DYNAMIC VOLTAGE RESTORER WITH UCAP, SOLAR (HYBRID SYSTEM) FOR IMPROVEMENT POWER QUALITY OF THE DISTRIBUTION GRID

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Abstract : In this paper, Now-a-days integration of energy storage technologies into the power grid is becoming a reality with the advent of the smart grid. One among the major applications is Dynamic Voltage Restorer (DVR), it is a custom power device to guard sensitive loads against voltage disturbances such as voltage sag and voltage swell, both considered to be important parameters of power quality. In hybrid system with DVR under neural networks concepts explaining the Power transfer capacity and Power quality profile improvement in the Power systems. And reduce the Power quality problems such as Harmonics and voltage distortion. The validation of the proposed operation is done by MATLAB simulation.

IndexTerms : Dynamic Voltage Restorer (DVR), Hybrid system, Energy, Storage Integration, DC–DC Converter, Sag/Swell, Ultra capacitor (UCAP).

I. INTRODUCTION

Power quality is a major cause of concern in the industry and it is important to maintain good power quality on the grid. Therefore, there is renewed interest in power quality products like the dynamic voltage restorer (DVR) and the active power filter (APF). The topology which resulted after the integration of dynamic voltage restorer (DVR) and active power filter (APF) through a back-back inverter topology was termed as a unified power quality conditioner (UPQC). DVR prevents sensitive loads from experiencing voltage sags/swells and APF prevents the grid from supplying non sinusoidal currents when the load is nonlinear. The concept of integrating the DVR and APF through a back– back inverter topology was first introduced in and the topology was named as unified power quality conditioner (UPQC). The design goal of the traditional UPQC was limited is paper, energy storage integration into the power conditioner topology is being proposed, which will allow the integrated system to provide additional functionality. With the increase in penetration of the distribution energy resources (DERs) like wind,

Solar, and plugin hybrid electric vehicles (PHEVs), there is a corresponding increase in the power quality problems and intermittencies on the distribution grid in the seconds to minutes time scale . Energy storage integration with DERs is a potential solution, which will increase the reliability of the DERs by reducing the intermittencies and also aid in tackling some of the power quality problems on the distribution grid.

Hydro power generation is restricted to geographically suitable areas, and reserves of coal, although presently plentiful, are not renewable. But to assist in keeping electrical supply in many of our societies, seems likely that an increasing nuclear power presence, involving breeder and possibly fusion reactors, will be tolerated. In renewable energy wind is mostly important. Wind farm is a receiving device which the energy wants to be special conditions to work properly. The variable speed directly connected to the grid wind farm is the mostly in use. Disconnection of wind farms can originate by systems faults. Dynamic voltage restorer is a custom power device which removes voltage power quality problems such as sag, swells, etc.

Applications where energy storage integration will improve the functionality are being identified, and efforts are being made to make energy storage integration commercially viable on a large scale. Smoothing of DERs is one application where energy storage integration and optimal control play an important role. Super capacitor and flow battery hybrid energy storage system are integrated into the wind turbine generator to provide wind power smoothing, and the system is tested using a real-time simulator. Super capacitor is used as auxiliary energy storage for photovoltaic (PV)/fuel cell, and a model-based controller is developed for providing optimal control. a battery energy storage system-based control to mitigate wind/PV fluctuations is proposed.

Multi objective optimization method to integrate battery storage for improving PV integration into the distribution grid is proposed theoretical analysis is performed to determine the upper and lower bounds of the battery size for grid-connected PV system's-based control rule is proposed to optimize the battery discharge while dispatching intermittent renewable resources. Various types of rechargeable energy storage technologies based on superconducting magnets (SMES), flywheels (FESS), batteries (BESS), and ultra capacitors (UCAPs) are compared in for integration into advanced power applications such as DVR.

Efforts have been made to integrate energy storage into the DVR system, which will give the system active power capability that makes it independent of the grid during voltage disturbances.

In this Current work Hybrid systems that are wind and solar sources are connected with DVR. The input supply give from wind farm to the transmission line. This Transmission line has three phase transformer for voltage level change. When the input supply give to the transmission line by Wind farm the voltage level will changes depends upon the voltage level through the transmission line. This voltage level has sudden reduction or sudden increase, this voltage is given to the DVR unit which has Controller, Ultra Capacitor (UCAP), Inverter and semiconductor. The unbalanced voltage level given to the Controller this gives the balanced voltage values to the power transmission line.

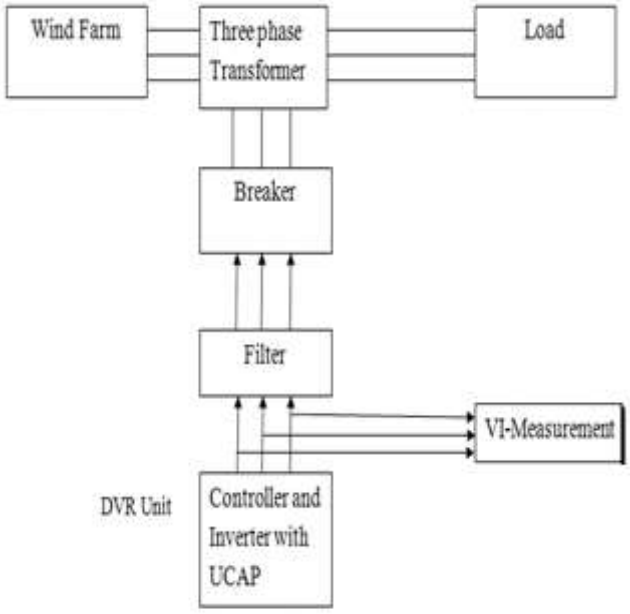

Fig.1. Block Diagram of Proposed System.

II. DC- AC CONVERTER

Electrical device that converts direct current (DC) to alternating current (AC); the converted AC can be at any required voltage and frequency with the use of appropriate transformers, switching, and control circuits.

A. Power Quality

Power quality is defined as the concept of powering and grounding sensitive equipment in a matter that is suitable to the operation of that equipment. There are many different reasons for the enormous increase in the interest in power quality. Some of the main reasons are:

1.Electronic and power electronic equipment has especially become much more sensitive. Equipment has become less tolerant of voltage quality disturbances, production processes have become less tolerant of incorrect of incorrect operation of equipment, and companies have become less tolerant of production stoppages. The main perpetrators are interruptions and voltage dips, with the emphasis in discussions and in the literature being on voltage dips and short interruptions. High frequency transients do occasionally receive attention as causes of equipment malfunction.

2. Equipment produces more current disturbances than it used to do. Both low and high power equipment is more and more powered by simple power electronic converters which produce a broad spectrum of distortion. There are indications that the harmonic distortion in the power system is rising, but no conclusive results are obtained due to the lack of large scale surveys.

3. The deregulation of the electricity industry has led to an increased need for quality indicators. Customers are demanding, and getting, more information on the voltage quality they can expect.

4. Also energy efficient equipment is an important source of power quality disturbance. Adjustable speed drives and energy saving lamps are both important sources of waveform distortion and are also sensitive to certain type of power quality disturbances. When these power quality problems become a barrier for the large scale introduction of environmentally friendly sources and users‟ equipment, power quality becomes an environmental issue with much wider consequences than the currently merely economic issues.

III. POWER QUALITY TERMINOLOGY

DSTATCOM: means Distribution Static Compensator. STATCOM is a static VAR generator, whose output is varied so as to maintain or control specific parameters of the electric power system.

SAG: is a decrease in rms voltage or currents to between 0.1 to 0.9 p.u at the power frequency for duration of time from 0.5 cycles to 1 minute.

Balanced Sag: is an equal drop in the rms value of voltage in the three-phases of a three-phase system or at the terminals of three-phase equipment for duration up to a few minutes.

Voltage dip : is sudden reduction in the supply voltage by a value of more than 10% of the reference value, followed by a voltage recovery after a short period of time.

Unbalanced Fault : is a short circuit or open circuit fault in which not all three phases are equally involved.

Voltage Tolerance : it is the immunity of a piece of equipment against voltage magnitude variations (Sags, Swells and Interruptions) and short duration over voltages.

Duration (of Voltage Sag) : it is the time during which the voltage deviates significantly from the ideal voltage.

Critical Distance: is the distance at which a short circuit fault will lead to a voltage sag of a given magnitude for a given load position.

Current Disturbance: it is a variation of event during which the current in the system or at the equipment terminals deviates from the ideal sine wave.

Voltage Disturbance: it is a variation of event during which the voltage in the system or at the equipment terminals deviates from the ideal sine wave.

Power Quality: it is the study or description of both voltage and current disturbances. Power quality can be seen as the combination of voltage quality and current quality.

Interruption : is the voltage event in which the voltage is zero during a certain time. The time during which the voltage is zero is referred to as the "duration" of the interruption. (OR) A voltage magnitude event with a magnitude is less than 10% of the nominal voltage.

Over Voltage : is an abnormal voltage higher than the normal service voltage, such as might be caused from switching and lightning surges. (OR) Abnormal voltage between two points of a system that is greater than the highest value appearing between the same two points under normal service conditions.

Under Voltage : is a voltage event in which the rms voltage is outside its normal operating margin for a certain period of time. (OR) A voltage magnitude event with a magnitude less than the nominal rms voltage, and a duration exceeding 1 minute.

Swell : it is a momentary increase in the rms voltage or current to between 1.1 and 1.8pu delivered by the mains, outside of the normal tolerance, with a duration of more than one cycle and less than few seconds.

Recovery Time : is the time interval needed for the voltage or current to return to its normal operating value, after a voltage or current event.

Fault : is an event occurs on the power system and it effects the normal operation of the power system.

Voltage Fluctuation: is a special type of voltage variation in which the voltage shows changes in the magnitude and/or phase angle on a time scale of seconds or less. Severe voltage fluctuations lead to light flicker.

IV. A. Voltage Source Converters (VSC)

A voltage-source converter is a power electronic device, which can generate a sinusoidal voltage with any required magnitude, frequency and phase angle. Voltage source converters are widely used in adjustable-speed drives, but can also be used to mitigate voltage dips. The VSC is used to either completely replace the voltage or to inject the „missing voltage". The „missing voltage" is the difference between the nominal voltage and the actual.

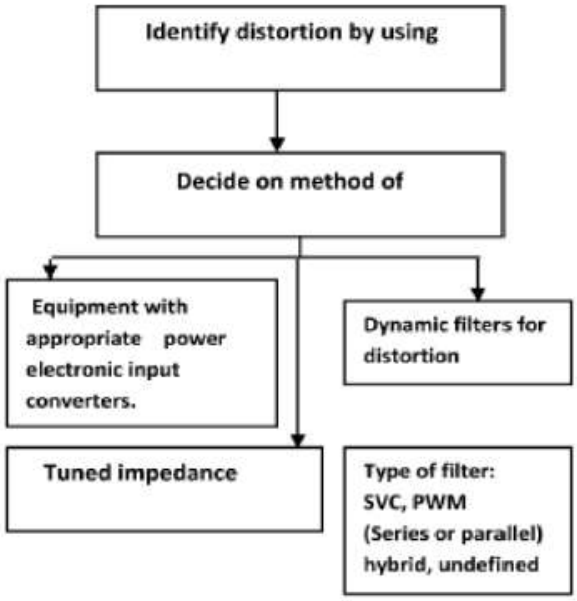

Fig.2. Improving power quality by distortion.

B. PRINCIPLES FOR IMPROVING POWER QUALITY

From the discussion already presented, it is evident that for improving power quality, the steps given in the following Fig.4 have to be taken. As also pointed out, the appropriate decomposition of power for purposes of both identification and control of the distortion elimination by filters has to be achieved. Since it is essential to use clear and consistent terminology, the term non-active power filter will be used for equipment that eliminates non-active power. The actual types of these filters are to be discussed in a further chapter of this paper.

Elimination: The non-active power filters to be used can be divided into the classes of input converters, dynamic filters and tuned impedance filters. To improve the power quality, some devices need to be installed at a suitable location. These devices are called custom power devices, which make sure that customers get pre specified quality and reliability of supply.

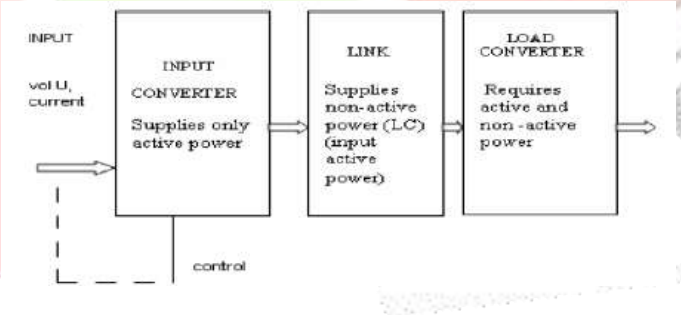

Fig.3. Principle of input converter to eliminate distortion loads on the power network.

V. SIMULATION DIAGRAM OF THE PROPOSED SYSTEM

This Present work simulation model is shown in figure.4. The Current system was done by Matlab Simulation and the output waveform was studied. This closed loop system having three phase supply which is given to the three phase transformer from Wind farm which act as Source. Here the unbalanced voltage level balanced by the DVR whose connected with Hybrid system.

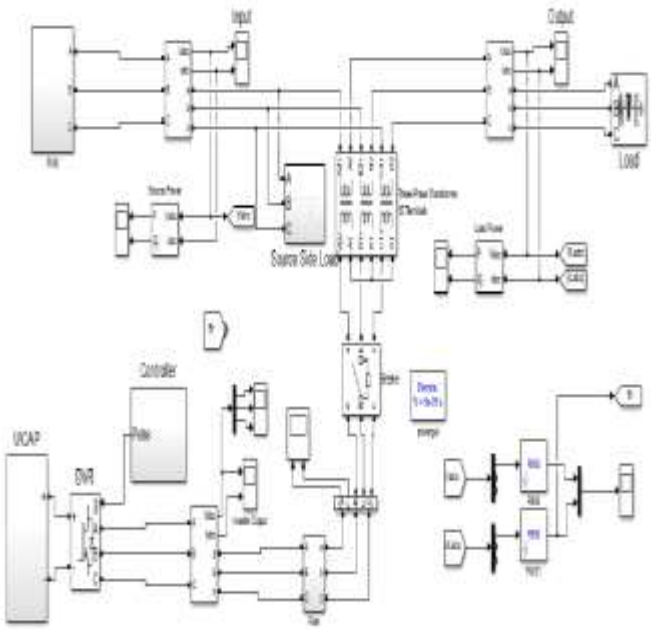

Fig.4. Simulation Diagram of the Proposed System

Dynamic Voltage Regulator: Increasing the use of electronic and non linear load can cause error function on sensitive devices, because of this various power quality problems such as sag/swell, harmonics and voltage distortion are occurs. From these problems the systems becomes unbalanced voltage level. For overcome this Power quality issues various devices are used. But all among the Dynamic Voltage restore mitigate and solve the problems in the distributed load in sensitive devices.

Ultra Capacitor: UCAP means Ultra Capacitor while electrochemical capacitor having high storage sense with lower voltage limits and also its rechargeable one. Here the voltage generated from Dynamic Voltage Restore was stores in this Capacitor.

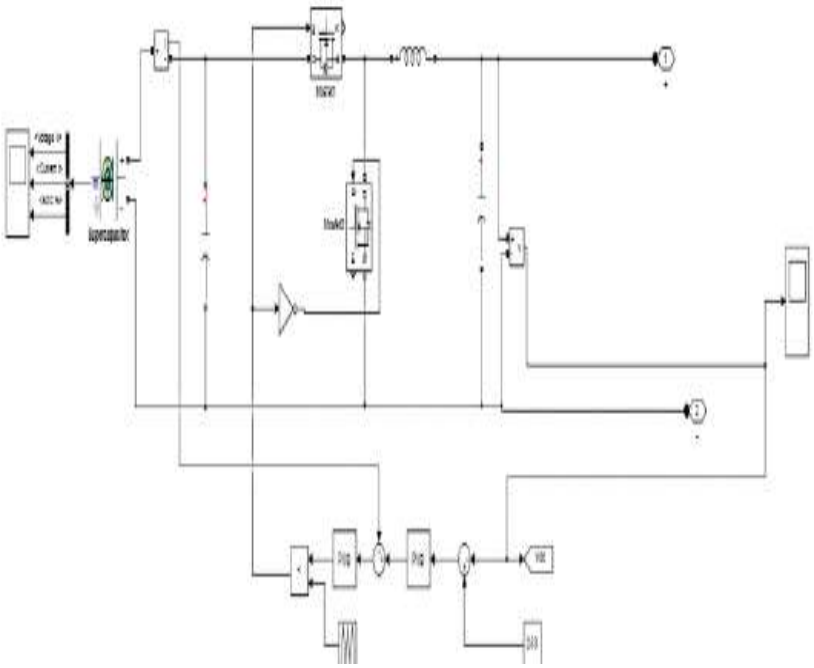

Fig.5. UCAP structure.

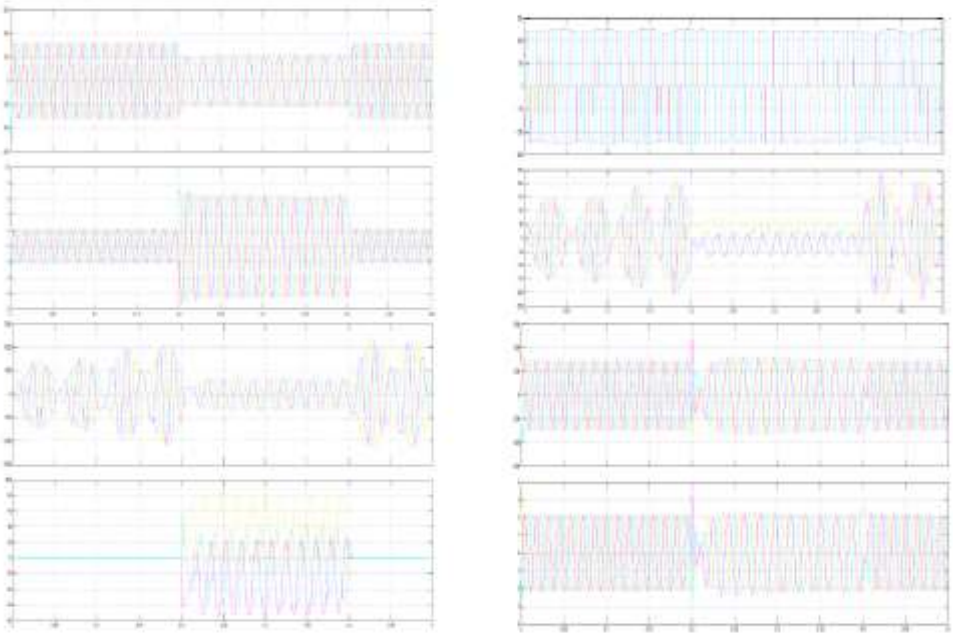

Fig.6. Matlab simulation Output waveform.

Comparison of Existing and Proposed Method:

In the Previous System, the PV solar farm is utilized with STATCOM, for balancing voltage level in the transmission line, thereby improving power quality and increasing grid connectivity. (But Compare to PI controller the DVR reduce Power quality problem and improve the power systems performance.

Comparison between Solar with STATCOM and Solar with SSSC:

Compared with PI controller SSSC gives effective way to improving the Voltage Profile.STATCOM is a shunt connected device it needs extra switches. But SSSC is a Series Controller impacts the driving and hence controls the current in power flow directly. This SSSC is more powerful than STATCOM .Compare to STATCOM, the SSSC give the highly Improved Power Quality, Power transfer capacity and voltage profile

Comparison between Solar with SSSC and Solar with DVR:

Comparing with SSSC the DVR gives better Performance.DVR is Series Compensation for find and control the voltage unbalanced level. Also comparing with SSSC the DVR is flexible, fast and efficient solution for voltage unbalanced level. DVR restoring line Voltage to its nominal value within few milliseconds

Comparison between Solar with DVR and Hybrid System with DVR:

Hybrid systems give more efficient solution compare to single renewable source. Comparing with all above systems this Hybrid system with DVR improves power quality in the power system.

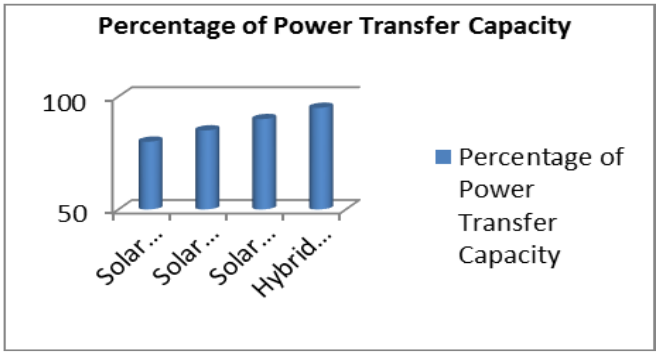

Fig.7. Percentage of power transfer capacity of various systems

This proposed system also avoiding any Power disruption to the load. Figure.7, shows that Percentage of power transfer capacity of various systems. On comparing this all Hybrid system with DVR give above 90% of Power transfer capacity than other systems

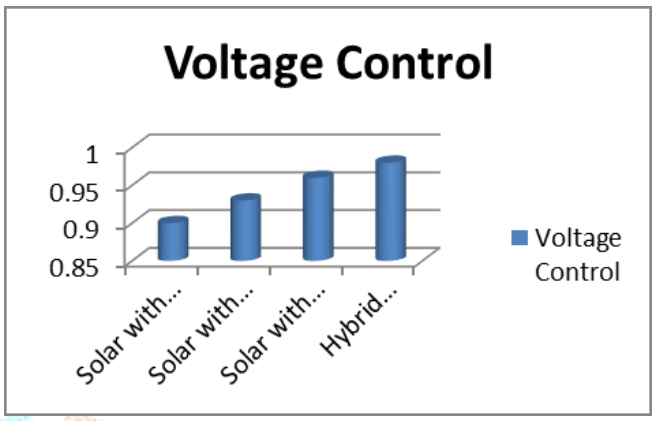

Fig.8. Voltage controls of various systems.

Figure.8, shows that Voltage control of various systems. On comparing this all Hybrid system with DVR give better voltage control than other systems. DVR with Hybrid systems give better voltage profile. And also it avoids any power disruption to the load.

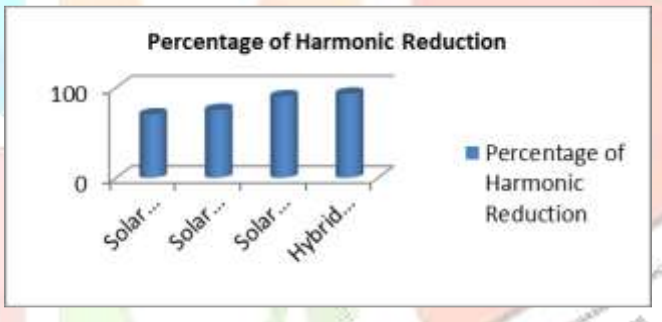

Fig.9. Percentage of Harmonic reduction of various systems

Figure.9, shows that Percentage of Harmonic reduction of various systems. Comparing this all, Hybrid system with DVR gives above 90% of Harmonic reduction than other systems. So this system reduces the Power quality Problems in the transmission line.

VI. CONCLUSION

In this paper, the concept of integrating UCAP-based rechargeable energy storage to a power conditioner system to improve the power quality of the distribution grid is presented. With this integration, the DVR portion of the power conditioner will be able to independently compensate voltage sags and swells and the APF portion of the power conditioner will be able to provide active/reactive power support and renewable intermittency smoothing to the distribution grid.

Hybrid power generation system gives effective power generation compare to conventional energy resources. Hybrid power generation with DVR gives better Performance and has greater efficiency. DVR helps to improve power quality in the power system as very faster and effectively. Result of the proposed controls power transmission capacity, Voltage profile, and Power quality are improved. Then also Harmonics, voltage distortion are reduced.

Comparing the existing system the capacity of power transfer is 80% only. But in propose system capacity of power transfer is above 90%.Voltage control of proposed system is better than existing system. Then the Harmonic reduction of existing system is below 80%. But in proposed system gives above 90% of harmonics reduction.

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