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Simulation of Voltage Regulation in Distributed Networks with High penetration using Battery Energy Storage Systems

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Abstract:
***Background**: The voltage rise issue in low voltage (LV) distribution networks with high entrance of photovoltaic (PV) assets is one of the most important situations in the advancement of these renewable assets. In this paper, BES frameworks are utilized to explain the voltage fall during the peak PV age just as the voltage drop while meeting the peak load.*
***Method adopted**: In this paper, a control method of procedure is suggested for BESs employed in rooftop PV systems to moderate the voltage rise/drop issues in the LV distribution networks with high entrance of PV sources. A planned control methodology is presented in this paper to direct the charge/release of BESs utilizing a mix of the nearby hang based control strategy and an appropriated control conspire which guarantees the voltages of feeder stay inside allowed limits.*
***Results**: This paper shows the methodology which has been approved by a LV radial distribution feeder under various working conditions in MATLAB/Simulink. The test results validate that the control plot keeps the voltage in the system inside as far as possible during everyday activities is concerned.*
***Conclusion:** In this paper, yet another voltage guideline methodology in the low voltage (LV) distribution networks with high PV penetration has been simulated in MATLAB environment. This technique having a tendency to voltage rise/drop issues utilizing the distributed battery energy stocking (BES) systems. In like mode, a designed control conspire has been created to handle the system voltage and effectively use the capacity range of BESs during every day actions.*
***Key Word**: Battery energy Stocking (BES); Distribution networks; Low Voltage(LV); Voltage drop.*

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I. Introduction

Photovoltaic (PV) Systems which converts sun oriented energy directly to electrical power can be utilized for a wide scope of utilizations. The Balance of System (BOS) plays a significant role in power regulating and energy storage as well as mounting and/or backing of the cluster estimation of framework (PV cluster) execution and safety confirmation. Several arrangements have been proposed by various researchers [1-9] to manage this impact on the expansion of the PV entrance in distribution networks. The most straightforward way is the framework support. In spite of the fact that this arrangement is successful and diminishes the misfortunes in feeder since it is very expensive. The usage of battery storing at PV systems in order to enable the energy accumulation and step-up the close by use during the zenith age periods, is an appropriate response for displacing the power reduced form strategy [10]. Cutting down battery cost close by development improvement has made the use of this system reasonable. The battery can be also utilized for top power wastage.

Diversified control procedures are being utilized to control the capacity systems are basically partitioned into three classifications namely: unified, nearby and disseminated. A brought together strategy for the coordination of battery energy storage (BES) systems has been studied and simulated to take care of overvoltage issue. An organized control of PV and BES system has been exhibited in for voltage control of private distribution networks. The proposed strategy utilizes a nearby hang based control of BES put at each house and doesn't require an intricate correspondence framework. In [11] a few nearby voltage control procedures have been presented utilizing PV storage systems.

The proposed control basically incorporates a nearby hang based control strategy and a conveyed control calculations. The nearby hang calculation decides the charging/releasing commencing moment and the underlying capacity to be traded by BESs at each transport. The dispersed control is utilized to facilitate the BESs that for the most part have various limits and inconsistent starting of SoCs. The planned control depends on two agreement calculations, the weighted consensus control (WCC) evaluation and the dynamic consensus control (DCC) findings. The mix of these calculations prompts efficient usage of BESs capacity to manage voltage. The WCC calculation decides the stockpiles interest in voltage road map in a reasonable route relative to their ability. The DCC calculation further changes storage support so as to check early and extreme consumption considering the SoC of BESs.

II. Coordinated Control Strategy

The figure 1 shows the square outline which is the proposed control technique for the PV system arranged at the nth vehicle, where solid and spotted lines show power flow and control signals, independently. The PV board is related with the DC association of the inverter through a lift converter which deals with the DC interface voltage. A bidirectional converter interfaces the BES system to the inverter for enabling force exchange. The PV control relies upon maximum power point following (MPPT). Power mixture by MPPT figuring may cause overvoltage in distribution feeders in the hour of PV top age.

Veritable power mixture from PV inverter can be obliged by taking care of the extra power in the BES system. Thusly, the voltage rise issue will be helped. Likewise, in top weight periods which generally concur with low PV age, the set aside energy in batteries can be used for voltage drop pay toward the finish transports of the feeder.

In this fragment, another methodology for charge/discharge coordination of batteries is presented. The proposed methodology is a mix of neighborhood hang based control and appropriated understanding control counts all of which has been used for specific goals. In case the voltage at any vehicle wanders off from the pre-defined limits, the close by hangs based control chooses the fundamental exchanged (charge/discharge) power for the BES.

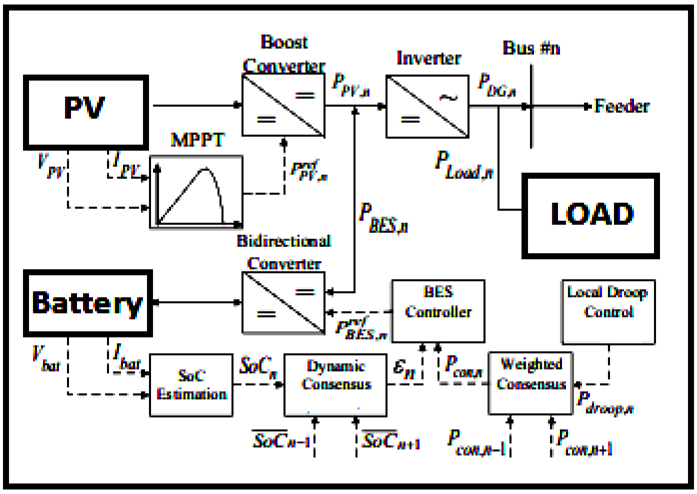


Figure 1 Block Diagram of Control strategy

The proposed method is a combination of

- Local droop based control
- Weighted consensus control(WCC) algorithm
- Distributed consensus control(DCC) algorithm

DROOP BASED CONTROL: A hang control methodology chooses the proportion of exchanged force between the BES and the system reliant on a hang work when the voltage deviation dismisses beyond what many would consider possible. On account of the manner in which that the base and maximum point of confinement voltages could be uncommon, two obvious hang limits are defined for charge and discharge modes respectively.

WCC ALGORITHM: It is enormous for all the BESs in a distribution network to be controlled in a reasonable manner for participating in the voltage rule process. Utilizing the wcc estimation suggested for the reasonable charging/releasing of BESs.WCC is a dispersed control method that can be utilized to arrange all subsystems. The WCC computation shares the total beginning powers calculated by the hang control comparative with BESs limit. Since this computation doesn't consider the energy level of BESs, it is ordinary that the batteries with higher basic SoC will end up being full in the charge mode. At the point when a BES ends up being full, it cannot add to decrease the voltage rise during times of high PV age.

DCC ALGORITHM: The primary idea of this algorithm is based on the average SoC estimation of all batteries in a distributed manner and calculating a correction factor to modify their participation in voltage profile improvement process. The correction factor is calculated by comparing the SoC of each battery and the estimated average SOC across the network.

The BES exchanged power (Pcon,n) evaluated such that the charge/discharge power to storage capacity ratio is identical for all BESs. When batteries have different SoC, this strategy may cause early saturation or depletion in some units. To avoid this problem, the εn is applied to modify the BESs participation. In charge/discharge mode, it is desirable that the storage systems with smaller/larger SoC have higher participation in voltage rise/drop mitigation until the SoC of all BESs move to an identical value gradually.

III. Simulation results

The simulations results are presented in this section.

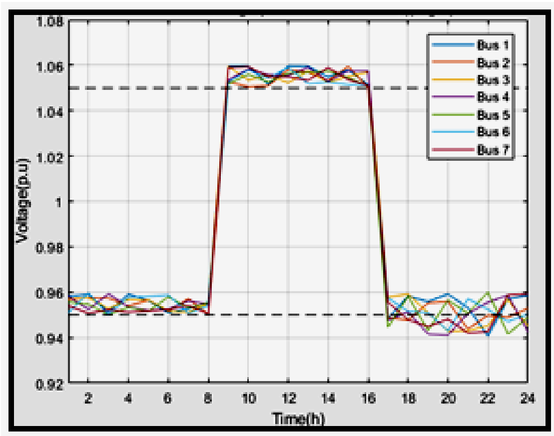
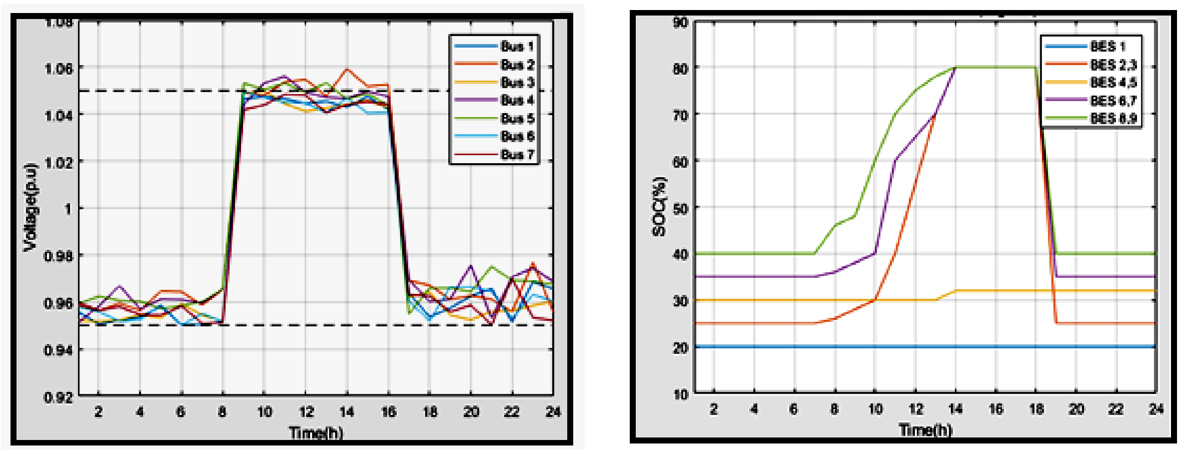


Figure 2 Voltage versus Time plot



(a) (b)

Figure 3 (a) Voltage (p.u) versus Time plot (b) SOC (%) versus Time plot

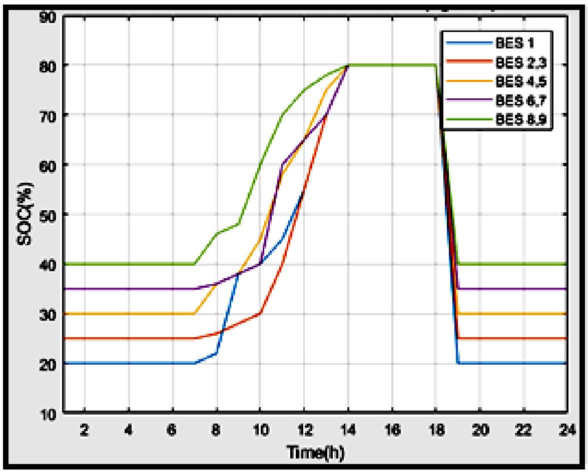


Figure 4 SOC variation without WCC

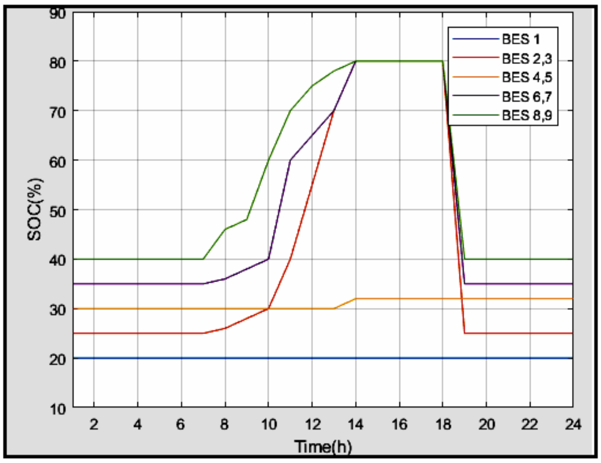


Figure 5 SOC Variation of charging and Discharging

IV. Discussion

The Figure 2 depicts the 24 hour voltage profile without BES. Figure 3 (a) represents the voltage plot with Droop control method. Figure 3(b) shows the SOC variation with BES respectively. The Figure 4 represents the SOC plot without considering the WCC method. The Figure 5 depicts the charging as well as discharging plot of SOC's.

V. Conclusion

In this paper, a voltage guideline based technique in the low voltage (LV) distribution networks with high PV penetration has been simulated. This technique tends to the voltage rise/drop issues utilizing the disseminated battery energy stocking (BES) systems. This control methodology has been approved by a LV spiral distribution feeder that was mimicked under various working conditions in Matlab/Simulink environment. The test outcomes verified that the control plot keeps the voltage in the system inside as far as possible during every day activities.

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