Integrated Solar PV and Thermoelectric Energy System

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Abstract: Solar panels are used for converting solar energy and wind turbines are used for converting wind energy into electricity. This electrical power can utilize for various purpose. Generation of electricity will be takes place at affordable cost. This paper deals with the generation of electricity by using two sources combine which leads to generate electricity with affordable cost without damaging the nature balance. In this paper, we develop an optimal design for a hybrid solar-wind energy design, where integrated energy is optimized. Proposed integrated solar wind energy system gives minimum ripple in output voltage and current .DC current and Voltages are track maximum power in solar PV mode and wind turbine. Total harmonics distribution is 2% in 3 phase inverter current as compared to non-integrated Model. Integrated solar wind system produced very less power loss due to very less switching frequency. The switching Frequency used in the model is 2 Khz.

Keywords: MPPT, Solar , PV, P & O .

I. INTRODUCTION

From some last decade the industrial fuels like coal, gas, oil and others are in very critical condition and thus due to this there is rapid growth in the development of renewable energy resources. Thus due to this limited availability of these industrial fuels the renewable energy resources are becoming more popular now days. There are also some other reason for their popularity like there availability in huge amount, they are recyclable and they are eco-friendly and did not emits any harmful gases thus also provide a solution for global warming issue. There are several renewable energy resources are present like wind, solar, tidal and hydro etc. among all these renewable resources the wind and solar energy are the technique which are fastest growing technique around the world. Thus in these technology we use the PV cells and wind for the energy generation with no harmful gases emission [2].In this paper we are presenting a wind-photovoltaic hybrid power system model and simulate that model. As this has been found that a individual power generation system is not much reliable so get the much advantage we use the hybrid power generation system which provide the more advantage over individual system. Another advantage for this system is that if by any reason one energy generation plant stop working then in this condition another will work and provide the energy. So in diagram given below we shown a block diagram for the hybrid system [5]. In this hybrid system there are mainly two components on is PV and other is wind system. Thus the photo-voltaic system is power by using solar energy which is available In large amount in nature. The PV energy system is made up of PV modules and the maximum power point tracing system. In this system we convert the solar energy incident n the PV cells by using solar harvesting means. The maximum power tracking system used here contains the Perturb & absorb algorithm, which is sued for the extraction of maximum power from the PV modules. Here we also used the ac-dc converter which is used to convert the ac voltage to dc voltage [6].

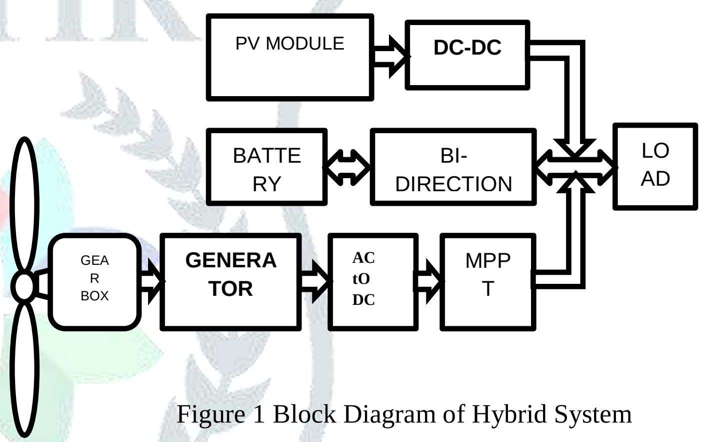

Figure 1 Block Diagram of Hybrid System

In this study we present the hybrid system which consists of solar system along with wind power generation system. The main component of a wind power generation system is turbine, gearbox, rotor, generator, converter etc. The main function of wind energy system is to convert the wind energy into mechanical energy through the rotation shaft and thus this shaft is connected to the generator shaft which will generate the electrical energy. As both the system which we sue in hybrid system are used to charge the battery by using bi-directional converter. Thus this bi directional converter and the battery we use will make the extra load over the wind and solar power generation system [7].

The rest of paper is design as follows. The problem statement of research work is described in section II. Modeling of PV cell is described in section III. Simulation results & analysis is described section IV. The overall conclusion of research work describe in section V.

II. Problem Statement

As the solar system is not alone sufficient to generate the electricity continuously because there are several conditions in which is does not work like in nigh or cloudy atmosphere. Thus here we present the hybrid power plant which will work in day or night. During the sunny days in day hours the solar system will get the maximum efficiency. Alternatively the wind power system will able to work in both night and cloudy condition thus this hybrid system is able to continuously supply the power. Thus to get the much higher efficiency from the renewable energy system throughout the day, the hybrid wind system is the most optimal solution to produce the energy at any time and in all the weather conditions.

III. Modeling of PV Cell

The main advantage of photovoltaic system is that ti will convert the solar energy to the electrical energy without producing any harmful effect over the environment. As we study before the basic building block of a PV array is the PV cells, which is generally a semiconductor P-n junction tool. In the above figure.3.4we shows the circuit of PV cell. We can express the current supplied to the load by [26].

$$I = I_{PV} - I_{\circ}\left\{exp\left\{\frac{V+IR_s}{\alpha V_T}\right\} - 1\right\} - \left\{\frac{V+IR_s}{R_p}\right\}$$

Where,

I_{PV}–Photovoltaic current

α–Ideality factor

V_t –Thermal voltage

R_s– Series resistance

R_p–Shunt resistance

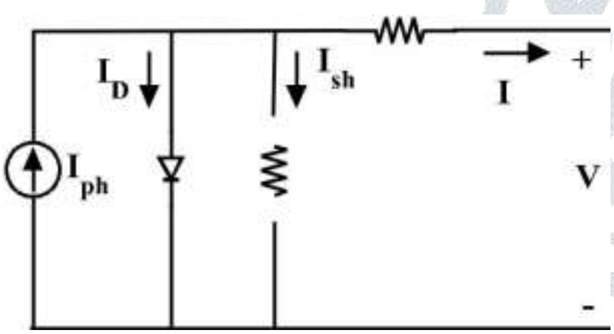

Figure 2 Equivalent circuit of Single diode modal of a solar cell

We can show the PV cell photocurrent as.

$$I_{PV} = (I_{PV}\_stc + K_1\Delta T)\frac{G}{G_{stc}}$$

Where,
G – Solar irradiation in W/m^2
G_{stc} – Nominal solar irradiation in W/m^2

The reverse saturation current varies as a cubic function of temperature, which is represented as $I_{\circ} = I_{\circ}\_stc\left(\frac{T_{stc}}{T}\right)$

Where

$I_{\circ}\_stc$ –Nominal saturation current

q –Charge of electrons

The reverse saturation current can be further improved as a function of temperature as follow

$$I_{\circ} = \frac{(I_{sc\_stc} + K_{I\Delta T})}{exp\left[\frac{(V_{oc\,STC})}{\alpha V_T}\right]}$$

There are several models are present by the authors which are much developed and provide the higher accuracy for the various applications. in some of these presented models the recombination effect of carrier is shown by the extra diode. In some studies some authors also propose the three diode system which includes the influence of some other effects which are not taken in the previously presented models. But because of simple construction and lesser complexity we use the single diode model to present our work.

IV. Simulation & Result Analysis

Simulink Model of integrated PV Solar wind is design step by step in MATLAB. In accordance to which Power of Solar and wind is measure separately.

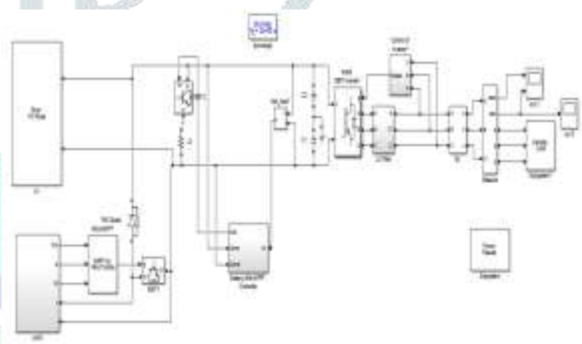

Fig 3 Simulink Model of Integrated PV Solar Wind Model

Simulink Model of Integrated PV Solar Wind Model is shown in Fig 3. The Model includes PV array configuration, Wind generation setup. Generation of wind depend upon the speed of blades & velocity of wind. A MPPT algorithm is applied in this.

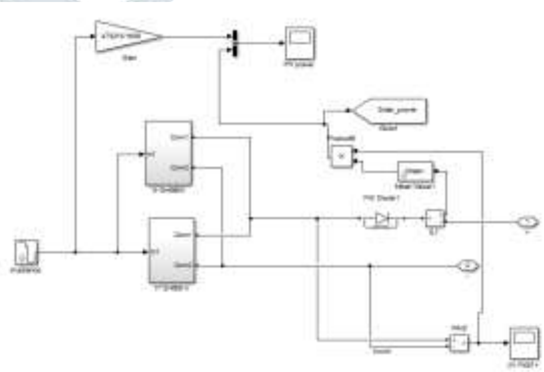

Fig 4 Solar PV Array used in Proposed Simulink Model

Solar PV Array used in Proposed Simulink Model is shown in fig. Solar power generation & booster are applied in compete setup. A gain controller is applied to control the gain of solar irradiance.

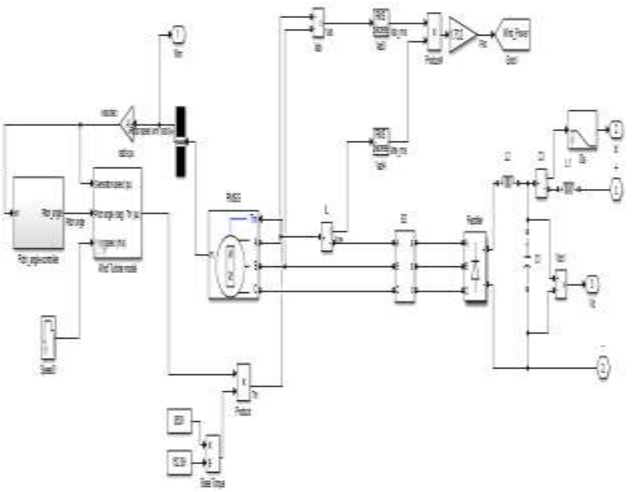

Fig 5 Wind Generation Simulink setup

Wind generation setup is shown in Fig 5. Wind Generator is applied in the complete setup & speed of wind is depending upon the rotor speed. The pitch angle controller is applied to rotate the angle of speed of the wind.

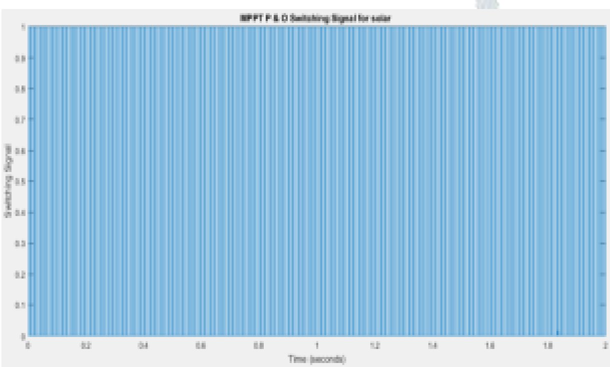

Figure 6 MPPT P& O Switching Signal for Solar

Figure 6 shows the MPPT perturb and Observer Switching Signal this switching signal gives switching signal to boost converter switch to attain maximum power. The frequency of MPPT switching signal is 2 KHz.

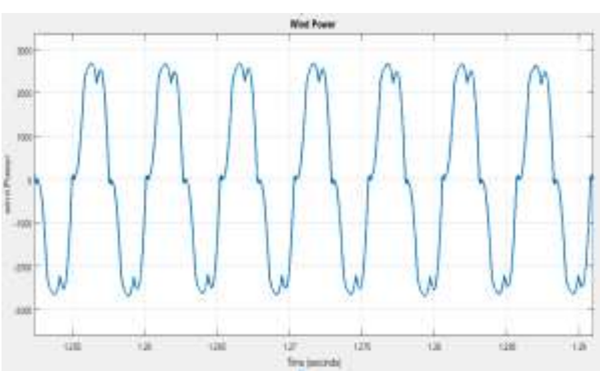

Figure 7 Wind power output of wind turbine

Figure 7 Shows the phase A electrical power generated by Wind Power using PMSG 3 Kilo Watt electrical power is generated by wind turbine.

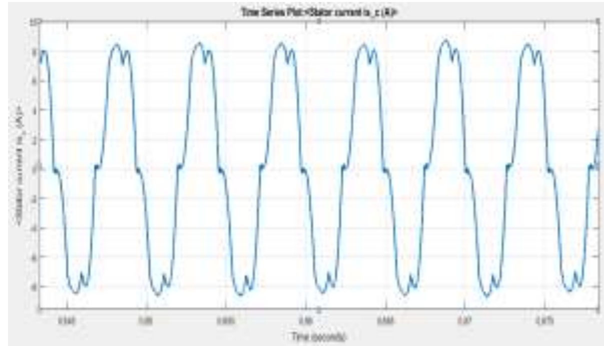

Figure 8 Stator Current of wind turbine

Figure 8 Shows Phase A Stator Current of wind turbine PMSG Current is 8 ampere

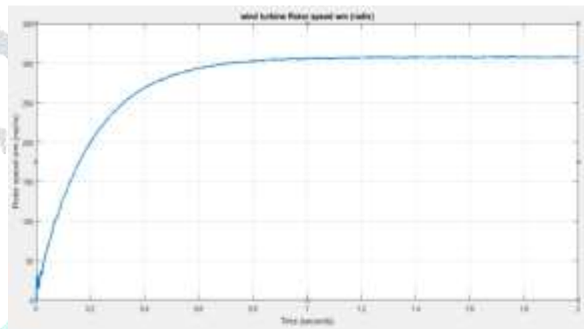

Figure 9 Rotor Speed of wind turbine

Figure 9 Shows Rotor Speed of wind turbine rotor speed is here 300 rad/sec.

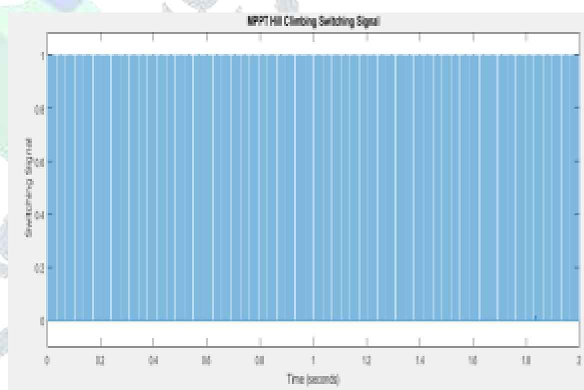

Fig 10 Hill Climbing Switching Signal after MPPT

Figure 10 represents the Hill Climbing Switching Signal of MPPT the objective of MPPT is to track maximum wind power.

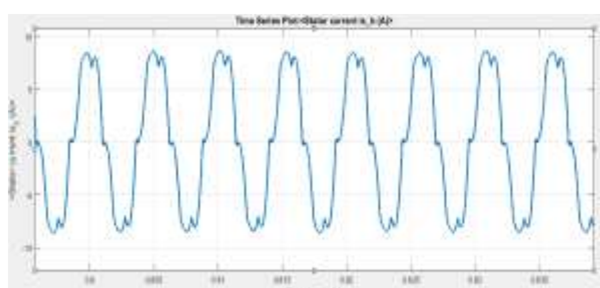

Figure 10 Phase B Stator Current of wind turbine PMSG

Figure 10 Shows Phase B Stator Current of wind turbine PMSG (Permanent Magnet Synchronous generator) Current is 8 ampere

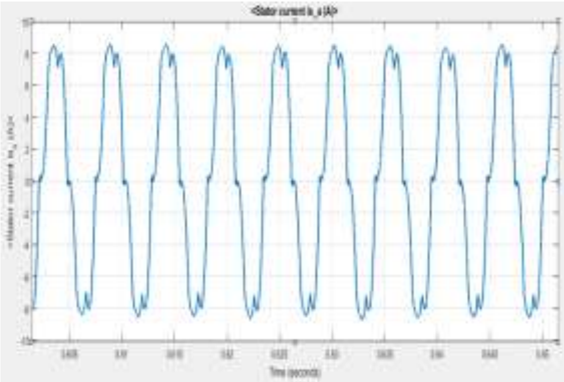

Figure 10 Stator Current phase C after MPPT

Figure 10 Shows Phase C Stator Current of wind turbine PMSG (Permanent Magnet Synchronous generator) Current is 8 ampere

V. Conclusion

In this study we are studied about the photovoltaic cells, module and array and also studied about the various effects of atmospheric factors over their characteristics. Consequently we also studied about the wind power generation system. For both the PV and wind system we track the maximum power point of operation by using the P&O MPPT algorithm. Thus in this study to get the advantages of both the system we integrate both these systems and this resulted hybrid system is sued for the charging and discharging of batteries. Thus after studying this model we make the following observations:

1. Minimum ripple in solar PV model DC current and Voltage
2. Track maximum power in solar PV mode and wind turbine
3. Total harmonics distribution is 2% in 3 phase inverter current as compared to previous algorithm.
4. Perfect DC current and voltage at solar PV panel
5. 2 KHz switching frequency of SVPWM in Voltage source inverter very less power device loss

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