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Modeling and Simulation of Hybrid System

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ABSTRACT— *The article presented is a simulation, modeling and designing of a hybrid power generation system which is based on non-conventional (renewable) wind turbine energy and solar photovoltaic reliable sources. The primary system is the solar electric generator, which consist of six models and connected to each other in series, based on predicted P&O and is connected to a MPPT controller and AC/DC converter, system is associated with Permanent Magnet Synchronous Generator. The main purpose this article is serving is to interconnect system so that it generates maximum power for single auxiliary phase loading, and the solar PV generator and systems of wind turbines for simulation with using Simulink/ MATLAB. The result of this simulation indicates that the hybrid power system is planned for efficiency, stability, reliability and model. Wind Turbine and Solar PV from the use of a renewable energy source for maximum voltage generation. The solar photovoltaic saturation flow and an ideal factor.*

Keywords— MPPT algorithm, perturb-observe, Wind power, Irradiance etc.

I. INTRODUCTION

In electricity systems, significant ad fundamental roles are played by renewable energy sources and there is an exceptional rise in utilization of photovoltaic solar energy day by day. Solar power is generated using photovoltaic panels and electrical inverters. In nature, the output power generated by the photovoltaic panels is discontinuous and varies depending on the level of irradiancy, aging of the panel, temperature, various orientations etc [1].

In several implementations, rural areas particularly, a solar photovoltaic system is more environmental friendly and cost effective. This work develops and reveals the fundamental combination of the photovoltaic array and with that it examines the substantially different output characteristics of the solar photovoltaic array in different conditions with variations in temperature, changes in irradiance and several other internal resistances to show the different impacts of the parallel and the series photovoltaic array. The model of a photovoltaic cell on the basis of Shockley diode's equation in MATLAB is discussed in this article [2]. A comparison between single and double diode models of the cell of solar photovoltaic' was also discussed. The feature model of a photovoltaic cell with filters and inverters has generally been designed in this work. Two or more non-conventional energy sources are integrated in a hybrid electric system. There are a few benefits; it is more efficient than separate productivity,

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mobility, reliability of energy sources and cost. And, there are few environmental and financial benefits, which can also be achieved with up and down production costs.

A. Principle of operation

When sunlight is exposed, current is generated in a photovoltaic cell and the pair of electron hole is generated, while photovoltaic cell equipment absorbs photons with an energy that exceeds the material's band gap. These generate the photons and carriers that remove this cell's internal electrical fields and help to the current, when the external circuits linked to the cell.

B. Photovoltaic Cell corresponding circuits

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

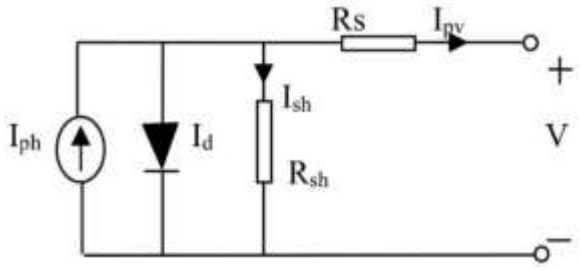

Figure 1: Circuit of single diode

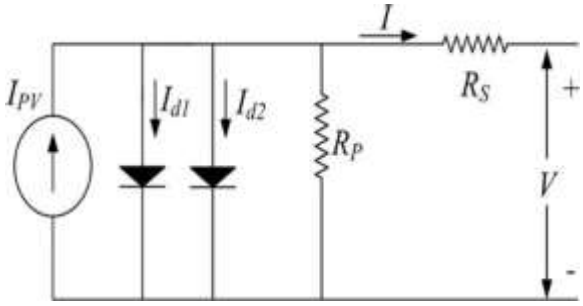

Figure 2: Circuit of double diode

When sunlight is exposed to photovoltaic's cell, a direct current is generated that varies widely sequentially with photovoltaic radiation, and the model could be enhanced by adding shunt resistances 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].

C. 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 accuracy than the single diode model. Mathematical errors are less in the single in view of mathematical calculations and the number of iterations.

II. PHOTOVOLTAIC CELL

It is one of the semiconductor devices that absorbs and coverts the photon energy that approaches energy from sunlight. In a perfect photovoltaic cell model, determining the parameter associated with cell temperature is very complex.

It leads to the rise in the response time of the process on the other hand, steady state oscillation around the MPP is produced by enlargement of the size of permutation radiation intensity such as IOS,ILG, Rsh and Rs. Manufacturers of photovoltaic' arrays give various observational conceptual parameters including current of short circuit ISC, voltage of open circuit Voc, maximum voltage point Vm, max power point current Im and maximum power point Pm.

$$I = I_{PV} - I_{d_1} - \frac{V + IR_s}{R_p} \qquad (1)$$

On the other hand, Rp and Rs are the parallel and series resistance, correspondingly. Although Vt is the diode thermal voltage. The created current by lights is Ipv.

$$I_{PV} = \left(I_{PV-STC} + K_I\left(T - T_{STC}\right)\right)\frac{G}{G_{STC}} \qquad (2)$$

Ipv 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 K1 is frequently delivered by the constructor, which is coefficient of the Isc. Diode's saturation current is specified by [7]

$$I_{d1} = I_{d2} = \frac{I_{SC-STC} + K_I\left(T - T_{STC}\right)}{\exp\left(\left(V_{OC-STC} + K_V\left(T - T_{STC}\right)\right)/V_T\right) - 1} \qquad (3)$$

In (3), Isc_stc the short circuit current and Voc_stc is the open circuit voltage in standard test condition (STC). The voltage's temperature factor is denote3d by Kv.

III. PERTURB AND OBSERVE (P&O) METHOD

On describe of simplicity of implementation as presented in diagram below, the cark Perturb & Observe algorithm is applied widely. Until the operative point unites at the MPP, it is a constant gradation 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 conversion of the solar panel is done by a minor voltage perturbation; voltage perturbation is constant in the equivalent pathway. On the other hand negative delta power, point out that the maximum power point is far-off and the perturbation is decreased to trace the maximum power point. The abstract of the cark P&O is figured out in Table 1. Hence, like this the entire P-V curve is check red by minor perturbations to discover the maximum power point .Mutation in the P&O algorithm have been projected by Numerous scholars to overwhelm the steady state oscillations and response.

IV. PREDICTIVE_PO BASED MPP TRACKER

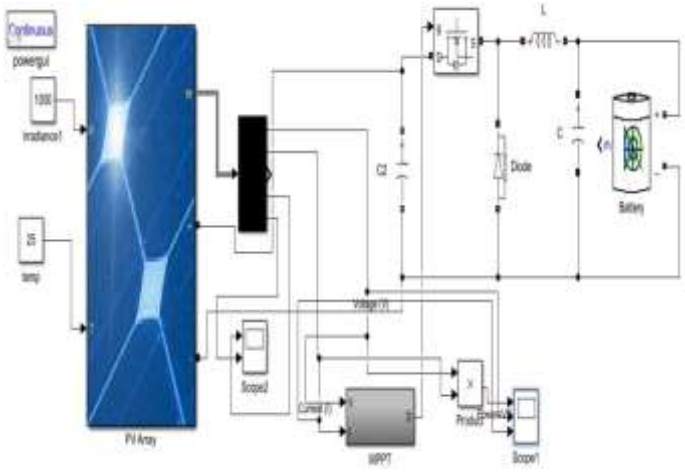

Figure 3: Solar PV model simulation in Simulink

If a filter regulates its carriage task by itself stated by an optimization process is called an adaptive filter (AF). On describe 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. Comparison of double and single diodes models

For numerous age , the adaptive filter is a broad range 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,

$$y(n) = x(n)Tw(n) = w(n)Tx(n) \qquad (4)$$

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

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

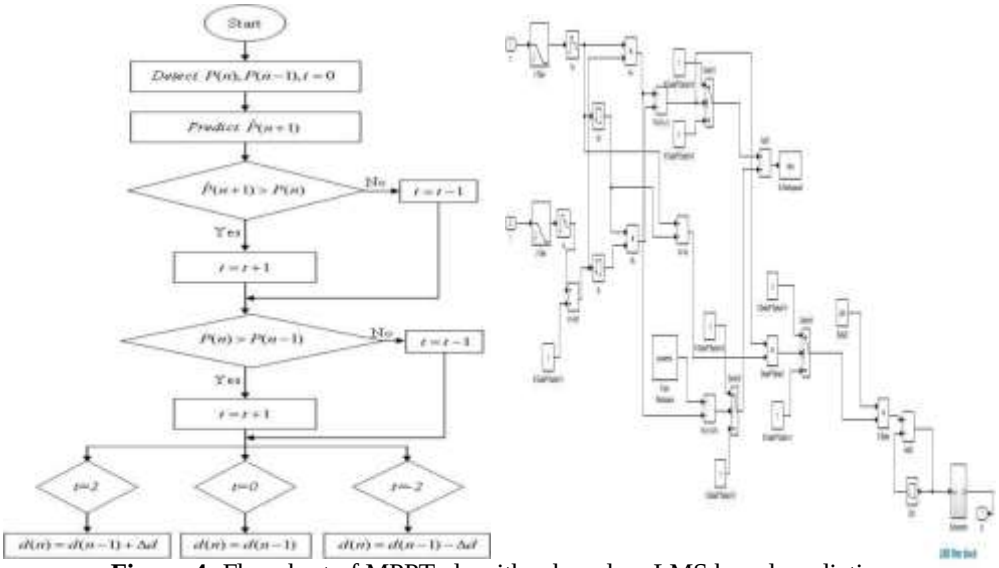

Figure 4: Flowchart of MPPT algorithm based on LMS based predictive power

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 made of 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 projected 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].

V. RESULTS OF SPV SIMULATIONS:

The result of simulation of 30 series modules and 15 parallel modules is taken. The attributes used in modules are as follows. Open circuit voltage (Voc) = 30 voltage, Short Circuit Current (Isc)=15 Ampere, Voltage at Maximum Power Point (Vmp)=20 voltage, current at Maximum Power Point(Imp)=18 Ampere, cells per module= 10. The current voltage -PV plot for working module at optimum condition is shown in fig.6. Solar power waveforms by using regular PO method & Predictive-PO based improved method is shown in fig.7. The working of proposed MPP Tracking algorithm has been examined at 1000 W/m2 and temperature at 25^{o}.

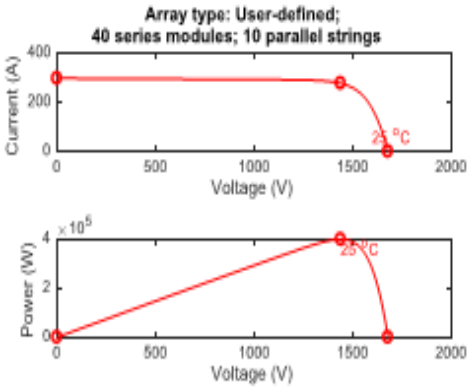

Figure 5: Flowchart implementation of MPPT algorithm

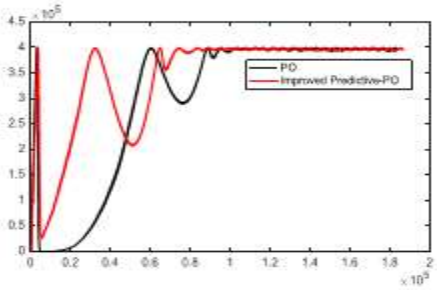

Figure 6: IV-PV plots of array in optimum conditions

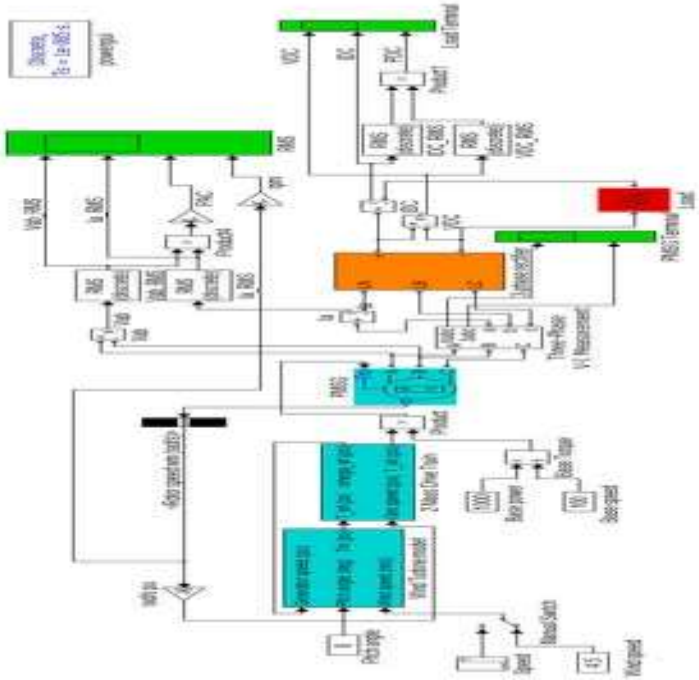

Figure 7: Comparison of power output

Table 2 provides power values using two compare methods [9]. It is observed that prescribed method achieves highest point much earlier than previous PO methods. In this observation, for conversion buck-booster DC-DC converter is used and to on-off the energy storage circuit MOSFET switch is used. It is also observed that proposed method provides power with least fluctuation variation and achieves higher stability in peak value earlier that of PO method.

VI. WIND TURBINE MODELING

Wind energy is a source of unlimited and eco-friendly energy. It is renewable source of energy which can fulfill the future demand of electrical power supply with wind energy generation system. It converts kinetic energy of wind into mechanical energy and this mechanical energy is used to generate the electric power. The magnitude of mechanical energy depends upon the speed of wind and air density [10] - [14].

Wind power generated by wind turbines (Pm) is given by equation:

$$Pm=1/2\ Cp\ (\lambda, \beta)\ \rho A w3 \quad (9)$$

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

Cp is the coefficient of fraction of kinetic energy which is converted into useful mechanical power by wind turbines, it depends on the ratio of Tip velocity (λ). The wind turbine torque is given by the equation:

$$Tm=1/2\ \rho A Cp\ (w/\lambda) \quad (10)$$

The optimal power curve of wind turbine is used to determine the different region of operations at different speed of wind as, rated wind speed, cut in wind speed, cut out wind speed [15].

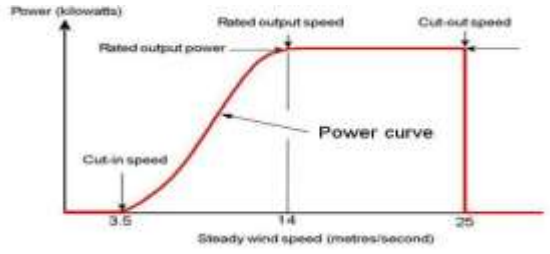

Figure 8: Typical wind turbine power output with steady wind speed

The combination of wind system and PMSG Generators using Simulink /MATLAB is shown in fig.9.

The PMSG turbine for wind power generation has been simulated accurately and the DC and AC output have shown in form of voltage waveforms Figure10. Dc and AC voltage PMSG under different wind speed

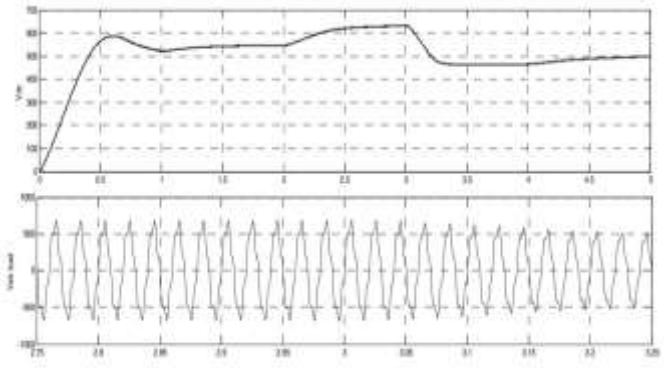

Figure 9: Wind turbine model simulation in Simulink.

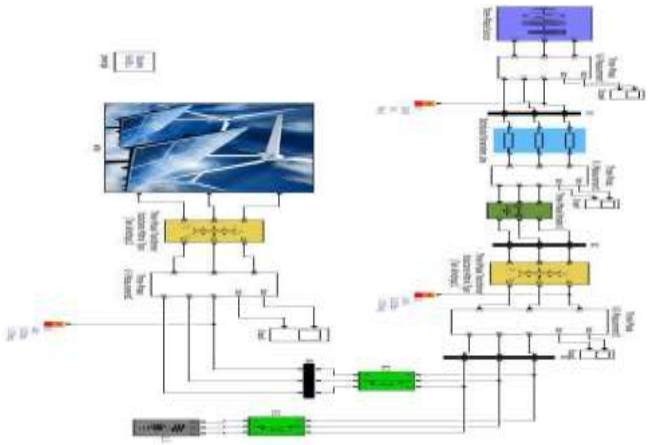

Figure10: Dc and AC voltage PMSG under different wind speed

VII. Grid Connected Hybrid power system simulation and modeling

The hybrid power system consists of two non-conventional sources of energy which are the combination of solar photovoltaic and wind turbine system. Moreover, the hybrid power system provides single phase AC load.

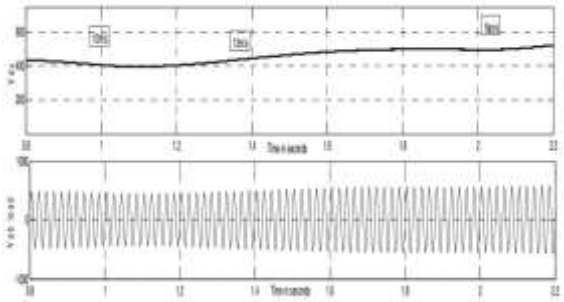

Figure 12: Output for both wind speed and solar

The voltage waveform of wind turbine and Solar Photovoltaic System which is based on the predictive – P&O MPPT technique is represented in the above figure.

VIII. CONCLUSION

The integration of wind turbine system with solar photovoltaic system is the main objective of this article in order to demonstrate the efficiency, reliability and maximum power generation of a hybrid power system. Then, for the comparison of the volatile and power variation, this system was premeditated and modeled unaccompanied and subsequently joined with the use of Simulink/ MATLAB. The efficiency of the plant hybrid power system is actually demonstrated by the effects of simulation in order to produce maximum power for moist summer weather in various countries which are trying to use non-conventional energy. The implementation of power generation of solar photovoltaic model is done with the use of MATLAB/ Simulink. There are five parameters in the description of Simulink execution of the Solar Photovoltaic Model.

REFERENCES

1. B H Khan, “Non-Conventional Energy Resources,” Tata McGraw-Hill Pub.Co., 2009.
2. Gazia Manzoor, Kamalkant Sharma, Satyanand Vishwakarma”PSO-GSA based MPPT Algortihm for Photovoltaic Sytems”, International Journal of Recent Technology and Engineering (IJRTE), ISSN:2277-3878, vol.7, issue-6S4, April 2019
3. H.Renaudineau,F.Donatantonio,G.Petrone, G.Spagnuolo, J. P. Martin, S.Pierfederici, J. Fontchastagner,“A PSO-based global MPPT technique for distributed PV power generation,” IEEE Trans. Ind. Electron., vol. 62, no. 2, pp. 1047–1058, Feb. 2015
4. Vpiasha Sharma, Harpreet Kaur, Inderpreet Kaur,”Design and Implemetation of Multi Junction PV cell for MPPT to improve the Transformation efficiency
5. K. Sundareswaran, V. Vigneshkumar, P. Sankar, S. P. Simon, P. S. R. Nayak, and S. Palani, “Development of an improved P&O algorithm assisted through a colony of foraging ants for MPPT in PV system,” IEEE Trans. Ind. Informat., vol. 12, no. 1, pp. 187–200, Feb. 2016.
6. D. Teshome, C. H. Lee, Y. W. Lin, and K. L. Lian, “A modified firefly algorithm for photovoltaic maximum power point tracking control under partial shading,” IEEE J. Emerg. Sel. Topics Power Electron., vol. 5, no. 2, pp. 661–671, Jun. 2017.
7. X. Liu, P. Wang and P. C. Loh, “A Hybrid AC/DC Microgrid and Its Coordination Control,” IEEE Transaction on smart grid, vol. 2, June 2011, pp.278 - 286.
8. J. Ahmed and Z. Salam, “A critical evaluation on maximum power point tracking methods for partial shading in PV systems,” Renewable Sustain. Energy Rev., vol. 47, pp. 933–953, Jul. 2015.
9. Obaidullah Lodin , Inderpreet Kaur, Harpreet Kaur “Predictive- P&O Mppt Algorithm for Fast and Reliable Tracking of Maximum Power Point in Solar Energy Systems”, International Journal of Recent Technology and Engineering (IJRTE), ISSN:2277-3878, Volume-7, Issue-6S4, April 2019

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10. A. M. Osman Haruni, Michael Negnevitsky, Md. Enamul Haque, A.Gargoom, “A Novel Operation and Control Strategy for a Standalone Hybrid Renewable Power System,” IEEE Transactions on sustainable energy, vol. 4, no. 2, April 2013,pp.402-413.
11. F. Paz and M. Ordonez, “Zero oscillation and irradiance slope tracking for photovoltaic MPPT,” IEEE Trans. Ind. Electron., vol. 61, no. 11, pp. 6138–6147, Nov. 2014.
12. Shefali, Harvinder Singh, Sachin Kumar, Inderpreet Kaur,” Designing and Imulation of Solar module in the Islanded network of a solar PV microgrid”, International Journal of Recent Technology and Engineering (IJRTE), ISSN:2277-3878, Volume-7, Issue-6S4, April 2019.