Solar Energy Data for Three Consecutive Days at Bakas Tourist Village, Klungkung, Bali

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Abstract: Bakas is a tourist village in Banjarangkan District, Klungkung Regency, Bali Province, Indonesia. Research on solar irradiance in Bakas Village was conducted to determine the amount of solar energy per unit area (per unit area) that arrives at the surface at a certain angle measured in watts per square meter, W/m^2. This study collected solar irradiance data for horizontal surfaces from June to July 2022. The solar irradiance value is then integrated into the unit of time to obtain the solar irradiation value. We analyze the sum and average value of three consecutive days. The sum value of solar energy at Bakas Village in July 2022 appears more scattered with lower values than in June 2022. The average value of solar energy at Bakas Village in July 2022 also appears to fluctuate with lower values than in June 2022.

1 INTRODUCTION

Due to the geographical aspect, as modeled by Tambunan *et al*., the monthly maximum solar irradiance was in December 2014. In contrast, the maximum solar daily irradiance was on December 17 for Java and Bali islands. It is based on the National Aeronautics and Space Administration (NASA) predictions of the global energy resource (POWER) database (Tambunan *et al*., 2020).

Solar PV is planned to be the most dominant technology in terms of installed capacity, with 45 GWp in 2050, which would be 10.1% of the total and 26.8% of renewable capacity. For this, the roofs of up to 30% of government buildings and up to 25% of developed residential housing should be occupied by solar PV (Langer *et al*., 2021).

For the installed capacities, there are two open parameters in the basic system, i.e., the installed solar panel capacity and the installed storage capacity. These two parameters depend on each other. The larger the installed solar panel capacity, the smaller the storage capacity, and vice versa. There is a system configuration for which the solar panel capacity is at its minimum at the cost of large storage (Günther, 2018).

Sianturi stated that Indonesia's annual average of daily solar radiation in 2018 ranged from 3.0 to 5.6 kWh/m^2. The highest potential is observed over the southern part of Indonesia, particularly in Bali and Nusa Tenggara islands (Sianturi, 2018).

A review of solar energy potential in Indonesia based on the solar resource data is presented by Fathoni *et al*. Estimation of solar resources in Indonesia was done using solar radiation data from NASA Surface Meteorology and Solar Energy (SSE). Retscreen software was used for all of the calculations in the study. It is found that the proposed system can generate electricity annually, varying from 0.46 GWh/year in Denpasar to 217 GWh/year in Pontianak (Fathoni *et al*., 2014).

Another researcher, Saskara *et al*., stated that the HOMER application simulation results show that the energy potential in the two pilot projects is 3% and 39% greater than the actual energy. In addition, the solar panel rooftop on both pilot projects has a 20° slope solar panel, while the calculation results show an optimal slope is 15° (Saskara *et al*., 2018).

Our previous research concluded that the 150-Watt peak solar panel in Denpasar City, Bali has a

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maximum received wattage of 0.76 kW/day in October (Narottama *et al*., 2018). However, due to a lack of ground observation, we observe the solar energy potential in Bakas Village, Klungkung Regency, Bali Province, Indonesia, from June to July 2022. The results of observations are then used as the basis for forming a rooftop solar power plant.

2 METHODOLOGY

We collect the solar irradiation data at Bakas Village (-8.52173360274 lat, 115.364125576 lon). The map of Bakas Village is shown in Figure 1.

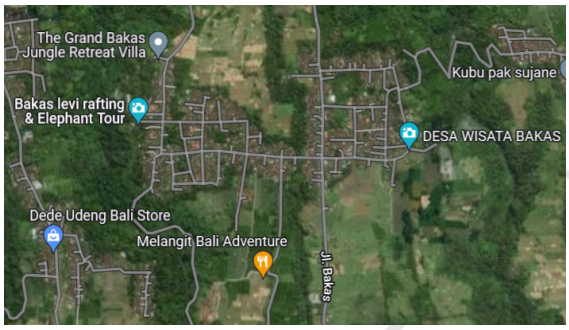

Figure 1: Map of Bakas Village.

The solar irradiation data was collected using Lutron SPM-1116SD device from June to July 2022 on a minute basis. We put the device in a position not blocked by buildings or trees at 6 meters from the ground. Furthermore, we process the data to obtain daily solar energy data. In this study, we analyze the sum and average of three consecutive days of solar energy at Bakas Tourism Village.

3 RESULT AND DISCUSSION

The solar energies at Bakas Village in June and July 2022 are shown in Figures 1 and 2. On June 2022, the sum and average of solar energy for three consecutive days have descriptive statistics as shown in Tables 1 and 2. Meanwhile, on July 2022, the sum and average of solar energy for three consecutive days have descriptive statistics as shown in Tables 3 and 4.

Tables 1 and 3 show that the standard deviation in July is greater than in June. It shows that in July, the sum value of solar energy for three consecutive days is farther away from the mean or more spread out, although it has a lower maximum and minimum value than June 2022. The mean value in June is 11407.69 Wh/m^2, while in July is 9104.79 Wh/m^2. Bakas Village gets a higher sum value of solar energy for three consecutive days in June.

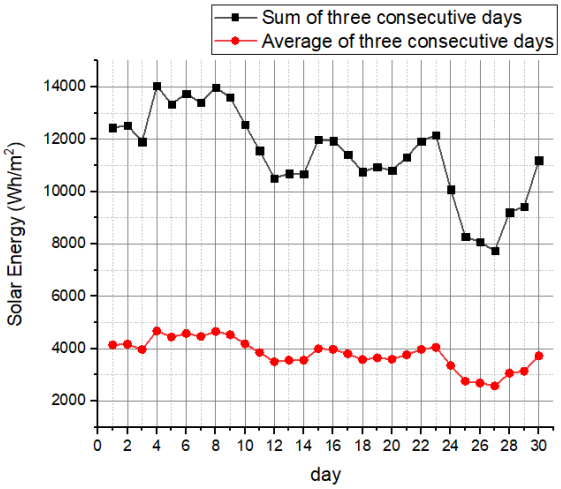

Figure 2: Solar energy at Bakas Village on June 2022.

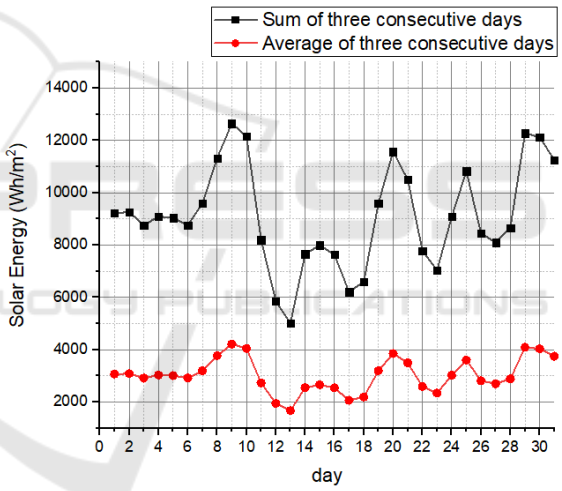

Figure 3: Solar energy at Bakas Village on July 2022.

Table 1: Sum of solar energy for three consecutive days on June 2022.

N total	Mean	Standard Deviation	Sum	Minimum	Median	Maximum
30	11407,69	1708,01	342230,72	7742,04	11485,67	14037,39

Table 2: Average solar energy for three consecutive days on June 2022.

N total	Mean	Standard Deviation	Sum	Minimum	Median	Maximum
30	3802,56	569,34	114076,91	2580,68	3828,56	4679,13

Table 3: Sum of solar energy for three consecutive days on July 2022.

N total	Mean	Standard Deviation	Sum	Minimum	Median	Maximum
31	9104,79	1984,65	282248,46	5017,42	9039,91	12645,52

Table 4: Average solar energy for three consecutive days on July 2022.

N total	Mean	Standard Deviation	Sum	Minimum	Median	Maximum
31	3034,93	661,55	94082,82	1672,47	3013,30	4215,17

Tables 2 and 4 also know that the standard deviation in July is greater than in June. It shows that in July, the average value of solar energy for three consecutive days is farther away from the mean or more spread out, although it has a lower maximum and minimum value than June 2022. The mean value in June is 3802.56 Wh/m^2, while in July is 3034.93 Wh/m^2. It means Bakas Village gets a higher average value of solar energy for three consecutive days in June.

4 CONCLUSIONS

The sum value of solar energy at Bakas Village in July 2022 appears more scattered than in June. Also, it has a sum of solar energy with lower values than June 2022. The average value of solar energy at Bakas Village in July 2022 also appears more fluctuated than in June. Also, it has average solar energy with lower values than June 2022.

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APPENDIX

Date	Solar Energy(Wh/m^2)	Sum of Solar Energy of 3 Cons. Days	Average of Solar Energy of 3 Cons. Days
01-06-2022	2773,218333	12439,26167	2773,218333
02-06-2022	4897,841667	12531,64333	3835,53
03-06-2022	4235,551667	11906,61167	3968,870556
04-06-2022	4904	14037,39333	4679,131111
05-06-2022	4201,885	13341,43667	4447,145556
06-06-2022	4635,275	13741,16	4580,386667
07-06-2022	4557,143333	13394,30333	4464,767778
08-06-2022	4785,328333	13977,74667	4659,248889
09-06-2022	4253,998333	13596,47	4532,156667
10-06-2022	3525,093333	12564,42	4188,14
11-06-2022	3783,8945	11562,98617	3854,328722
12-06-2022	3205,116667	10514,1045	3504,7015
13-06-2022	3695,3675	10684,37867	3561,459556
14-06-2022	3774,006667	10674,49083	3558,163611
15-06-2022	4524,125	11993,49917	3997,833056
16-06-2022	3639,786667	11937,91833	3979,306111
17-06-2022	3244,438333	11408,35	3802,783333
18-06-2022	3874,881667	10759,10667	3586,368889
19-06-2022	3830,995	10950,315	3650,105
20-06-2022	3094,323333	10800,2	3600,066667
21-06-2022	4390,271667	11315,59	3771,863333
22-06-2022	4444,9175	11929,5125	3976,504167
23-06-2022	3324,263333	12159,4525	4053,150833
24-06-2022	2315,436667	10084,6175	3361,539167
25-06-2022	2637,553333	8277,253333	2759,084444
26-06-2022	3121,246667	8074,236667	2691,412222
27-06-2022	1983,235	7742,035	2580,678333
28-06-2022	4107,196667	9211,678333	3070,559444
29-06-2022	3335,963333	9426,395	3142,131667
30-06-2022	3750,988333	11194,14833	3731,382778

Date	Solar Energy(Wh/m^2)	Sum of Solar Energy of 3 Cons. Days	Average of Solar Energy of 3 Cons. Days
01-07-2022	2133,405	9220,356667	3073,452222
02-07-2022	3377,235	9261,628333	3087,209444
03-07-2022	3246,038333	8756,678333	2918,892778
04-07-2022	2470,781667	9094,055	3031,351667
05-07-2022	3323,088333	9039,908333	3013,302778
06-07-2022	2966,805	8760,675	2920,225
07-07-2022	3297,73	9587,623333	3195,874444
08-07-2022	5059,615833	11324,15083	3774,716944
09-07-2022	4288,175	12645,52083	4215,173611
10-07-2022	2802,135833	12149,92667	4049,975556
11-07-2022	1111,718333	8202,029167	2734,009722
12-07-2022	1936,045833	5849,9	1949,966667
13-07-2022	1969,651667	5017,415833	1672,471944
14-07-2022	3758,601667	7664,299167	2554,766389
15-07-2022	2262,301667	7990,555	2663,518333
16-07-2022	1616,403333	7637,306667	2545,768889
17-07-2022	2330,261667	6208,966667	2069,655556
18-07-2022	2648,101667	6594,766667	2198,255556
19-07-2022	4613,73	9592,093333	3197,364444
20-07-2022	4308,346667	11570,17833	3856,726111
21-07-2022	1578,743333	10500,82	3500,273333
22-07-2022	1897,083333	7784,173333	2594,724444
23-07-2022	3558,976667	7034,803333	2344,934444
24-07-2022	3625,881667	9081,941667	3027,313889
25-07-2022	3634,92	10819,77833	3606,592778
26-07-2022	1186,633333	8447,435	2815,811667
27-07-2022	3277,241667	8098,795	2699,598333
28-07-2022	4199,003333	8662,878333	2887,626111
29-07-2022	4800,731667	12276,97667	4092,325556
30-07-2022	3120,066667	12119,80167	4039,933889
31-07-2022	3332,221667	11253,02	3751,006667