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Mitigation of Power Quality Issues in Distributed Generation Systems

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ABSTRACT

This paper discusses the power quality issues of the power of distributed production systems renewable energy sources such as solar and wind power. This paper provides an in-depth study of the energy quality of energy systems, including those using renewable energy sources. Learn more about energy quality monitoring strategies and potential energy quality solutions. Next, we will analyse how to reduce these problems with custom power systems like D-STATCOM, UPQC, UPS, TVSS, DVR, in microgrid systems. In renewable energy systems, STATCOM has many benefits for and it may be a possible choice, but rotating repositories can improve the quality of power of traditional systems. Finally, in check the power quality of the DC system. The simplified structure and improved reliability are two main advantages of DC systems, but they also address other power quality issues such as: Stability and error detection. It incorporates mitigation technologies such as static power supply, flexible power detection, filters, flexible compensation, power storage systems, flexible AC transmission systems, and transformers. Leading international processes in accordance with IEEE rules should be applied to the grid to achieve optimal energy quality.

KEYWORDS: *Power Quality, System Stability, Instantaneous Power Theory*

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INTRODUCTION

Today, reliability and quality are among the most talked about topics in the energy industry. There are different types of power quality problems that have been seen in the distribution system, each with different possible causes. The types of power quality problems may be categorised by how the voltage waveform is distorted. Short-term events, short-term fluctuations (immersion, swelling, and distortion), long-term fluctuations (constant disruption, inefficiency, power outages), power imbalances, waveform distortions (DC offset, harmonics, harmonics, Notch, and noise), electrical fluctuations[1].

Both electric utilities and end users of electrical power are becoming Concerns about the quality of electricity are growing. The term "power quality" has become one of the most prolific buzzwords in the power industry [2]. The issue of electricity power sector delivery is not confined to only energy efficiency and but also on supply quality and continuity, or power quality and supply quality. Electrical power quality is the degree of any deviation from the nominal values of the voltage magnitude and frequency. Power quality may also be defined as the degree to which both the utilisation and delivery of electric power affect the performance of electrical equipment [3]. From a customer perspective, a power quality problem is defined as any power problem manifested by voltage, current, or frequency deviations that result in power failure or disoperation of customer equipment. Power quality is certainly a major concern in the present era; it has become especially important with the introduction of sophisticated devices, whose performance is very sensitive to the quality of power supply. [4]. Modern industrial processes are based on a large number of electronic devices, (shown in fig-1) such as programmable logic controllers and adjustable speed drives. Electronic devices are very sensitive to disturbances and, thus, industrial loads become less tolerant to power quality problems such as voltage dips, voltage swells, harmonic flickers, interruptions, and notches[5].

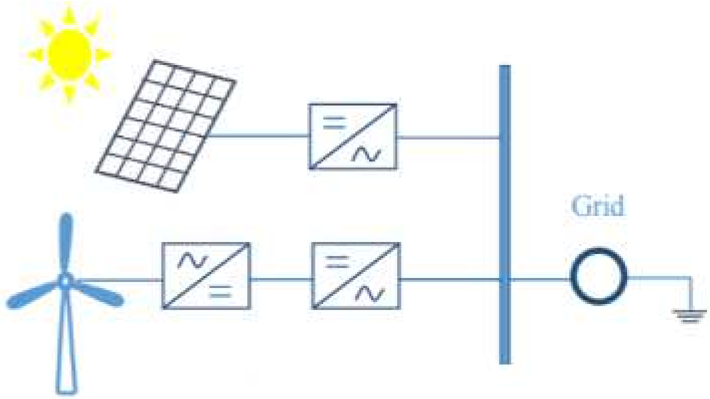

Fig-1 Proposed Hybrid model

Electrical PQ is the approximate voltage range and the degree of deviation from the frequency. PQ can also be defined as the level at which both the consumption and supply of electricity affects the performance of electrical equipment. When devices connected to a network are compatible with what is happening in the network, it is often helpful to consider power quality as a compatibility problem. There are at least two solutions to compliance issues. Clean the stream or make the device more solid. Both suppliers and end users are very concerned about electrical quality[6]. Electrical PQ magnitude of power and degree of deviation from frequency. PQ can also be defined as the level at which both the consumption and supply of electricity affects the performance of electrical equipment.

Series Active Power Filter:

Shunt active power filters compensate for current harmonics by injecting equal but opposite harmonic compensating current. In this case, the shunt active power filter operates as a current source, injecting the harmonic components generated by the load but phase shifted by 180 degrees. As a result, components of harmonic currents contained in the load current are cancelled by the effect of the active filter, and the source current remains sinusoidal and in phase with the respective phase-to-neutral voltage. This principle is applicable to any type of load considered as a harmonic source[7]. Moreover, with an appropriate control scheme, the active power filter can also compensate for the load power factor. In this way, the power distribution system sees the nonlinear load and the active power filter as ideal resistors. The Series active power filter and passive filter combined in a one system in Fig. 2.

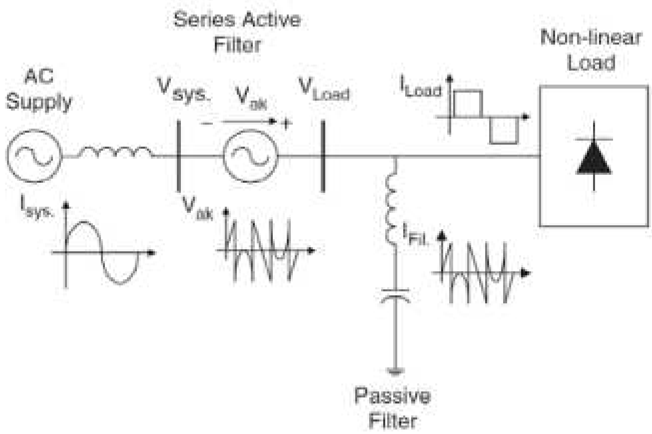

Fig-2 Series active power filter and passive filter combined in a one system

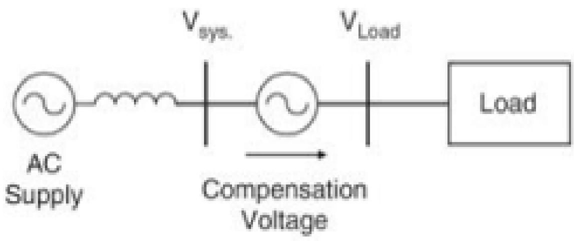

Fig-3 A voltage restorer: Series Active power Filter

Active power filters (APF) have proved to be effective for compensating nonlinear loads [8]. The shunt configuration has been the most studied topology, in which the APF is connected in parallel to the load. Its traditional use is the elimination of current harmonics produced by loads generating disturbances, known as harmonic current source (HCS) loads. However, parallel APF is not effective in situations where the load generates voltage harmonics, which are called harmonic voltage source (HVS) loads [9]. In this case, a series connection APF configuration has been proposed, and different control strategies have been tried out [8]. In any event, compensation systems composed only of an APF, whether in parallel or in series, do not completely solve the problem of harmonic elimination for all load types. To this end, other configurations have been proposed [10] that are combinations of series and parallel topologies with active and passive filters. These are called hybrid topologies.

Power Quality Mitigation:

This section describes some basic ways to reduce energy quality problems such as STATCOM, UPQC, and UPS. In general, SR is a traditional power system allows the system to compensate for unpredictability, inequality, and errors in load balancing and production. Spin reserve defined power generator to provide with a supply that exceeds its maximum capacity when additional torque is applied. With renewable energy, there is a way to measure this. This method of measuring renewable energy limits revealed a different approach , but it is not effectively provide satisfactory results.

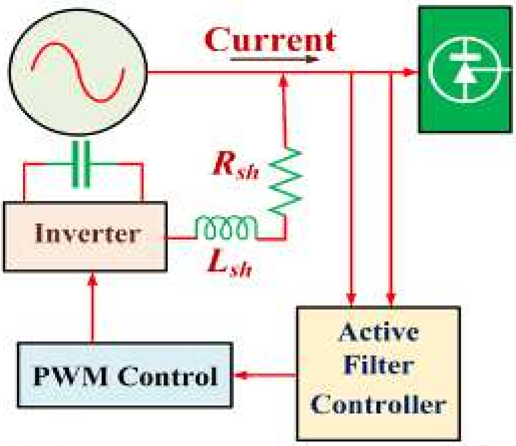

Fig-4 (a) System configuration of D-STATCOM with active filter and PWM controller

A shunted power device, D-Statcom compensates for the power factor and current harmonics, thereby improving energy quality. It also provides filtering, bus power control, and load balancing. Contains IGBT installed in shunt switch voltage source converter (VSC) and is sometimes referred to as an active power filter in PWM [11]. Called D-Statcom because it was installed on distribution area. IGBT, with high switching frequency, is mainly used to improve speed. Capacitors are used to store energy and the LC branch acts as a synthetic filter [12]. D-STATCOM cancels harmonics by injecting harmonic components produced at a load of 180 degrees outside the phase. D-STATCOM can also be used to compensate for inadequacies power factor.

Filter Design:

When an input filter is introduced to a dc-dc switch-mode power converter, the negative input impedance of the converter is thought to be the cause of instability [7]. A system that has an EMI filter terminated with negative impedance may be unstable, and the stability of such a system can be assessed using chain characteristics. We refer to this input system instability, as in [14]. It should be made clear that the instability of the input system, which is also brought on by the input filter, is not the instability of the converter caused by the loop-gain of the converter decreasing.

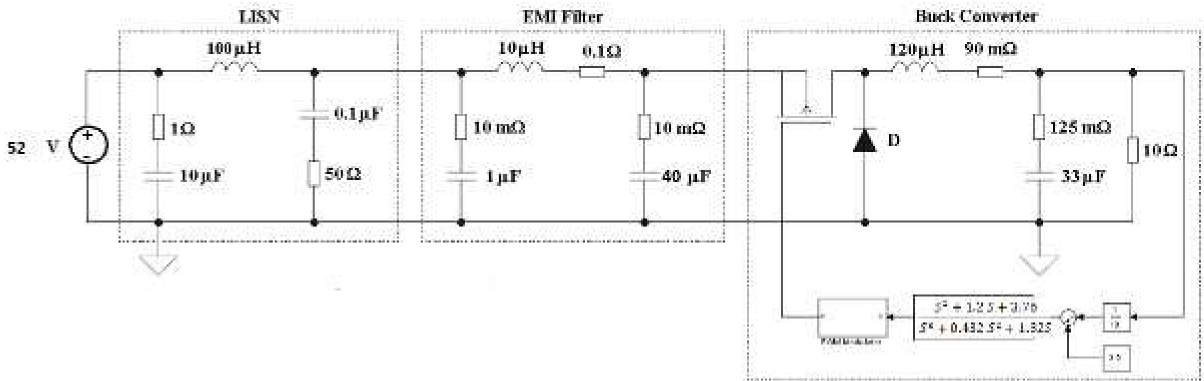

Fig-4 (b) The components of the VMC buck converter, the EMI filter and the LISN

There are different types of PQ failures in power systems. They fall into categories and their meaning is important in classifying the measurement results and defining electromagnetic events that can cause PQ problems. The categories can be divided as follows: Short-term fluctuations in energy b. Long-term voltage fluctuations c. Temporary occurrence d. Voltage asymmetry e. Waveform distortion f. Voltage fluctuations g. Frequency fluctuations of large pipelines.

Power Quality Costs Evaluation:
The costs associated with PQ disruption can be divided as follows: 1) Direct costs: Direct costs due to disruption. These costs include equipment damage, loss of productivity, loss of raw materials, cost of non-productive work, and re-start costs. Other savings can be made in less productive hours, such as:. Energy savings that must be deducted from the cost. Some interruptions do not mean shutdown, but other costs may be incurred, such as: B. Decreased device efficiency and reduced device life. 2) Overhead: It is very difficult to assess these costs. Due to some confusion and unproductive time, the company may miss some service delivery dates and may lose future orders. Investing to avoid energy quality issues can be considered normal. 3) Invisible interruptions: Other interruptions caused by power outages cannot be financially demonstrated. The only way to describe this disorder is to set a price that consumers are willing to pay to avoid this disorder [13]. Confusion is a PQ problem that has a very important impact on the environment. Table II summarizes the average cost of short-term disruption for different types of consumers. Estimated costs do not include large technological investments to empower riding skills to handle the turmoil.

Table-1 Mitigation of Power Quality Issue

Parameters	With STATCOM and filter	Without STATCOM and filter	Without STATCOM and with filter
THD	0.7953	.7235	0.568
Voltage(rms)	0.566	0.2644	0.264
Frequency	50.06	50.01	50.06

Result: The different results have been shown with and without a filter, with and without STATCOM to mitigate the power quality issues explained above. Figure 5 depicts the power supply's DC equal wind output voltage with filter and STATCOM, grid voltage, and THD These have been shown in figs. 6 and 7 respectively.

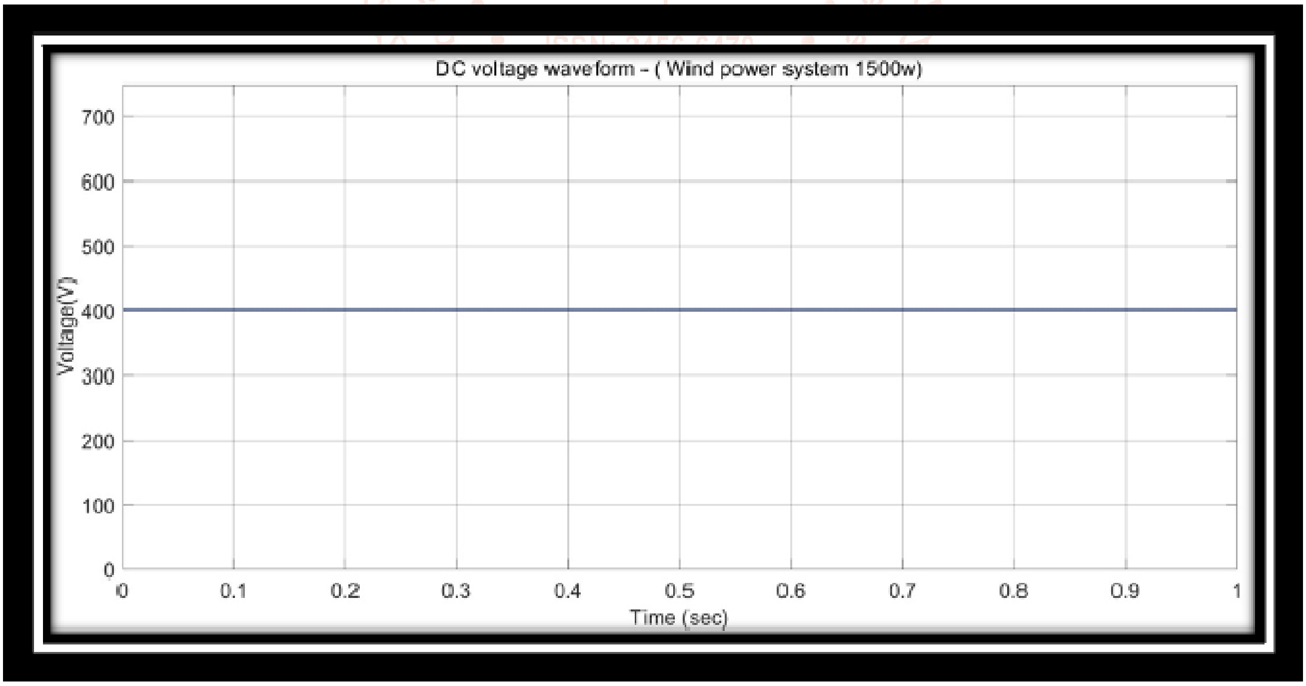

Fig- 5 wind voltage with filter and STATCOM

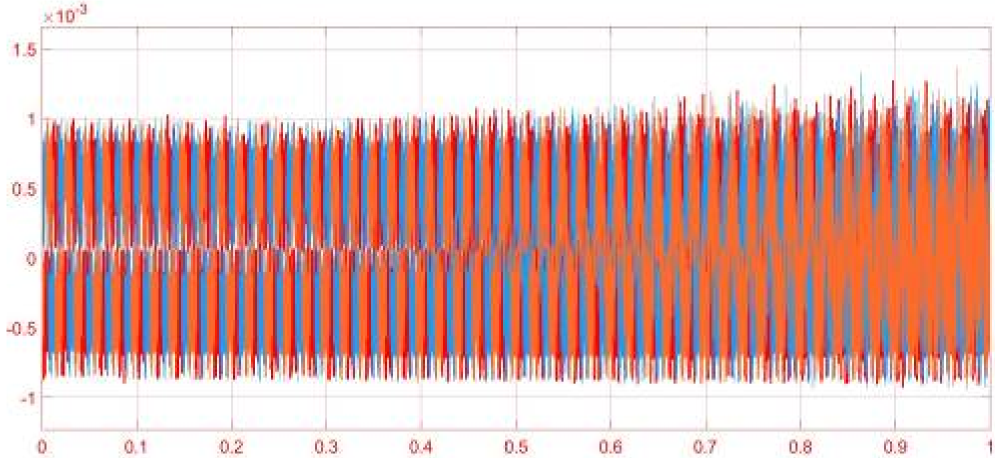

Fig-6 Grid voltage (Perunit) with filter and STATCOM

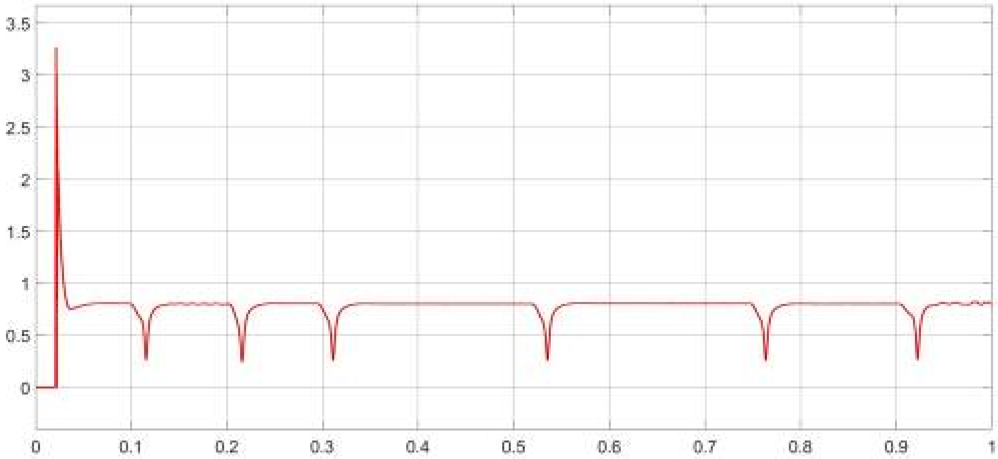

Fig-7 THD in Power supply with filter and STATCOM

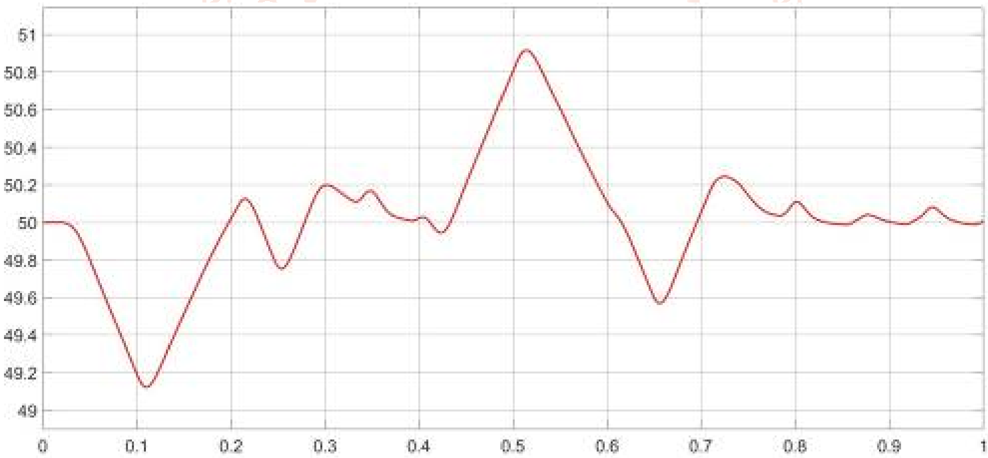

Fig-8 Grid frequency without filter and STATCOM

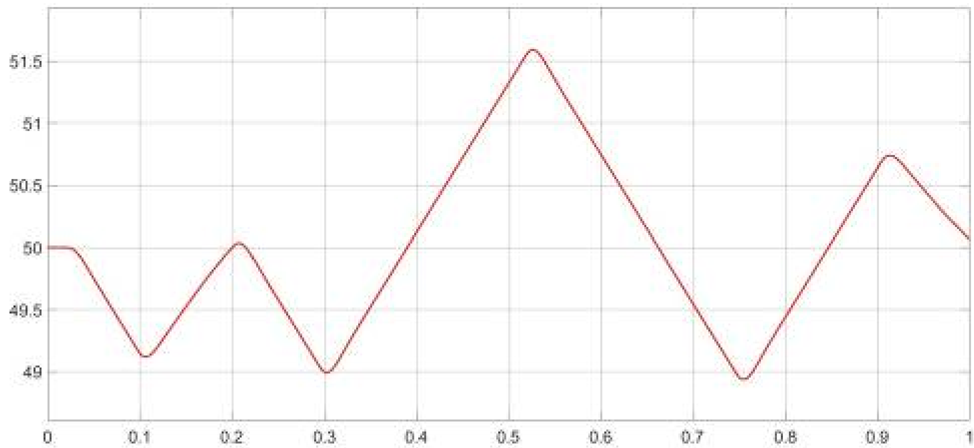

Fig-9 Grid frequency with filter and STATCOM

Conclusion:

In this paper, we have examined in detail the indicators of energy quality and mitigation measures. The causes of power quality problems extend to unbalanced power supply and unacceptable voltage. The line frequency varies, causing distortion of current waves and sinusoidal voltage. Reduction technologies such as regular power supply, the implementation of available power supply devices, var static compensation filters, stand-up thyristor-powered switches, power storage systems, flexible AC transmission systems, transformers, etc. Power quality indicators are fully extended to low, low voltage. voltage, voltage spikes, voltage expansion, flicker, frequency conversion, overvoltage termination, and harmonics.

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