DESIGN OF CONTROLLER FOR BATTERY ENERGY STORAGE SYSTEM IN GRID TIED SOLAR APPLICATIONS

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ABSTRACT

The depletion of fossil fuel resources on a worldwide basis has necessitated an urgent search for alternative energy sources to meet up the present day demands. Solar energy is a clean inexhaustible and environment friendly potential resource. But neither a standalone solar photovoltaic system nor a wind energy system can provide a continuous supply of energy due to seasonal or periodic variations. Therefore to satisfy the loads grid connected energy systems are now being implemented. Thus the generated output power of grid tied solar PV is highly variable resulting in many issues like voltage swings, frequency changes , sudden weather induced changes in generation.

This paper discusses an approach to mitigate problems with solar power generation such as ramp rate and voltage swings, The work include use of battery energy storage system to mitigate problems associated with solar power generation and design of controller for optimal selection of battery and Solar PV as per load requirement to power the load.

Keyword : - ***Battery energy storage system, smart grid, photovoltaic, microcontroller etc***

I. INTRODUCTION

The integration of significant amount of Photovoltaic (PV) solar power generation to the electric grid leads to unique set of challenges like voltage swings, frequency regulation, ramp rate control to utilities and system operators. The grid connected Solar PV units generates power from few KW to several MW, this power is the pushed out to power grid at distribution level, where systems are often designed for 1-way power flow from the substation to customer. In the areas where climatic conditions are favourable for the working of PV means distributed generation such adoption is beneficial.

In country like India solar energy is available around 300days, 10 to 12 hours daily but, some kind of energy present irregular or intermittent. solar radiation are not available during night,so it is necessary to provide some storage means to store the energy which is generated in bulk radiation period and utilized it, in the period when solar radiation is not present there, and again various distributed energy sources are integrated in order to utilize natural present energy (green energy) i.e wind energy ,solar energy, wind energy, tidal energy, geothermal energy. So it is needed to integrate them to a common storage device and it generally done by utilizing battery energy storage for the storing the energy.

Battery energy storage system (BESS) aims to develop methods for strategically planning and operating renwable PV units along with an efficient usage of BES sources in distribution networks. The BESS technology is presented below. The PV coupled BESS system described in this paper utilizes XP-Dynamic power resource, BESS for renewable energy application.

2. LITERATURE SURVEY

The literature survey carried out related to technology impact in the study of Battery Energy Storage System with different technique

N.Miller[2]Paper discusses the advances of power grid particularly to acccomodate increasing penetration of variable resources such as wind and solar power. The generation of power due to these distributed resources is often unable to supply regulation. Thus there is a gap between frequency regulation requirements and capability. These factor lead to the need of new technology to supply regulation and spinning reserves. Under these new emerging conditions BESS can be used to provide these ancillary services. In this application energy storage is tightly coupled with specific variable resource, rather than providing a grid level ancillary service. Energy storage using FACTS technology gives precise control and quick response. A BESS relatively small in comparison to the deployed wind power capacity on the system offered substantial frequency performance improvements by injecting or removing power to balance sudden increase or decrease in wind power.

C.Hill [3] In this paper variability of wind generation and its contribution to meeting system load is discussed. But this variability poses challenges on system operator who must keep generation and load closely balance at all times. So for this purpose energy storage is used which can improve output profile of renewable power sources: renewable energy time shift, renewable capacity firming, wind generation grid integration. Here xtrme power is connected to wind farms with turbine generators. The BESS control system uses CTs and PTs to take real time measurements of the wind farm output power after converting the PT and CT signals from analog to digital. the control computer can determine the necessary power to be absorbed or discharged by the battery bank.

N.W.Miller [4] The paper gives the overview of design and commissioning of 5MVA, 2.5MWH Battery energy storage system. The BESS is designed to work with the existing plant control system to automatically shed all non critical loads as soon as possible after an incident. This permits load up to 2.5 MW to operate for up to one hour. This time is necessary for plant to safely shut down its critical processes. The control of the Power Conditioning System used in installation, is provided by the station level control, consists of microcontroller controller for regulator function. The Battery monitoring function is implemented in PLC working with the operator interface computer.

3. Types of PV systems

1. Grid connected PV system
2. Grid tied with Battery backup PV system.

3.1 Grid connected PV system

These systems are connected to broader electricity network. The PV system is connected to the utility grid using a high quality inverter, which converters Dc power from the solar array into AC power that conforms to grid electrical requirements. During the day the solar electricity generated by the system is either used immediately or sold off to electricity companies. In the evening when the system is unable to supply immediate power, electricity can be bought back from the network.

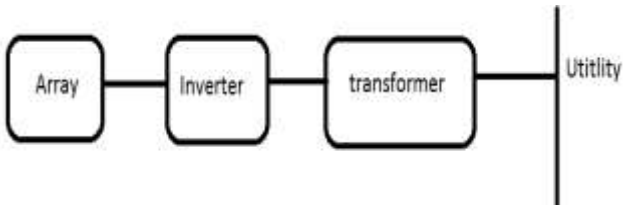

Fig. 1 Grid connected PV system

3.2 Grid tied PV system with battery backup

Solar energy stored in batteries can be used at night time. Using net metering unused solar power can be sold back to grid.

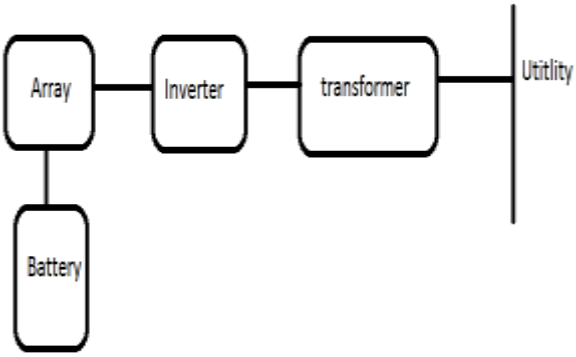

Fig. 2 Grid tied PV system with battery backup

4. BATTERY ENERGY STORAGE SYSTEM

A BESS consists of a battery bank, a control system, and a power electronics interface for AC-DC power conversion as shown in fig.3. The BESS is connected to the power grid in a shunt configuration, often in parallel with a renewable power generating facility or critical load. Control modes for BESS/Solar PV installations include:

• Time Shifting / Peak Extension

• Solar Smoothing / Ramp Rate Limiting

• Solar Leveling

• Load Leveling

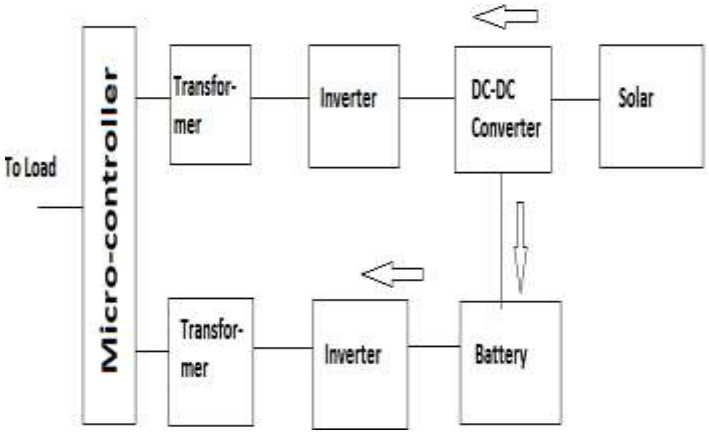

Fig.3 Block diagram for Battery Energy Storage system

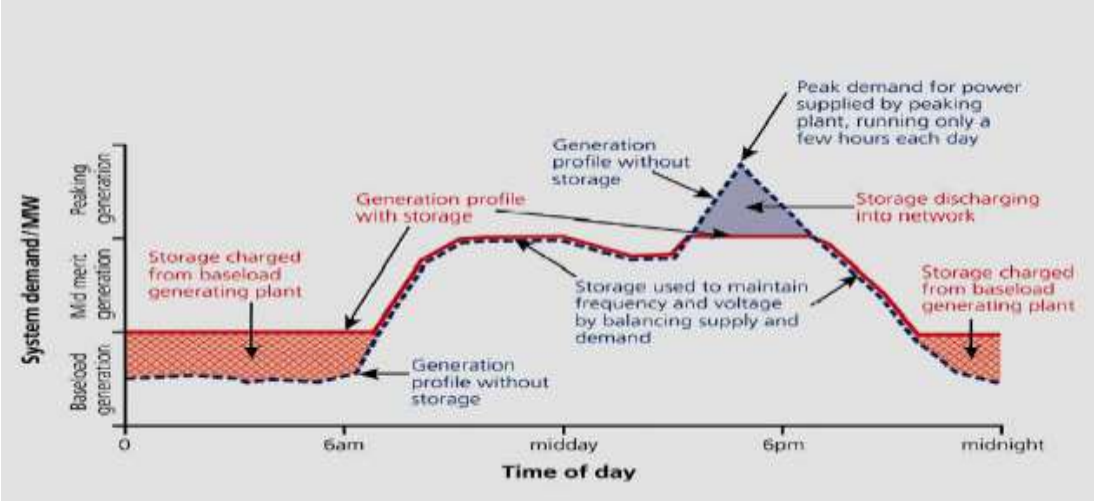

Fig 4: graph of system demand and time of day

The graph in Fig 4. explains that the system demand can be handled efficiently if storage is incorporated into the electrical network. As shown the storage is charged from the base load generating plant during the early hours of the day when the demand is low. And then as the demand rises during the day the generating plants belonging to mid merit category, account for the demand. And during the peak demand time if storage is taken into account then the demand can be supplied by the peaking plant which runs only for few hours of the day decreasing the total cost of operating such a storage incorporated system. Thus we see that when the generation profile with storage is taken, there is a much controlled demand graph as storage takes care of the load leveling and then it is charged again at the end of the day from the baseload generating plant.

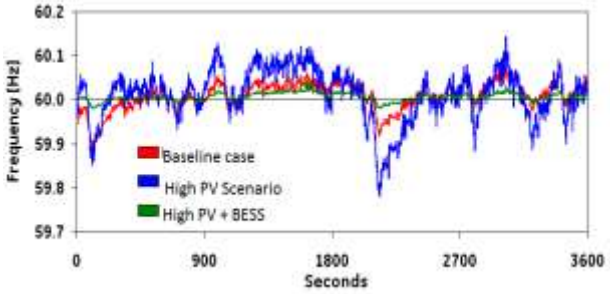

Fig.5 Frequency response for sudden PV drop

The sudden PV power fluctuation cause a substantial enough imbalance between load and generation to cause a large frequency drop on the system. In order to maintain tight frequency a battery energy storage system is considered. Frequency response for the case of high PV and BESS is shown in fig.5. Inspection of the curve shows the frequency variation is substantially reduced. The storage system improves the system frequency response to an even tighter frequency band.

5. PROPOSED METHODOLOGY

The power systems that are not connected with major grids experience frequent service interruptions, also the cost of fuel in these remote locations is very high. So to make the conditions favourable BESS is used in such locations.

An algorithm for microcontroller 16f877a is developed which uses sensor for voltage and current of battery and solar. The controller provides selection of battery and solar as per the load requirement, to supply necessary power to the load.

6. CONCLUSIONS

In this paper comparison of grid connected PV system and grid connected PV system with battery backup is done. This paper describes the grid connected PV system with battery backup and need for battery energy storage used in distributed solar power generation. Thus by managing the real power variability of solar by controller algorithm, optimizes the benefit of solar PV. The Solar PV integration challenges can be reduced by using BESS to provide voltage stability, frequency regulation.

7. ACKNOWLEDGEMENT

We take this opportunity to thank all the individuals for their guidance, help and timely support which made us to carry out the project work in stipulated time. We also thank all teaching and non-teaching staff members for their patience and special consideration for the completion of our work. Lastly, we offer our regard for all those, in particular our parents and who supported us in any respect during this project work.

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