ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 7, Issue 11, November 2018

ANFIS Controller for Battery Control Used in Three Phase Grid Connected PV System

N.Vasuki[1], Dr.K.Punitha[2] , Er.C.Kavitha[3]

PG Scholar, Department of Electrical and Electrical Engineering, P.S.R.Rengasamy College of Engineering for Women, Sivakasi, Tamilnadu, India[1]

Head of the Department, Department of Electrical and Electrical Engineering, P.S.R.Rengasamy College of Engineering for Women, Sivakasi, Tamilnadu, India[2]

Assistant Professor, Department of Electrical and Electronics Engineering, P.S.R.Rengasamy College of Engineering for Women, Sivakasi, Tamilnadu, India[3]

ABSTRACT: This project proposes LUO converter based grid voltage stability in PV system based three phase AC grid using Neuro Fuzzy based MPPT algorithm. The LUO converter is used to maintain constant voltage to the three phase voltage source inverter by MPPT algorithm. This enables grid to always supply/absorb a balanced set of fundamental currents at unity power factor. The energy management is achieved using Bidirectional converter with buck and boost operation. This project is implemented in Matlab simulation.

I. INTRODUCTION

Due to the critical condition of industrial fuels which include oil, gas and others, the development of renewable energy sources is continuously improving. This is the reason why renewable energy sources have become more important these days. Few other reasons include advantages like abundant availability in nature, eco-friendly and recyclable. Many renewable energy sources like solar, wind, hydel and tidal are there.

Among these renewable sources solar and wind energy are the world's fastest growing energy resources. With no emission of pollutants, energy conversion is done through wind and PV cells.

Day by day, the demand for electricity is rapidly increasing. But the available base load plants are not able to supply electricity as per demand. So these energy sources can be used to bridge the gap between supply and demand during peak loads. This kind of small scale stand-alone power generating systems can also be used in remote areas where conventional power generation is impractical.

In this thesis, a wind-photovoltaic hybrid power generation system model is studied and simulated. A hybrid system is more advantageous as individual power generation system is not completely reliable. When any one of the system is shutdown the other can supply power. A block diagram of entire hybrid system is shown below.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 7, Issue 11, November 2018

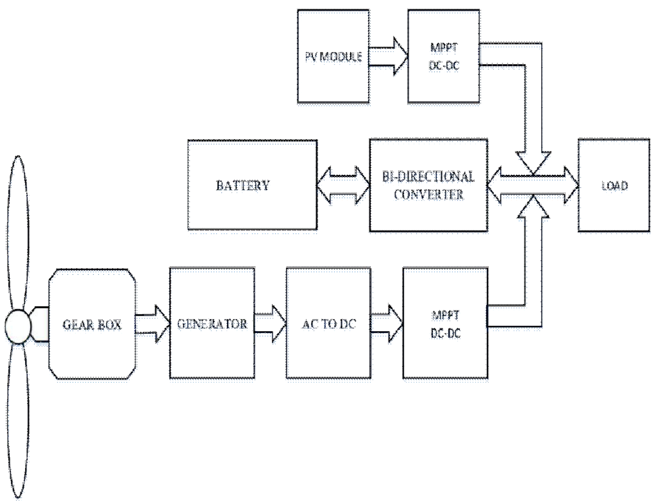

Fig 1.1: Block diagram of hybrid system

The entire hybrid system comprises of PV and the wind systems. The PV system is powered by the solar energy which is abundantly available in nature. PV modules, maximum power point tracing systems make the PV energy system. The light incident on the PV cells is converted into electrical energy by solar energy harvesting means. The maximum power point tracking system with Perturb & absorb algorithm is used, which extracts the maximum possible power from the PV modules. The ac-dc converter is used to converter ac voltage to dc.

Wind turbine, gear box, generator and an AC – DC converter are included in the wind energy system. The wind turbine is used to convert wind energy to rotational mechanical energy and this mechanical energy available at the turbine shaft is converted to electrical energy using a generator. To coerce the maximum power from wind system we used a maximum power point tracing system.

Both the energy systems are used to charge a battery using bi-directional converter. Bidirectional converter and the battery form the common additional load to the wind and PV energy systems.

Hybrid generation systems that use more than a single power source can greatly enhance the certainty of load demands all the time. Even higher generating capacities can be achieved by hybrid system. In stand-alone system we can able to provide fluctuation free output to the load irrespective of weathers condition. To get the energy output of the PV system converted to storage energy, and constant power delivered by the wind turbine, an efficient energy storage mechanism is required, which can be realized by the battery bank.

II. LITERATURE REVIEW

Due to high demand of energy and limited availability of conventional energy, nonconventional sources become more popular among researchers. A lot of research work is going on to enhance the power efficiency of non-conventional sources and make it more reliable and beneficial.

Hybrid generation system uses more than one source, so that we can extract energy from different sources at the same time which enhances the efficiency. From [2],[3] the working of PV /Wind hybrid system is understood, different topologies that can be used for the hybridization of more than one system and also about advantages and disadvantages of hybrid system. From [1], [4] and [5] basic details of PV cell, PV module, PV array and their modelling are studied. Also, the behaviour of PV modules at varying environmental conditions like solar irradiation and temperature are studied. Behaviour of PV module during partial shading condition and also how it's bad effects can be minimized is explained in [6]-[8]. Different MPPT techniques, their advantages and disadvantages and why MPPT control is required is explained in [9]-[11].The wind energy system, its working and also techniques to extracts the maximum power from the wind energy system is understood from [13]-[17]. From [18]-[20] study about different type of bi-directional converters, their working and how to use them in battery charging and discharging is carried out.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 7, Issue 11, November 2018

III. SYSTEM IMPLEMENTATION

The main objective of the thesis is to implement a power system that is a hybrid of both Photovoltaic and wind powers. The step by step objectives are

- To study and model PV cell, PV array and PV panels
- To study the characteristic curves and effect of variation of environmental conditions like temperature and irradiation on them
- To study the PV module's behavior under partial shading condition
- To trace the maximum power point of operation the PV panel irrespective of the changes in the environmental conditions
- To study and simulate the wind power system and track its maximum power point
- Implement hybrid system

A) PHOTVOLTAIC ARRANGEMENT

A photovoltaic energy system is mainly powered by solar energy. The configuration of PV system is manifested in figure 2.1.

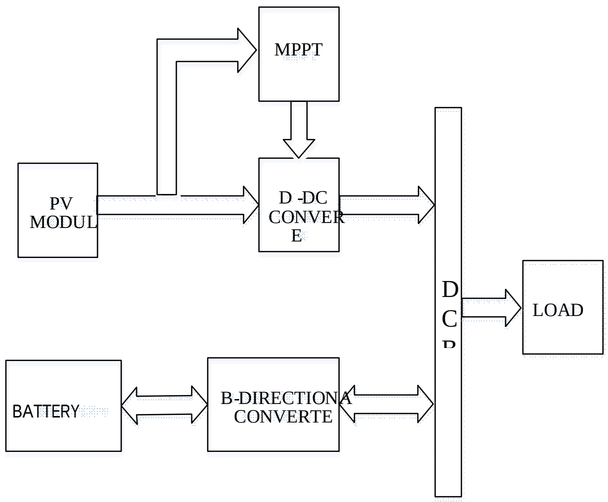

Fig.2.1 Overall block diagram of PV energy system

It contains PV modules or arrays, which convert solar energy in the form of solar irradiation into electric energy. The dc-dc converter changes the level of the voltage to match it with the electrical appliances that are supplied by this system. This DC-DC converter may be either buck or boost or buck-boost contingent on the required and available voltage levels. The maximum power point tracing system coerces the maximum power from the PV modules. A bi-directional converter which is able to supply the current in both the directions is used to charge the battery when there is a power surplus and the energy stored by the battery is discharged into the load when there is a power deficit.

B)MAXIMUM POWER POINT TRACKING

Maximum power point tracing (MPPT) system is an electronic control system that can be able to coerce the maximum power from a PV system. It does not involve a single mechanical component that results in the movement of the modules changing their direction and make them face straight towards the sun. MPPT control system is a completely electronic system which can deliver maximum allowable power by varying the operating point of the modules electrically [9]. There are many algorithms which help in tracing the maximum power point of the PV module. They are following:

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 7, Issue 11, November 2018

a) P&O algorithm
b) IC algorithm
c) Parasitic capacitance
d) Voltage based peak power tracking
e) Current Based peak power tracking

(i) Perturb and observe

Each and every MPPT algorithm has its own advantages and disadvantages. Perturb and observe (P&O) method is widely used due its simplicity. In this algorithm we introduce a perturbation in the operating voltage of the panel. Perturbation in voltage can be done by altering the value of duty-cycle of dc-dc converter.

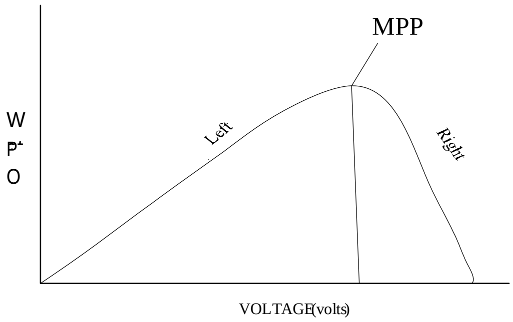

Fig. 2.11 P-V characteristics (basicidea of P&O algorithm)

Fig 2.11 show the p-v characteristics of a photovoltaic system, by analyzing the pv characteristics we can see that on right side of MPP as the voltage decreases the power increases but on left side of MPP increasing voltage will increase power. This is the main idea we have used in the P&O algorithm to track the MPP [11]. The flow chart of P&O algorithm is manifested in figure 2.12.

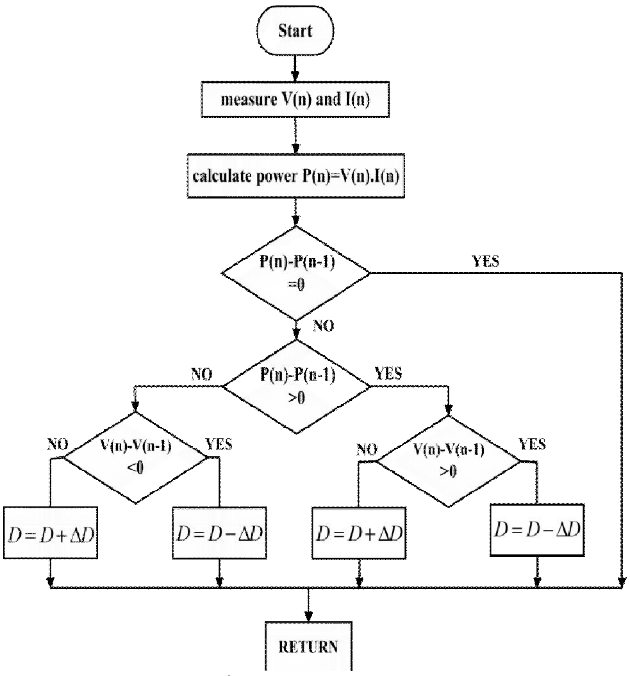

Fig.2.12 Flowchart of Perturb & Observe MPPT algorithm

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 7, Issue 11, November 2018

As we can see from the flow chart first of all we measure voltage and current, by using these values we calculate power, calculated power is compared with previous one and accordingly we increase or decrease the voltage to locate the Maximum Power Point by altering the duty cycle of converter.

IV. RESULTS AND DISCUSSIONS

The parameters used for the modeling of PV module are shown in table 2.1 [2]

Sl.no.	Parameter	Value
1	Imp	7.61 A
2	Vmp	26.3 V
3	Isc	8.21 A
4	Pmax	200.143 W
5	V_{oc}	32.9 V
6	K_v	-0.1230 V/K
7	K_i	0.0032 A/K
8	Ns	54
9	N_p	4

TABLE 2.1 Parameters of the PVarray at 25^{0}C, 1000w/m^2

Simulation results of PV module

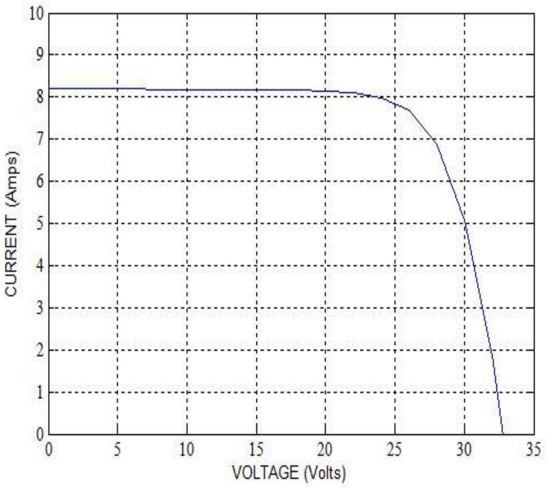

Fig. 5.1 V-I curve of PV module

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 7, Issue 11, November 2018

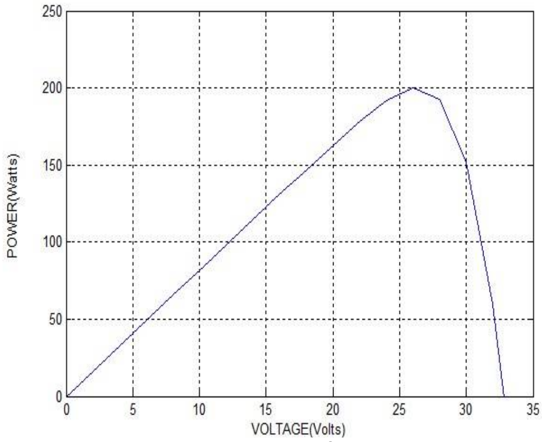

Fig. 5.2 P-V curve of PV module

Fig 5.1, 5.2 represent the I-V and P-V characteristics of a PV module. From fig 5.1 we can see that short circuit current (I_{sc}) of PV module is approximately 8.2A and open circuit voltage (V_{oc}) is approximately 32.9 volts. From fig 5.2 we can observe that maximum power is approximately 200W and it occurs at a current of 7.61A and voltage at 26.3V approximately.

Effect of variation of irradiation

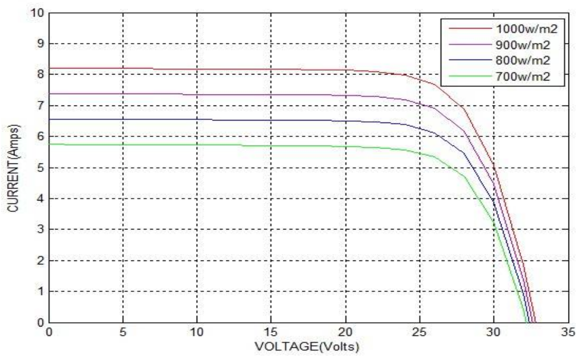

Fig. 5.3 Effect of variation of irradiation on I-V characteristics

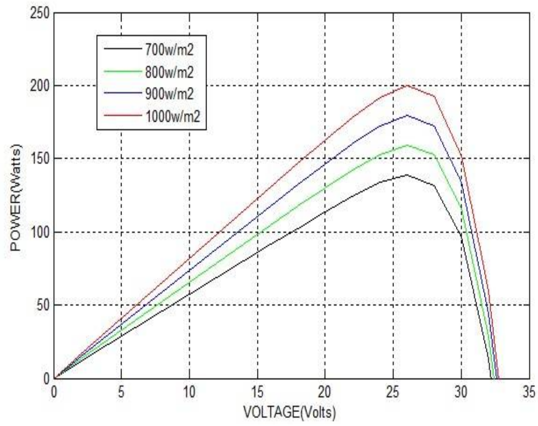

Fig. 5.4Effect of variation of irradiation on P-V characteristics

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 7, Issue 11, November 2018

In fig 5.3, 5.4 we can see the effect of change in solar irradiation on PV characteristics. From fig 5.3 we observe that as we increase the solar irradiation short circuit current increases. Variation in Solar irradiation effects mostly on current, as we can observe from fig 5.3 as we increase solar irradiation from 700 w/m^2 to 1000 w/m^2 current increases from 5.7A to 8.2A approximately but effect of variation of solar irradiation on voltage is very less. Fig 5.4 shows the effect of variation of solar irradiation on P-V characteristics. As solar irradiation increases, power generated also increases. Increase in power is mainly due to increment in current.

Effect of variation of temperature

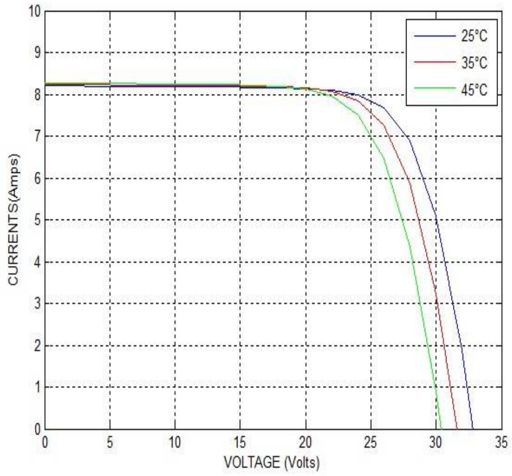

Fig. 5.5 Effect of variation of temperature on I-V characteristics

The outcome of variation of temperature on I-V characteristics is shown in the fig 5.5. From the fig 5.5 we can see the variation of temperature mostly effects voltage, as we increase the temperature voltage decreases but current remains almost unaltered. Fig 5.6 shows effect of temperature variation on the P-V characteristics. As temperature increases power generated decreases, because on increment of temperature voltage decreases.

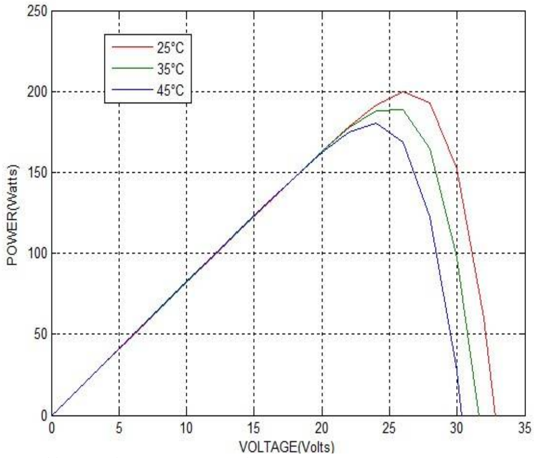

Fig. 5.6 Effect of variation of temperature on P-V characteristics

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 7, Issue 11, November 2018

Shading effect on PV array

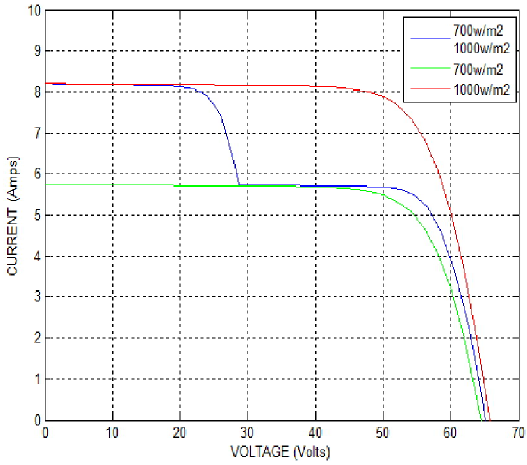

Fig. 5.7V-I characteristics in partial shading condition

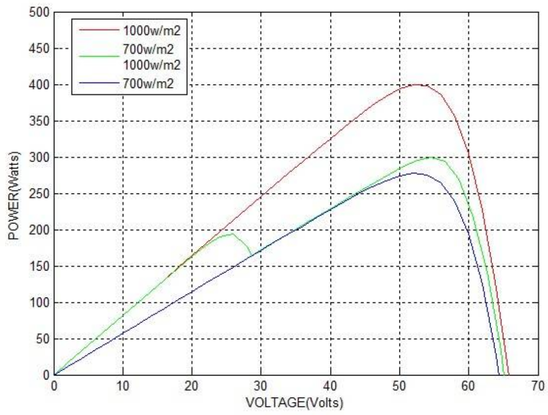

Fig.6.8 P-V characteristics in partial shading condition

I-V, P-V characteristics of a PV array in shading condition can be seen in fig. 5.7 and fig 5.8. As we can observe from fig 5.6 partially shaded PV modules generate less current than the unshaded module. Under partially shading condition we can observe more than one maximum power picks from fig 5.8.

Outputs after MPPT

Output power and output voltage after maximum power point tracing are manifested in the figures 6.9 and 6.10 respectively. As we observe from the fig 6.2, maximum power is achieved at voltage 26.3 volts; from fig 6.10 we can see we are able to track the output voltage where we can get the maximum power which is approximately 26.3 volts. From fig 6.9 we can see the maximum power which is approximately 200 watts can be tracked.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 7, Issue 11, November 2018

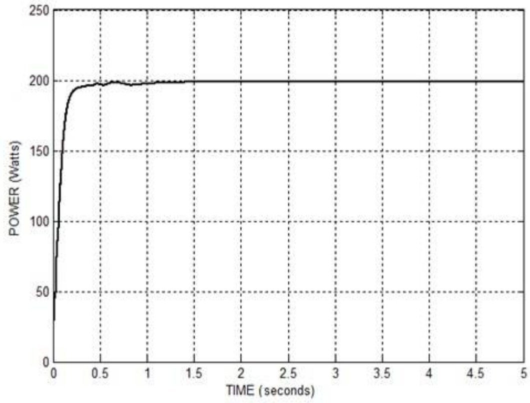

Fig. 5.9 Output power of PV module after MPPT

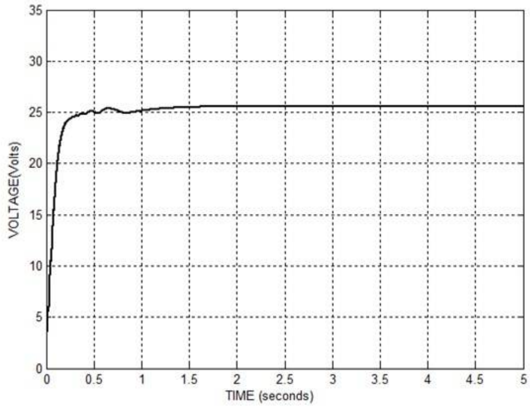

Fig. 5.10 Output voltage of PV module after MPPT

Simulation result of wind energy system

Fig 6.11 shows turbine power characteristics at different wind speed. From the fig 6.11 we can observe that as wind speed increases turbine output power also increases.

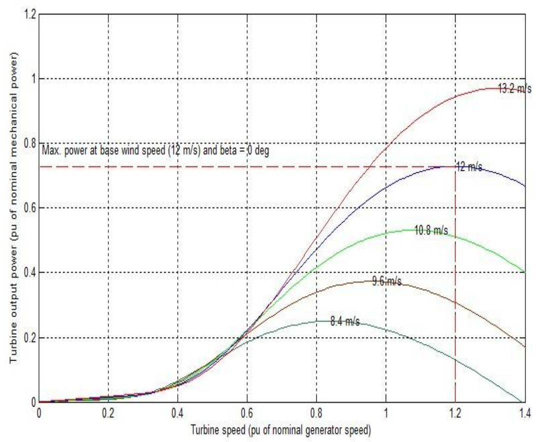

Fig 5.11 Turbine Power characteristics (pitch angle beta=0°)

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 7, Issue 11, November 2018

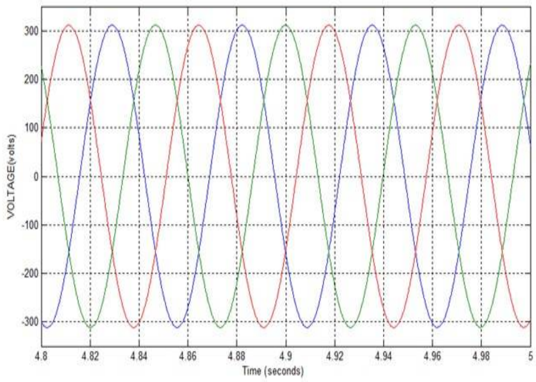

Fig 5.12 Three phase line output voltage of PMSG

PMSG output is shown in the fig 5.12.The point of operation of crest power of wind generator output is traced by a maximum power point tracing system is shown in the fig 5.13 given below. Output Voltage of wind generator at which maximum power is achieved is shown in the fig 5.14.

Simulation results of charging/ discharging

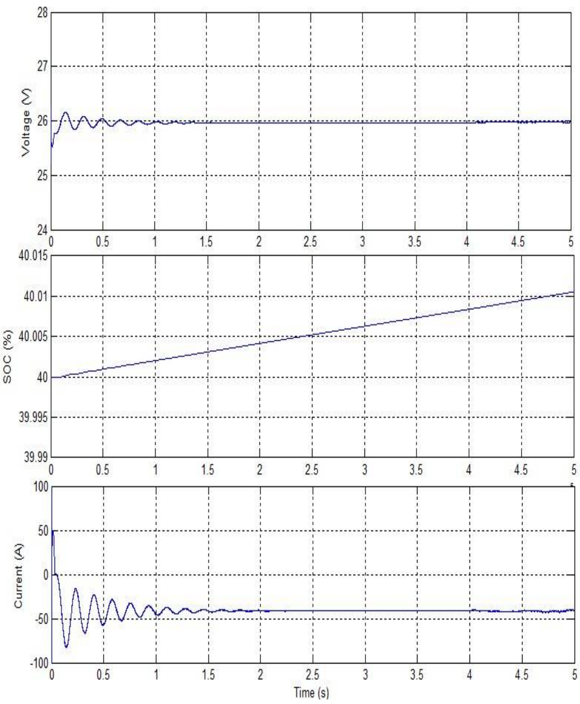

Fig 5.15 charging characteristics of battery

From fig 5.15 we can observe that during charging state of charge (SOC) of the battery is gradually increasing and also during charging current is negative. We can observe at 40% SOC battery voltage is around 26 volts, as state of charge of battery is increased battery voltage exceeded its nominal voltage.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 7, Issue 11, November 2018

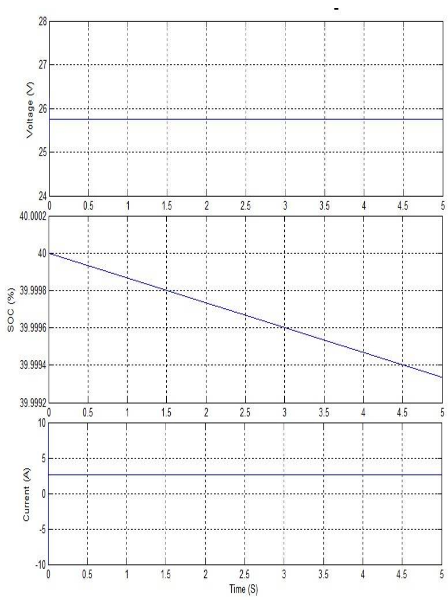

Fig 5.16 Discharging characteristics of battery

From fig 5.16 we can see during discharging, battery start supplying constant voltage and state of charge start decreasing and also during discharging current become positive, which shows battery is supplying the power to the load.

V. CONCLUSIONS

- PV cell, module and array are simulated and effect of environmental conditions on their characteristics is studied
- Wind energy system has been studied and simulated
- Maximum power point of operation is tracked for both the systems using P&O algorithm
- Both the systems are integrated and the hybrid system is used for battery charging and discharging
- FUTURE SCOPE
- MPP can be tracked using different algorithms
- Battery charge controller can be designed for more reliable operation and better battery life

REFERENCES

1. T. Salmi, M. Bouzguenda, A. Gagtli, "MATLAB/Simulink based modeling of solar photovoltaic cell," *International journal of renewable energy research,* vol.2, no.2, 2012.
2. S. Meenakshi, K.Rajambal, S. Elangovan "Intelligent controller for stand-alone hybrid generation system," *IEEE,* May. 2006.
3. Nabil A. Ahmed, MasafumiMiyatake, "A stand-alone hybrid generation system combining solar photovoltaic and wind turbine with simple maximum power point tracking control," *IPEMC* 2006, *IEEE,* 2006.
4. M. G. Villalva, J. R. Gazoli, "Modeling and circuit based simulation of photovoltaic arrays," *Brazilian power electronics conference (COBEP),* 2009.
5. Marcelo GradellaVillalva, Jonas RafelGazoli, "Comprehensive approach to modeling and simulation of photovoltaic arrays," *IEEE transaction on power electronics,* vol.24, no.5, May 2009.
6. Hiren Patel and VivekAgarwal, "Matlab based modeling to study the effect of partial shading on PV array characteristics," *IEEE transaction on energy conversion,* vol.23, no.1, March 2008.
7. Mohammed Abdulazeez, IresIskender, "Simulation and experimental study of shading effect on series and parallel connected PV modules," *IEEE transaction on energy conversion,* vol.27, no.2, March 2008.
8. SiyuGuo, Timothly Michael Walsh, "Analyzing partial shading of PV module by circuit modeling," *IEEE* 2011.
9. Zhou Xuesong, Song Daichun, Ma Youjie, Chen Deshu, "The simulation and design for MPPT of PV system based on Incremental conductance method," *Wase International conference on information engineering,* 2010.
10. Azadeh Safari, SaadMekhilef, "Simulation and Hardware Implementation of Incremental Conductance MPPT with Direct Control Method Using Cuk Converter," *IEEE transaction on industrial electronics,* vol. 58, no. 4, april 2011.