ABSTRACT

The world has been through an unprecedented period with the outbreak of the pandemic. The world has sustained the difficult period with varying degrees of difficulty, mainly with the help of power supply. On the other hand, climatic changes all over the globe call for alternate eco-friendly source of power supply. The power system is on the verge of a paradigm shift from a centralized large- scale generation, transmission and distribution system to a small-scale, decentralized local generation and consumption system. This localized generation and consumption system is called a microgrid.

The research work focuses on improving certain technical aspects of the microgrid to enable it to enhance its performance. In this work, two different renewable energy sources, namely solar PV system and wind generator system are modelled. As renewable sources are inherently intermittent in nature, for providing stability, a battery source is also considered. In MATLAB/Simulink, the solar PV system is modelled based on the implemented solar plant consisting of 9 Emmvee 240 Wp solar PV panels connected in series. Proper sizing and orientation of the PV panel is very significant in extracting maximum output from the solar plant. In this work, a modified incremental conductance method called the variable step size incremental conductance method is adopted for simulation of solar plants. A battery bank of 4 numbers of 12 V batteries connected in series is also used for simulation model.

A one-of-a kind experimental setup has been developed to investigate the characteristics of four types of electrical generators for wind energy conversation system (WECS) namely, permanent magnet DC

generator (PMDC), permanent magnet synchronous generator (PMSG), squirrel cage induction generator (SCIG) and slip ring induction generator (SRIG). An armature voltage controlled separately excited (DC) motor is mechanically coupled to the generators one at a time with the help of portable coupling. By analyzing the performance of all the four types of generators using this arrangement it is concluded that for low and varying wind velocity scenario PMSG and PMDC are the best choices. Similarly for a constant wind velocity scenario SRIG and SCIG are the best choices.

As the load and sources are both varying in nature, obtaining a stable system parameter like voltage and frequency is a challenging task. Power management is also done based on available renewable power and load demand. The droop control technique is utilized for achieving stable voltage and frequency. In this technique real and reactive power is calculated based on measured voltage and current and compared with set values to implement the control. It basically implements a direct correlation between real power to frequency and reactive power to voltage. It ensures load sharing among inverters without the need for a communication link.

No three- phase system is perfectly balanced; this issue becomes more severe when the grid is a weak grid, as in a microgrid. Many other factors like unbalanced load unequal conductor impedance, blown fuse in a three-phase bank of power factor improvement capacitor etc., can unbalance a three phase system. According to different standard like IEC, IEEE, Engineering Recommendations, the value of unbalance should be limited to 2%. In this research work, the dual vector current control (DVCC) scheme for unbalance compensation in three phase three leg inverter is extended to inverters in a microgrid and its effectiveness is substantiated by MATLAB/ Simulink simulation results. The percentage unbalance reduced from 5 % to less than 2%.

Further unbalance compensation using a three phase four-leg inverter is also done. In a three phase, three-leg inverter, for connecting a single phase load, a delta-star transformer is normally used for getting the neutral point. But, the three phase four-leg inverter has neutral point on its fourth leg. This greatly reduces the size and cost of the system. In this control scheme, a modified virtual oscillator control (VOC) scheme is adopted for the voltage and frequency stabilization in a three phase, four-leg inverter. Moreover, sliding mode control along with modified VOC technique is adopted for harmonic and unbalance compensation. The effectiveness of the control technique is substantiated with MATLAB/Simulink results. The percentage unbalance reduced from 5% to less than 1% and THD for non linear load reduced from 20% to 2%.