REVIEW OF PRACTICES OF GRID CONNECTED SOLAR PHOTOVOLTAIC POTENTIAL

Rohit Pandey*

Dr. M. K. Gaur*

Dr. C. S. Malvi*

ABSTRACT

The depletion of fossil fuel resources on a worldwide basis has necessitated an urgent search for alternative energy sources to meet up the present day demands. Solar energy being a clean, inexhaustible and environment-friendly potential resource among all renewable energy options. But in the present scenario, there is a need of continuous supply of energy, which cannot be full filled by alone wind energy system or solar photovoltaic system due to seasonal and periodic variations. Therefore, in order to satisfy the load demand the combination of solar and conventional conversion units are now being implemented as a Grid connected energy systems. The objective of this work is to estimate the potential of grid quality solar photovoltaic system and developed a system based on the potential estimations made for a chosen area of 50m². The specifications of equipment are provided based on the availability of the component in India. Annual energy generation by proposed Grid connected SPV power plant is calculated.

Keywords: *Solar energy, Grid connected SPV system.*

*Department of Mechanical Engineering, Madhav Institute of Technology and Science Gwalior (M.P.), INDIA

1. INTRODUCTION

Photovoltaic's offer consumers the ability to generate electricity in a clean, quiet and reliable way. Photovoltaic systems are comprised of photovoltaic cells, devices that converted light energy directly into electricity. It is anticipated that photovoltaic systems will experience an enormous increase in the decades to come. However, a successful integration of solar energy technologies into the existing energy structure depends also on a detailed knowledge of the solar resource. But to note it is essential to state the amount of literature on solar energy, the solar energy system and PV grid connected system is enormous. Grid interconnection of photovoltaic (PV) power generation system has the advantage of more effective utilization of generated power. However, the technical requirements from both the utility power system grid side and the PV system side need to be satisfied to ensure the safety of the PV installer and the reliability of the utility grid. For this survey we have gone through different books, journals and papers to get its keen knowledge.

2. LITERATURE REVIEW

M.R.Narayaoan et.al (1994) [1] This paper briefly describes features of the two power plants, the developmental approach adopted based on "Building Block Philosophy" With 25 KW System as the basic unit with the attendant advantages. It includes the indigenous design and development effort made for grid connected operation and most importantly the special design features incorporated to ensure a very high degree of safety and protection so necessary in the rural areas with predominantly non-literate users. Tile paper is concluded with some important lessons learnt from both the technical and logistics point of view for guiding installation of similar such plants in the remote rural areas in India and other developing countries in the future.

D. Picault et.al (2009) [2] presented an over view of current architectures used in grid connected systems, five key points for comparison based on topology upgradeability, performance under shaded conditions, degraded mode operation, investment costs and ancillary service participation. The proposed method can be adapted to the user's particular needs and expectations of the photovoltaic plant. These evaluation guidelines may assist grid-tied PV system users to choose the most convenient topology for their application by weighting the evaluation criteria

Hironobu lgarashi et. al (2005) [3] presented a Recent advances in semiconductor technology have seen growing efforts to improve the efficiency and reduce the size/weight of power conditioners. The power conditioner is an indispensable component of a photovoltaic power generation system. On the other hand, power conditioners do have a serious problem: they generate electromagnetic noise. To make matters worse, the electromagnetic noise that is generated at power conversion is transmitted to the solar cells through electric wires, the solar cells serving as an antenna to radiate the electromagnetic noise. The radiated electromagnetic noise may cause operation and communication failures in other electronic equipment.

Souvik Ganguli et.al (2009) [4] presented a Estimation of Grid Quality Solar Photovoltaic Power Generation Potential and its Cost Analysis in Some Districts of West Bengal. The objective of their work was to estimate the potential of grid quality solar photovoltaic power in some districts of West Bengal (Birbhum, Burdwan, Hooghly, Howrah and Kolkata), study the solar radiation level and potential of the above mentioned districts and finally develop a system corresponding to the potential. Equipment specifications were provided based on the system developed and finally cost analysis was also carried out.

R. Ramkumar et.al (1993) [5] presented a paper of photovoltaic systems including adiscussion of major U.S. and international activities. After a brief review of system types and output characteristics, various system configurations were discussed and a classification based on photovoltaic (PV) system rating was provided. Modeling, design, and economic Considerations were briefly discussed. The worldwide status of PV system technology was discussed with a view to making an assessment of the future. The assessment presented includes some specific areas for further research and development. Although no major technical barriers are evident the entry of PV, as the level of penetration increases, several key issues identified in this paper will need further consideration. Photovoltaics is still evolving and has not reached its full potential. It is likely to grow for decades to come; however, the rate of growth may depend on several exogenous factors such as cost of conventional energy sources and the people’s desire to improve the global environment.

Prakasit Sritakaew et.al (2006) [6] presented a paper on the Reliability Improvement of Distribution Systems Using PV Grid-Connected Systems. The purpose of their paper was to examine issues related to the distribution system reliability improvement using photovoltaic (PV) grid-connected systems. The output characteristics of a PV system were experimentally measured. The measured data were used to investigate the effects of PV system installation to improve the distribution system's reliability. The system constraints such as, recovered real power, and loading reduction of the tie line/switch after the installation of PV grid-connected systems are concentrated. Simulation results show that with the action of a tie switch, system losses and loading level of the tie switch can be reduced with proper installation location.

G. Ofualagba [7] in his paper first explained the reasons for the mounting interest in photovoltaic technology and has provided a quick synopsis of the operation of these technology and their applications and markets. Photovoltaic technology have received increasing attention over the last decade as one response to the challenges of global warming, increasing demand for energy, high fuel costs, and local pollution. This paper describes photovoltaic systems (PV modules, batteries, power conditioning, generators, and pumps) and discusses the photovoltaic markets including on-grid, off grid and water pumping applications

Phil Bolduc et.al (1993) [8] presented a performance of a grid connected PV system with energy storage. One kilo watt amorphous photovoltaic system has been operated in a grid-connected mode with energy storage. The purpose of the system development and performance experiment is to investigate the additional value a grid connected system garners with dispatch able battery energy storage. These values are then weighed against the added cost of the system and inefficiencies incurred in the charging and discharging of the battery.

A.S. Elhodeiby et.al (2011) [9] presented a performance analysis of 3.6 kW Rooftop grid connected solar photovoltaic system in Egypt. The system was monitored for one year and all the electricity generated was fed into the 220 V, 50 Hz low voltage grid to the consumer.

Evert Nieuwlaar et.al (1997) [10] gives us idea about environmental aspects of PV power systems. During normal operation, photovoltaic (PV) power systems do not emit substances that may threaten human health or the environment. In fact, through the savings in conventional electricity production they can lead to significant emission reductions. There are, however, several indirect environmental impacts related to PV power systems that require further consideration. The production of present generation PV power systems is relatively energy intensive, involves the use of large quantities of bulk materials and (smaller) quantities of substances that are scarce and/or toxic. During operation, damaged modules or a fire may lead tothe release of hazardous substances. Finally, at the end of their useful life time PV power systems have to be decommissioned, and resulting waste flows have to be managed.

3. METHODOLOGY

To find out the solar potential at India, the solar radiation over different months measured. Then the diurnal variations, average monthly output are find out and related graphs are plot for showing the variation. We started our project work from January month. So we measured value of solar radiation from January to April month after that we calculated the diurnal variations, average monthly output for four months (Jan 2012 to April 2012). Thus from these data we can estimate the rating of solar PV power plant for Indore. For estimation of solar potential we need reading of solar radiation for our site. For the better understanding of the methodology, the measured radiation data sheet of Indore district for the month of April 2012 has been given as a sample. The diurnal variation for four months are plotted. From that the monthly output are calculated. Input solar radiation means how much amount of solar radiation is coming from sun and Output solar radiation means how much amount of solar radiation we can utilize to generate electricity which is depends upon the efficiency of the PV module. For calculating the output the efficiency of the PV module is taken as 13.2%. Chosen area for the estimated plant capacity is considered as 50 m².

3. 1 Diurnal Variations for April Month 20121

The below table shows us the diurnal variation for April month. In the second coulomb of table shows the average solar radiation available for whole month at different time interval of day .From this data we calculated the average solar radiation in Watts-hour per mtr

TIME	AVG O/P SOLAR RADIATION	AVG OUTPUT SOLAR RADIATION IN HOUR	DAILY ENERGY OUTPUT	MONTHLY ENERGY OUTPUT
	Watts/mtr^2	Watts-h/mtr^2	Watts-h/mtr^2	Watts-h/mtr^2
10:00AM	61.208664	61.208664		
11:00AM	80.179061	80.179061		
12:00PM	106.16846	106.156846		
1:00PM	102.571907	102.571907		
			350.116478	10503.49434

Table 1.

3.2 Diurnal Variations Tables (Jan 2012 to Mar 2012)

The below table shows the diurnal variation for January month.

TIME	AVG O/P SOLAR RADIATION	AVG OUTPUT SOLAR RADIATION IN HOUR	DAILY ENERGY OUTPUT	MONTHLY ENERGY OUTPUT
	Watts/mtr^2	Watts-h/mtr^2	Watts-h/mtr^2	Watts-h/mtr^2
10:00AM	30.16426	30.16426		7

11:00AM	48.43263	48.43263		
12:00PM	56.28624	56.28624		
1:00PM	60.21643	60.21643		
			195.09956	5852.9868

Table 2.

The below table shows us the diurnal variation for February month.

TIME	AVG O/P SOLAR RADIATION	AVG OUTPUT SOLAR RADIATION IN HOUR	DAILY ENERGY OUTPUT	MONTHLY ENERGY OUTPUT
	Watts/mtr^2	Watts-h/mtr^2	Watts-h/mtr^2	Watts-h/mtr^2
10:00AM	62.21968	62.21968		
11:00AM	74.108396	74.108396		
12:00PM	88.21268	88.21268		
1:00PM	92.16238	92.16238		
			316.703136	9501.09408

Table 3.

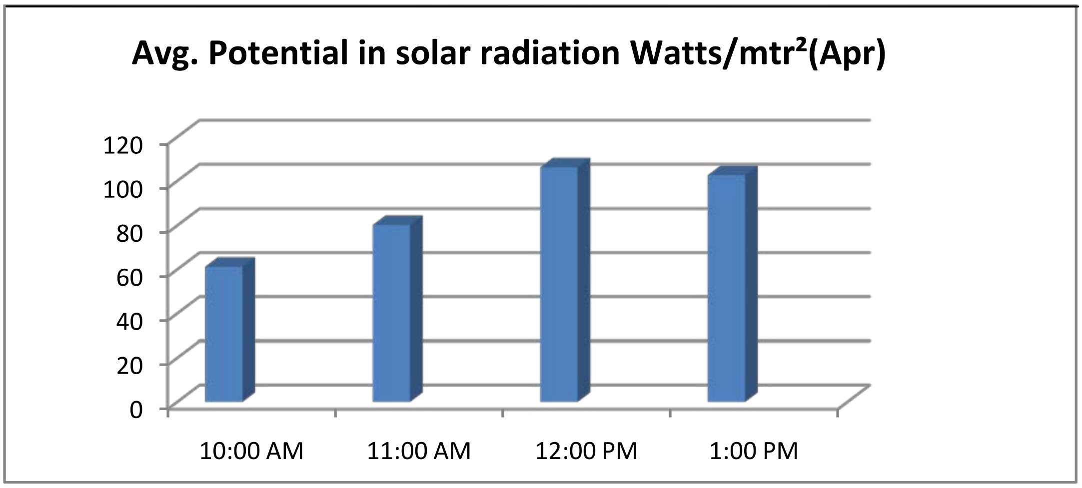
The below table shows us the diurnal variation for March month.

TIME	AVG O/P SOLAR RADIATION	AVG OUTPUT SOLAR RADIATION IN HOUR	DAILY ENERGY OUTPUT	MONTHLY ENERGY OUTPUT
	Watts/mtr^2	Watts/mtr^2	Watts/mtr^2	Watts/mtr^2
10:00AM	65.42681	65.42681		
11:00AM	82.32761	82.32761		
12:00PM	88.64286	88.64286		
1:00PM	90.18632	90.18632		
			326.5836	9797.508

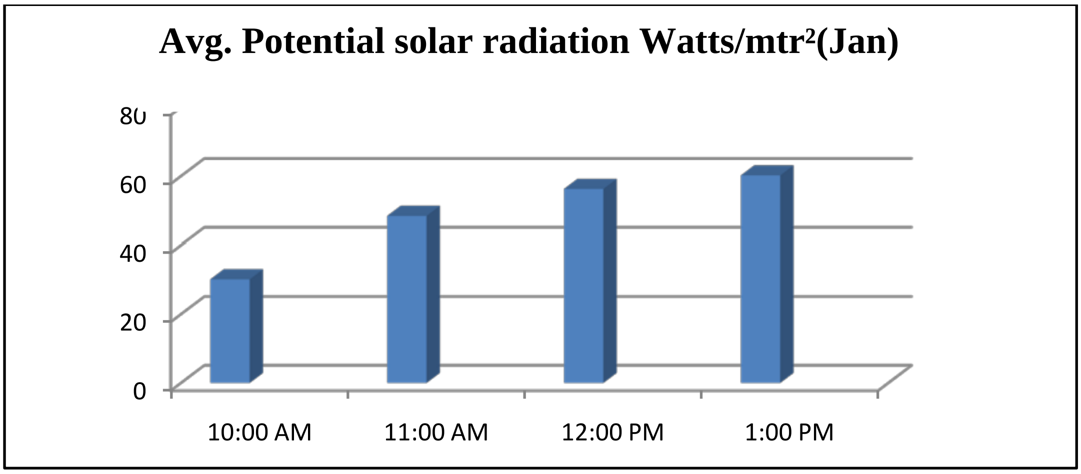
Table 4.

3.3 Graphs for Diurnal Variations (Jan 2012 to April 2012)

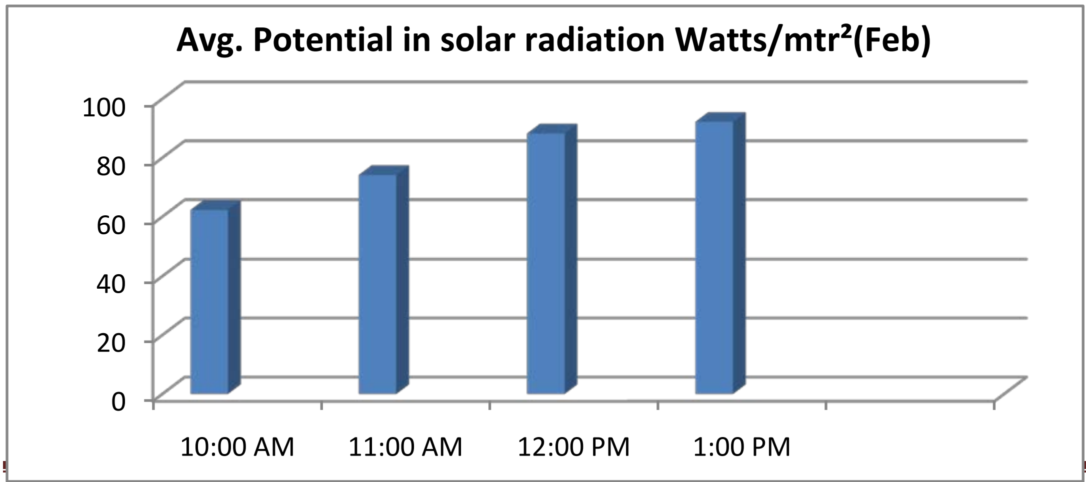
Graph is plotted between average solar radiation available in Watts/mtr² and different time interval of day for different months.

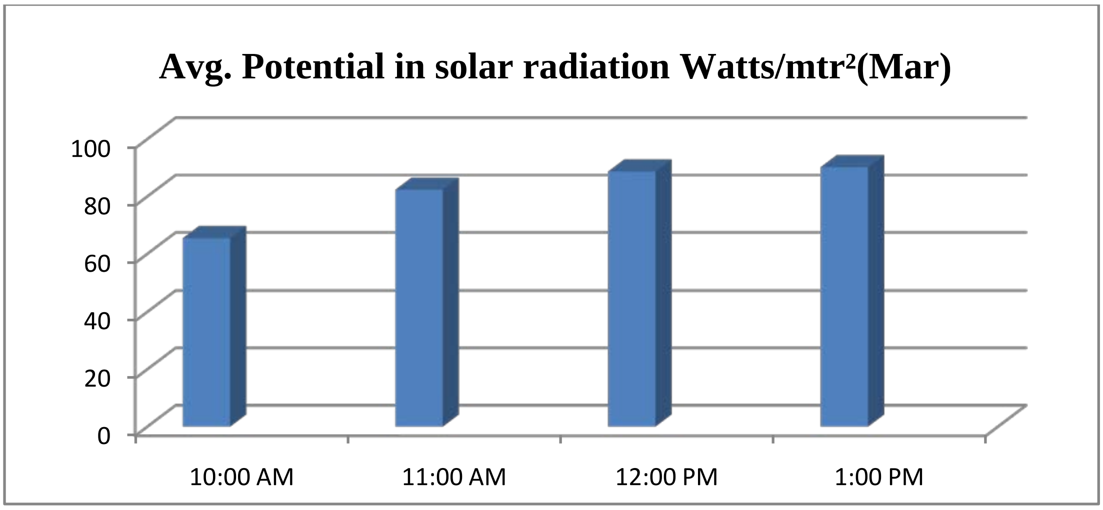


Graph 1



Graph 2,3





Graph 4

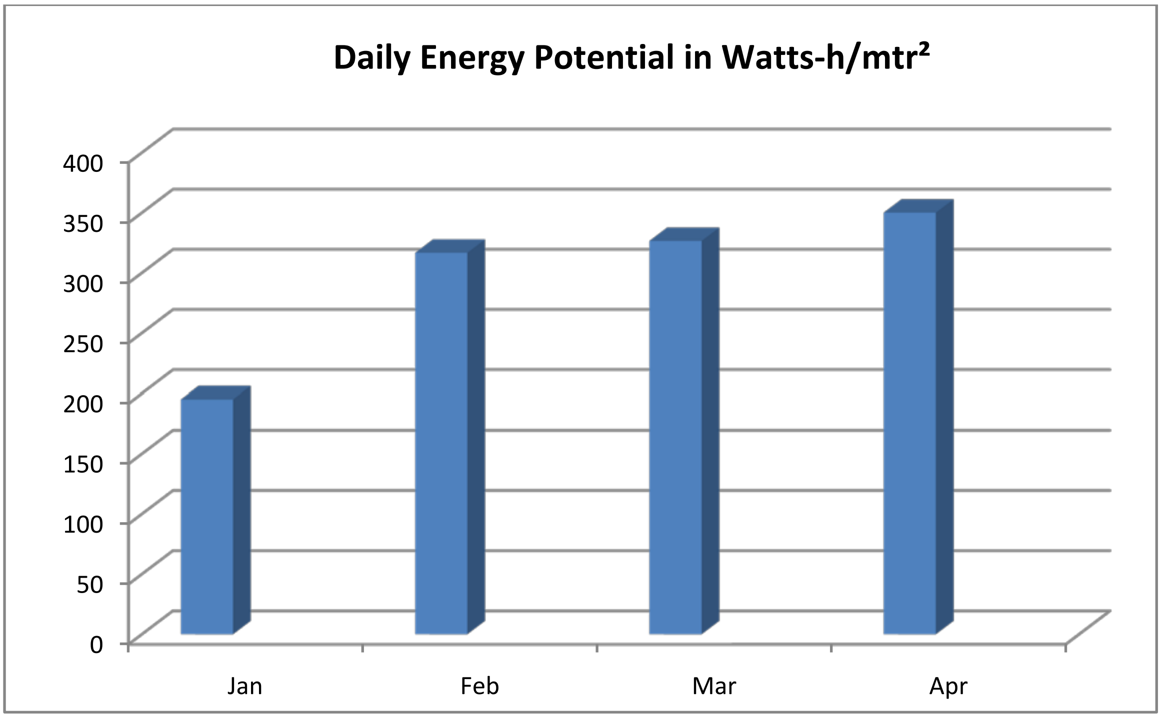
4. TOTAL POTENTIAL

Here the average yearly energy output is calculated by multiplying average monthly energy output with total number of month12. The daily energy output also calculated for various months shown in 2nd coulomb. Monthly energy output is calculated by multiplying the number of days of month with the daily energy output shown in 3rd coulomb for various months. Kilowatt-Hour (kWh) means 1,000 thousand watts acting over a period of 1 hour. The kWh is a unit of energy. 1 kWh=3600kJ.

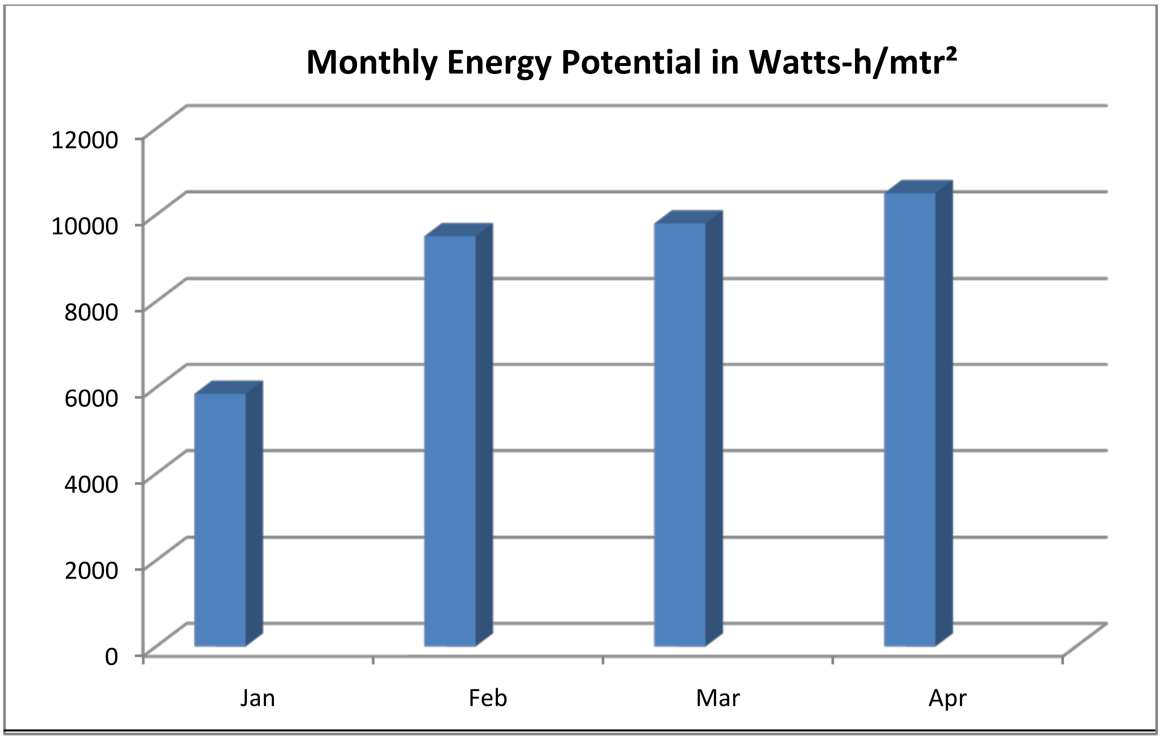
MONTHS	DAILY ENERGY OUTPUT	MONTHLY ENERGY OUTPUT	AVG MONTHLY ENERGY OUTPUT	AVG YEARLY ENERGY OUTPUT
	Watts-h/mtr^2	Watts-h/mtr^2	Watts-h/mtr^2	Watts-h/mtr^2
Jan	195.09956	5852.9868		
Feb	316.703136	9501.09408		
Mar	326.5836	9797.508		
Apr	350.116478	10503.49434		
			8913.770805	106965.2497

Table 5.

4.1 Graph for Daily & Monthly Energy Potentials (Watt/ mtr^2-hr)



Graph 5



Graph 6

5. CONCLUSION

The April months gives the maximum monthly energy output out of four months. Solar Photovoltaic generation potential during the period January 2012-April 2012 is assessed for India. It is found that the month of January produced the lowest solar radiation. Monthly and yearly outputs were calculated on the basis of 50 m² area. The methodology adopted seems satisfactory for determining the possible plant capacity for an arbitrarily chosen area.

6. ACKNOWLEDGEMENT

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7. REFERENCES

1. Brig.M.R.Narayaoan, D.V.Gupta, R.C.Gupta & R.S.Gupta, “Design, Development and Installation of 100 kW utility grid connected solar PV plants for rural applicationan Indian experience”. IEEE first world conference on Photovoltaic Energy conversion. Volume: 1. Page(s): 1073 – 1076, 1994.
2. D. Picault, B. Raison, and S. Bacha, “Guidelines for evaluating grid connected PV system topologies”. IEEE International Conference on Industrial Technology. Page(s): pp. 1-5, 2009.
3. Hironobu lgarashi and Shoichi Suenaga, “Electromagnetic Noise from Solar Cells”. Photovoltaic Specialists IEEE Conference, Page(s): 1820 – 1822,2005.
4. Souvik Ganguli and Sunanda Sinha, “A Study and Estimation of Grid Quality Solar Photovoltaic Power Generation Potential in some districts of West Bengal Patiala, Page(s): 522-528, 29-30th Oct., 2009.
5. R. Ramkumar & J. E. Bigger, “Photovoltaic Systems”. Proceedings of IEEE. Volume: 81, Page(s): 365 – 377, 1993.
6. P.Sritakaew & A.Sangswang, “On the Reliability Improvement of Distribution Systems Using PV Grid-Connected Systems”. IEEE Asia Pacific Conference on Circuits and systems. pp. 1354 - 1357, 2006.
7. G. Ofualagba, “Photovoltaic Technology, Applications and Market”, IEEE Conference on Power and Energy society general meeting - conversion and delivery to electrical energy, Vol.21, Page(s): 1 – 5, 2008.
8. Phil Bolduc, David Lehmicke & Joseph Smith, “Performance of a grid connected PV system with energy storage”. IEEE Photovoltaic. Page(s): 1159 – 1162, 1993.

9. A.S. Elhodeiby, H.M.B. Metwally and M.A. Farahat, "Performance analysis of 3.6KW Rooftop grid connected photovoltaic system Egypt. International Conference on Energy Systems and Technologies (ICEST 2011) 11-14 March 2011, Cairo, Egypt.
10. Evert Nieuwlaar & Erik Alsema, "Environmental aspects of PV power systems",Report on the IEA PVPS Task1 Workshop, 25-27 June 1997, Utrecht TheNetherlands. Report no. 97072, December 1997.