"Design and Control of Power System Hybrid Model using Matlab/Simulink"

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ABSTRACT—This article is a simulation, designing and modeling of a hybrid power generation system based on nonconventional (renewable) solar photovoltaic and wind turbine energy reliable sources. The primary premeditated system is the solar electric generator, consisting of six models and series connected to each other, based on predicted-P&O and connected to a MPPT controller and DC/AC converter, system is associated with PMSG (permanent magnet synchronous generator). The main purpose of this article is to interconnect systems to generate maximum power for single auxiliary phase loading, as well as the solar PV generator and systems of wind turbines for simulation with execution use of Simulink / MATLAB. The results of this simulation indicate that the hybrid power system is planned for stability, reliability, efficiency and model. Solar PV generator and wind turbine from the use of a renewable energy source (for maximum voltage generation). The solar photovoltaic module executable in MATLAB / Simulink captures five parameters, series parameters and shunt resistance is an inverse photovoltaic saturation flow and an ideal factor.

Keywords—MPPT algorithms, irradiance, Perturb-observe, wind power etc.

I. INTRODUCTION

In electricity systems renewable energy sources are playing a significant and fundamental role, and utilization of photovoltaic solar energy is rising exceptionally day by day. Photovoltaic panels and electrical inverters are used to generate solar power. In nature, the output power generated. By the photovoltaic panels is discontinuous and varies depending on the level of irradiancy, temperature, aging of the panels, various orientations etc [1].

In several implementations, particularly in rural areas, a solar photovoltaic system is more cost effective and environmentally friendly. This work develops and reveals the fundamental combination of the photovoltaic array as well as examines the substantially different output characteristics of the solar photovoltaic array under different conditions along with variations in temp, changes in irradiance and various internal resistances to illustrate the different impacts of the parallel and the series solar PV array. The article discusses the model of a photovoltaic cell on the basis of equation of Shockley diode in MATLAB [2]. A comparison was also discussed between double and single diode models of the cell of solar photovoltaic's. This work generally designs the feature model of a photovoltaic cell with inverters and filters. The hybrid electric system integrates of two or more non conventional energy sources. There are certain benefits; it is more efficient than separate productivity, cost, mobility and reliability of energy sources. Moreover, it is mostly a few financial and environmental benefits, but also achievable with up and down production costs.

i. Principle operation

When sunlight is irradiated, a photovoltaic cell generates current and the pair of electron holes is generated, while photo voltaic cell equipment absorbs photons with and energy that exceeds the material's band gap. These generate photons are carriers that remove this cell's internal electrical fields and help to the current when the external circuit is linked to the cell.

ii. Photo voltaic cell corresponding circuits

Two types of diodes and established equivalent circuit shown in Figure 1 & 2 can represent a photovoltaic cell.
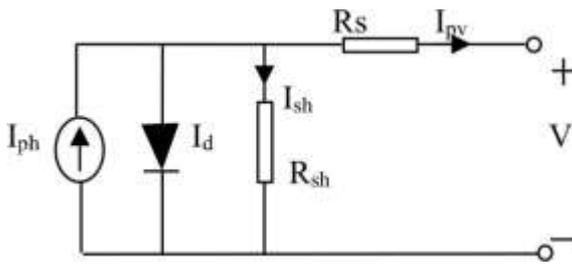
Fig2.Circuitofdoublediode

Whenever sun light irradiated to photovoltaic's cell, it generates direct current that varies widely sequentially with photo voltaic radiation, and the model could be enhanced by adding shunt resistance (RP) and series (Rs) effects. Rs is initiated here to take into account internal losses and voltage drops due to current flow and Rp reflects the leakage of current to the surface whenever diodes are reversed [3-6].

iii. Comparison of double and single diodes models

Any double diode model reflects the impact of free electron and pair of photons recombination. However, it actually increases the number of equations, and also unspecified parameters, attempting to make simulations slight, complex, but greater precise than the single - diode model. Mathematical errors are less in the single in view of mathematical calculations and the number of iterations.

II. Photo voltaic Cell

The photovoltaic cell is one of the semiconductor devices that absorbing and converting the photon energy that approaches energy from sunlight radiation. In the perfect photovoltaic cell model, it is extremely complex to determine the parameter associated with cell temp and

Which rises the response time of the process. On the contrary, steady state oscillation around the MPP is produced by enlargement the size of perturbation.

radiation intensity such as ILG, IOS, Rsh, and Rs. Manufacturers of photovoltaic's arrays give various observational conceptual parameters including current of short circuit ISC, voltage of open circuit VOC, max voltage point Vm, max power point current Im, and max power point Pm.

I_{PV_STC} is computed in the standard test condition (STC), i.e., irradiance G = 1000 W/m^2 and temperature T = 298 K (25°C). Variable K_I is frequently delivered by the constructor, which is coefficient of the I_{SC}. Diode's saturation current is specified by [7]

$$I_{d1} = I_{d2} = \frac{I_{SC-STC} + K_1(T - T_{STC})}{\exp((V_{OC-STC} + K_V(T - T)) / V_{STC}) - 1}_T \quad (3)$$

In (3), I_{SC_STC} is the short circuit current and V_{OC_STC} is the open circuit voltage in standard test condition (STC). The voltage's temperature factor is denoted by Variable K_V.

III. PERTURBANDOBSERVE(P&O)METHOD

On account of simplicity of execution as presented in diagram below, the Conventional Perturb & Observe algorithm is applied widely. Until the operative point unites at the MPP, it is a constant progression of observation and perturbation. The P&O algorithm equates the voltage and power of time (K) along with the model at a time (K-1) and guesses the time to method to maximum power point. If the power modification is +ve, then the power transformation of the solar panel is done by amin or voltage perturbation; voltage perturbation is constant in the equivalent path way. On the other hand negative delta power, point out that the maximum power point is far-off and the perturbation is reduced to trace the maximum power point. The abstract of the conventional P&O is figured out in Table 1. Hence, like this the entire P-V curve is checkered by minor perturbations to discover the maximum power point

Variations in the P&O algorithm have been proposed by numerous scholars to overwhelm the steady state oscillation sand response time issue.
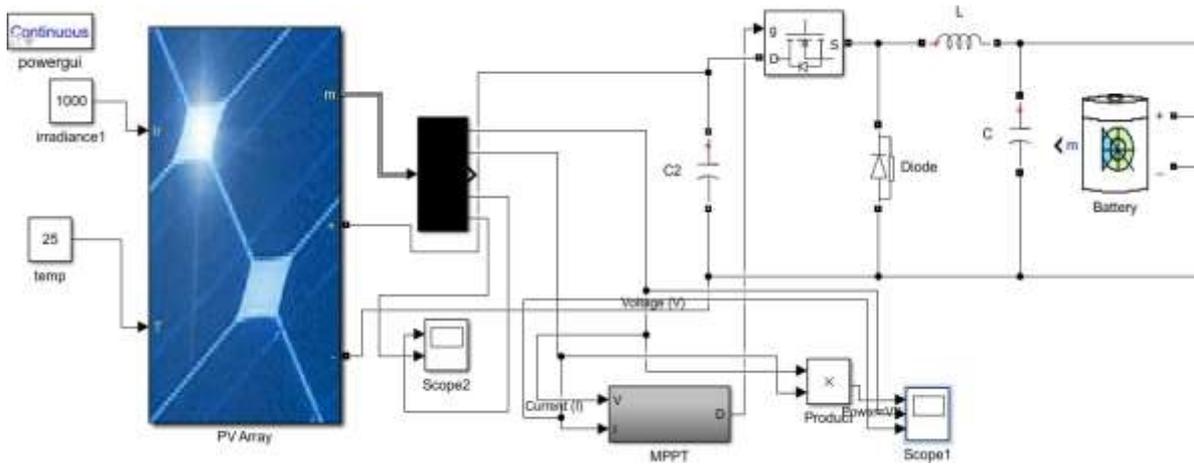
IV. PREDICTIVE_POBASEDMPPTRACKER

Fig3.SolarPV model simulation in Simulink

If a filter regulates its conveyance task by itself stated by an optimization process is called an adaptive filter (AF). On account of complexness of the optimization algorithms, digital filters are also adaptive filters which execute digital signal processing (DSP) & adjust their act built on the incoming signals to the filter. By means of compare, a non-adaptive filter has static filter factors (that jointly custom the transfer functions).

A. An Adaptive FIR Filter execution by using the least mean squares (LMS) Algorithm

LMS procedures are a session of adaptive filter applied to simulate a preferred filter by defining the filter factors that narrate to creating the LMS of the error signal.

B. Least Mean Square(LMS)Algorithm

For numerous age , the adaptive filter is a widespread and operative device for examining signals. Let the length of the adaptive filter for instance L. For input vector x(n), the arrangement produces output signal y(n) as presented in the subsequent equation,

$$y(n)=x(n)\mathrm{T}w(n)=w(n)Tx(n) \qquad (4)$$

The weight updated vector for the LMS algorithm is specified by the subsequent equation;

$$w(n+1)=w(n)+\mu x(n)e(\mathrm{n}) \qquad (5)$$

Where μ is the step size, the whole PV system which has been working is shown in figure4 where MPPT block uses PREDICTIVE-PO based tracking method.
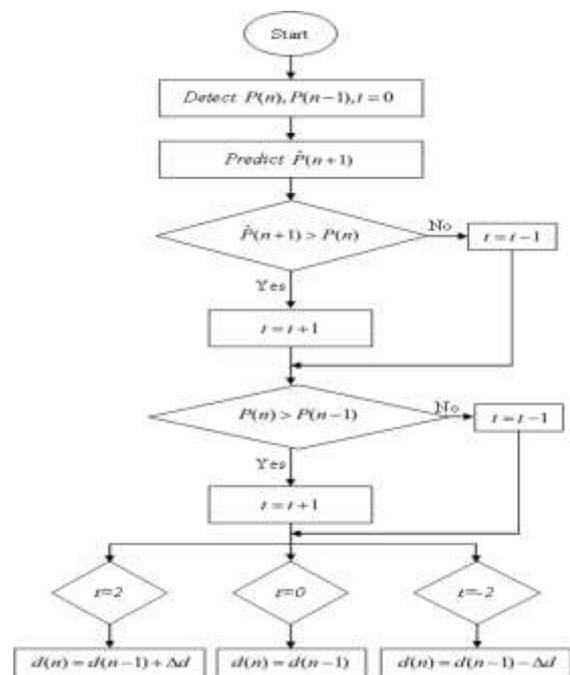

Fig.4:Flow chart of MPPT algorithm based on LMS based predictive power

Whole Photovoltaic system designed for efficient mppt tracking has been shown in figure 2.Due to the variance in irradiance and temperature, the voltages and currents cannot fed directly to the energy storage units or appliances, these need to be first fed to the controller device which tracks the maximum power for the available voltage and current in such a way that an energy storage unit which consists of inductance and capacitance circuit hold the extra power for some time when there is extra power generation from previous cycle and donates the power when there is less Power production in previous round. This on-off time set is provided by a MOSFET /IGBT switch to the LC circuit using the MPPT control unit.

The LC circuit and switch constitutes the buck booster system which works on DC-DC conversion level. In existed algorithm of perturb-observe; only current and previous readings were utilized without any consideration of optimized future power values. In proposed

methodology, predictive power is induced which is optimized using least mean square algorithm in order to maintain optimum maximum point of power. In flowchart below, p(n+1) is predictive power[8].
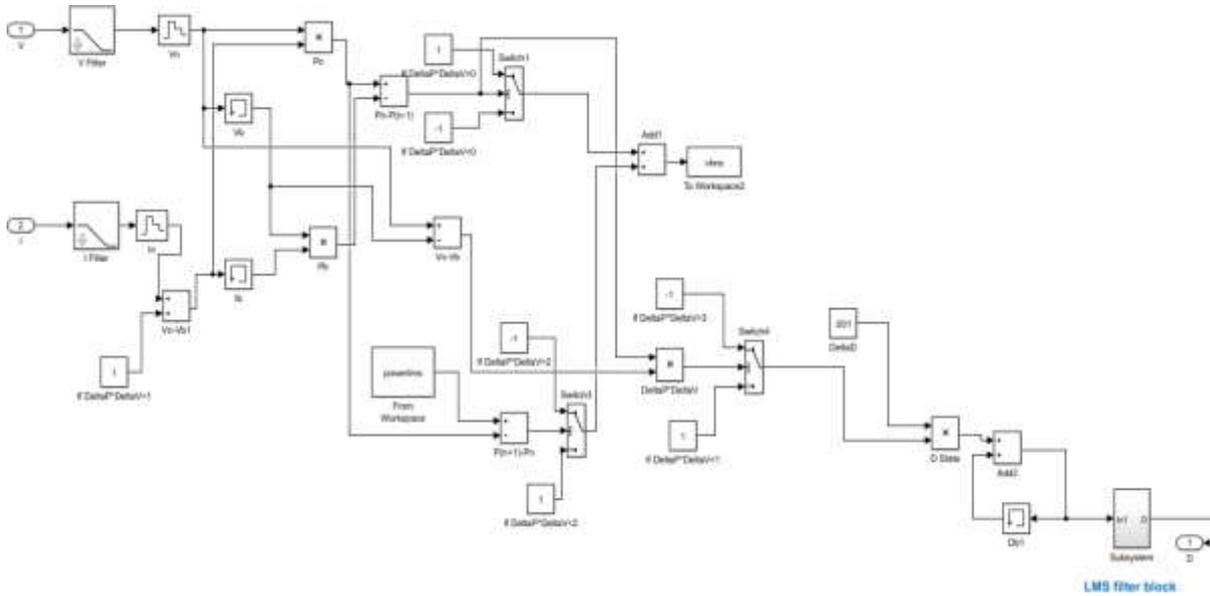

Fig.5:Flow chart implementation of MPPT algorithm based on LMS based predictive power

buck-booster DC-DC converter is used and mosfet switch is used to on-off the energy storage circuit.

V. Result of SPV simulations

Simulation results are carried out for an array consists of 40 series modules and 10 parallel modules. User defined attributes of module used are as follows. Open circuit voltage (Voc (V)) is 42 , Isc(A)=29.7,Voltage at MPP Vmp(v)=36, ,current at MPP Imp(A)=27.7, cells per module= 10Fig. 6 shows the IV-PV plots of array when it works at optimum conditions. Fig. 7 Shows the PV power wave forms using traditional PO method and PREDICTIVE- PO based improved method. The performances of proposed MPPT algorithm have been evaluated at 1000 W/m^2 and25^o temperature. Table two gives the power values using two compared methods [9].
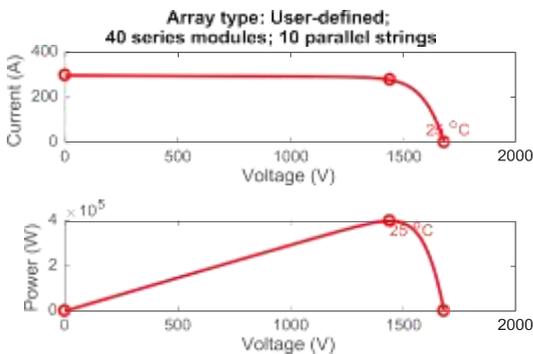

Fig.6:IV- PV plots of array in optimum conditions

It has been found that proposed method achieves highest point far early than traditional PO method. In this work,
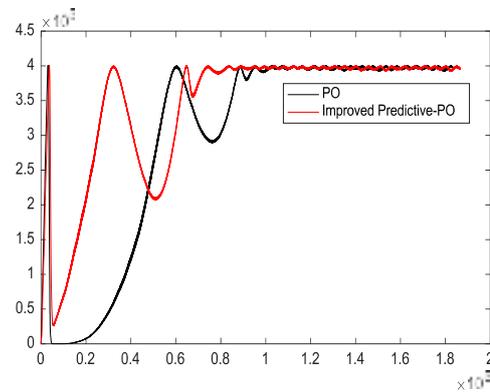

Fig.7:Comparison of power output using perturb Observe and Proposed PREDICTIVE-PO based MPPT tracking

It is also been found that proposed method gives power with least fluctuation variance and achieves stability in peak value earlier than PO method.

VI. Wind Turbine Modeling

Energy of wind is a source that is friendly to the environment and unending. Moreover, one of the exciting sources of renewable energy for future demand may be a wind energy generation system. Its converting wind kinetic energy into mechanical energy, and the magnitude of this mechanical energy that has been converted depends on the wind speed and air

density [10]-[14]. Wind turbines power (Pm) is determined by this equation:

Pm=1/2Cp(λ,β)ρAw3(9) Where:

w=Wind speed (m/sec)

ρ = Density of Air

(Kg/m3)A=Turbine blades

area(m3)

Cp=Turbine performance coefficient

β = Angle of blade pitch (degree)

λ=Rotor blade tip velocity ratio to wind velocity

The Cp coefficient is the fraction of kinetic energy that is converted into mechanical energy through wind turbine, and it's depending on the ratio of tip velocity(λ). For calculation of wind turbine torque (Tm) uses this equation:

Tm=1/2ρACp(w/λ)(10)

Wind turbine optimal power curve is determining different operation regions and different speed of wind as rated wind speed, cut in wind speed, cut out wind speed [15].
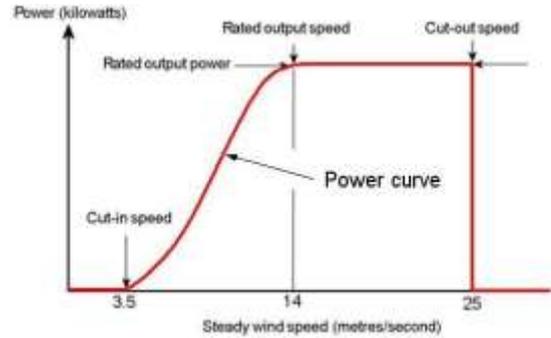

Fig.8:Typicalwindturbinepoweroutputwithsteadywind speed

Joint the turbine of wind system and PMSG Generator uses software Simulink /MATLAB and seen in Fig9.

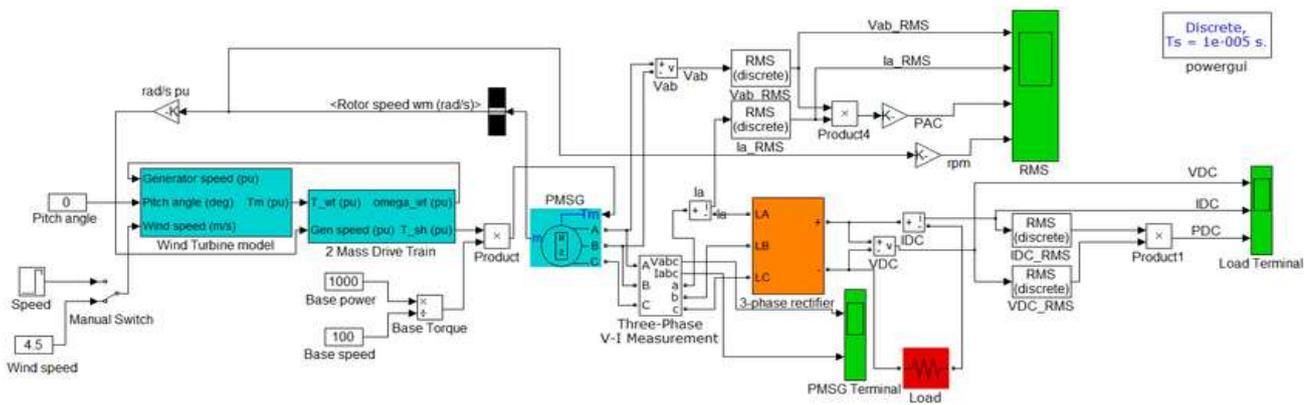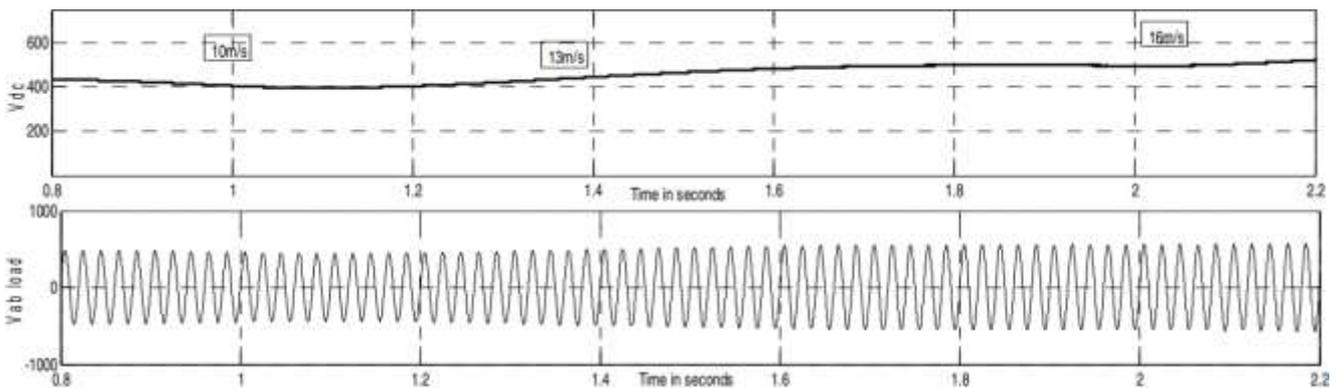Fig9.Wind turbine model simulation in Simulink.

Figure10.Dc and AC voltage PMSG under different wind speed

The PMSG turbine for wind power generation has been Simulated accurately and the DC and AC output have shown in form of voltage waveforms.

VII. Grid Connected Hybrid power system simulation and modeling

Perhaps the hybrid power system, which consists of two non conventional energy sources, the combination of solar

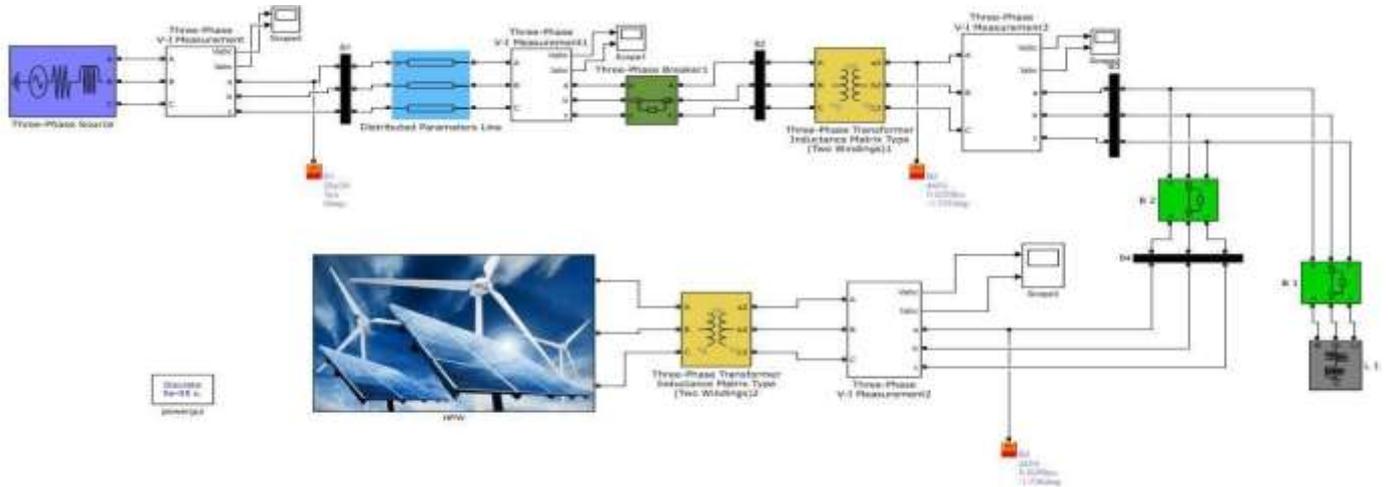Photo voltaic and wind turbine system and providing single phase AC load.

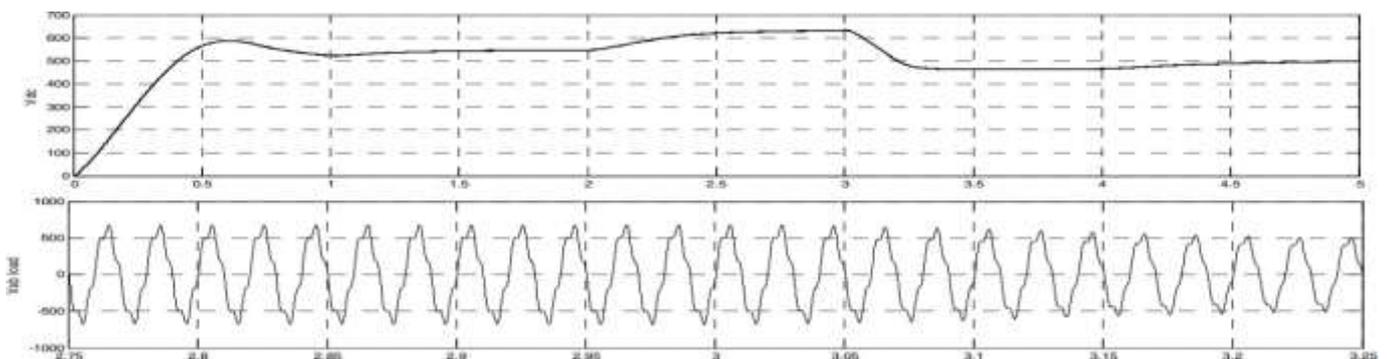Fig11.Wind and Solar photo voltaic hybrid power system connection with Grid system model Simulink.

Fig12:Output for both wind speed and solar

The above figure represents the voltage waveform of wind turbine and solar photovoltaic system based on the predictive -P&O MPPT technique.

VIII. CONCLUSION

The objective of this article is the integration of wind turbine system with solar photovoltaic's system to demonstrate the efficiency, reliability, and maximum power generation of a hybrid power system. Then each system was premeditated and modeled unaccompanied and subsequently joined to compare the voltage and power variation use of Simulink/ MATLAB. In fact, the effects of the simulation actually demonstrate the efficiency of the planned hybrid power system, in order to generate maximum power for moist summer weather in various countries trying to use renewable energy. Recently, the power generation of average lightness and wind velocity are valuable and beneficial. The solar cell's performance depends mainly on climate conditions. Entirefield tests to monitor solar cell performance are highly costly .A

comprehensive simulation study can accumulate resources and time, however. All these concerns are covered by the solar photovoltaic's model implemented using MATLAB /Simulink. The Simulink execution of the solar photovoltaic model has five parameters in the description.

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