IJIREEICE
ISSN (O) 2321-2004, ISSN (P) 2321-5526
International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering
Impact Factor 7.047 ⋇ Vol. 10, Issue 4, April 2022
DOI: 10.17148/IJIREEICE.2022.10484

MATLAB SIMULATING MODEL OF HYDRID POWER GENERATION FROM NATURAL RESOURCES FOR HIGHWAY

MISS. SHITAL B. WAKADE[1], PROF. NILIMA B. DHANDE[2], PROF. SAMEER S. RAUT[3]

[1] Department of Electrical Engineering, Shri Sai College of Engineering & Technology, Bhadrawati, Maharashtra, India

[2] Professor, Department of Electrical Engineering, Shri Sai College of Engineering & Technology, Bhadrawati, Maharashtra, India

[2] Professor, Department of Electrical Engineering, Shri Sai College of Engineering & Technology, Bhadrawati, Maharashtra, India

Abstract: This paper introduces a hybrid system connected to a DC load. The hybrid system is made up of a photovoltaic generator (Kaneka GSA060), a turbine generator (Air X 600W) made of a turbine and a permanent magnet-compatible generator, an uncontrolled third phase converter and a DC-DC amplifier to power the power converted to each source and is controlled by a command based on the Perturb and Observe method. The purpose of the control is to extract the maximum energy of each source in the proposed system for different variation of the input parameters (radiation and air velocity). Our program saves with MATLAB / SIMULINK environment.

Keyword, Photovoltaic PV generator, Wind Turbine generator, permanent magnet synchronous generator (PMSG), Perturb and Observe technique (P&O), boost converter, hybrid station, DC load, Maximum Power Point Tracking (MPPT).

1. INTRODUCTION

In recent years, the energy generated by renewable energy sources, especially wind speed and the radiation is considered to be another important production in the energy system. Two popular applications using a hybrid system can be used in two popular systems: grid-connected use and the standalone application is widely used in the hybrid system. Many studies based on renewable energy in hybrid systems have been published. References and are of interest to the converter focused on performance in size. Dedicated to Design remain in Performance Test. Our work focuses on hybrid system management using the same MPPT control based on the Perturb and Observe (P&O) approach. This method is used to obtain an independent system with the required power from a hybrid system. In this paper, we introduce a Photovoltaic-Wind hybrid system connected to a DC load using an MPPT control based on P&O method that allows MPP tracking or by changing environmental conditions in a photovoltaic generator and wind turbine generator. The model is simulated with the MATLAB / SIMULINK environment.

2. MODELING OF THE PHOTOVOLTAIC GENERATOR

A simplified equivalent circuit model of a Photovoltaic cell is given in Figure 1 and is represented in the following figures. This model is made up of the current source I, depending on the photovoltaic radiation in the same way, the diode and shunt resistor Rsh, All components are in series with resistance Rs.

$$I = I_L - I_d \tag{1}$$

$$I_d = I_s\left[exp\left[\frac{q \times V_{pv}}{A \times k \times T}\right] - 1\right] \tag{2}$$

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$$I_L = [I_{sc} + K_I \times (T - T_{Ref})] \times \frac{S}{S_r} \tag{3}$$

$$I_s = I_{Rs}\left(\frac{T}{T_{Ref}}\right)^{\left(\frac{3}{A}\right)} \times exp\left[\frac{q \times E_{gap}}{A \times k}\left(\frac{1}{T_{Ref}} - \frac{1}{T}\right)\right] \tag{4}$$

$$I_{Rs} = \frac{I_{sc}}{exp\left(\frac{q \times V_{oc}}{A \times k \times T_{Ref}}\right) - 1} \tag{5}$$

$$I = I_L - I_s\left[exp\left(\frac{q\times(V_{pv}+I)\times R_s}{A\times k\times T}\right) - 1\right] - \left(\frac{V_{pv}+I\times R_s}{R_{sh}}\right) \tag{6}$$

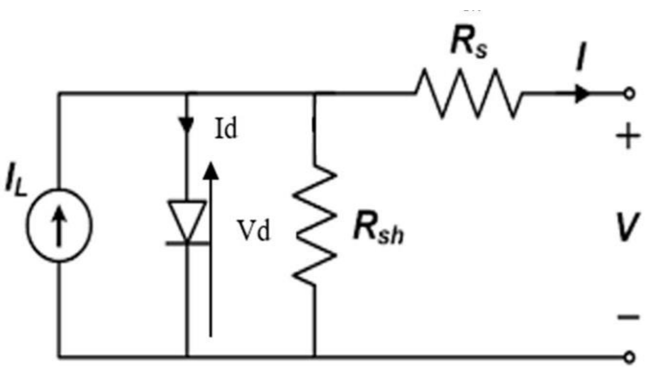

Fig -1: The equivalent electric circuit of the PV cell

The characteristics of the P(V) and I(V) with a variation of radiation and temperature equal to 25°C are shown in Figure 2.

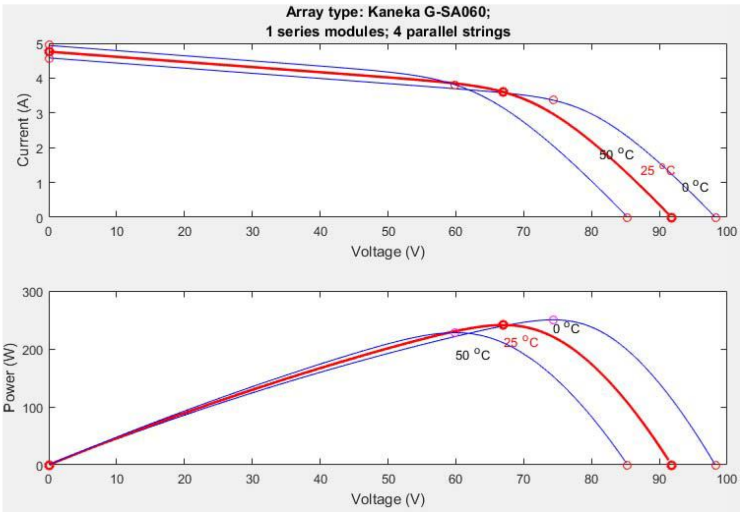

Fig -2: photovoltaic generator characteristics under different level of radiation and Temperature at (25°C): I = f (V) and P= f (V)

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Technical parameters of the Photovoltaic generator are shown in Table. 1:

TABLE I. KANEKA GSA060 VALUES USED WITH MATLAB/SIMULINK (AT STANDARD TEST CONDITIONS: 1000W/M² AND 25°C)

Parameters	Values
Maximum Power P_{max}	60W (+10/-5%)
Cells per Module	108
Voltage at P_{max}	67V
Current at P_{max}	0.91 A
Open circuit voltage V_{oc}	94 V
Short-circuit Current I_{oc}	1.19 A
Shunt Resistance R_{sh}	4 ohm
Series Resistance R_s	0.16 ohm

3. 3 MODELING OF THE WIND TURBINE GENERATORS

The turbine generator system is made up of a wind turbine with particles, a three-phase controlled rectifier and a powerful permanent synchronization mechanism for electromechanical conversion. The technical parameters of the Wind Turbine generator are presented in Table. 2:

TABLE II. TECHNICAL SPECIFICATIONS OF THE AIR X WIND TURBINE USED WITH MATLAB/SIMULINK

Parameters	Values
Rotor Diameter	46 in (1.15m)
Weight	13 Ib (5.85 kg)
Start Up Wind Speed	15.6 mph (7.5 m/s)
Voltage	24 VDC
Rated Power	586 Watts at 28 mph (12.5 m/s)
Base rotational Speed	1700 rpm
Initial rotational Speed	500 rpm
Moment of inertia	0.001m kg.m²

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3.1 Modelling of the wind turbine

The principle of the wind turbine machine is converting the wind energy to mechanical energy. The power developed by a (WT) is shown by:

$$P_{turbine} = \frac{1}{2} C_p(\beta, \lambda) \rho \pi R^2 V_v{}^3 \quad (7)$$

The tip speed ratio is demonstrated by

$$\lambda = \frac{R \times \Omega_{turbine}}{V_v} \quad (8)$$

3.2 Modelling of the wind turbine

The mathematical model of the (PMSG) is defined by the

equations (9) and (10) :

$$V_q = -R_s i_q - L_q \frac{di_q}{dt} + \omega_e L_d i_d + \omega_e \lambda_m \quad (9)$$

$$V_d = -R_s i_d - L_d \frac{di_d}{dt} + \omega_e L_q i_q \quad (10)$$

The expression for the electromagnetic torque can be defined

by:

$$T_{em} = \left(\frac{3P}{2}\right) \left[\left(L_d - L_q \right) i_q i_d + i_q \lambda_m \right] \quad (11)$$

The relation between electrical angular speed and mechanical angular speed is described as:

$$\omega_e = \frac{P}{2} \Omega_{turbine} \quad (12)$$

3.3 Modeling of the three phase uncontrolled rectifier

The instantaneous voltage of the permanent magnet synchronous generator is shown by:

$$V_{an} = V_m \sin \omega t \quad (13)$$

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$$V_{dc}=\frac{3\sqrt{3}}{\pi}V_m=\frac{3\sqrt{6}}{\pi}\lambda_{m-eff}P\Omega \quad (14)$$

$$I_{dc}=\frac{\pi}{\sqrt{6}}I_a \quad (15)$$

4. DC-DC BOOST CONVERTER

There are many types of chopper reinforcement. The most widely used are Boost, Buck and Buck-Boost. The reinforcement converter is used in our system. This type is preferred because it allows for an increase in the output power relative to the input voltage, and also ensures PPM compliance from the proposed controller.

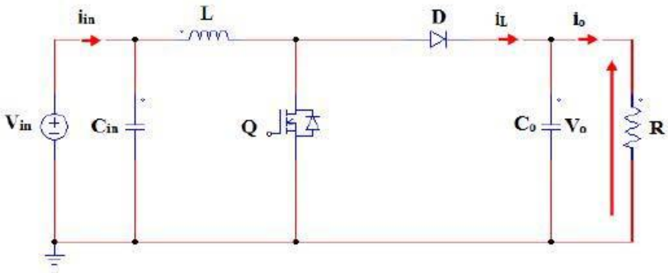

Fig -3: Schema of DC-DC boost converter

5. RESULT

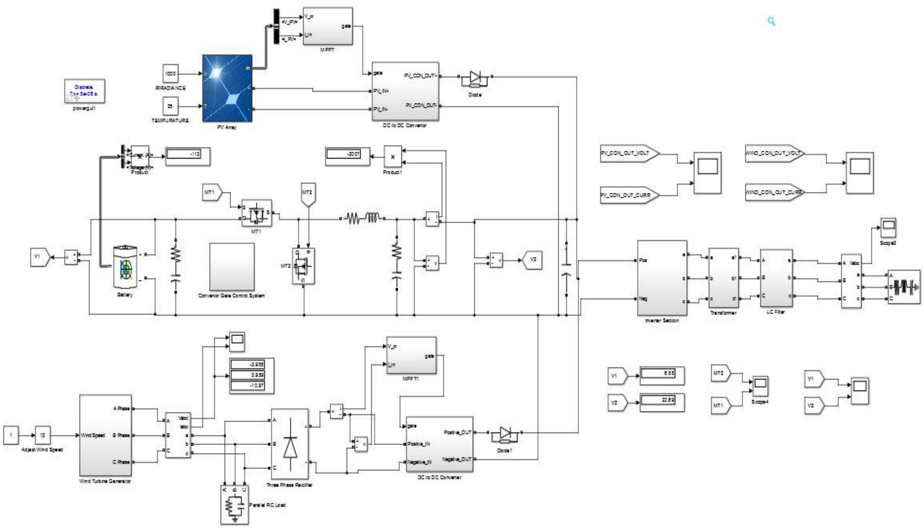

Fig -4: Simulink model for the complete grid-connected wind turbine model

The hybrid system is composed by a photovoltaic generator and a wind turbine, both of them are coupled with a DC load through an intermediary power converter (Boost) dedicate for each source. They are also controlled by a command based on the method Perturb and Observe (P&O). Our system modulates using MATLAB/SIMULINK environment.

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5. Result

This scope are show that each IGBT gate signal are provide from PWM control system to generate the each PWM signal for given to IGBT with zero to one amplitude.

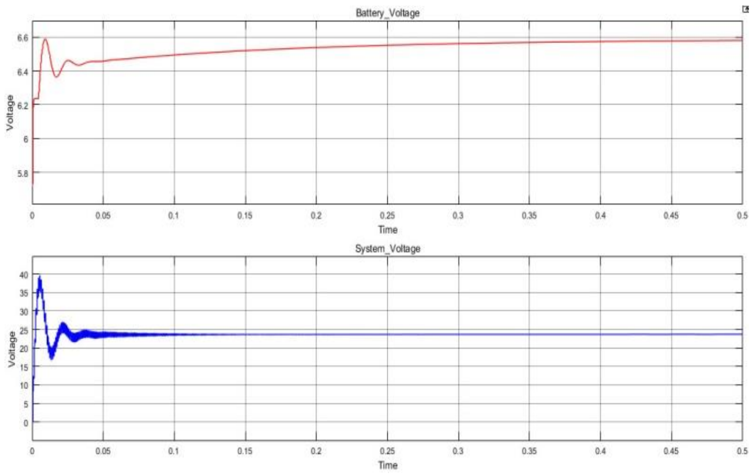

Fig -5: Bidirectional Output

This waveform shows the battery parameter. the battery is connected to the bidirectional converter that means battery are two dimensional work it has a load as well as source, This waveform shows that the charging of the battery and system voltage shown to output of the bidirectional converter are near about this constant voltage.

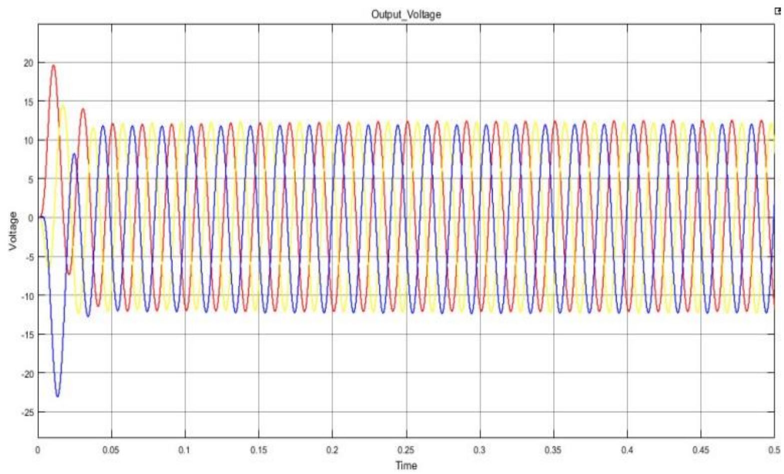

Fig -6: Inverter Output

This figure is show that the output of three phase inverter are connected to the linear load this overall output is show that the stand alone output of the inverter and with reduction of the harmonic in inverter output and also this graph are shown in voltage with respect to time.

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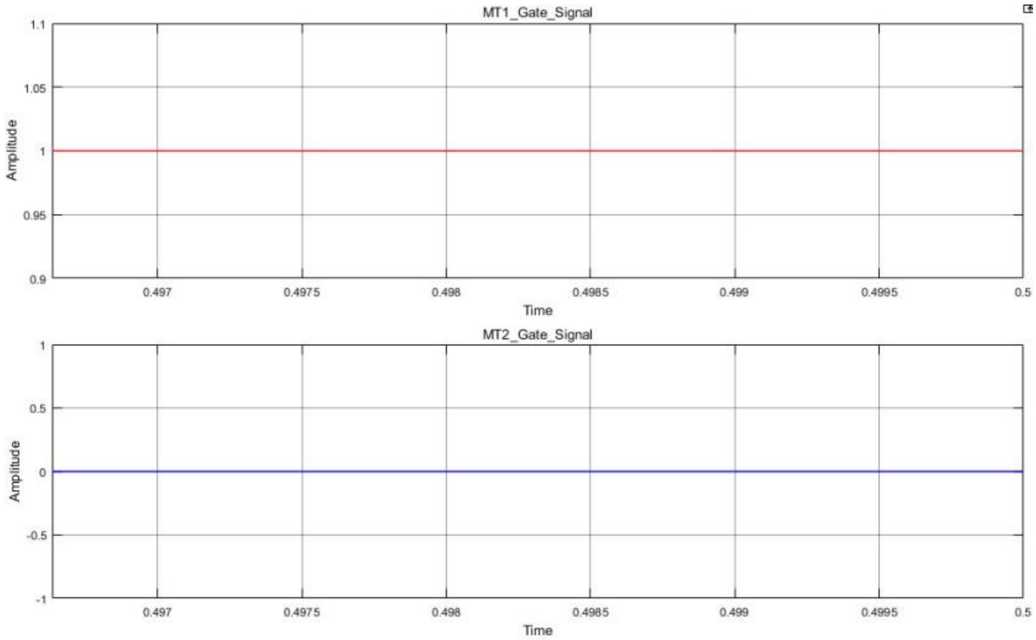

Fig -7: MOSFET Gate Output

This waveform are show to gate pulses of MPPT MOSFET one is a photovoltaic MPPT MOSFET and another is the wind generator mppt both are the operated to gate pulses this is shown in the waveform.

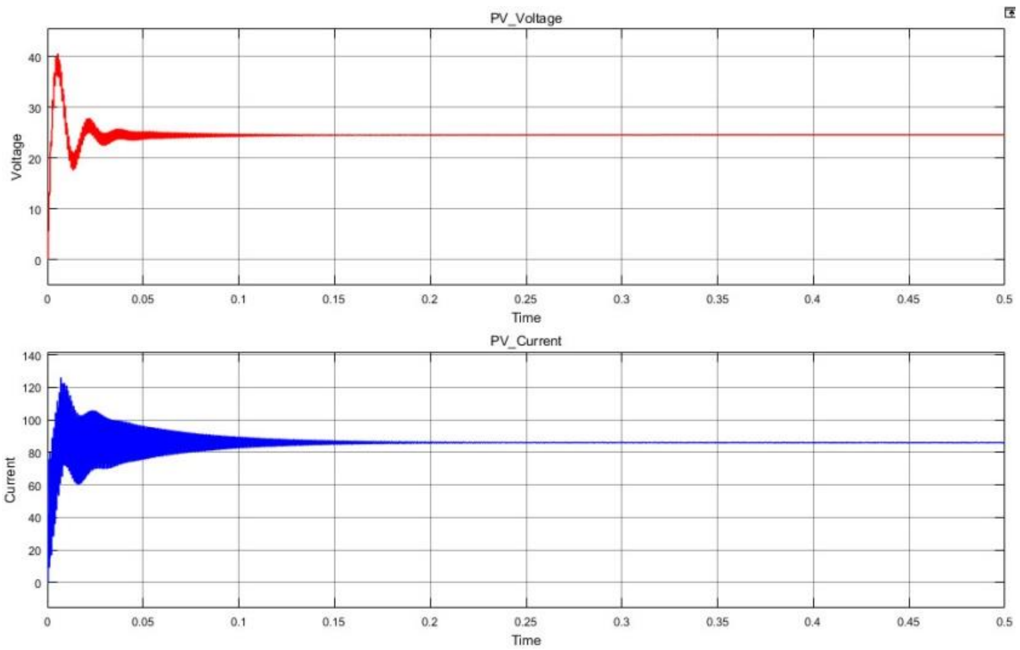

Fig -8: PV Output

This graph is shown in the output of the photovoltaic system to measure the voltage and current waveform with respect to time. This graph shows that the voltage is near about 25volt and current is near about 85amp, it means irradiance and temperature are maximum generated to the photovoltaic plate. This voltage and current are fed back is given to the converter as well as MPPT.

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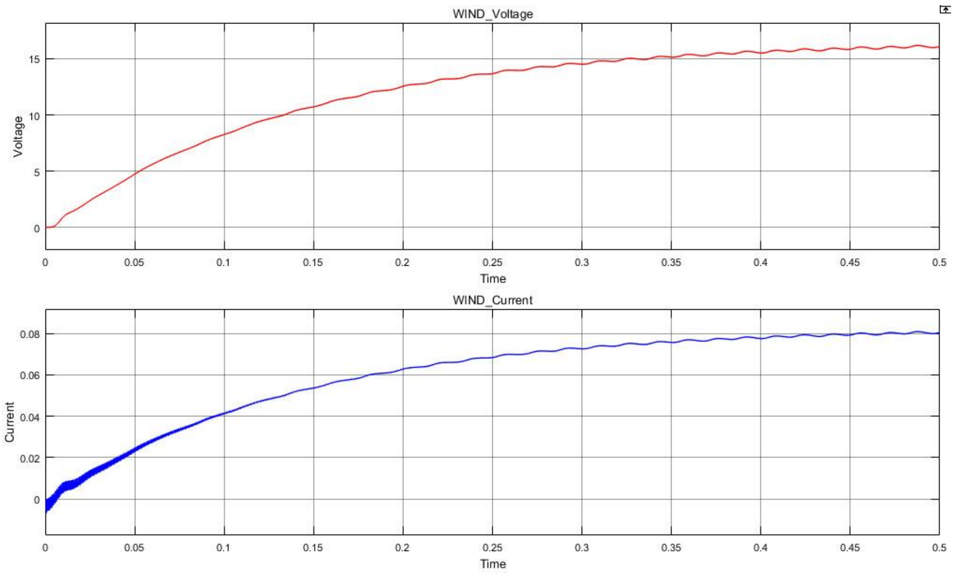

Fig -9: WIND Output

In this figure it is shown that the output of the wind generator with dc output this waveform is gradually increased voltage as well as current. The voltage rating are near about 16 to 18voltage and current rating are near about 0.10 amp.

6. CONCLUSION

In this thesis, a new PV-wind turbine hybrid power system was designed, modelled and implemented using the MATLAB/Simulink software package for smart grid applications. As the available power from the proposed PV system is highly dependent on solar radiation, to overcome this deficiency, the PV system was integrated with the wind turbine system. The dynamic behaviour of the proposed model was examined under different operating conditions. Solar irradiance, and wind speed data were gathered for a grid-connected wind-solar power system installed in a residential area in Lisbon. The developed system and its control strategy exhibited an excellent performance. The proposed model offers a proper tool for smart grid performance optimization.

In general, wind-solar hybrid energy systems are recognized as a viable alternative to stand-alone PV or wind systems all over the world. Recent literature reveal that renewable energy based hybrid systems are not cost competitive against conventional fossil fuel power systems. However, the need for cleaner power and improvements in alternative energy technologies bear good potential for widespread use of such systems. Moreover, the less-fortunate rural households in less developed countries attach high value to a reliable, limited supply of electricity.

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