International Journal of Scientific Research & Engineering Trends
Volume 8, Issue 1, Jan-Feb-2022, ISSN (Online): 2395-566X

A Review Article of Control and Performance Evolution of Fopid Based Single Stage Grid Connected PV System

M. Tech. Scholar Srishti Dehariya, Prof. Dr. Anil Kumar Kori
Department of Electrical Engineering,
JEC, Jabalpur,MP,India

Abstract- Traditional power systems are designed in large half to utilize large base load power plants, with restricted ability to speedily ramp output or prune output below an exact level. The increase in demand variability created by intermittent sources like photovoltaic (PV) presents new challenges to increase system flexibility. This paper aims to analysis and emphasize the importance of the grid-connected PV system regarding the intermittent nature of renewable generation, and thus the characterization of PV generation with relevancy grid code compliance. The investigation was conducted to critically review the literature on expected potential problems associated with high penetration levels and islanding bar methods of grid tied PV. In line with the survey, PV grid affiliation inverters have fairly good performance.

Keywords- Solar PV grid connected system (SPVGC), Inverter.

I. INTRODUCTION

Mankind has always needed the energy resources, as these are the primary and most essential need. Initially Conventional sources like coal, oil etc, were being used for fulfilling the needs of human being, but its use over the years has led to various serious worldwide problems like global warming, depletion of fossil fuels, pollutions in the atmosphere etc. In view of these serious challenges, world's attention has been shifted towards renewable energy sources. These resources became very popular in these days as they affect the environment very less and acts as the substitute of conventional energy sources.

Solar and Wind energy, among various renewable energy sources, have gain much popularity and focus due to more capability to challenge the concerns raised by conventional energy resources, and also became the efficient alternatives of fossil fuels. Solar energy has several advantages while comparing it with others. The sun acts as a practically inexhaustible source of heat and light, and relatively easy to use it. Various technologies are available to get electricity from solar. But recently, solar photovoltaic technology has shown its trend in the society due to its usefulness as an effective, inexhaustible and environmental friendly nature [1-7].

The photovoltaic effect was invented in nineteenth century by Alexandre Edmond Becquerel, but still very less portion of electrical energy is being produced by this. Solar PV comprises of various merits, like absence of moving parts, existence at every place, negligible maintenance required, compact in area, very simple operation and long lifetime etc. All of these facts make the PV modules an interesting choice for the development of electrical distributed generation systems.

As far as generation cost is concerned, solar PV has higher as compare to other sources, but recent research is carry on for establishment of efficient PV modules with reduced cost in coming future. This solar PV module, which transforms solar energy into electrical energy, is a combination of solar cells connected in series and parallel plus some additional protections provided.

In green and environmental safe power generation is most important things to select to best approach to selection of power source. In this way modern globalization used renewal power generation source are used. PV and wind are best example of green energy generation system. But some limitation of solar and wind plants like as power fluctuation and higher THD variation. Hence this paper are gives a better approach to control of load across power.

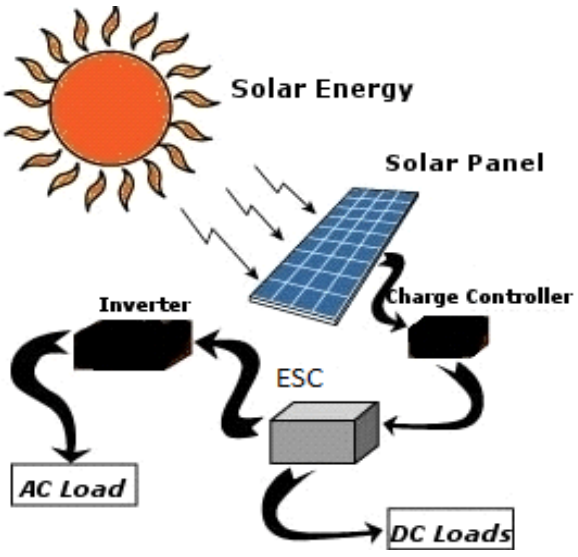

Fig 1. Solar based power generation.

II. RESEARCH MOTIVATION

Renewable energy resources are gaining more importance these days owing to the increasing energy demand, rising fuel cost, depletion of fossil fuels, and global warming (Gonzalez 2007). Among all the renewable energy resources, solar energy is very popular because sunlight is available throughout the year.

Owing to the technological advancement, the energy production cost of Solar Photovoltaic (SPV) system gets decreased (Rupees 80 lakhs per 100kW), but energy conversion efficiency of SPV system is only 12% to 20%. But optimal utilization of available solar energy has become inevitable in grid connected SPV system.

Hence, this research work focuses on performance improvement of SPV power conversion system with implementation of advanced power electronics technology.

III. PV SYSTEM

A solar cell, or photovoltaic cell (PV), is a device that converts light into electric current using the photovoltaic effect. The first solar cell was constructed by Charles Fritts in the 1880s.[7] The German industrialist Ernst Werner von Siemens was among those who recognized the importance of this discovery. [8] In 1931, the German engineer Bruno Lange developed a photo cell using silver selenide in place of copper oxide, [9] although the prototype selenium cells converted less than 1% of incident light into electricity. Following the work of Russell Ohl in the 1940s, researchers Gerald Pearson, Calvin Fuller and Daryl Chapin created the silicon solar cell in 1954.[10] These early solar cells cost US$286/watt and reached efficiencies of 4.5–6%.[11]

In 1957, Mohamed M. Atalla developed the process of silicon surface passivation by thermal oxidation at Bell Labs.[12][13] The surface passivation process has since been critical to solar cell efficiency.[14]

The array of a photovoltaic power system, or PV system, produces direct current (DC) power which fluctuates with the sunlight's intensity. For practical use this usually requires conversion to certain desired voltages or alternating current (AC), through the use of inverters.[6] Multiple solar cells are connected inside modules. Modules are wired together to form arrays, then tied to an inverter, which produces power at the desired voltage, and for AC, the desired frequency/phase. [6]

Many residential PV systems are connected to the grid wherever available, especially in developed countries with large markets.[15] In these grid-connected PV systems, use of energy storage is optional. In certain applications such as satellites, lighthouses, or in developing countries, batteries or additional power generators are often added as back-ups. Such stand-alone power systems permit operations at night and at other times of limited sunlight.

IV. LITERATURE REVIEW

Ahmed Hussain Elmetwaly, An Adaptive D-FACTS for Power Quality Enhancement in an Isolated Microgrid: Technologies of microgrids (MGs) help power grid evolve into one that is more efficient, less polluting, reduced losses, and more flexible to provide energy consumers' want and need. Because of the nature of various renewable energy sources (RESs) integrated into the MGs such as variability and inability to accurately predict and control, different technical problems are created. Power quality is one of the most important issues to be addressed, especially harmonic distortion and voltage stabilization. Many devices have been proposed to improve these two aspects that may result from loads nonlinearity and sources uncertainty.

In this study, an adaptive switched filter compensator (ASFC) with developed proportional-integral-derivative (PID) controller is proposed to improve the overall dynamic performance of the MGs. The PID's controller gains are optimally tuned via the application of grasshopper's optimization algorithm (GOA) to act adaptively with self-tuning as the operating conditions may subject to change during MG operation. Different case studies are proposed to reveal the robustness of the presented ASFC on harmonic mitigation, dynamic voltage stabilization, reactive power compensation and power factor improvement considering the features of RESs such as variations of wind speed, solar PV irradiation and temporary fault conditions.

A distribution synchronous static compensator (D-STATCOM), as one of the most popular D-FACTS, with optimal tuned PID controller by using the GOA is also proposed. To validate both the proposed ASFC topology and the modified D-STATCOM, comparative studies including what has been published in literature are examined by using MATLAB/Simulink platform. The results advocate the effectiveness, robustness and latency of the proposed devices.

Abhilash Sen, A comparative analysis between two DPFC models in a grid connected Hybrid Solar- Wind Generation system: In this paper a detailed performance analysis between two different models of Distributed Power Flow Controller (DPFC) is performed. The first type being the normal Distributed Power Flow Controller using batteries and the second type obtained by utilizing an extra three faze converter in place of the batteries. The system in study is a Hybrid Solar-Wind Generation system integrated with the Grid. The effect of the two models on

the Hybrid System is studied in detail using results obtained from MATLAB/Simulink platform.

Milad Farsi, Nonlinear Optimal Feedback Control and Stability Analysis of Solar Photovoltaic Systems: The efficiency of solar photovoltaic (PV) systems is directly affected by the convergence and steady-state responses of the implemented control method. In this paper, considering the nonlinearity appearing in the model of the solar PV system, we employ a nonlinear optimal feedback control scheme to deal with the oscillations around the maximum power point (MPP) of the system, induced by the chattering phenomenon in the control. Taking into account the improved transient response and flexibility, brought by including the cross-weighting terms in the cost functional, we develop an optimal control framework with a nonquadratic cost for addressing the MPP tracking (MPPT) problem of the solar PV system.

Exploiting the fact that a Lyapunov function candidate can be considered as the steady-state solution of the Hamilton-Jacobi-Bellman (HJB) equation, we obtained the optimal feedback controller via minimizing the resultant Hamiltonian. The stability analysis of the closed-loop system is done for the obtained control law with a guaranteed performance measure. Moreover, to enhance the practicality of the obtained control law, we present two procedures to implement the obtained control scheme under nonuniform insolation and as a model-free approach, separately.

To demonstrate the merits of the proposed framework, the obtained optimal feedback control, together with the partial shading condition and model-free approach, is simulated under various weather conditions. The optimal approach illustrates an improved performance in terms of the convergence rate and the amplitude of oscillations around the MPP, compared to existing results in the literature.

Shital Thorat, Improvement of Power Transfer Capability of Grid Employing Solar Farm as STATCOM: This paper introduces a modem method of utilizing PV solar inverter as static synchronous compensator, for increasing power transfer capability of the interconnected grid. The solar farm generates active power at day time and totally idle at night time The entire PV farm utilizes voltage controller and damping controller for increasing power transfer capacity during the time period. The capacity of inverter left after the active power production at day time which is used to accomplish the above objectives. This novel control concept of PV solar farm improves power transfer capacity, therefore other additional flexible AC transmission system controllers or series/shunt capacitors are not required.

Kurian Kevin, Micro Grid: An Energy Efficient Approach for Modern Power System: Renewable Energy Generation is a fast growing field of study under Power System Engineering. Renewable Energy has gained much popularity due to the fact that it can be easily setup near load centres and have very low running cost. Renewable Energy Generation also has the added advantage that it is environment friendly and will help in sustained development. This paper intends to study the interaction of multiple renewable sources when it is operated together to supply AC as well as DC Loads. This paper studies the behaviour of micro-grid in grid connected mode of operation. Bi-Directional operation of converter is also studies using decoupled vector control. Centralized Micro-Grid Controller is used for the Energy Management of the test system. Solar and Wind are the two renewable energy sources selected for study in this paper. Battery is also used in this system for energy storage. AC as well as DC loads are connected to the system to study the flow of energy.

Kritika Jain, Power Quality Enhancement Using Unified Power Flow Controller in Standalone Grid Connected Solar PV System: With the ever-advancing technology, our electricity consumption is taking a hike, too. To indemnify this hike, the power engineers have to ensure that the consumers get an uninterrupted power supply. Unfortunately, the conventional grid is no longer reliable to provide a continuous power supply to the consumers. So, the power industry has switched onto the new power generation sources like solar photovoltaic, wind energy systems, hydel power etc. Out of these, solar photovoltaic has proved to be the most efficient one. In this paper, we shall integrate the solar power with the conventional grid and study the effects of high solar penetration on the conventional grid. The problems which arise due to high solar penetration include load variation, voltage rise and reverse power flow.

Also, the sporadic nature of solar PV makes the system a bit unstable. So, to resolve all these issues, a new FACTS device, UPFC has been used. The UPFC ameliorates the voltage profile of the system as the series converter of UPFC injects an ac bus voltage into the system. Also, during the specified switching time, the UPFC removes the power oscillations arising at the utility grid side. The model also enhances the voltage profile of the system and increases the power at the grid side. The model is simulated on MATLAB Simulink and simulation outcomes have been shown.

Jing Wang, Development of a microgrid control system for a solar-plus-battery microgrid to support a critical facility: In the existing Microgrid (MG) market, the technology (MG controller) mainly focuses on operation and management of MG with large size (such as campus/industrial/community etc.) and the generation resources generally involves diesel at least and other renewables (such as PV, wind turbine, Fuel Cell) and storage units. However, MG technology enabling to support a specific critical facility like, for instance

hospital, police and fire department, wastewater etc., is overlooked due to the fact that an UPS unit or standalone generator is always used as a backup power supply and there is no real operation and management for this critical facility. With the integration of renewables in particular PV in this critical facility, it is essential to develop a suitable MG control system offering a completely autonomous and self-sustained MG System. This communication paper presents a GE MG solution aiming to develop a MG control system for a small battery-based (Solar-Plus-Storage) MG to support any critical facility with increasing penetration of PV. The expected outcome is to provide some industrial insights and engineering construction experience for Solar-Plus-Storage type of MGs.

Priyanka R. Yelpale, New control strategy for grid integrated PV solar farm to operate as STATCOM: This paper presents a new control strategy for grid integrated PV solar farm so that it can operate as STATCOM, for increasing grid power transfer capacity. Solar plants produce active power during day and are totally inactive in nights. The whole ratings of PV Farm remain inactive during night, which are utilized with the help of voltage and damping control to increase power transfer capacity. The inverter capacity left after the real power production is used to perform above objective. This new proposed strategy of PV system improves the power transmission capacity, for which other expensive alternatives are used for example series or shunt capacitor or other separate controllers of flexible AC transmission system.

Mohamed Azab, DC power optimizer for PV modules using SEPIC converter: In this paper an instantaneous maximum power extraction scheme is proposed as a PV power optimizer. The presented power harvesting scheme is rely on a weather-based power forecasting model in which the instantaneous value of the maximum power that should be extracted from the individual PV module is computed. The control unit of the proposed dc power optimizer is composed of a PI power controller and a PWM unit driving a SEPIC converter as a power conditioner. The chopper duty cycle is continuously adjusted such that the PV module is forced to operate near the maximum power point that is determined from the online measurements of the meteorological data model. The system is studied under both steps down and step up modes of operation permitted by the SEPIC converter.

The proposed scheme is investigated under different patterns of solar irradiance. The obtained results indicate both fast transient response and the good accuracy with low computation complexity due to the simple meteorological data model of the PV module. Compared with the commonly used perturb and observe (P&O) technique, the proposed scheme has better performance in terms of lower peak-peak power ripple. However, it has relatively lower tracking efficiency of (1-2)% due to the intentional reduction in the reference power signal to guarantee the fact that the actual harvested PV power can't exceed the reference value determined by the weather based model. The application area of the proposed scheme would be extended from a dc power optimizer for an individual PV to include microgrid applications, where commercially available temperature and solar irradiance transducers can be embedded with the distributed control unit of the SEPIC converter without dramatic increase to the initial cost of the overall system.

Ubaid U. Khan, Design and implementation of a low-cost MPPT controller for solar PV system: In this paper a maximum power point tracking (MPPT) algorithm using perturb and observe (P&O) method is discussed in order to improve the efficiency of the solar photovoltaic (PV) system. The magnificence of this method is the fact that it retains the value of the previous state and iterates for the future values of the system state. Comparing the past and the present states, the one which has more output power will be selected. ATMEGA328 microcontroller is used for constant voltage PWM control which is modulated by using a Buck-Boost converter.

This control observes the panel voltage and sets the duty cycle according to the input voltages from the solar panel. As the input voltage of the solar panel increases, the duty cycle decreases and vice versa to keep the output voltage constant. We have designed a low-cost solution which will optimally convert the solar DC voltage to an AC voltage to be used in home appliances.

Stefano Leonori, Multi objective optimization of a fuzzy logic controller for energy management in microgrids: This paper presents a novel power flow optimization strategy in Micro Grids (MGs) connected to the main grid. When the MG includes stochastic energy sources, such as photovoltaic and micro eolic-generators, it is very useful to rely on Energy Storage Systems (ESSs) to buffer energy. In fact, an ESS can be employed to perform several functionalities, related to different user requirements, such as power stability, peak shaving, optimal energy trading, etc.

The Energy Management System is based on a Fuzzy Logic Controller (FLC) optimized by a Multi-Objective Genetic Algorithm in order to maximize both the total profit in energy trading with the main grid and the State of Health (SOH) of the ESS. The FLC manages the neat aggregate energy deficit and surplus inside the MG, analyzing in real time the state of the MG (aggregated energy demand and production, State of Charge of the ESS, energy sale and purchase prices).

The FLC is tested on a MG composed by a photovoltaic solar generator, a domestic user and a Li-ion battery. A

multi-objective genetic algorithm is in charge to find the set of solutions on the Pareto front. The results are compared with the same FLC optimized by a mono-objective Genetic Algorithm (GA) minimizing in a first case only the total profit and in the second case a convex linear combination of the total profit and a measure of the battery stress.

Hesamaldin Maleki, Coordinated control of PV solar system as STATCOM (PV-STATCOM) and Power System Stabilizers for power oscillation damping: This paper presents a novel control of PV solar farm as a STATCOM (PV-STATCOM) coordinated with Power System Stabilizers (PSSs) for damping of electro mechanical oscillations in a power system. A two-area power system with a 150 MW PV solar plant connected at the midpoint of the tie line is simulated in PSCAD/ EMTDC software. During contingencies, the capacity of the PV inverter remaining after real power generation is utilized for dynamic reactive power exchange to accomplish power oscillation damping.

The advantage of master-slave feature in PSCAD/EMTDC software is utilized for performing the optimization and controller coordination. It is demonstrated that a coordinated control of PV-STATCOM and PSS can effectively enhance the damping of power oscillations, leading to higher power transfers in lines. This novel control of PV solar farms will result in a more optimal utilization of the expensive PV system asset for grid stabilization and enhancement of power transmission capability.

Radak Blange, MPPT of solar photovoltaic cell using perturb & observe and fuzzy logic controller algorithm for buck-boost DC-DC converter: Solar Photovoltaic (PV) power keeps changing with solar insolation(S) and ambient temperature (T) because PV cell exhibits non-linear current-voltage characteristic. So the Maximum Power Point (MPP) varies with the changing S and T. However with the advancement of power electronics converter technology, it is now possible to operate the PV power at its MPP in order to improve the overall efficiency. This paper presents maximum power point tracking (MPPT) based on Perturb & Observe (P&O) and Fuzzy Logic Controller (FLC) for PV with dc-dc buck boost converter for the purpose of performance evaluation and comparison analysis thereof.

Both the algorithms were simulated in MATLAB-Simulink with 100W PV module (Solar Alpex Panel 1552P-3613G-166109) connected to buck-boost dc-dc converter. The results of simulation and analysis indicate that the proposed FLC algorithms provide better MPP than that of conventional P&O method. FLC algorithms significantly improve the efficiency of MPPT and provide faster responses particularly during fast changing environmental conditions besides the fact that it is simple and can be implemented with PIC Microcontroller or FPGA.

Sayantani Dey, Fuzzy based optimal load management in standalone hybrid solar PV/Wind/Fuel Cell generation system: Sustainable and eco-friendly nature of renewable energy resources render them the best alternatives to conventional fossil fuels. The project proposes analysis and study of Photovoltaic-Wind-Fuel Cell hybrid system for distributed generation system for a remote residential load. A fuzzy logic controller is designed to extract maximum power from both solar and wind energies, which deliver maximal power to a fixed voltage DC bus which then supplies the load, while the surplus power is fed to the electrolyzer which generates hydrogen for the fuel cells and the batteries.

Simulation results prove the efficacy of the fuzzy logic controller and establish the fact that these renewable resources can be a viable solution to distributed production of electricity for standalone applications at inaccessible remote locations.

Rajiv K. Varma, New Control of PV Solar Farm as STATCOM (PV-STATCOM) for Increasing Grid Power Transmission Limits During Night and Day: This paper presents a novel concept of utilizing a photovoltaic (PV) solar farm inverter as STATCOM, called PV-STATCOM, for improving stable power transfer limits of the interconnected transmission system. The entire inverter rating of the PV solar farm, which remains dormant during nighttime, is utilized with voltage and damping controls to enhance stable power transmission limits. During daytime, the inverter capacity left after real power production is used to accomplish the aforementioned objective. Transient stability studies are conducted on a realistic single machine infinite bus power system having a midpoint located PV-STATCOM using EMTDC/PSCAD simulation software.

The PV-STATCOM improves the stable transmission limits substantially in the night and in the day even while generating large amounts of real power. Power transfer increases are also demonstrated in the same power system for: 1) two solar farms operating as PV-STATCOMs and 2) a solar farm as PV-STATCOM and an inverter-based wind farm with similar STATCOM controls. This novel utilization of a PV solar farm asset can thus improve power transmission limits which would have otherwise required expensive additional equipment, such as series/shunt capacitors or separate flexible ac transmission system controllers.

S. Kalika, Designing and implementation of MPPT controller for varying radiance in solar PV system: Photo voltaic power generation has an important role to play due to the fact that it is a green source. After their installation they generate electricity from the solar irradiation without emitting greenhouse gases. Electrical

energy presently comprises about fifteen percent of energy demand in the world, but this percentage is considerably higher for developed societies and tends to increase. Electricity consumption is strongly correlated with economic growth; economic growth allows further use of electric appliances which in turn increases electricity demand. The output power produced by photovoltaic systems is directly related to the amount of solar energy acquired by the system, and so it is extremely important to track the sun's position according to its trajectory with accuracy. In this paper the deigning and implementation of a solar tracker is explained which is using a stepper motor and light sensor and automatically follows sun's trajectory.

This tracker can be used for increasing power collection efficiency by tracking the sun. An MPPT solar tracking system has been designed, implemented and presented in this paper.

Ravi Seethapathy, Novel nighttime application of PV solar farms as STATCOM (PV-STATCOM): Photovoltaic solar farms generate power only during daytime and remain completely idle during the nights. This paper presents a novel technology of utilizing Photovoltaic (PV) Solar Farms in the nighttime. 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.

During the daytime, the same objectives can be achieved to a substantial degree with the inverter capacity remaining after real power generation. This technology is termed PV-STATCOM. Two novel applications of solar farms operating as PV-STATCOM in realistic transmission and distribution systems are presented in this paper. These are: i) Improving power transfer capacity of transmission lines. And ii) Increasing the connectivity of neighbouring wind farms.

V. CONCLUSION

This paper presents a literature review of the recent developments and trends bearing on Grid Connected photovoltaic Systems (GCPVS). In countries with high penetration of Distributed Generation (DG) resources, GCPVS are shown to cause accidental stress on the electrical grid. A review of the prevailing and future standards that addresses the technical challenges related to the growing variety of GCPVS is bestowed.

Maximum power point tracking (MPPT), solar following (ST) and also the use of rework less inverters will all result in high potency gains of electrical phenomenon (PV) systems whereas guaranteeing least interference with the grid. Inverters that support appurtenant services like reactive power management, frequency regulation and energy storage area unit important for mitigating the challenges caused by the growing adoption of GCPVS.

REFERENCE

[1] Ahmed Hussain Elmetwaly, an Adaptive D-FACTS for Power Quality Enhancement in an Isolated Microgrid, IEEE Access (Volume: 8), DOI: 10.1109/ ACCESS.2020.2981444.
[2] Abhilash Sen, A comparative analysis between two DPFC models in a grid connected Hybrid Solar- Wind Generation system, 2020 IEEE International Conference on Power Electronics, Smart Grid and Renewable Energy (PESGRE2020), DOI: 10.1109/ PESGR E45664.2020.9070373.
[3] Milad Farsi, Nonlinear Optimal Feedback Control and Stability Analysis of Solar Photovoltaic Systems, IEEE Transactions on Control Systems Technology (Volume: 28, Issue: 6, Nov. 2020), 1558-0865.
[4] ShitalThorat, Improvement of Power Transfer Capability of Grid Employing Solar Farm as STATCOM, 2019 International Conference on Computation of Power, Energy, Information and Communication (ICCPEIC), 978-1-7281-0837-7.
[5] Kurian Kevin, Micro Grid: An Energy Efficient Approach for Modern Power System, 2019 IEEE International Conference on Distributed Computing, VLSI, Electrical Circuits and Robotics (DISCOVER), 978-1-7281-3735-3.
[6] Kritika Jain, Power Quality Enhancement Using Unified Power Flow Controller in Standalone Grid Connected Solar PV System, 2018 International Conference on Inventive Research in Computing Applications (ICIRCA), 978-1-5386-2456-2.
[7] Jing Wang, Development of a microgrid control system for a solar-plus-battery microgrid to support a critical facility, 2017 IEEE Power & Energy Society Innovative Smart Grid Technologies Conference (ISGT), 978-1-5386-2889-8.
[8] Priyanka R. Yelpale, New control strategy for grid integrated PV solar farm to operate as STATCOM, 2017 International Conference on Circuit ,Power and Computing Technologies (ICCPCT), 978-1-5090-4967-7.
[9] Mohamed Azab, DC power optimizer for PV modules using SEPIC converter, 2017 IEEE International Conference on Smart Energy Grid Engineering (SEGE), 978-1-5386-1776-2.
[10] Ubaid U. Khan, Design and implementation of a low-cost MPPT controller for solar PV system, 2016 International Conference on Open Source Systems & Technologies (ICOSST), 978-1-5090-5586-9.
[11] Stefano Leonori, Multi objective optimization of a fuzzy logic controller for energy management in microgrids, 2016 IEEE Congress on Evolutionary Computation (CEC), 978-1-5090-0623-6.

[12] HesamaldinMaleki, Coordinated control of PV solar system as STATCOM (PV-STATCOM) and Power System Stabilizers for power oscillation damping, 2016 IEEE Power and Energy Society General Meeting (PESGM), 978-1-5090-4168-8.
[13] RadakBlange, MPPT of solar photovoltaic cell using perturb & observe and fuzzy logic controller algorithm for buck-boost DC-DC converter, 2015 International Conference on Energy, Power and Environment: Towards Sustainable Growth (ICEPE), 978-1-4673-6503-1.
[14] SayantaniDey, Fuzzy based optimal load management in standalone hybrid solar PV/Wind/Fuel Cell generation system, 2015 Communication, Control and Intelligent Systems (CCIS), 978-1-4673-7541-2.
[15] Rajiv K. Varma, New Control of PV Solar Farm as STATCOM (PV-STATCOM) for Increasing Grid Power Transmission Limits During Night and Day, IEEE Transactions on Power Delivery (Volume: 30, Issue: 2, April 2015), 0885-8977.