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Air Humidity Measurement Through Solar Panel

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ABSTRACT

In this work, we will examine the placement of solar panels at certain heights to obtain optimal efficiency. To prove the effect of altitude and humidity, the authors conducted tests in areas with different altitudes and different temperatures, namely in the areas of Medan and Berastagi cities, where the city of Medan is located at an altitude of 2.5-7.5 meters above sea level, and the city area of Berastagi is higher, namely at an altitude of 1220 meters above sea level. The distance between the two areas is around 70 km and can be reached in approximately 2 hours of travel. With different altitudes and different climates, the authors are very interested in studying and researching how the effectiveness of solar panels is at different altitudes and humidity level and how it affects the Medan area, which has a tropical climate, and Berastagi, which has a cold climate.

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1. INTRODUCTION

Solar technology occupies an important part in the evolution of electricity generation, given that the sun is the world's abundant source of renewable energy. Solar energy is considered the most preferred renewable energy source because it is abundant in nature and the least harmful to the environment when compared to other energy sources. The performance of solar panels is influenced by several things, one of which is the intensity of solar radiation. The power received by the sun is about 1300 W per hour per meter of earth every day. This solar energy can be used using solar panels everywhere around the world (photovoltaic generation). With the growing demand for new sources of energy, solar power has become an attractive solution to the current energy crisis. Unfortunately, the solar tracking system is a difficult problem and an area of research in today's world [1]–[7].This work wants to show how much influence the effectiveness of solar panels has by placing them at different heights. The higher the place, the lower the humidity, and the lower the place, the higher the humidity. Seeing the different geographical location and climate of Indonesia, where it gets sunlight every year, the installation of solar panels is certainly inseparable from the influence of the climate in an area. So the installation of solar panels must be placed in areas or places that really do not affect their quality and efficiency [8]–[11].

In addition to improving the quality of the power produced by a solar panel, many things must be considered, starting with the intensity of the light emitted by the sun, the temperature around the panel and the installation placement of the panel itself, as well as the humidity. As well as some of the variables that affect the performance of a solar panel depending on the geographic location of the system, angle of installation, time of year, and clipping characteristics, the daily energy delivery of a system can depend heavily on the performance of the module at low levels of radiation. Determining the optimal position of the solar collector is critical for maximum benefit from solar energy received by solar panels and facilities, including those of such large sizes as concentrated solar energy systems or large-scale solar photovoltaic installations [12]–[14].

2. METHOD

The steps that are taken in this study were a literature study, analyzing voltage and current comparison in the Medan area which is located at an altitude of 2.5 -37.5 meters above sea level, and the Berastagi city area is higher, namely at an altitude of 1220 meters above sea level, with PLTS which is monocrystalline 10 watt peak (WP) on grid [15]–[17]. Measurements of voltage, current, humidity were carried out on November 13th - November 18th, 2022. The data collection stage is 1 hour apart and use pick-up time from 09.00 – 16.00 WIB. And this data collection under sunny weather conditions in both places. The processing procedure is as shown in Figure 1.

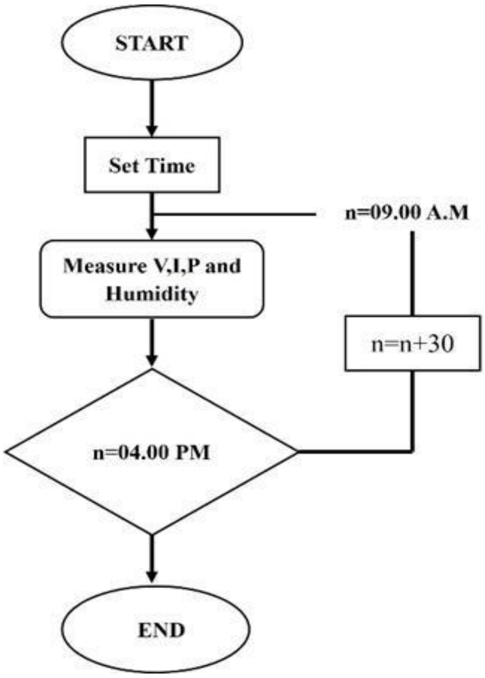

Figure 1. Flowchart

The solar panel used was a monocrystalline 10 WP solar panel. The specifications of the solar panels are shown in table 1 below. It has short current circuit of 0.63 A and maximum voltage of 17.82 V.

Table 1. Solar panel specification

Specification	Explanation
Model Panel	GH10M-18
Voltage	21,96 volt
Maximum Power	10 watt
Short Circuit Current	0.63 A
Maximum Voltage	17.82 volt

3. RESULTS AND DISCUSSIONS

The following is the data obtained during data collection in the cities of Medan and Berastagi for 6 consecutive days. The humidity is measured using a hygrometer.

Table 2. Data collection, day 1

Time (WIB)	MEDAN				BERASTAGI			
	Voltage (V)	Current (I)	P=V*I	Humidity (%)	Voltage (V)	Current (I)	P=V*I	Humidity (%)
9:00	11.42	0.25	2.855	52	12.65	0.32	5.313	57
10:00	14.84	0.55	8.162	48	12.78	0.42	5.367	49
11:00	15.05	0.61	9.1805	30	14.18	0.48	6.806	40
12:00	15.15	0.62	9.393	29	15.15	0.61	9.241	35
13:00	14.16	0.49	6.9384	40	14.2	0.5	7.1	51
14:00	14.08	0.5	7.04	40	11.44	0.26	2.974	43
15:00	11.25	0.24	2.7	50	11.3	0.25	2.825	41
16:00	11.8	0.27	3.186	50	10.91	0.2	2.182	56

Table 3. Data collection, day 2

Time (WIB)	MEDAN				BERASTAGI			
	Voltage (V)	Current (I)	P=V*I	Humidity (%)	Voltage (V)	Current (I)	P=V*I	Humidity (%)
9:00	11.77	0.28	3.295	55	11.03	0.22	2.426	46
10:00	14.76	0.54	7.97	49	12.04	0.31	3.732	47
11:00	15.11	0.62	9.368	37	14.39	0.54	7.777	37
12:00	15.01	0.58	8.705	37	15.33	0.63	9.657	34
13:00	11.72	0.28	3.281	45	13.44	0.44	5.913	58
14:00	12.15	0.32	3.888	40	11.82	0.29	3.427	43
15:00	13.11	0.41	5.375	49	10.56	0.18	1.9	58
16:00	11.27	0.25	2.817	55	10.99	0.22	2.417	56

Table 4. Data collection, day 3

Time (WIB)	MEDAN				BERASTAGI			
	Voltage (V)	Current (I)	P=V*I	Humidity (%)	Voltage (V)	Current (I)	P=V*I	Humidity (%)
9:00	12.17	0.33	4.016	50	11.31	0.24	2.714	55
10:00	14.28	0.52	7.425	45	12.51	0.36	4.503	42
11:00	15	0.56	8.4	40	12.47	0.22	2.743	44
12:00	15.18	0.58	8.804	39	15.23	0.62	9.442	35
13:00	14.05	0.52	7.306	40	13.36	0.44	5.878	58
14:00	14.93	0.58	8.211	40	11.7	0.28	3.276	42
15:00	14.05	0.52	7.306	49	11.25	0.24	2.7	41
16:00	11.7	0.26	3.402	55	10.31	0.16	1.649	68

Table 5. Data collection, day 4

Time (WIB)	MEDAN				BERASTAGI			
	Voltage (V)	Current (I)	P=V*I	Humidity (%)	Voltage (V)	Current (I)	P=V*I	Humidity (%)
9:00	12.15	0.32	3.888	45	11.12	0.23	2.557	53
10:00	14.41	0.53	7.637	38	12.61	0.36	4.539	45
11:00	15.06	0.54	8.132	30	12.27	0.21	2.576	44
12:00	15.26	0.59	9.003	30	15.07	0.58	8.74	30
13:00	14.05	0.52	7.036	38	11.82	0.29	3.427	43
14:00	14.1	0.52	7.332	38	11.31	0.25	2.827	43
15:00	13.39	0.43	5.757	40	10.74	0.19	2.04	64
16:00	12.65	0.32	4.048	45	11.04	0.22	2.428	43

Table 6. Data collection, day 5

Time (WIB)	MEDAN				BERASTAGI			
	Voltage (V)	Current (I)	P=V*I	Humidity (%)	Voltage (V)	Current (I)	P=V*I	Humidity (%)
9:00	13.11	0.41	5.375	40	11.11	0.22	2.444	56
10:00	13.28	0.42	5.577	39	13.15	0.41	5.391	40
11:00	15.06	0.54	8.132	34	12.15	0.19	2.308	46
12:00	15.34	0.63	9.664	30	13.87	0.48	6.657	41
13:00	15.4	0.64	9.856	30	14.02	0.49	6.869	50
14:00	14.14	0.53	7.494	35	11.7	0.29	3.393	55
15:00	14.1	0.52	7.332	37	13.11	0.41	5.375	41
16:00	13.1	0.42	5.502	36	10.91	0.2	2.182	56

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Table 7. Data collection, day 6

Time (WIB)	MEDAN				BERASTAGI			
	Voltage (V)	Current (I)	P=V*I	Humidity (%)	Voltage (V)	Current (I)	P=V*I	Humidity (%)
9:00	13.14	0.44	5.781	50	11.83	0.29	3.43	52
10:00	13.22	0.48	7.799	40	12.61	0.36	4.539	40
11:00	15.26	0.59	9.003	34	13.02	0.4	5.208	40
12:00	16.62	0.65	10.803	26	13.37	0.42	5.615	39
13:00	15.2	0.55	8.36	30	12.33	0.34	4.192	52
14:00	14.84	0.55	8.162	28	11.33	0.25	2.832	43
15:00	14.16	0.53	7.504	28	10.76	0.19	2.044	63
16:00	14.09	0.52	7.326	36	10.32	0.16	1.651	56

As shown in Table 2, the highest voltage in Medan occurred at 12.00 WIB at 15.15 V, and the lowest occurred at 15.00 WIB at 11.30 V. Meanwhile, for the Berastagi area, the highest voltage occurred at 12.00 WIB at 15.15 V and the lowest at 16.00 WIB at 10.91 V. The highest current in Medan occurred at 12.00 WIB of 0.62 A, and the lowest occurred at 15.00 WIB of 0.24 A. Meanwhile, for the Berastagi area, the highest current occurred at 12.00 WIB at 0.61 A and the lowest at 16.00 WIB at 0.20 A. The highest power in the Medan area occurs at 12.00 WIB as much as 9,393 W, and the lowest occurs at 15.00 WIB as many as 2,700 watt. Meanwhile for the Berastagi area, the highest power occurred at 12.00 WIB at 9,241 W and the lowest at 16.00 WIB at 2,182 W. From Figure 2 it can be seen that the highest humidity in the Medan area occurs at 09.00 WIB as much as 68%, and the lowest occurs at 12.00 WIB as much as 29%. Meanwhile for the Berastagi area the highest humidity occurs at 16.00 WIB as much as 68% and the lowest at 12.00 WIB as much as 35%.

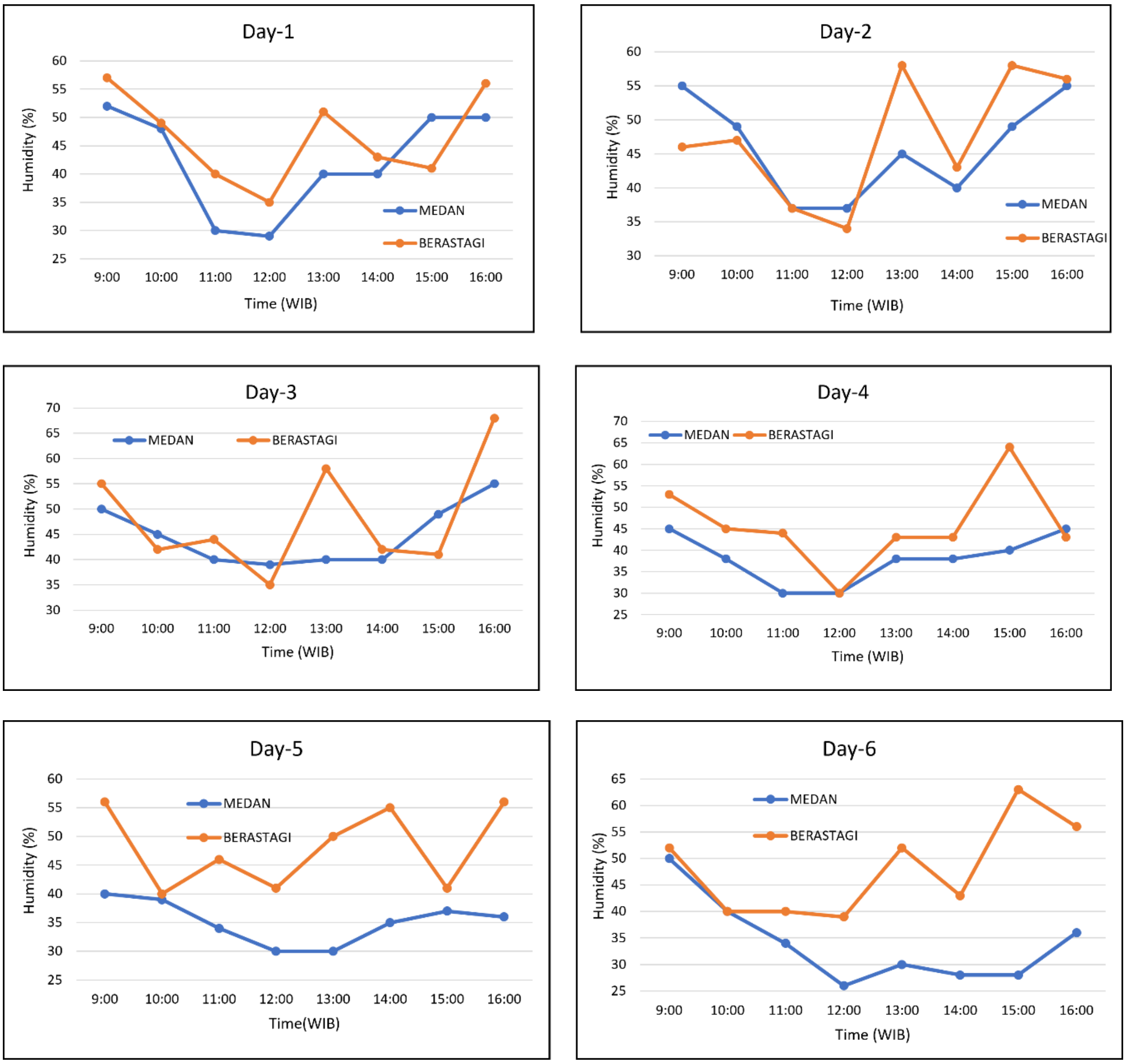

Figure 2 Comparison graphs of humidity in two cities during 9.00 to 16.00 WIB of 6 days observation

From Table 3, it can be seen that the highest voltage in the Medan area occurred at 11.00 WIB at 15.11 V, and the lowest occurred at 16.00 WIB at 11.27 V. Meanwhile, for the Berastagi area, the highest voltage occurred at 12.00 WIB at 15.33 V and the lowest at 15.00 at 10.56 V. The highest current in the Medan area occurred at 11.00 WIB at 0.62 A, and the lowest occurred at 09.00 WIB and 13.00 WIB at 0.28 A. Meanwhile, for the Berastagi area, the highest current occurred at 12.00 WIB at 0.63 A and the lowest at 15.00 WIB at 0.18 A. The highest power in the Medan area occurred at 11.00 WIB at 9,368 W, and the lowest occurred at 16.00 WIB as much as 2,817 W. Meanwhile, for the Berastagi area, the highest power occurred at 12.00 WIB with 9,657 W and the lowest at 16.00 WIB with 2,417 W. From Figure 2 it can be seen that the highest humidity in the Medan area occurs at 09.00 and 16.00 WIB as much as 55%, and the lowest occurs at 11.00 and 12.00 WIB as much as 37%. Meanwhile for the Berastagi area the highest humidity occurred at 13.00 WIB as much as 58% and the lowest at 12.00 WIB as much as 34%.

From Table 4, it can be seen that the highest voltage in the Medan area occurred at 12.00 WIB at 15.18 V, and the lowest occurred at 16.00 WIB at 11.70 V. Meanwhile, for the Berastagi area, the highest voltage occurred at 12.00 WIB at 15.23 V and the lowest at 16.00 WIB at 10.31 V. The highest current in Medan occurred at 12.00 WIB and 14.00 WIB at 0.58 A, and the lowest occurred at 16.00 WIB at 0.26 A. Meanwhile, for the Berastagi area, the highest current occurred at 12.00 WIB at 0.62 As and the lowest at 16.00 WIB at 0.16 A. The highest power in the Medan area occurred at 12.00 WIB as much as 8,804 W and the lowest occurred at 16.00 WIB as many as 3,042 W. Meanwhile, for the Berastagi area, the highest power occurred at 12.00 WIB with 9,442 W and the lowest at 16.00 WIB with 1,649 W. From Figure 2 it can be seen that the highest humidity in the Medan area occurs at 16.00 WIB as much as 55%, and the lowest occurs at 15.00 WIB as much as 41%. Meanwhile for the Berastagi area the highest humidity occurred at 16.00 WIB as much as 68% and the lowest at 12.00 WIB as much as 39%.

From Table 5, the highest voltage in Medan occurred at 12.00 WIB at 15.26 V, and the lowest occurred at 09.00 WIB at 12.15 V. Meanwhile, for the Berastagi area, the highest voltage occurred at 12.00 WIB at 15.07 V and the lowest at 15.00 WIB at 10.74 V. The highest current in the Medan area occurred at 12.00 WIB of 0.59 A, and the lowest occurred at 09.00 WIB and 16.00 WIB of 0.32 A. Meanwhile for the Berastagi area, the highest current occurred at 12.00 WIB of 0.58 A and the lowest at 15.00 WIB of 0.19 A. The highest power in Medan occurred at 12.00 WIB as much as 9.003 W, and the lowest occurred at 09.00 WIB as many as 3.888 W. Meanwhile, for the Berastagi area, the highest power occurred at 12.00 WIB at 8,740 W and the lowest at 15.00 WIB at 2,040 W. From Figure 2 it can be seen that the highest humidity in the Medan area occurs at 09.00 WIB and 16.00 WIB at 45%, and the lowest occurs at 11.00 WIB and 12.00 WIB at 30%. Meanwhile, for the Berastagi area, the highest humidity occurs at 15.00 WIB at 64% and the lowest at 12.00 WIB at 30%.

From Table 6, the highest voltage in the Medan area occurred at 13.00 WIB at 15.40 V, and the lowest occurred at 16.00 WIB at 13.10 V. Meanwhile, for the Berastagi area, the highest voltage occurred at 13.00 at 14.02 V and the lowest at 16.00 at 10.91 V. The highest current in the Medan area occurred at 13.00 as much as 0.64 A, and the lowest occurred at 09.00 WIB as much as 0.41 A. In the Berastagi area, the highest current occurred at 13.00 WIB at 0.49 A and the lowest at 09.00 WIB at 0.22 A. The highest power in the Medan area occurred at 13.00 WIB as much as 9,856 W, and the lowest occurred at 09.00 WIB as many as 5,375 W. Meanwhile, for the Berastagi area, the highest power occurred at 13.00 WIB with 6,869 W and the lowest at 16.00 WIB with 2,182 W. From Figure 2 it can be seen that the highest humidity in Medan occurs at 09.00 WIB by 40%, and the lowest occurs at 12.00 WIB and 13.00 WIB by 30%. Meanwhile, for the Berastagi area, the highest humidity occurs at 16.00 WIB as much as 68% and the lowest at 10.00 WIB as much as 40%.

From Table 7, the highest voltage in Medan occurred at 12.00 WIB at 16.62 V, and the lowest occurred at 09.00 WIB at 13.14 V. Meanwhile in the Berastagi area, the highest voltage occurred at 12.00 WIB at 13.37 V and the lowest at 16.00 WIB at 10.32 V. The highest current in Medan occurred at 12.00 WIB of 0.65 A, and the lowest occurred at 09.00 WIB of 0.44 A. While in the Brastagi area, the highest current flow occurred at 12.00 WIB at 0.42 A and the lowest at 16.00 WIB at 0.16 A. The highest power in Medan occurred at 12.00 WIB at 10,803 W, and the lowest occurred at 09.00 WIB at 5,781 W. Meanwhile, for the Berastagi area, the highest power occurred at 12.00 WIB with 5,615 W and the lowest at 16.00 WIB with 1,651 W. From Figure 2, the highest humidity in Medan occurs at 09.00 WIB by 50%, and the lowest occurs at 12.00 WIB by 26%. Meanwhile, in the Berastagi area, the highest humidity occurs at 16.00 WIB as much as 63% and the lowest at 12.00 WIB as much as 39%.

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4. CONCLUSION

Based on the series of studies that have been carried out, several conclusions can be drawn, namely the research results also show that humidity affects the effectiveness of solar panels. And inversely proportional to the voltage, current, and power. Areas with tropical or lowland climates are more effective than highland areas or plains which tend to be humid, because high areas are vulnerable to cloud cover which can hinder the process of Solar Cell performance due to obstruction of sunlight. Low-lying areas are more effective than highland areas, because the ambient temperature is noticeably hotter and with stronger visible sunlight due to the lack of cloud cover. The results of a comparison of the voltage research in the lowlands and the highlands show that the voltage in the lowlands is greater, reaching 16.62 V and the lowest voltage is 11.25 V. The results of a comparison of current studies in the lowlands and the highlands show that the currents in the lowlands are greater, reaching 0.65 A and the lowest current is 0.25 A. Comparison of power research results in the lowlands and in the highlands shows that the plains in the lowlands are larger, reaching 10,803 W, the lowest power is 2,700 W. While the power in the highlands reaches 9,657 W and the lowest power is 1,649 W. The results of a comparison of humidity studies in the lowlands and in the highlands show that the lowlands achieve the highest humidity of 55%, the lowest humidity of 26%. While the humidity in the highlands reaches 68% at most and the lowest power is 35%.

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