Evaluating the Global Solar Energy Potential at Chandrapur, India

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ABSTRACT
Evaluation of the global solar energy potential at chandrapur, latitude 20.06 N and longitude 70.3 E was carried out in this work. The amount of incident solar radiation significantly determines the electricity produced by Photovoltaic (PV) system . The paper reports a novel method to measure the potential of solar electricity generation in chandrapur on the basis of solar radiation data obtained for one year. Further, possible plant capacity is estimated for an arbitrary chosen area. The results supported justified the method proposed.

Keywords:
Solar energy potential , daily energy output, monthly energy output, solar radiation data.

1. INTRODUCTION
Solar radiation is the radiant energy that is emitted by the sun from a nuclear fusion reaction that creates electromagnetic energy. The knowledge of the amount of solar radiation in a given location (area) is essential in the field of solar energy physics. This in effect helps one to have a fair knowledge (idea) of the insolation power potential over the location. The demand for oil may sooner or later outweigh the available resources associated with oil production and distribution logistics. With the dwindling supply of oil, coal and natural gas, increased emphasis on the use of solar energy and other renewable energy sources in generating electricity should be developed.

Solar energy is abundant, free and clean. Nowadays, there is the campaign for the popularization of solar energy for domestic and industrial uses, the need , to know how to evaluate insolation levels for any site becomes paramount. It is therefore, necessary to approximate radiation from commonly available climate parameters such as sunshine hours, relative humidity, maximum and minimum temperatures, cloud cover and geographic location. Solar energy modeling focuses upon the level of solar radiation incident at a given location on the earth's surface. This is simply a function of; (i) the level of solar intensity reaching the top of the earth's atmosphere; (ii) the transmission of radiation through the earth's atmosphere and; (iii) the location and orientation of collecting surfaces on the earth's surface with respect to the position of the sun with time. [1]

Sun emits energy at an extremely large and relatively constant rate; 24 h per day, 365 days per year. If all of this energy could be converted into usable forms on earth, it would be more than enough to supply the world's energy demand. However, this is not possible because;(i) the earth intercepts only a small fraction of the energy that leaves the sun; (ii) the earth rotates such that a collection device on the earth's surface is exposed to solar energy for only about half of each 24 hour period and;(iii) conditions of the atmosphere such as clouds and dust, sometimes significantly reduce the amount of solar energy reaching the earth's surface. Weather patterns and other atmospheric conditions which scatter incoming rays also affect the rate at which solar energy reaches the earth's surface. The summation of the amount of solar energy arriving at a unit of area (one sq. mt.) during 1 hour is called the solar radiation or insolation (U.S. Technology White Paper, 2006). [3]

2. METHODOLOGY
To find out the solar photovoltaic generation potential at Chandrapur , the solar radiation data for one year (1st July, 2010 to 30th June , 2011) is measured. For this work , thin film (amorphous) PV module with efficiency 7 % is considered. The chosen area for the estimated plant capacity is considered as 100 sq. Meter. The monthly average output , yearly average output and possible plant capacity has been determined. [2]

3. OBSERVATION & DISCUSSION:
Table No 1 Solar radiation data for the month of June - 2011 taken as a sample.

Date	Radiation KW/M2/Day	Start Time	Stop Time	Total Hrs
1-Jun-11	5.23	5.55	17.20	11.25
2-Jun-11	2.73	9.35	18.20	8.45
3-Jun-11	5.14	6.10	18.20	12.10
4-Jun-11	4.54	9.25	18.25	9.00
5-Jun-11	5.24	5.55	18.25	12.30
6-Jun-11	4.94	6.00	16.55	10.55
7-Jun-11	5.43	5.55	18.20	12.25
8-Jun-11	5.11	6.10	18.20	12.10
9-Jun-11	3.55	6.05	18.35	12.30
10-Jun-11	3.27	6.05	18.20	12.05
11-Jun-11	5.47	6.05	18.35	12.30
12-Jun-11	5.50	6.00	18.20	12.20
13-Jun-11	5.23	6.00	18.35	12.35
14-Jun-11	2.68	6.05	15.10	9.05
15-Jun-11	4.54	6.25	18.30	12.05
16-Jun-11	4.34	6.15	18.30	12.15
17-Jun-11	4.95	5.55	18.40	12.35
18-Jun-11	4.76	6.20	18.40	12.20

19-Jun-11	2.68	6.10	17.50	11.40
20-Jun-11	3.37	6.15	17.55	11.40
21-Jun-11	3.10	6.15	18.05	12.10
22-Jun-11	4.22	6.05	18.30	12.25
23-Jun-11	4.55	6.00	18.40	12.40
24-Jun-11	2.96	6.00	18.35	12.35
25-Jun-11	0.81	6.20	18.00	12.20
26-Jun-11	1.02	6.20	18.30	12.10
27-Jun-11	2.90	7.10	18.15	11.05
28-Jun-11	2.97	6.40	18.05	11.35
29-Jun-11	2.10	6.20	18.25	12.05
30-Jun-11	5.92	6.05	18.35	12.30

Table No. : 2 Solar Radiation Data available from Radiation Hand- Book NASA & Actual data for One Year at Chandrapur (M.S.)

Month	Data from Radiation hand-Book (KW/M2/D)	Data From NASA (KW/M2/D)	Actual Radiation (KW/M2/D)
July -2010	5.42	7.04	3.32
Aug – 2010	5.52	6.68	3.66
Sept- 2010	5.46	6.18	4.25
Oct-2010	4.60	5.50	4.68
Nov-2010	4.30	4.59	4.45
Dec- 2010	3.96	4.07	3.88
Jan- 2011	5.04	4.30	4.31
Feb-2011	6.12	5.39	4.84
Mar-2011	6.69	6.38	5.32
April- 2011	6.80	7.05	5.28
May- 2011	6.28	7.45	5.22
June -2011	5.59	7.17	3.98

Table No. : 3 Monthly Radiation data, Calculations of various outputs & Possible Plant capacity Thin Film (Amorphous) PV Module: Efficiency: 07.00 % [8]

Month	Radiation kw/m^2 /day	O/p kw/m^2	Monthly O/p kw/m^2	Monthly Avg. Output kw/m^2	Yearly Avg. O/p kw/m^2	Avg. output for 100 sq.m. area KW	Possible Plant Capacity KW
July -2010	3.32	0.23	7.20	8.83	105.94	10594.25	26
Aug – 2010	3.66	0.26	7.94				
Sept-2010	4.25	0.30	8.92				
Oct-2010	4.68	0.33	10.15				
Nov-2010	4.45	0.31	9.35				
Dec-2010	3.88	0.27	8.42				
Jan-2011	4.31	0.30	9.35				
Feb-2011	4.84	0.34	9.49				
Mar-2011	5.32	0.37	11.54				
April-2011	5.28	0.37	11.09				
May-2011	5.22	0.36	11.33				
June -2011	3.98	0.28	8.36				

From the result obtained, it is found that, in the month of August, produced the lowest solar radiation. And in the month of March, produced the highest solar radiation. Monthly and Yearly outputs were calculated on the basis of 100 sq. mt. area. The methodology adopted seems satisfactory for determining the possible plant capacity for an arbitrary chosen area. From the calculations, we found a solar Photovoltaic power plant capacity 26 KW can be achieved in Chandrapur (M.S.) over an available area 100 Sq. Mt.

4. CONCLUSIONS

Available area for the calculation shown has been considered to be 100 Sq. mt. . With greater available area higher capacity plant can be set up. Moreover, the possible plant capacity has been estimated from the output results available from the solar radiation readings of each month. No optimized approach has been carried out which can be taken up as a future scope of work. Thus the average output and subsequent calculation there from may not reflect the true scenario of solar photovoltaic generation potential of Chandrapur. Maximum Power Point Tracking (MPPT) has not been employed for the calculation which could have produced better results. It is found that in the month of March and April which offers the highest solar radiation, the result would have been for more accurate and yielded higher capacity plant. For future studies, designing, cost analysis and efficiency calculations of this solar photovoltaic power plant now need to be done once the capacity is estimated, which can be carried out in future publications. .Environmental impact of this photovoltaic plant can be taken up as one of the important issues in near future.

5. REFERENCES

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