A Review on Dvr Based Voltage Sag Mitigation in Hybrid Power System

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***Abstract*—There is only one option for the globe to produce green energy: renewables that are plentiful in creation and environment. Wind energy photovoltaics (PV) have a limited capacity because of their variable renewable, which is dependent on wind velocity and illuminance, respectively. It is customary to utilise a dynamic voltage restorer (DVR) to adjust for electric supply variations and faults and safeguard sensitive loads. The goal of this study is to develop a grid-connected composite PV- wind power that can tolerate and smooth out voltage fluctuations. Battery- and SMES-based DVR is used to compensate in the event of voltage sag conditions in this way. The pre-sag replacement technique locks the instantaneously real-time saves it separately it so it can be utilised for payment of compensation of a perturbation. DVR responses for different voltage sags cases are considered and simulation results are carried out using MATLAB Software.**

***Index Terms*—BES-SMES based DVR, Voltage Sag mitigation, SOC (State of charge).**

I. INTRODUCTION

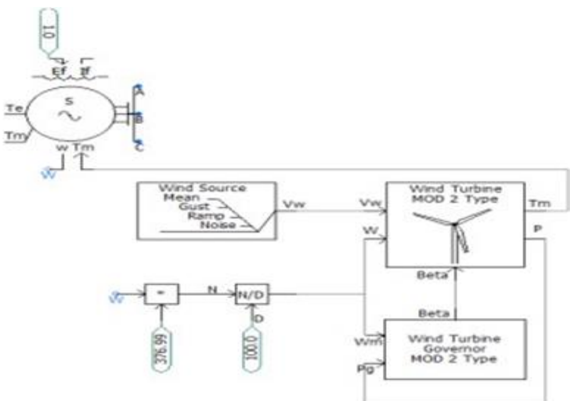
Our planet's consumption of energy climbed by 2.9 percent in the previous year, which is almost twice the average annual rise of 1.5 percent during the last 10 years [1]. [2] did a research study and found that from 2018 to 2050, the electricity consumption of commercial subsectors (carbon dense manufacturer, non-energy intensive mass production, plus non-manufacturing) would grow by 50% compared to 2018, based on the findings. Non-renewable fuel sources should not be used to meet this need because of their greenhouse gas emissions, limited supply, and volatile price. As a result, the future strategy for meeting overall energy needs should include appropriate usage of RES such as wind energy photovoltaic (PV) electricity.

As per the plan for aerobic respiration in 2050, wind and solar photovoltaic (PV) power sources will add 2.5% to GDP, expand employment by 70%, cut CO_2 emissions by that amount, and fulfil all of the country's energy needs at the lowest possible cost [3, 4]. Two-thirds of the energy in the world and it needs should come by Renewable energy sources (RES) since they are plentiful, environmentally friendly, economically viable, and widely accepted by the general public [5]. Countries aspire to rely more on renewables because of the environmental repercussions and connected difficulties of non-renewable energy sources [7].

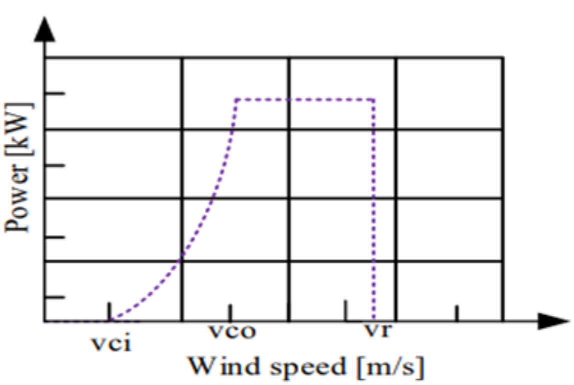
According to the study [3], [4], [8], [11], this will be the implementation of the 2050 road plan of the Environmental Working Group. To ensure that end-user power fluctuation issues are minimised as a result of its alternative power, the adoption of Alternative Energy Sources (RESs) has a bright future [12]. To put it another way: The intermittent nature is mostly attributable to meteorological factors like wind speed and sun irradiation. Corporate load patterns such as semiconductors production and process industries are very susceptible to external disturbances due to the evolution of microelectronics, and the users and the energy providers should consider such scenarios to be within the prescribed limit. So series type custom power device like dynamic voltage restorer (DVR) is the most effective one regarding to cost for this task.

II. THE GRID CONNECTED PV-WIND HYBRID POWER SYSTEM:

It is a potential electrical energy source because of its plentiful nature and decreasing capital cost [3], [4]. A total of 539 GW and 405 GW will be built in the world's wind and solar PV renewable resources by 2017. Irradiance and gust speed are the two most important meteorological variables for wind and photovoltaic (PV) energy sources. Wind speed multiple output curves supplied by wind energy firms may be used to compute the peak power of a windfarm (P_{WT}) as illustrated in Fig. 1 and (1). The output energy is controlled in the range between the cut-in and the rated wind speeds values. Consequently, it may be able to incorporate it with some other energy source in order to provide recipients with consistent power supply, since the generated power is not stable and may be below the adequate marketing. A PV cell's power output is determined by its IV properties as illustrated in Fig. 2 a.



a) The Wind turbine Energy System



b) Wind turbine Power Curve

Fig 1: The Wind System and its Power Curve

$$P_{WT}(v) = \begin{cases} 0, & 0 < v < v_{ci} \\ 0.5\rho A v^3 C_p, & v_{ci} \le v < v_r \\ 0.5\rho A v_r^3 C_p, & v_r \le v < v_{co} \\ 0, & v \ge v_{co} \end{cases} \quad (1)$$

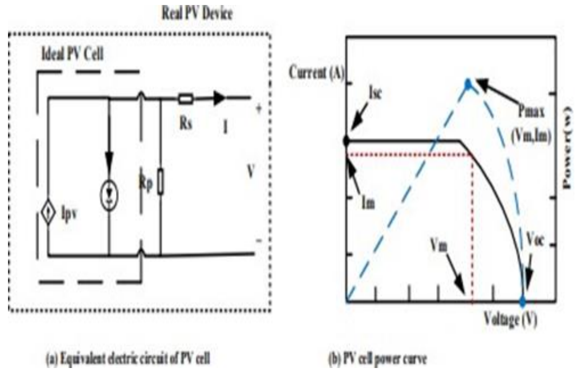


Fig 2: Power circuit and Curve of PV-Cell

The Solar PV, the Wind and the low voltage lines from main grid are all linked to a point of common coupling bus, i.e., it delivers the power towards the sensitive load in this research as illustrated in Fig. 3. Assuming everything goes well, the sunlight PV, wind turbine, and mainline grid line will all provide the PCC bus with a steady 5 kV. Photovoltaic / wind power stations will supply the PCC bus with voltages below or over 5 kV in the event of abnormal situations caused by electrical renewables. It is critical to install a suitable CPD in this situation so that the fragile load does not suffer from the fluctuation it will experience.

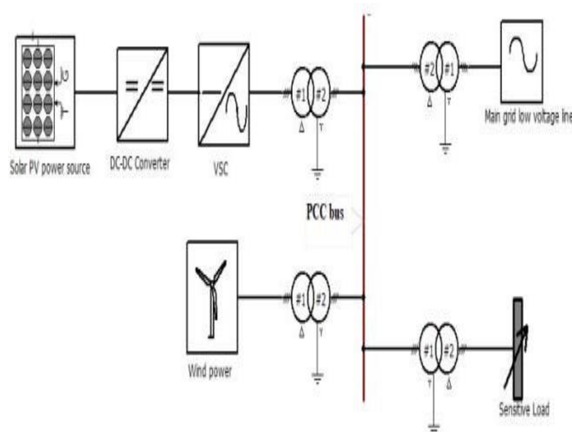


Fig 3: PV- Wind on Grid Hybrid System.

TABLE 3.1. Specifications of on grid hybrid system

Parameters	value
The PV source voltage step up transformer	1 kV/5 kV, 50 Hz
Grid line voltage and step down transformer	11 kV/5 kV, 50 Hz
PCC Bus base Voltage	5 kV

Distribution transformer	5 kV/0.48 kV, 50 Hz
Sensitive load and its capacity	0.1 MW + 0.1 MVAr

III. THE BES-SMES BASED DVR.

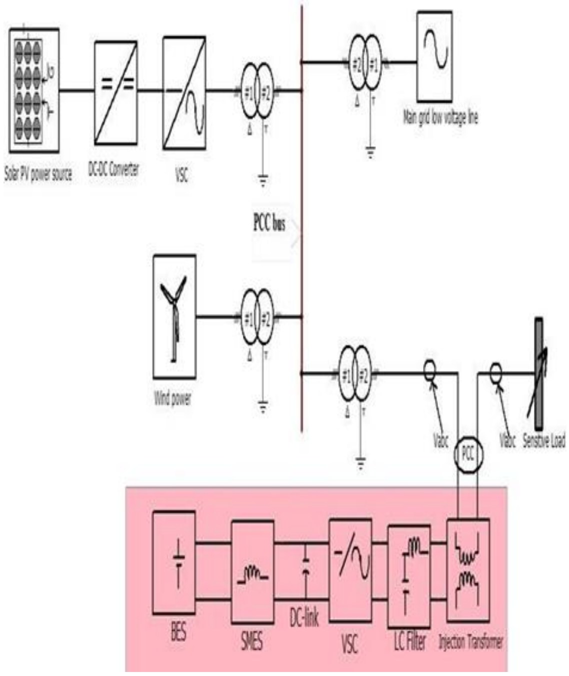


Fig 4: The BES-SMES based DVR.

Parameter	Values
LC Filter inductance	2 µH
LC Filter capacitance	30 mF
Capacitance of Dc Link	55 mF
Dc-link voltage (rated) Inductance of SMES	500 V 0.1 H
SMES Critical Current	150 A
Capacity of BES Battery Nominal Voltage Injection Transformer rating	200 Ah 600 V 0.48 kV/0.48 kV, 50 Hz

TABLE 4.1. Specifications of the proposed BES-SMES based DVR

IV. RESULTS

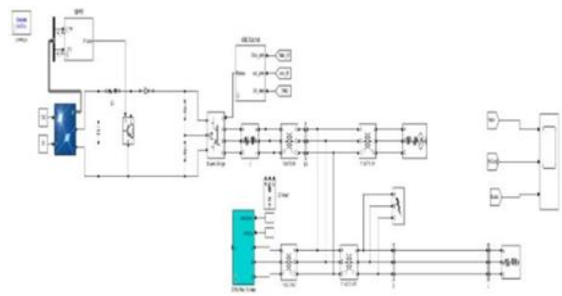


Fig 5.1: PV-Wind on Grid hybrid system

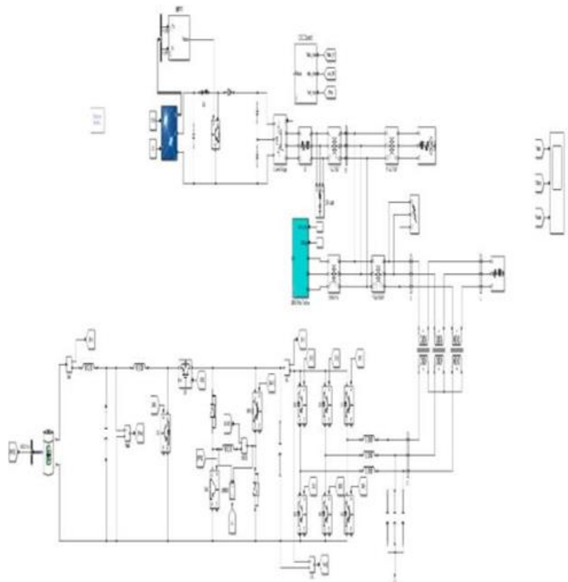
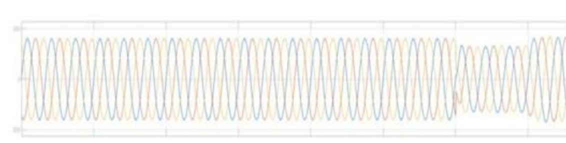


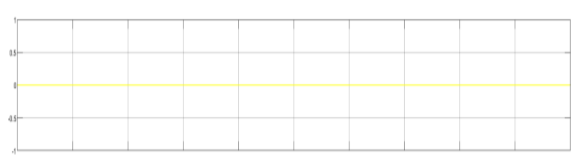
Fig 5.2: BES-SMES based DVR.

6.1 Simulation results for PV-Wind on Grid System:

(a) Load voltage without DVR



(b) DVR injected voltage



(c) Load voltage with DVR

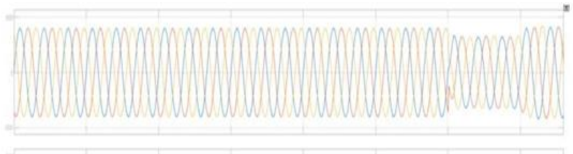
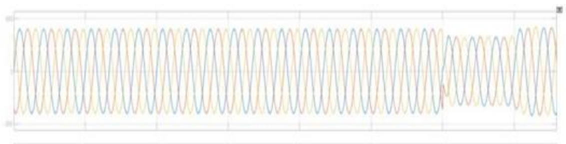


Fig 6.1: PV-Wind on Grid System.

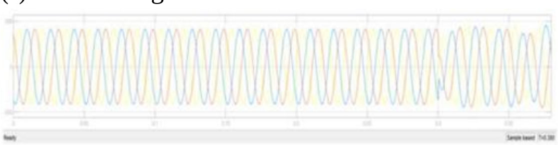
6.2 DVR performance for 25% symmetrical voltage sag case and its results: -

(a) Load voltage without the DVR



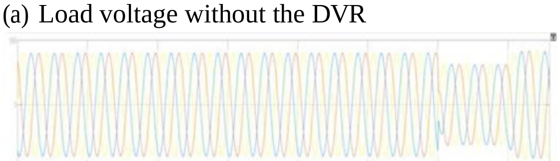
(b) The DVR injected voltage

(c) Load voltage with the DVR

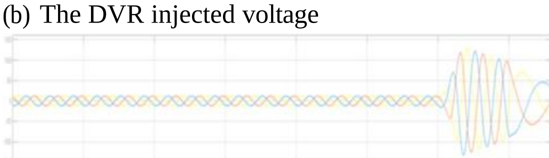


6.3 DVR Performance for 12% symmetrical voltage sag case and its results: -

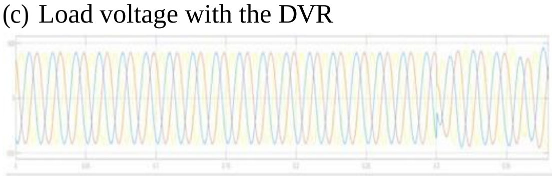
(a) Load voltage without the DVR



(b) The DVR injected voltage

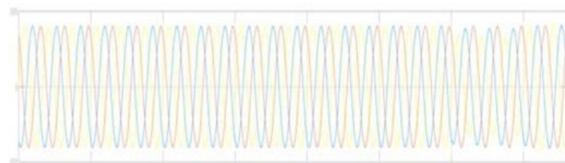


(c) Load voltage with the DVR

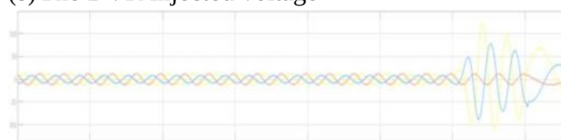


6.4 DVR performance for 25% asymmetrical voltage sag case and its results:

(a) Load voltage without the DVR



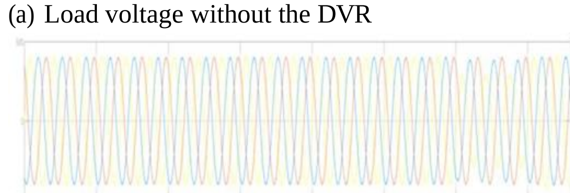
(b) The DVR injected voltage



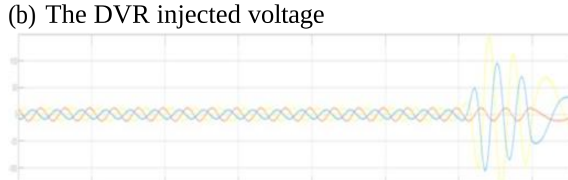
(c) Load voltage with the DVR

6.5 DVR performance for 12% asymmetrical voltage sag case and its results:

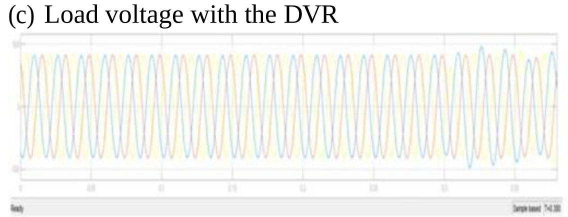
(a) Load voltage without the DVR



(b) The DVR injected voltage



(c) Load voltage with the DVR



V. CONCLUSION

HES-based DVR is proven in this research to improve the power losses of a sensitive load receiving electricity from a generator PV-wind power system. Protecting sensitive loads from overvoltage caused by a malfunction or unsteady power production from a Wind turbine is the goal of a suggested DVR. Viewing grid volts at the BIC (bidirectional AC/DC interlinking converter) and BES and SMES SOC levels helps enhance the management and operation of BES / SMES devices. Additional to this, the dc supply at the PCC is monitored to develop control and functioning of the VSC, which is required for the envisioned DVR process to make properly. This technique is chosen based on its capacity to restore both phase and frequency jumps before the sag occurs. Typical (unproductive state), filling state, and discharged state of the DVR are all described by the circumstances. The suggested operational states' efficacy has been tested in real-world scenarios. It is possible to run the model with balanced and unbalanced energy discrepancies since the HES-based Recording works well in all of the varied voltage sag circumstances. Future studies will show how voltage sags, voltage swells, and harmonics may all be combined.

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