HYBRID SINGLE PHASE POWER SUPPLY

A mini project submitted in Particular fulfillment for the award of the degree of

1. **A.S.L. DEEPTHI(15BQ1A0203)**
2. **CH. NARAYANA REDDY (16BQ5A0209)**
3. **B. DEVA KUMAR(15BQ1A0209)**
4. **A.CHAITANYA DEEP(15BQ1A0204)**
5. **A. SAMPATH KUMAR(16BQ5A0202)**

BACHELOR OF ENGINEERING

In

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Under the Esteemed guidance of

I.L.J.BHAKTHA SINGH

ASSISTANT PROFESSOR

VASIREDDY VENKATADRI INSTITUTE OF TECHNOLOGY

Accredited by NBA, Approved by AICTE, Permanently Affiliated to JNTUK, NAAC Accredited with 'A' Grade, ISO 9001:2008 Certified,

Nambur (V), Pedakakani (M), Guntur (Dt.), Andhra Pradesh – 522 508,

www.vvitguntur.com

VASIREDDY VENKATADRI INSTITUTE OF TECHNOLOGY

(Approved by AICTE and Affiliated to JNTU, Kakinada)

NAMBURU (V), PEDAKAKANI (M), GUNTUR DT – 522 508

Tel No: 0863-2119782, URL: www.vvitguntur.com

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

CERTIFICATE

This is to certify that the project work titled **"SINGLE PHASE HYBRID POWER SUPPLY"** by XXXXXXXX during the academic year 2018 – 2019 under the guidance of **I.L.J.BHAKTHA SINGH** is submitted in partial fulfillment for the award of the degree of Bachelor of Technology in Electrical & Electronics Engineering.

I.L.J.BHAKTHA SINGH	Dr. A. V Naresh Babu
Assiatant professor	Head of the department,
Department of EEE	Department of EEE
VVIT,	VVIT,
Nambur	Nambur.

ACKNOWLEDGMENT

We express our sincere thanks where it is due

Foremost we would like to extend our heartfelt thanks to our beloved parents whose blessings and encouragement were always there as source of strength and inspection.

We express our sincere thanks to our beloved **Director Dr. R Naveen** garu for providing support and stimulating environment for developing the project.

We thank **Dr. Y. Mallikajuna Reddy** **Principal**, Vasireddy Venkatadri Institute of Technology, Nambur, for providing us the resource for carrying out the project.

Our sincere thanks to **Dr. A. V Naresh Babu, HOD, EEE** for his co-operation and guidance in helping us to make our project successful and complete in all aspects. We are grateful to his precious guidance and suggestions.

We also express our sincere thanks and are grateful to our guide **I.SHOBA RANI**, department of EEE for motivating us to make our project successful and fully complete. We are grateful for his precious guidance and suggestions.

We also place our floral gratitude to all other teaching staff and lab technicians for their constant support and advice throughout the project.

Last but not the least we thank our friends who directly or indirectly helped us in the successful completion of our project.

1. A.S.L. DEEPTHI(15BQ1A0203)
2. CH. NARAYANA REDDY (16BQ5A0209)
3. B. DEVA KUMAR(15BQ1A0209)
4. A.CHAITANYA DEEP(15BQ1A0204)
5. A. SAMPATH KUMAR(16BQ5A0202)

ABASTRACT

Demand of electricity is growing very rapidly for industrialization & urbanization of India. Renewable energy sources being available abundantly in nature can be considered as a better option over conventional energy sources. Solar and wind energy are available in large amount and can be considered as reliable source of power generation. Hybrid solar and wind energy systems can be used for rural electrification and modernization of remote area. Solar energy is generated using PV arrays and wind energy using wind generator. Both the generated voltages are boosted up by boost converters.

For this project simulation and hardware model of hybrid solar and wind power system connected to grid is done. The prototype hardware model of single phase is developed. Seven level inverters is used for converting dc power generated from solar into ac. The advantage of using seven inverter is used to improve the overall power quality of the system. A battery is used as a backup supply and also a synchronising panel is used to synchronise input and output power flow.

PV output is dc and then converted to ac by inverter. By approaching new strategy for multi - level inverter for reducing harmonic reduction. Multilevel inverters are recently used for harmonic reduction. H-Bridge multilevel inverter is used for improvement of power quality. In the proposed work solar energy is connected to the grid through seven level inverters and wind energy is directly connected to the grid.

Simulation models are constructed for both single phase inverter and single phase multi inverter and is validated through experimental results using PIC microcontroller. The hardware prototype model of the proposed scheme was also developed for single phase power system.

INDEX

TITLE **PAGE NO.**

TABLE OF FIGURES

INTRODUCTION

1.1 GENERAL INTRODUCTION

The renewable energy resources are omnipresent, freely available and environment friendly. A renewable hybrid energy system consists of 2 or more energy source and an optimal energy storage system. These hybrid systems are becoming more popular in remote area power generation application. This project will combine photovoltaic and wind energy to make hybrid system. Photovoltaic and wind energies can hold most potential to meet the demand.

Wind energy is capable of supplying large amount of power but its presence is highly is predictable as it may or may not present all the day. Similarly solar energy is present all the day but the solar irradiation levels may vary due to sun intensity and ‘is unpredictable .The common drawback of photovoltaic and wind systems are their intermittent nature that makes them unreliable. By the combined utilisation of these two renewable energy resources, the power transfer efficiency and reliability of the system can be improved significantly.

When a source is unavailable or insufficient in meeting load demand the other energy source can compensate the difference. Here seperate DC-DC boost converters are connected to reach maximum demand from both the sources. Both ends of this converter are connected to single phase multi inverter to get desired waveforms. Passive input filters are connected to system to reduce high frequency harmonics in wind generators. These may increase power loss so alternative multi input rectifier structure is connected to wind energy system.

2. PROJECT PLANNING

2.1 SCOPE OF THE PROJECT

Future Study:

In future more sophisticated and less power consuming hybrid system can handle more loads for colleges and industries. In India more solar energy is received from the sun and the full energy is not utilized for generation of power. In future, using solar panel and wind generator for all domestic, industrial and colleges the more energy can be received from the hybrid system and energy requirement from the government can be reduced. So the non-renewable energy sources usages are minimized. Moreover it can be implemented in Electric Vehicle.

Integrated system of two or more renewable energy systems, also known as hybrid renewable energy system (HRES), is gaining popularity because the sources can complement each other to provide higher quality and more reliable power to customer than single source system.

Approximately one-fifth of the global populations are living without electricity in the world. In developing countries of Asia, it is estimated that almost one third of total population are deprived of electricity. An alternative to the grid connected power is the renewable energy based off-grid power system.

2.2 OBJECTIVES OF THE PROJECT

A grid connected Hybrid renewable energy source can supply electricity to both load and grid. The operating mode of HRES can be classified into island mode where the generated electricity is consumed locally and grid connected mode where the renewable energy source is connected to the grid.

1) The objective of the project is to generate green energy from the renewable energy resources like solar and wind.

2) By using this hybrid power generation pollution free earthing system can be developed and level of non-renewable energy sources can be maintained.

3) By using solar and wind energy power generation global warming can be reduced.

4) Since domestic solar panels and domestic wind mills are used, during day time solar panels provide supply and during the rainy day or night time windmill produces the energy. So there will be continuous production.

3. LIST OF COMPONENTS

1. SOLAR PANELS
2. WINDMILLS
3. HYBRID DC-DC BUCK BOOST CONVERTER
4. H-BRIDGE SINE WAVE SINGLE PHASE INVERTER
5. SYNCHRONISING PANEL
6. BI DIRECTIONAL BUCK CONVERTER
7. SINGLE PHASE LOAD
8. BATTERY
9. PROTECTION RELAYS

a) Over current relay

b) Over voltage relay’

c) Frequency fault relay

d) Directional relay

4. COMPONENTS DESCRIPTION

4.1. SOLAR PANEL:

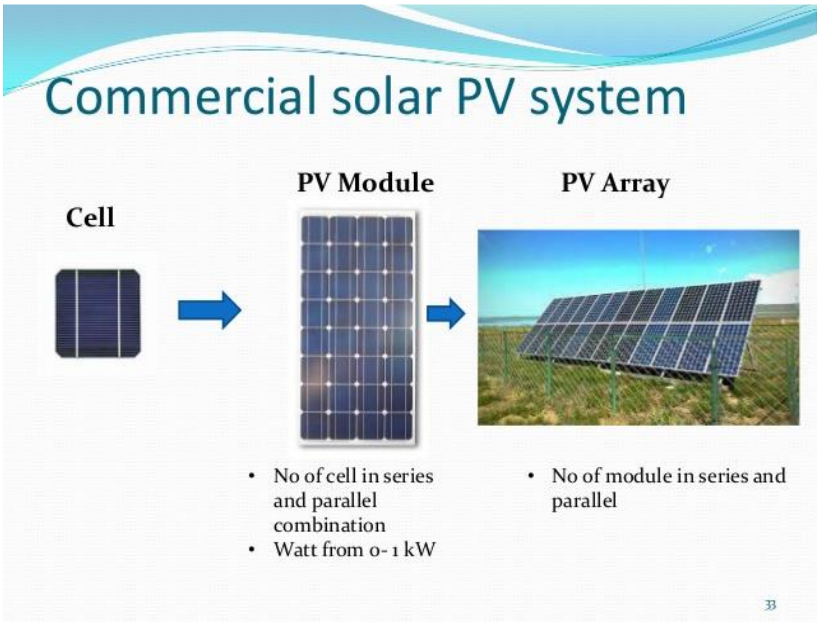
A solar panel is a packed interconnected assembly of solar cell also known as photovoltaic cells. A single solar panel can only produce a limited amount of power, many installations have several panels. Hence it is called as photovoltaic array. The flexibility of the modular PV system allows designers to create solar power systems that can meet a wide variety of electrical needs.

Solar panels use light energy from the sun to generate electricity to photovoltaic cells. The majority of the modules use wafer-based crystIline silicon cells or a thin film cell based on cadmium telluride or silicon. In order to use the cells in practical applications, they must be connected electrically to one another and top must be protected from mechanical damage and moisture which corrodes metal contacts and interconnections. Most of the modules are rigid.

To achieve the desired voltage and current, Modules are wired in series and parallel into Array. Electrical connections are made in series to achieve a desired output voltage and in parallel to provide a desired amount of current source capability. Diodes are included to avoid overheating of cells in case of partial shading. Since cells heating reduces the operating efficiency it is desirable to minimise the heating by providing good ventilation behind the module. New design of modules include concentrator modules in which light is concentrated by an array of lenses or mirrors into an array of small cells.

FIG:1 SOLAR PANELS

FIG 2: COMMERCIAL SOLAR PV SYSTEM



A photovoltaic array is the complete power-generating unit, consisting of any number of PV modules and panels. The performance of PV modules and arrays are generally rated according to their maximum DC power output (watts) under Standard Test Conditions (STC).

Solar Module/Panel refers to a single photovoltaic panel which is a packaged, connected assembly of solar cells. They are used as a component of a larger PV system when connected in series or parallel with other modules.The solar panel output is electric power and is measured in terms of Watts or Kilo watts. These solar panels are designed with different output ratings like 5 watts, 10 watts, 20 watts, 100 watts etc. So, based on the requirement of output power, we can choose appropriate solar panel.

4.2. WINDMILLS

Wind energy is also one of the renewable energy resources that can be used for generating electrical energy with wind turbines coupled with generators. There are various advantages of wind energy, such as wind turbines power generation, for mechanical power with windmills, for pumping water using wind pumps, and so on.

Wind turbines are used to convert wind power into electrical power. Electrical generator inside turbine convert mechanical power to electrical power. These can be classified based on physical features, generation of power etc. The production by wind turbines depends on wind velocity acting on the turbine.Wind turbine systems are available ranging from 50 watts to (2-3)Mega watts. In this project we use 200V, 3500Watts generator. Power production capacity based on classification has four sub classes.They are:

- Small power systems
- Moderate power systems
- Big power systems
- Mega watt turbines

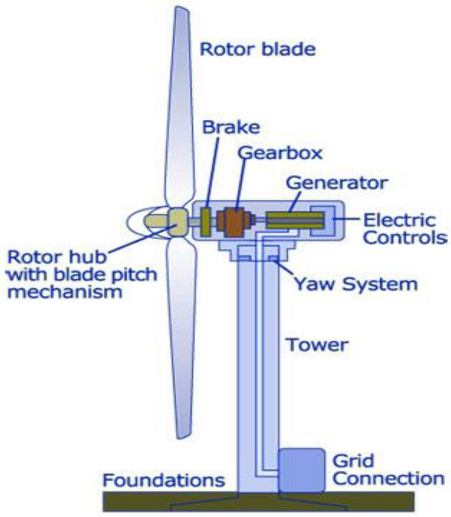


FIG3:WIND TURBINE GENERATOR

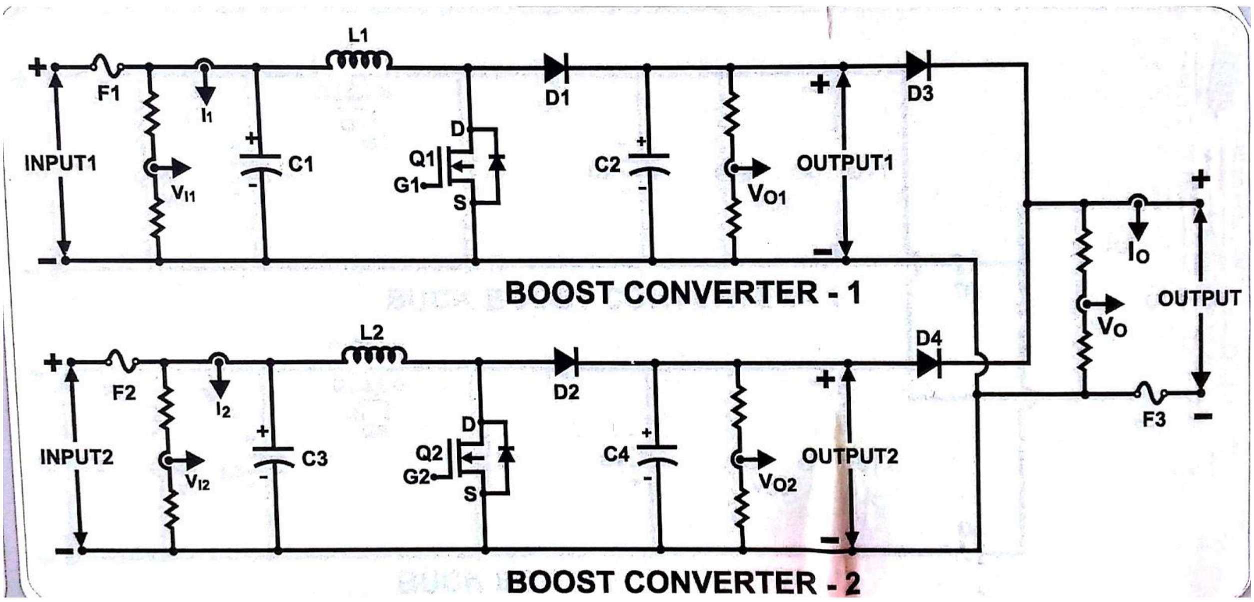
FIG 4: WIND MILL

Large wind turbines are made to rotate with the blowing wind and accordingly electricity can be generated. The minimum wind speed required for connecting the generator to the power grid is called as cut in speed and maximum wind speed required for the generator for disconnecting the generator from the power grid is called as cut off speed. Generally, wind turbines work in the range of speed between cut in and cut off speeds.

4.3. HYBRID DC-DC BUCK BOOST CONVERTER:

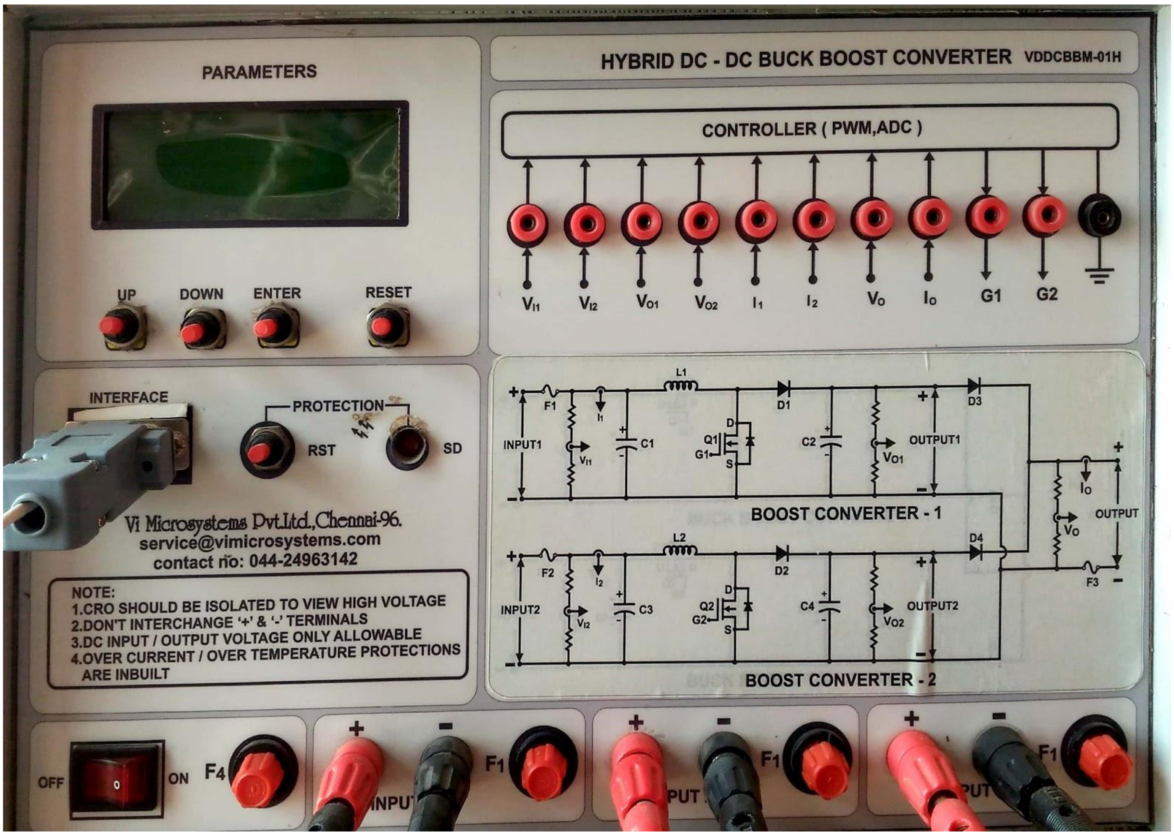
In today systems often additional energy sources are required to assist the main source and must be able to transfer the energy from all sources to the load. Several solutions have been proposed if more than one dc source is used to feed the load. Multi-input (dual) DC-DC converters are obtained from two DC-DCconverters coupled in a way that allows the sharing of the output filter. Four power switches and four diodes are employed in the proposed converter. This have two unidirectional and a bidirectional inputs make the structure a suitable for hybrid power generation. Then tracking the maximum power of the PV source and calibrating the output voltage can be equipped by controlling duty ratios of the switches.

FIG 5:HYBRID DC BUCK BOOST CONVERTER



By using buck and boost converters the voltage can be step up or step down according to load requirements. A boost converter (step-up converter) is a power converter with an output DC voltage greater than its input DC voltage.

FIG 6: PANEL DIAGRAM



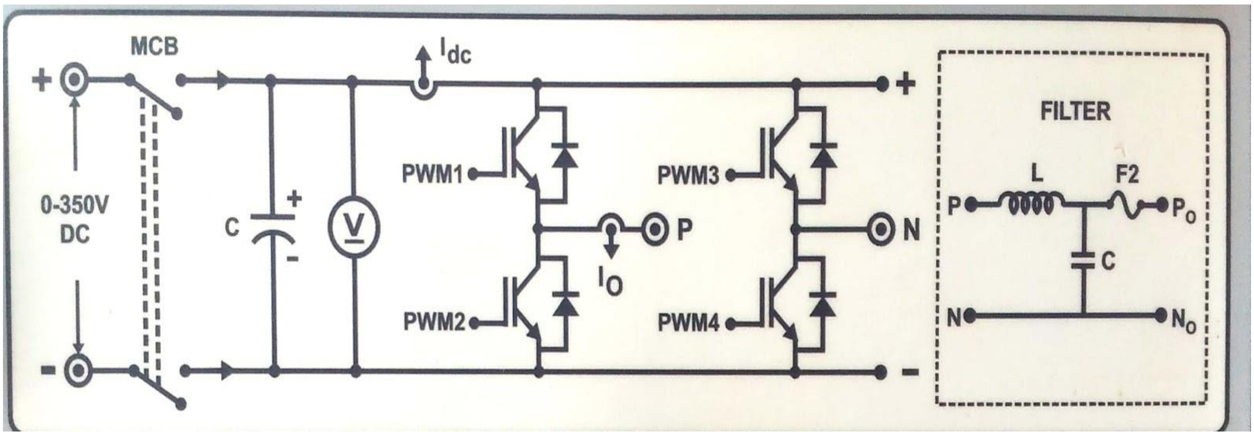
It is a class of switching-mode power supply (SMPS) containing at least two semiconductor switches (a diode and a transistor) and at least one energy storage element. Filters made of capacitors (sometimes in combination with inductors) are normally added to the output of the converter to reduce output voltage ripple. A buck converter is a step-down DC to DC converter. It is a switched-mode power supply that uses two switches (a transistor and a diode), an inductor and a capacitor.

The simplest way to reduce a DC voltage is to use a voltage divider circuit, but voltage dividers waste energy, since they operate by bleeding off excess power as heat; also, output voltage isn't regulated (varies with input voltage). Buck converters efficiency is up to 95% for integrated circuits.

4.4. H- BRIDGE SINE WAVE SINGLE PHASE INVERTER

An inverter is an electrical device that converts direct current (DC) to alternating current (AC). since the output voltage from wind turbine is not pure sinusoidal so it must be converted into dc. The converted AC can be at any required voltage and frequency with the use of appropriate transformers, switching, and control circuits. There are three types of DC-AC inverters, the square wave, the modified sine wave and pure sine wave.

FIG7:H-BRIDGE SINE WAVE INVERTER



Pure sine wave inversion is obtained by taking a DC voltage source and switching it across a load using an H-bridge. H-Bridge is an electronic device that consists of four switching elements that allow voltage to be applied across a load in either direction. The inverted signal is composed of a pulse width-modulated signal which encodes a sine wave. In Pulse width modulation the width of a pulse carrier is made to vary in accordance with the modulation voltage.

4.5. SYNCHRONISING PANEL:

In an AC power system, synchronization is the process of matching the speed and frequency of a generator or other source to a running network. An AC generator cannot deliver power to an electrical grid unless it is running at the same frequency as the network. If two segments of a grid are disconnected, they cannot exchange AC power again until they are brought back into exact synchronization.

once the load increases or there is not sufficient wind or enough sun rays to produce required voltage then the system switches to other sources whose output power will be synchronised with the alternate sources so that the load will be driven by synchronised sources simultaneously. Similarly if the load decreases the local grid is disconnected and the load can be fed by the synchronised output of the solar-wind power system.

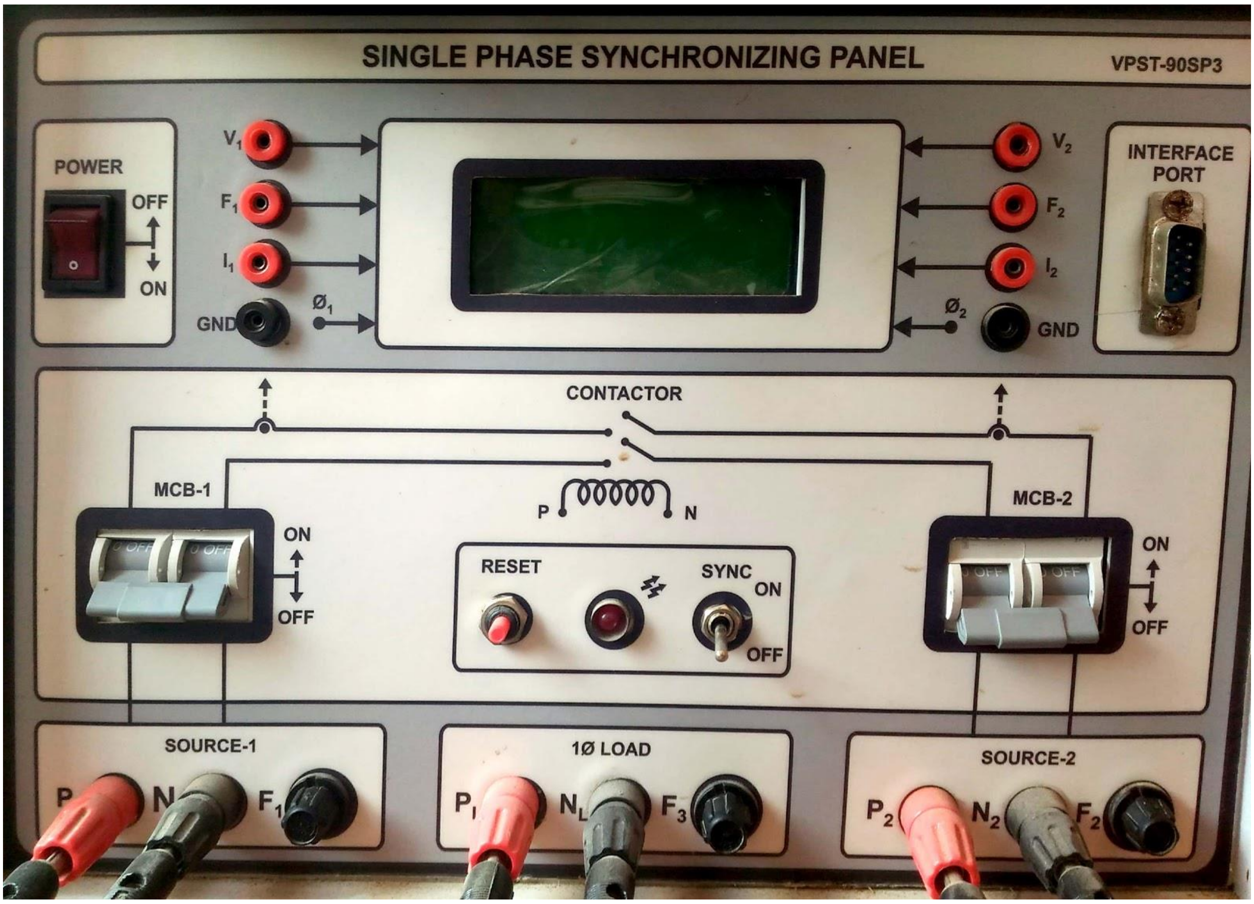


FIG 8: SYNCHRONISING PANEL

once the load increases or there is not sufficient wind or enough sun rays to produce required voltage then the system switches to other sources whose output power will be synchronised with the alternate sources so that the load will be driven by synchronised sources simultaneously.Similarly if the load decreases the local grid is disconnected and the load can be fed by the synchronised output of the solar-wind power system.

4.6. BI- DIRECTIONAL BUCK CONVERTER

A common configuration for a stand-alone PV power system may consist of three converters: a buck converter for the PV panel to charge the battery, a boost converter for the battery to discharge to the load and one for the load voltage regulation. Such a system requires a coordinated control scheme for three converters which can be complicated. so a bidirectional converter which is a combination of a buck andboost converter is used. When controlled properly the system can provide uninterrupted power to the load, despite the intermittent availability of sunlight.

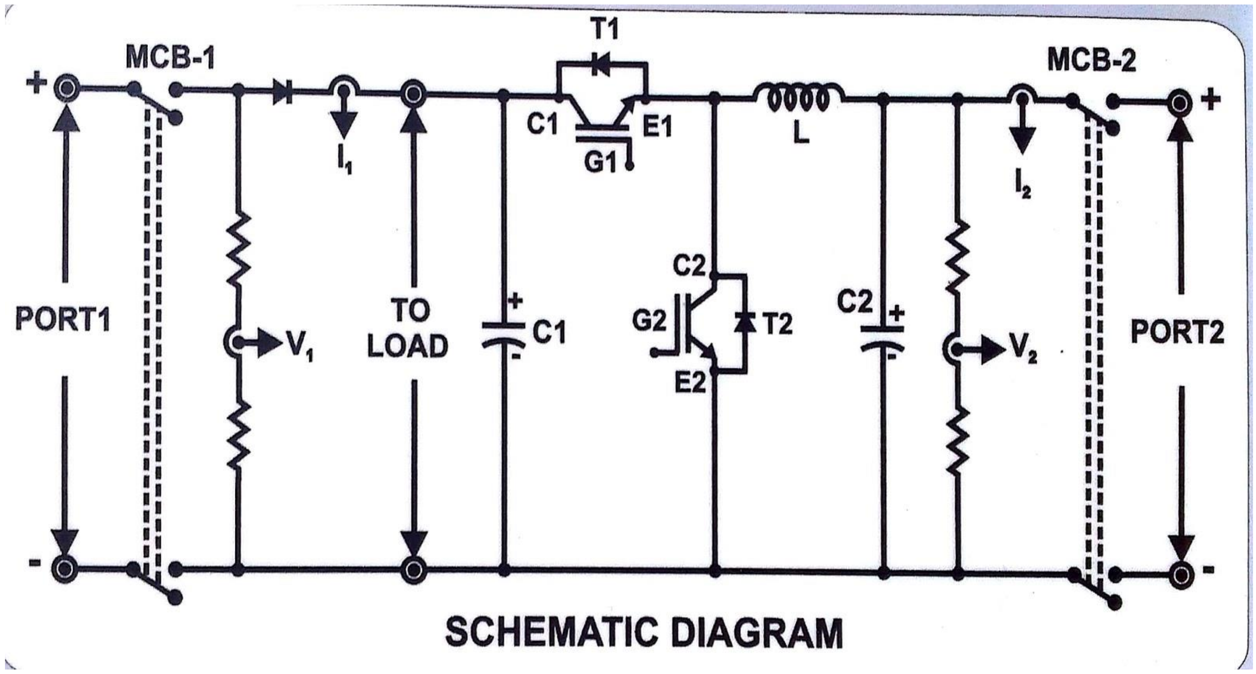
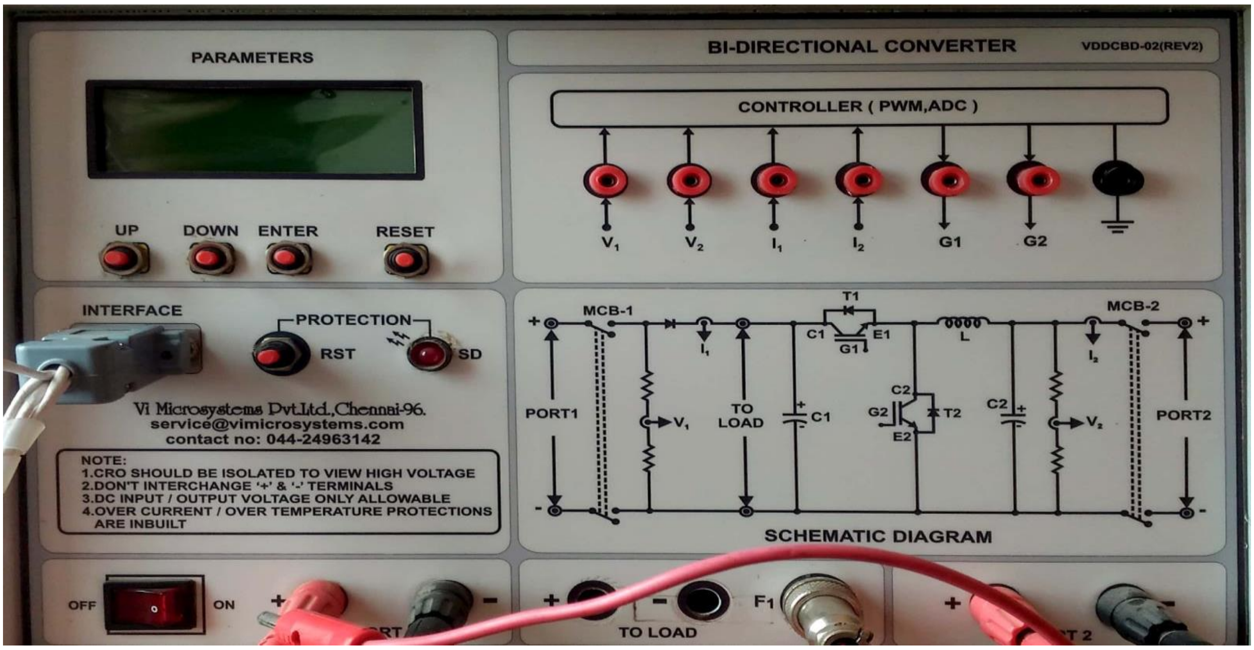


FIG 9: BIDIRECTIONAL CONVRTER

Voltage mode control technique is used to control the bidirectional converter. In this technique, voltage across the load is sensed to regulate output voltage. Sensing of voltage using voltage sensor where load voltage is sampled first then it will be sensed by voltage sensor and then its output is given to comparator circuit which compare load voltage. If load voltage is less than fixed or voltage which is to be regulated then battery will supply power to the load through the bidirectional converter. Also using this voltage mode, charging as well as discharging of battery is regulated.

FIG 10: PANEL DIAGRAM



4.7. LOAD:

Generally load selection depends on the demand required. In this project we choose a single phase load i.e a lamp with an energy meter.

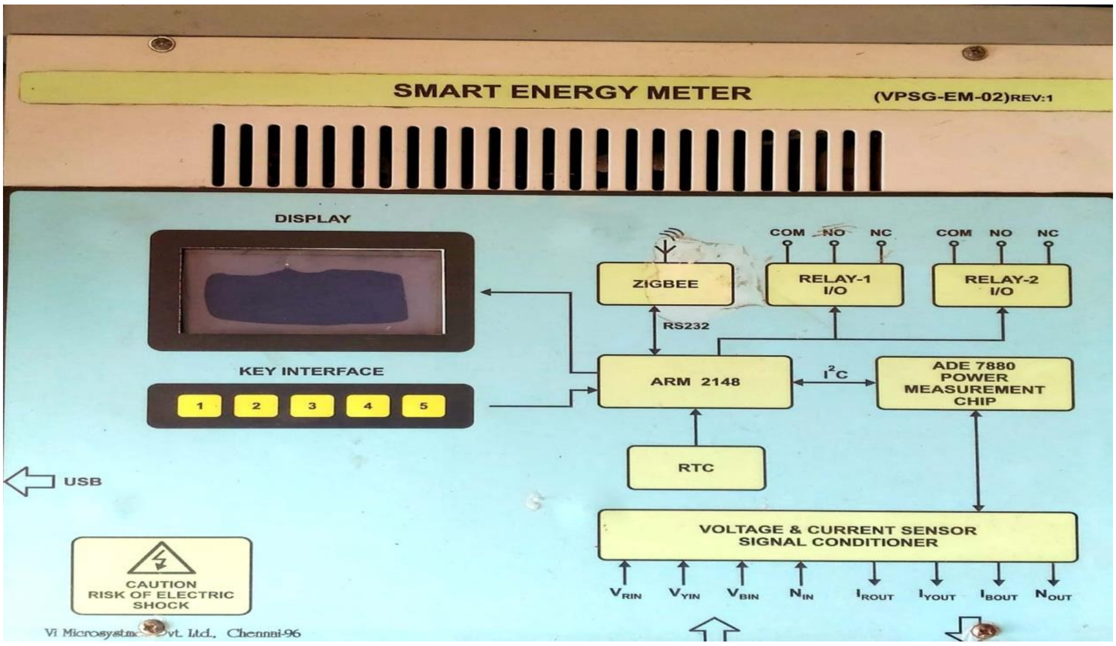


FIG 11: SMART ENERGY METER

4.8. BATTERY :

An electrical battery is one or more electrochemical cells that convert stored chemical energy into electrical energy.

FIG 12: BATTERY

4.9. PROTECTION DEVICES:

a) ***OVER CURRENT RELAY***: The overcurrent relay is defined as the relay, which operates only when the value of the current is greater than the relay setting time. It protects the equipment of the power system from the fault current.

b) ***OVER VOLTAGE RELAY***: An over-voltage relay operates when the current produced by a load,or device connected to the output of a circuit, exceeds a predetermined value. It serves primarily the same purpose as an overcurrent relay except that it is connected in the line by a potential transformer which measures the voltage across the line. When an overvoltage exists the relay operates and opens the circuit breaker.

c) ***FREQUENCY FAULT RELAY:*** For synchronising process both the devices should have same frequency. So if any imbalances occur between the frequencies the the relay operates.

d) DIFFERENTIAL RELAY: differential relay is very commonly used relay for protecting

transformers and generators from localised faults.The operation whose relay depends on the phase difference of two or more electrical quantities is known as the differential protection relay.

5.CONSTRUCTION:

5.1 BLOCK DIAGRAM:

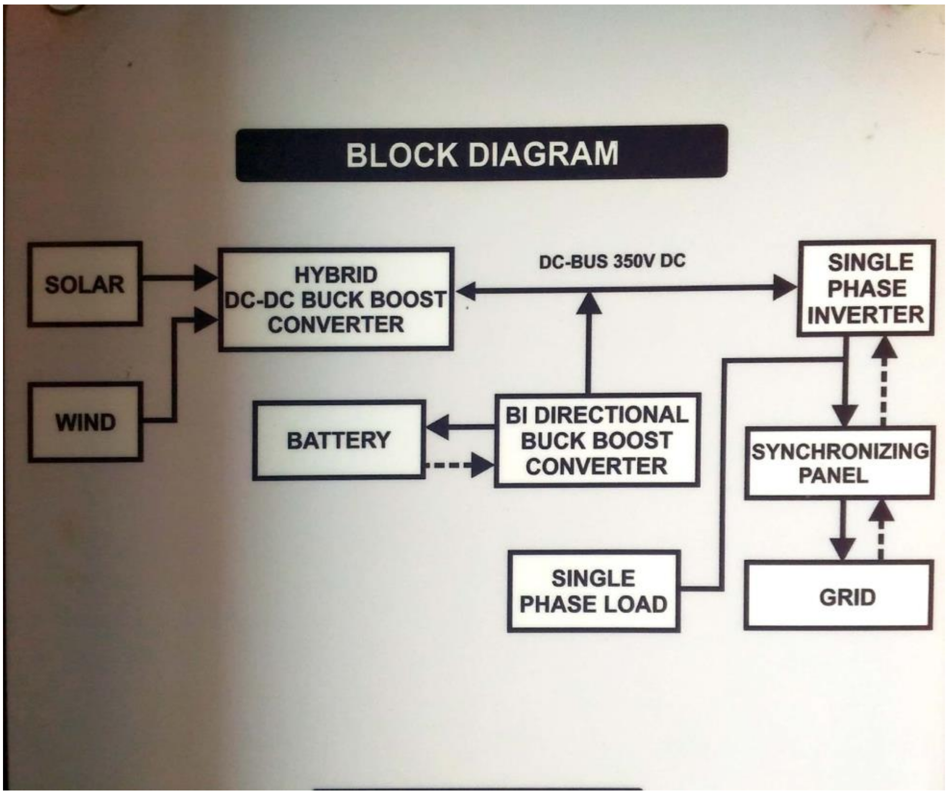


FIG 13: BLOCK DIAGRAM

5.2 MATHEMATICAL MODELING

A hybrid energy system might consist of various renewable energy conversion component like wind turbine, PV array and hydro turbines as well as conventional non-renewable generators like diesel generators, micro turbine and storage device like battery. A hybrid energy system might have all or part of it. In order to correctly select the components and subsystems for optimal sizing of the entire system,the first step is the modeling of individual components. Modeling process enables to identify and assists in knowing the components' characteristics and supports

in decision making. The details of modeling is reflected by its correct prediction of performance,however it is too complex or extremely time consuming to design a perfect model. A sufficiently appropriate model should be tradeoff between complexity and accuracy. Performance of individual component is either modeled by deterministic or probabilistic approaches. General methodology for modeling energy system is described below.

PV System:

Power output of a PV array is based on solar irradiance and ambient temperature. The power output in this model is calculated as

Ppv= ηpvg Apvg Gt

where ηpvg is PV generation efficiency, Apvg is PV generator area (m2), and Gt is solar irradiation in tilted module plane (W/m2). ηpvg is further defined as

ηpvg= ηrηpc[1-β(Tc-Tc ref)]

The total radiation in the solar cell considering normal and diffuse solar radiation can be estimated as

IT= IbRb+ IdRd+ Ib Id + (Ib+ Id) Rr

5.3.System Modeling:

Solar cell, the building block of the solar array, is basically a P-N junction semiconductor capable of producing electricity due to photovoltaic effect.37 PV cells are interconnected in series-parallel configuration to form a PV array. Using ideal single diode as shown in Fig. 1

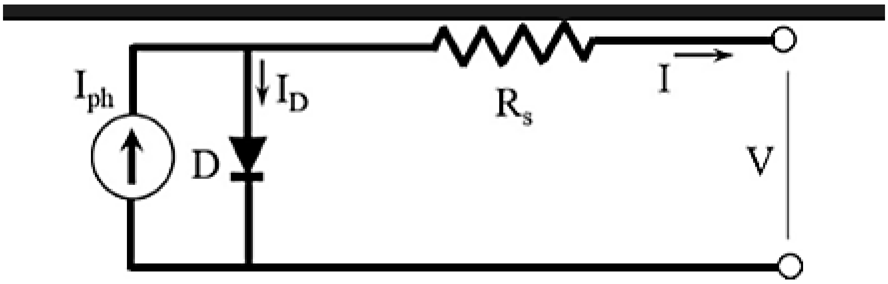


Fig. 1 Ideal single diode PV cell model

for an array with Ns series connected cells and Np parallelconnected cells, the array current may be related to the array voltage as

$$I = N_p\left[I_{ph} - I_{rs}\left[\exp\left(\frac{q(V+IR_s)}{AKTN_s} - 1\right)\right]\right]$$

$$I_{rs} = I_{rr}\left(\frac{T}{T_r}\right)^3 \exp\left[\frac{E_G}{AK}\left(\frac{1}{T_r} - \frac{1}{T}\right)\right]$$

and q is the electron charge (1.6 × 10-9C), K is Boltzmann’s constant, A is the diode ideality factor, T is the cell temperature (K). Irs is the cell reverse saturation current at T, Tr is the cell referred temperature, Irr is the reverse saturation current at Tr, EG is the band gap energy of the semiconductor used in the cell.

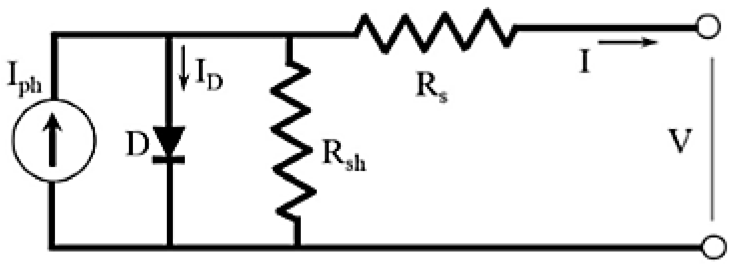


Fig. 2 Single diode PV cell model

The photo current Iph varies with the cell’s temperature and radiation as follows

$$I_{ph} = \left[I_{SCR} + k_i (T - T_r) \frac{S}{100} \right]$$

where ISCR is cell short circuit current at reference temperature and radiation, ki is the short circuit current temperature coefficient and S is the solar radiation in (mW/cm2).

Solar cells are generally modeled as single diode in Fig. 2 and double diode circuit model in Fig.

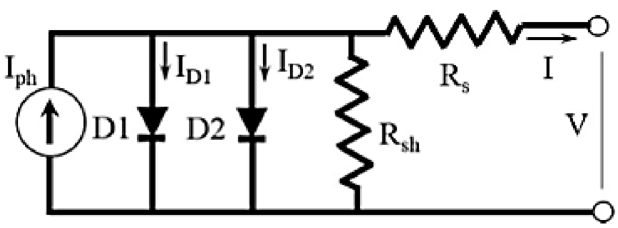


Fig. 3 Double diode PV model

Single diode model uses an additional shunt resistance in parallel to ideal shunt diode model. I-V characteristics of PV cell can be derived using single diode model, as follows:

$$I = I_{PV} - I_{D1} - I_{D2} - \left(\frac{V + IR_S}{R_{SH}}\right)$$

$$I_{D1} = I_{01}\left[\exp\left(\frac{V + IR_s}{a_1 V_{T1}}\right) - 1\right]$$

$$I_{D2} = I_{02}\left[\exp\left(\frac{V + IR_s}{a_2 V_{T2}}\right) - 1\right]$$

I01 and I02 are reverse saturation current of diode 1 and diode 2, VT1 and VT2 are thermal voltage of respective diode. a1 and a2 represent the diode ideality constants.

6.Working of Solar Wind Hybrid System

To better understand the working of solar wind hybrid system, we must know the working of solar energy system and wind energy system. The block diagram of solar wind hybrid system is shown in the figure in which the solar panels and wind turbine are used for power generation.

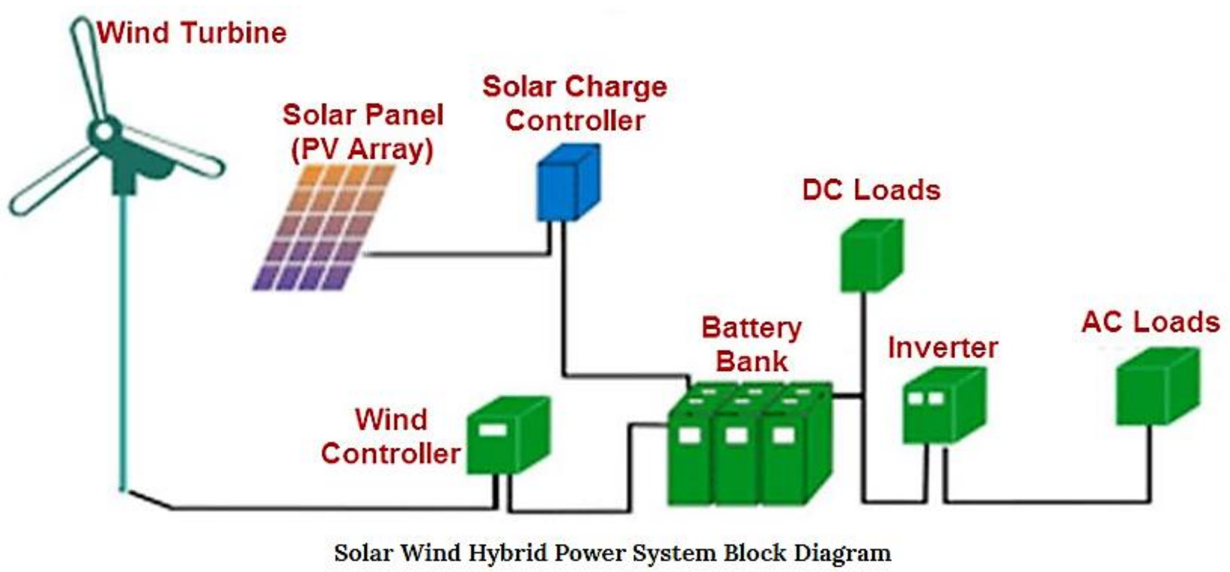


FIG 14: BLOCK DIAGRAM

6.1 Working of Solar Power System

Solar power system consists of three major blocks namely solar panels, solar photovoltaic cells, and batteries for storing energy. The solar panel will get the energy from the direct sunlight and the generated power from the solar panel is directly connected to the control unit. The generated electric power is the alternating voltage. The AC voltage given to the rectifier circuit will convert into DC voltage. Then the rectified voltage is given to filter circuit to remove the ripple voltage. The electrical energy (DC power) generated using solar panels can be stored in batteries or can be used for supplying DC loads or can be used for inverter to feed AC loads.

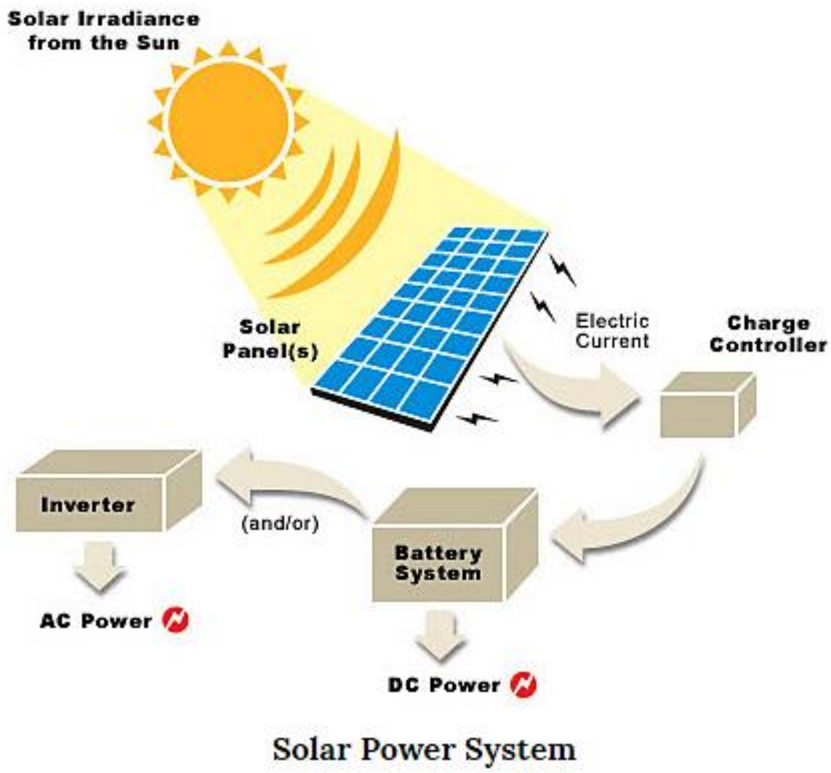
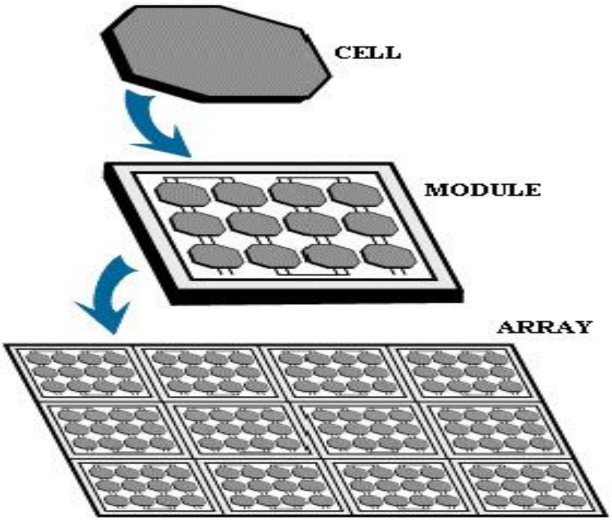


FIG15: SOLAR POWER SYSTEM

After the filtration the pure DC voltage is given to battery through the charging circuit. The stored DC voltage can be used to different application and the excessive energy is connected to the grid using energy meter for reading purpose. During the non-availability of wind mill, Solar panel will supply the load which is fed from EB supply.

6.2 Solar Panels' Working Principle

FIG16:PANELS



The solar panels utilize Ohmic material for interconnections and external terminals. Thus, the electrons produced in the N-type material are passed to the battery through electrode and wire. From the battery, electrons reach p-type material, where these electrons and holes are combined. Hence, the solar panel connected to the battery behaves like another battery, and hence, is comparable to the two serially connected batteries.

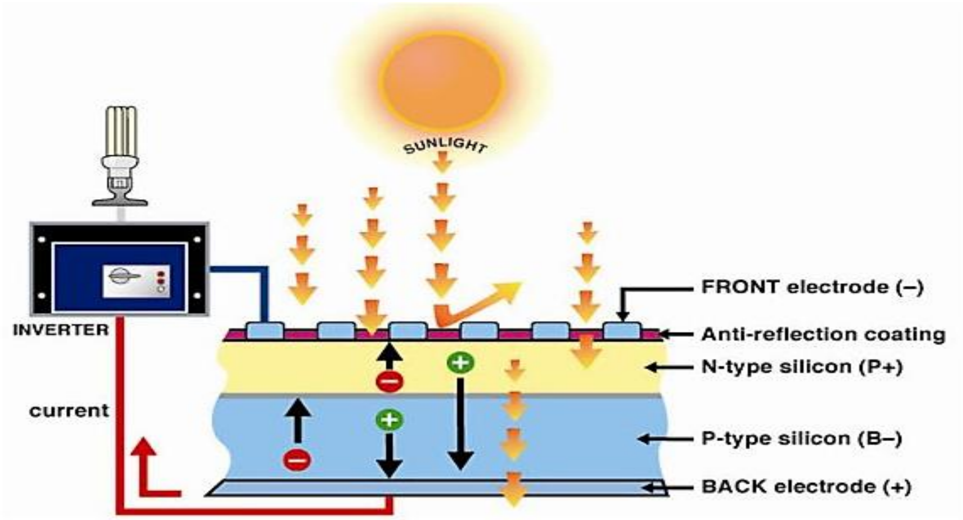
During normal sunlight a 12 volt 15 watts solar panel produces around 1 Ampere current. Generally, solar panels maintained properly will work for 25 years. It is essential for designing the solar panel arrangement on the roof top for efficient usage and typically solar panels are arranged such that they face the East at an angle of 45 degree.

6.3.Solar Photovoltaic Cells Working

Solar photovoltaic cell consists of a P-type of silicon layer that is placed in contact with an N-type silicon layer. The electrons diffuse from the N-type material to the P-type material. The holes in the P-type material accept the electrons but there are more electrons in the N-type material. So, with the influence of the solar energy, these electrons in the N-type material moves from N-type to P-type.

These electrons and holes combine in the P-N junction. Due, to this combination a charge on either side of the P-N junction is created and this charge creates an electric field. This formation of electric field results in developing a diode like system that promotes the charge flow. This is called as drift current and the diffusion of electrons and holes is balanced by drift current. This drift current occurs in an area where mobile charge carriers are lacking and is called as the depletion zone or space charge region. Thus, during night time or in the darkness, these solar photovoltaic cells behave like reverse Bias diodes.

FIG17: PV CELL WORKING

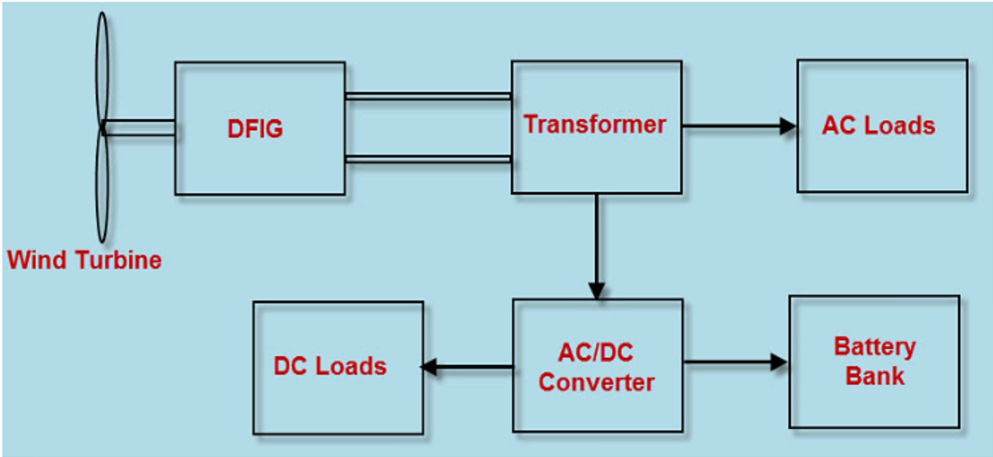


Solar Photovoltaic Cell

6.4.WIND TURBINE WORKING:

Wind mill arrangement is the mechanical arrangements which are easily rotated. The rotating speed depends upon the wind strength. The windmill arrangements and solar panel arrangements are fixed. The wind mill arrangement is coupled with the dynamo. The fan shaft which is coupled with the dynamo shaft is used to generate the electricity power from the generator. The electric power is generated through the dynamo.

The figure shows different blocks of the wind turbine generator system.



Wind Power System

FIG 18:WIND POWER SYSTEM

Wind turbines are used to convert wind power into electrical power. Electrical generator inside turbine convert mechanical power to electrical power. Wind turbine can be defined as a fan consisting of 3 blades that rotate due to blowing wind such that the axis of rotation must be aligned with the direction of blowing wind. A gear box is used for converting energy from one device to another device using mechanical method; hence, it is termed as a high-precision mechanical system. There are different types of wind turbines, but the frequently used wind turbines are horizontal axis turbines and vertical axis turbines.

Large wind turbines are made to rotate with the blowing wind and accordingly electricity can be generated. The minimum wind speed required for connecting the generator to the power grid is called as cut in speed and maximum wind speed required for the generator for disconnecting the generator from the power grid is called as cut off speed. Generally, wind turbines work in the range of speed between cut in and cut off speeds.

6.4.MAXIMUM POWER POINT TRACKING:

Maximum power point tracking (MPPT) is a technique that grid connected inverters, solar battery chargers, wind generators and similar devices use to get the maximum possible power from one or more photovoltaic devices, typically technology. Solar cells have a complex relationship between solar radiation, temperature and total resistance that produces a non-linear output efficiency which can be analyzed based on the I-V curve.

The power generated by solar array depends upon insolation and temperature. The voltage-current relation and voltage power relation are non-linear as shown in Fig

FIG 19: V-I CHARACTERSTICS

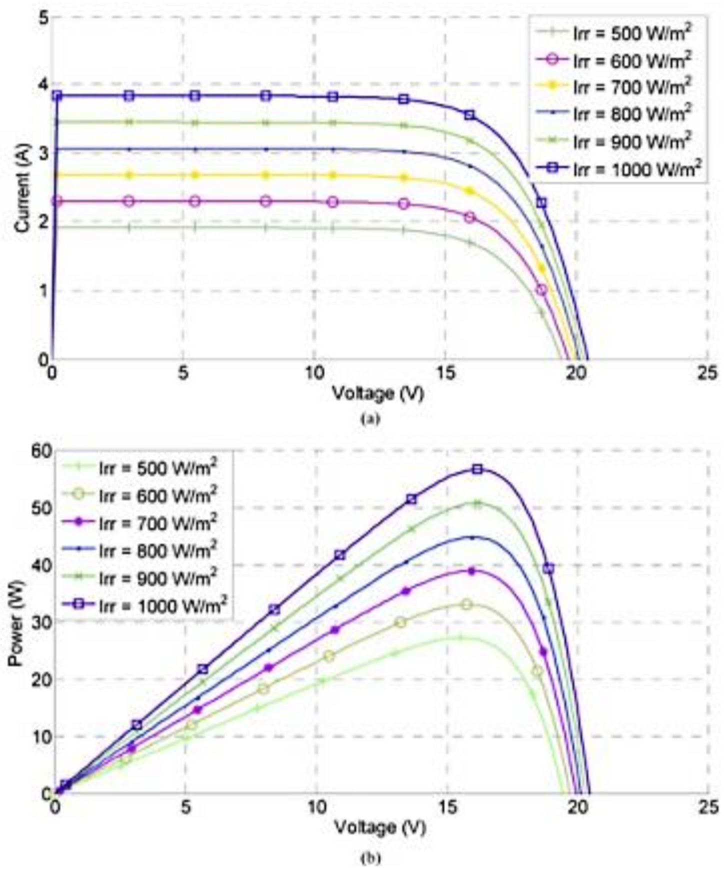


Fig. 7 Solar cell characteristics (a) voltage-current characteristics and (b) voltage-power characteristics

It is the purpose of the MPPT system to sample the output of the cells and apply the proper resistance (load) to obtain maximum power for any given environmental conditions. MPPT devices are typically integrated into an electric power converter system that provides voltage or current conversion, filtering, and regulation for driving various loads, including power grids, batteries or motors.

MPPT in solar is important because it reduces the solar array cost by decreasing the number of solar panels needed to obtain the desired output.

Io=Ig-Isat{Exp(q[V o+ I0Rs])/ AKT)-1)

here A is dimensionless factor.

The output characteristic of PV array is shown in Fig . It shows MPP tracking during varying weather condition.

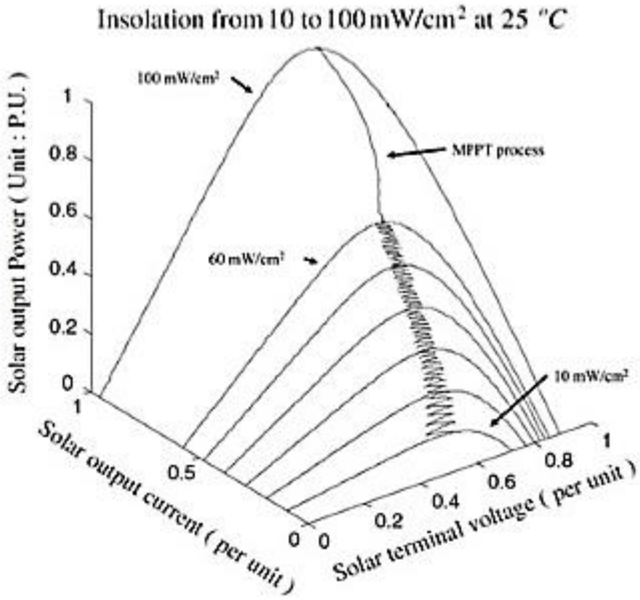


FIG 20: OUTPUT CHARACTERSTICS OF PV ARRAY

a)Perturb and Observe (P&O):

P&O is the most widely used technique because of its simple feedback structure and fewer measured parameters. The basic idea behind P&O is discussed in earlier section. P&O for solar system involves periodically increase or decrease of solar voltage and look for the subsequent power change. If a given perturbation leads to an increase in the array power then the subsequent perturbation is done in the same direction otherwise perturbation is done in opposite direction. As discussed earlier, MPPT for solar using P&O works better than that in wind because the solar irradiance change is relatively slower compared with wind.

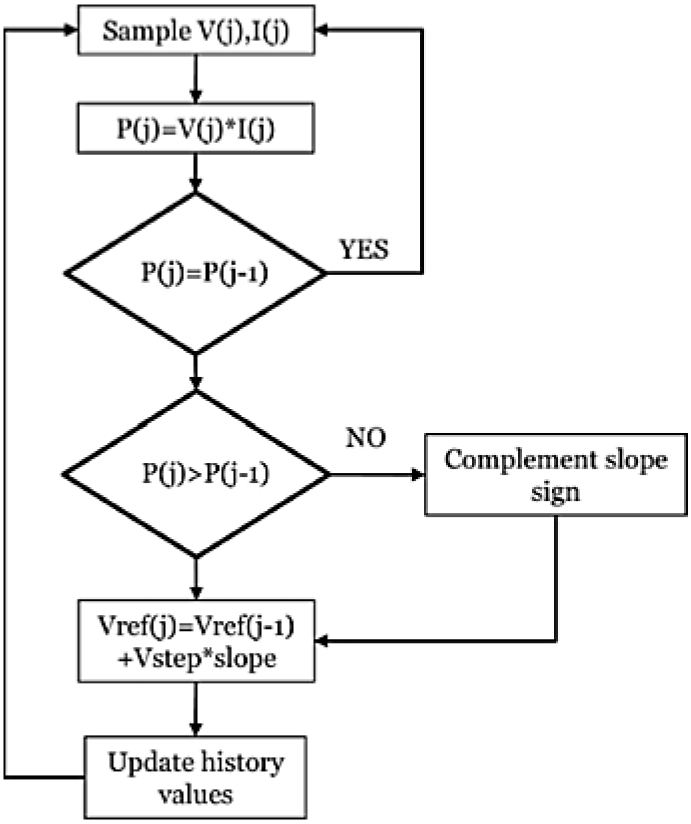


Fig. 14 Flow chart of P&O algorithm for PV system

FIG 21: FLOWCHART OF P&O METHOD

b)Incremental Conductance Method:

Incremental conductance (IC) method is an alternative to P&O method where solar array terminal voltage can be adjusted relative to the MPP voltage by measuring the incremental and instantaneous array conductance (dI/dV and I/V). It seems to overcome the limitations of P&O by using incremental conductance to compute the sign of dP/dV without perturbation.It does this by using expression dP/dV =0.

OPERATION WITH BATTERIES:

At night, an off-grid PV power system may use batteries to supply loads. Although the fully charged battery pack voltage may be close to the PV panel's maximum power point voltage, this is unlikely to be true at sunrise when the battery has been partially discharged. Charging may begin at a voltage considerably below the PV panel maximum power point voltage, and an MPPT can resolve this mismatch.

When the batteries in an off-grid system are fully charged and PV production exceeds local loads, an MPPT can no longer operate the panel at its maximum power point as the excess power has no load to absorb it. The MPPT must then shift the PV panel operating point away from the peak power point until production exactly matches demand.

In a grid connected photovoltaic system, all delivered power from solar modules will be sent to the grid. Therefore, the MPPT in a grid connected PV system will always attempt to operate the PV panel at its maximum power point.

Output Waveforms:

Fig22: Breaker in open condition(grid voltage)

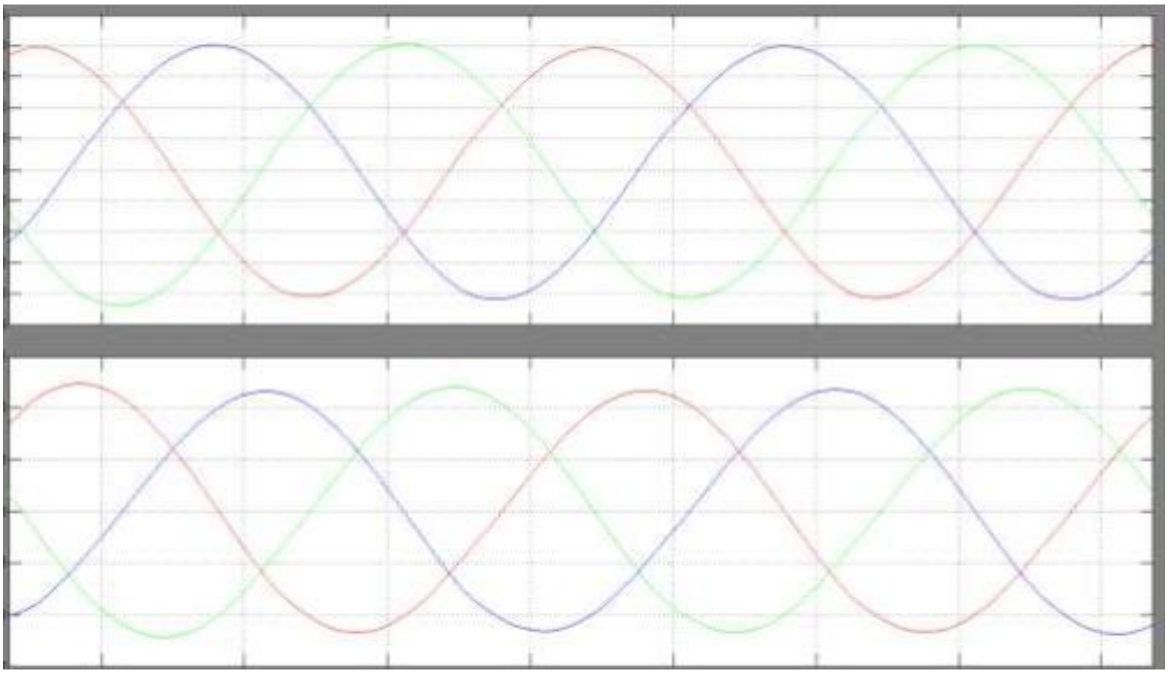


Fig23: Breaker in open condition (load voltage)

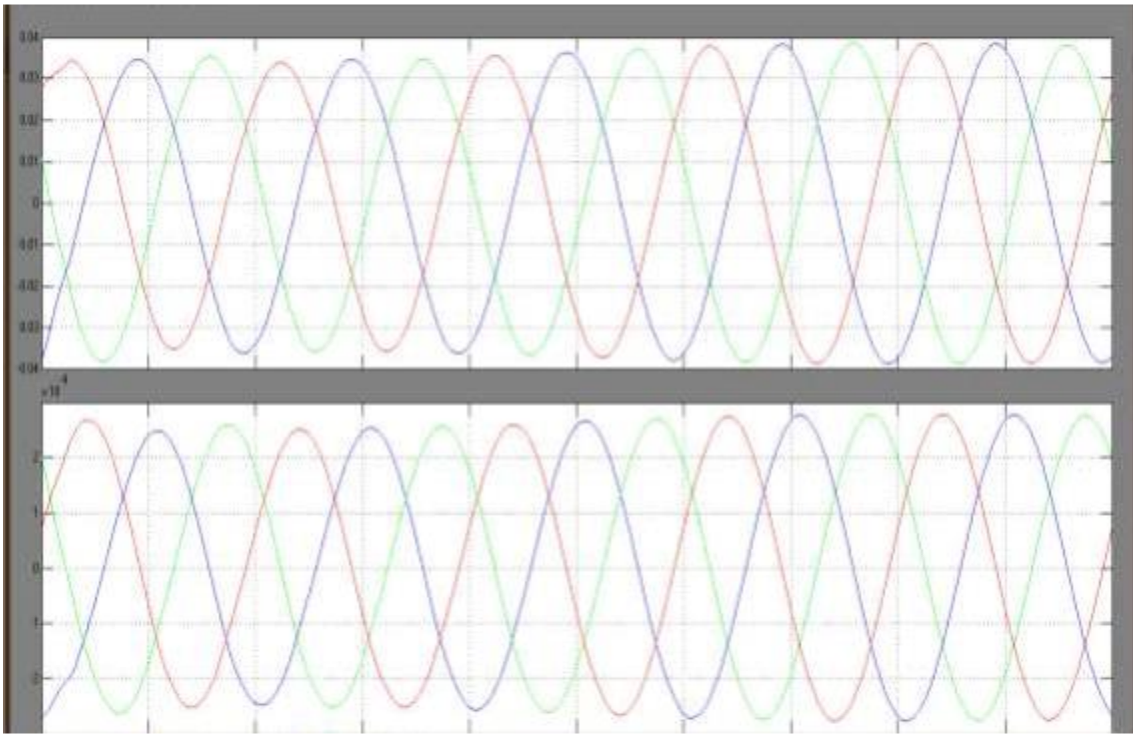


Fig24: PV panel , wind generation output, dc bus voltage, 3phase inverter output.

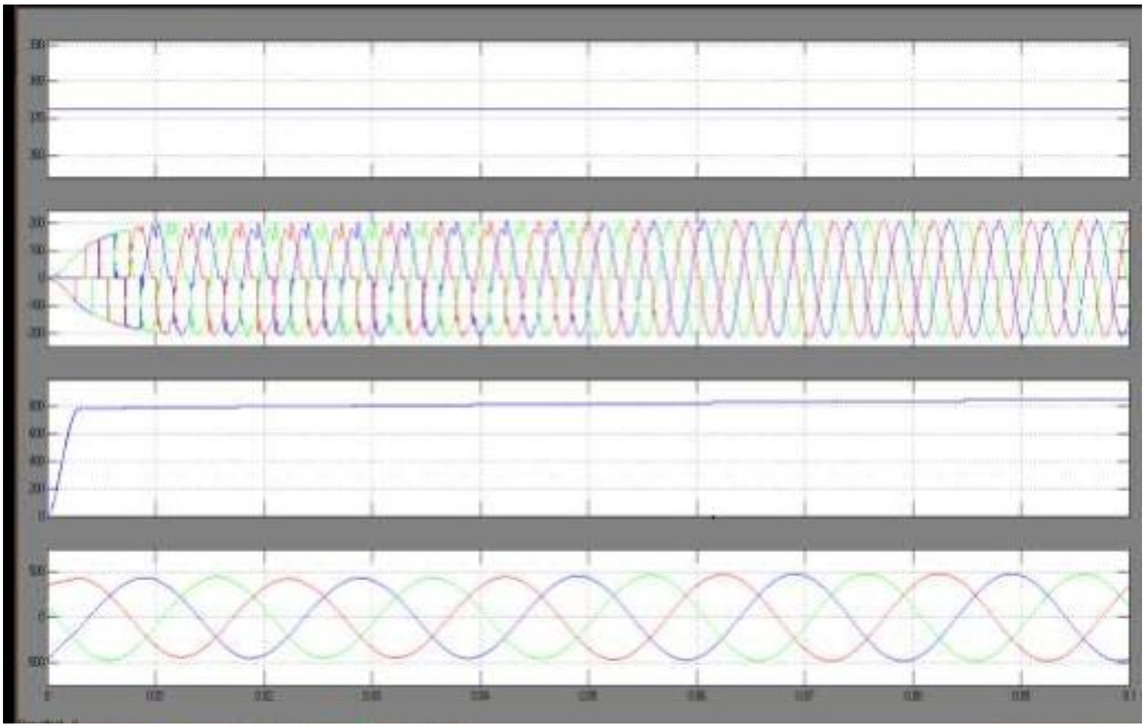
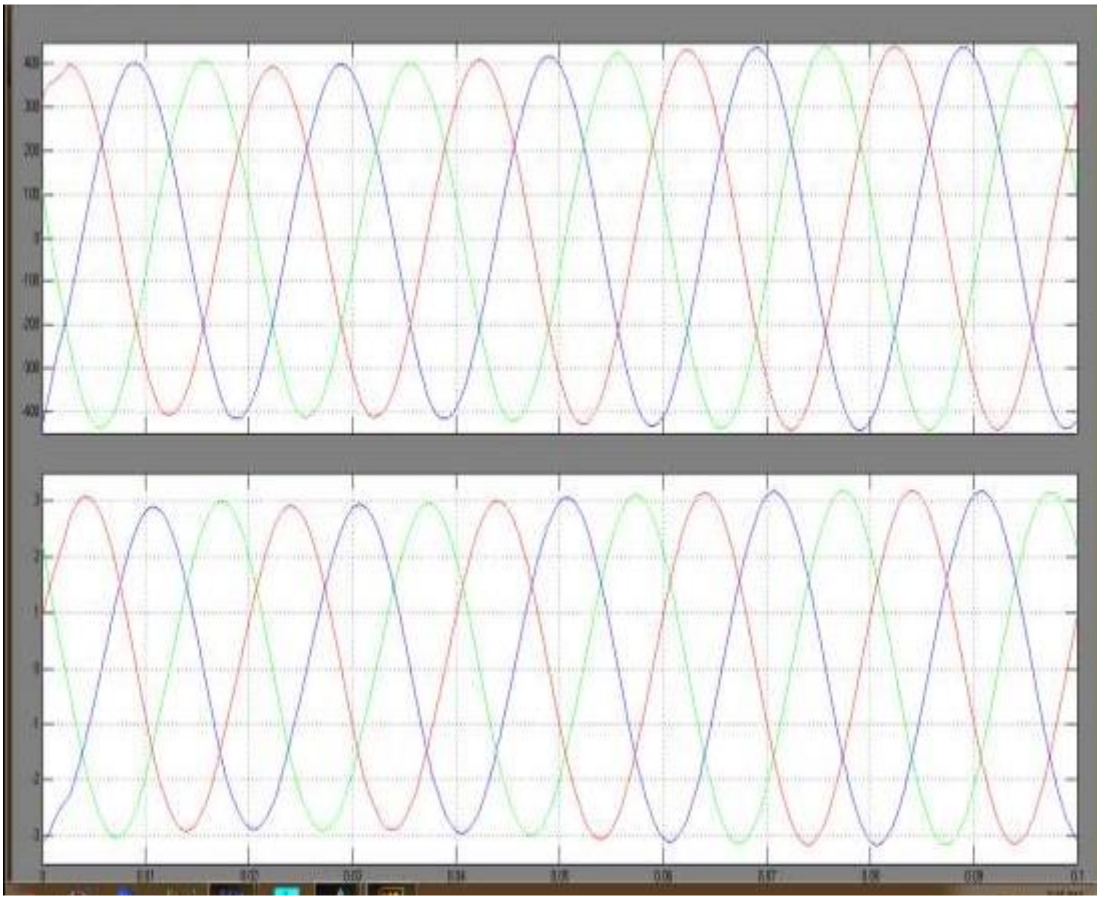


Fig4: Battery voltage



Advantages:

1. Power generation is double.

2. Reduce the power demand .

3. Easy to implement .

4. Used in many areas .

5. Uninterrupted power supply.

6. Eco friendly operation.

7. Cost efective power generation.

Disadvantages :

1. Installation Cost is high

2. Solar power is not available during night time

3. Used for lighting purpose only.

4. If used for power loads initial cost is very high.

5. During non – availability of natural sources electric battery supply is used so it increase the running cost.

Applications:

1. Applicable in high wind flow areas.

2. Applicable in high sun light areas.

3. Applicable in home, all buildings etc.

CONCLUSION

In this work a hybrid power generation system is designed which shows different characteristics of the system. From the study of the model characteristics it is clear that this hybrid power system provides voltage stability and automatic load sharing capability. For these reasons the system is very much useful to provide good quality of power.

Focusing on the three top most used renewable energy sources, we have presented a summary of mathematical modeling of various renewable power systems. Non-linear characteristics of wind power system and PV system such as the power, voltage and current are summarized for maximum power point tracking. Various MPPT techniques and modeling of storage device were presented.