International Journal of Recent Research and Review, Vol. XV, Issue 4, December 2022
ISSN 2277 – 8322

A Review on Grid Connected Solar PV System with Maximum Power Point Tracking System

Vishnu Kumar Jabdoliya[1], Umesh Kumar[2]
Research Scholar, Dept. of EE, JIT Group of Institutions, Jaipur, Rajasthan, India
[1]jvkumarjabdoliya@gmail.com
Asst. Prof., Dept. of EE, JIT Group of Institutions, Jaipur, Rajasthan, India
[2]umeshsain08@gmail.com

***Abstract*—The sources of energy which are non-renewable in nature are not in position to meet the increased demand due to rapid industrialization and agriculture. These resources of energy are depleting in nature at fast rate. It is winning situation for India that it has a high and vast potential of RE sources. The modern power system network is becoming complex in nature day by day due to increased integration of the large size turbo generators, renewable energy sources and high power transmission lines. Further, increased use of the power electronics based loads (non-linear loads) has also deteriorated the quality of power supply. Hence, in the recent years the electrical power quality is emerging as a main concern for both the utilities as well as customers because the customer load gets affected and it may also get damage. In a solar power system, maximum power point tracker is a main part and plays a very vital role to get maximum power output. This article gives a detailed information about the grid connected SPV system and different MPPT techniques.**

Keywords—Renewable Energy, Solar System, Grid System, Maximum Power Point, Perturb & Observe Technique.

I. INTRODUCTION

The sources of energy which are non-renewable in nature are not in position to meet the increased demand due to rapid industrialization and agriculture. These resources of energy are depleting in nature at fast rate. It is winning situation for India that it has a high and vast potential of RE sources. Further, a number of technologies are being developed for harnessing the RE sources. RE energy received from the sun and wind is being utilized on large scale in the country. Solar energy and wind energy are important and prime sources of RE power plants which are integrated to the network of utility grids in large quantum recently [11]. Energy directly received from the Sun is considered as solar energy. This energy is converted to electricity in the solar thermal plant and Solar Photovoltaic (PV) plant. Solar PV plants are being extensively used for conversion of solar energy into electrical power. Solar PV plants are considered as solar energy supply systems, which are effective to convert sunlight directly into the electrical power. Main and important component of the solar PV system is the solar panel. This is structured by putting together various PV cells which are connected in series and parallel combinations. PV modules are formed by putting together several PV cells. Several modules are connected together to form the arrays. Several arrays are connected together to form panels. Modular nature of PV cells is suitable for their use in wide range of power applications which ranges from a few milli-watts such as wrist watches and scientific calculators to megawatts range in the grid integrated power plants. Solar cells are composed of the semiconductor materials. PV systems can be arranged in two main groups which are considered as off-grid systems and Grid-connected systems. Off-grid PV systems are the small size power plants which not connected to the utility electricity grid and used in isolated mode. Energy storage system is the essential requirement of these systems. This energy storage device is used to store the generated energy because energy generated is not usually required at the same time and it is used at other time. This PV system is also called as the stand-alone system. Grid-connected PV systems are generally integrated to large independent power network which is usually the public utility grid. These systems feed power directly to the network of utility grid. These systems are generally used in the decentralized grid-connected solar PV applications as well as also in the centralized grid-connected solar PV plants. The rooftop solar PV generators, for which the PV systems are erected on rooftops of buildings or on land and incorporated into the building's integrated system are the best examples of Decentralized grid-connected solar PV applications. For the residential or building mounted grid connected solar PV plants, the electricity load of the building is supplied by the solar PV plant and surplus power is fed into the grid. These plants have their capacities generally in the lower range which in the form of kilowatts. A grid-integrated solar PV system contains main parts as solar PV Modules which convert sunlight

directly to electricity, Inverter is used to convert the DC current supplied by the solar PV modules into the AC current and this AC current is injected into the utility grid.

II. RELATED RESEARCH

P. Shukl et al [2020] A genuine concern in regards to decay in power quality has developed with the expanding coordination of sun powered photovoltaic (PV) vitality sources to the utility essentially in the situation of a frail appropriation network. Along these lines, power quality improvement of the network tied sun oriented vitality transformation framework is foremost by execution of a strong control procedure. This paper manages a delta-bar-delta neural system (NN) control for working ideally by taking care of dynamic capacity to the heaps and remaining capacity to the framework as an element of conveyance static compensator abilities, for example, relieving music, adjusting of burden, and improving force factor. The control calculation gives the capacity to change loads adaptively in a freeway, and subsequently, it offers lightening in model unpredictability prevalent during irregular lattice conditions alongside decrease in computational time. The sun based PV-cluster effective usage is practiced through a gradual conductance-based greatest force point following strategy. For approving the conduct of the proposed framework, its exhibition is considered utilizing reproduction results. In addition, a model is created for approval, and exploratory outcomes substantiate solid activity under non ideal matrix conditions containing a wide scope of burden varieties, voltage hang, and changing sun powered insolation conditions.

F. Chishti et al. [2019] This work proposes a microgrid (μ-lattice) that combines wind and wind and solar powered photovoltaic (PV), alongside bet vitility stockpiling (BES) into a three-dimensional framework that takes care of the offline load. The μ frame that suffers from the inferior timeline limits and its properties is neglected by the solid regulators used to convert the lattice side voltage converter (GVSC) and the converter voltage converter (MVSC). The receiving and emitting power request is always carried by the SEGCS and in this way keeps the frame volume and sinusoidal current and is in phase by acquiring the control capabilities of the voltage at various edges as for the framework voltage is among one of the strategies which can be utilized to control the greatness of voltage and consequently the receptive force stream can be controlled. The irreversible natural influences are exacerbated by the use of a very bother and watch (P&O) point (MPP) to form a strong wind base and a P&O variable size for the solar imaging step.

C. M. Nirmal et al. [2018] In this paper are included two phase Solar Energy Grid Connected (SEGCS) and Zeta converter for DC-DC and Cascaded H-connect Multilevel Inverter (CHB-MLI) for converting to DCC. The corresponding shunt SEGCS is displayed with an approximate load that is not a direct receiver of unequal reception. Motive power is generated in the Photo Voltaic (PV) frame as illumination is shared by the mass and the spectrum. The receiving and emitting power request is always carried by the SEGCS and in this way keeps the frame volume and sinusoidal current and is in phase by acquiring the control capabilities of the voltage at various edges as for the framework voltage is among one of the strategies which can be utilized to control the greatness of voltage and consequently the receptive force stream can be controlled. Now and then it isn't practical to utilize compensators for solidness control for enormous electrical framework organize as these frameworks may have the issue of increment in load request and dependability issue simultaneously as the expansion popular may influence the soundness at the force age unit. Simulation testing of the proposed work was done with a 100 kVA limit on the MATLAB / SIMULINK model and was performed on a mechanical model. Flexible switching and dynamic operation of the SEGCS under PV side opposite and side effects of the unbalanced load are performed and the results are presented in this paper to allow insight.

W. J. Praiselin et al [2017] The accompanying points are managed: photovoltaic force frameworks; power matrices; appropriated power age; voltage control; invertors; sustainable power sources; power age control; hereditary calculations; PI control; power gracefully quality. C. Shen et al [2007] In this paper a half-connect photovoltaic (PV) framework is proposed, which can process power bi-directionally as well as improve power quality. As indicated by fluctuating insolation, the framework conditions genuine force for dc and air conditioning burdens to oblige distinctive measure of PV power. Moreover, the framework wipes out current music and improves power factor all the while. As contrasted and traditional PV inverter, the absolute number of dynamic switches and current sensors can be decreased so its expense is brought down altogether. For current order assurance, a straight guess strategy (LAM) is applied to maintain a strategic distance from convoluted computation and accomplish most extreme force point following (MPPT) include. For controlling, an immediate source-current-molding (DSCS) calculation is introduced to shape the waveform of line current. Reenactment results and down to earth estimations exhibit the possibility of

the proposed half-connect PV framework.

U. K. Kalla and M. Mantri, [2016] This paper presents a versatile back proliferation learning plan for three stage four wire lattice incorporated sun based PV - battery microgrid taking care of three stage and single stage nonlinear loads at the same time. The proposed power quality improved 3 stage 4 wire sun oriented PV - battery microgrid is fit for conveying exceptionally non-sinusoidal flows to nonlinear and unbalance heaps of various sorts to such an extent that solitary and three stage modern and local burdens, while the source flows in each of the three stages stays adjusted and sinusoidal. A versatile back spread learning plan is utilized to control the microgrid voltage control and force quality improvement under different stacking conditions through alleviation of consonant flows, responsive force remuneration and dynamic force adjusting in the framework. It likewise improve the framework power factor in exceptionally nonlinear and uneven stacking conditions. The proposed plot fundamentally improves the consistent state and dynamic exhibitions of the 3 stage 4 wire lattice coordinated sun based PV - battery microgrid system.

R. Ramaprabha, S. H. Jubair, K. Suhas and A. Lokesh [2015], This paper presents examination investigation of counterfeit neural system (ANN) and versatile neuro fluffy surmising framework (ANFIS) computerized reasoning (AI) based most extreme force point following (MPPT) methods for following greatest force from the Photovoltaic (PV) exhibit. These calculations are fundamental since PV exhibits have non-straight attributes with its firm reliance on changing sunlight based illumination and temperature. To expand the force separated from sun oriented board, PV exhibit must work at a most extreme force point (MPP) under given burden conditions. Regular calculations, for example, Perturb and Observe (P&O) and Incremental-Conductance (Inc-Cond) endures, with high motions during changing sunlight based light prompting low effectiveness, consequently AI based procedures are planned and introduced in this paper. ANFIS is increasingly proficient in following MPP with less settling time, less overshoot, less motions and less time taken to follow MPP than ANN based Controller.

D.B Kumar [2014], Solar Photovoltaic (PV) frameworks have non straight qualities. Most extreme force point following (MPPT) is a difficult undertaking when they are interfaced with load. At the point when the PV boards in an exhibit get non-uniform insolation/incompletely concealed, hostile to resemble diodes called sidestep diodes are utilized over a gathering of cells to evade the harm of low lit up cells/boards. A few focal points are accomplished, for example, basic structure, cost-productive execution and no following constraint close to the Voc. A circuit for a 72 W PV board is reenacted and actualized to confirm the practicality of the proposed bend tracer utilizing.

III. MAXIMUM POWER POINT TRACKING

The MPPT stands for maximum power point tracking. This is the most widely used technique to extract maximum power from the solar system using specified terms and conditions. As for the connection between the photovoltaic system and the inverter system, the external network, the battery pack, or other loads. However, regardless of the ultimate goal of solar energy, the main problem solved by MPPT is that the efficiency of solar cell transmission depends on the amount of sunlight falling on the solar panels and the characteristics of the load. When the sunlight changes, the transmission properties that provide the highest power transmission efficiency will change. When the load properties change, the system's efficiency will be enhanced to maintain the highest power transmission efficiency. This characteristic of the load is called the most vital point, and MPPT is the process of finding that point and maintaining the load-carrying characteristic there. The circuitry can be designed to place all the loads on the solar cell and then convert the power, current, and frequency accordingly to other devices or systems, and the MPPT solves the selection problem. The best load to be delivered by the battery. Solar cells have a complex relationship between temperature and absolute resistance, which will produce a non-volatile product, which can be analyzed based on the IV cycle. The purpose of the MPPT system is to test the output of the photovoltaic cell and apply the resistance (load) that can obtain the maximum power according to the ambient conditions. MPPT devices are often integrated into power converter systems, which provide automatic conversion, filtering, and control to transmit various loads, including grid, battery, or engine. The solar converter converts DC to AC and may contain MPPT: This type of inverter checks the output power (curve IV) of the solar model and uses a resistor (load) that can obtain maximum power especially.

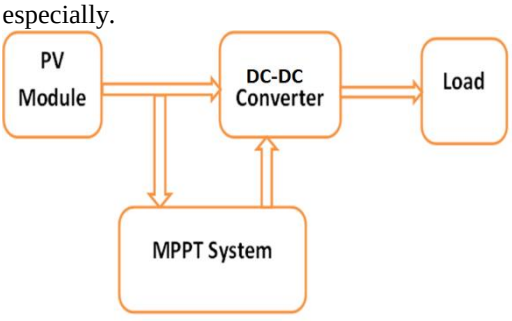

Figure: 1 Block diagram of MPPT System

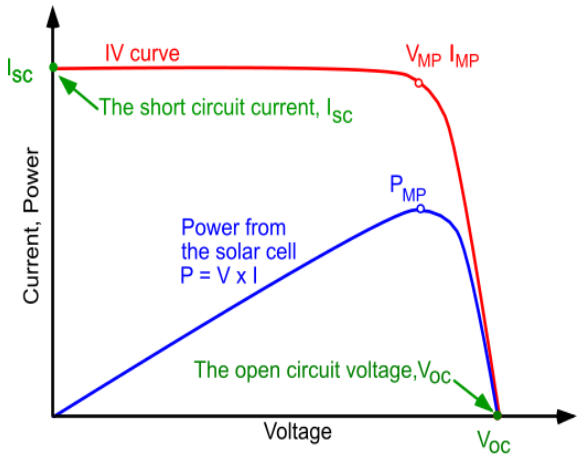

Figure: 2 PV Panel Characteristics

IV. MPPT TECHNIQUES

There are various MPPT techniques, some of them are illustrated below;

1) Perturb & Observe technique

As the name of this method, the means of perturb is change in voltage, current and power of solar panel and the means of observe is to measure that change and compare with last measured values. This is one of the most widely used MPPT technique. Perturb and Observe method is the most commonly used method for solar and wind energy conversion systems. In a solar PV system, the PV output voltage and current are measured two consecutive intervals. The power is calculated for two successive intervals. The change of power to change voltage is calculated dP/dV. Based on the positive and negative values of the slope dP/dV, the duty cycle is incremented or decremented. Accordingly, the voltage and power are adjusted to the MPP. If the slope dP/dV=0, then the maximum power point is reached for the present environmental conditions. This is a continuous process. The measurements are to be continuously taken, and change power and voltage change are calculated to take control actions. The MPP is achieved by making the impedance of the solar PV with the impedance of the load side. The duty cycle is adjusted to match the impedance. This MPPT algorithm is explained in the previous chapter with a flow chart and algorithm.

The flow chart of P & O method is shown in below figure;

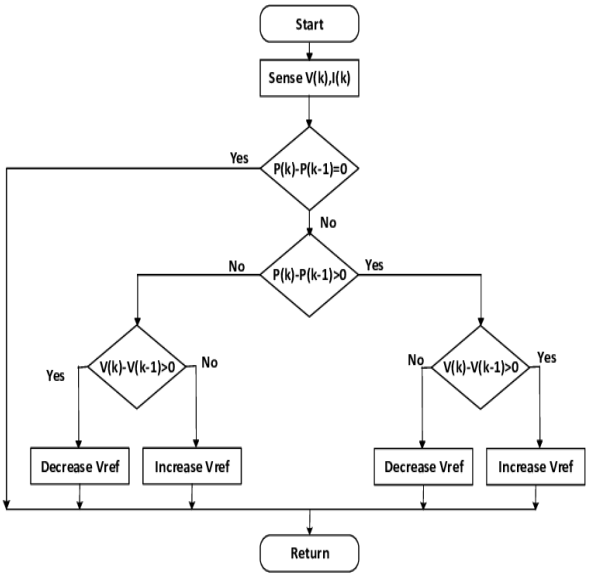

Figure: 3 Flowchart of Perturb & Observe MPPT

2) Incremental Conductance Method: This algorithm is based on the following fact

V P = 0 (I P = 0) at the MPP V P > 0 (I P < 0) on the left V P < 0 (I P > 0) on the right

By comparing the power gain and the power gain (current) between two consecutive samples, the change in power of MPP can be resolute. The plot of the algorithm is shown in

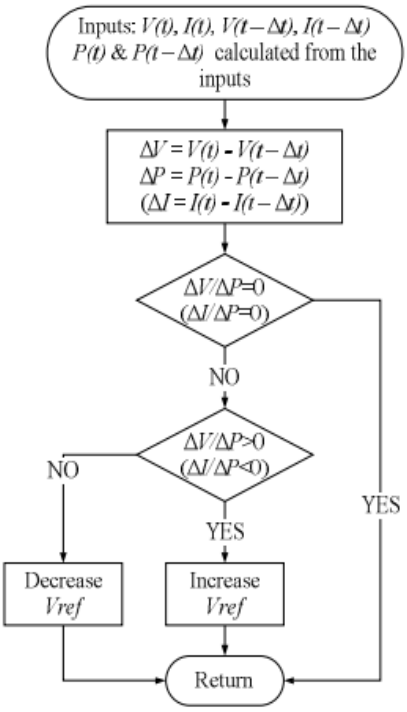

Figure 4: Incremental Conductance Algorithm.

, the speed to attain MPP depends on the magnitude

of the power surge. There are two significant disadvantages to these technologies. The first or significant problem is that if radiation changes rapidly, it can easily divert the MPP [7]. If a change occurs, they will closely monitor the MPP, as the change is immediate and the curvature will not change continuously. However, when the interval mirror changes, the algorithm-based curvature changes continuously with processing. Therefore, the power and current changes are not just the results of a power outage. As a result, the algorithm cannot conclude whether a change in voltage is due to increased power output or a change in radiation.

3) Fuzzy Logic Control

Over the past decade, fuzzy logic controls have become more popular because they can handle inaccurate inputs, do not require accurate mathematical models, and tolerate inequalities. A single microcomputer contributes to the information of fuzzy logic controls [8]. Fuzzy logic consists of 3 stages: development, system thinking, and destruction. Fuzzification involves the procedure of transforming a digital entry into a language change depending on the level of membership in a particular group. The member function is used to associate a priority with each word.

4) Neural Networks

Another MPPT method that is very suitable for microcontrollers is the headset network [8]. They have fuzzy logic and are in the so-called "soft computing." The simplest example of a neural network (NN) includes three layers: an input layer, a hidden layer, and an output layer, as shown in Figure 5. More complex NN constructions add more hidden layers. The number of layers and nodes in each layer and the operations used by each layer will be different and depend on the user's knowledge. Application variables can be different standards (such as VOC and ISC), atmospheric data (such as radiation and temperature), or their combination. The output is usually one or more signals, such as address cycles or DC bus input voltage.

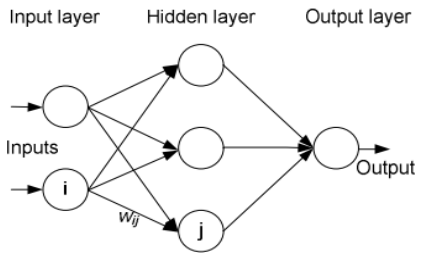

Figure 5: Neural Network.

The effectiveness of NN depends on the operation of the hidden layer or level of training in the network. The links between nodes are heavy. In Fig. 16, the values of nodes i and j are marked wij. Adjust your weight during training. For the training process, it is necessary to record the data between input and output of the neural network over a long period so that the MPP can follow it accurately. The main disadvantage of this MPPT technology is that data required for the training process must be specific to each queue and location of PV, as the security characteristics of the PV depend on the model and the weather depends on location.

5) Fractional Open Circuit Voltage

This method uses a correlation between MPP voltage (VMPP) and the open-circuit voltage (VOC), which varies depending on the temperature and humidity [8]. For example, k1 is constant, which depends on the nature of the PV sequence, and must be determined in advance by seminal the VMPP and VOC for different irradiation levels and different temperatures. . According to [8], the sustained k1 was reported to be between 0.71 and 0.78.

Once constant k1 is identified, the amount of MPP VMPP can often be determined by VOC measurements. To measure VOCs, the power converter must be turned off quickly to have an electric loss per measurement. Another problem with this method is that because the VMPP definition is constant, it is impossible to monitor the MPP below the measurement threshold. Another disadvantage is that MPP reached is not a true MPP because the relationship is only close.

6) Fractional Short Circuit Current

Like in the fractional open circuit voltage method, there is a connection under varying atmospheric situations amid short circuit current ISC and the MPP current, IMPP. The scaling factor k2 must be specified for each PV sequence, as was the case for k1 in the previous method. According to [8], constant k2 is between 0.78 and 0.92.

Measuring the short-circuit output during the system is a problem. It is often necessary to add a switch to the power converter to rotate a short circuit of the PV range and measure the ISC. In [21], ISC was measured by inserting an additional field effect transistor between the PV array and capacitor of the DC link to shorten the PV seat. Another option is to use an amplifier converter and use the converter switch to cancel the PV queue. Short periods of PV installation can also result in power losses. The final hurdle is that the real MPP is not achieved because the human interaction is

average.

V. CONCLUSIONS & DISCUSSION

This article contains the basic information about the renewable energy, photovoltaic system, and maximum power point tracking system and maximum power point techniques. After a details study about the maximum power point tracking techniques, we have concluded that Perturb & Observe MPPT technique is one of the most widely used technique to extract the maximum power from the photovoltaic system.

REFERENCES

[1] P. Shukl and B. Singh, "Delta-Bar-Delta Neural-Network-Based Control Approach for Power Quality Improvement of Solar-PV-Interfaced Distribution System," in IEEE Transactions on Industrial Informatics, vol. 16, no. 2, pp. 790-801, Feb. 2020.

[2] F. Chishti, S. Murshid and B. Singh, "Development of Wind and Solar Based AC Microgrid With Power Quality Improvement for Local Nonlinear Load Using MLMS," in IEEE Transactions on Industry Applications, vol. 55, no. 6, pp. 7134-7145, Nov.-Dec. 2019.

[3] C. M. Nirmal Mukundan and P. Jayaprakash, "Cascaded H-Bridge Multilevel Inverter Based Grid Integration of Solar Power with PQ Improvement," 2018 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES), Chennai, India, 2018, pp. 1-6.

[4] W. J. Praiselin and J. B. Edward, "Improvement of power quality with integration of solar PV and battery storage system based micro grid operation," 2017 Innovations in Power and Advanced Computing Technologies (i-PACT), Vellore, 2017, pp. 1-5.

[5] U. K. Kalla and M. Mantri, "An adaptive control of voltage source converter based scheme for grid connected solar PV - battery system," 2016 IEEE 7th Power India International Conference (PIICON), Bikaner, 2016, pp. 1-5.

[6] R. Ramaprabha, S. H. Jubair, K. Suhas and A. Lokesh, "Development of improved curve tracer for photovoltaic system under partial shaded conditions," 2015 International Conference on Circuits, Power and Computing Technologies [ICCPCT-2014], Nagercoil, 2014, pp. 585-589.

[7] O. V. S. R. Varaprasad, D. B. Kumar and D. V. S. S. S. Sarma, "Three Level Hysteresis Current Controlled VSI for power injection and conditioning in grid connected solar PV systems," 2014 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES), Mumbai, 2014, pp. 1-5.

[8] P. Shah and B. Singh, "Leakage current alleviation in solar energy conversion system enabling power quality improvement," in IET Renewable Power Generation, vol. 14, no. 9, pp. 1618-1630, 6 7 2020.

[9] P. K. Pardhi and S. K. Sharma, "Power Optimized Architecture based Converter and Its Control for Single Phase Grid-Tied Solar Photovoltaic System," 2020 IEEE International Conference on Power Electronics, Smart Grid and Renewable Energy (PESGRE2020), Cochin, India, 2020, pp. 1-6.

[10] M. Kumar and B. Tyagi, "Multi-variable constrained non-linear optimal planning and operation problem for isolated microgrids with stochasticity in wind, solar, and load demand data," in IET Generation, Transmission & Distribution, vol. 14, no. 11, pp. 2181-2190, 5 6 2020.

[11] M. A. Mansor, K. Hasan, M. M. Othman, S. Z. B. M. Noor and I. Musirin, "Construction and Performance Investigation of Three-Phase Solar PV and Battery Energy Storage System Integrated UPQC," in IEEE Access, vol. 8, pp. 103511-103538, 2020.

[12] B. Parija, S. Behera, R. Pattanayak and S. Behera, "Power Quality Improvement in Hybrid Power System using D-STATCOM," 2019 3rd International Conference on Computing Methodologies and Communication (ICCMC), Erode, India, 2019, pp. 564-567.

[13] S. Chauhan and B. Singh, "Grid-interfaced solar PV powered electric vehicle battery system with novel adaptive digital control algorithm," in IET Power Electronics, vol. 12, no. 13, pp. 3470-3478, 6 11 2019.

[14] P. Shah and B. Singh, "LVRT Capabilities of Solar Energy Conversion System Enabling Power Quality Improvement," 2019 IEEE International Electric Machines & Drives Conference (IEMDC), San Diego, CA, USA, 2019, pp. 2083-2088.

[15] V. Narayanan, S. Kewat and B. Singh, "Standalone PV-BES-DG Based

Microgrid with Power Quality Improvements," 2019 IEEE International Conference on Environment and Electrical Engineering and 2019 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe), Genova, Italy, 2019, pp. 1-6.

[16] F. Chishti, S. Murshid and B. Singh, "LMMN-Based Adaptive Control for Power Quality Improvement of Grid Intertie Wind–PV System," in IEEE Transactions on Industrial Informatics, vol. 15, no. 9, pp. 4900-4912, Sept. 2019.

[17] O. P. Mahela, P. Gupta, S. Ali and N. Gupta, "Power Quality Improvement in Renewable Energy Sources Based Power System Using DSTATCOM Supported by Battery Energy Storage System," 2019 Fifth International Conference on Electrical Energy Systems (ICEES), Chennai, India, 2019, pp. 1-6.

[18] R. K. Agarwal, I. Hussain and B. Singh, "Dual-function PV-ECS integrated to 3P4W distribution grid using 3M-PLL control for active power transfer and power quality improvement," in IET Renewable Power Generation, vol. 12, no. 8, pp. 920-927, 11 6 2018.

[19] P. Shukl and B. Singh, "Recursive Digital Filter Based Control for Power Quality Improvement of Grid Tied Solar PV System," 2018 8th IEEE India International Conference on Power Electronics (IICPE), JAIPUR, India, 2018, pp. 1-6.

[20] S. d. Cavalcante Paiva, D. Keuton Alves, F. B. Costa, R. Lúcio de Araújo Ribeiro and T. O. Alves Rocha, "Real-Time Impedance Estimation in Grid-Connected Photovoltaic System Using the Discrete Fourier Transform," 2018 Workshop on Communication Networks and Power Systems (WCNPS), Brasília, 2018, pp. 1-5.

[21] S. Puthalath and G. Bhuvaneswari, "Power quality enhancement and renewable energy integration in ship's distribution grid," 2018 IEEMA Engineer Infinite Conference (eTechNxT), New Delhi, 2018, pp. 1-6.

[22] S. Mane, F. Kazi, H. Jondhle and N. Seth, "Controller Design and Analysis of Standalone PV System for DC Microgrid Applications with Combined MPPT and DPC Strategy," 2018 International Conference on Computing, Power and Communication Technologies (GUCON), Greater Noida, Uttar Pradesh, India, 2018, pp. 1054-1059.