

# PERFORMANCE OF BATTERY BANK ON HYBRID MICROGRID

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## ABSTRACT

*A hybrid microgrid is composed of combination of the AC and DC grid which are interlined with bidirectional converter. To avoid the multiple conversion and more reliable the proposed hybrid microgrid is designed by taking diesel generators, Photovoltaic cell, induction generators and battery bank. It is connected to the utility grid in normal operating mode. During fault condition, it should disconnect and shift into island operation mode. This paper proposes a standalone hybrid generation system, fed by induction generator which is run with a battery banks, solar power, and storage battery. Hybrid microgrid is an excellent solution for electrification of remote rural areas where the grid extension is very difficult and not economical. Practically it has been seen that most of the isolated grid is powered by the diesel generation system, such systems has several problems like high cost fuel with extra transportation cost and making more pollution to the environment .To make pollution free environment ,an eco-friendly hybrid microgrid system has designed. It maintains the power quality in steady state condition. During this transient condition, the voltage and frequency of the microgrid may change rapidly due to low inertia present in microgrid. Therefore, local voltage and frequency control is one of the major challenges in islanded condition. To achieve this particle swarm optimization (PSO) algorithm is implemented in the proposed microgrid which is verified by MATLAB Simulink*

**Keywords:** Battery Bank, Hybrid Microgrid, PSO Algorithm, PV Cell, Matlab 2016b

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## 1. INTRODUCTION

In present scenario, the batteries is a major energy carriers in hybrid microgrid. The demand of battery is increased because of the more application and advancement of wireless device [1]. Solar Energy is converted into electrical energy by following the application of photoelectric principle. Power electronics plays a vital role in this regard by converting the DC power into AC power. Depending on the application of loads, this power can be utilised [2]. when the load demand is less, batteries are used for supplying local loads. Low cost and long life of battery are vast application in storage system. Application of Battery banks in large quantity is not that much economical and convenient [3]. Lead-Acid battery is taken in this project by considering of its low cost and long life[4].The battery is modelled as a nonlinear voltage source whoseoutput voltage depends not only on the current but also on the battery state of charge(soc),which is a nonlinear function of the current and time[5].Microgrid is a semiautonomous power system which can capable to manage the power flow from the local micro sources. The key feature that design the microgrid is power electronics, control and communications network with integration of renewable energy source. When the power demand is high, the microgrid can provide benefits to the utility by dispatching power to shave the peak loads [6]. Hence it helps to maintain system stability when generation doesn't meet demand. Cost of electricity for the end users can be reduced when the microgrid meet the load demand especially when electric prices are high [7]. Microgrid helps to reduce the transmission losses by producing power at local facilities. Moreover, any upgrades needed by the transmission system to increase its capacity can be postponed. Many of the sources used in the microgrid like solar array, wind farm, rechargeable batteries are environmental friendly, and hence there are less carbon emissions[8]. A charging and discharging controller of battery bank for charge equalization control of a battery storage system is demonstrated by using particle swarm optimization (PSO) algorithm [9].The bidirectional conversion can be done by the fly back DC-DC converter which are responsible for the exchange of energy from a battery bank -1 to an overcharged battery bank -2 and vice versa .The constant voltage and current ,proportional integral and discontinuous current mode control are applied to charge and discharge the battery bank [10]. Sizing of a suitable battery bank in terms of power and energy helps in sharing the peak demand of the cutomer [12].It stores excess renewable energy and supply supply to the load when solar power is low. Battery generate positive real power when it discharges to microgrid [13]. The battery storage system will be beneficial not only a. daily saving but reducing the PV output power fluctuation. The PSO algorithm is implemented in proposed microgrid system [14-15]. Design of microgrid is illustrated in Section II. Simulation results will be given in Section III. Section IV will make some conclusions of the proposed design.

## 2. DESIGN OF HYBRID MICROGRID

The proposed hybrid system should consider many items, types of load, load demand, battery, solar environment condition, type of location and economic constraint. The load demand is fulfilled by the Induction generator & PV. Here base demand is fulfilled by PV & peak demand is fulfilled by induction generator coupled with battery bank. It is shown in Fig. 1. by considering the combination of AC and DC microgrid, a hybrid microgrid is designed.

4.5MW and PV farm In this project 27.5MW microgrid system has been designed where Induction generator is generating15MW, Induction generator is 4.5MW and PV farm is generating 8MW. Simulation of 4MW (100\*40KW) vehicle to microgrid and vice versa is taken as dc load to the dc bus system . Microgrid has Independent of the structure of the power system, power flows throughout the network is largely distributed as a function of transmission line impedance; a transmission line with low impedance enables larger power

flows through it than does a transmission line with high impedance. However, transmission systems do not behave in an ideal manner. The systems react dynamically to changes in active and reactive power, influencing the magnitude and profile of the power systems voltage. Quite often it gives rise to a myriad of operational problems; the system operator has to intervene to try to achieve power flow redistribution, but with limited success.

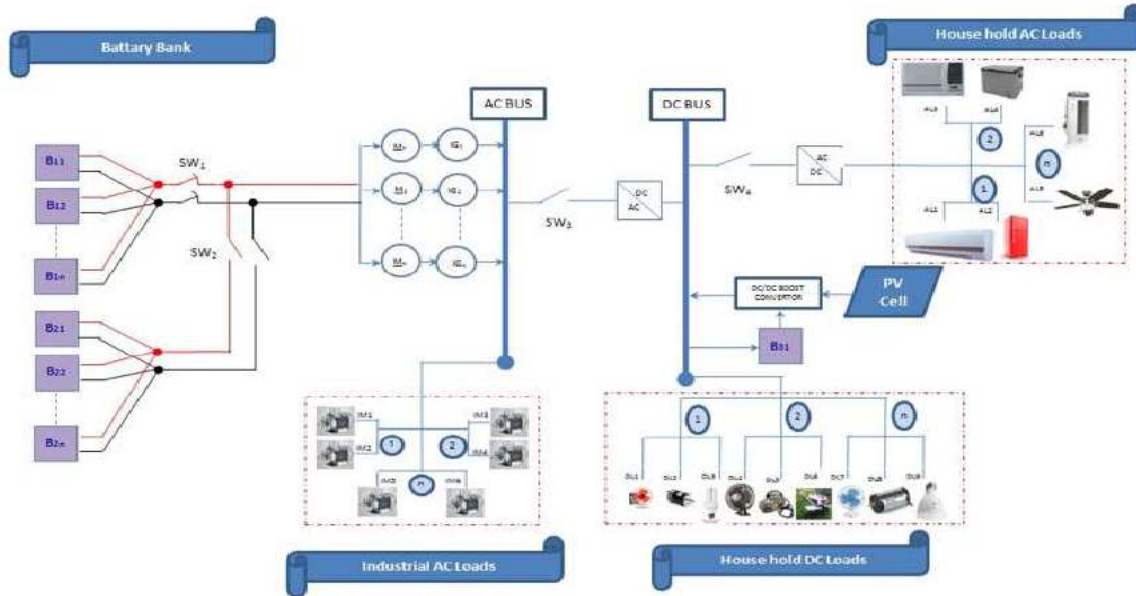


Figure 1 Proposed Hybrid microgrid system

### 3. DESIGN OF THE BATTERY CONTROL

The design of battery is done by taking the voltage ,current and power consumed by the customer which is taken from the Matlab 2016b .The system diagram of the battery with the proposed control structure is shown in Fig. 2.A block diagram of the control system is presented in Fig.3

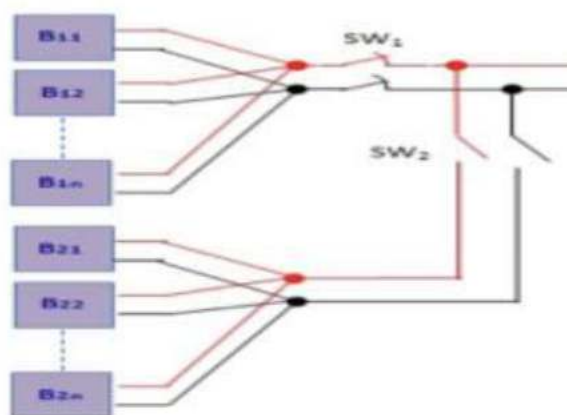


Figure 2 System diagram of the proposed battery banks

In the proposed microgrid, two groups of battery bank is coupled by a switch and the instructed is given in such a way that after discharging of 60% of one bank, the microgrid will

disconnect and connect to battery bank 2 which is presented in Fig 2. The battery controller is presented in Fig 3.

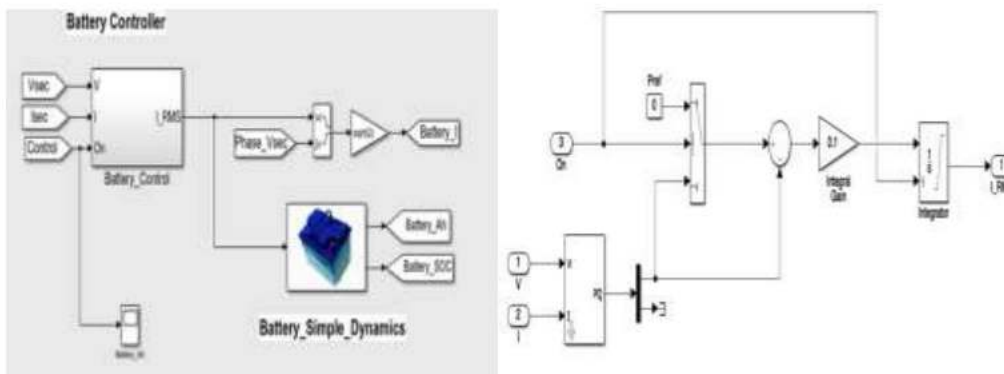


Figure 3 Battery controller and its dynamics

#### 4. SIMULATION RESULT

The impact of distribution energy is represented in Fig 4, according to the variation of load demand. Hence, the charging capacity of battery has been observed within 24hr interval. From 20h to 4hr, the solar power generation is considered to be zero. From 14hr to 15hr ,it reaches its peak amount .From 0 hr to 12hr and from 18hr to 24hr ,battery control is performed by battery controller. The battery control performs the tracking control of the current so that the active power which is flows into the system is set to zero . The storage battery bank 1 supplies insufficient current when the power of the proposed microgrid is insufficient. By discharging 60% of storage amount ,it gives the trip signal and instruct to run the battery bank 2 by using PSO algorithm. The following simulation result has been noted and presented in Fig 4 to 9.

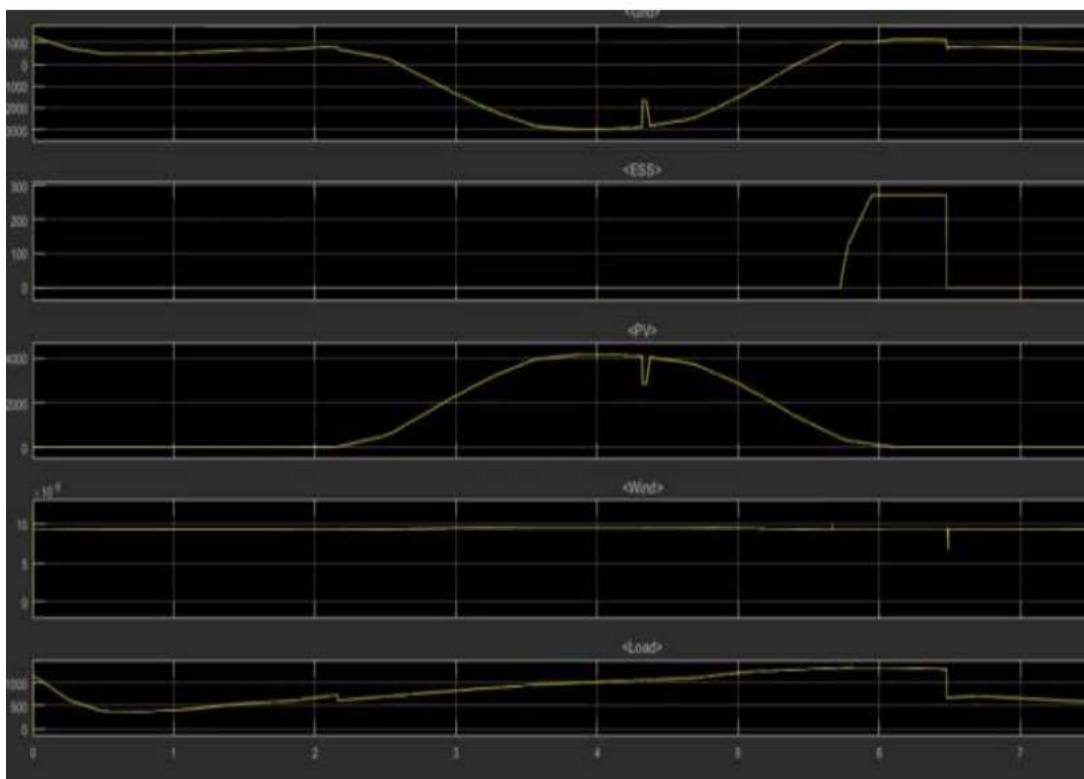
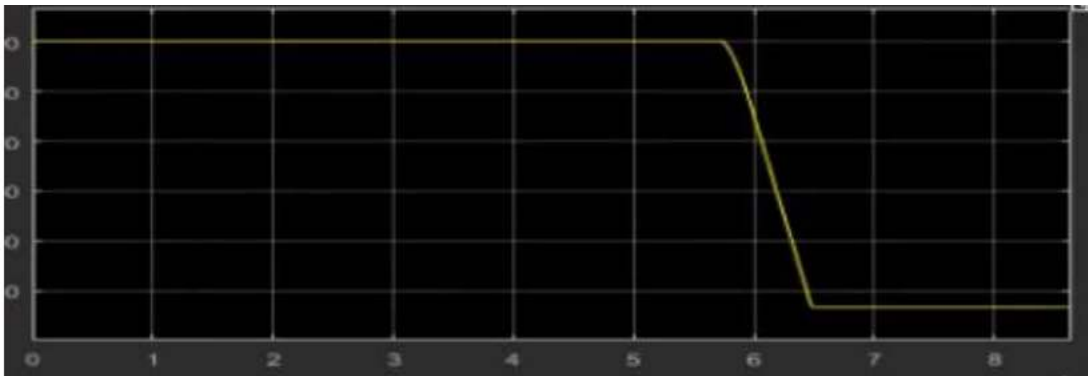
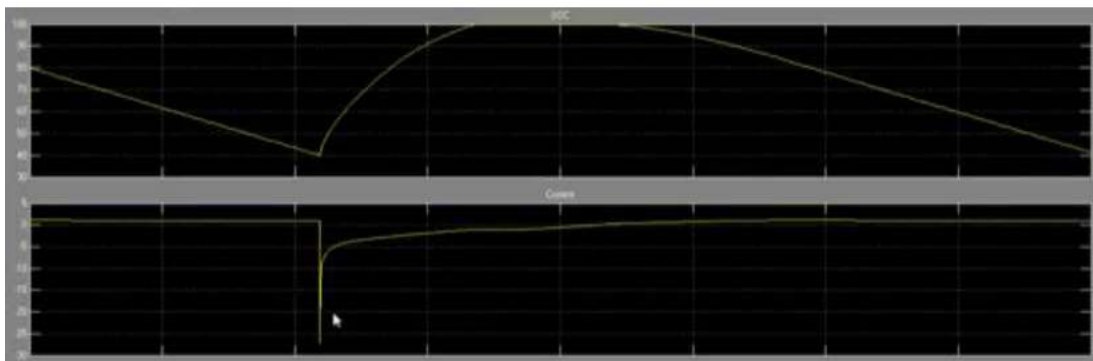


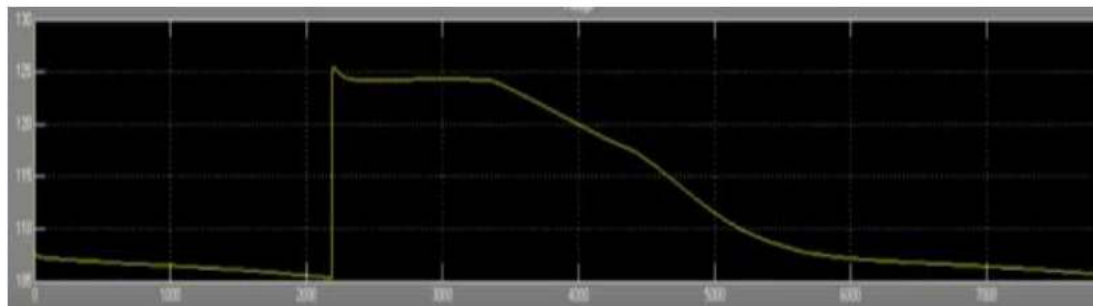
Figure 4 Impact of distributed energy sources in accordance to its load demand



**Figure 5** Percentage of stored energy



**Figure 6** State of charge of battery and the current flowing through it

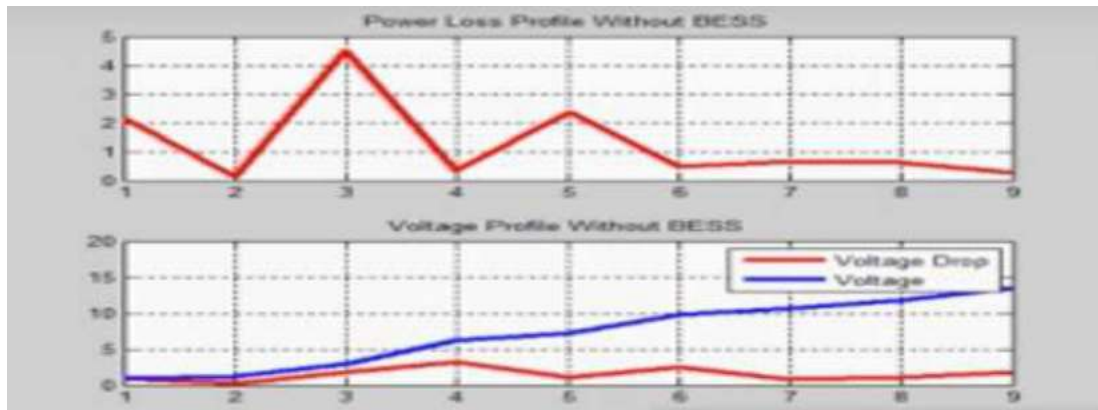


**Figure 7** Voltage across the terminal of the battery.

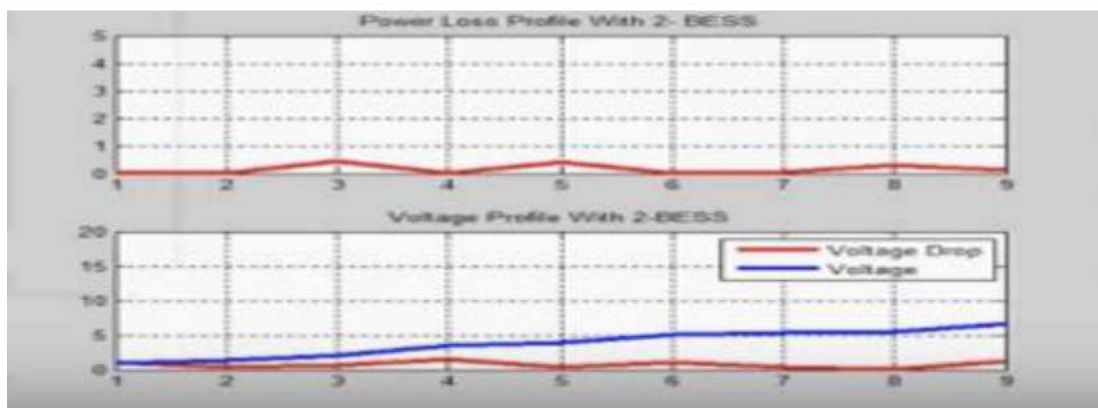
From the simulation graph of Fig 4 and 5 implies that initially batter bank -1 is supplying power to the induction generator, that is the reason its state of charge (SOC) is decreasing. Once it reaches to 60%,the induction generator(IG) will get disconnected and at the same time battery bank -2 will start charging the battery -1 and the Current was coming out from the battery .Once the IG gets disconnected and the battery bank-2 is charging battery 1,the current value will be negative .That means current is flowing into the battery bank-1,which shows the battery is charging.The impact of distribtes generators on the power loss and voltage profile of distribution network is presented in Fig 7 to Fig 10.It depends on the type of DG technology and the location in which they are connected to the grid. The integration of DGs reduced the power losses and the voltage drop across it.

It has been analyzed that improper placement of Battery bank and its sizing lead to undesired power loss and risk of voltage stability. The particle swarm optimization (PSO) algorithm is proposed in the paper to minimize the power loss and improve the system voltage profile. The detailed simulation results for each case clearly demonstrate in Fig 7 and Fig 8.

## Performance of Battery Bank on Hybrid Microgrid

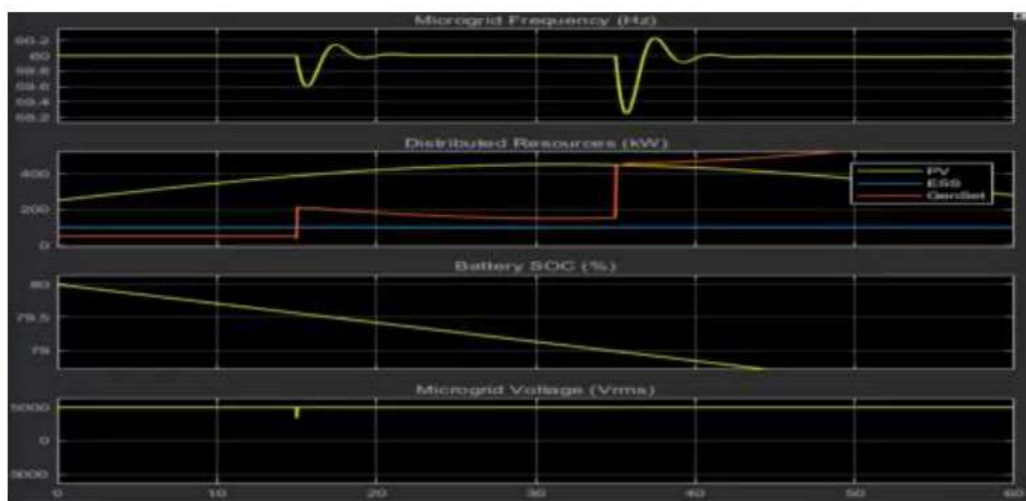


**Figure 8** Power loss and voltage profile without battery



**Figure 9** Power loss and voltage profile with battery

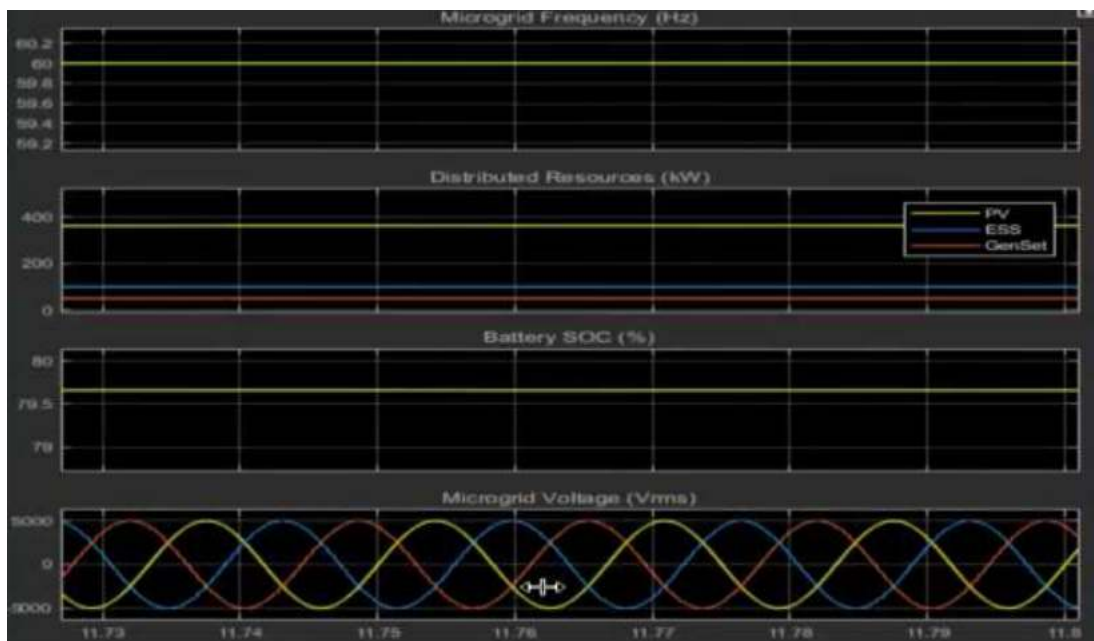
Fig 8 and 9 represents the power loss and the voltage profile of the system without and with considering battery. The study in battery bank and its application to induction generator presents a smart energy management system to optimize the operation of microgrid. The system power loss and cost are minimized by the smart management of two groups of battery bank and operation optimization of distributed generation.



**Figure 10** Fluctuation of microgrid frequency and discharging of battery power with the Variation of load demand.

PSO algorithm is presented to minimize the power generation cost and to maximize the useful life of battery bank which support to the network voltage control in a distributed system. Particle swarm optimization (PSO) has become an efficient tool for solving the nonlinear, non-differentiable, multi objective, and discrete variables optimization problems due to its flexible applications and better robustness in controlling parameters. The proposed algorithm solve economic dispatch problem in a microgrid along with the system cost, power loss and emission are reduced sharply. Linear and nonlinear models of a microgrid operating in grid-connected and autonomous modes have been presented in MATLAB 2016b.

The variation of load demand may cause many control problems which affect the quality of power within microgrid. This might be cause large frequency and voltage deviations in the system due to unpredictable output power fluctuation.



**Figure 11** Power balancing of distributed energy sources and synchronization of frequency

It has been seen from the result that when the percentage of state of charging is decrease, it will sense to other battery bank which is fully charged and reactive power compensate through it.

It is represented in Fig 11. A power balancing method presented here is to minimize the operation costs of the distribution system.

## 5. CONCLUSION

This paper implies the application of battery which is coupled with induction generator to the hybrid microgrid. The performance of distributed energy sources can be noted down and the corresponding voltage and frequency can be noted for synchronization. The coupled of Battery and induction generator has vital role for production of renewable energy where sufficient wind is not available. The capacity and life of battery is dependent on the rate of discharge, depth of discharge and the temperature of the surrounding. The results show that the pso algorithm can operate under varying load condition. The methods to minimize the torque/ speed ripples need to be addressed. The simulation and experimental results for the battery bank performance is presented. The simulation has been obtained by using MATLAB Simulink-2017. It is a reliable solution to mitigate the power crisis in remote area. It has an great impact on the power quality of system.

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