Grid Interfaced Windfarm Using Dynamic Voltage Restorer for Power Compensation with Pv Fed Sepic Converter

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Abstract: In this paper, the wind energy generation farm is connected with the grid system. The dynamic voltage restorer (DVR) is installed to control the grid side’s under and overvoltage. The photovoltaic (PV) system is installed in the DVR system, and the voltage of the grid over and under voltages is also addressed to achieve the proposed system’s high efficiency. The grid voltage compensation is harvested from PV and injected through the DVR. In this system, the SEPIC converter is used to achieve high voltage gain from the PV plant to improve DC link capacitor voltage which is the inverter input source. The DVR based wind energy farm using PV with SEPIC system results are achieved in MATLAB/Simulink.

Keywords: PV array, DVR, SEPIC, Wind farm, Grid system.

1. Introduction
Because of the increment in the concerns of the global environment and the conventional depletion of power resources, the power generation of renewable sources is mostly preferred. [4] In recent years the wind energy-based power generation is highly preferred for electricity production growth [1]. PV based energy generation has preferred electricity generation because it has less cost in panels and utilization of power electronics devices. While using a sole generation of power in PV, the hybrid electrical energy generation system in which PV-wind system has offered more reliability to achieve the high improvement in the power production [2]. The additional merit in the hybrid system is that adding the PV panels in the free available space of wind turbine farms is effectively used for power generation. The system should be connected with the low voltage ride through or fault ride through operations to prevent the losses in power from the wind farm. [3] The above operations are also used to avoid and accomplish the grid system’s instability and to the immediate fault clearance, respectively [5].

The power quality (PQ) problems in the grid-connected system are mostly affected by the unsymmetrical voltages in the wind generation source. The unbalanced grid voltage directs current stator flow based on the negative sequence [8]. The wind farm's turbine and generator system are suffered due to the torque and power pulsations made by both negative and positive current flow, which is caused due to mechanical stress. The DVR system is proposed to compensate the under and overvoltage’s in the wind connected grid system to overcome these issues [10]. The shunt and series
compensators are investigated to protect the wind generators from such sag and swell disturbance. The shunt and series compensators are investigated. However, the DVR and STATCOM compensation are reliability considered series and shunt power injection to the grid for the fixed and variable speed wind system. [6] Mainly the wind farm stability is maintained by the quick recovery in the grid voltages from the sag and swell disturbances and controlled by means of DVR reactive power control [11]. In a wind farm, the DVR is used to protect the power generator from the voltage disturbances, but it remains idle when the grid is in normal conditions. The grid voltage compensation is harvested from PV and injected through the DVR. The boost converter is used in existing systems to improve the available power from PV [13]. The DVR system's input supply is achieved by the DC link capacitor voltage regulation fed by the PV arrays. Series compensation is done by the inverter, which is connected in series with the grid system. The PQ is improved by the DVR system in wind farm when protecting it from the grid PQ issues [7].

In this paper, the voltage disturbances in the grid voltages are mitigated using the DVR system, injecting the power in a grid with the series interfaced inverter. The control of the proposed system is to control the sag and swells. The SEPIC converter fed by the PV Array improves the DC link voltage, which is regulated using a controller [9].

2. Proposed System and control strategy
In this proposed system, the dynamic voltage restorer is installed at the wind farm connected grid system. The PQ problems are mitigated by using the PV fed SEPIC converter with the series-connected inverter compensation. The block diagram of the DVR device with the PV fed SEPIC converter is illustrated in Figure 1. The DC supply is fed to the conversion system to achieve the DC busbar voltage regulation's inverter power source. [12] The regulated supply is fed to the DVR system, which controls the disturbances voltages in the grid-tied wind farm. In the conventional systems, the normal DVR is used for the power system controlling of PQ problems. The proposed system having the PV array is integrated with the DVR to inject power to the grid system, and the injecting power is harvested from the renewable power sources. The various control modes are proposed to the grid voltages fluctuations and determining the PV energy. The power mitigates the sag and swells from the SEPIC converter, which accomplishes high power improvement and reliability. In existing systems, a boost converter is used. This paper consists of a SEPIC special converter is used, which is made of the semiconductor materials [14].

3. PV with SEPIC converter
The PV system generates DC supply from the sunlight, which is not sufficient for the grid-connected system compensation about the grid disturbances mitigation through the DVR device. Therefore, the power converter SEPIC, as shown in Figure 2 is utilized to increase the generated PV voltage, which
is stored in the parallel capacitor of inverter system that is injecting the power to grid system where the voltages are disturbed.

![SEPIC Converter Circuit Diagram](image)

**Figure 2: SEPIC Converter Circuit Diagram**

4. **Control System**
   The configuration of the proposed PV fed DVR system with the wind farm, which is interfaced with the grid system consists of a DC link voltage-based converter control and the power injecting inverter control. The regulation of the input supply can exchange the grid and DC link power. DC busbar voltage is enhanced to reach the required active power and generator voltage phase angle control. The converter is controlled using the MPPT control method for providing switching pulses to the SEPIC converter power switch. The inverter control is done by the double loop system, which effectively controls the PV fed DVR system dynamic responses. The inner loop controls the inverter current response, and the outer loop system controls the injecting grid system voltage. The sinusoidal PWM is used to achieve the reference grid voltage and PV power.

5. **Simulink model and result analysis**
   In this system, the DVR-based wind farm tied grid system voltage disturbances are controlled, as shown in Figure 3, which shows the proposed system's overall Simulink model. The generated wind energy is fed to the grid system through the distribution network. The grid voltages are disturbed, as shown in fig. 4. The DVR system is used to mitigate PQ's problem through the PV fed SEPIC converter system, which is achieving the high power from the PV system.

![Overall Simulink Model of Proposed Wind farm with grid system based DVR system](image)

**Figure 3: Overall Simulink Model of Proposed Wind farm with grid system based DVR system**
The PV input is 12V as illustrated in fig. 6 that supplied to the converter of SEPIC. Here, the DC link voltage is improved, 83V and fed to the inverter that is converting AC power.

Figure 4: Grid voltage sag

The inverter voltage is, as represented in Figure 8, injected in the grid distribution network to compensate for the PQ issues. The grid voltages' disturbances can be controlled and compensated in Figure 4 by using the PV-fed DVR system. Figure 5 represents Grid compensated voltage. Figure 7 shows the SEPIC Converter output voltage.

Figure 5: Grid Compensated voltage
Figure 6: PV input voltage

Figure 7: SEPIC Converter output voltage
Figure 8: Inverter voltage

6. Conclusion
The grid disturbed voltages are compensated using the proposed PV fed DVR system consisting of SEPIC converter-based PV array. The inverter system's input source is the DC link voltage capacitor, which achieves a high amount of sufficient power through the SEPIC converter. The proposed DVR fed by a PV system has accomplished the mitigation of the power quality issue in which the grid voltage disturbances are compensated successfully. The simulation results are verified using MATLAB/Simulink.

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