JES
Journal of Engineering Sciences

Vol 13, Issue 02, FEB /2022
ISSN NO: 0377-9254

VOLTAGE SAG MITIGATION IN ON-GRID HYBRID POWER SYSTEM USING BATTERY AND SMES BASED MULTI LEVEL DYNAMIC VOLTAGE RESTORER

D.ANIL KUMAR PG scholar, Dept of EEE, TKR COLLEGE OF ENGINEERING & TECHNOLOGY
Mrs. V. SWARUPA, Associate Professor, Dept of EEE, TKR COLLEGE OF ENGINEERING & TECHNOLOGY

ABSTRACT

In conventional power systems, the intensity of sensitive loads is rising day by day, as a consequence, power quality problems are becoming more significant in the contemporary world. It has been discovered and recorded that there are extreme power quality concerns such as voltage swell, voltage sag, harmonics and flicker, amongst others. As a result, by injecting voltage into the system, the DVR is able to prevent voltage sag from occurring. Issues with power quality develop as a consequence of the introduction of various non-linear loads into the power grid, such as diode bridge rectifiers and variable speed drives. In order to restore voltage to the output terminals of a load, the DVR is the most effective approach available. Whenever the supplied voltage's quality degrades this phenomenon happens. When a grid-connected PV-wind hybrid power system is simulated, it is discovered that the voltage fluctuation increases significantly. The key reasons for taking variation into consideration are the occurrence of faults and the non-stable generation of electricity from renewable energy sources. The compensation plan employed in this project a pre-sag compensation strategy, which is discussed in detail, along with the control and operational principles that govern it. Under balance mode circumstances, the DVR can adjust for voltage variations while maintaining the rated load voltage as a consequence of an appropriate injection of voltage in series with the grid voltage. In order to maintain the load voltage constant while injecting voltage with sufficient control over the magnitude and phase angle, an unique inverter architecture is being developed with the purpose of minimising voltage disturbances at the load voltage. Among the topics covered in this project the design and analysis of voltage sag reduction in on-grid hybrid power systems that employ batteries and SMES-based multilevel dynamic voltage restorers. In order to implement the proposed converter simpower system, the recommended circuit design is simulated and carried out in MATLAB SIMULINK.

INTRODUCTION

The Increasingly crucial in today's world as the intensity of sensitive loads in power systems grows on a daily basis, power quality problems are becoming more prevalent. It has been discovered and recorded that there are extreme power quality concerns such as voltage swell, voltage sag, harmonics and flicker, amongst others. When there are problems on the load or supply side, inappropriate operation (e.g., when an electrical motor starts up or when an electric heater comes on) or a combination of these factors, the voltage drops.

As a result, by injecting voltage into the system, the DVR is able to prevent voltage sag from occurring. Many nonlinear loads, including as diode bridge rectifiers, adjustable speed drives (ASD), switched mode power supplies (SMPS), laser printers, and other similar devices, have been introduced into the system, resulting in power quality difficulties, among other things.

In the preceding section, it was stated that voltage sag is defined as a drop in RMS voltage from 0.1pu to 0.9pu over a short period of time, often 0.5 to a few cycles. When a voltage drop of 40 % to 50 % of the rated voltage happened for less than 2 seconds or less, issues arose in the majority of situations in distribution systems. Because the power quality concerns stated above have an influence on sensitive loads, it is critical to minimise the implications of these difficulties. Aside from that, new power electronic devices, referred to as customised power devices, are being developed for specific applications. Devices such as the distribution static compensator (D-STATCOM), the universal power quality conditioner (UPQC), and the dynamic voltage restorer are examples of this kind of technology (DVR)For the DVR, the dq0 transformation or the Park transformation are used to set the controller's parameters. This approach will also provide information on the phase shift, in addition to giving information on the depth of a voltage drop and phase shift with regard to the starting point and end point of a voltage drop, when used in conjunction with a voltage drop..

LITERATURE REVIEW

M. R. Banaei and S. H. Hosseini, “Verification of a new energy control strategy for dynamic voltage restorer by simulation,” vol.14, pp. 112–125, 2006. In order to compensate voltage sag it is possible to use dynamic voltage restorer (DVR) in distribution system for a sensitive load. In this paper the control strategies for the compensation of the supply voltage sag is presented. In addition, a new concept of restoration technique is proposed to inject minimum energy in unbalance sags. Proposed control method makes zero injection power during shallow sag and controls DVR so that injection of power is minimized during deep sag. The proposed method can minimize the injected active power of DVR for a specific apparent power.

H. M. Al-masri, and M. Ehsani,, “Feasibility Investigation of a Hybrid On-Grid Wind Photovoltaic Retrofitting System,” IEEE Trans. Ind. Appl., vol. 52, no. 3, pp.1979–1988, 2016. This paper investigates the feasibility of wind-PV penetration into an existing utility grid system for Ibrahimyya city in Jordan. Ibrahimyya is selected because it enjoys both high annual wind speed of 7.27 m/s and high annual solar radiation of 6.05 kWh/m2 /day. Two sizing methods are presented using MATLAB and Hybrid Optimization Multiple Energy Resources softwares. A stepby-step analysis of the proposed system is presented. . A sensitivity analysis on interest rate, inflation rate, wind power law exponent, annual average daily energy demand and fuel price are implemented to assess the robustness of the system. The results prove the feasibility to apply the proposed Hybrid Wind-PV system for this city. The same procedure can be applied anywhere.

Soeren Baekhoej Kjaer, et al A review of single-phase grid-connected solar module inverters” Review of Single-Phase Grid-Connected Photovoltaic Module Inverters is presented. Inverter methods for connecting photovoltaic (PV) modules to a single-phase grid are the subject ofthis study. The inverters are classified into four categories: 1) the number of power processing stages in cascade; 2) the kind of power decoupling between the PV module(s) and the single-phase grid; 3) whether or not they use a transformer (line or high frequency); and 4) the type of grid- connected power stage.

S. B. Supported, A. M. Gee, F. Robinson, and W. Yuan, “A Superconducting Magnetic Energy Storage- Emulator/Battery Supported Dynamic Voltage Restorer,” This paper presents the comprehensive review and discussion on DVR to enhance power quality at grid and industrial competence. Modern developments and different topologies of DVR have been discussed by focusing on their advantages and advantages. Different control strategies and functioning of compensation methods for power quality enhancement by mitigating the power quality issues using DVR has been discussed. With this review it is been concluded that DVR are beneficial in voltage Sag mitigation and other voltage related power quality issues.

PROBLEM IDENTIFICATION

Everyday there is an increase in the intensity of sensitive loads in conventional power systems, so the power quality issues play a vital role in the current days. There are extreme power quality problems mentioned as voltage swell, voltage sag, harmonics, flicker etc. Voltage sag

Vol 13, Issue 02, FEB /2022
ISSN NO: 0377-9254

generally origin from the faults on load or supply side, maloperation, electrical motor startup, electrical heaters turning on, etc. So the DVR is mitigating the voltage sag through injecting the voltage.

PROPOSED SYSTEM SIMULATION

Power quality problems are affected due to the appearance of various non-linear loads such as diode bridge rectifiers, adjustable speed drives. DVR is the perfect solution for restoring the load voltage at output terminals. When, the quality of source voltage is disturbed.

The fluctuation consideration is mainly due to the non-stable power output of renewable energies and fault conditions. The compensation strategy used in this project is a pre-sag compensation and it is presented in detail with its control and working principal. Renewable energy sources; which are abundant in nature and climate friendly are the only preferable choice of the world to provide green energy. The limitation of most renewable energy sources specifically wind and solar PV is its intermittent nature which are depend on wind speed and solar irradiance respectively and this leads to power fluctuations.

To compensate and protect sensitive loads from being affected by the power distribution side fluctuations and faults, dynamic voltage restorer is commonly used. DVR compensate the voltage sag with an appropriate injection of voltage in series with grid voltage, in order to maintain the rated load voltage with balance mode condition. The power quality improvement is main criteria from the customer side. Generally, the power quality issues is more concentrated about transmission current, voltage or frequency deviation which also causes the failure of power station. For solving the power quality problem a new method. Aside from that, new power electronic devices, referred to as customized power devices, are being developed for specific applications. Devices such as the distribution static compensator (D-STATCOM), the universal power quality conditioner (UPQC), and the dynamic voltage restorer are examples of this kind of technology (DVR). In order to restore voltage to the output terminals of a load, the DVR is the most effective approach available. Whenever the supplied voltage's quality degrades, this phenomenon happens. Under balance mode circumstances, the DVR can adjust for voltage variations while maintaining the rated load voltage as a consequence of an appropriate injection of voltage in series with the grid voltage.

This project more concentrate on the new strategy for controlling power known as Dynamic voltage restorer (DVR) has been implemented. The new concept presented here called 'Dynamic Voltage Restorer (DVR)'.In order to restore voltage to the output terminals of a load, the DVR is the most effective approach available. Whenever the supplied voltage's quality degrades, this phenomenon happens. Under balance mode circumstances, the DVR can adjust for voltage variations while maintaining the rated load voltage as a consequence of an appropriate injection of voltage in series with the grid voltage. Dynamic voltage restorer (DVRs) are generally made up of three components: an inverter, an injection transformer, and an energy-storing device. In order to maintain the load voltage constant while injecting voltage with sufficient control over the magnitude and phase angle, an unique inverter architecture is being developed with the purpose of minimising voltage disturbances at the load voltage.

Vol 13, Issue 02, FEB /2022
ISSN NO: 0377-9254

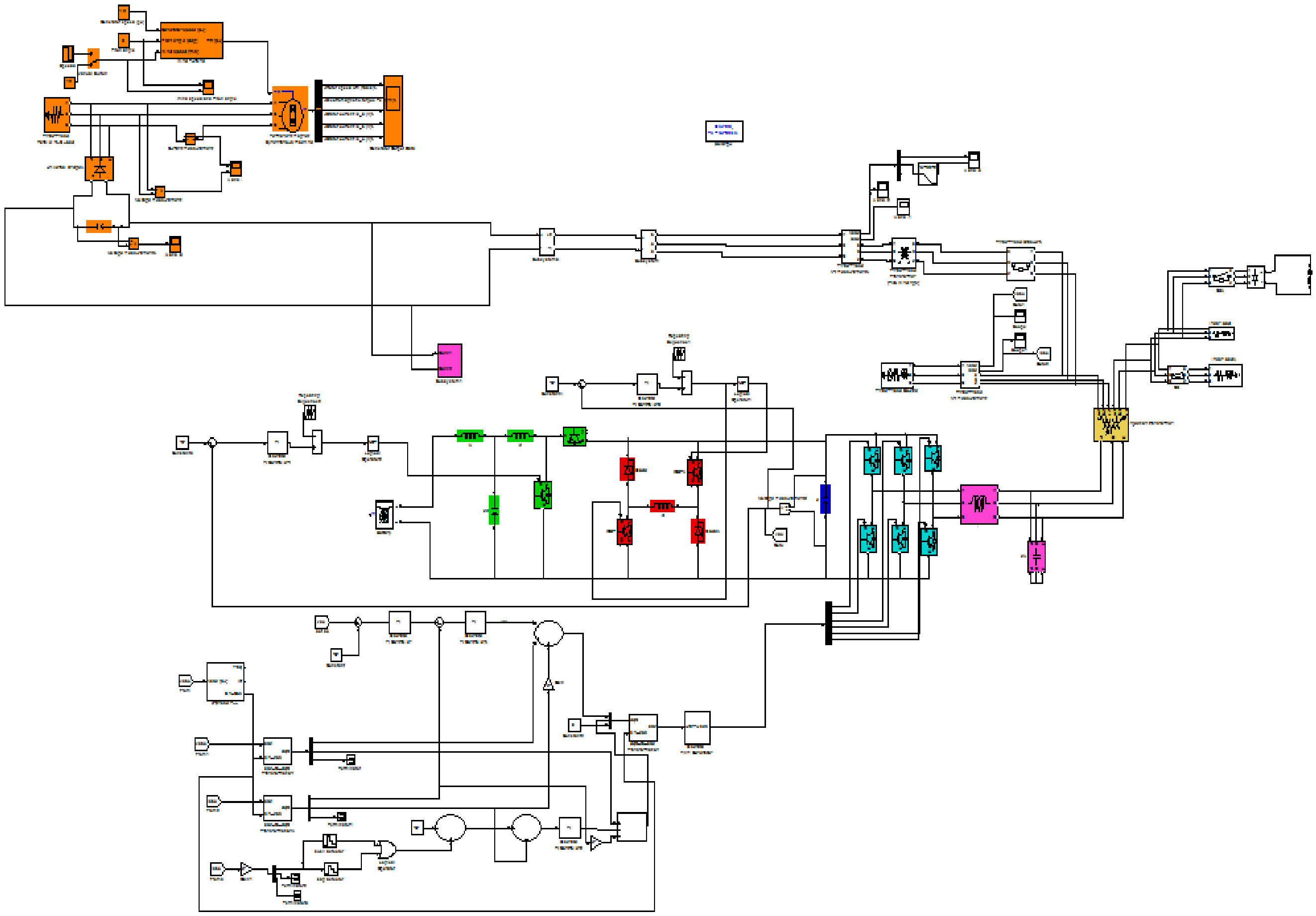

Fig 1 Total circuit configuration with existing controller

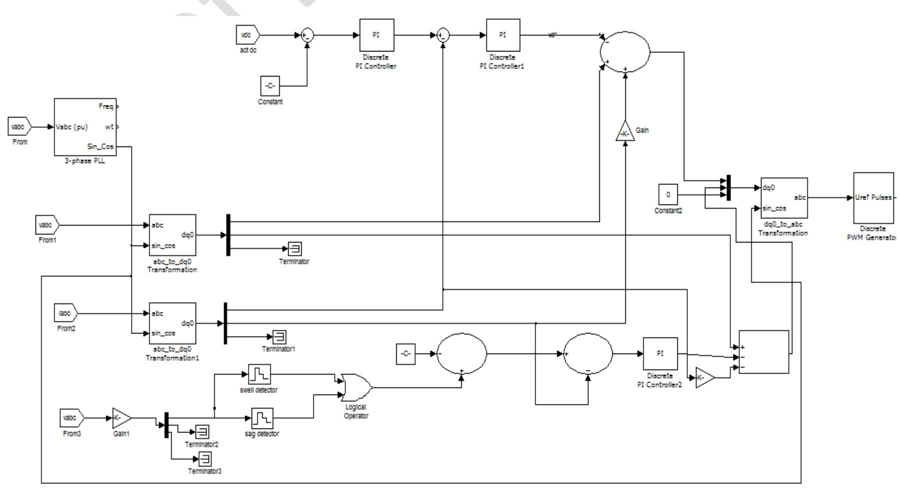

Fig 2 Simulink diagram for existing controller

Vol 13, Issue 02, FEB /2022
ISSN NO: 0377-9254

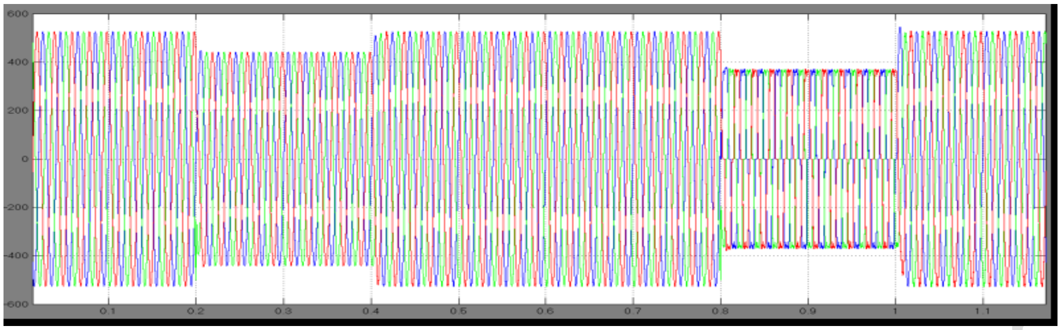

Fig 3 Voltage profile vs Time without DVR

During the time 0 to 0.2 secs the voltage is normal and there is no presence of voltgae harmonics but from 0.2 to 0.4 secs voltage harmonics reduces due to transition time. So the overall waveform of voltage profile vs time without DVR is shown in fig

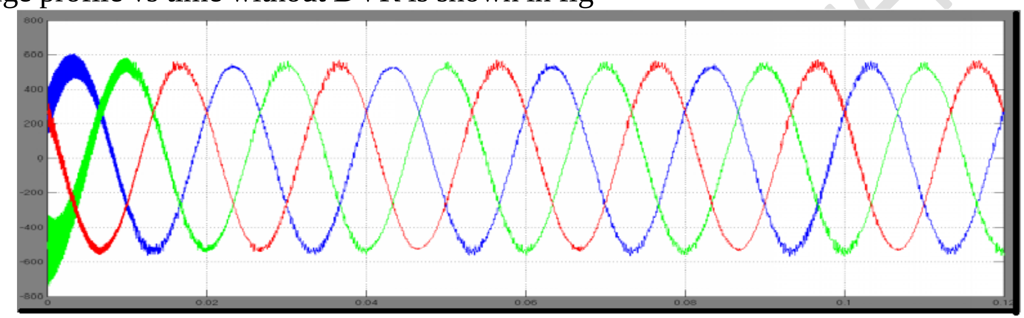

Fig 4 **Voltage profile vs Time with existing controller**

Here compare to without DVR the voltage harmonic content is reduced in existing DVR system. The voltage is mostly uniform with less harmonics. So the voltage profile vs time with existing controller is shown in fig

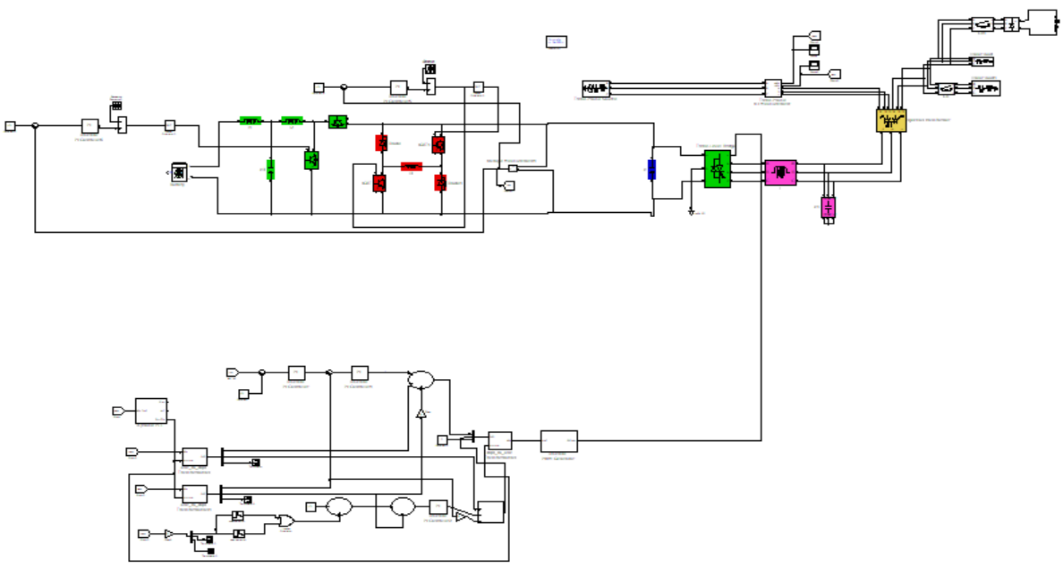

Fig 5 **Proposed controller configuration with ML-DVR**

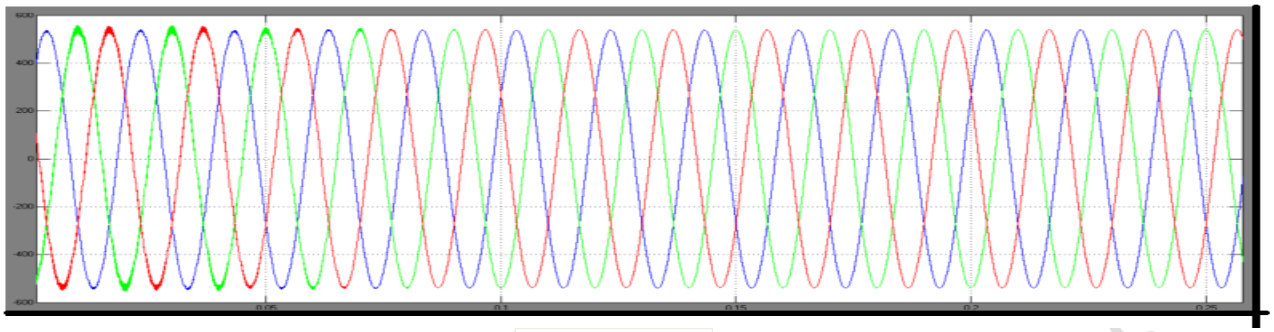

Fig 6 **Voltage profile vs time for proposed controller**

Here due to presence of ML-DVR the voltage harmonics are mostly reduced and the voltage is mostly uniform. So the wave forms for voltage profile vs time is shown in fig

S. No	Type of controller	Voltage THD (%)
1	**Without DVR**	**18.80%**
2	**With DVR**	**2.71%**
3	**With ML-DVR**	**0.80%**

Conclusion

The control system for the DVR has been investigated and is given. The control scheme is made up of separate controls for each converter in the system. In order to maintain the load voltage constant while injecting voltage with sufficient control over the magnitude and phase angle, an unique inverter architecture is being developed with the purpose of minimizing voltage disturbances at the load voltage. Among the topics covered in this project is the design and analysis of voltage sag reduction in on-grid hybrid power systems that employ batteries and SMES-based multilevel dynamic voltage restorers. The project also includes a case study. In order to implement the proposed converter sim power system, the recommended circuit design is simulated and inspected in MATLAB Simulink, The DVR model was created in the MATLAB/SIMULINK environment and then tested for accuracy.

REFERENCES

[1] BP Statistical Review of World Energy, 68th ed. 2019.
[2] M. R. Banaei and S. H. Hosseini, “Verification of a new energy control strategy for dynamic voltage restorer by simulation,” vol.14, pp. 112–125, 2006.
[3] IRENA, Future of wind: Deployment, investment, technology, grid integration and socio-economic aspects (A Global Energy Transformation paper). International Renewable Energy Agency, Abu Dhabi, 2019.

[4] IRENA, Future of Solar Photovoltaic: Deployment, investment, technology, grid integration and socio-economic aspects (A Global Energy Transformation: paper). International Renewable Energy Agency, Abu Dhabi, 2019.
[5] H. M. Al-masri, S. Member, M. Ehsani, and L. Fellow, “Feasibility Investigation of a Hybrid

On-Grid Wind Photovoltaic Retrofitting System," IEEE Trans. Ind. Appl., vol. 52, no. 3, pp.1979–1988, 2016.
[6] X. Xu, Z. Wei, Q. Ji, C. Wang, and G. Gao, "Global renewable energy development : In fl uencing factors , trend predictions and countermeasures," Resour. Policy, vol. 63, no. April, 2019.