When the inclination angle is increased by 5 °, solar cell temperature drops by 3.62 ° C indoors and 2.70 ° C outside. Power production increases by 4.06 W indoors as well 5.56 W without any 100 W / m2 increase in radiation intensity, while efficiency decreases 1.01 percent indoors and 1.44 percent outside. [1][9][10].

VI. EFFECT OF LIGHTS WITH DIFFERENT WAVELENGTH

Most LED lights have a wavelength distribution of 0.46m to 0.636m. From short to long, the waves are represented by blue, green, yellow-green, yellow, yellow-orange, and red. Blue-0.47m, blue-green- 0.505m, green-0.525m, yellow-0.59m, and green-0.525m, 0.615m orange, and 0.625m for red high frequency variations of standard LEDs.

With the same 110lx light intensity, this color-changing LED light can emit blue, green, green, orange, yellow, and red light, representing six different light waves.[11][12].

Table 2: Various parameters for different wavelengths

	Blue	Blue green	Green	Yellow	Orange	Red
Wavelength (um)	0.47	0.505	0.525	0.59	0.615	0.625
Current(mA)	0.09	0.12	0.13	0.20	0.31	0.33
Voltage (mV)	2.8	3.3	3.6	5.8	8.7	9
Power(nW)	0.252	0.396	0.468	1.16	2.697	2.97

VII. METHODS TO IMPROVE EFFICIENCY OF SOLAR PV PANELS

Focused on enhancing the efficiency of photovoltaic panels using multiple strategies to boost power and efficiency, the first approach utilizing a solar tracker with the panel that tracks the sun continually throughout the day to collect maximum solar energy. Dust cleaning is the second approach for increasing efficiency. Between the solar panel and the sun, dust acts as a barrier. The cooling procedure is the third approach. Another technique is to cover the solar panel with an anti-reflection coating, which increases the efficiency of the panel. Mirrors that function as reflectors can also aid to boost the panel's efficiency.

Cooling:

When the temperature of solar cells climbs from 46o C to 84oC under intense sun radiation, their performance drops by half. As a result, an effective cooling system is required to enhance solar cell performance while also preventing deterioration and damage. Active and passive cooling options are available for photovoltaic panels. The distinction between active and passive systems is that active systems require an external power source to operate, whereas passive systems do not. The majority of the research concentrated on cooling photocells with various approaches in order to lower the cell's surface temperature and enhance power with improved efficiency. Because the output voltage of the solar panel drops as the panel temperature rises, it is required to cool the panel to enhance efficiency.[13][14][15].

VIII. CONCLUSON

Many factors contribute to the emission of solar energy, one of which is the inclination of the module. Moving angle is one of the control parameters in the reflection of solar light performance, which is important for the performance of the PV system. The impact of various tilt angles on the performance of PV module and electrical attributes has been investigated using both internal and external tests. The angular shape of the PV modules has been found to have a significant impact on their electrical performance. Making a few changes to the tilt angle of the module can significantly reduce the cost of using staff or tracker engines. Mirrors and cooling help increase efficiency. The power output of a simple solar panel without mirrors was 24 watts, while the output power of a solar panel with mirrors and cooling was 37.709 watts, which means that instead of buying a new solar panel, the device could receive 52 percent more solar panel. According to the sources of this work, PV panels are often placed at fixed angles, so we must choose the right angle that will result in the highest performance.

REFERENCES

[1] M.A.A. Mamun, M.M. Islam, M. Hasanuzzaman, ,Jeyraj Selvaraj, “Effect of tilt angle on the performance and electrical parameters of a PV module: Comparative indoor and outdoor experimental investigation” Southwest Jiatong University, 2666-1233/Copyright, 2021 Elsevier B.V. provided publishing services on behalf of KeAi Communication Co. Ltd.

[2] Begum, S., Banu, R., Ahammed, G.A. and Parameshachari, B.D., 2017, December. Performance degradation issues of PV solar power plant. In *2017 International Conference on Electrical, Electronics, Communication, Computer, and Optimization Techniques (ICEECCOT)* (pp. 311-313). IEEE.

[3] Priya Gupta, K.S.Sandhu “Performance Analysis of Solar panel under different operating conditions”, The Third International Conference on Electronics, Communication, and Aerospace Technology (ICECA 2019) has published its proceedings. IEEE Xplore ISBN: 978-1-7281-0167-5; IEEE Conference Record # 45616

[4] Handbook of Energy Efficiency and Renewable Energy, edited by F. Kreith and D. Y. Goswami. Taylor & Francis Group, CRC Press, 2007.

[5] Martin Gahid, Pavol Spanik University of Zilina Department of Mechatronics and Electronics Zilina, Slovakia

[6] T.U. Townsend, Master's Thesis, University of Wisconsin-Madison, 1989, "Simplified Performance Modeling of a Direct-Coupled Photovoltaic Systems."

[7] Zhiqiang Gao, Song Li, Xuesong Zhou, Youjie Ma,” An Overview of PV System, The 2016 IEEE International Conference on Mechatronics and Automation was held in Harbin, China, from August 7 to 10.

[8] Esram T, Chapman P L, comparison of photovoltaic array maximum power point tracking techniques [J]. IEEE. Transactions on Energy Conversion, 2007, 22: 439-449.

[9] A. Hafez, A. Soliman, K. El-Metwally, I. Ismail, Tilt and azimuth angles in solar energy applications–a review, Renew. Sust. Energ. Rev. 15 (2011) 713–720

[10] "Handbook of Photovoltaic Science and Engineering, 2nd Edition," Wiley, December 2010, ISBN 978-0-470-72169-8. A Luque, S. Hegedus, "Handbook of Photovoltaic Science andEngineering, 2nd Edition," Wiley, December 2010, ISBN 978-0-470-72169-8.

[11] Aram Mohammed Ahmed, Dr. Suad Hassan Danook Al-Kitab University's 2nd International Conference on Engineering, Technology, and Science will be held on December 4-5, 2018.

[12] Mustafa Q. Ali1,, Monaf S. Tapou1 , Hayder A. Dhahad,” Under LabVIEW Platform, Fully Automated Measurement Setup for Photovoltaic Panel Performance Evaluation andTesting” 132-150 in Journal of Advanced Research in Fluid Mechanics and Thermal Sciences, Volume 77, No. 1 (2021).

[13] "Physics of the Thermal Behavior of Photovoltaic Devices," by Olivier Dupré. INSA, Lyon, PhD diss., 2015.

[14] "Effects of passive cooling on performance of silicon photovoltaic cells," by Erdem Cuce, Tulin Bali, and Suphi Anil Sekucoglu. 299-308 in International Journal of Low- Carbon Technologies, vol. 6, no. 4 (2011).
[15] Luque, G. Sala, and I. L. Heredia, “Photovoltaic concentration at the onset of its commercial deployment,” Progress in Photovoltaics: Research and Applications, vol. 14, no. 5, pp. 413–428, 2006.