REVIEW ON POWER QUALITY BY OPTIMIZATION AND WITHOUT OPTIMIZATION APRROACHES

Sayiq Javeed Rather[1], Er. Sushma Gupta[2]
[1]*Student, Swami Devi Dyal Institution of Engineering & Technology, Barwala Panchkula Haryana, INDIA*
[2]*Assistant Professor, Department of Electrical Engineering, Swami Devi Dyal Institution of Engineering & Technology, Barwala Panchkula Haryana, INDIA*

Abstract- Distributed Generation (DG) is predicted to play an important role in the electric power system in near future. It is widely accepted that photo voltaic generation is currently attracting attention to meet users' need in the distributed generation market. In order to investigate the ability of photo voltaic (PV) units in distribution systems, their efficient modelling is required. Distributed generation technology is a new, promising way of energy utilization. Where solar power is competitive to stand out from a variety of distributed power and become more developed relatively . The control of grid-connected photovoltaic power generation system is a comprehensive process, which involves not only the technology about solar cell and grid-connected inverter, but also to the control and optimization problems of the system. In the end of the distribution network, the impact on power quality caused by the reactive load in the end of distribution network is more serious than which in centre grids. The fluctuations of reactive load will have a great impact on the supply voltage of power system, there by affecting other loads on this node .

Keywords: *Wireless Sensor Network.*

I. INTRODUCTION

PV penetration is really high Photovoltaic systems can subject the grid to several negative impacts. They are i) Reverse power flow, ii) Overvoltage along Distribution feeders, iii) Voltage control difficulty, iv) Phase unbalance, v) Power Quality problems, vi) Increased Reactive power and vii) Islanding detection difficulty. This paper considers the following three impacts.

A. Power quality problems/Harmonics: The inverter forms the core of the grid connected PV system and is responsible for the quality of power injected into the grid. Inverters also introduce harmonics into the system in the presence of non-linear loads, during DC to AC conversion. Harmonic currents introduce voltage drop and result in distortion of supply voltage. Harmonics can also cause resonance in the supply system, resulting in malfunction, reduction in lifetime or permanent damage of electrical equipment [14] [19].

B. Increased Reactive Power: Photovoltaic inverters usually operate at unity power factor. The owners of small residential PV systems in an incentive based program are levied based on their kilowatt-hour yield and not on their kilovolt-ampere hour yield. Hence they prefer to operate PV inverters at unity power factor, maximizing the active power generation, and accordingly their returns. As a result the reactive power demand met by the PV system is minimal. Hence, the grid is responsible for supplying majority of reactive power, and it makes the distribution transformer operate at a low power factor [19] [22].

C. Islanding Detection: The condition when the solar system continues to supply to the load even though grid power from the utility is not present is called islanding. Islanding can be dangerous to utility workers, who may not realize that a circuit is still energized while working on repairs or maintenance [18]. Hence, the solar inverter must detect islanding and disconnect the PV system when the grid is down. This function of the PV system is known as 'anti-islanding'.

These impacts are dependent on the size and location of the PV system. According to the Solar America Board for Codes and Standards (Solar ABCs) PV systems are classified into three categories, based on the ratings of the system. Small-scale systems are rated at 10kW or less; Medium-scale systems are rated between 10kW and 500kW; and large-scale systems are rated above 500 kW.

1.4 Control Compensating Methods

1.4.1 Reactive Power Compensation

1. P/Q control: As the interface between the microgrid and macrogrid, the basic function of inverters is to control the active and reactive output [20] [23]. In P/Q control, the inverters can produce active power and reactive power, and the determination of reference power is the prerequisite for power control. For purpose of power control, the DGs with a mediate or small capacity can be integrated to the grid with a constant power, the grid provides rigid support for voltage and frequency, and the DGs do not participate in frequency and voltage regulation and just inject or absorb power [25]. This can avoid direct participation of DG in the regulation of feeder voltage, thus eliminating adverse impacts on the electric power system.

P/Q control is based on the grid voltage oriented P/Q decoupled control strategy, in which the outer loop adopts power control and the inner loop adopts current control. The PI controller is usually used for outer-loop power control.

2. U/f control: In U/f control, the inverters output constant voltage and frequency to ensure continual operation of slave DGs and sensitive loads after the grid is isolated from the grid. In this control mode, the AC-side voltage is regulated according to voltage feedback from the inverter to maintain a constant output, and the dual loop control scheme with outer-loop voltage control and inner-loop current control is often adopted [7] [9]. Outer-loop voltage control can maintain stable voltage output, and inner-loop current control constitutes the current servomechanism system, and can significantly accelerate the dynamic process to defend against disturbances. This dual-loop control can make the best use of system status information, and has a high dynamic performance and steady-state precision. Furthermore, inner-loop current control increases the bandwidth of the inverter control system, thereby speeding up the dynamic response of the inverter, enhancing the inverter's adaptability to nonlinear load disturbance, and reducing harmonic distortion of the output voltage [10] [16].

3. Droop control: Droop control is realized by simulating the droop characteristic of generators in a traditional grid and controlling the output voltage and frequency of the voltage source inverter (VSI) according to variation of the output power. The control strategy is based on inverter parallel-connection technology. As all DGs are integrated to the grid/microgrid via inverters, the microgrid in islanded operation is equivalent to multiple inverters being connected in parallel, and the active and reactive output of individual inverters are connected, respectively [20] [22].

1.4.2 Harmonic Compensation

The form of DG connection being considered is shown in figure 1.6. An inverter supplies a set of local loads and has a connection to the local distribution network. The inverter system consists of an inverter bridge and an L–C filter. The network connection is assumed to be short and of relatively low impedance (represented by Z_{line}). The main grid is represented by a harmonic-free voltage source and a relatively large impedance Z_G (as it would be in a remote connection).In a general case, the local load consists of a combination of linear and nonlinear loads that produce harmonically distorted currents and consume both reactive as well as active power.

1. Invertor output control: The aim of this control strategy is to generate inverter output current, i_o, that is harmonic-free under all circumstances including, in particular, the case of the voltage at the point of the connection, V_o being harmonically distorted. Under such control, the inverter presents an infinite impedance to the grid voltage harmonics. The inverter current will also be harmonic-free, provided the control is accurate. The inverter contributes power according to the product of its own (sinusoidal) current and the fundamental component of the local-grid voltage. Any harmonic power (active or non-active) required by the load must be sourced from the grid by the flow of harmonic current. The voltage at the point of connection will be harmonically distorted to an extent dependent on the grid impedance and the magnitude of the harmonic load current. The controller makes no attempt to compensate this distortion. For the inverter output current to be harmonic-free, the sum of the harmonic current driven through the output capacitor (by the harmonic voltage at the point of connection) must be compensated by a harmonic current contribution, through the filter inductor.

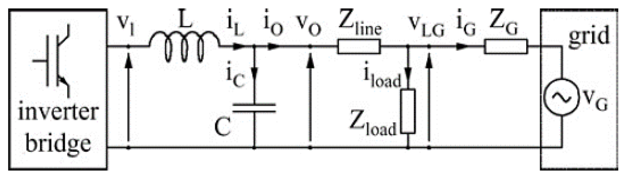

Figure 1.6: Inverter connection to local loads and utility grid

Equations (1) and (2) show how this compensating current is calculated.

$$I_O(n\,w_O) = I_L(n\,w_O) - j\,n\,w_O\,C\,V_O(n\,w_O) = 0 \ldots\ldots\ldots\ldots\ldots\ldots..(1)$$

$$I_L(n\,w_O) = j\,n\,w_O\,C\,V_O(n\,w_O) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

2. Resistor emulation: An inverter can be operated to emulate a resistance at harmonic frequencies by drawing a current proportional to the harmonic voltage. Resistor emulation may be viewed as providing a sink for the harmonic currents originating in nonlinear loads and, because this reduces the magnitude of harmonic current in the grid impedance, the local voltage quality improves. The inverter will have a non-sinusoidal output current (unless the voltage at the point of connection is perfectly sinusoidal). The output power of the inverter will contain terms due to the fundamental voltages and currents and also some power consumption (damping) at the harmonic frequencies. Equation (3) shows the relation between the desired value of the output current I_o, the voltage at the point of connection V_o and the emulated harmonic resistance Rem (nv_o), and(4) shows the required value of filter inductor current it.

$$I_O(n\,w_O) = I_L(n\,w_O) - j\,n\,w_O\,C\,V_O(n\,w_O) = -\frac{V_O(n\,w_O)}{R_{em}(n\,w_O)} \ldots\ldots\ldots\ldots\ldots..(3)$$

$$I_L(n\,w_O) = j\,n\,w_O\,C\,V_O(n\,w_O) - \frac{V_O(n\,w_O)}{R_{em}(n\,w_O)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

1.5 UPQC Configuration

UPQC mainly consists of following parts:

Series inverter: It is a series connected VSI (voltage-source inverter) acting as a source of voltage. Its connection is in series with the line by using a series transformer. It helps in overcoming the voltage based distortions. It helps in maintaining a sinusoidal load voltage by eliminating the load voltage imbalances and the flickers in the terminal voltage. PWM techniques are used for controlling the series inverter. Mostly hysteresis band technique of pulse width modulation is used. There are many advantages of using this PWM technique. It provides a better and faster response speed, easy to implement and it can work properly even without having the knowledge about the parameters of the system [31, 35].

Shunt inverter: A shunt connected voltage source inverter acts as shunt inverter. It is helpful in cancellation of current distortions i.e. compensates the harmonic current of the load. It also provides assistance in keeping up a steady value for the DC link capacitor voltage and also helps in improvement of system power factor. Furthermore it is also helpful in compensation of load reactive current. Usually hysteresis band controller is employed for controlling of the shunt inverter output current. By adjusting the semiconductor switches reference current can be made to follow the output current and stays within the particular hysteresis band.

DC link capacitor: It is used for back to back connection of the series and shunt VSIs. The DC voltage developed across the capacitor acts as a constant voltage and helps in proper operation of both shunt and series inverters. If regulated properly the voltage provided by this capacitor can be used a source for both active and reactive power and the use of any outer DC source e.g. battery etc. can be eliminated [31, 35].

LC filter: It is present near the series inerter output of UPQC. Acting as a low-pass filter (LPF), it is helpful in attenuation of high-frequency voltage components of the output voltage of the series inverter.

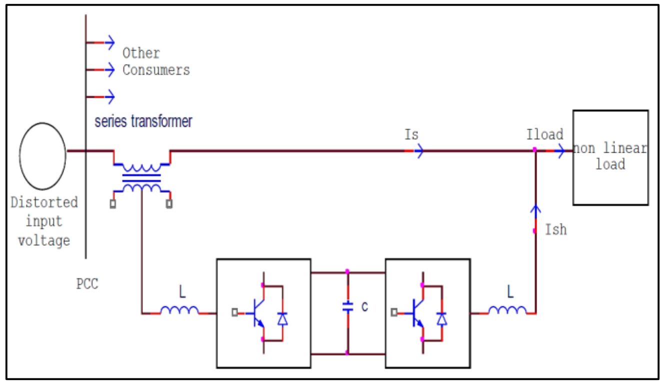

Figure 1.7: UPQC Basic Block Diagram [31]

Shunt coupling inductor: It is helpful in interfacing of the shunt inverter to the network. The main benefit of this is to smoothen the wave shape of the current by elimination of the ripples produced in the current.

Series transformer: The series inverter generates a voltage for maintenance of load voltage sinusoidal at a particular required value. Series inverter helps in injection of this voltage through the series transformer. It is required to maintain a particular turn's ratio in order to maintain a low current flow through the series inverter.

Advantages of using UPQC

- Real and reactive power flow would be controlled with help of UPQC.
- Power quality issues such as sag, swell, harmonics and notches will be minimized.
- It is easy to control, because absence of multiple controllers.
- Overall cost of system will be reduced.
- Overall efficiency of the system will be improved.
- Switching frequency is fixed.
- Best option for dynamic conditions.

1.6 UPQC Classification

There are many criteria for classifying the UPQC. The main criteria of classification can be divided broadly into two groups. The first one is classifying them on the basis of their structure which is seen physically and the other based on the method in which they compensate the sag in the load voltage. These two methods can further be subdivided into various groups. The one that depends on the physical structure can be again divided based on the type of converter used, type of supply whether three phase or single phase and the last one is in the basis of

UPQC configuration. The various classes of UPQC have been described below.

1.6.1 On the basis of supply system

It can either use a single phase supply or a three phase supply.

(i) Single Phase
1. 2H bridge- It has a total of eight switches and it's the most familiar configuration.

2. 3leg topology- It has 6 switches in total. It can be used for the operations demanding less cost and power.

3. Half bridge- It uses the minimum number of switches i.e. 4 switches. The reduction in the number of switches also has an impact on the level of compensation.

(ii) Three Phase
1. Three wire - it is the one that is most commonly used. It can be used in arc welding, frequency converter etc. The configuration of three phase system is given below in figure 1.8

(iii) 3 phase 4 wire
It is widely used in the industrial applications. Because of the extra neutral wire present it needs a higher and better degree of compensation. It can be of various types like two capacitor, three half bridge inverter and four inductor configuration. In two capacitor configuration two split capacitor acts as DC link and in four inductor configuration additional 4th leg of shunt inverter helps in load neutral current compensation [36].

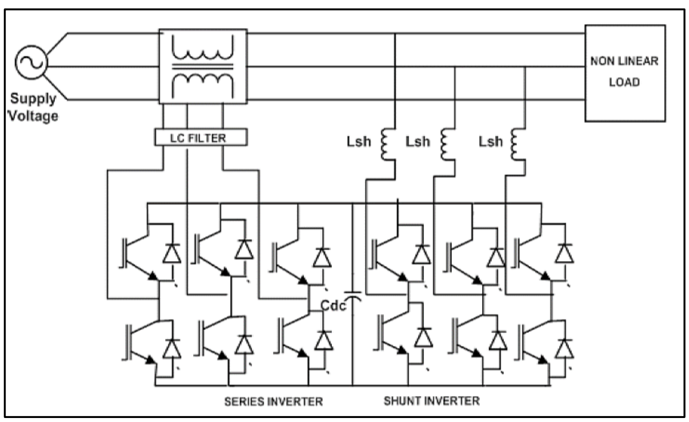

Figure 1.8: 3-Φ UPQC [31]

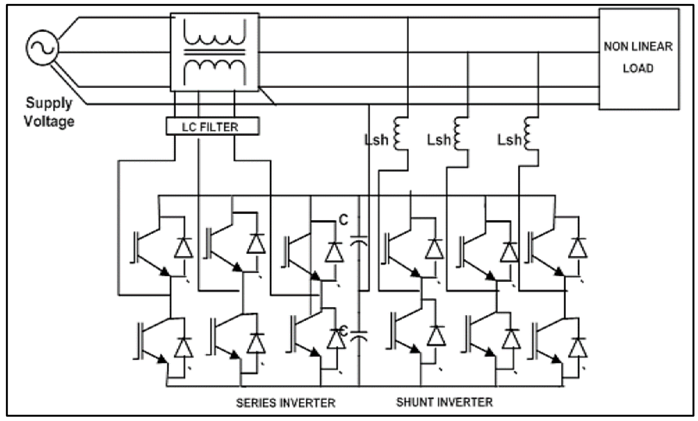

Figure 1.9: 3-Φ, 4 wire UPQC [31]

1.6.2 On the basis of physical structure

On the basis of physical structure it can be further subdivided into three groups as given below

(a) Based Topology of the Converter: Converter used can be either:

- VSI-Shares a common DC link capacitor. This is used commonly as losses are low losses, low price and it can be utilized in case of multi-level inverter also.
- CSI-Uses an inductor to form the DC link. This is not used commonly as it results in high losses, high price and it's not possible to incorporate them as we go for multi-level inverter.

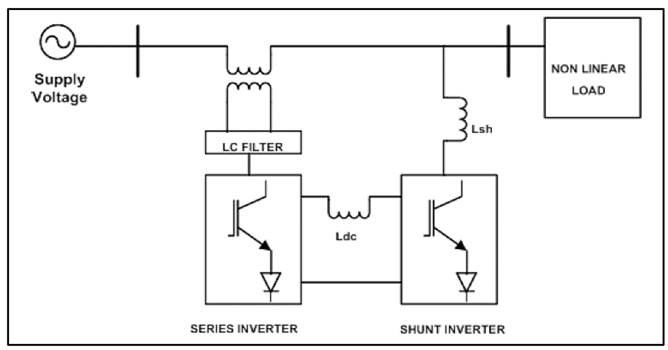

Figure 1.10: CSI based UPQC

1.6.3 On the basis of UPQC configuration

On the basis of UPQC configuration mainly there are five types of UPQC as described below:
1. Interline UPQC: Here both the inverters of UPQC i.e. series and shunt inverters are used in between two distribution feeders. The connection of one UPQC is in series with the first feeder and the second is in parallel with the second feeder. In

this way both the feeders gets the advantage of effective control of the voltage. But it also shows some problems and hence used only for certain particular cases.

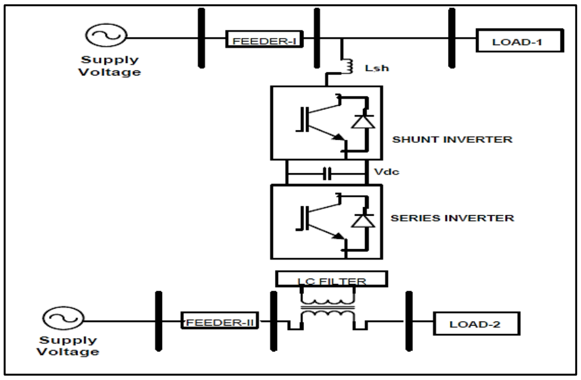

Figure 1.11 Interline UPQC [31]

2. Modular UPQC: It is the connection of several H-bridge inverter modules. The shunt part has series connected H-bridge inverter modules with that of the transformer and series part connection is in directly in series and doesn't need a series transformer for connection with the distribution transformer.

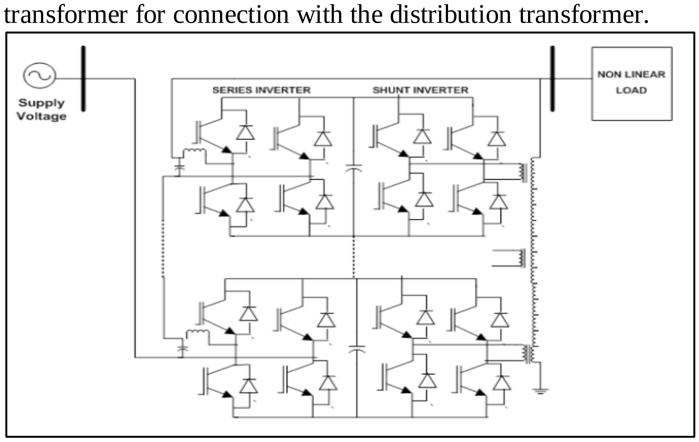

Figure 1.12 Modular UPQC [31]

3. Right and Left Shunt UPQC: It is based on the position of parallel converter as compared to the series converter. If the shunt converter is laced on the right hand side of the series converter then it is termed as UPQC-R and if it is laced on the left hand side then it is termed as UPQC-L. UPQC-R is the one that is most commonly used. It shows improved performance in comparison to that of the UPQC-L. UPQC-L can be utilized for some articular cases.

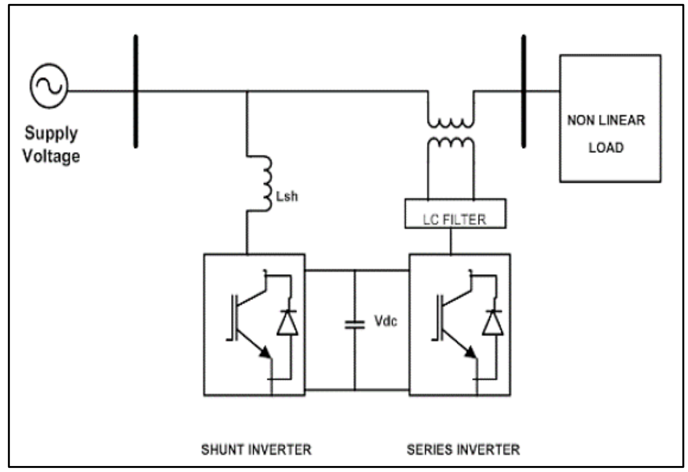

Figure 1.13 UPQC-L [31]

II. RELATED WORK

Ali Reaz Reisi, et.al [1] firstly discussed the overview of grid-associated photovoltaic systems (PVs). Secondly, the experts analyzed a more deep detailed look over grid-connected PVs via the technology of active filter. This part explained the modelling of shunt active filter and photovoltaic panel. In other part, the analysts enroll distinct MPPT (maximum power point tracking) methods and also enroll various method for designing DC link in terms of a common bus of photovoltaic system and shunt active filter. In the final part, Simulink/ MATLAB simulations verified the performance of the model proposed.

Beena V, et.al [2] presented a methodology in which the process of enhancing the quality of power was ensured including control of power for grid collective inverter. The work dealt with analyzing and modeling of a grid-associated inverter (transformer less) with reactive and active power control by the control of the phase angle-based inverter output and the amplitude in connection to the voltage of the grid. In conjunction to voltage and current control, the control of power quality was made to curtail the THD i.e. total harmonics distortion. The grid interactive inverter simulation was carried out in the environment of MATLAB/SIMULINK.

Daxa Rathva, et.al [3] presented the concept of compensating the reactive power for grid solar-based PV system. In this type of modeling STATCOM, inverter control, and the controlling strategy using the concept of dq0 transformation of 3-Φ PWM inverter was employed in grid associated PV generation and the PWM inverter control system was used to control the reactive and the active power. In the strategy of inverter control the experts have used various techniques such as PWM, dq0 transformation, and PLL techniques. Using the concept of STATCOM one can eliminate harmonics and compensate reactive power.

Mehrdad Tarafdar Hagh, et.al [4] investigated a grid-connected PV system with injection of active power, compensation of reactive power and the capability of eliminating harmonic current. The electrical equivalent model was presented in the analysis of literature used for implementing the photovoltaic system. In case of non-linear loads, the methods of low frequency-based SRF (synchronous reference frame) were not capable of eliminating the second and third order harmonics that appears in the current of the grid. This study involves a SRF approach based on mathematical analysis in order to compensate the reactive power of the system and to eliminate the harmonic current of non-linearized load with injection of active power. The results based on simulation were presented to verify the feasibility of the system and it also verified the suggested control method.

Abdalla Y.Mohammed, et.al [5] presented the mechanism of interfacing of 3-Φ grid associated PV system. Here, a boost DC-DC converter with MPPT i.e. maximum power point tracking was used for extraction of maximum power gained from the sun and further transfers it to the grid system. Comprehensive implementation and simulation 3-Φ grid associated inverter was presented for validation of the controller proposed for the grid associated PV system.

Kola Yekant, et.al [6] presented a proposed controller that help in utilizing the references of power showing some of the compelling advancements in theoretical part along with a simple controlling topology. DC-DC convertor was meant for connecting the PV module to the Shunt Active Filter DC side. The converter-based switch was mainly controlled by P&O (Perturb & Observe) and MPPT (Maximum Power Point Tracking) algorithms and it helps in eliminating the limitations in traditional system of PV. An MATLAB Simulink based on emulation was shown for validating the benefit of the system proposed.

[7] Sreedevi, J., Ashwin, N., & Raju, M. N. (2016, December). A study on grid connected PV system. In 2016 National Power Systems Conference (NPSC) (pp. 1-6). IEEE.

J Sreedevi, et.al [7] studied various effects grid associated PV system through the process of system simulation in a software, namely, RSCSD software in practical real time basis on the methodology of RTDS (Real Time Digital Simulator). The load-based power factor variation, PV penetration variation, harmonics introduction into the system using PV inverter and the effect of anti-islanding PV system was studied. Finally, grid associated PV system Performance Ratio was evaluated to find the grid connectivity and reliability of PV system.

Ali Rahnamaei, et.al [8] proposed a grid connected PV (Photovoltaic System) that functions as an APF (Active Power Filter) with MPPT (Maximum Power Point Tracking). The filter-based reference current was derived with the help of Fourier Transform. In inverter switches, by considering a reduction of 33%, there was reduction in cost of the grid-connected PV. Using such an approach, it was possible to compensate for the local loads based harmonic and reactive components; moreover this process help in injecting active power (generated) into grid at MPPT of of PV cells. During daytime, the system proposed mainly injects the active power to grid and simultaneously compensates for load-based reactive power. In case if there is no sunlight, the inverter of the system performs compensation for local loads only.

Mihai Ciobotaru, et.al [9] introduced a technique of active damping for grid-associated converter system with the help of LCL filter. The adaptive form of Notch filter (NF) considered was mainly implemented in a Canonical Form and it presented accurate discrete-time characterization with advanced technique of matched zeroes and poles. However, it also investigated the NF allowing tuning based on real-time of its bandwidth and resonance frequency that might be important on critical basis in case of LCL filter-based resonance frequency varying due to achievable changes in line inductance or non-linear inductors usage engaging magnetic materials, where the concept of inductance was a function of the current that was applied.

Bhavesh M. Jesadia, et.al [10] presented a grid associated photovoltaic system with the concept of using MPPT (Maximum Power Point Tracking). VSI (Voltage Source Inverter) has been related between the ac grid and PV system based dc output. The applied control strategy was based on the p-q theory i.e. instantaneous theory of reactive power. During day time, the system sends active power to the grid and simultaneously compensates the load-based reactive power and it also compensates the harmonics. In case of no sunlight, the system available only compensates for harmonics and load-based reactive power. The p-q theory controlling method applicability has been tested over the system test using MATLAB/Simulink simulation.

Li Fusheng, et.al [11] introduced the microgrid structure, integration, composition, control modes, and operation along with microgrid classification using demand function, AC/DC type, and capacity of the system.

Samir Kouro, et.al [12] presented a survey of existing PV based energy conversion system that addressed the configuration system of distinct PV power plants, and the topologies of PV converter have found real world applications for grid-associated systems. Additionally, the technology of PV converter was discussed underlining the possible benefits as compared to the already existing technology. Among all the topologies of the converter, it was found that the most significant appearance has been revealed by the converters of multilevel type, mainly the H-bridge and T-type for high applications of power and also for residential type of applications in the low-voltage range and kilowatt.

Renukadevi V, et.al [13] represented a strategy based on synchronous reference frame and a grid associated PVG i.e. photovoltaic generation system that sends active power to grid, absorbing the reactive power and compensating harmonics generated by the local loads. The models of converter controller were put into action using MATLAB/SIMULINK. Implemented PV model performance was studied related to isolated load. The strategy of synchronous reference frame was used for generating current reference for the process of compensation and traditional PI controllers were used for controlling purpose. The approach helps in utilizing co-ordinate transformations for separation of the harmonic and reactive content present in load current.

Panduri Renukeshwar, et.al [14] presented a grid (multi-functional) interactive PV system using the concept of fuzzy logic on the basis of MPPT. The proposed controller of MPPT was able to check and track the accurate form of MPP under rapidly changing and uniformly varying insolation and it provides fast process of convergence in terms of a variable step size in case of duty ratio when it was applied genetically with the help of algorithm. The fuzzy controller proposed maintains the voltage-based dc link within a specified limit for injection of power into grid system. Injection of active power during the interval of daytime, the PV-based inverter also help in compensating the reactive power and harmonics during the day as well as the night time. The current i.e. drawn from grid system was of sinusoidal form and the harmonic distortion in total was below the specified limit in IEEE-519 standard.

M.T.L.Gayatri, et.al [15] presented a review of distinct methods of compensating the reactive power in microgrid on the basis of control algorithms, devices, and methods. Several techniques were proposed for traditional grids and these techniques/approaches were adopted for compensation of reactive power in micro grid structures, progressively improved devices and methods were suggested and applied further. Among these devices, the growth in FACTS i.e. Flexible AC Transmission Systems was possibly meant for providing the compensation of reactive power in micro grids on dynamic basis. Finally, this paper represents various applications and techniques of FACTS devices for compensation of reactive power in microgrids.

Ankita Gaur, et.al [16] attempted to perform the evaluation of opaque and semi-transparent PV modules of distinct solar cell generation, reporting maximum efficiency in the section of literature at STC (Standard Test Conditions).This study was based particularly for the months of January and June. For commercially available opaque and semi-transparent modules of PV, outdoor-based performance was also evaluated. Annual capitalized cost, electrical energy, costper unit electrical energy, and uniform cost, for both solar modules types, namely, opaque and semi-transparent have been computed including characteristically build curves. PV module based on semi-transparent methodology have shown greater efficiencies as compared to opaque methodology.

Hao Wu, et.al [17] briefly explained the present development trends of implementing photovoltaics (PV) on the basis of status linked with electricity supply and energy distribution characteristics in China. The technology of PV, particularly the applications of grid-associated photovoltaic system was discussed. Finally, future suggestions and challenges for PV industry were presented and analysed.

Bin Li, et.al [18] presented a control based on grid-connection on the basis of a PV system model with paralleled load in the (large) system. It makes full use of power associated with photovoltaic and it also maintained a stable form of voltage with reactive (fluctuant) load. It mainly adopted the control based on double-loop methodology. The current of large system and the current associated with grid of the PV system both were decoupled into reactive and active component by using a transformer of abc/dq0 type. In case of PV grid-connected current, the active component of the system was adjusted to a reference value provided by MPPT (Maximum Power Point Tracking) for maintaining maximum form of active power PV output. Whereas, in case of large system current, reactive component was adjusted for maintaining a uniform output based on reactive power. It helps in maintain a stabilized voltage with fluctuant load, as the grid-PV system supply voltage was sustained mainly by large system.

Mohamed A. Eltawil, et.al [19] investigated and emphasized the significance of grid-associated PV system in regard to the renewable generation intermittent nature, and the PV generation characterization in regard with grid code agreement. The inspection was mainly conducted to review the literature based on the expected potential issues linked with high levels of penetration and the methods of islanding prevention in connection to grid connected PV. In this survey, the grid connected PV inverters have performed fairly well. For large operational range, the power factor and conversion efficiency exceeds 90%, while THD obtained was less than 5%.

Hyo-Ryong Seo, et.al [20] dealt with methods of reactive power and harmonics compensation by using grid associated Photovoltaic system. The experiment was carried on a proposed grid-associated single-staged PV system, and the system was controlled using TMS320F2812, a digitally built signal processor. The results obtained from the experiment involve converter-based operating features either as STATCOM i.e. static synchronous compensator or as an active power filter, while the process of transfer of real power to the grid system. The obtained results helps in validating the reliability of the proposed approach.

Milan Prodanovic, et.al [21] examined various methods of control emphasizing either local-voltage distortion or harmonic-line flows, or a compromising approach on the basis of resistance emulation was shown to be of effective nature. The experimental results based on 2 kVA inverter and 1Φ laboratory-based network were used for illustrating the additionally built control functions that can be integrated into a scheme of existing control for the management of real-power. The observers of Kalman were used for achieving an additional benefit of bypassing specific phase-locking mechanism while generating quadrature components that was useful in providing feed-forward compensation and in calculating reactive power instantaneously.

Marcelo Cavalcanti, et.al [22] presented a system providing PV generation and the functions of a UPQC i.e. unified power quality conditioner. Such a system can be used for controlling for harmonics and provide compensation of reactive power on simultaneous basis using an operating form of converter as an active shunt filter. The other form of converter was mainly used as active series filter which

Inferences drawn from literature survey

SNo.	Author's Name	Tool/Method Used	Paper Title	Application Domain	Inferences
1.	**Ali Reaz Reisi, *et.al***	MATLAB/MPPT i.e. Maximum Power Point Tracking	Optimal Designing Grid-Connected PV Systems	Modelling of shunt active filter and photovoltaic panel.	Analyzed a more deep detailed look over grid-connected PVs via the technology of active filter.
2.	**Mehrdad Tarafdar Hagh, *et.al***	SRF i.e. synchronous reference frame	Control strategy for reactive power and harmonic compensation of three-phase grid-connected photovoltaic system	Grid-connected PV system with injection of active power	The results based on simulation were presented to verify the feasibility of the system and it also verified the suggested control method.
3.	**Renukadevi V, *et.al***	MATLAB/SIMULINK	Harmonic and Reactive Power Compensation of Grid Connected Photovoltaic System	Synchronous reference frame and a grid associated PVG	The approach helps in utilizing co-ordinate transformations for separation of the harmonic and reactive content present in load current.
4.	**Zainal Salam, *et.al***	APF i.e. Active Power Filter	Harmonics mitigation using active power filter: A technological review	Mitigating the harmonics in utility-based power lines	Such a review was also considered in the form of tutorial-type paper as it helps in providing a comprehensive coverage of various technologies of APF by omitting the uninteresting details, but without any loss of the essence of subject-based matter.

5.	**M. El-Habrouk, *et.al***	Power Filters review	A survey of active filters and reactive power compensation techniques	Active electric power filters and reactive compensation of power	The subdivisions and presentation of the power system conditioners, accessible in this paper, display the drawbacks and the merits of every technique and type used in the system.
6.	**G. Grandi, et,al**	MATLAB/SIMULINK	Control methods for active power filters with minimum measurement requirements	Control strategies as a basic control algorithm and minimal current and voltage transducer necessities.	The performance acquired by the suggested control techniques was quite comparable to those of standard alternatives. The experimental results considerably confirmed the numerical results obtained by Simulink of MATLAB.
7.	**Leszek *S.* Czarnecki, *et.al***	CO-Fi (compensating and filtering) circuits	Methods of reactive power compensation and suppression of load-generated harmonics.	Suppression of harmonics generated by load and the compensation of the reactive power	The comparison was made based on the assumption that these circuits were mainly used for suppression of harmonics created by a 6-pulse and a 12-pulse, 3-Φ controlled AC/ DC converters.
8.	**Milan Prodanovic, *et.al***	2 kVA inverter and1Φ laboratory-based network. Kalman Filter	Harmonic and reactive power compensation as ancillary services in inverter-based distributed generation	Control emphasizing either local-voltage distortion or harmonic-line flows	The observers of Kalman were used for achieving an additional benefit of bypassing specific phase-locking mechanism while generating quadrature components that was useful in providing feed-forward compensation and in calculating reactive power instantaneously.
9.	**M.T.L.Gayatri, *et.al***	Comparison of the proposed and existing methods	Reactive Power Compensation in Microgrids: A Survey Paper.	A review of distinct methods of compensating the reactive power in microgrid on the basis of control algorithms, devices, and methods.	Represents various applications and techniques of FACTS devices for compensation of reactive power in microgrids.

Table.1 Existing Scheduling Model

III CONCLUSION

The conditioners are required in the power systems due to high frequency switching and non-linear loads. Unified Power Quality Conditioner (UPQC) is an electronic device which solves the problem of voltage sag and total harmonics distortion problems. The conditioner is a combination of series active and shunt active power filters. The power quality is enhanced by integrating the power filters. The proposed work is done by using fuzzy logic with swarm intelligence approach and proposes a new UPQC system. This system reduces the sag and harmonic distortion. The PSO is used to optimize the reference signal which is generated by the fuzzy logic controller. The proposed experiment is done on the MATLAB/ Simulink environment. The results and output received on this is used for the analysis

IV REFERENCES

[1] Reisi, A. R., & Alidousti, A. (2019). Optimal Designing Grid-Connected PV Systems. In *Recent Developments in Photovoltaic Materials and Devices*. IntechOpen.
[2] Beena, V., Jayaraju, M., & Davis, S. (2018). Active and Reactive Power Control of Single Phase Transformerless Grid Connected Inverter for Distributed Generation System. *International Journal of Applied Engineering Research*, *13*(1), 150-157.
[3] Rathva, Daxa, & Bhavsar, Falguni. (2018). Reactive power compensation on grid with connected solar pv system. *International Journal of Advance Engineering and Research Development*, *5(1)*, 2348-4470
[4] Hagh, M. T., Jadidbonab, M., & Jedari, M. (2017). Control strategy for reactive power and harmonic compensation of three-phase grid-connected photovoltaic system. *CIRED-Open Access Proceedings Journal*, *2017*(1), 559-563.
[5] Mohammed, A. Y., Mohammed, F. I., & Ibrahim, M. Y. (2017, January). Grid connected photovoltaic system. In *2017 International Conference on Communication, Control, Computing and Electronics Engineering (ICCCCEE)* (pp. 1-5). IEEE.
[6] Yekanth, K., Kishore, K. V., & Rao, N. S. (2016). Power Quality Improvement of Utility Current in Grid Connected Photovoltaic System by Active Filters. *Power*, *2*(10).
[7] Sreedevi, J., Ashwin, N., & Raju, M. N. (2016, December). A study on grid connected PV system. In 2016 National Power Systems Conference (NPSC) (pp. 1-6). IEEE.
[8] Rahnamaei, A., & Salimi, M. (2016). A Novel Grid Connected Photovoltaic System. Bulletin of Electrical Engineering and Informatics, 5(2), 133-143.
[9] Ciobotaru, M., Rossé, A., Bede, L., Karanayil, B., & Agelidis, V. G. (2016, June). Adaptive notch filter based active damping for power converters using LCL filters. In *2016 IEEE 7th International Symposium on Power Electronics for Distributed Generation Systems (PEDG)* (pp. 1-7). IEEE.
[10] Jesadia, B. M., & Trivedi, I. N. (2015). ANALYSIS OF PV SYSTEM EMBEDED TO DISTRIBUTION GRID FOR ACTIVE & REACTIVE POWER SUPPLY TO GRID. Development, 2(5).
[11] Li, F., Li, R., & Zhou, F. (2015). *Microgrid technology and engineering application*. Elsevier.
[12] Kouro, S., Leon, J. I., Vinnikov, D., & Franquelo, L. G. (2015). Grid-connected photovoltaic systems: An overview of recent research and emerging PV converter technology. *IEEE Industrial Electronics Magazine*, *9*(1), 47-61.
[13] Renukadevi, V., & Jayanand, B. (2015). Harmonic and Reactive Power Compensation of Grid Connected Photovoltaic System. *Procedia technology*, *21*, 438-442.
[14] RENUKESHWAR, P., KHAMURUDDIN, S., & RAKESH, A. (2014). Grid Interactive PV System with Compensation of Reactive Power and Harmonics by Fuzzy Logic and PID based MPPT.
[15] Gayatri, M. T. L., & Parimi, A. M. Reactive Power Compensation in Microgrids: A Survey Paper. 2015 *International Conference on Computation of Power, Energy, Information and Communication*
[16] Gaur, A., & Tiwari, G. N. (2013). Performance of photovoltaic modules of different solar cells. *Journal of Solar Energy*, *2013*.
[17] Wu, H., & Hou, Y. (2011). Recent development of grid-connected PV systems in China. *Energy procedia*, *12*, 462-470.
[18] Li, B., Tian, X., & Zeng, H. (2011, July). A grid-connection control scheme of PV system with fluctuant reactive load. In 2011 4th International Conference on Electric Utility Deregulation and Restructuring and Power Technologies (DRPT) (pp. 786-790). IEEE.
[19] Eltawil, M. A., & Zhao, Z. (2010). Grid-connected photovoltaic power systems: Technical and potential problems—A review. *Renewable and sustainable energy reviews*, *14*(1), 112-129.
[20] Seo, H. R., Kim, G. H., Jang, S. J., Kim, S. Y., Park, S., Park, M., & Yu, I. K. (2009, November). Harmonics and reactive power compensation method by grid-connected photovoltaic generation system. In *2009 International Conference on Electrical Machines and Systems* (pp. 1-5). IEEE.
[21] Prodanović, M., De Brabandere, K., Van den Keybus, J., Green, T., & Driesen, J. (2007). Harmonic and reactive power compensation as ancillary services in inverter-based distributed generation. *IET Generation, Transmission & Distribution*, *1*(3), 432-438.
[22] Cavalcanti, M. C., Azevedo, G. M., Amaral, B. A., & Neves, F. A. (2006). Unified power quality conditioner in a grid-connected photovoltaic system. *Electrical Power Quality and Utilisation. Journal*, *12*(2), 59-69.
[23] Salam, Z., Tan, P. C., & Jusoh, A. (2006). Harmonics mitigation using active power filter: A technological review. *Elektrika Journal of Electrical Engineering*, *8*(2), 17-26.
[24] Jianjun, G., Dianguo, X., Hankui, L., & Maozhong, G. (2002). Unified power quality conditioner (UPQC): the principle, control and application. In *Proceedings of the Power Conversion Conference-Osaka 2002 (Cat. No. 02TH8579)* (Vol. 1, pp. 80-85). IEEE.
[25] Kim, H., Blaabjerg, F., Bak-Jensen, B., & Choi, J. (2001). Instantaneous power compensation in three-phase systems by using pqr theory. In *2001 IEEE 32nd Annual Power Electronics Specialists Conference (IEEE Cat. No. 01CH37230)* (Vol. 2, pp. 478-485). IEEE.
[26] Abdel-Galil, T. K., Ei-Saadany, E. F., & Salama, M. M. A. (2001). Effect of new deregulation policy on power quality

monitoring and mitigation techniques. In *2001 IEEE/PES Transmission and Distribution Conference and Exposition. Developing New Perspectives (Cat. No. 01CH37294)* (Vol. 1, pp. 554-560). IEEE.