MPPT Based Simulation of Wind and PV hybrid System

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***Abstract*: This paper focuses on model predictive control method that is based on Maximum power point tracking (MPPT) control system which compels the maximum power from the hybrid wind and PV system for the management and operation. The hybrid system consists of photovoltaic panels, wind turbines and storage batteries. The combination of both the systems works efficiently with more reliability than wind or PV standalone system. The model is implemented using MATLAB with Simpower system which consists of wind and PV generation systems, battery bank, DC-DC Converters, AC-DC Converters, Inverters and MPPT. This model is simulated and executed in the MATLAB software with the specific inputs to get the required outputs.**

***Keywords*: MPPT, Standalone system, Wind turbines, Storage batteries.**

1. INTRODUCTION

Due to the increasing load demand and global warming many are looking at environment friendly type energy solutions to preserve the earth for future generations. Hence, renewable energy technologies are playing a vital role in the energy generation sectors and also gaining lots of scope with increasing time.

Since, there is a rapid increase of in the consumption of nuclear and fossil fuels, the renewable energy generation techniques with no alternative options. Hence, technologies that are based on wind and PV generation system are receiving national and world wide attentions. This system can be installed in isolated areas where laying of transmission lines are difficult and also where the power grids are not reachable. The system has many advantages like conservation of energy, reduced environmental damage, increased safety. The performance of this system mainly depends on climatic conditions at the locations of installations. Both the systems are highly complementary to each other as the PV generation system meet the peak load demand during day time while the wind energy system meet the peak load during the absence of solar radiations and also when the wind velocity is high.

Researches are continuously going on from many years to increase the energy in the supply side to meet the peak load demands. But due to scarcity in the production the supply is still unable to meet the demand. This modeling not only helps in increase in the generation but also acts as a bridge that connects between supply and demand during peak load time.

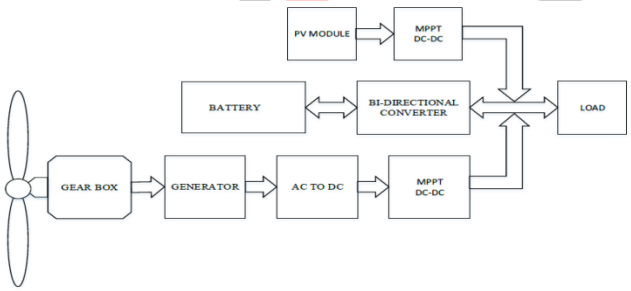

Fig 1.1 Block diagram of Hybrid wind and PV system.

2. MODELLING OF PV SYSTEM

Solar energy is the earth's most abundant energy source. India's annual solar radiation is about 5KWh per sq unit per day.And it provides unlimited supply of energy, has no hazardous impact on the environment. The solar PV modules convert the solar radiation into electrical energy. Although solar energy has many advantages, it requires complement source with it as the energy is not available throughout the day.

Solar cell is simplest unit of the PV panel system .A single cell generate very low voltage of about 0.5V,so more than one PV cell is connected either in serial or parallel or as grid to form a PV module to get more output.
The Equivalent circuit of a single PV cell is shown in the below ,

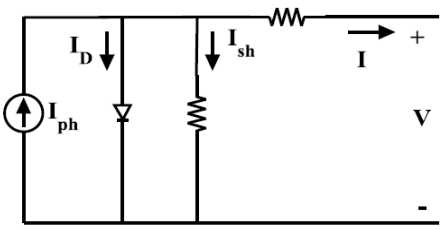

Fig 2.1 Equivalent Circuit of a Single PV cell

I= Iph - ID - Ish .

I= Total output current.
Iph= Light generated current in the cell.
ID= Voltage dependent current lost to recombination.
Ish.= Current lost due to shunt resistance.

The maximum output power of PV system increases with increase in the solar irradiance. The main sections of PV system module are irradiance, MPPT controller, DC-DC converter, Battery storage system[6]. The generation in the PV system lonely depends on the intensity of the solar radiations.

3. MODELING OF WIND ENERGY SYSTEM

One of the greatest challenges associated with wind power is the unpredictable character of the wind. Even at the best wind sites with reasonably high wind speed, there are variations in the speed and direction of the wind which affects the performance of the wind energy conversion system. The kinetic energy(in joules) in air of mass M, moving with the velocity V can be calculated from the expression,

E=1/2. M.V^2

The power in the wind is given by the rate of change of kinetic energy,

P= dE/dt = 1/2*dM/dt*Vw^2.

The wind modeling has Wind turbine model, Pitch angle Controller, Speed input block, PMSG (Permanent Magnet synchronous generator), Rectifiers, Voltage and current measurement units, Battery storage system, and MPPT controller. Pitch control model adjusts the turbine blade pitch angle with respect to the input values of wind and
turbine speed and also reduces the aerodynamic forces. In the speed input block, amplitude and time parameters can be adjusted as per the requirement. Wind turbine model requires the generator rotor speed, pitch angle, wind speed as inputs. It generates the required torque which is fed to the PMSG[9]. PMSG is a direct drive type generator and doesn't require gear box and excitation current. Rectifiers help in converting the AC to DC.

4. MAXIMUM POWER POINT TRACKING

MPPT system is an electronic control system that can be able to coerce the maximum power from system. It is not a device that involves a single component but it is a completely a electronic system that can deliver maximum allowable power by varying the operating points of the modules electrically[9]. The MPPT of the PV system consists of PV panels, DC-DC converters and Loads. And the MPPT of wind energy conversion system involves the wind turbine and fuzzy controllers to achieve maximum power tracking which protects the wind turbine during abnormal conditions [11]. And also protects the systems from being damaged.

5. BATTERY STORAGE SYSTEM

The conversion of AC to DC and the storage of the power is done by the Battery storage system. This system helps in the storage of the charge before to the load. Among many batteries available, Lithium ion battery is suitable option for the hybrid systems due to their high energy density, light weight, efficiency and good life cycle . The battery bank helps in continuous supply for the load without any interruptions, irrespective of the variations in the generation at different times of the day. The State of charge(SOC) of the battery can be given as,

SOC=Ic/Q

Q = Capacity of Battery
Ic = Current in the Battery

This management system requires the difference between the actual load and total power of the system for battery management. The life time of the battery depends on the SOC of the battery. Fuzzy is used for the maintenance of SOC of the battery. The Fuzzy logic system has two inputs and one output it maintains the charging and discharging of the battery which depends on the SOC[11]. The SOC of the battery is maintained 60% as its lowest value, battery has to discharge its charges, when the SOC reaches more than 100%.

6.FUZZY LOGIC

Fuzzy theory was first proposed in 1965 by Lotfi. Zadeh, an American scholar of automatic control, as a tool of quantitative expression for concepts that could not be clearly defined. A fuzzy control system is based on fuzzy- logic thinking in the design of how a controller works. The so-called fuzzy logic is to establish a buffer zone between the traditional zero and one, with logic segments of none- zero and none-one possible. It allows a wider and more flexible space in logic deduction for the expression of conceptual ideas and experience. A fuzzy controller differs from a

traditional controller in that it employs a set of qualitative rules defined by semantic descriptions Fuzzy control theory is designed for the hybrid system to achieve the optimization of the system. The design criterion requires that both the photovoltaic device and the wind turbine are supplied by a maximum power point tracker to maintain the maximum operating point. The difference between actual load and total generated power is taken into account for Li-ion

battery in charge and discharge modes. The life cycle and SOC of the battery are in direct proportion. To improve the life of the Li-ion battery, we can control and maintain the SOC of battery with fuzzy control.

6. HYBRID SYSTEM

The simulation diagram of the hybrid wind and PV system is shown in the below figure 6.1,

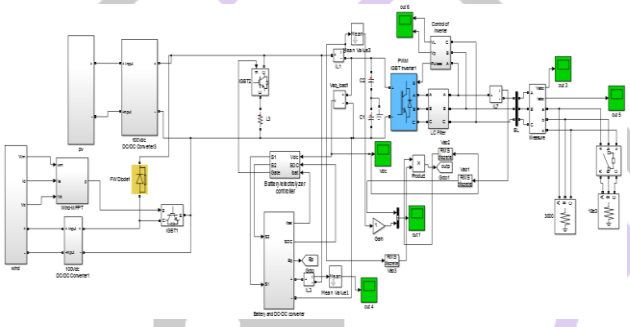

Fig 6.1 Simulation diagram of hybrid wind and PV system.

The primary source in the above is the PV generation system while the wind energy system acts as the secondary source. During summer, the PV generation system meet the peak load demand meanwhile the generation in the wind system reduces. And during winter, the wind energy system meets the peak load demand[3]. In the simulation model, the solar panels and wind systems generate the power separately. The power from the PV panels go to the battery while the power from the wind system is converted first to DC and then stored in the battery storage system based on the state of charge. The power for the DC loads is taken directly from the load while for AC loads, the power is fed to the inverters and given to the loads.

7. SIMULATION RESULTS

Simulation result of PV system,

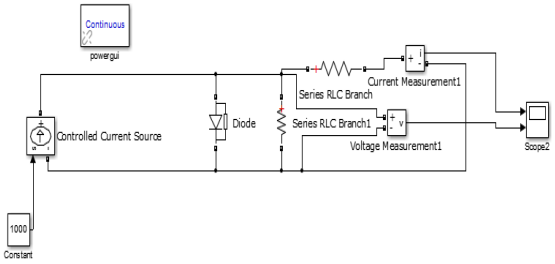

Fig 7.1 The **Simulation of Equivalent circuit of single solar cell**

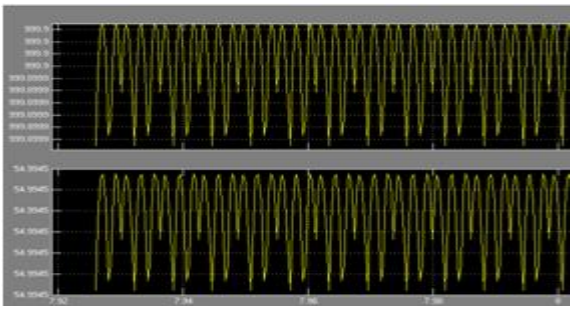

Fig 7.2 Output voltage and current from single PV cell.

The Simulation diagram of Solar subsystem where each subsystem has two PV cell (fig 7.3),

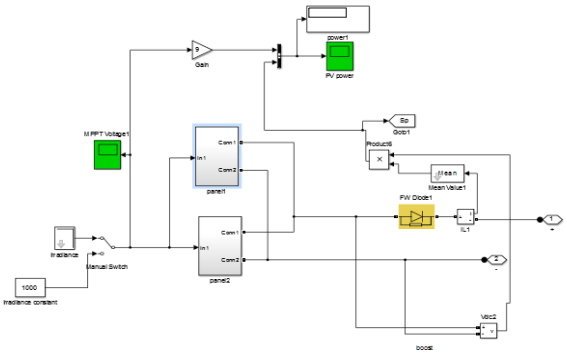

Fig 7.3 Simulation diagram of solar subsytem.

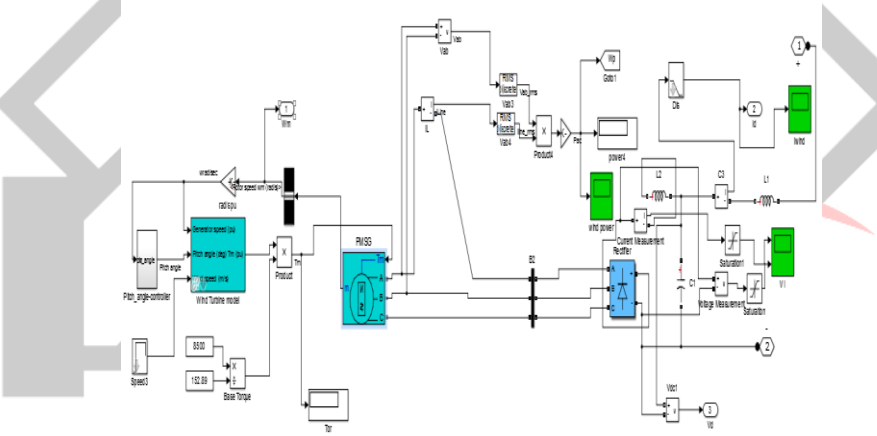

Fig7.4 Simulation diagram of wind energy system

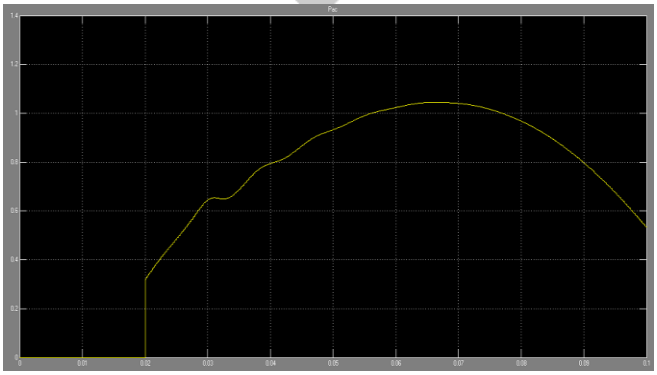

Fig 7.5 Output power of WECS

9. CONCLUSION

The scarcity in the fossil fuels and unavailability of the energy from conventional methods has made many scientist to put forward their thoughts about the advantages in harnessing renewable energy. Energy consumption is one of the most reliable indicator of development and quality of life in a country. The above system is simulated using MATLAB/Simulink [8]. The hybrid system comprises of Wind and PV system for the production of electrical power and MPPT technique is used for maximization in electrical power production. And this system is equipped with battery storage system as a backup energy source where excess energy is stored in it. The installation of this system reduces the gap between the supply and demand, has high efficiency, low cost and can be used in remote places.

REFERENCES

[1] M. G. Simoes, B. K. Bose, and R. J. Spiegel, "Fuzzy logic based intelligent control of a variable speed cage machine wind generation system," IEEE Trans. Power Electron., vol. 12, no. 1, pp. 87–95, Jan. 1997.

[2] K. Uhlen, B. A. Foss, and O. B. Gjosaeter, "Robust control and analysis of a wind-diesel hybrid power plant," IEEE Trans. Energy Conv., vol. 9, no. 4, pp. 701–708, Dec. 1994.

[3] Mualikrishna and Lakshminarayana [2008] proposed a hybrid system with solar and wind sources for rural electrification.

[4] Nayar et al., [2007], discussed the implementation of PV/Wind/diesel micro grid system in republic of Maldives, a remote island.

[5] Dihrab et al., [2009] proposed a feasibility of using the renewable resources for power generation by PV and wind hybrid system for grid connected applications for four cities in Jordan.

[6] Kumar et al., [2011] proposed a hybrid system which includes PV/Wind/Micro- Hydro/Diesel power generation suitable for remote area applications.

[7] Chedella et al., [2010] presented the preliminary study of modeling a small stand alone AC system with the fuel cells and solar panels as energy resources.

[8] Cristian Dragos, Dumitru, adrian Gligor, "Modeling and simulation of renewable hybrid power system using MATLAB/Simulink environment,"2010.

[9] Yerra Sreenivasa Rao, A Jaya Laxmi and Mostafa Kazeminehad, "Modeling and Control of hybrid photovoltaic wind energy conversion system," IJAET,May 2012.

[10] K Pavankumar Reddy and Venu Gopala Rao, "Modeling and Simulation of Hybrid wind energy system using MPPT," IJST,Vol8(23),september 2015.

[11] S D Saranya, S Satyamoorthi and R Gandhiraj,"Fuzzy logic based energy management system for a microgrid," ARPN Journal of Engineering and Applied Sciences ,Vol 10, NO. 6, April 2015.