www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 6 Issue 6 June 2017, Page No. 21838-21844
Index Copernicus value (2015): 58.10 DOI: 10.18535/ijecs/v6i6.48

Reconfiguration of 25 kW Solar PV Power Plant

P. Marimuthu[1], B. Praveen Kumar[2]
[1] Department of EEE, Kamaraj College of Engineering and Technology,
Virudhunagar, Tamilnadu, INDIA
marimuthu08p@gmail.com
[2] Department of EEE, Kamaraj College of Engineering and Technology,
Virudhunagar, Tamilnadu, INDIA
praveenbala038@gmail.com

Abstract: ***Power is one of the most critical components of infrastructure resolvent for the economic growth and welfare of nations. The development of sufficient infrastructure is essential for sustained growth of the Indian economy. . Electricity demand in the country has increased rapidly due to the fast growing industries and population growth. Solar play major role to meet the increasing demand. A 25 kW grid-connected photovoltaic (PV) power generation system was installed and monitored at the Kamaraj College of Engineering and Technology in Virudhunagar since March 2014. In this project work the various factors that affect the performance of the solar PV are analyzed. The solar PV panels installed here are mono crystalline, poly crystalline and low concentrated PV modules. Each PV panels are connected in series or parallel. In this PV plant several modules are get damaged due to the abnormal weather condition and some panels are in good working condition. The only solution of this problem is the rearrangement of solar PV panels. By doing reconfiguration, the performance of the solar plant should be improved and also it improves the reliability and reduces the vulnerability to power loss by damage.***

Keywords: Photovoltaic, Grid connected system, Reconfiguration.

1. Introduction

Energy is a necessity and sustainable renewable energy is a vital link in industrialization and development of India. A change from conventional energy systems to those based on renewable resources is necessary to meet the ever-increasing demand for energy and to address environmental concerns. As the worlds electrical demand is being more covered by photovoltaic (PV) systems, The Solar PV systems are designed either to feed the grid or for the residential applications. There are some losses produce in the photovoltaic system due to some main factors that are connection mismatching of PV module, abnormal weather conditions such as wind, temperature, soiling and cable losses. The study is needed to design a grid connected PV system without battery backup accurately from first principles. Several works are going on solar photovoltaic systems. Some of these are discussed below:

R. Ramkumar & J. E. Bigger [1] presented a paper of photovoltaic systems including a discussion of 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. Chang Ying-Pin & Shen Chung-Huang [2] presented a paper about Effects of the Solar Module Installing Angles on the Output Power. In their paper they discussed that the output power increment of photovoltaic cells is mainly based on two factors. One is decreasing the cell modular temperature and the other is increasing the cells received solar illumination intensity. The former can be simply achieved by maintaining a proper radiating space between the modules and the ground. M. Balato & L. Costanzo [3] presented a paper about simple and fast reconfiguration algorithm which is suitable for a PV array with Series–Parallel architecture is presented and discussed. The main advantage of such an algorithm is represented by its capability to find a nearly optimal configuration by testing only a very small subset of all the possible configurations.

DOI: 10.18535/ijecs/v6i6.48

The paper is organized as follows, section 2 gives System Description. Section 3 gives details about existing PV system. Section 4 gives Reconfiguration PV system is presented. This paper is finally concluded in section 5.

2. System Description

A 25 kW grid-connected photovoltaic (PV) power generation system was installed and monitored at the Kamaraj College of engineering and technology in Virudhunagar since March 2014. The system has totally 159 PV modules arranged in three layouts. Three different types of PV modules are connected in series and parallel. Three different types of PV modules are namely,

- Mono crystalline PV module (10)
- Poly crystalline PV module (69)
- Low concentrated PV module(80)

The specification of grid connected inverter and PV module are summarized in Table 1 and Table 2. The modules are south oriented inclining by 30°from horizontal. Totally three layout PV output is given to the input of the inverter terminals.80 LCPV modules are connected both series and parallel in layout 1. 45 poly crystalline PV modules are connected in layout 2.10 mono crystalline and 24 poly crystalline PV modules are combined connected series in layout 3.

PV Module	*A*	*B*	*C*	*D*	*E*
Nominal power (W)	250	235	100	200	265
Short-circuit current (A)	8.95	9.25	6.03	8.95	7.93
Open-circuit voltage (V)	37.23	30.28	22.3	33.5	43.97
Maximum power point current (A)	8.42	8.89	5.62	8.42	7.64
Maximum power point voltage (V)	29.7	26.46	17.8	26.4	34.70

25 kW solar PV system model is shown in Figure 1. In May 2016 Due to the abnormal weather condition, the solar PV system was not installed with the correct mounting equipment and there are high wind gusts, then the system could be damaged. The damage is significant and the electrical operation of the system could be affected. . In a worst-case scenario, nearly 52 solar panels could be fully damaged in PV layout 1.

TABLE 1: Grid-Connected inverter specification

Specification	*Grid connected Inverter*
Maximum voltage of direct current	900V
Operating voltage range (V)	580V
Maximum input direct current	17A
Rated output power of alternating current	20 KW
Power factor	0.9 lead lag
Total harmonic distortion (%)	<3%
Cooling Method	Wind

From the table 2, PV module A has both Poly crystalline and Mono crystalline PV Module specification B, C and D represent Poly crystalline, E specify the Low Concentration PV module at STC.

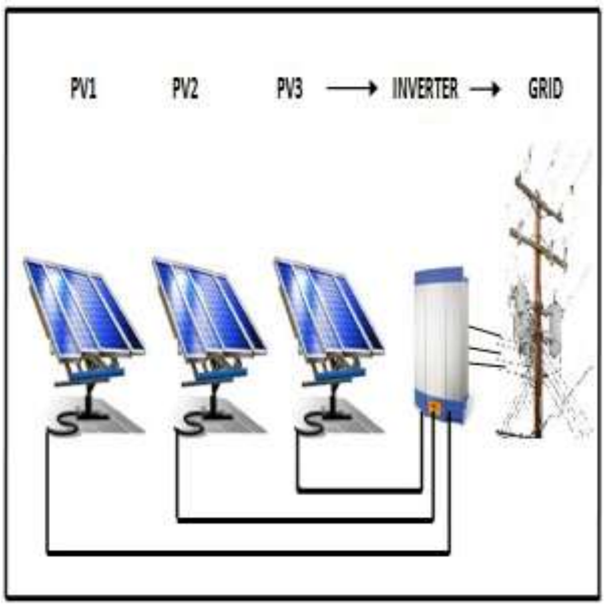

Figure 1: 25 kW solar power plant Model

TABLE 2: PV Module specification (under STC)*

* (STC- Standard Testing Condition)

3. Detection of problem in Existing PV System

The solar PV system installed and performance of PV system monitored from March 2014 to December 2016. The

DOI: 10.18535/ijecs/v6i6.48

monthly output energy of PV system for the monitoring are shown in Table 3.The performance chart is plotted for corresponding value of Table 3. Tilting process is starting October 2014, after that tilt PV modules the system performance is not able to obtain better improvements, because it based on the time the module facing the sun. When the angle changes depend on sunlight the system will improve their performance. In a worst-case scenario, the solar panels could be dislodged from the mounting equipment due to high winds. The system would lose electrical contact .The continuously performance will decrease up to till date due to the damage.

TABLE 3: Electricity generation in unit (2014-16)

Month	*Electricity generation in unit*		
	2014	*2015*	*2016*
January		52.1	82.2
February		71.8	92.8
March	92.3	68.6	104.6
April	60.56	47.8	100.95
May	51.16	46.4	56.58
June	51.86	44.2	39.03
July	52.58	89.3	39.5
August	51.3	97.4	37.1
September	64.9	106.4	32.3
October	…	100.4	29.2
November	24.5	76.13	26.06
December	45.1	68.8	27.06

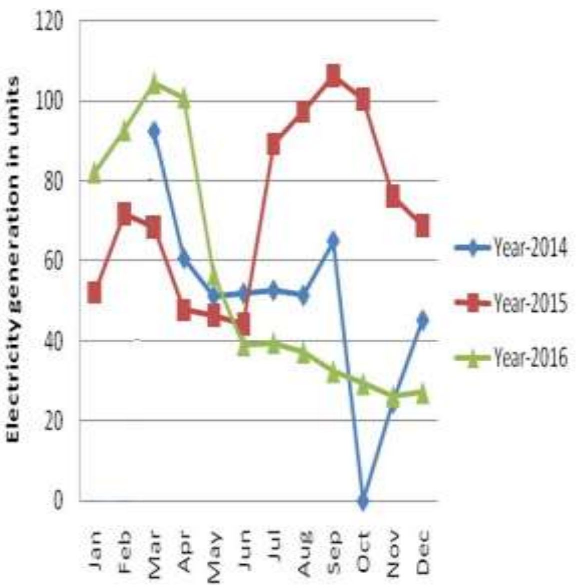

Figure 2: Average electricity generation in units

Existing system three PV layout arrangement are shown in following Figure 3, 4 and 5.

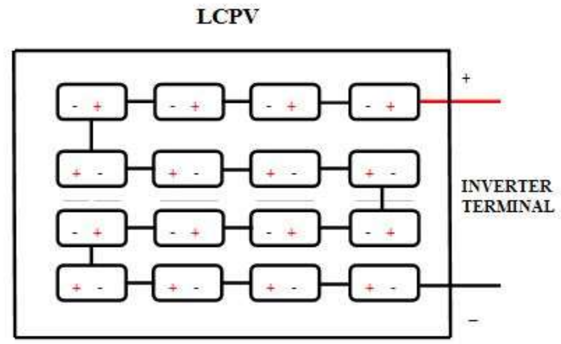

Figure 3: Existing system PV layout 1

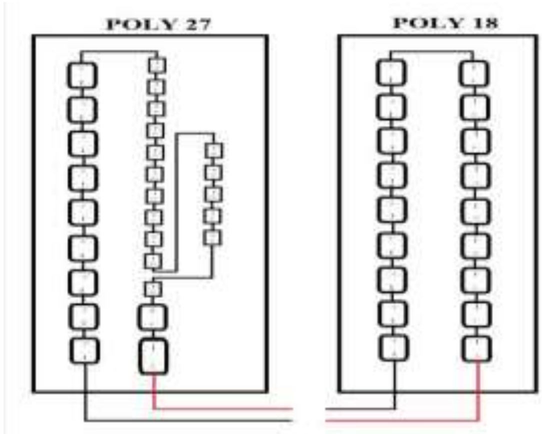

Figure 4: Existing system PV layout 2

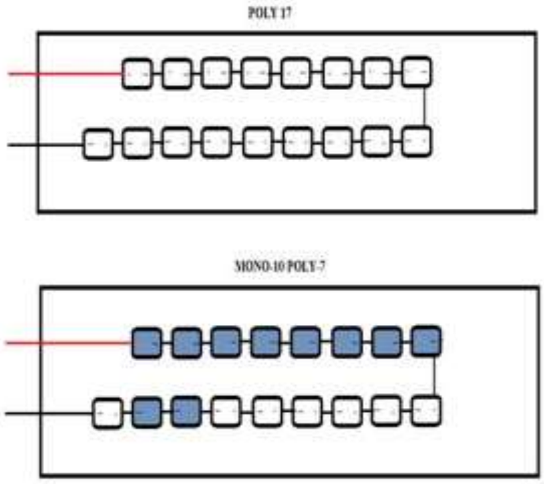

Figure 5: Existing system PV layout 3

Existing system PV layout 1 has totally 28 LCPV modules.16 modules are connected in series and 13 modules would lose electrical contact. In PV layout 3 single poly crystalline module replaced by another one PV module. Mismatch losses occur in the existing system. Mismatch losses are caused by the interconnection of solar cells or modules which do not have identical properties or which experience different conditions from one another. There are two mismatch losses occur through series mismatch that are open circuit voltage and short circuit current.

3.1. Voltage Mismatch

Voltage mismatch is occurs at PV layout 2. In this layout two parallel strings produce different voltages under the same conditions (Radiation and Temperature). There are measured independently. It will cause the voltage mismatch. There is a mismatch in voltages, the strings normally settle on the output of the lowest performing one. A severe voltage mismatch makes the panels operate far from their Maximum Power point, which has a negative impact on the efficiency of the inverter.

3.2. Current Mismatch

Current mismatch also occurs at PV layout 2. First string has two different current rating panels are series as a result current output of the sting is different. The currents are mismatched; the lowest performing panel in the string will reach its 'saturated state' first and thereafter limit the current of the whole string. Any extra energy from sunlight will then heat up the panels, in particular the lowest performing one.

4. Reconfiguration

Reconfiguration can also termed as reallocation or rearrangement of solar panels. The Reconfiguration technique can be applied in solar panels. The following possible combination of solar panel most arrangements are electrically equivalent and same result. It may become feasible and could improve energy extraction or degrade the PV system performance. The various possible combination of solar panel arrangement and their output voltage, current and number of solar panels used in the rearrangement are explained in the following Table 4.

TABLE 4: Possible combination of solar PV rearrangement

Operating DC Voltage	***V_{DC}=500***			***V_{DC}=600***		
	PV1	*PV2*	*PV3*	*PV1*	*PV2*	*PV3*
V(v)	527.4	514.8	514.8	615.5	545	632.9
I(A)	15.86	16.3	16.3	15.86	16.3	16.3
No. of Used Panels	24	44	28	28	45	34
No. of Unused Panels	04	01	06	0	0	0
Operating DC Voltage	**V_{DC}=700**			**V_{DC}=800**		
	PV1	PV2	PV3	PV1	PV2	PV3
V(v)	703.4	712.5	707	791.1	813	819
I(A)	7.93	8.15	8.15	7.93	8.95	8.15
No. of Used Panels	16	23	19	18	26	22
No. of Unused Panels	12	22	15	10	19	12

From the above Table 4.Optimum DC output voltage is 600V. In this particular DC output voltage has following advantages Reduce power loss, voltage and current mismatch, Improving voltage profile of the electrical network, Maximum short circuit current, Maximum number of panels are utilized proper rearrangement. In actual PV power plant, the Series Parallel is the most common connection. It is obtained by connecting solar modules in series in order to form strings which are able to provide the voltage required by the inverter; such strings are then connected in parallel to increase the total current. In this reconfiguration reduce the voltage mismatch losses and improve the output of the solar PV system and performance of the system. Optimum rearrangements of solar PV system layout are shown in following figure 6, 7 and 8.

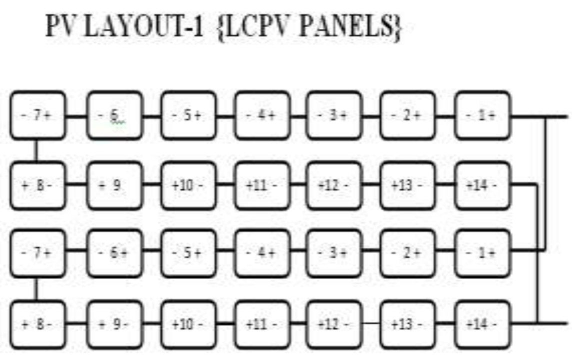

Figure 6: Reconfiguring system PV layout 1

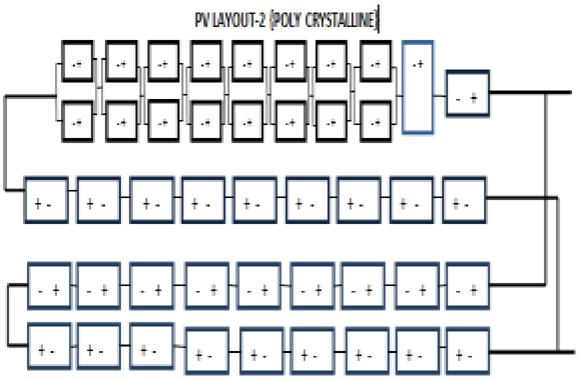

Figure 7: Reconfiguring system PV layout 2

In this Figure 7. Parallel connection of two 100W rating poly crystalline panels are connected in series with and the string. It reduces the mismatch losses.

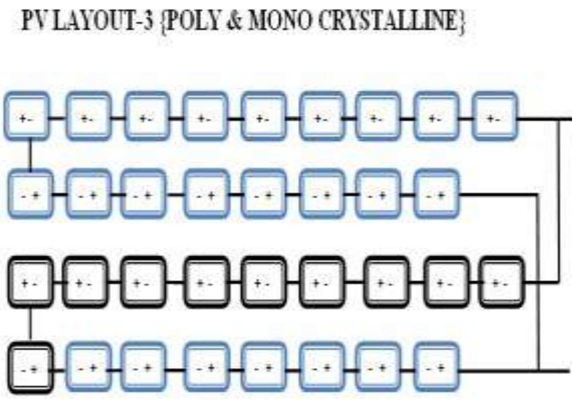

Figure 8: Reconfiguring system PV layout 3

4.1. Practical Implementation Of Reconfiguration of solar PV system

Reconfiguration process implemented on March last week, after that output of the PV system has been improved. The performances of PV system are compared to the existing system performance as shown in Table 5. The practical implementation of reconfiguration PV system performance chart is plotted for corresponding value of Table 5, as shown in Figure 9.

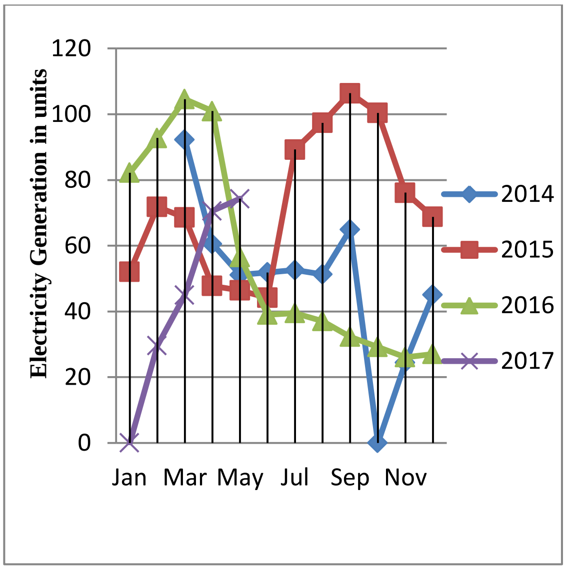

Figure 9: Electricity generation in units

Reconfiguration of PV system has been improved more than nearly 40 units average electricity per month , it leads to Maximizing output energy without replacing aged panels, No need expensive equipment, Energy efficiency and Cost efficiency are improved.

TABLE 5: Electricity generation in unit (2014-217)

Month	*Electricity generation in unit*			
	2014	*2015*	*2016*	*2017*
January		52.1	82.2	31.8
February		71.8	92.8	29.6
March	92.3	68.6	104.6	45
April	60.56	47.8	100.95	70.6
May	51.16	46.4	56.58	74.3
June	51.86	44.2	39.03	
July	52.58	89.3	39.5	
August	51.3	97.4	37.1	
September	64.9	106.4	32.3	
October	…	100.4	29.2	
November	24.5	76.13	26.06	
December	45.1	68.8	27.06	

5. Conclusion

In this project, Grid –Connected PV Plant Performance were analyzed. From the analysis we are able to find which factors are affecting the performance of PV plant such as Tilting, Abnormal weather conditions (Wind, Solar) and Mismatch losses. After that we are Reconfigure the panel in

Series Parallel Configuration. The proposed system performances which are more or less compared with existing system. The proposed system can produce maximum output power compared to existing system. The April months gives the better monthly energy output we all know summer session start from April. Solar radiation level goes on increasing till July so Jun or July may be the months will gives the maximum monthly energy output.

References:

[1] R. Ramkumar & J. E. Bigger, “Photovoltaic Systems”. Proceedings of IEEE. Volume: 81, pp. 365 – 377, 1993.

[2] Chang Ying-Pin & Shen Chung-Huang, “Effects of the Solar Module Installing Angles on the Output Power”. 8th International conference on Electronic Measurement and Instruments. pp. 1-278 - 1-282, 2007.

[3] M. Balato, L. Costanzo , M. Vitelli, “Series–Parallel PV array re-configuration: Maximization of the extraction of energy and much more” Journal of Applied Energy 159 , pp. 145–160, 2015

[4] Jung Hun So, Choi, et al., “Performance results and analysis of 3 kW grid-connected PV systems,” Renewable Energy 32, pp. 1858–1872, 2007.

[5] A. Benatiallaha R. Mostefaou, K.Bradja “Performance of photovoltaic solar system in Algeria,” Desalination 209, pp. 39–42, 2007

[6] Dunlop ED. “Lifetime performance of crystalline silicon PV modules,” In: Proceedings of 3rd world conference on photovoltaic energy conversion, vol.3 (12–16); pp. 2927–30, 2003

[7] S. Ponce Alcantara, C. Del Canizo, A. Luque, “Adaptation of monocrystalline solar cell process to multicrystalline materials,” Solar Energy Materials & Solar Cells, Vol. 87, 411–421, 2005.

[8] Thevenard D. “Performance monitoring of a northern 3.2kWp grid-connected photovoltaic system,” 28th IEEE photovoltaic specialist conference. Pp.1711–5, 2000.

[9] A. Hamizah, A. Maliki, and H. Zainuddin, “Modeling and Simulation of Grid Inverter in Grid Connected Photovoltaic System”, International Journal of Renewable Energy Research, Vol. 4, No. 4, pp. 949-957, 2014.

[10] S. Conti, S. Raiti, G. Tina, and U. Vagliasindi, “Study of the Impact of PV Generation on Voltage Profile in LV Distribution Networks,” Proc. IEEE Power Tech, Porto, Portugal, Vol.4, Sept. pp. 10-13, 2001.

[11] K. Sayed, et al., “Modeling and simulation of PV arrays”, ASME International Mechanical Engineering Congress & Exposition IMECE, pp. 1-8, 12-18 November 2010.

[12] D.P. Winston, M. Saravanan, “Single parameter fault identification technique for DC motor through wavelet analysis and fuzzy logic”, Journal of Electrical Engineering Technology, Vol.8 (5), 2013, pp. 1049–1055.

[13] D.Prince Winston & Ms. MERLIN, Fuzzy Logic Based Control of a Grid Connected Hybrid Renewable Energy Sources International Journal of Scientific & Engineering Research, Vol. 5, Issue. 4, 2014, pp.1043-1048.

[14] S.Praveen, D. Prince Winston, “Protection and Performance Improvement of a Photovoltaic Power System”, Advances in Electronic and Electric Engineering, Vol. 4, No. 1, pp. 41-48, 2014.

[15] K. Sakthivel D. Prince Winston, “Application of Optimization Techniques In Smart Grids”, International Journal of Science, Engineering and Technology Research (IJSETR), Volume 3, Issue 1, pp. 32-36, January 2014.

[16] M. Mahendran, V. Anandharaj, K. Vijayavel and D. Prince Winston, “Permanent Mismatch Fault Identification of Photovoltaic Cells Using Arduino” ICTACT Journal on Microelectronics, July 2015, VOL: 01, ISSUE: 02.

[17] S Cynthia Christabel, M Annalakshmi & Mr D Prince Winston, “Facial feature extraction based on local color and texture for face recognition using neural network”, International Journal of Science and Engineering Applications, Vol.2, Issue 4, 2013, pp.78-82.

[18] P Pounraj, D Prince Winston, S Cynthia Christabel, R Ramaraj “A Continuous Health Monitoring System for Photovoltaic Array Using Arduino Microcontroller”, Circuits and Systems, Vol.7, Issue.11, 2016, pp.3494.

[19] A Muthu Manokar, D Prince Winston, M Vimala, “Performance Analysis of Parabolic trough Concentrating Photovoltaic Thermal System”, Procedia Technology, Vol.24, 2016, pp.485-491.

[20] D Prince Winston, M Saravanan, “A Modified Energy Conservation Circuit for Chopper fed DC Motor Drive”, Przegląd Elektrotechniczny, Vol. 88, Issue.12a, 2012, pp.295-296.

[21] D Prince Winston, M Saravanan, S Arockia Edwin Xavier, “Neural Network Based New Energy Conservation Scheme for Three Phase Induction Motor Operating under Varying Load Torques”, International Conference on Process Automation, Control and Computing (PACC), 2011, pp.1-6.

[22] D Prince Winston, M. Saravanan, “Novel Energy Conservation Scheme for Three Phase Induction Motor Drives Employed in Constant Speed Applications”, Przegląd Elektrotechniczny, Vol. 88, Issue.11a, 2012, pp.243-247.

[23] K. Gurumoorthy, D. Prince Winston, D. Edison Selvaraj and Lieutenant. J. Ganesan, “Reduction of Harmonic Distortion by applying various PWM and Neural Network Techniques in Grid connected Photovoltaic Systems,” IJAREEIE, vol. 2, Issue 12, December 2013.

[24] O. Jeba Singh, D. Prince Winston, “A Survey on Classification of Power Quality Disturbances in a Power System” Journal of Engineering Research and Applications, Vol. 4, Issue 8(Version 2), August 2014, pp.80-84.

[25] P. Manikandan, V. Neviya, Lieutenant.J. Ganesan, D.Prince Winston “Experimental Analysis of Total Harmonic Distortion by Applying Various PWM Techniques on Three Phase Squirrel Cage Motor”,

DOI: 10.18535/ijecs/v6i6.48

International Journal of Research in Computer Applications and Robotics, Vol.2 Issue.2, pp. 82-92 February 2014.

[26] B.Ganesh Raja, D. Prince Winston, "Design and Simulation of Multilevel Inverter Suitable for Grid Connected Photovoltaic System", Advances in Electronic and Electric Engineering, Vol. 4, No. 1, pp. 31-40, 2014.

[27] R.Ramaraj, P.Pounraj, Dr.D. Prince Winston, J. S. SakthiSuriya Raj, S.Cynthia Christabel "Analysis of PV Power Generation under Partial Shading and Hotspot condition" International Journal of Applied Engineering Research, ISSN 0973-4562 Vol. 10 No.55 (2015), pp.3443-3447.

[28] J. S. Sakthi Suriya Raj, P. Pounraj, Dr. D. Prince Winston, R.Ramaraj, S.Cynthia Christabel "Intelligent MPPT Control Technique for Solar PV System" International Journal of Applied Engineering Research, ISSN 0973-4562 Vol. 10 No.55 (2015).

Author Profile

P.Marimuthu received the B.E. degree in Eletrical and Electronics Engineering from Theni Kammavar Sangam College of Technology, Tamilnadu, India, in 2013, where he is currently study toward the M.E. degree in Power system engineering from the Kamaraj College of Engineering and Technology.

B. Praveen kumar received the B.E degree in Eletrical and Electronics Engineering from Mohamed Sathak Engineering College, Tamilnadu, India, in 2014 and the M.E. degree from Kamaraj College of Engineering and Technology, Tamilnadu, India, in 2016. He is currently working toward the Ph.D. degree in the area of Renewable Energy Sources in Anna University, Tamilnadu, India.