

Analysis characteristics of power PV cells and wind turbine from power generation 50 watt

Walid Aborid Abdannabi, Mohamed Fouzi Omar , Ibrahim A Fadil ,
Sami Salem Bitro

Student on Department of Mechanical Engineering UNS University Solo, Indonesia.

Abstract: This paper presents the implementation of a generalized photovoltaic model using Matlab Simulink software package, which can be representative of PV cell, module, and array for easy use on simulation platform. The proposed model is designed with a user-friendly icon and a dialog box like Simulink block libraries. This makes the generalized PV model easily simulated and analyzed in conjunction with power electronics for a maximum power point tracker. Taking the effect of sunlight irradiance and cell temperature into consideration, the output current and power characteristics of PV model are simulated and optimized using the proposed model. This enables the dynamics of PV power system to be easily simulated, analyzed, and optimized.

For Wind Turbine modeling and simulation of wind driven electricity generation system or WECS (an acronym for Wind Energy Conversion System) has been done. Our aim is to design and test a power 300W capacity, operating at 3 m/s to 6 m/s , induction permanent magnet generator Matlab simulation. The different components of a wind energy system namely the wind turbine, generator, rectifier, as per the scope of this project following which the design steps and modeling of the system in Matlab simulation environment - Simulink was undertaken.

Keywords: power pv cells, wind turbine, power generation 50 watt.

I. Introduction

The global needs for polluting greenhouse gases, the rapid rise in the cost of energy and fossil fuels and cause unavoidable energy shortages lead to a global trend to reduce renewables. Among the renewable energy Photo-Voltaic (PV) attracts a special focus. However, relying on renewable energies associated with some concern, as the high degree of uncertainty, unavailability during a day and fast-changing periods out of hand.

The output power fluctuation of renewable energy can cause excessive variations of voltage and frequency of the system. In recent years, storage systems have been combined to form photovoltaic systems that are capable of an energy reserve provided with less fluctuating output power. Electricity generation from solar can be performed by solar cells or photovoltaic (PV).

The aim of this study experiment and simulate structure of PV study and see the effect of solar irradiation on cell temperature, which made the output characteristics more practical PV model and the transient analysis of power , study state regime using basic circuit equations of the PV solar cells including the effects of solar irradiation Tested the PV model response in a DC load.

1.1 Problem statement:

1. How do wind and light intensity influence the characteristic of power generation from pv/ wind turbine ?
2. How does wind velocity and light intensity influences the efficiency between pv /wind turbine?
3. What's the characteristic of power generation 50 w between wind and solar energy?

1.2 Objectives of Research

1. Study the best efficiency regarding to load PV and Wind turbine
2. Obtained the knowledge about the characteristics of system for small power generation between PV and wind turbine

II. Basic Theory

2.1 Wind Power Calculations

The power output, P, from a wind turbine is given by the following expression:

$$1. P = \frac{1}{2} C_p A \rho V^3$$

Where C_p is the power coefficient of the rotor varies between 0.2 and 0.5 and A is the swept area perpendicular to the wind velocity (m^2).

$$2. A = \frac{\pi(RD)^2}{4}$$

Where RD is the rotor diameter (m), ρ is the density of air (approximately 1.225kg/m³) and V is the wind speed (m/s).

Moreover, the energy obtained from a wind turbine depends mainly on the velocity of wind across the turbine.

A typical wind turbine characteristic

A typical wind turbine characteristic

Where RD is the rotor diameter (m), ρ is the density of air (approximately 1.225 kg/m³) and V is the wind speed (m/s).

Normally the wind potential is given as the specific wind power, and then the power per unit of area can be formed by:

$$3. P_{potential} = \frac{\rho V^3}{2}$$

The maximum power could be expressed as follows:

$$4. P_{max} = \frac{8}{27} \rho V^3$$

Then the maximum efficiency of an ideal wind turbine will be as follows:

$$5. \eta_{max} = \frac{P_{potential}}{P_{max}} = \frac{16}{27} = 0.593$$

The factor $16/27 = 0.593$ is sometimes called Betz Coefficient or the Betz limit. It shows that an actual turbine cannot extract more than 59.3% of the power in an undisturbed tube of air of the same area. In practice, the fraction of power extracted will always be less because of mechanical imperfections. A good fraction is 35–40% of the power in the wind under optimum conditions, although fractions as high as 50% have been claimed. A turbine which extracts 40% of the power in wind is extracting about two-thirds of the amount that would be extracted by an ideal turbine. This is rather good, considering the aerodynamic problems of constantly changing wind speed and direction as well as the fractional loss due to blade surface roughness.

The efficiency of a solar cell is dependent on both the irradiance and cell temperature, i.e., both the open-circuit voltage and fill factor decrease substantially with temperature (as the thermally excited electrons begin to dominate the electrical properties of the semi-conductor), while the short-circuit current increases, slightly.

The power output (in Watts) for a photovoltaic (PV) panel at a given time can be expressed as

$$6. P = GHI \cdot \eta_{pv} \cdot A_{pv}$$

Where GHI is the global horizontal irradiance (W/m²) received on a horizontal surface, η_{pv} is the efficiency of the PV and A_{pv} is the total area of the PV panel (m²).

Own characteristics regarding a battery model, the maximum energy storage capacity used (Boaro, Fuselli et al. 2012)

7.

$$E_b = A_b V_b$$

III. The Research Method

1.2 Research Tools

The equipment used for this study PV system PV model 60 w and microcontroller ,charger controller 12/24V, 2 battery 24v and load 50WAT and the model following specific limitation and we mention it here , module ND-060p1,maximal power p(max) is 60 wat ,Open circuit voltage 22v ,Short circuit curent 3.9A Voltege at point of max power 17.4 v

Curent at point of max power 3.45 A , Over curent protaction 7.5 A Irradioion 1000w/m2

The equipment of wind turbine ,wind model 300w ,rectifierload 50w , 2 fan to move the wind turbine,wind system following specific limitation and we mention it here

ouyad angel 300 ,rated power300wrated voltege 24V vrotar dameter1.44m

startup wind speed 2m/swind speed rated 9m/scut- out wind speed 35m/scan be seen in the circuit.

1.3 Research Procedures

Experimental to Study Wind turbine and Photovoltaic PV system we used different radiation 400w/m2 600w/m2 800w/m2 1000w/m2 to study the characteristic of power output

The wind speed is variable speed 3m/s 4m/s 5m/s 6m/s and we will study the characteristic of power output on different speed of wind turbine.

The aim of research methodology experiment the PV system and wind turbine and simulate the both of models to compare the results regarding to the experimental and simulation

3.3 DC-DC buck converter

A boost converter is a switch mode power supply that has an output voltage higher than its input voltage. The switching in a boost converter is done through a MOSFET or IGBT. When the switch is closed the current flows in the first loop only, the current through the inductor grows. The switch then opens, and the voltage across the inductor and the input combine in series to charge up the output capacitor to a higher voltage than the input. The duty cycle of the switching signal determines the output voltage. The longer the switch is closed, the higher the output voltage will be expected.

Design of the boost converter Current ripple factor (CRF)

According to IEC harmonics standard, CRP should be bounded within 30%

$$\text{ie } \frac{\Delta I_L}{I_L} = 30\%$$

Voltage ripple factor (VRF)

$$\text{ie } \frac{\Delta v_o}{v_o} = 5\%$$

Switching frequency (fs)

$$F_s = 100 \text{ KHZ}$$

DATA:

Input voltage $V_g = 12\text{V}$

Output voltage $V_o = 24\text{V}$

Output load current $I_o = 3.45\text{A}$

Step1: calculation of duty cycle (D)

$$\frac{V_o}{V_g} = \frac{1}{1-D} \implies D = 0.5$$

Step 2: calculation ripple current (ΔI_L)

$$\Delta I_L = (0.3 * 3.45)\text{A} = 1.035\text{A}$$

Step3: calculation of inductor value (L)

$$L = \frac{(V_g * D)}{(f * \Delta I_L)} = 5.8 * 10^{-5}\text{H}$$

Step 4 : calculation of capacitor value (C)

$$\text{We have } \frac{\Delta V_o}{V_o} = \frac{DT_s}{R_o C}$$

$$R_o = \frac{V_o}{I_o} = \frac{24}{3.45} = 6.96\Omega$$

SO

$$C = \frac{0.5}{(10^5 * 6.96 * 0.3)} = 2.3 * 10^{-6}\text{F}$$

1.4 Wind turbine model by Matlab K

a. Wind Turbine Model

There are two types of wind turbines namely vertical axis and horizontal lexis types. Horizontal lexis wind turbines are preferred due toothed vantages of ease in design a dresser cost particularly for high repower ratings.

b. Rectifier Model

A three-phase diode bridge rectifier converts the AC generated output voltage, which will be varying in magnitude and also in frequency, into DC.

The average output voltage of the three phase diode rectifier is obtained as follows

- i. $V_{dc} = (3 * V_m) / \pi$

- ii. $I_{dc} = V_{dc} / R_L$

- iii. $I_{rms} = V_{rms} / R_L$

c. Permanent Magnet Synchronous Generator Model

Permanent Magnet Synchronous Generator provides an optimal solution for varying speed wind turbines. Permanent Magnet Synchronous Generator provides an optimal solution variable for-speed 3m/s 4m/s 5m/s 6m/swine turbines 3 phase output ,generate 300 watt.

IV. Result And Discussion

The results for both experiment and simulation. It starts by giving Results of the analyzed experimental PV system and WIND turbine, the presented experimental results Are discussed. The second half of the chapter reports on the simulation results thereafter a Discussion of the reported results given

4-1 Experimental results and discussion

The experimental results which are presented here are; tasted the PV in different Radiation with dc load 50 w start from radiation 400w/m² the voltage is 14V and current 0.50A ,power 7V and also when the radiation 600w/m² the voltage is17V,current 0.80A ,power 13.60w and also in radiation 800 w/m² voltage is 20v,current 1.1A,power is 22w in the last radiation 100wlm² voltage is25V,current1.3A,power is 32.50w we can show output power of PV with different radiation .

4.2 Simulation results and discussion

PV model MATLAB SIMULINK

Modeling circuit of PV it was module by MATLAB SIMULINK. The modeling of the PV is done as we mention it before in chapter three We tasted the PV model in different irradiance 1000,800,600,400)W/m² at constantan premature(T=25°C) 60 Wto study characteristics of PV on V and PI in dc load 50 Ω

Power According to the simulation in PV the total power for all radiations 400,600, 800, 1000 W/m²:

In first radiation 400W/m² the power study state 1.74 W and second radiation 600W/m² the power is 9.1W, 800W/m² radiation the power is 22 W, the last radiation 1000W/m² the power is 41W

4.3 characteristics Of PV CELL

We tasted PV cell in radiation 1000W/m² and different RL start from 1 until 18 RL we got MPP at pv cell in RL18 ohm as Power injection versus load resistance characteristics .Maximum power point is tracked at 80 Ohm load resistance. Power injection versus of load voltage characteristics. Maximum power point is tracked at 12 Volt load voltage.

4.4 Simulation results and discussion of wind turbine

The simulation results of variable wind speed started from 3 M/S until 6 M/s with dc load 63Ω wind velocity M/s is given output power, current, voltage

4.5 characteristics. Of wind turbine

We tasted wind turbine velocity 3ms .4m/s 5m/s 6m/s and different RL start from 16 until 60 RL we got MPP at wind turbine RL24 ohm Power injection versus load resistance characteristics .Maximum power point at 24 Ohm load resistance.

2. Table and Figure

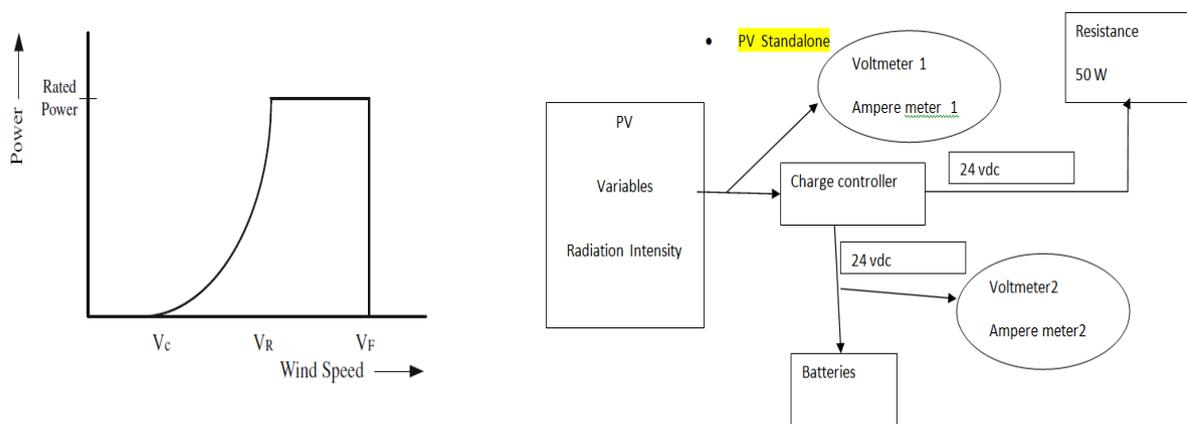


Fig 1 A typical wind turbine characteristic

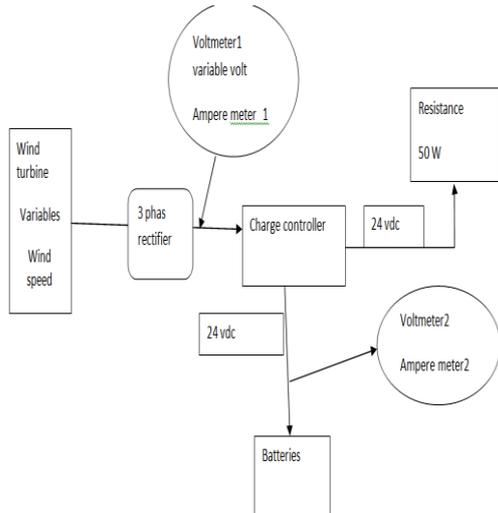


Fig 2 experimental of wind turbine

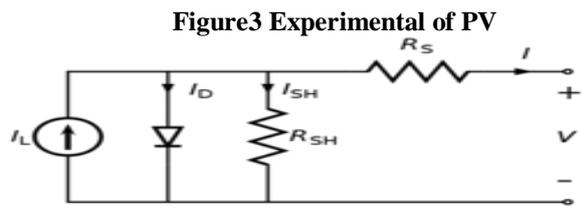


Fig 4 PV model

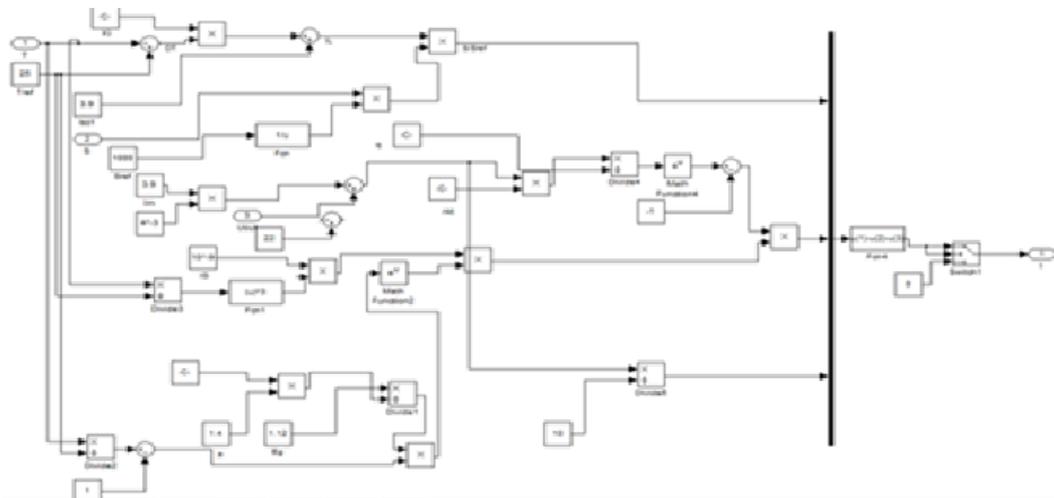


Fig 5 PV cell's modeled in MATLAB SIMULINK

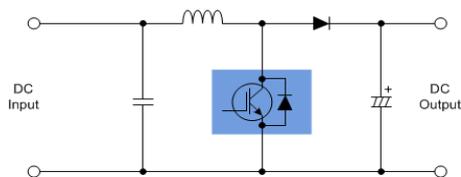


Fig 6 Boost Converter

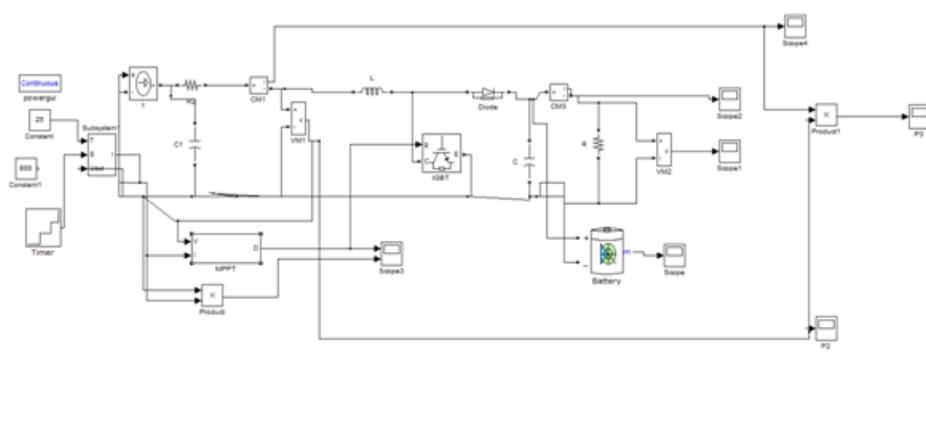


Fig 7 model of PV whole system

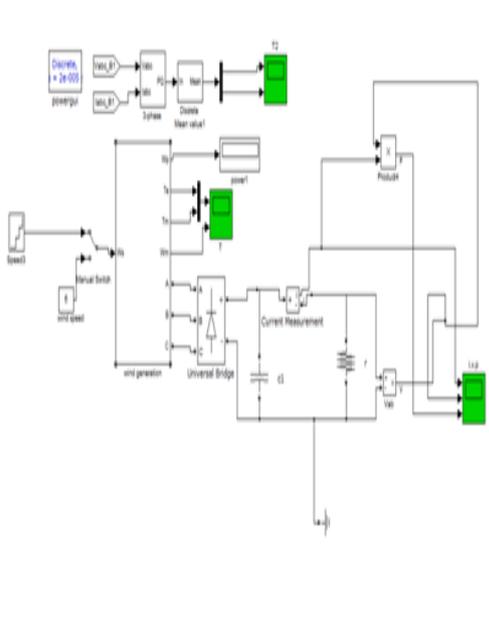


Fig8 model of wind turbine with dc load MATLAB SIMULINK

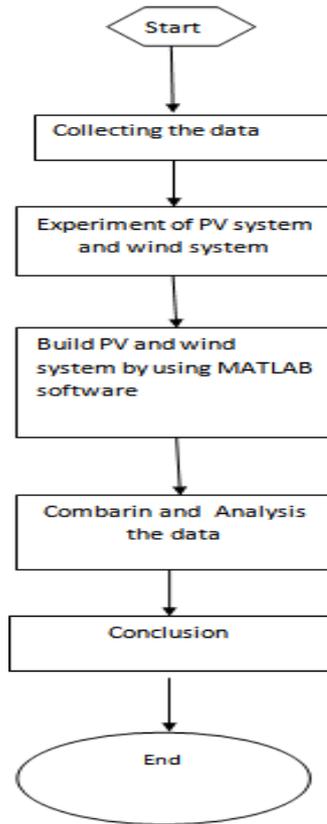


Fig 9flow chart of The Research Methodology

Table1 results experiment of PV

area of PV:	power of pv	Radiation Intensity (watt/m2)	V (volts)	I (amps)	P (V x I)	eff	V (volts)btry	I (amps)btry	P
0,4352	174,08	400,00	18,20	0,34	6,19	0,036	24,70	0,19	4,693
0,4352	261,12	600,00	22,90	0,42	9,62	0,037	25,40	0,30	7,62
0,4352	348,16	800,00	23,3	0,58	13,51	0,039	25,60	0,30	7,68
0,4352	435,2	1000,00	31,8	0,76	24,17	0,056	25,20	0,70	17,64

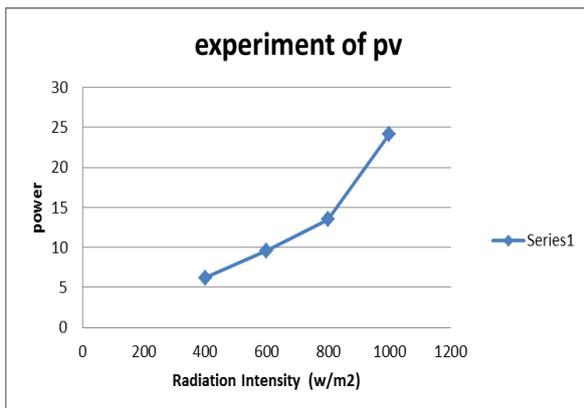


Fig 10 Output power of PV with different radiation

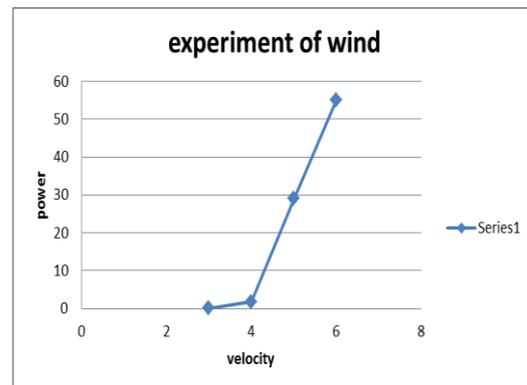


Fig 11 Output power of wind turbine in different velocity

V. Conclusion

The present THESIS describes the simulation and the experiment of PV and wind turbine system studied characteristics the of power both of PV/wind turbine dc load 50 w and steady state ,transient regime in PV model as we mention in result.

We tasted the maximum power point in PV cell with different RL For wind energy conversion system using variable speed 3m/s 4m/s 5 m/s 6m/ synchronous generator (PMSG)with rectifier dc load 50 w studied the output of wind power ,current , voltage Characteristic of wind in different RL.

References

- [1]. Sannino,A.,Postiglione,G.,and Bollen,M.H.J. (2003).“Feasibility Ofa DCN etwork for Commercial Facilities,” IEEETrans.Industry Applications,vol.39,no.5,pp.1499–1507.
- [2]. Jager, W., 2006. Stimulating the diffusion of photovoltaic systems: a behavioural perspective. Energy Policy 34, 1935–1943. (7)
- [3]. Salmi, M. Bouzguenda,A. Gastli, andA. Masmoudi, “Matlab/Simulink based modellingof solar photovoltaic cell,”IntJofRenewableEnergyResearch2012,vol.2,no.2, pp. 213–218.Wamukonya, N., 2007. Solar home system electrification as a viable technology option for Africa’s development. Energy Policy 35, 6–14.
- [4]. I.H.Altas,andA.M.Sharaf,“A photo voltaicarraysimulationmo delfor Matlab-Simulink GUIenvironment,”International ConferenceonClean Electrical Power 2007,ICCEP’07,Capri, pp. 341–345.
- [5]. Muller,S.;Deicke,M.;deDoncker,R.W.Doubly fedinductiongenerator system for wind turbines. IEEE Ind. App. Mag. 2002, 8, 26–33
- [6]. BharanikumarR.,YazhiniA.C.,KumarN.,(2012): ModellingandSimulationof WindTurbine Driven PermanentMagnetGenerator withNewMPPT Algorithm. Asian Powerelectronics journal,Vol.4.
- [7]. Mittal,R.;Sandhu,K.S.;Jain,D.K.Battery energystorage systemfor variablespeeddriven PMSG for wind energy conversion.Int. J. Innov. Manag. Tech. 2010, 1, 300–304
- [8]. Zeng, R.; Nian, H.; Quan, Y.; Liu, J. Improved Load-Adaptive Control Strategy for PMSG BasedStand-AloneWindEnergyGeneration.InProceedingoftheInternational Conferenceon Electrical Machines and Systems, Tokyo, Japan, 15–18 November 2009; pp. 1–6.
- [9]. Chan,T.F.;Lai,L.L.Permanent-MagnetMachinesforDistributedGeneration:AREview.In Proceeding of the IEEE Conferenceon Power EngineeringSociety General Meeting, Tampa, FL, USA, 24–28 June 2007; pp. 1–6.
- [10]. (Wargadalam, Zulkarnain et al. 2009)