A REVIEW ON CURRENT TRENDS IN MODELLING, SIMULATION AND VALIDATION OF SOLAR PHOTOVOLTAIC POWER PLANTS

Kedri Janardhana[1] D Bhagwan Das[2] A K Saxena[3]
[1] Assistant Professor [2,3] Professor
Department of Electrical Engineering, Faculty of Engineering, Dayalbagh Educational Institute, AGRA

Abstract-Modelling and simulation has been a successful tool for estimating system behavior before actually implementing the system. In case of solar photovoltaic systems, this tool is used to compare how well the system is behaving before and after installation by simulating it and comparing the simulated results with field results. Validation of the model is done by giving field values of the plant as input to the model and comparing them with the actual results. Modelling a solar photovoltaic plant is a complex problem comprising of many subsystems like SPV arrays, Inverters, Batteries, Grid, Load etc. Developing a model will help in system optimization and provide high reliability at low economy. This paper presents a review of current trends in modelling, simulation and validation of solar photovoltaic power plants. This review has been done by the authors during their research on a set of seven distributed solar power plants having a total capacity of 518.2 kWp at Dayalbagh Educational Institute, Dayalbagh, Agra, India. These plants are grid connected with battery storage systems for back up. Absence of good simulation models of such systems motivates the authors in this research direction in order to achieve optimized system operation.

Keywords – **Modelling , Simulation, Microgrids, Module, Inverter, Battery, Charge controller, Validation.**

I. INTRODUCTION

Energy and water are the keys to modern life. Growing environmental concerns are quickly changing the global energy panorama. Industrialized societies have become increasingly dependent on fossil fuels. Modern conveniences, mechanized agriculture, and global population growth have only been made possible through the exploitation of inexpensive fossil fuels. Securing sustainable and future energy supplies is the greatest challenge faced by all societies in this century [1]. Future energy demands can only be met by introducing an increasing percentage of alternative fuels**.** Incremental improvements in existing energy networks will be inadequate to meet this growing energy demand. Due to dwindling reserves and ever-growing concerns over the impact of burning carbon fuels on global climate change, fossil fuel sources cannot be exploited as in the past. [1]

Finding sufficient supplies of clean and sustainable energy for the future is the global society's most daunting challenge for the twenty-first century. The future will be a mix of energy technologies with renewable sources such as solar, wind, and biomass playing an increasingly important role in the new global energy economy. The key question is: How long it will take for this sustain able energy changeover to occur? And how much environmental, political, and economic damage is acceptable in the meantime? If the twenty-first century sustainable energy challenge is not met quickly, many less-developed countries will suffer major famines and social instability from rising energy prices. Ultimately, the world's economic order is at stake. Approximately one-third of the world's population lives in rural regions without access to the electric grid, and about half of these same people live without access to safe and clean water. Solar energy is unique in that it can easily provide electricity and purified water for these people today with minimal infrastructure requirements by using local energy resources that promote local economic development. [1]

II SOLAR PLANTS AS MICROGRIDS

A group of interconnected loads and distributed energy resources (DER) with clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid [and can] connect and disconnect from the grid to enable it to operate in both grid connected or island mode[2, 4] is said to be a Microgrid. At present, there is a need to assess the effects of large number of distributed generators and short term storage in Micro grid[3].

III National/International Status

The Indian government is promoting solar-powered micro-grid systems as part of its national redevelopment program, and hopes to use that experience to establish India as a world leader in solar power technology [5, 7]. One recent estimate put the potential market for "off-grid" power networks in India at around $2 billion a year [6].As on March 2017, the installed capacity of Solar Power Plants in India is 12GW and an ambitious target of 100GW is in pipeline. A demonstration project was sanctioned to TERI under the aegis of Asia-Pacific Partnership on Clean Development and Climate (APPCDC) in March, 2009 with the contribution of Rs.87 lakhs from the Ministry of New & Renewable Energy. The project was completed with the technical collaboration of the Solar Energy Centre under the Ministry of New & Renewable Energy in July 2011. The smart mini grid has been deployed at TERI Retreat building in which 3.2 kW wind generator, 10.5 kW solar PV power, 1 kW thin film, 2 kW SPV systems, 100kW biomass gasifier and diesel generator have been integrated to demonstrate optimal evacuation of renewable power[8]. Dayalbagh Educational Institute is a unique university that has commissioned 668 kWp Solar PV distributed power plants (11 in number) with a project cost of Rs. 12.5 crore, sufficient to fulfill all electric power requirements (including

classrooms, laboratories, workshops, computer center, water pumps etc.) of the institute on a clear day. This is an ideal test bed for the application of the concept of smart micro grid and for synergy along with energy storage allows for demand-response reliability and cost saving and reducing the carbon footprint [9]. The effectiveness of renewable energy based micro grid was clearly seen during the Northern Grid failure on30th and 31st August 2012. For two consecutive days the whole of Eastern and Northern India came to a standstill. However, thanks to the SPV micro grid, Dayalbagh Educational Institute was not affected by the grid failure. Even during normal days, a power cut of about 2-4 hours is observed in Agra. DEI, through the SPV plants, is coping up very well. [10]

Post Fukushima, all major European countries have decided to phase out nuclear power and replace it with renewables[11]. As most of them have almost exhausted all their Hydro resources, the only viable options left are wind and SPV [11]. In 2010, Illinois Institute of Technology (IIT) received US$12.6 million to establish IIT Smart Grid Education and Workforce Center. IIT signed a contract with Exelon Energy for about UD$40/MWh for a generation mix that is 75% carbon free with 25% hydro power[12]. Schneider Electric has collaborated with the Innovation Center for Mobility and Social Change (InnoZ) to complete a micro smart grid at the EUREF-Campus in Germany's capital city.The aim of the micro smart grid is to test the possibilities of energy storage with regards to renewable energy sources and electric mobility together [13].

IV Road to Review

After having installed the sufficient capacity of SPV power plants, for any customer/organization, it is a challenge to come up with an efficient, reliable and economically viable system in the presence of dynamic loading conditions, generation sources which depend on the weather and an unreliable utility supply. The main problems in efficient operation of the plants were many but the one on which this paper emphasizes on is “Absence of a good simulation model of the micro grid which would facilitate analysis and optimization of the system under different loading conditions and can also pave way for an optimized systemoperation”.

Typical problems can be solved with integrated operation, monitoring, communication, control and fault diagnosis of all the Solar Electric Power Plants, through a central control station. This would lead towards the philosophy of Smart Micro Grid. An important part of a Smart Micro Grid is a Decision Support System to assist the operator for optimal efficiency, economy and reliability in system operation. This makes a good simulation model of the micro grid very essential.

V REVIEW

This paper presents a review and deep insight of the research work being carried out, currently, in modelling, simulation and validation of SPV power plants.

V(a) Review on SPV Module modelling

Testing in a natural environment using solar panels presents difficulties in terms of repeatability as well as achieving full range of environmental parameters such as solar radiation and temperature which strongly impact the performance of photovoltaic systems. The paper [14] work presents a programmable solar photovoltaic simulator which can eliminate the need for using actual solar panels for testing and development purposes. From 1986 onwards, New England Electric has carried out and supported a wide range of research, development and demonstration projects related to the use of solar photovoltaic (PV) energy. The paper [15] describes each project and summarizes performance to date. Several projects embody the concepts of distributed generation (DG) and demand-side management (DSM) as well as utilization of renewable energy. The design of an autonomous SPV based system is presented in [16]. The result shows that PV system would be suitable to supply electricity to cover the load requirement without using energy from the grid. The Paper [17] presents a simulation program to implement the selected design procedures and calculates size ratings of the various components of the PV system. The program accepts the load demand details from the client as input data together with the solar insolation.

A study of the effects of PV string size on annual system energy production and yield has been conducted for several locations in Europe with significantly different weather as well as for locations with extreme climatic conditions such as high altitude and desert areas[18].A test set-up for the study of Arc faults in SPV modules is presented in [19]. The analysis of the measured signals in time and frequency domain presented show that the Parallel arcing involves significant changes in the current at the primary side of the converter and is therefore easily detectable. A parallel inverter configuration for residential photovoltaic (PV) systems consisting of two inverters of different sizes is proposed in the paper [20]. The paper [21] presents a comprehensive testing, validation and installation plan for a new technology which utilizes PV solar farm as a STATCOM both during night time and daytime. The paper [22] presents a novel technology of utilizing Photovoltaic (PV) Solar Farms in the night time. New controls are developed for the solar farm inverters to operate as STATCOM – a Flexible AC Transmission System (FACTS) Controller, using the entire inverter capacity in the night for accomplishing various power system objectives, such as voltage regulation, improvement of power transfer capacity, load compensation, etc. An auto-interference controller for SPV-wind system is presented in [23]. To capture the wind and the light in the greatest degree, the method of nonlinear transform of aerodynamic force is used, as well as the theory of brushless double-fed wind generator and the principle of extremism control on solar inverter are adopted. The hierarchical fuzzy controller algorithm is presented for controlling the loading and unloading of wind generators, solar cells and the grid, considering the multi-input and multi-output of the distributed hybrid power system. Paper [24] provides a bottom-up approach for modelling hourly electricity output based on meteorological data and technical specifications for different reference plants. Electricity output for wind power is based on hourly data on wind speed, ambient temperature and atmospheric pressure and calculated considering different turbine power curves and hub heights. Paper [25] presents an integrated design method of PV stations using Dig SILENT Power Factory and Mat lab/Simulink. The method enables a fast and effective access to complex PV system modelling and analysis. A real time optimization of parameters for the current control strategy for a 3-phase photovoltaic grid-connected Voltage Source Inverter (VSI) system is reported in [26]. The proposed controller scheme is

implemented based on a synchronous reference frame; the Phase-Locked Loop (PLL) is used as grid phase detector. Particle Swarm Optimization (PSO) algorithm is used to implement the real time self-tuning method for the current control parameters. The results show that the proposed strategy provides an excellent dynamic response within real time optimization.

V(b) Review on Charge controller modelling

DC power from solar panel is boosted through an MPPT controller and fed to an inverter which gives ac output. One such scheme is proposed in the paper [27]. In this work, depending on solar radiation and temperature, the MPPT controller gives optimized duty cycle. Neural network and fuzzy logic are two MPPT controllers, simulated to give optimum duty cycle. These MPPT controllers are compared based on the power obtained from the boost converter. Simulation results are also presented.

The paper [28] presents a PSCAD/EMTDC model of PV solar panels, the grid connected three phase voltage sourced inverter (VSI) and its controller system. The VSI control is implemented with current control loops. A maximum power point tracking (MPPT) algorithm is implemented to get the maximum output power for any given solar irradiation and temperature. The paper [29] focuses on the impact of large solar plants on power systems due to rapid variation in power injection caused by various factors such as the intermittency of solar radiation, changes in temperature and tripping out of power electronic based converters connected to the system.

The paper [30] presents, a strategy for tracking the maximum power point (MMPT) for several solar insolation levels. The paper [31] presents, a voltage based maximum power point tracking scheme developed for the inverters. Mathematical models are formulated and then a tracking algorithm is evolved. The paper [32] concerns the combination of a photovoltaic (PV) grid-feeding inverter with a motor control unit for two-axis solar trackers. The paper [33] presents, a maximum power point tracking algorithm that optimizes solar array performance and adapts to rapidly varying irradiance conditions. In particular, a novel extremism seeking (ES) controller that utilizes the natural inverter ripple is designed and tested on a simulated solar array with a grid-tied inverter. The new algorithm is benchmarked against the perturb and observe (PO) method using high-variance irradiance data gathered on a rooftop array experiment in Princeton, NJ. The paper [34] proposes Sinusoidal Pulse- Width Modulation (SPWM) technique in single-phase PWM inverter for PV generation system. A novel stand-alone PV generation system based on a nonlinear maximum power point tracking method and SPWM control scheme for single-phase voltage source PWM inverter is built in Matlab/Simulink software. Simulation results show the feasibility and effectiveness of the proposed method. The paper [35] focuses on the impact of large solar plants on power systems due to rapid variation in power injection caused by various factors such as the intermittency of solar radiation, changes in temperature and tripping out of power electronic based converters connected to the system.

The paper [36] presents, the design procedure and performance of a solar-PV (photovoltaic) energy generating system using an isolated zeta converter for meeting an energy demand of rural households.

The paper [37] presents, control algorithm design for a three-phase single-stage grid-connected PV inverter to achieve either maximum power point tracking (MPPT) or a certain amount of real power injection, as well as the voltage/var control. The switching between MPPT control mode and a certain amount of real power control mode is automatic and seamless.

The paper [38] proposes techniques of maximum power point tracking (MPPT) implemented with finite step model predictive control (FSMPC) for the application of Z-source inverter. Incremental conductance MPPT algorithm and FSMPC model is developed to control the output current of the grid-tied Z-source inverter in order to extract maximum solar power from the panel and then directly injecting the power into grid. A DC to AC Inverter and power switching system is presented in the paper [39]. The paper [40] presents the theoretical analysis, design and simulation of a single phase single stage boost dc-ac converter powered from PV array. The main attribute of the boost inverter topology is the fact that it generates an ac output voltage larger than the dc input one, depending on the instantaneous duty cycle. The paper [41] presents laboratory implementation of a photovoltaic artificial neural network (ANN) based maximum power tracking controller. The control purpose is to track the maximum available solar power in a photovoltaic array interfaced to an electric utility grid via a line commutated inverter. Due to its ability to handle nonlinear functions regardless of the derivative information, Evolutionary Programming (EP) is envisaged to be very effective for Maximum Power Point Tracking (MPPT) of Photovoltaic cell (PV). The paper [42] proposes a critical evaluation of MPPT algorithm of PV model using EP. The paper [43] presents a simulation model of the electric part of a grid connected photovoltaic generation system. The model contains a detailed representation of the main components of the system that are the solar array, and the grid side inverter multilevel inverter Neutral Point Clamped (NPC) VSI.

The paper [44] presents, perturbation and observation method to implement Maximum Power Point Tracking (MPPT) for solar cells. Owing to the existence of converters, photovoltaic system is a hybrid system contains continuous dynamic and discrete dynamic. Traditionally, the power electronic converter is difficult to model. The paper [45] presents, a new control algorithm of MPPT (Maximum Power Point Tracking) is proposed. The proposed algorithm takes the interaction between solar arrays, photovoltaic inverter, MPPT control, dc side dynamic model of solar arrays and the light intensity of the solar arrays into consideration.

The paper [46] proposes a high performance, single-stage inverter topology for grid connected PV systems. The proposed configuration can not only boost the usually low photovoltaic (PV) array voltage, but can also convert the solar dc power into high quality ac power for feeding into the grid, while tracking the maximum power from the PV array.

The paper [47] presents Laboratory implementation of a photovoltaic artificial neural network (ANN) based maximum power tracking controller. The paper [48] presents, integration of PV module and STATCOM. And a sample system is simulated in MATALB software to verify the advantages of proposed integrated system. The paper [49] reports on the modelling and simulation of a stand-alone photovoltaic (PV) plant with maximum power point tracking (MPPT) feature and dedicated battery storage. The proposed model is used to determine the voltage, current and power at the maximum power point and then investigate the quality of voltage available at load terminals for different operating scenarios.

V(c) Review on Inverter modelling

In paper [50] a reliability study of the entire system (i.e. the solar panels and the inverter) shows that the voltage generated by the solar panel matrix has to be low (< 100 V). This is realized by means of an appropriate feedback system. Paper [51] describes solutions to unbalance problem of the input DC voltages of the five-level neutral point clamping (NPC) voltage source inverter (VSI) using proportional integrator regulator (PI) and fuzzy logic controller (FLC). In the paper [52], starting from the utilization of solar energy, solar inverter status and the basic control method are analyzed. The practical significance and application prospects of the digital power conversion technology and network control are discussed.

The objective of the paper [53] is to propose a novel multilevel inverter using hybrid Photo Voltaic (PV)/wind power system in order to simplify the power system and reduce harmonics and the cost effect. The inverter in a photovoltaic (solar) power system has a critical influence on the efficiency of the overall system [54]. In the paper [55] a hybrid PWM approach has been developed to reduce the switching power losses of the inverter connecting the DC/DC converter to the grid.

The paper [56] presents analysis of a grid connected MLC as an inverter having variable dc sources(which can be the output of wind farms, solar panels etc.). In the paper [57], the design of a vector control including a repetitive controller is outlined. The paper [58] proposes a three-phase three-wire (3+3W) half-bridge single-stage grid-connected PV power inverter. The inverter system can not only transfer solar power into ac power to supply loads or/and to feed utility but eliminates current harmonics and improves power factor.

Analysis and practical implementation of the regular (symmetric, asymmetric) sampled three-phase PWM inverter waveform has been presented in the paper [59], which was digitally implemented on an Xilinx field programmable gate array FPGA and the essential considerations involved in the feasibility of using a Xilinx XCNOSE software-based to generate PWM.

Based on DSP TMS320F2812, a 10 kW single-phase grid-connected inverter has been built in the paper [60]. DC-DC Boost chopper structure circuit and full bridge inverter circuit are used in the system, with the functions of Maximum Power Point Tracking and anti-islanding effects and a robust digital predictive current controller and etc. The paper [61] proposes a two-stage structure solar inverter topology with maximum power point tracking capability. The control of the solar inverter is digitally implemented using Free scale DSP56F8346. In the paper [62], a three-phase grid-connected inverter has been implemented using DSP-TMS320LF2407A microprocessor. The current controller strategy, namely hysteresis current control, has been employed as an inverter control strategy. Paper [63] has analysed the behaviour of a renewable source of energy by means of analysis of its performance. It has a system of data acquisition to measure variables and to generate data base with these results. The obtained data are analysed by means of data mining technique based on an Evolutionary algorithm. In the study of the paper [64], a grid interactive inverter which is capable of importing electrical energy, generated from renewable energy sources such as wind, solar and fuel cells, to the grid line is designed and simulated with MATLAB/Simulink. The paper [65] presents a Rule based controller, based on fuzzy set theory to control the output power of a PWM inverter in Photo- Voltaic Energy conversion interface scheme. The objective is to track and extract maximum available solar power from the PV array under varying solar irradiation levels. The paper [66] presents the advantage of wind-solar complementary power supply system from the complementarities of time and region. It describes the development of wind-solar complementary single-phase sine wave power inverter and presents its hardware structure, operation principle, and intelligent control method to design for charging and discharging. The paper [67] focuses on the key technical issues and design optimization of large solar power plants. The objective of the paper [68] is to design and analyze a mini solar grid system consisting of PV panels, charge controller, battery and inverter to serve a remote locality. The papers [69-70] presents, Power Electronics Equipment applying superior characteristics Silicon Carbide (SiC) power semiconductors have been researching and developing. In the paper [71] a microcontroller based grid tied solar inverter (GTSI) has been designed and developed. The paper [72] classifies the kW and above range power rating GCTI (grid connected transformer less PV inverter) topologies based on their leakage current attributes and investigates and/illustrates their leakage current characteristics by making use of detailed microscopic waveforms of a representative topology of each class. The cause and quantity of leakage current for each class are identified, not only providing a good understanding, but also aiding the performance comparison and inverter design. The paper [73] presents, a multilevel (5-level) inverter which is used to make total harmonic reduction. The DC/AC inverter is capable of bidirectional power transfer. The LC filter is used in series with the multilevel inverter for filtering the harmonics. The fuzzy controller is implemented in closed loop with the multilevel inverter for the better results. The simulation results are shown in the paper [73]. Using fuzzy logic controller in closed loop with the multilevel inverter, the harmonics is reduced to low value.

The boost inverter presents an interesting topology for solar photovoltaic (PV) applications as a single stage that provides regulated, boosted, and inverted output voltage from a nonlinear dc input. While the boost inverter has been previously addressed from design, implementation, and control perspectives, the paper [74] analyzes its fault modes, failures, and reliability. The inverter is first experimentally tested to validate a simulation model used in the reliability analysis. In the paper [75] a simulation model for the 10kW PV-STATCOM is developed in PSCAD software. The paper presents the steady state and transient performance of the PVSTATCOM controller for voltage regulation and power factor control both during night time and daytime. The paper [76] proposed a two-switch dual-buck grid-connected inverter with hysteresis current control.

A multi-input multi-output high frequency ac link inverter is proposed as the power electronics interface for photovoltaic (PV) with a built in battery energy storage system (BESS),is described in the paper [77]. In this inverter, a single stage power conversion unit fulfils all the systems requirements i.e. inverting dc voltage to proper ac, stepping up or down the input voltage, maximum power point tracking (MPPT), generating low harmonic ac current with unity power factor at the output and input/output isolation. In the paper [78] a photovoltaic (PV) 3-phase inverter system is simulated jointly with its control in PSIM software. The main objective of the paper [79] is to develop a power conditioning system, which can be used to extract the variable solar DC power from sun and convert it into AC power to feed a 3- phase AC load effectively. The paper [80] proposes the modified space vector pulse width modulation for the modified Z-source inverter or T-source inverter. The paper [81]

discusses potential impacts and benefits of large-scale and micro-scale PV-DG based on conventional power factor control and Generator Emulator Control (GEC) for PV inverters. The purpose of the paper [82] is to model and simulate a three phase inverter that is able to perform well in the presence of balanced or unbalanced loads, and is also able to restrict the fault currents effectively without significant distortions of voltage and current waveforms. To reduce stress on semiconductor devices and harmonic distortion of current waveform, multilevel topology based solar inverters are suggested in literature of the paper [83]. The aim of the paper [84] is to model and simulate a boost inverter and its control method for implementing DC to AC power conversion method. The photovoltaic based load connected system depends up on the number of components and stages involved in the power conversion. Solar integrated current-fed quasi-Z-source inverter (qZSI) has been proposed to overcome the limitations of current-source inverter (CSI) and current fed Z (impedance) source inverter (ZSI), presents in the paper [85]. The paper [86] contributes the digital simulation of renewable energy source controlled EZ-Source inverter system. Input to the Embedded EZ-Source inverter is obtained from solar cell the ripple in the output voltage of solar cell is filtered using Z-jilter. The paper [87] presents the design of a unique inverter with D-STATCOM capability for small to mid-sized (10kW-20kW) permanent magnet wind installations. The proposed inverter can actively regulate VARs on individual feeder lines at a programmable output while providing the variable output power of the renewable energy source. A power loss model which is a function of the input/output voltage and the output power is proposed in the paper [88] to optimize the efficiency of the interleaved micro-inverter at various input/output conditions. Micro-inverters convert direct current (DC) from a single solar panel to alternating current (AC). The paper [89] presents, structure design and control system of 3KW wind and solar hybrid power systems for 3G base station. The system merges into 3G base stations to save power in order to fully ensure that base stations can supply power normally in any case.

V(d) Review on Battery modelling

For solar power to provide continuous capabilities a method of energy storage is required. This is usually provided by large lead acid batteries that are charged by the panels during sunny times and then discharged at night or bad weather. The most common setup is a lower pack voltage with at most 48V and high capacity batteries in the thousands of amp hours. There are many advantages of having a higher backup battery voltage. While this can be accomplished with traditional lead acid batteries, the number of batteries required can be cost prohibitive. An alternative solution is inexpensive second life NiMH batteries from end of life hybrid vehicles. While these batteries have come out of vehicles that are no longer rated for traction applications, they still have enough useful life for stationary storage operation. In addition they are sealed and maintenance free making them attractive for backup storage. [90]

The parallel operation of conventional DC-to-DC converters with voltage source characteristics mostly used requires special control mechanism to ensure correct power distribution. The solution proposed in the paper [91] is capable to improve the parallel operation of power stages in conventional converters with modern current sharing techniques. Paper [92] identifies the impacts of high penetration of storage and solar PV by evaluating different case scenarios on a small distribution network in Rockhampton, Queensland, Australia.

VI CONCLUSION

It is clear from the literature survey that most of the effort is based on standard mathematical models / MATLAB SIMULINK models available for typical system components. Any analysis or optimization study is meaningful only when the results obtained on simulation models can be physically realized on the system. Therefore, needs exists for developing accurate mathematical models and simulate an existing physical utility system. Its validation is as important as modelling and simulation and a real physical system is required for achieving it.

VII REFERENCES

[1] Robert Foster, Majid Ghassemi, and Alma Cota.” Solar Energy: renewable Energy and the Environment”. CRC Press. Taylor & Francis Group.2010.

[2]http://www.smartgrid-live.com/wp-content/uploads/2012/12/ Introduction-to-Microgrids-by-Tristan-Glenwright.pdf

[3] Wencong Su, Zhiyong Yuan and Mo-Yuen Chow.” Microgrid Planning and Operation: Solar Energy and Wind Energy”.Power and Energy Society General Meeting, IEEE 25-29 July 2010. Minneapolis, MN .pp.1-7.

[4] Department of Energy.” DOE Microgrid Workshop Report”. Office of Electricity Delivery and Energy Reliability Smart Grid R&D Program. San Diego, California August 30-31, 2011 .pp.1-32.

[5] Murthy S.S., Renewable Energy Research in India, Solar Thermal Technologies, Indo-Swiss Workshop on Renewable Energies and Rational End Use, EPFL, Lausanne, Switzerland, October, 22-24, 2012

[6] Tom Metcalfe, From Micro grids to Smart Grids, Kidela, http://www.kidela.com/resources/blackout-from-micro-grids-to-smart-grids/, November 20, 2012

[7] Renewable Energy News, Akshay Urja, Ministry of New and Renewable Energy, New Delhi, pp 8, October 2012.

[8] http://www.greenprospectsasia.com/content/renewable-energy-based-smart-mini-grid-system-commissioned-india

[9] D. Bhagwan Das, Development Of Smart Micro Grid For Optimal Spv-Grid Synergy And Rational End Use At The Dayalbagh Educational Institute, Agra, Indo-Swiss Workshop on Renewable Energies and Rational End Use, EPFL, Lausanne, Switzerland, October 22-24, , 2012

[10] Hindustan Times, Delhi edition, September 1, 2012.

[11] Hans B. Püttgen Publicly Funded Energy Research: A Contribution To Sustainable Development, Indo-Swiss Workshop on Renewable Energies and Rational End Use, EPFL, Lausanne, Switzerland, October 22-24, , 2012

[12] http://www.pv-magazine.com/news/details/beitrag/germany--micro-smart-grid-concluded-in-berlin_100006285/#axzz2Pfe75PMk

[13] http://cleantechnica.com/2012/06/28/remote-microgrids-will-help-developing-world/
[14] Avneet Singh, Ashish R. Hota and Amit Patra." Design and Implementation of A Programmable Solar Photovoltaic Simulator". Power, Control and Embedded Systems (ICPCES), International Conference on Nov.29 2010-Dec. 1 2010.Allahabad.pp.1-5.
[15] John J. Bzura. "Photovoltaic Research And Demonstration Activities At New England Electric". IEEE Transactions on Energy Conversion, Vol. 10, No. 1, March 1995. Pp. 169-174.
[16] K K Prajapat, Abhishek Katariya, Ashok Kumar and Shuchi Shukla." Simulation and Testing of Photovoltaic with Grid Connected System ".Computational Intelligence and Communication Networks (CICN), International Conference on 7-9 Oct. 2011.Gwalior.pp.692-697.
[17] Zakaria Anwar Zakaria, Bai-Chao Chen and Mohammed Osman Hassan. "Modeling of Photovoltaic Power Plants". Electrical Machines and Systems. ICEMS 2008. International Conference on 17-20 Oct. Wuhan. pp. 3835-3839.
[18] Panagiotis Bakas, Konstantinos Papastergiou and Staffan Norrga. "Solar Pv Array-Inverter Matching Considering Impact Of Environmental Conditions". Photovoltaic Specialists Conference (PVSC), 2011 37th IEEE. 19-24 June. Seattle, WA pp. 001779-001784.
[19] Christian Strobl and Peter Meckler. "Arc faults in photovoltaic systems". Electrical Contacts (HOLM), 2010 Proceedings of the 56th IEEE Holm Conference on 4-7 Oct. Charleston, SC.pp.1-7.
[20] El Bassiouny O. A., Dhople S. V., Davoudi A. and Chapman P. L. "Energy-Efficient Cost-Effective Inverter Configuration For Residential Photovoltaic Systems". Photovoltaic Specialists Conference (PVSC), 2010 35th IEEE. 20-25 June. Honolulu, HI. Pp. 000400-000406.
[21] R.K. Varma, , Rangarajan, S.S. ,Axente, I. and Sharma, V," Novel application of a PV Solar Plant as STATCOM (PV-STATCOM) during Night and Day in a Distribution Utility Network: Part 2". Power Systems Conference and Exposition (PSCE), 2011 IEEE/PES. 20-23 March. Phoenix, AZ.pp.1-8.
[22] Rajiv K. Varma, Shah Arifur Rahman, Mahendra, A.C.,Ravi Seethapathy and TimVanderheide" Novel Nighttime Application of PV Solar Farmsas STATCOM (PV-STATCOM)". Power and Energy Society General Meeting, 2012 IEEE. 22-26 July. San Diego,CA.pp.1-8.
[23] Yi-feng Wang , Jian Wu, Jun-min Xu,Yun Zhang and Ning Chen." Wind/Photovoltaic Hybrid Power Generator Based on Fuzzy Control ".Power Electronics and Motion Control Conference, 2009. IPEMC '09. IEEE 6th International. 17-20 May. Wuhan.pp.2284-2287.
[24] Gerda Schubert." Modeling hourly electricity generation from PV and wind plants in Europe ".European Energy Market (EEM), 9th International Conference on 10-12 May 2012. Florence.pp 1-7.
[25] Xiangqing Jiao and Qi Gao." Integrated Dynamic Simulation of Photovoltaic Installations and Its Low Voltage Ride-Through Capability Analysis ".Universities Power Engineering Conference (AUPEC), 22nd Australasian.26-29 Sept. 2012.Bali.pp.1-5.
[26] Waleed Al-Saedi, Stefan W. Lachowicz and Daryoush Habibi." An Optimal Current Control Strategy for a Three-Phase Grid-Connected Photovoltaic System Using Particle Swarm Optimization ".Power Engineering and Automation Conference (PEAM), 2011 IEEE (Volume:1). 8-9 Sept.Wuhan.pp.286-290.
[27] Anna Mathew and A. Immanuel Selvakumar." MPPT Based Stand-Alone Water Pumping System ".Computer, Communication and Electrical Technology (ICCCET), 2011 International Conference on 18-19 March.Tamilnadu.pp.455-460.
[28] Shah Arifur Rahman and Rajiv K. Varma." PSCAD/EMTDC Model of a 3-Phase Grid Connected Photovoltaic Solar System ".North American Power Symposium (NAPS), 2011. 4-6 Aug.Boston,MA.pp.1-7.
[29] T. Alquthami, H. Ravindra, M. O. Faruque, M. Steurer and T. Baldwin. "Study Of Photovoltaic Integration Impact On System Stability Using Custom Model Of PV Arrays Integrated With PSS/E". North American Power Symposium (NAPS), 2010. 26-28 Sept. Arlington, TX.pp.1-8.
[30] Goncalves Wanzeller, M. Alves, R.N.C. da Fonseca Neto, J.V. Fonseca, W.Ad.S. "Current control loop for tracking of maximum power point supplied for photovoltaic array". Ns IEEE Transactions on Instrumentation & Measurement Vol. 53, No. 4, Aug 2004. Pp . 1304-1310.
[31] M. Veerachary, Kalpana P, Kiranmai K. S, "A New Maximum Power Point Tracking Scheme for Inverters". Telecommunications Conference, 2005. INTELEC '05. Twenty-Seventh International. Sept.Berlin. pp. 429-433.
[32] "Combined Mechanical and Electrical Control of Solar Trackers in (C)PV Power Plants". Power Electronics and Applications, 2009. EPE '09. 13th European Conference on. 8-10 Sept. Barcelona.pp.1-5.
[33] Steven L. Brunton, Clarence W. Rowley, Sanjeev R. Kulkarni, , and Charles Clarkson ." Maximum Power Point Tracking for Photovoltaic Optimization Using Ripple-Based Extremum Seeking Control". IEEE TRANSACTIONS ON POWER ELECTRONICS, VOL. 25, NO. 10, OCTOBER 2010. pp.2531-2540.
[34] Hadi Aghazadeh, Hossein M.K and Ahmad S.Y." Stand-Alone PV Generation System with Maximum Power Point Tracking". Environment and Electrical Engineering (EEEIC), 9th International Conference on 16-19 May 2010. Prague, Czech Republic.pp.549-552.
[35] T. Alquthami, H. Ravindra, M. O. Faruque, M. Steurer and T. Baldwin." Study of Photovoltaic Integration Impact on System Stability Using Custom Model of PV Arrays Integrated with PSS/E ".North American Power Symposium (NAPS). 26-28 Sept. 2010. Arlington, TX.pp.1-8.
[36] Neha Adhikari, Bhim Singh and A. L. Vyas." Design and Performance of Low Power Solar-PV Energy Generating System with Zeta Converter ".Industrial and Information Systems (ICIIS), 2012 7th IEEE International Conference on 6-9 Aug.Chennai.pp.1-6.

[37] Huijuan Li, Yan Xu, Sarina Adhikari, D. Tom Rizy,, Fangxing Li and Philip Irminger." Real and Reactive Power Control of a Three-Phase Single-Stage PV System and PV Voltage Stability ".Power and Energy Society General Meeting, 2012 IEEE. 22-26 July. San Diego, CA.pp.1-8.
[38] Mo Wei; Loh Poh Chiang, Andrew, Frede and Blaabjerg." Maximum Power Point Tracking Technique Implementation of Z-source Inverter through Finite Step Model Predictive Control Strategy ".Industrial Electronics and Applications (ICIEA),7th IEEE Conference on 18-20 July 2012.Singapore.pp.1523-1528.
[39] Yun-Pam Lee, En-Chi Liu and Huang-Yao Huang." A Small Scale Solar Power Generation, Distribution, Storage,MPPT and Completed System Design Method". Communications, Circuits and Systems (ICCCAS), International Conference on 28-30 July 2010.Chengdu..pp.597-600.
[40] M.Kaliamoorthy, R.M.Sekar and I. Gerald Christopher Raj." Solar Powered Single Stage Boost Inverter with ANN Based MPPT Algorithm Communication Control and Computing Technologies (ICCCCT), IEEE International Conference on 7-9 Oct. 2010 . Ramanathapuram pp.165-170.
[41] Hussein M. Mashaly, Adel M. Sharaf, Mohamed M. Mansour and Abmed A. El-Sattar." Implementation Of An Artificial Neural Network Based Controller For A Photovoltaic Energy Scheme". Neural Networks. IEEE World Congress on Computational Intelligence., IEEE International Conference on (Volume:4) 27 Jun-2 Jul 1994 . Orlando, FL pp.2545-2549.
[42] M.Kaliamoorthy and V.Rajasekaran." A Novel MPPT Scheme for Solar Powered Boost Inverter using Evolutionary Programming ".Recent Advancements in Electrical, Electronics and Control Engineering (ICONRAEeCE), International Conference on 15-17 Dec. 2011.Sivakasi.pp.346-351.
[43] F.Bouchafaal, D.Beriberl and M.S.Boucherit." Modeling and simulation of a gird connected PV generation system With MPPT fuzzy logic control ".Systems Signals and Devices (SSD), 7th International Multi-Conference on 27-30 June 2010.Amman.pp.1-7.
[44] Ma Youjie, Cheng Deshu , Zhou Xuesong and Guo Runrui." MPPT Control of Photovoltaic System Based on Hybrid Modeling and its Simulation". Sustainable Power Generation and Supply. SUPERGEN '09. International Conference on 6-7 April 2009 .Nanjing.pp.1-5.
[45] Pan Lei, Gong Wei and Wang Yinghong." Maximum Power Point Tricking Control of Solar Photovoltaic Power Generation System Based on Model Reference Adaptive". Sustainable Power Generation and Supply. SUPERGEN '09. International Conference on 6-7 April 2009 .Nanjing.pp.1-5.
[46] Sachin Jain and Vivek Agarwal." A Single-Stage Grid Connected Inverter Topology for Solar PV Systems With Maximum Power Point Tracking". IEEE Transactions On Power Electronics, Vol. 22, No. 5, September 2007.pp.1928-1940.
[47] Hussein M. Mashaly, Adel M. Sharaf, Mohamed Mansour and Ahmed A. El-Sattar." A Photovoltaic Maximum Power Tracking Using Neural Networks". Control Applications. Proceedings of the Third IEEE Conference on 24-26 Aug 1994. Glasgow.pp.167-172.
[48] H. Toodeji, N. Farokhnia and G.H. Riahy." Integration of PV Module and STATCOM to Extract Maximum Power from PV". Electric Power and Energy Conversion Systems.. EPECS '09. International Conference on 10-12 Nov. 2009.Sharjah.pp.1-6.
[49] N. W. Vanden Eynde, S.Chowdhury,and S.P.Chowdhury." Modeling and Simulation of a Stand-Alone Photovoltaic Plant with MPPT Feature and Dedicated Battery Storage". Power and Energy Society General Meeting, 2010 IEEE. 25-29 July. Minneapolis, MN.pp.1-8.
[50] Bonte L. And Dr. Baert D." A Low Distortion Pwm Dc-Ac Inverter, With Active Current And Voltage Control, Allowing Line-Interfaced And Stand-Alone Photovoltaic Applications". Telecommunications Energy Conference. INTELEC 1982. International. 3-6 Oct. Washington, DC, USA. pp. 90-95.
[51] Saliha Arezki and Mohamed Boudour." Solutions to the instability problem of the DC input voltages of neutral point clamping multilevel inverter in photovoltaic chain connected to the network ".Environment Friendly Energies and Applications (EFEA), 2012 2nd International Symposium on 25-27 June. Newcastle upon Tyne.pp.13-19.
[52] Huanqi Tao, Gujing Han and Min Zou."The System Analysis of Solar Inverter based on Network Controlling". Challenges in Environmental Science and Computer Engineering (CESCE), 2010 International Conference on (Volume:2) 6-7 March. Wuhan,China.pp.243-246.
[53] C.S.Kiruba Samuel and K.Ramani."Multilevel Inverter Control for Wind-Photovoltaic Generation Systems ". Computing, Electronics and Electrical Technologies (ICCEET), 2012 International Conference on 21-22 March.Kumaracoil.pp.457-462.
[54] Michael S. Mazzola and Robin Kelley." Application of a Normally OFF Silicon Carbide Power JFET in a Photovoltaic Inverter ".Applied Power Electronics Conference and Exposition. APEC 2009. Twenty-Fourth Annual IEEE. 15-19 Feb. Washington, DC.pp.649-652.
[55] Antonio Testa, Tommaso Scimon and Salvatore De Caro." A Solar AC Module with active filter capabilities ".Power Electronics Electrical Drives Automation and Motion (SPEEDAM), 2010 International Symposium on 14-16 June. Pisa. pp.616-621.
[56] Abu Tariq, Mohammed Aslam Husain, Mohammad Ahmad and Mohd. Tariq." Simulation and study of a grid connected Multilevel Converter (MLC) with varying DC input". Environment and Electrical Engineering (EEEIC), 10th International Conference on 8-11 May 2011.Rome.pp.1-4.
[57] Stefan Engel, Klaus Rigbers and Rik W. De Doncker." Digital Repetitive Control of a Three-Phase Flat-Top-Modulated Grid Tie Solar Inverter". Power Electronics and Applications, 2009. EPE '09. 13th European Conference on 8-10 Sept. Barcelona.pp.1-10.

[58] C.-L. Shen and J.-Y Wang.” A 3+3W Half-Bridge Single-Stage Grid-Connection PV Power Inverter with Direct-Source-Current-Shaping Algorithm to Improve Power Factor”. TENCON 2006. IEEE Region 10 Conference. 14-17 Nov.Hong Kong.pp.1-4..
[59] Saad MeHuIef and N.A. Rahim.” Xilinx Fpga Based Three-Phase Pwm Inverter And Its Application For Utility Connected Pv System”. TENCON '02. Proceedings. 2002 IEEE Region 10 Conference on Computers, Communications, Control and Power Engineering (Volume:3). 28-31 Oct.pp.2079-2082.
[60] Hao Zhou,Chaonan Tong,Meiqin Mao and Chuan Gao.” Development of Single-phase Photovoltaic Grid-connected Inverter Based on DSP Control”. Power Electronics for Distributed Generation Systems (PEDG), 2nd IEEE International Symposium on 16-18 June 2010. Hefei, China.pp.650-653.
[61] Lili Zhang,Yueping Mo,Wei Jiang and Jin Cong.” The Research on Grid-Connected Photovoltaic Inverter Based On DSP Intelligent System Design and Engineering Application (ISDEA),International Conference on (Volume:2) 13-14 Oct. 2010. Changsha.pp.723-726.
[62] PooyaGhani, Vahi Hossein Madadi Kojabadid Asadzadeh and Hossein Madadi Kojabadi.” Implementation of Three-phase grid-connected inverter Using TMS320LF2407A microprocessor”. Power Electronics, Drive Systems and Technologies Conference (PEDSTC), 2011 2nd . 16-17 Feb. Tehran.pp.305-310.
[63] Alvarez, J.L., Enrique, J.M, Durhn, E., Pedro, M. and M. Sidrach.” Achievement Of The Behaviour Rules Of A Renewable Source Of Energy (Solar Arrays + Inverter) Using Evolutionary Algorithms Techniques”. Automation Congress, 2004. Proceedings. World (Volume:17). June 28 2004-July 1 2004.Seville.pp.391-396.
[64] N.Altin and I.Sefa.” Simulation of Neuro-Fuzzy Controlled Grid Interactive Inverter”. Information, Communication and Automation Technologies (ICAT), 2011 XXIII International Symposium on 27-29 Oct. Sarajevo.pp.1-7.
[65] Rohin. M. Hilloowala And Adel. M. Sharaf.” A Rule-Based Fuzzy Logic Controller For A PWM Inverter In Photo-Voltaic Energy Conversion Scheme”.Industry Applications Society Annual Meeting, 1992., Conference Record of the 1992 IEEE. 4-9 Oct. Houston, TX. pp.762-769.
[66] Li Yong-jian, Yue Da-wei, Liu Hong-xun and Liu Ya-feng.” Wind-solar Complementary Power Inverter Based on Intelligent Control”. Industrial Electronics and Applications, 2009. ICIEA 2009. 4th IEEE Conference on 25-27 May. Xi'an .pp.3635-3638.
[67] E.H. Camm and S. E. Williams.” Solar Power Plant Design and Interconnection”. Power and Energy Society General Meeting, 2011 IEEE. 24-29 July. San Diego, CA.pp.1-3.
[68] Shahidul I. Khan, Md. Abul Kashem and Md. Ariful Hoque.”Design and Analysis of A Mini Solar Grid in Remote Area of Bangladesh”. North American Power Symposium (NAPS), 2009. 4-6 Oct. Starkville, MS, USA.pp.1-5.
[69] Yasushi Matsumoto, Ryuji Yamada, Yasushi Kondo, Yoshinari Ikeda and Hiroshi Kimura.” Characteristics of the Power Electronics Equipments Applying the SiC Power Devices “.Power Engineering and Renewable Energy (ICPERE), 2012 International Conference on 3-5 july.Bali,Indonesia .pp.1-5.
[70] Hironori Mine, Yasushi Matsumoto, Ryuji Yamada, Kazuaki Mino, Hiroshi Kimura, Yasushi Kondo and Yoshinari Ikeda” Characteristics of the Power Electronics Equipments Applying the SiC Power Devices “.Power Engineering and Renewable Energy (ICPERE), 2012 International Conference on 3-5 july.Bali,Indonesia .pp.1-5.
[71] Md.Nahid Hossain,Tushar Kanti Routh, Abdul Hamid Bin Yousuf, Miah Md. Asasduzzaman, Md. Iqbal Hossain and Ummul Husnaeen.” Design and Development of a Grid Tied Solar Inverter “.Informatics, Electronics & Vision (ICIEV), 2012 International Conference on 18-19 May.Dhaka.pp.1054-1058.
[72] Ziya Özkan and Ahmet M. Hava.” A Survey and Extension of High Efficiency Grid Connected Transformerless Solar Inverters with Focus on Leakage Current Characteristics “.Energy Conversion Congress and Exposition (ECCE), 2012 IEEE. 15-20 Sept. Raleigh, NC.pp. 3453-3460.
[73] T. Ilakkia and G. Vijayagowri.” Hybrid Pv/Wind System For Reduction Of Harmonics Using Artificial Intelligence Technique “.Advances in Engineering, Science and Management (ICAESM),International Conference on 30-31march 2012. Nagapattinam, Tamil Nadu.pp. 303-308.
[74] Eric Hofreiter and Ali M. Bazzi. “Single-Stage Boost Inverter Reliability In Solar Photovoltaic Applications”. Power and Energy Conference at Illinois (PECI), 2012 IEEE. 24-25 Feb. Champaign, IL .pp.1-4.
[75] Rajiv. K. Varma, Byomakesh Das, Iurie Axente and Tim Vanderheide.” Optimal 24-hr Utilization of a PV Solar System as STATCOM (PV-STATCOM) in a Distribution Network “.Power and Energy Society General Meeting, 2011 IEEE. 24-29 July. San Diego, CA.pp.1-8.
[76] Zhilei Yao and Lan Xiao.” Two-Switch Dual-Buck Grid-Connected Inverter With Hysteresis Current Control “.Power Electronics, IEEE Transactions on (Volume:27 , Issue: 7). 12 December 2011.pp.3310-3318.
[77] Mahshid Amirabadi, Hamid A. Toliyat and William C. Alexander.” A Multi-input ac Link PV Inverter with Reduced Size and Weight “.Applied Power Electronics Conference and Exposition (APEC),Twenty-Seventh Annual IEEE. 5-9 Feb. 2012. Orlando, FL.pp.389-396.
[78] Ravi Prakash Vishvakarma, S.P.Singh, Prof. T. N. Shukla, Shashank Kr. Kushwaha and Devbrat.” 3-Phase Grid-Connected Liquid Solar Arrays Photovoltaic Inverter Control Loop Design “.Electrical, Electronics and Computer Science (SCEECS), 2012 IEEE Students' Conference on 1-2 March.Bhopal.pp.1-4..
[79] Dogga.Raveendhra, Dr. M.K. Pathak and Aurobinda Panda.” Power Conditioning System for Solar Power Applications: Closed Loop DC-DC Convertor Fed FPGA Controlled Diode Clamped Multilevel Inverter “.Electrical, Electronics and Computer Science (SCEECS), 2012 IEEE Students' Conference on 1-2 March.Bhopal.pp.1-4.
[80] K. Mahendranl, B. Indhumathl, Dr. S.u. Prabha and S. Suryakala.” Adapted SVPWM for T -Source Inverter for Renewable Energy System “.Computing, Electronics and Electrical Technologies (ICCEET), 2012 International Conference.pp.404-408.

[81] Bhavya Gudimetla, Farid Katiraei, Julio Romero Agüero,Johan H.R. Enslin and Hussam Alatrash.” Integration of Micro-Scale Photovoltaic Distributed Generation on Power Distribution Systems: Dynamic Analyses “.Transmission and Distribution Conference and Exposition (T&D), 2012 IEEE PES. 7-10 May.Orlando, FL.pp.1-7.
[82] Shiva Prasad Pokharel, Sukumar M. Brahma and Satish J. Ranade.” Modeling and Simulation of Three Phase Inverter for Fault Study of Microgrids “.North American Power Symposium (NAPS). 9-11 Sept. 2012. Champaign, IL.pp.1-6.
[83] Sandeep Anand and B. G. Fernandes.” Multilevel Open-ended Transformer Based Grid Feeding Inverter for Solar Photovoltaic Application “.IECON 2012 - 38th Annual Conference on IEEE Industrial Electronics Society. 25-28 Oct. Montreal, QC. pp.5738-5743.
[84] VIJA Y ANAND.M and SARITHA.S.N.” PV-Fed Single Phase Single Stage Boost Inverter”. Computing, Electronics and Electrical Technologies (ICCEET), International Conference on 21-22 March 2012. Kumaracoil.pp.443-446.
[85] S.Karolin Selvia and F.X.Edwin Deepak.” Solar Integrated Current-Fed Quasi-Z-Source Inverter With Power Buck-Boost Capability”. IEEE-International Conference On Advances In Engineering, Science And Management (ICAESM -2012) on March 30, 31, 2012. Nagapattinam,Tamil Nadu.pp.190-195.
[86] S. Kamalakkannan and S. Deve Gowda.” Digital Simulation Of Renewable Energy Source Controlled Ez-Source Inverter System Computing, Electronics and Electrical Technologies (ICCEET), 2012 International Conference on 21-22 March. Kumaracoil.pp.424-428.
[87] Pedram Sotoodeh, Colin P. Tareila, and Ruth Douglas Miller.” A Single-Phase D-STATCOM Inverter for Distributed Energy Sources”. North American Power Symposium (NAPS), 2012. 9-11 Sept. Champaign, IL.pp.1-6.
[88] Zhe Zhang, Mingzhi Gao, Qiong Mo, Min Chen and Zhaoming Qian.” Loss-Model Based Interleave Technique to Improve the Efficiency of Micro-inverter”. IECON 2011 - 37th Annual Conference on IEEE Industrial Electronics Society. 7-10 Nov. 2011. Melbourne, VIC.pp.3888-3893.
[89] Weijun Yu and Xianyi Qian.” Design of 3KW Wind and Solar Hybrid Independent Power Supply System for 3G Base Station”. Knowledge Acquisition and Modeling. KAM '09. Second International Symposium on (Volume:3). Nov. 30 2009-Dec. 1 2009.Wuhan..pp.289-292.
[90] Chad Davis and Bryan Schultz.” Second Life Hybrid Vehicle Batteries Used In Solar Backup”. Green Technologies Conference, 2012 IEEE. 19-20 April. Tulsa, OK.pp1.
[91] K. H. EDELMOSER, F. A. HIMMELSTOSS.” Bi-directional DC-to-DC Converter for Solar Battery Backup Applications”. 35th Annual IEEE Power Electronics Specialists Conference Aachen, Germany, 2004. PP .2070-2074.
[92] Arif MT, Oo, A.M.T., Ali, A.S. and Shafiullah, G..” Impacts of Storage and Solar Photovoltaic on the Distribution Network”. Universities Power Engineering Conference (AUPEC), 2012 22nd Australasian. 26-29 Sept.Bali.pp.1-6.