International Journal of Scientific Research & Engineering Trends
Volume 7, Issue 6, Nov-Dec-2021, ISSN (Online): 2395-566X

A Review On Performance Of Power Quality Improvement Of Hybrid Energy In Grid Connected System

Research Scholar Sweta Kumari, Prof. Dr. Manju Gupta, Asst. Prof. Mamta Sood, Prof. Dr. Anuprita Mishra
Department of Electrical and Electronics Engineering
Oriental Institute of Science & Technology Bhopal, India
1994swetakumari@gmail.com, manjugupta@oriental.ac.in,mamta_sood@oriental.ac.in, anupritamishra@oriental.ac.in

Abstract- This paper presents a review on grid Integration and power quality issues associated with the integration of renewable energy systems in to grid and Role of power electronic devices and Flexible AC Transmission Systems related to these Issues. In this paper, recent trends in power electronics for the integration of wind and photovoltaic (PV) power generators are presented. Discussions about common and future trends in renewable energy systems based on reliability and maturity of each technology are presented. Classification of various Power Quality Issues used by different researchers has been done and put for reference. Application of various techniques as applied to mitigate the different Power Quality problems is also presented for consideration. Power Electronics interface not only plays a very important role in efficient integration of Wind and Solar energy system but also to its effects on the power-system operation especially where the renewable energy source constitutes a significant part of the total system capacity. However there are various issues related to grid integration of RES keeping in the view of aforesaid trends it becomes necessary to investigate the possible solutions for these issues and Power Quality is the main problem in Renewable energy sources. Nowadays there were Scarcity of non-renewable resources and the requirement of consumers was fulfilled by the renewable energy resources. The usage of renewable energy sources are less compared to other energy sources and the renewable energy also causes PQ issues in grid. Some of the issues may be sag, swell, flicker, harmonic, interruptions and voltage imbalance .This review shows what else the issues are caused due to the solar and wind energy while connected to grid and how it can be improved.

Keywords-controllers, grids, power quality enhancement devices, power converters.

I.INTRODUCTION

Power quality related problems are of most concern nowadays. Power quality issues related renewable energy sources are listed below. It is necessary for Engineers, Technicians and system operators to become familiar With power quality issues.On the measurement side, the measurement of harmonics, voltage sags and swells, flicker, surges, energy usage, and changes in the frequency can be listed present existing power quality problems from two perspectives, one looking at the disturbances generated at the utility side but affecting the customers, and the other looking at the customer caused disturbances that also affect the utility side. While the acceptance of the revenue meter location as the boundary between the customer and the utility is well established, this may not be the most natural boundary with respect to the power quality considerations. Fault clearance times that lead to voltage sags unacceptable to the customers, and time varying loads like arc furnaces or variable speed drives that pollute the utility feeder with unwanted harmonics, are two such cases. In both cases, poor power quality penetrates beyond the revenue metering point into the other party's zone. The results of system studies can be utilized to develop strategies for assessment of the customer power quality problems in particular if the customer problems are caused by the utility system operation. In some instances, both the utility and the customer may have to work together to find the best solution for the overall problem. This may quite possibly involve cost sharing for the implementation of a mutually agreed solution even when it is implemented only by one side or in the operating zone of only one of the involved parties. Most temporary faults, switching of power factor correction capacitor banks, large motor starting transients, or the use of static var compensators may lead to power quality problems due to voltage sags, swells, flickers, surges and interruptions that are initiated by these events. Coney summarizes the causes and the

effects of voltage sags and interruptions as well as the possible ways of characterizing such events in a quantitative manner. He also mentions an artificial neural network based intelligent auto-reclosing scheme by which unsuccessful autoreclosing can be reduced to a minimum. Characterizing voltage flicker has been a concern since its recognition as one of the common power quality problems. Helping and Burch have described a simulation based method for analyzing and evaluating some mitigation strategies for the voltage flicker problem. Other issues pertain to the mitigation of harmonics, modeling of harmonics sources, and assessment of the distortion of voltage and current signals at critical points in the system via a harmonics study .An important portion of the power quality research is devoted to the processing of the measured or recorded signals in order to assess the quality of power.

II. RELATED WORK

BhagyashreeParija et.al (2019) The ultimate use of distributed energy in the grid creates a new ultimatum for load, power quality, power stability and efficient energy use. Wind energy and solar energy are considered to be the most reliable renewable energy sources. However, independent operation of photovoltaic or wind power systems cannot provide a very reliable source of power generation, mainly due to the lack of wind and solar processing. Thus, various wind and solar power systems can create a very efficient and reliable power source. In this work, a combination of wind power and photovoltaic systems is proposed.

This type of system is especially useful and useful in remote or isolated areas where grid integration is not very lucrative. However, the interaction between the power electronics and the DG system can cause very serious power quality problems, such as harmonic generation and reactive power compensation, which can interfere with the power distribution system. In this work, a proposed model of a hybrid wind photovoltaic power generation system having 750 KW is proposed. The effectiveness of the system in grid -connected mode is examined. By calculating the total harmonic distortion (THD) at the wind speed, we evaluate the quality of the hybrid SPV system. By using D-STATCOM, the power quality of the hybrid system was improved.

WesamRohouma et al. (2019) as the number of loads on power quality increases, ensuring high power quality (PQ) becomes more important. Mitigating power quality problems and providing local compensation within the distribution network (close to the source of the problem) can reduce total system losses and adverse effects. the waves moving on the plate. In this article, a three-phase capacitor less matrix converter (MC) has been used as a static compensator (D-STATCOM) of a distribution system to compensate for reactive power in low-voltage output networks. To extend the service life, the energy is stored in a capacitor rather than a capacitor. Use the Predictive Control Model (MPC) to control the D-STATCOM load to provide dynamic power to the distribution network. To validate the proposed method, an experimental analysis was performed and the results were obtained in 7. The 5KVA test prototype demonstrates the effectiveness of the proposed technology in reactive power compensation.

SuvarnaJadhav et al. (2018) Electricity is a safe and widely used form of energy. It's easy to change one shape to another. With the constant development of technology, the dependence on electrical energy is growing rapidly. However, the quality of the natural power supply is affected by many internal and external factors in the energy system. The efficiency of harmonics, intervals and differences often impair the efficiency of the power supply system. In this paper, the problem of recurrent power loss is discussed, such as power changes in the form of sags and swelling. The S conversion method is used to detect and analyze this power wave and to record the problem. Use a variety of methods to overcome this recurring problem. By using a static diffusion compensator (D-STATCOM) with an L-C-L passive filter in the power supply system used by the user, the value of the voltages can be visualized. The structured model is based on a resource converter (VSC). It incorporates current into the connecting system to reduce the power drop or surge. The passive L-C-L filter is an addition to the compensator, which can improve the quality and reduce the harmonic distortion and low power consumption (PF).

Swaroopa S. Bhosale (2018)in power distribution systems, most power quality problems are related to soft wax. As a result, people have sought various solutions to compensate for this power outage, to avoid economic losses in the retail industry. The static diffusion compensator (D-STATCOM) is gaining more approval in the commercial industry to reduce the adverse effects of power consumption on heavy loads. The D-STATCOM is fitted with a flexible load, and has the ability to quickly respond to fluids from end-user devices. This article describes the adjacent reactive injection. The proposed method is to set up the study aspect and prove it by case study of the IEEE RTS 39-bus system. The duct can be removed by injecting a small amount of electricity or recirculating force into the system. This technique combines the symmetrical mixing method immediately.

In this paper, BurudiJahnavi et al. (2021) proposed a static scattering compensator (D-STATCOM), which combines the same sound resonance (PR) filter and a beam filter. The proposed monitor reduces the difficulty of transmitting the resonant eye and also provides a better current coordinated response. By applying a border filter, many harmonics in the measuring tube can be

compensated. Unlike PR monitors, the filter does not need to be adjusted for a single payout. This paper applies two different types of header filtering, such as feedforward form and feedback form, and compares the results. The D-STATCOM topology uses a continuous processing technology, i.e. sinusoidal conversion technology (SPWM) to convert the technology to a moving force and corresponding compensation. MATLAB / Simulink results are provided to validate the theoretical requirements.

Hariom Kumar et al. (2018) harmonics are a popular power quality problem faced by end users. It has a negative impact on the electrical environment. In order to run well and efficiently, it must be reduced. In the proposed study, a static scattering compensator (D-STATCOM) was activated to improve the power quality from a harmonic reduction perspective. The control strategy is based on the instantaneous power theory. Harmonic compression is achieved by providing a compensatory current, so that any unbalanced load on the distribution line will result in this sinusoidal source. You are reducing the continuity of the current end of the source. Non-continuous load transfer results in 30.30% THD (total noise conversion) in the current source.

DSTATCOM with the instantaneous power theory reduces the total diffraction (THD) of the current source by up to 2.31%. The effectiveness of D-STATCOM depends in large part on the monitoring strategies used to generate compensation payments. In addition to the many control strategies, the instantaneous power theory also well proves its work. The amount of current compensation for the waveform generated by the source inverter (VSI) depends on the transmission method of the VSI IGBT.

Ahmed Hussain Elmetwaly et.al (2020) 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.

Linggom Enrico Christian et.al (2019) Future of small and isolated power system depend on microgrids based on solar and wind power plan, which the technology is immature. Poor power factor and voltage fluctuation could affect the system's power quality, which can decrease the reliability. This paper discusses about the power factor correction and voltage fluctuation improvement using distribution static synchronous compensator or D-STATCOM. For demonstrating the proposed idea, D-STATCOM is installed on a radial distribution system and simulated under different operating condition. Variable and flexible reactive power support from this device corrects the power factor and regulates the voltage. The performance of D-STATCOM installation is proven by simulation in increasing the system power factor and voltage regulation.

Sivarajan K N et.al (2020)this paper presents Power Quality (PQ) problems and mitigation using D-STATCOM with H-Bridge topology in solar Photo Voltaic (PV) integrated distribution system. D-STATCOM solve current related issues of networks. Three-phase, four-wire, 400 V and 50 Hz system is selected as distribution source. The power quality improvement along with PV integration is intended by using D-STATCOM. Another goal is to design the components of shunt compensator for a PV integrated three phase distribution system. The Custom Power Device (CPD) is 50 kVA rated and uses battery storage system. Economical and robust design is ensured. Various loads were connected in the system for simulation studies and results were analyzed and validated.

LakshmanNaikPopavath et.al (2020) Utilization of Renewable Energy sources have been increasing exponentially to reach the world power demand. Less utilization of rating of power converters in renewable energy system forces the researchers to develop new applications like power quality improvement. Power pollution is the key problem because of distorting or non-linear loads and distributed generation. The major power

quality issues like wave form distortions (harmonics) and reactive power demand can be completely neutralized by the Custom power devices like Statcom. In this paper PV Solar Farm is performing as a PV-Statcom to elevate qualitative power in Grid coalesced Wind-PV system. The PV-Statcom control strategy results amplification of power quality. The results are obtained using Matlab/Simulink. The effectiveness of present concept gesture towards that improvement in PF and reduction of THD values.

D. Joe Meisner et.al (2020)today's grids are changing fast and operators are facing new challenges. The increasing number of inverters and renewable power generation necessitate new and innovate solutions to operate the grids within the required power quality parameters. Traditional equipment for power quality optimization is not flexible enough to handle the fast-changing grid conditions. The implementation of active harmonic filtering is a solution to maintain the quality of power transmission today and into the future. This paper is about the design and real time testing process of the Active Filter Control of Siemens Static Synchronous Compensator (STATCOM) located at American Electric Power's (AEP) Falfurrias station.

AmitaAmita et.al (2018) Generation of power from conventional energy sources has increased in the last thirty years and among all, the wind energy is mostly considered to be used where the required solar energy is not available. The main advantages of using wind as energy source are reduction in consumption of fossil fuels, reduction in the energy production cost, minimization of greenhouse gas emissions and thus clean and natural source of energy. We know that wind speed is very fluctuating in nature due to which implementation of wind energy into power system has many technical challenges such as security, reliability, availability and quality related to power to be supplied, either to the grid or to the load center. In this work the circuit model for the UPQC has been developed to improve power quality in grid connected wind system and results have been compared with STATCOM by simulating the model in MATLAB/Simulink software. The output of WECS with and without controller is observed through simulations.

BiswajitSaha et.al (2019) In this paper a control scheme to improve power quality as well as voltage synchronization of self-excited induction generator (SEIG) driven by wind turbine feeding power to a remote area has been proposed. In practice, Neuro-Fuzzy PI (NFPI) controlled hybrid static compensator (STATCOM) is used to control voltage and frequency regulation of SEIG. The NFPI controlled STATCOM is used to balance the reactive power requirement of SEIG under load perturbation and tries to make terminal voltage constant. Integration of STATCOM with BESS is done to make a hybridized STATCOM system to enhance the active power capability of traditional STATCOM. This helps to offset the deviation resulted in both active and reactive power thus enhancing active power capability, reliability and system stabilization. The dynamic model of Hybrid STATCOM using stationary two-axis theory is developed for analyzing system behavior. Simulated results show improved power quality and performance of the system under variable loading condition in stand-alone application.

Dib Djalel et.al (2018) The problem of controlling the transport of electrical energy has given rise to FACTS (Alternate Current Transmission Systems) systems to provide system stability, thereby improving controllability and power transfer capability. The STATCOM (Static Synchronous Compensator) is the FACTS device chosen in our paper. The main objective of this research study is to evaluate the performance of STATCOM as a static compensator of reactive power using the transmission line of electrical energy. The action of the Statcom in the electrical network disturbed by short circuit or overload has shown its effectiveness in restoring the stability of a fault system by compensation of the reactive power by injecting a controlled current into the system in order to adjust the voltage at the connection nodes. We consider that the objective of this work is achieved through the results obtained which showed a clear recovery of defects after connecting the Statcom to the already disturbed electrical network.

Arif S. Tamboli et.al (2018)now day, measure issue in the power system is maintaining the power quality. To maintain that power quality reactive power compensation is required. Maintaining the power quality under different loading condition and the under voltage sag and unbalanced current is important. For improving reactive power compensation Flexible AC transmission System (FACTS) devices is play important part in the system. SVC and STATCOM play important part in the reactive power compensation. Due to some drawbacks of the SVC, STATCOM is used in this paper. Traditional STATCOM have some drawbacks such slow response and low reactive power compensation range. Hence in this paper Hybrid STATCOM is used.

PouryaSarvghadi et.al (2018)the existence of harmonics and low power factor in electrical networks is inevitable. These factors will reduce the network efficiency and service quality to consumers. One way of alleviating such effects is using the line conditioners such as D-STATCOM. As redundancy and cost reduction are important issues in the design of electrical apparatus and networks, in this paper a new scheme comprises two parallel D-STATCOMs is proposed. Hence redundancy and cost reduction are provided while power quality problem i.e. harmonics and power factor are greatly improved. Simulation results for non-linear and inductive loads in 220V voltage are reported and discussed. The

obtained results show that the proposed scheme has a proper operation in improving harmonics and power factor of loads.

Aishwarya A. Patil et.al (2019) Solar energy is available abundant in nature and it is free from pollution. As the system is a noiseless solar photovoltaic system (PV) is the best solution at residential levels but the main drawback of solar energy is unreliability. It is important to give a reliable supply of power quality. In the case of OFF-grid solar system, storage batteries are required in order to have a reliable supply, it improves the total cost of the system. In ON-grid solar system, the demand can be assured by solar energy and energy can be drawn from the grid. In such framework surplus power is provided to the grid, and that sent out power must be accounted for.

The energy meter has to records exported power from consumer to grid and imported power from grid to consumer load. In this paper grid-connected solar PV system having bidirectional energy meter with power quality improvement by DSTATCOM is proposed. The work is divided into two modes: 1. DSTATCOM mode: In this mode, some of the produced solar energy is used for the operation of DSTATCOM. The simulation was carried out using MATLAB software. The results clearly show DSTATCOM works properly on voltage sag. 2. NET-METERING mode: In this mode, the energy meter monitors the distinction between imported power from network and surplus or sent out power to the network. The proposed meter consists of a voltage and a current measurement circuit that measured the instantaneous voltage and current. The raspberry pi acts as a processing unit and to display the energy at regular intervals, the LCD display is used.

Yogita R. Ashtekar et.al (2018) Quantity of the output power delivered from the utilities has become major concern of the modern industries for the last decade. The power quality associated problems are voltage sag, flicker, voltage imbalance, interruption and harmonics problems which results in the malfunctutioning of equipment's in the industries by affecting the microprocessor based loads, sensitive electric components which are highly sensitive to voltage level fluctuation. The power consumed by the heavy load creates unsymmetrical currents which results in reduced power quality in the electrical grid. The stimulating functions of Flexible AC Transmission system (FACTS) estimate the critical clearing time, voltage regulation, steady state power flow and oscillation damping control. The main objective of this paper is the application of modular multilevel cascade (MMC) converter based Static synchronous Compensator (STATCOM) for reactive-power control and improved power quality. The complete simulation of this system is performed in the MATLAB software and the PI control is used for the controlling.

Ali HadiAbdulwahid et.al (2019)at present, the world economy as a whole stress the need for sustained and quality services in all sectors. Most industries are dependent on electricity and different electrical equipment and, as a result, maintaining energy quality has become a major issue for all industries to flourish and profitably. The Distribution Static Synchronous Compensator (D-STATCOM) is an advanced device-based power electronics device that can be used to control the power flow of distribution lines. Space Vector Pulse Width Modulation (SVPWM) is an advanced, intensive computational PWM method. In this paper, SVPWM technology based on Particle Swarm Optimization (PSO) is used to avoid the computational complexity used in traditional implementations.

The integral proportional controller is adjusted by means of a particle swarm optimization (PSO) algorithm to improve the response performance of the switch angular. In the design of the PSO algorithm, adjust the Pi controller parameters kp and ki, so that the switching angle can achieve the best parameter values.PSO is required to determine the optimal switching angle while maintaining the base voltage, which can reduce some of the higher harmonics. To promote this technology, it can be extended to multi-stage inverters. When any loading effect, the structure of the system can be introduced to restore the bus voltage, and the control algorithm using the PSO controller effectively control the amount of power without problems under fault conditions. The simulation results show that the new D-STATCOM based on SVPWM can achieve better control and improve system efficiency.

Moayed Moghbel et.al (2018)a new custom power device (CPD) is introduced for real-time control of reactive power and improving the overall network voltage quality of smart grid (SG) at fundamental and harmonic frequencies, respectively. The idea is to take advantage of the online smart meter data transmitted from each bus to the SG central control to concurrently perform the static synchronous compensator and the active power line conditioner operations by optimal compensations of fundamental reactive power and harmonic currents at selected optimal buses. The proposed strategy involves two particle swarm optimization algorithms. The first algorithm is implemented for the worse operating condition to determine the optimal locations and sizes of CPDs while the second algorithm relies on smart meter information to continuously compute fundamental and harmonic reference currents for real-time operation and control of the allocated CPDs. The objective functions are cost minimizations associated with bus voltage regulations, network total harmonic distortions voltage and custom device sizing while the constraints include upper limits for CPD sizes, fundamental, and harmonic bus voltages. Detailed simulations are performed in

MATLAB/Simulink to evaluate the performances of allocated CPDs in controlling the reactive power and voltage quality of a distorted 15-bus SG with six nonlinear loads according to the IEEE-519 standard.

Deepsikha Panda et.al (2018) This paper depicts voltage and current control of micro-grid system which is adequate to meet the power demand of local loads. The Hybrid microgrid considered in this work is a combination of a micro hydro based SEIG system, a PV array along with a Battery Energy Storage System(BESS) and a STATCOM. The SEIG system delivers a fixed amount of power to the loads. During load variation the SEIG does not have ample amount of power to serve the load requirement, so the system voltage and frequency fluctuations occurs and system performance deteriorates. To maintain the power quality the Fuzzy Controller based STATCOM is employed which supplies the required power to the loads. The active power demand of the load is managed by the dc side of the STATCOM which houses a PV-BESS system. The STATCOM controls the dc link voltage which on the other hand manages the active power flow to the load. The model has been simulated in real-time simulator for various load conditions like linear RL load, dynamic load and nonlinear load and the results are presented in the paper.

JayanthR. Ramamurthy et.al (2018)the addition of four 7000 HP, 13.2 kV induction motors by an offshore oil production and drilling company to its existing fleet of four 6000 HP motors resulted in power quality concerns for other utility customers served from the 115-kV transmission system. While new transmission upgrades planned in the area are expected to provide additional short-circuit capacity, detailed motor starting studies indicated the need for fast reactive power compensation in order to isolate other customers from unacceptable voltage sags. This paper describes the planning and design considerations for application of distribution-class Static Synchronous Compensator (STATCOM) technology to mitigate power quality issues. The optimal size and location for application of a STATCOM has been determined. In addition, measurements were performed to benchmark the magnitude of voltage sag that can be experienced during motor starting. A detailed Electromagnetic Transient Program (EMTP) model of the system was developed to verify the proposed solution.

Meiqin Mao et.al (2018) Stability analysis is the primary task for ac microgrids operation. For a Single-Bus Micro Grid (SBMG) including voltage- and current-controlled inverters, the existing impedance analysis methods divide the microgrid into two parts and judge the stability by whether the impedance ratio of the two parts satisfies the Nyquist stability criterion. However, it would be complicated for the SBMG interconnection system. This paper proposes a single-bus based stability analysis method for interconnected ac islanded microgrids. The main idea starts from each SBMG stability analysis, and then according to the power line topologies among buses and the distribution of loads to derive the reference node voltage for the stability analysis of the entire system. The influence of controller parameters on system stability is analyzed by using the proposed method. Simulation results for interconnected ac islanded microgrids are given and indicate that the stability of the SBMG interconnection system shows different sensitivities to the controller parameters of different controlled inverters.

Abdelsalam A. Eajal et.al (2019)the future smart grid encompasses ac-dc clusters known as ac-dc microgrids. For reliability and security purposes, each microgrid hosts a mix of synchronous-based and converter-based distributed resources. However, synchronous-based generators, in particular, are characterized by their limited reactive power capabilities because of the limitation of their excitation systems, which could lead to voltage instability problems when the hosting microgrid is islanded. AC-DC microgrids also comprise controllable thermal and electrical loads. Most modern ac-dc loads have power electronics interfaces that control the voltage at their ends, exhibiting constant power characteristics. AC-DC microgrids with high penetrations of constant power ac-dc loads are vulnerable to voltage collapse.

As with other power system architectures, microgrids are subject to contingencies, e.g., a line circuit outage, during which their load ability can be jeopardized. For this reason, the work reported in this paper involved the investigation of the steady-state voltage stability of islanded ac-dc hybrid microgrids (HMGs) during contingencies. Voltage stability analysis was carried out on a 12-bus ac-dc HMG. Several case studies were designed to reveal the likelihood of voltage instability/collapse in microgrids under severe contingencies. The voltage stability analysis also shows that interfacing ac and dc microgrids does not always enhance load ability. The analysis was carried with the goal of raising awareness among microgrid planners and operators of the possibility that a voltage collapse phenomenon can develop in islanded ac-dc microgrids under extreme events. Contingency analysis should therefore be incorporated into planning and operations criteria for islanded ac-dc microgrids.

XinboLiu et.al (2019) Hybrid AC/DC microgrid combines the advantages of AC and DC microgrids, and it develops rapidly. The energy storage unit contained in the hybrid AC/DC microgrid has the characteristics of constant power load, and its negative impedance characteristics can cause system instability. This paper analyses the large signal stability of the hybrid AC/DC microgrid in island mode with energy storage unit and considers the dynamic characteristics of the energy storage unit. T-S fuzzy model method is used to construct

the Hybrid AC/DC microgrid system model. Then the linear matrix inequality (LMI) is adopted as a criterion to obtain the Lyapunov function, and Lyapunov's second method is also utilized. Finally, the region of stability is obtained. The proposed method is verified by simulation results.

BhuvneshRathor et.al (2018)this paper analysis and investigates the effect of symmetrical fault on grid connected AC microgrid and improve the stability to primary control of synchronous distribution generators. In this ac microgrid four distribution generation units three renewable energy sources PV energy farm, wind energy farm and hydro power source and diesel generator is connected for backup power. The various power system stabilizers are used in control scheme and reduced the damping oscillation overshoot and settling time and comparison of time domain response having without power system stabilizes (PSS), with simple PSS like delta PSS and acceleration power (Pa) PSS, multi-band PSS (MB-PSS) and robust fuzzy based design PSS. Analyzing and performance of the various robust controller as microgrid system stability accessed on simpowersystem toolbox of MATLAB software.

Wenchao Cao et.al (2020) For system planning of three-phase inverter-based islanded ac microgrids, the low frequency instability issue caused by interactions of inverter droop controllers is a major concern. When internal control information of procured commercial inverters is unknown, impedance-based small-signal stability criteria facilitate prediction of resonances in medium and high frequency ranges, but they usually assume the grid fundamental frequency as constant and thus they are incapable of analyzing the low-frequency oscillation of the fundamental frequency in islanded microgrids. Aiming at solving this issue, this paper proposes two stability analysis methods based on terminal characteristics of inverters and passive connection network including the dynamics of the fundamental frequency for analysis of low-frequency stability in islanded multiple-bus microgrids.

Based on the Component Connection Method (CCM) to systematically separate inverters from the passive connection network, a general approach is developed to model the microgrid as a multiple-input-multiple-output (MIMO) negative feedback system in the common system d-q reference frame. By applying the generalized Nyquist stability criterion (GNC) to the return-ratio and return-difference matrices of the MIMO system model, the low-frequency stability related to the fundamental frequency can be analyzed using the measured terminal characteristics of inverters. Analysis and simulation of a 37-bus microgrid verify the effectiveness of the proposed stability analysis methods.

XinBo Liu et.al (2018)many urban communities are increasingly turning to AC Microgrids (AC MGs) as an alternative source of electricity. Distributed energy sources, different loads, and energy storage systems are all interfaced with AC MGs through power electronic converters. These tightly regulated loads could be regarded as constant power loads (CPLs), usually inducing negative impedance instability problems. Unfortunately, most stability studies have been based on small signal linearization techniques. This paper investigates the large signal stability of AC MGs based on mixed potential theory, and considers the influences of the storage system and CPLs. Firstly, the AC MGs are converted to DC systems in dq rotating frame. Then the mixed potential models are constructed and analyzed, and large signal stability criteria are derived. The criteria give important constraints on control parameters of the storage system, and the characteristics of CPLs are also taken into account. Simulation results indicate the criteria could guarantee the whole AC system stable during large disturbances.

Moudud Ahmed et.al (2019) Microgrid stability depends on a number of factors, such as the microgrid feeder characteristics, real/reactive power dispatch level, and the load dynamics. This paper focuses on the influence of the feeder characteristics on the stability of hybrid AC/DC microgrids. The line resistance (R), inductance (L), and capacitance (C), parameters highly depend on the rated voltage of the feeder; hence, these parameters affect the active and reactive power sharing of the parallel connected voltage source converters (VSCs).

This paper investigates the dynamic stability impact of hybrid AC/DC microgrids having low voltage (LV) and medium voltage (MV) distribution feeders. The transient stability is analyzed by: 1) developing a hybrid AC/DC microgrid with 6.6 kV and 22 kV distribution voltage levels; 2) by applying active and reactive power load switching; and 3) outage of a large distributed energy resource (DER). It is observed that the transient effect due to an active power load switching event on induction motor (IM) rotor speed and system frequency is relatively small for the MV distribution feeder based microgrids, while the impact is larger for the LV distribution feeder based microgrids. The active and the reactive power sharing performance of the parallel operating VSCs depend on the distribution feeder RLC parameters and the load composition that the distribution feeder is supplying.

Yan Guo et.al (2019)this paper proposes a region based stability analysis method of active damper in an AC microgrid with multiple inverter interfaces. Compared to the traditional analysis using root loci of system eigen-function with single parameter change, the proposed region based approach can analyze system stability and depict the stability region when multiple dominant parameters vary. This proposed method can provide effective reference for parameter selection of active damper and make active dampers operate more flexibly

in inverter dominated microgrids. Case studies and experiment results present the effectiveness of the proposed region based stability analysis method..

Vandana Agrawal et.al (2018)the upward thrust of power demand for in a power system so need the small-grid systems which is called microgrid and the broadly spread of networked manage structures require using discrete-time mode gadgets. A discrete time mode power device stabilizer is designed for the hydro and diesel power station silent-pole synchronous generator of the ac microgrid, associated to electrical main grid bus. Virtual devices are broadly unfold and play a vital project in the action and manage of energy structures. Numerous types of virtual controlled gadgets have been placed into practical use in energy structures for the ultimate decade, such as electricity gadget various Power System Stabilizers (PSSs) like Delta PSS (Omega and Pa), Multiband PSS. The consequences of sampling time and PSS parameters are simulated and tested. MATLAB/Simulink software powersystemtoolbox library is used to put in force the discrete mode time PSS via networked improve the stability of the microgrid.

Moudud Ahmed et.al (2020) Self-governing small regions of power systems, known as "microgrids", are enabling the integration of small-scale renewable energy sources (RESs) while improving the reliability and energy efficiency of the electricity network. Microgrids can be primarily classified into three types based on their voltage characteristics and system architecture; 1) AC microgrids, 2) DC microgrids, and 3) Hybrid AC/DC microgrids. This paper presents a comprehensive review of stability, control, and power management and fault ride-through (FRT) strategies for the AC, DC, and hybrid AC/DC microgrids. This paper also classifies microgrids in terms of their intended application and summarizes the operation requirements stipulated in standards (e.g., IEEE Std. 1547-2018). The control strategies for each microgrid architecture are reviewed in terms of their operating principle and performance. In terms of the hybrid AC/DC microgrids, specific control aspects, such as mode transition and coordinated control between multiple interlinking converters (ILCs) and energy storage system (ESS) are analyzed.

A case study is also presented on the dynamic performance of a hybrid AC/DC microgrid under different control strategies and dynamic loads. Hybrid AC/DC microgrids shown to have more advantages in terms of economy and efficiency compared with the other microgrid architectures. This review shows that hierarchical control schemes, such as primary, secondary, and tertiary control are very popular among all three microgrid types. It is shown that the hybrid AC/DC microgrids require more complex control strategies for power management and control compared to AC or DC microgrids due to their dependency on the ILC controls and the operation mode of the hybrid AC/DC microgrid. Case study illustrated the significant effects of microgrid feeder characteristics on the dynamic performance of the hybrid AC/DC microgrid. It is also revealed that any transient conditions either in the AC or DC microgrids could pro...

Yuxi Men et.al (2020) In this paper, a holistic small-signal model of hybrid AC and DC microgrids is developed, including AC subsection, DC subsection, and interface inverters between AC and DC buses. Based on the derived complete small-signal model, a region-based stability analysis approach is proposed and developed. Meanwhile, to obtain the steady-state operating points used in the region-based stability analysis, practical and effective power flow calculation is conducted for droop-controlled hybrid AC and DC microgrids. Rather than following a conventional point-by-point stability evaluation procedure, the stability region implemented in this work is derived based on the selected cross-domain parameters from either control systems or main power circuits. Furthermore, an artificial intelligence (AI) assisted Kernel Ridge Regression (KRR) algorithm is implemented to derive the stability boundary with enhanced computational efficiency. Simulation tests are presented to demonstrate the effectiveness of the proposed method.

Oluleke Babayomi et.al (2020) the need for converter-based synthetic inertia has become more important due to the increasing level of renewable generation penetration in power systems. In this paper, the distributed secondary regulation of frequency and voltage is implemented for model predictive-controlled (MPC) voltage source converters (VSCs) in an AC microgrid (MG). A virtual synchronous generator (VSG) provides inertia-emulation to reduce the rate of change of frequency (ROCOF) that arises from sudden load changes. First, a small-signal stability analysis for parallel-connected VSG-based inverters in a MG is analyzed. Next, the secondary control of voltage and frequency in a distributed AC MG (with parallel-connected inertia-emulating VSCs) is realized. In addition, for the applied load changes in this study it is shown that the proposed control scheme effectively reduces the load change-induced ROCOF by up to 89% and also has very fast and accurate dynamic response that supports robust and rapid recovery from perturbations to MG stability.

Zhiyi Li et.al (2019) the deployment of hybrid ac/dc microgrids is a promising alternative for using local distributed energy resources to serve both ac and dc loads. Hybrid ac/dc microgrids, like other types of microgrids, are subjected to dynamic instability when operated in island mode. This paper analyzes the small-signal stability of islanded hybrid ac/dc microgrids and proposes a droop-based control mechanism to coordinate the operation of ac and dc sections. A general approach is presented which uses a linearized state-space model of microgrids for establishing adequate stability margins in

hybrid ac/dc microgrid operations. The proposed case studies are conducted to investigate the small-signal behavior of a hybrid ac/dc microgrid based on time-domain simulations and frequency-domain analyses.

BhuvneshRathor et.al (2018) This paper analysis and investigates the effect of symmetrical fault on grid connected AC microgrid and improve the stability to primary control of synchronous distribution generators. In this ac microgrid four distribution generation units three renewable energy sources PV energy farm, wind energy farm and hydro power source and diesel generator is connected for backup power. The various power system stabilizers are used in control scheme and reduced the damping oscillation overshoot and settling time and comparison of time domain response having without power system stabilizes (PSS), with simple PSS like delta PSS and acceleration power (Pa) PSS, multi-band PSS (MB-PSS) and robust fuzzy based design PSS. Analyzing and performance of the various robust controller as microgrid system stability accessed on simpowersystem toolbox of MATLAB software.

Wenchao Cao et.al (2020) For system planning of three-phase inverter-based islanded ac microgrids, the low frequency instability issue caused by interactions of inverter droop controllers is a major concern. When internal control information of procured commercial inverters is unknown, impedance-based small-signal stability criteria facilitate prediction of resonances in medium and high frequency ranges, but they usually assume the grid fundamental frequency as constant and thus they are incapable of analyzing the low-frequency oscillation of the fundamental frequency in islanded microgrids. Aiming at solving this issue, this paper proposes two stability analysis methods based on terminal characteristics of inverters and passive connection network including the dynamics of the fundamental frequency for analysis of low-frequency stability in islanded multiple-bus microgrids.

Based on the Component Connection Method (CCM) to systematically separate inverters from the passive connection network, a general approach is developed to model the microgrid as a multiple-input-multiple-output (MIMO) negative feedback system in the common system d-q reference frame. By applying the generalized Nyquist stability criterion (GNC) to the return-ratio and return-difference matrices of the MIMO system model, the low-frequency stability related to the fundamental frequency can be analyzed using the measured terminal characteristics of inverters. Analysis and simulation of a 37-bus microgrid verify the effectiveness of the proposed stability analysis methods.

XinBo Liu et.al (2018)many urban communities are increasingly turning to AC Microgrids (AC MGs) as an alternative source of electricity. Distributed energy sources, different loads, and energy storage systems are all interfaced with AC MGs through power electronic converters. These tightly regulated loads could be regarded as constant power loads (CPLs), usually inducing negative impedance instability problems. Unfortunately, most stability studies have been based on small signal linearization techniques. This paper investigates the large signal stability of AC MGs based on mixed potential theory, and considers the influences of the storage system and CPLs. Firstly, the AC MGs are converted to DC systems in dq rotating frame. Then the mixed potential models are constructed and analyzed, and large signal stability criteria are derived. The criteria give important constraints on control parameters of the storage system, and the characteristics of CPLs are also taken into account. Simulation results indicate the criteria could guarantee the whole AC system stable during large disturbances.

Li Zekun et.al (2018) As the important part of future AC/DC hybrid distribution networks, maintaining the voltage stability of DC microgrid is very important for the safe operation of the distribution network. Based on Brayton-Moser's mixed potential theory, this paper first studies the large disturbance stability of a DC microgrid with constant power load. Then, the stability criterion of the analytic form of the system under large disturbance is obtained, which the effects of parameters such as AC side inductance, resistance, controller control parameters, and constant power load power values on the system stability are taken into account. According to the criterion, a stability control strategy for energy storage system is proposed. This strategy can avoid the unnecessary switching between the master and slave source, ensure the system stable under large disturbances and help the system quickly return to the stable state. The criterion and stability control strategy are simple and can be easily implemented. Simulation results demonstrate that the stability criterion and the control strategy are effective.

Hong-Tao Li et.al (2018) In order to solve multi-converter control problems in ac/dc hybrid microgrid, such as “gap” problem in the process from grid-connected mode to islanding mode, and the low system immunity and stability when the ac/dc hybrid micro grid interface converter in droop control mode. This paper puts forward the coordination stability control strategy, energy storage converter in ac microgrid adopts VSG control and the distributed generation converters adopt MPPT control to solve “gap” problem in the process from grid-connected mode to islanding mode; DC microgrid adopts no communication lines connected control technology, independently to meet the energy balance inside the dc microgrid, and save the communication cost; AC/DC microgrid interface converter adopts bidirectional VSG control to improve the immunity and stability of the system compared the bidirectional droop control. The coordination stability control strategy of multi-converter in AC/DC hybrid

microgrid this paper provided gives reference for the future ac/dc hybrid microgrid project implementation.

XialinLi;et.al (2019) Hybrid ac/dc microgrids (MGs) integrated with traditional diesel generators, distributed energy storage systems (ESSs), and high penetration of renewable energy sources (RESs)-based distributed generators (DGs) have become an attractive power supply solution for isolated remote areas and islands, which can effectively reduce environmental protection pressure and improve power supply reliability. However, in such inherent low-inertia systems, randomness and fluctuation of the output power of RESs and uncertain load consumption can easily incur dynamic stability issues, such as transient power impact, unacceptable frequency deviations, and operation mode transitions for security. To solve the above problems and enhance the dynamic stability of the system, an enhanced dynamic stability control (EDSC) scheme with locally measured signals only is proposed in this paper. In this control scheme, the bi-directional interlinking dc-ac converter uses the ac frequency in ac MG as the reference value of dc voltage and adopts the current feed forward control to control the dc voltage in the dc MG to be consistent with the ac frequency. By electrically coupling dc voltage and ac frequency, power disturbances in ac or dc sides will cause almost identical variation degrees in both ac frequency and dc voltage.

Under the proposed EDSC scheme, the distributed ESSs in both ac and dc sides are then automatically coordinated and controlled by the unified droop control to balance transient power disturbances and smooth output of diesel generator under normal condition, which can effectively improve stability and controllability of such low-inertia systems. Furthermore, in an emergency such as failure of diesel generator, the operation mode can be switched seamlessly with the proposed EDSC scheme. The detailed theoretical analysis including control system design, small signal model analysis of key parameter influence on system dynamics, and simulation verifications in the PSCAD/EMTDC enviro...

Ali Zafari et.al (2020) In this paper, a grid-connected hybrid DC/AC microgrid including a PV-based DC/DC converter, a bidirectional Lithium Battery (LB)-based DC/DC converter and a grid-connected DC/AC converter is controlled by proposing various linear compensators embedded in the inner dynamics of the used power converters. The proposed control strategies are designed for the power converters in such a way that all DC-link voltage fluctuations are instantaneously combined with other parts of closed-loop systems through suitable compensators design. The best performance for the compensators components is achieved by evaluating the natural frequencies and amplitude of transfer functions realized from the proposed control techniques-based closed-loop systems. To assess the proposed control technique performance, comparative simulation results in MATLAB/SIMULINK are presented to verify desired DClink voltage, the appropriate control of DC/DC power converters output currents, AC grid stability, and accurate performance of AC power-sharing. As a solution for optimized, reliable and flexible operation of distribution systems, multiple AC microgrids can be interconnected. In this paper, a low-order low-frequency small-signal model is proposed for large-scale interconnected AC microgrids in order to analyze stability and dynamics as well as synthesize high-level controllers, e.g. grid-tie power controller. A sensitivity analysis-based technique is introduced for finding effective modules of fully inverter-based AC microgrids on the dominant low-frequency modes.

The low-order model of AC microgrids including both droop-based and PQ-controlled distributed generation units is obtained by removing non-effective modules and reconfiguring the effective modules. The concept of virtual swing equation and the aggregation modeling method are employed to achieve a single-order model for each AC microgrid with any number of sources. The analysis and synthesis of the large-scale interconnected microgrids can easily be done using the proposed single-order model. The frequency analysis and control of three interconnected AC microgrids are presented as a case study, which leads to introducing the inter-microgrid oscillatory modes.

Mohammad Raeispour et.al (2020) In this paper, a new robust hierarchical control scheme is proposed for off-grid (autonomous) voltage-sourced converter (VSC)-based alternative current (AC) microgrids (MGs). The main focus of this paper is devoted to the primary layer, including the cascade structure of inner (current), outer (voltage), the virtual impedance, and droop control loops. In the inner control loop, a robust controller is designed based on an adaptive backstepping integral non-singular fast terminal sliding mode control (ABINFTSMC) strategy to regulate and track the reference of current signals in the presence of unknown bounded uncertainties and external disturbances. The outer loop is designed based on a mixed H2/H∞ control strategy by utilizing the state feedback control law to generate the inner-loop reference signal and achieve stability and robustness versus perturbations, and sufficient conditions are derived based on linear matrix inequalities (LMIs).

The performance of the controllers is improved to consider time-varying delay (TVD). The droop control and virtual impedance loops are applied to enhance the power-sharing quality of the system. Also, a distributed consensus-based protocol is used in the secondary layer. Finally, to evaluate the performance of the control laws and demonstrate the effectiveness of the proposed robust control scheme, offline digital time-domain simulation studies are carried out in MATLAB/Simulink software

environment. The obtained simulation results and comparison with previous work prove that the proposed robust hierarchical control scheme can effectively, and robustly enhance the transient response and steady-state performance, and fault ride-through (FRT) capability of MG when faced with small- and large-signal disturbances, and show better robust performance over conventional proportional-integral (PI)-based nested-loop control strategies.

III.POWER QUALITY ISSUES

Wind energy : Wind power is a major success story in renewable energy. The issues caused by most popular power electronic and machine in wind turbines are listed below.

Thermal loading: The grid requirements for the wind turbines especially the low voltage ride through (LVRT) ability during grid faults are getting stricter. By using other multilevel converter topologies, the loading profile of power devices during LVRT can be modifiedthe junction temperature of the most stressed devices in the 3LNPC, 3L-HB and 5L-HB topologies for wind.

Stability problem: Energy storage will have impact on electric grid in several other ways including stability. This work addresses the impact of DG with storage on transient stability of the electric grid system. The test plan involved replacing existing synchronous generators with SCIG and DFIG generators while adding battery energy storage. It was seen that when the fixed speed turbine (SCIG) is introduced, there are certain fault conditions that produce instability. There are also instances where the system becomes unstable as penetration of fixed speed turbine generation is increased. All of these instances of instability have a characteristic of a superimposed high frequency oscillation that occurs a number of seconds after application of the fault. When the variable speed turbines (DFIG) were introduced into the system, all instances of transient disturbance produced a stable response. Additional tests were then performed to attempt more instability, without success, by removing generation, as well as entire buses from the system. The conclusion is made that the test system is very strong network that requires a very severe disturbance to produce instability for the DFIG.

Voltage stability: Voltage stability drawback is sorted out with the help of flexible AC transmission system (FACTS) devices like static synchronous compensator (STATCOM). A STATCOM is used to counter problems like transient stability support in network including Squirrel Cage wind generator. While analysis the STATCOM results are better than static var compensator (SVC) for the stable operation of SCIG. STATCOM improves the stability problem and so help the wind generator system to remain in service throughout grid faults. However, islanding of a connected IG disturbs its voltage and frequency, owing to lack or surplus of reactive and active power. The most significant capable strategy to control a turbine received electrical power is used to regulate the blade pitch angle. Blade pitch is analogous to the throttling valve in typical steam turbines, except that its response is much quicker than that of steam turbines. However now a days, a power electronics based mostly FACTS controller (i.e. STATCOM, SVC etc.) is also paralleled to IG, to enhance the response of the system.

MPPT: The maximum power which will be delivered by a PV panel depends greatly on the simulation level and therefore the operative temperature. The weather change operation of PV system to vary most of the days. There are two methods of MPPT control. Perturb and observe method Increment conductance method. Ezhiljenekkha G.B. and MarsalineBeno M. / Materials Today: Proceedings 24 (2020) 2137–2143 2141 MPPT techniques are used to extract the maximum output power from PV modules, and different DC/ DC converter topologies are used to transfer maximum power from PV modules to loads/ batteries. Different techniques of MPPT have been proposed, e.g. open circuit voltage methods , short circuit current methods , fuzzy logic technique , perturb and observe (P&O), incremental conductance (IC) technique .

Voltage Regulation The droop characteristics are used, particularly for DFIGs to control the voltage magnitude and frequency [26]. This can be extended to WECS by doing a voltage sensitivity analysis to achieve voltage regulation at PCC. The high DC bus ripple is a result of the voltage-drive mode to provide the best AC power quality [27] and concludes that the bidirectional power flow and the bottom-up decentralized control methods make DG systems are well controlled and organized. To overcome this problem in [28] author focuses on the grid-interfacing architecture, with fuzzy logic controllers to improve voltage quality. For wind generators is landed micro grid. Here, the complex power droop the unbalances control systems use a virtual impedance loop to compensate

Voltage Sags/ Swells: The operation of Sensitive loads connected to the grid is influenced by the voltage dips. To overcome this disadvantage author presented power electronic converter in [29] using a series compensator, which requires considerably less active power and is able to restore the voltage at the load side. Grid-interfacing power quality compensator for three-phase four-wire micro-grid applications was developed using the sequence components to inject voltages as a complementary measure Under the Net-metering scenario a Power Quality Control Center (PQCC) would regulate voltage due to the reversal of power flows from the DG and the increase in short circuit current [30].

Harmonics The grid interaction and grid impact of wind turbines have been focused on during the past few years. The reason behind this interest is that wind turbines are among the utilities considered to be potential sources of bad power quality. Especially, variable-speed wind turbines have some advantages concerning flicker. But, a new problem arose with variable-speed wind turbines. Modern forced-commutated inverters used in variable-speed wind turbines produce not only harmonics but also inter harmonics. The International Electro technical Commission (IEC) initiated the standardization on the power quality for wind turbines in 1995 as part of the wind-turbine standardization in TC88, and ultimately 1998 IEC issued a draft IEC-61400-21 standard for "power quality requirements for Grid Connected Wind Turbines" [31].

Recently, high-frequency (HF) harmonics and inter harmonics are treated in the IEC 61000-4-7 and IEC 61000-3-6 the methods for summing harmonics and inter harmonics in the IEC 61000-3-6 are applicable to wind turbines. In order to obtain a correct magnitude of the frequency components, the use of a well defined window width, according to the IEC 61000-4-7, Amendment 1, is of a great importance, as has been reported in [34]. In [35] author introduces a new Adaptive Notch Filtering (ANF) approach which can address issues like, extracting harmonics, voltage regulation, complex power control, suppressing frequency variations and noise contents using the sequential components of voltages as reference. Some methods for harmonic damping are presented in [36] such as (i) a shunt harmonic impedance method adaptable for islanded micro-grids application, (ii) The voltage-based droop control strategy to have controllable harmonic current and PQ (iii) heuristic Optimization techniques such as differential evolution algorithm (DEA) are used to obtain the switching states of CPDs, as a nonlinear optimization problem

IV.POWER QUALITY IMPROVEMENT TECHNIQUES METHOD

Power quality problems can be defined as the difference between the quality of power supplied and the quality of power required for reliable operation of the load equipment. Several types of power enhancement devices have been developed over the years to protect equipment from power disturbances. Some of the effective and economic measures can be identified as following:

Lightning and surge arrestors: Arrestors are using to protect the transformers from lightning and voltage surges but are certainly not sufficient for limiting voltage disturbances to protect sensitive electronic circuits from voltage surges. 2-Transient Voltage Surge Capacitors (TVSC): These units clamp spikes to a level that it is safe for the sensitive loads. Employing an entire facility protection strategy will safeguard the electrical system against most transients. 3-Filters: Provide protection against high frequency low voltage noises. Filters are designed to pass the fundamental frequency and reject the higher frequency noise such as electromagnetic interference (EMI) and radio frequency interference (RFI). Harmonics filters prevent the harmonics content of non linear loads from back to the power source. 4-Isolation transformer: Provides a degree of filtering and isolation. Isolation transformers reduce electrical noise by separation of the primary and secondary through magnetic isolation. Isolation transformer reduce noises and harmonics but it does not compensate for power outages and voltage fluctuations 5-Voltage Regulators Voltage regulators maintain output voltage at nominal voltage under severe input voltage variations. There are three basic types of regulators:

Tap changing Transformer: Designed to adjust for varying voltages by automatically transferring taps on a power transformer. The main advantage of tap changers is high efficiency, wide input range, high over load current capability and good noise isolation compared to other voltage regulation technology. Disadvantages are noise created when changing taps and no waveform correction. The tap-changing transformer is: slow in response, exhibits contact erosion needs routine maintenance of its parts, has an uneconomical size and requires frequent replacement of transformer oil [9]

Buck boost: Utilizes similar technology to the changers except the transformer being not isolated. One of the advantages is that it can withstand high in-rush currents. Disadvantages are noise created when changing taps, poor noise isolation and no waveform correction

Constant Voltage Transformer (CVT): It is also known as Ferro resonant transformer. The CVT is a static regulator that maintains a nearly constant output voltage during large voltage variations in the input voltage. Advantages are superior noise isolation, very precise output voltage and current limiting for overload protection. The lack of moving parts means that the transformer requires little maintenance. Disadvantages are large size, audible noise and low efficiency. 6-Uninterruptible Power Supply (UPS) UPS systems provide protection in the case of a complete power interruption. There are three major UPS topologies each providing different levels of protection: off-line UPS, Line interactive UPS and on-line UPS. Topology may be considered according to the load requirement based on efficiency, cost and transfer time. Moreover, UPS also requires a high level of maintenance because of, leakage of batteries and also needs replacement for every five years.

CUSTOM POWER DEVICES Customers are demanding electrical power with high quality from the electric utilities. Custom power devices are capable to

solve power quality problems. The concept of custom power is based on the use of power electronic controllers in the distribution system for the purpose of providing reliable and high quality power that is needed by sensitive equipments to power quality variations. Types of Custom Power Devices. 1-network reconfiguring type 2- compensating type 1-Network reconfiguring type (switchgear) which used for power quality enhancement and these include: Static current Breaker (SCB), Static current limiter(SCL) and Static Transfer Switch (STS).

Static Current Limiter (SCL): SCL limits a fault current by quickly inserting a series inductance in the fault path. It consists of a pair of antiparallel gate turn off thyristors switch with snubbers (RC circuit) and a current limiting inductor. The currents limiter is connected in series with a feeder such that it can restrict the current in the case of a fault downstream. In the healthy state, the opposite poled switch remains closed. These switches are opened, when a fault is detected, such that the fault current now flows through the current limiting inductor[9] ii)Static Circuit Breaker (SCB): SCB breaks a faulted circuit much faster than a mechanical circuit breaker. An SCB has almost the same topology as that of an SCL except that the limiting inductor is connected in series with an opposite poled thyristor pair. The Gate Turn Off thyristor (GTO) is the normal current carrying elements. Simultaneously as the bidirectional switch GTO is switched off once a fault is detected. This will force the fault current to flow through the limiting inductor. The Thyristor pair is blocked after a few cycles if the fault still persists. The current through the thyristor pair will case to flow at the next available zero crossing of the current[10].

Solid-State Switch Based on The Thyristor Device (STS): The properties of a thyristor (ON- state and OFF-state) are used to perform an intelligent switch which can choose between two power sources and provide the best available power to the electrical load [9]. In most cases the STS is capable to limit the duration of voltage sags and interruptions to less than 0.5 cycle by transferring the loads from the affected feeder to a backup feeder. STS response is very high speed [11] but when both the feeders are affected by voltage disturbances STS become not suitable 2- Compensating type which used for voltage regulation, Power factor correction , load balancing and active filtering. Compensating type isincluding: Distributed Static Compensator (DSTATCOM), Dynamic Voltage Restorer (DVR) and Unified Power Quality Conditioner (UPQC).

Dynamic Voltage Restorer: DVR is a compensating custom power type device. Voltage Source Inverter (VSI) of DVR generates a compensating voltage, which is then injected in the distribution system by means of series injection transformer. Passive filter connected between the VSI and the injection transformer, eliminates the higher order harmonic components from the inverter output voltage. Energy storage device connected to the VSI provides the necessary active power for the compensation [11]. DVR compensation ability depends on the range of sags and size of the energy storage.

DSTATCOM Shunt devices are effective to compensate small voltage variation, which can be controlled by reactive power injection. The ability to control the fundamental voltage at a certain point depends on the impedance to the supply and the power factor of the load. The compensation of a voltage dip by current injection is very difficult to achieve, because the supply impedance is usually low and the injected current has to be very high to increase the load voltage.

V.CONCLUSION

In this paper, the various power quality improvement techniques and solutions were discussed. Poor power quality can create much serious effect on our power system like overheating in system equipment, over loading, harmonics generations, waveform distortion etc. which can be mitigated through various techniques through filters facts devices and power factor corrected circuit'setc.The FACTS devices are used to improve the power transfer capabilities and stability margins of the transmission line. The custom power devices are effective to restore the sensitive load voltage to the pre-fault value and make it smooth under different cases of faults and nonlinear load condition. Some of these custom power devices include DSTATCOM, UPQC, and DVR etc.this paper will be helpful for researchers, users and suppliers of electrical power to get a guideline about the power quality

REFERENCE

1. BhagyashreeParija;SantiBehera;RuturajPattanayak;SasmitaBehera Power Quality Improvement in Hybrid Power System using D-STATCOM 2019 3rd International Conference on Computing Methodologies and Communication (ICCMC) Year: 2019 DOI: 10.1109/ IEEE Erode, India
2. WesamRohouma;Robert S. Balog;Aaqib Ahmad Peerzada;Miroslav M. Begovic Development of a Capacitor-less D-STATCOM for Power Quality Improvement in Low Voltage Network 2019 IEEE 13th International Conference on Compatibility, Power Electronics and Power Engineering (CPE-POWERENG) Year: 2019 DOI: 10.1109/ IEEE Sonderborg, Denmark
3. SuvarnaJadhav;Nayana Jangle Improvement in Power Quality Performance using S-Transform Based D-STATCOM 2018 IEEE International Conference on

System, Computation, Automation and Networking (ICSCA) Year: 2018
4. Swaroopa S. Bhosale;Y. N. Bhosale;Uma M. Chavan;Sachin A. Malvekar Power Quality Improvement by Using UPQC: A Review 2018 International Conference on Control, Power, Communication and Computing Technologies (ICCPCCT) Year: 2018 DOI: 10.1109/ICCTCT.2018.8550927 IEEE Coimbatore, India
5. BurudiJahnavi;SrinivasBhaskarKaranki;Pratik Kumar Kar Power quality improvement with D-STATCOM using combined PR and Comb filter- Controller 2021 1st International Conference on Power Electronics and Energy (ICPEE) Year: 2021
6. HariomKumar;JagannathPatra;AshiwaniYadav;Nitai Pal Power quality assessment and improvement of 3-phase 3-wire non-linear system using instantaneous power theory based DSTATCOM 4th International Conference on Recent Advances in Information Technology (RAIT) Year: 2018
7. Ahmed Hussain Elmetwaly;Azza Ahmed Eldesouky;Abdelhay Ahmed Sallam An Adaptive D-FACTS for Power Quality Enhancement in an Isolated Microgrid IEEE Access Year: 2020
8. Linggom Enrico Christian;LesnantoMultaPutranto;SasongkoPramono Hadi Design of Microgrid with Distribution Static Synchronous Compensator (D-STATCOM) for Regulating the Voltage Fluctuation 2019 IEEE 7th International Conference on Smart Energy Grid Engineering (SEGE) Year: 2019
9. Sivarajan K N;Jasmin EA;B Jayanand Power Quality problems And Mitigation Using D-STATCOM With H-bridge topology In Solar PV Integrated Distribution System 2020 International Conference on Power, Instrumentation, Control and Computing (PICC) Year: 2020
10. LakshmanNaikPopavath;GNagaraju;K. Naresh A PV-Statcom for Enhancement of power quality in grid integrated system using Unit Vector Controller 2020 International Conference on Artificial Intelligence and Signal Processing (AISP) Year: 2020
11. D. Joe Meisner;BerndNiemann;MykolaShevchenko;EmmanuelFombang;ImanKhosravi;Heinrich von Geymüller STATCOM with Active Filter Using STATCOM as Active Filter, Improving Power Quality and reducing Harmonics 2020 IEEE/PES Transmission and Distribution Conference and Exposition (T&D) Year: 2020
12. AmitaAmita;Abhishek Kumar Sinha Power Quality Comparison of Grid Connected wind Energy System with STATCOM and UPQC 2018 International Conference on Intelligent Circuits and Systems (ICICS) Year: 2018
13. BiswajitSaha;Sankar Narayan Mahato Power Quality Improvement of a Self-Excited Induction Generator Using NFPI Controller Based Hybrid STATCOM System 2019 IEEE International Conference on Intelligent Techniques in Control, Optimization and Signal Processing (INCOS) Year: 2019
14. Dib Djalel;GhoudelboukSihemOverview on the STATCOM Performance in the Power Quality Improvement in the Electrical Grid 2018 International Symposium on Advanced Electrical and Communication Technologies (ISAECT) Year: 2018
15. Arif S. Tamboli;H. T. Jadhav Hybrid STATCOM for Reactive Power Compensation 2018 International Conference on Current Trends towards Converging Technologies (ICCTCT) Year: 2018
16. PouryaSarvghadi;AliYazdian;Reza Ghazi Increasing Redundancy and Cost Reduction to Improve Power Factor and Reduce Harmonic Using Parallel Connection of D-STATCOMs 2018 Electrical Power Distribution Conference (EPDC) Year: 2018
17. Aishwarya A. Patil;YoginiBhosale Development of Bi-directional energy meter for a grid-connected PV system with power quality improvement using D-STATCOM 2019 International Conference on Computation of Power, Energy, Information and Communication (ICCPEIC) Year: 2019
18. Yogita R. Ashtekar;Anuja A. Mude;Sneha A. Khubalkar Power quality improvement by using modular multilevel cascade converter based STATCOM 2018 2nd International Conference on Inventive Systems and Control (ICISC) Year: 2018 DOI: 10.1109/IEEE Coimbatore, India
19. Ali HadiAbdulwahid Advanced Control Method for Improving Power Quality of Microgrid Based on SVPWM Technology 2019 4th International Conference on Power and Renewable Energy (ICPRE) Year: 2019
20. Moayed Moghbel;Mohammad A. S. Masoum;AlirezaFereidouni;SaraDeilami Optimal Sizing, Siting and Operation of Custom Power Devices With STATCOM and APLC Functions for Real-Time Reactive Power and Network Voltage Quality Control of Smart Grid IEEE Transactions on Smart Grid Year: 2018
21. DeepsikhaPanda;Bharat Singh Rajpurohit Real-time FuzzyLogic Based Power Quality Analysis of Hybrid microgrid System 2018 8th IEEE India International Conference on Power Electronics (IICPE)nYear: 2018
22. Jayanth R. Ramamurthy;SharmaKolluri;Douglas J. Mader;ErnstCamm Mitigation of Motor Starting Voltage Sags Using Distribution-Class STATCOM 2018 IEEE/PES Transmission and Distribution Conference and Exposition (T&D) Year: 2018