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Design of Battery Energy Storage System for Generation of Solar Power

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***Abstract*—Solar power generation which depends upon environmental condition and time needed to back up the energy to maintain demand and generation . The output of a grid tied solar power generation which is a distributed resource can change very quickly. Solar power can be integrated into the grid by the help of Battery Energy Storage System .Real and reactive power can be absorbed and delivered by the photovoltaic systems with very few response times. PV modules and back up battery are connected to a DC link through DC-DC converter**

***Keywords*— Battery energy storage system overview, Charge controller, Solar cell and its application**

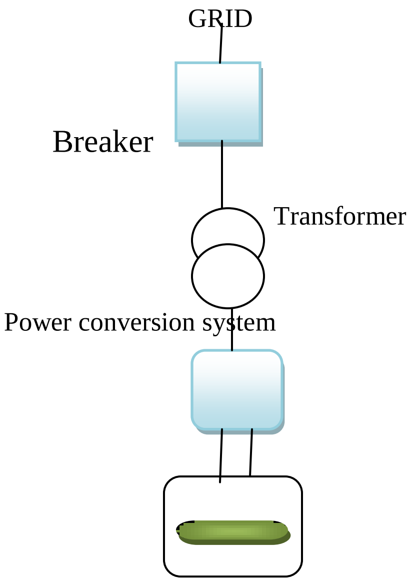
I. INTRODUCTION

Among all renewable energy resources, energy harvesting from the solar photovoltaic system is the most essential and suitable way. The major challenge now a days is to store the excess energy ,when the demand is low, and reuse this energy later or when needed. This energy can be stored in a Storage unit called 'Battery'. Power from grid connected solar PV units is generated in the form of few KW to several MW. Grid connected solar PV dramatically changes the load profile of an electric utility customer . The widespread adoption of solar power generation posses significant challenges both in transient and steady state operation. This application is Valuable for both voltage and frequency regulation and also serving as a backup supply during system faults or unavailability of renewable energy.

II. BATTERY ENERGY STORAGE SYSTEM REVIEW:

A. Basics of Energy Storage

The one-line diagram of a Battery Energy Storage System (BESS) is represented as follows. The BESS is connected to grid via circuit Breaker (CB) . A step down transformer is connected to reduces the voltage to the required



level of voltage for the PCS (power Conversion System) . The four quadrant power conversion between the ac and dc system can be provided by the power conversion system (PCS). The status of the battery can be monitored by the BMS (Battery Management System) which is included by the protection and control of the battery.

B. Storage for energy Integration:

Electrical energy in an ac system cannot be stored directly.Energy can be stored by converting the ac into dc and storing it electromagnetically,electrochemically,kineically, or as potential energy.Energy storage technlogy usually includes a power conversion unit for conversion of energy.Energy storage depends upon two factors i.e. i) Amount of energy that can be stored in the device. ii) The rate at which energy can be transferred into or out of the storage device.The rating for energy is normally expressed in watt-hours (Wh).

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C. Battery Basics

Higher cycling capabilities, increased in densities of energy storage, greater reliability and minimum vaue can be can be found from the advancement in Battery technlogy. BESS have emerged as one of the more promising technology in the field of power application, by offering a wide range of power system application i.e optimum shaving,spinning resrve and regulation of frequency. The unit of battery energy is Ampere-Hours (Ah).

D. Application of Stored Energy:

Design and decission of choosing the right battery for power to energy ratio is an important aspect for utility application. The power to the energy ratio of various batteries is an important aspect in the design and decission of choosing the right battery for utility application. Batteries which have a more power than ratings of energy or vice versa can be used for either power application or energy storage. By using wrong technology of battery results in a overall system damage and affecting the cost of the system.

Different types of requirements in storage system include:

- Ancillary works- It includes frequency regulation, operational reserve
- Optimum shaving
- Islanding
- Different Renewables Integration- Managing wind solar variability , Ramp rate control.
- Optimum shift, Large energy capacity
- Part of a Microgrid
- Long duration constraints- energy aaplication
- Short duration constraints- Stability, Power application

E. Battery Energy Storage system (BESS) and Solar Power Integration:

A major goal of BESS is to achieve dispachability, such that the combined renewable energy and battery system appears to the grid like other conventional controllable resouce.

III. CHARGE CONTROLLER

The main use of charge controller is to protect the battery and to clarify that battery has a long working life without disturbing the system efficiency. Overcharging is not allowed in battery. The main function of charge controller is to ensure that the battery is not overharged.

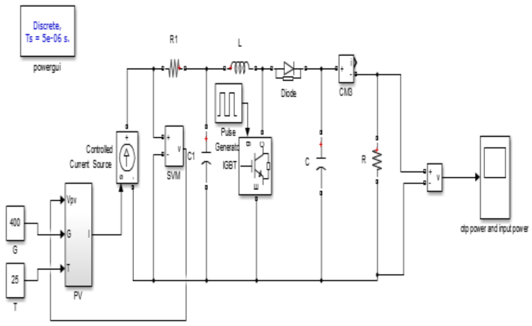
Major Roles of Battery Storage System :

- Load leveling
- Mitigation of fluctuation caused by renewable energy
- Enhancement of power quality
- Emergency power supply
- Voltage control in distributed network

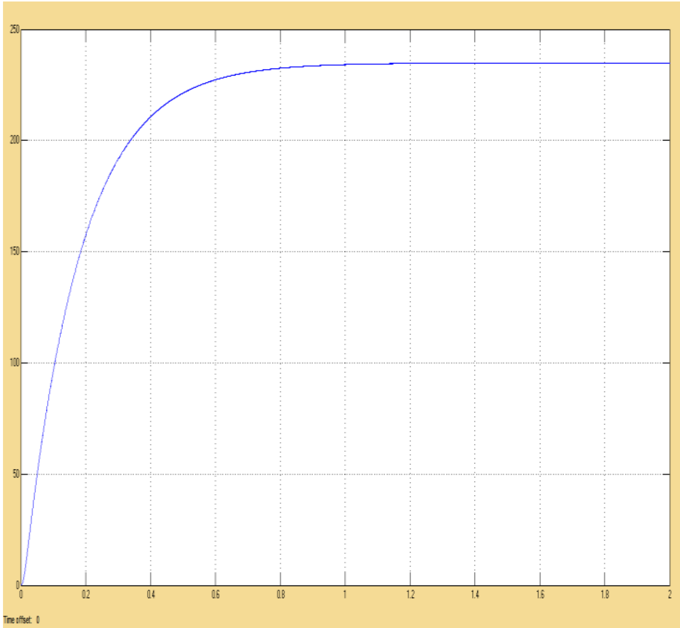
IV.SOLAR CELL AND ITS APPLICATION :

Solar photovoltaic energy is the most power energy which is mostly used in standalone system, plentily available and environment friendly.Photovoltaic cells which are made from solar panels are connected in parallel and series. Photovoltaic cells convert the solar energy in DC electric energy. In all stand alone hybrid systems battery technology plays a significant role.

SIMULATION RESULT OF SOLAR CELL INTEGRATION



RESULT:



V. BATTERY ENERGY STORAGE SYSTEM (BESS) IN PV SYSTEM:

Distributed generation (DG) system which is integrated into the renewable energy into the grid involves interfacing through power electronic converters and energy storage device. Both utility scale and in small scale application require Energy storage systems.

SIMULATION RESULT OF DC-DC CONVERTER WITH PID CONTROLLER

Switching mode DC-DC converters are of 3 types.i.e Buck converter, Boost converter,Buck-Boost converter. The output voltage can be reduced by the Buck converter. The output voltage can be increased by the Boost converter. In Buck-Boost mode, the voltage is balanced but in opposite polarity.Here we use BUCK Converter.

$$C\frac{dVc}{dt} = i_C - v_c/R - i_o$$

$$L\frac{dil}{dt} = uv_{in} - v_C$$

Where i_o is the load current

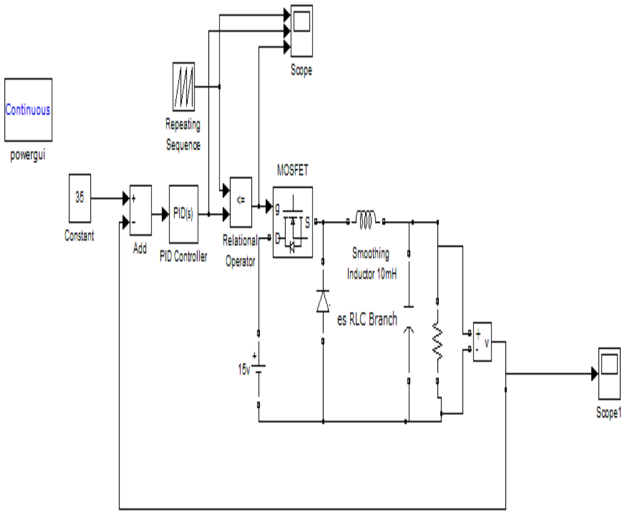
The overall model is represented by the equation :

$$C\frac{dVc}{dt} = \frac{R}{R+Rc}(i_l - v_c/R - i_o)$$

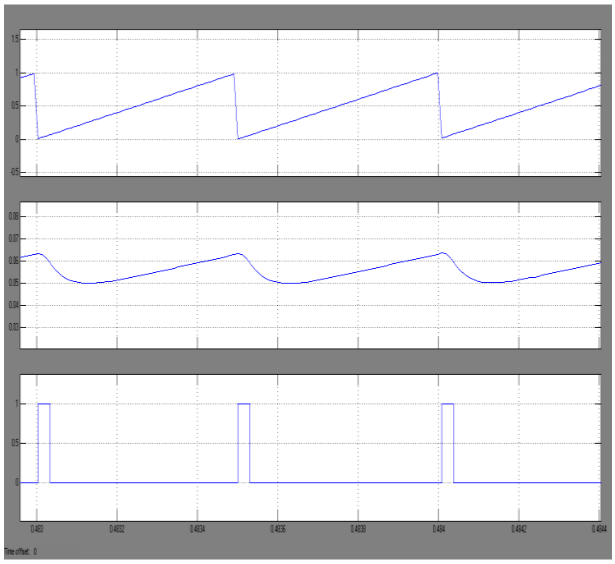
$$L\frac{dil}{dt} = uv_{in} - \frac{Rvc}{R+Rc} - (R_{l+}\frac{RRc}{R+Rc})i_l + \frac{RRcio}{R+Rc}$$

$$V_o = \frac{Rvc}{R+Rc} + \frac{RRc}{R+Rc}(i_l - i_o)$$

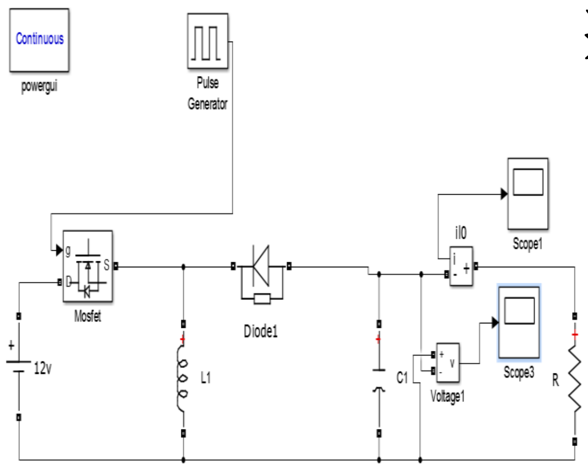
CONVERTER WITH PID CONTROLLER SIMULATION



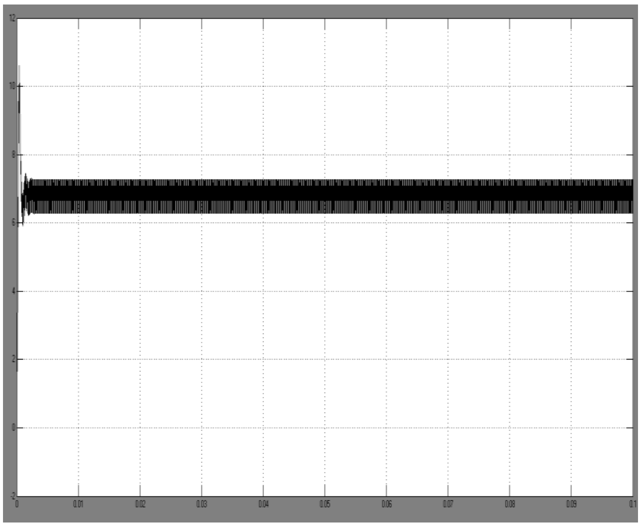
RESULT:



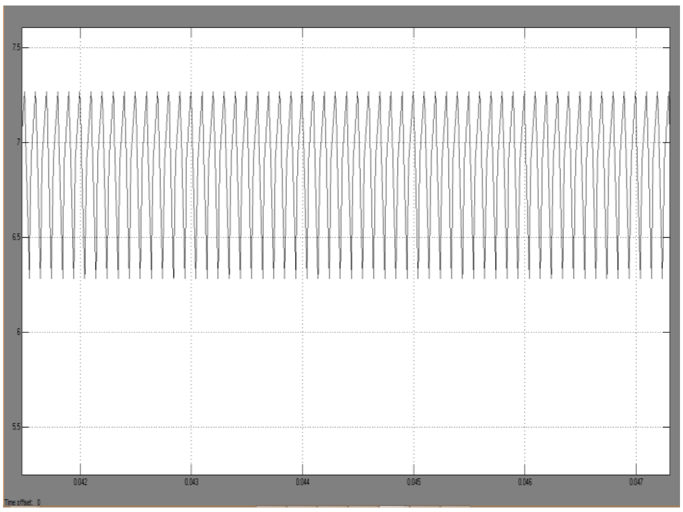
MODELLING OF BUCK- BOOST CONVERTER:



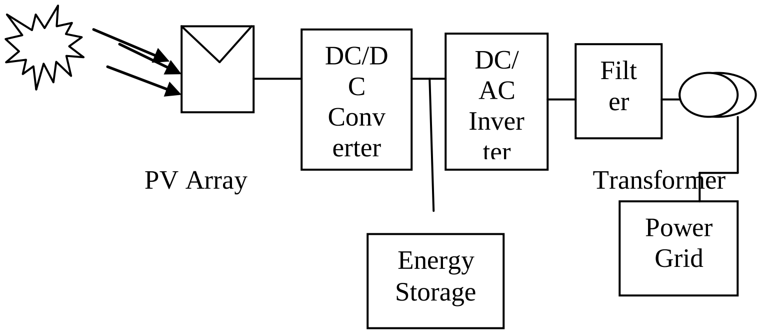
RESULT: 1



RESULT-2 (DURING STEADY STATE CONDITION)

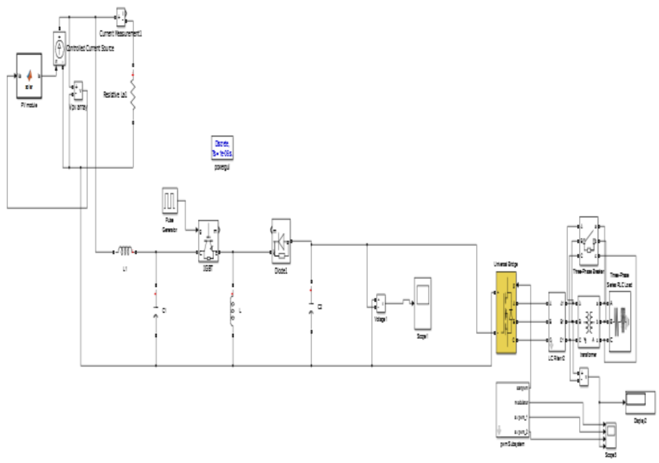


OPERATION OF INTERATED CIRCUIT:

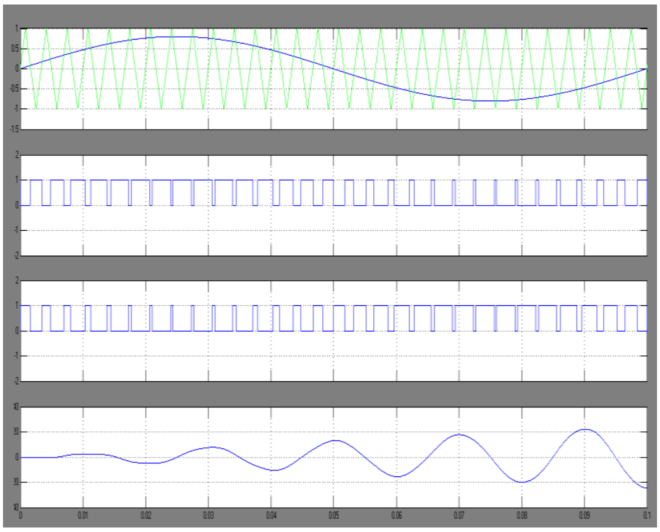


The system can be divided in three main parts which are to be considered; these are the PV panels, the power electronics and the control system. The PV panels are the point of power input and the main emphasis will be on how to extract the maximum power from the panels at any time through power conditioning by the power electronics stage. This stage includes the DC-DC converter, the DC link and the inverter. The Dc-Dc converter is responsible for Maximum Power Point Tracking,while the inverter is keeping the DC link voltage on a constant level. The DC link is decoupling each of the converter stages and its purpose is to act as an energy storage element and filter. To obtain a stable system operation the voltage in the system need to be monitored and controlled. This is accomplished by implementing a control system through digital signal processing

MODELLING OF INTEGRATED CIRCUIT:



RESULT:



VI. CONCLUSION:

Due to the modernisation being made in battery chemistry i.e installation, design and integration services on to the grid so the oppotunities for battery seems to be more high.The main objective of this paper is operation and control of battery energy storage system,inproving system stability,reliability,economy and system overall efficiency.The main motivation of this paper is to design the control and operation strategies of BESS to mitigate the negative impacts of PV integration.The main things to do in this paper is to modelling battery,power factor correction,Ac sysnchronisation and inverter designing. Due to continuous increase ofrenewable resouces and the installation of grid, energy storage system has potential to help the next generation smart grid.

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VIII. BIBILOGRAPHY

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