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Polycrystalline and Monocrystalline Solar Panels Outdoor Performance Comparison inAkwa Ibom, Nigeria

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ABSTRACT
Solar panels are used to convert light from the sun into electricity that can be used to power electrical loads. In Nigeria, electricity is a major problem for its citizens and the available solution is electricity from the sun through solar panel. The most commonly used panels are the monocrystalline and polycrystalline solar panels. The aim of this paper is to determine the better performing crystalline solar panel technology between polycrystalline and monocrystalline technology in Uyo, Akwa Ibom. The optimal tilt angle was found out to be 20° when facing South. The solar panels were placed at 20° and the corresponding voltage and currents were measured at time interval of one hour from 7:00am to 6:00pm for twenty-eight days. The results show that the polycrystalline panel produced an average outpower of 85.91W while the monocrystalline panel produced and average outpower of 80.13W. Thus, polycrystalline panel performed better than monocrystalline panel under uyo meteorological condition.

KEYWORDS: *Solar panel, Monocrystalline, Polycrystalline, Voltage, Current, Power*

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I. INTRODUCTION

The request for electrical power to meet the demands of the society is increasing at a disturbing rate in most nations of the world, especially in Nigeria. To meet these demands, numerous Nigerians are presently looking for alternate sources of energy other than the rapidly exhausting and contaminating fossil powers that the current infrastructure has gotten to be depending on.

As the non-renewable energy sources will be consumed after a particular period and as their generation is exceptionally costly, it becomes compulsory to decide alternative fuel sources and to gain from these sources with high proficiency. Also, the utilization of fuel sources which can't be recharged at an enormous degree had altogether expanded the environmental problems.Thus, inclination towards sustainable power sources with low ecological impacts is beneficial.

The use of solar energy (photovoltaic) to meet residentialenergy needs have been promoted for some years now inNigeria by some renewable energy companies [1]. This wasdue to the numerous advantages that solar energy hascompared to fossil fuels.The energy flows of renewable energy sources are described as which are substituted as they are used at the same speed. All on earth, renewable energy sources are the result of the influence of solar radiation, which can be transformed directly or indirectly to energy by the use of various technologies.

Solar energy is the energy produced directly by the sun in form of radiation and captured on earth for practical ends especially for generation of electricity [2]. A PV module is an assembly of photo-voltaic cells mounted in a framework for installation. Photo-voltaic cells use sunlight as a source of energy and generate direct current electricity. Photovoltaic energy conversion in solar cells consists of two essential steps. First, absorption of light generates an electron-hole pair. The electron and hole are then separated by the structure of the device; electrons go to the negative terminal and holes to the positive terminal, in effect generating electrical power.

The most commonly used solar technology is the crystalline technology which is made up of three main types; Monocrystalline panelwhich are made from pure silicon, the solar cells appear black in color and reaches 20%. Polycrystalline panels are made from silicon but the polycrystalline cells are made from fragment of the silicon crystal melted together, they appear blue in color and reaches 15-17% efficiency. Thin film is not always made from silicon, they can be made from a variety of materials including cadmium telluride(CdTe), amorphous silicon(a-Si) and Copper Indium Gallium Selenide (CIGS). A collection of PV modules is called a PV Panel, and a system of Panels is an Array. Arrays of a photovoltaic system supply solar electricity to electrical equipment.

A collection of PV modules is called a PV Panel, and a system of Panels is an Array. Arrays of a photovoltaic system supply solar electricity to electrical equipment.Uyo is the capital of Akwa Ibom which is located in southern part of Nigeria with latitude 5.03°N, 7.91°E.Within the scope of this experiment, monocrystalline 130W and polycrystalline 130W are used.

II. MATERIAL AND METHOD

In this study, the outdoor experiment was conducted in October,2020 under meteorological conditions in Uyo, Akwa Ibom state, Nigeria. The system testing model includes 130W monocrystalline panel (664x1179x35)mm and 130W polycrystalline panel (680x1480x35)mm, a multimeter to measure the voltage and current from the panel. In other to obtain electric energy from the solar panel systems in the most efficient manner, the panels should be positioned to be perpendicular to sunlight and to face the south [3].

Using tracking systems is the best way to collect maximum daily energy. This mechanical device follows the direction of the sun all day. The trackers are expensive, need energy for generation and are not always applicable. Therefore, it is often practicable to orient the solar panel at an optimum tilt angle. [4]. The solar panel was thus oriented at various angles and20° tilt angle gave the best output value when measured and thus adopted for this outdoor experiment. The outputs of the mono and poly crystalline panels were measured with a multimeter at an hourly interval from 7:00am to 6:00pm for 28 days.

III. RESULT AND DISCUSSION

1.1 Day 1 data for Monocrystalline and Polycrystalline solar panels

TIME (AM/PM)	VOLTAGE (V)	CURRENT (A)	POWER (W)	WEATHER
7:00	18.4	0.32	5.88	FAIR
8:00	19.4	0.87	16.87	FAIR
9:00	20.0	4.18	83.60	SUNNY
10:00	19.5	6.08	118.56	SUNNY
11:00	20.0	6.83	136.60	SUNNY
12:00	19.2	1.64	31.48	FAIR
1:00	19.8	1.98	39.20	SUNNY
2:00	20.0	2.98	59.60	SUNNY
3:00	20.0	5.50	110.00	SUNNY
4:00	19.8	2.12	41.97	SUNNY
5:00	17.7	0.28	4.95	FAIR
6:00	14.9	0.07	1.04	FAIR

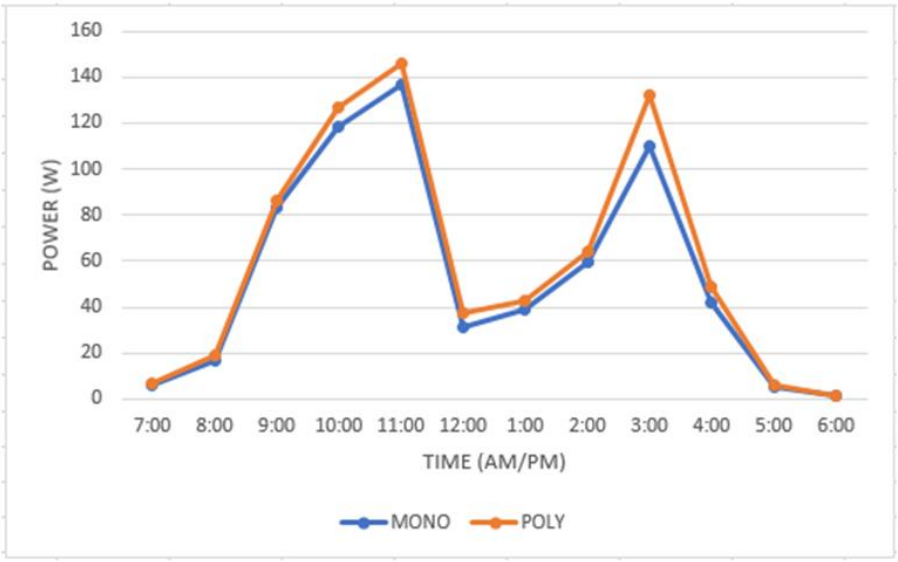
Table 1: Monocrystalline Solar Panel Data

TIME (AM/PM)	VOLTAGE (V)	CURRENT (A)	POWER (W)	WEATHER
7:00	18.6	0.38	7.06	FAIR
8:00	19.7	0.95	18.71	FAIR
9:00	20.0	4.30	86.00	SUNNY
10:00	19.5	6.50	126.75	SUNNY
11:00	20.0	7.30	146.00	SUNNY
12:00	19.4	1.92	37.248	FAIR
1:00	20.0	2.12	42.40	SUNNY
2:00	20.0	3.21	64.20	SUNNY
3:00	20.0	6.60	132.00	SUNNY
4:00	20.3	2.42	49.12	SUNNY
5:00	17.9	0.33	5.91	FAIR
6:00	16.4	0.07	1.14	FAIR

Table 2: Polycrystalline Solar Panel Data

From tables 1 and 2, during sunny weather condition the solar panels gave high outputs data unlike in fair weather that the outputs are relatively low. Polycrystalline panel has higher output readings than the monocrystalline panel.

Figure 1: Power Generated by Monocrystalline and Polycrystalline Panels on Day 1



1.2 Day 28 data for monocrystalline and polycrystalline solar panels

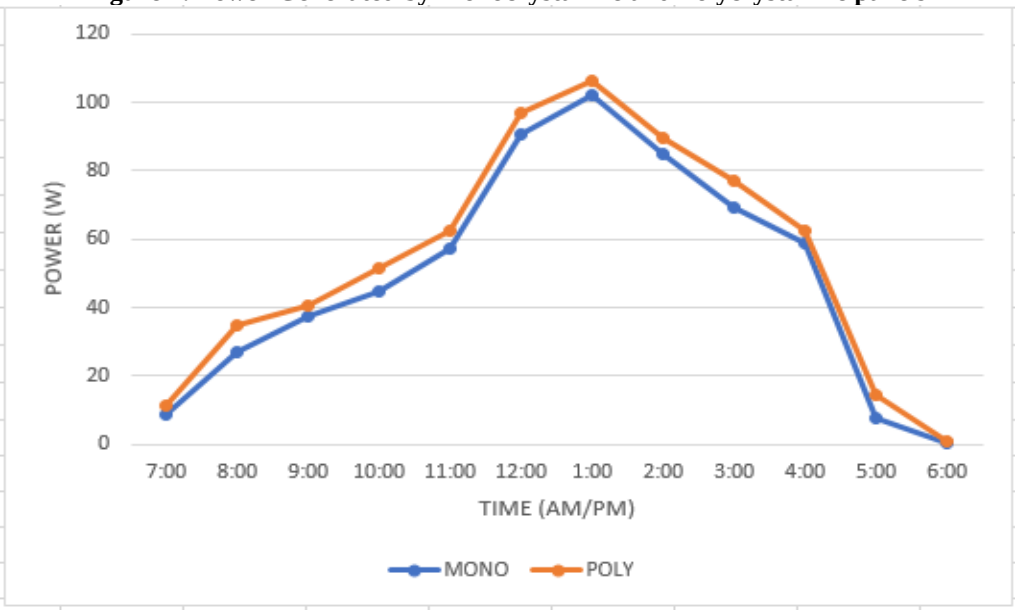
TIME (AM/PM)	VOLTAGE (V)	CURRENT (A)	POWER (W)	WEATHER
7:00	18.4	0.62	11.40	FAIR
8:00	19.5	1.78	34.71	FAIR
9:00	19.8	2.06	40.78	SUNNY
10:00	20.2	2.56	51.71	SUNNY
11:00	20.3	3.08	62.52	SUNNY
12:00	20.4	4.75	96.90	SUNNY
1:00	20.4	5.20	106.08	SUNNY
2:00	20.3	4.42	89.72	SUNNY
3:00	19.9	3.86	76.81	SUNNY
4:00	19.4	3.21	62.27	FAIR
5:00	18.6	0.78	14.50	FAIR
6:00	17.2	0.06	1.03	FAIR

Table 3: Monocrystalline Panel Data

TIME (AM/PM)	VOLTAGE (V)	CURRENT (A)	POWER (W)	WEATHER
7:00	18.2	0.47	8.55	FAIR
8:00	19.2	1.41	27.07	FAIR
9:00	19.6	1.92	37.63	SUNNY
10:00	19.8	2.26	44.74	SUNNY
11:00	20.0	2.87	57.40	SUNNY
12:00	20.2	4.48	90.49	SUNNY
1:00	20.2	5.06	102.21	SUNNY
2:00	20.1	4.23	85.02	SUNNY
3:00	19.6	3.54	69.38	SUNNY
4:00	19.1	3.07	58.63	FAIR
5:00	18.2	0.43	7.82	FAIR
6:00	16.5	0.04	0.66	FAIR

Table 4: Polycrystalline Panel Data

Figure 2: Power Generated by Monocrystalline and Polycrystalline panels



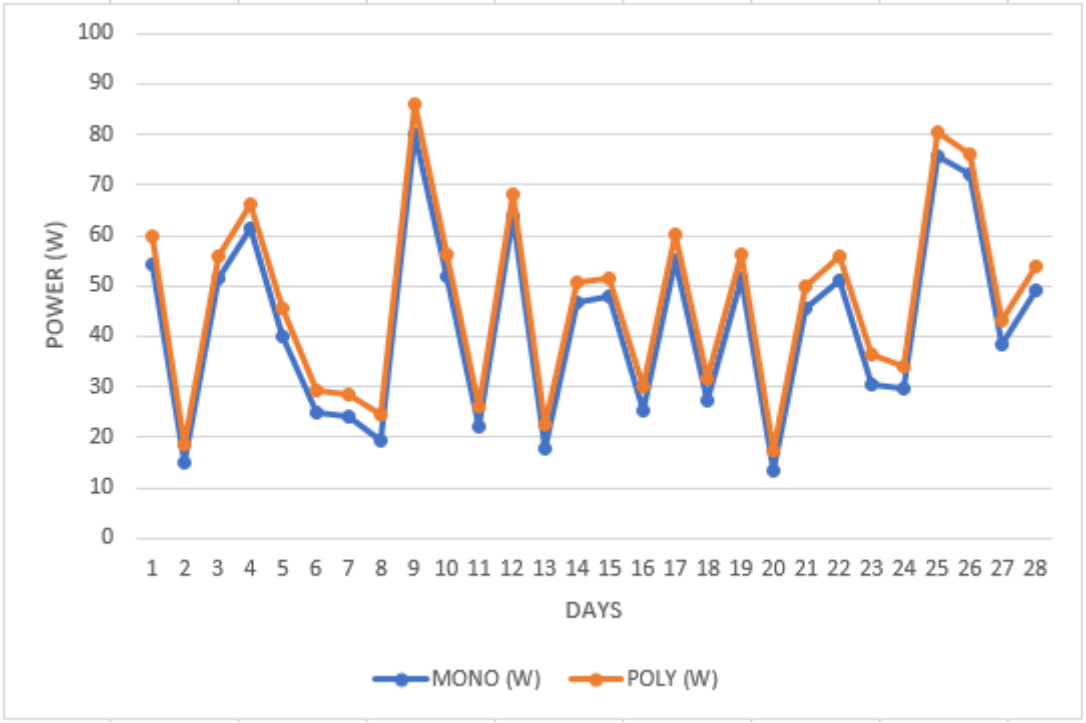
1.3 Daily Average Power Generated By Both Panels For 28 Days

Table 5: Mono and Poly Crystalline Daily Average Power

DAYS	1	2	3	4	5	6	7	8	9	10	11	12	13	14
MONO (W)	54.15	14.86	51.33	61.56	40.12	24.71	23.96	19.18	80.13	51.71	22.12	63.69	17.87	46.79
POLY (W)	59.71	18.64	55.92	66.20	45.56	29.22	28.48	24.57	85.91	56.28	26.02	67.96	22.64	50.86

DAYS	15	16	17	18	19	20	21	22	23	24	25	26	27	28
MONO (W)	47.86	25.28	55.08	27.28	51.63	13.44	45.64	51.18	30.42	29.54	75.60	71.97	38.41	49.13
POLY (W)	51.65	30.17	60.22	31.75	56.17	17.51	49.94	55.72	36.29	34.11	80.27	76.13	43.26	53.78

Figure 3: Daily Average Power Generated per Day by Monocrystalline and Polycrystalline panels



The tilt angle used for was within the scope of this work which was 20° with solar panel facing south. From the test conducted it was observed that the highest average reading values of both monocrystalline and polycrystalline panels between 11:00am and 1:00pm daily on an average sunny day.

From figure 3, the average highest power reading was obtained on day 9 of the experiment with 80.13W for monocrystalline and 85.91W for polycrystalline due to the sunny weather for the day. The lowest average reading was observed on day 20 with 13.44W for monocrystalline and 17.51W for polycrystalline panel due to the cloudy nature of the day.

IV. CONCLUSION

From the results of the outdoor experiment conducted in uyo, Akwa Ibom State. The solar panel facingsouth at 20° tilt angle had the polycrystalline panel having a higher current and voltage readings than the monocrystalline panel which thus results in higher output power for polycrystalline panel over the monocrystalline panel.

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