Photovoltaic System in Term of the Variable Irradiation Connected To Micro-Grid DC

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***Abstract*— In non-linear photovoltaic power system, the output power can be influenced heavily on two factors, radiation and temperature. Solar cells rarely work at the maximum power point, so one of the disadvantages of these systems is low efficiency. In this paper, a maximum power point tracking algorithm MPPT and the proposed buck boost model with power controlled to simulate the solar cells are used. Network inputs to model solar cells include: short circuit current, temperature and voltage output of the network load and current of cell. Network inputs predict the maximum power point, the irradiation and temperature. The voltage and current output are corresponding the maximum power point. In this paper, the assumption is constantly changing of sunlight condition and in this condition, the proposed system has to transfer maximum output power to a DC micro-grid. Control strategy with simulations in Matlab / Simulink is validated.**

Keywords*— Maximum power point tracking, Photovoltaic Systems, DC-DC Converters, Buck Boost Converter, Renewable Energy.

I. INTRODUCTION

At present, energy supply more than 160 thousand villages around the world are based on solar energy, and this is just the beginning. In a country like Indonesia, which is composed of several thousands of large and small islands. Therefore, applying power plants and transmission lines is almost impossible. And solar energy is the only hope for Indonesia's rural population of 20 million. Generalizing other methods is under consideration.The Nevada desert where U.S. nuclear tests were done is the largest solar lab now. The World Bank have been pressured for a long time to support the use of solar energy and other projects compatible with the environment. Recently photovoltaic systems are taken much attention to issues of the environment protection. However, the photovoltaic systems output density is low.

photovoltaic systems outputs depend on solar radiation in condition of radiation and temperature of the PV array strongly. In addition, there are several points having the local maximum in I-P characteristics in condition of non-uniform irradiation. But only a maximum power point in photovoltaic systems I-P characteristic is in condition of uniform radiation. The above mentioned characteristics of photovoltaic systems, maximum power point tracking (MPPT) for photovoltaic system is controlled to maximize efficiency. Many papers have been reported MPPT control method. For example, dv / di method, fuzzy theory, genetic algorithm and etc. The theory of fuzzy sets and genetic algorithms can identify true maximum power point in the distribution of radiation. However, many of these procedures are controlled rather than complicated. Sometimes, the work point is likely to converge on a local maximum power point that is not the peak power point in I-P curve of array photovoltaic. The equivalent resistance is proportional to the ratio of open circuit voltage VOC to the short circuit current Isc to control the process that both VOC and ISC are defined by the amount of online supervision. Therefore, the control system is installed effectively.

II. PHOTOVOLTAIC SYSTEM

The initial model of photovoltaic system is shown in Fig.1 This model includes a photovoltaic current generator parallelled with a diode and resistor RSh and the series resistance RS.

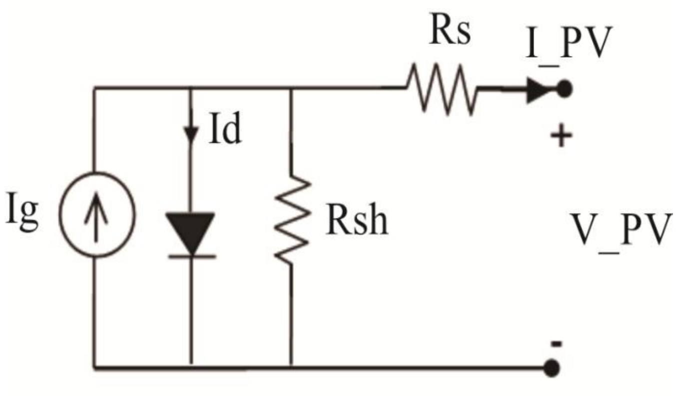

Fig. 1: Equivalent circuit of a photovoltaic array

V-I characteristics of PV array can be represented the following equation.

$$I_{PV}(V_{PV}) = I_g - I_o[\exp\left(\frac{v + R_S I}{aVt}\right) - 1] - \left(\frac{V_{PV} + R_S I_{PV}}{R_P}\right) \quad (1)$$

Ig and Io are the photovoltaic currents and solar arrays currents saturated, respectively.

$Vt = \frac{N_s KT}{q}$ Is the thermal voltage module with Ns series cells.

q the electronic charge, k Boltzmann's constant, T Kelvin temperature of a p-n Junction diode and a diode ideal constant are identified.

To increase the output voltage of the solar modules into cells are connected in series and parallel combinations of them are used to increase the output current.If the module is made up a parallel composition of Np.

In equation (1) RP and RS are equivalent resistance in parallel and series, respectively. Equation (1) is extracted from the IV curve in Fig. 2. Typically, manufacturers of PV modules give their consumers some experimental data on the electrical and thermal characteristics of the module rather than PV module characteristic equation. This information includes: the nominal short circuit current (Isc, n), current and voltage at the maximum power point (VMPP, IMPP) and the nominal open-circuit voltage (Voc, n), temperature coefficient of the open circuit voltage (KV), the thermal coefficient of short circuit (KI) and the maximum experimental power (Pmax, e). This information is got in the standard conditions of fixed temperature and solar radiation standard.

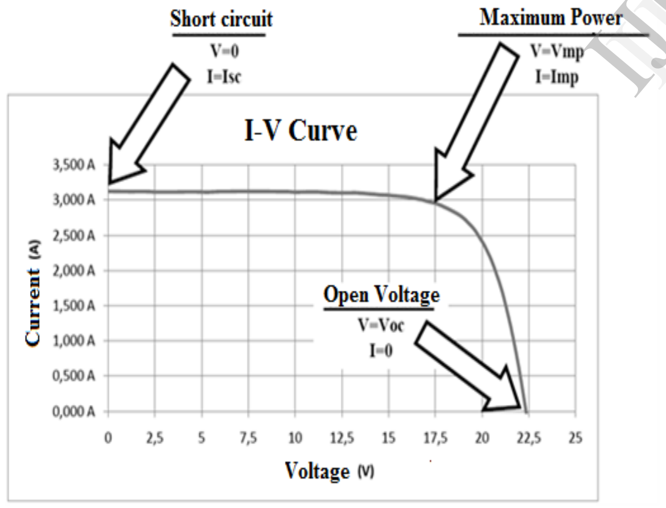

Fig. 2: Equation IV characteristic of photovoltaic module and three important points open circuit, short circuit and maximum power point.

Also, some manufacturers present IV curves for several different modes of radiation and temperature. With the above description, the parameters of equation (1) must be extracted from market data. In general, determination of the photovoltaic current Ig is difficult even without considering the series and parallel resistances. Therefore, the approximate Isc,n = Ig is used to determine it. Because the large Rp and the small Rs, the proximity of Isc,n = Ig is acceptable. On the other hand, the photovoltaic current of solar cell dependents on radiation of solar linearly and is affected by temperature. This dependence is displayed below.

$$I_g = \left(I_{g,n} + k_I \Delta_T\right)\frac{G}{Gn} \quad (2)$$

In this equation, Ig, n is photovoltaic current in standard conditions

25C,1000W/m^2 ‹(ΔT=T-Tn), difference of solar irradiation in Kelvin on module surface and Gn is the nominal irradition in terms of watts on per square meter.

Io is Diode saturation current and its dependence on temperature is discussed below.

$$I_o = I_{o,n}\left(\frac{T_o}{T}\right)^3 \exp\left[\frac{qE_g}{ak}\left(\frac{1}{T_n} - \frac{1}{T}\right)\right] \quad (3)$$

Eg is semiconductor energy gap (Eg = 1.12ev) and Io, n is the nominal saturation current.

$$I_{o,n} = \frac{I_{sc,n}}{\exp\left(\frac{V_{ov,n}}{aV_{t,n}}\right) - 1} \quad (4)$$

Vt, n is thermal voltage of Ns cells series in temperature Ts. In this paper, Io, n based on the information provided by the manufacturer and by equation (4) is obtained. The value of constant diode is different in papers and is chosen arbitrarily in the interval 1 ≤ a ≤ 1.5. Constant diode representing a kind of ideal diode Boone coefficient is quite experimental and its changes are negligible effect on the fitted curve of the solar module.

Rp and Rs are unknown parameters in equation (1). The determination method of Rp and Rs is based on the fact that there is only one pair {Rp and Rs} that the power output at the point of IMPP VMPP equal to maximum experimental power Pmax, e. Therefore, the relationship between Rp and Rs are calculated with using equation (1).

$$P_{max,m} = V_{Mp}\left\{ I_{pv} - I_o\left[\exp\left(\frac{V_{ov,n}}{aV_{t,n}}\right) - 1\right] - \frac{V_{MP} + R_s I_{MP}}{R_p} \right\} = P_{max,e} \quad (5)$$

$$R_p = \frac{V_{MP}\left(V_{MP} + I_{MP} R_s\right)}{\left\{ V_{MP} I_{pv} - V_{MP} I_O \exp\left[\frac{(V_{MP} + I_{MP} R_s)}{a N_s}\frac{q}{kT}\right] + V_{MP} I_O - P_{max,e} \right\}} \quad (6)$$

Equation (6) states that there is Rp disconnecting mathematical IV curve at the point (VMPP, IMPP) for each value of Rs. The purpose of finding Rs (as a result of Rp) matches the peak P-V curve with a experimental maximum power at the IMPP VMPP point which will require several iterations.In the iteration process, Rs is increased from zero initial point slowly. This process will continue until the PV curve will be the same as the experimental results.

III. RESEARCHING OF MPPT ALGORITHM

Incremental algorithm MPPT ,In this method, the output voltage of the photovoltaic systems is used continuously according to the MPP voltage and comparing the conductivity changes (IPV / Vpv) to change the location of its negative conductance (dIpv / dVpv) to set the operating point

IV. MODEL AND SIMULATION

Proposed model for photovoltaic system is shown in Figure 3.

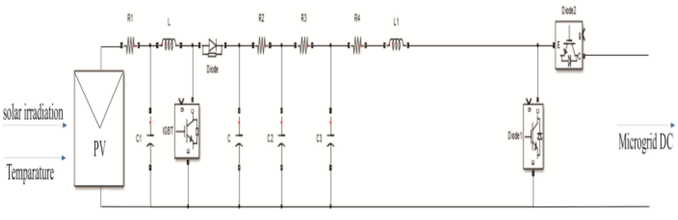

Fig. 3: Proposed model for photovoltaic systems

The proposed model of photovoltaic systems presented in Matlab / Simulink are implemented and the results are listed below, the control circuit model of Boost MPPT system model are shown in Fig. 4 and Fig.5. The amount of sunlight irradiation at various times is shown in Fig.6. Power, voltage and current produced by the PV system is shown in Fig. 7 and power, voltage and current in microgrid side is shown in Fig. 8.

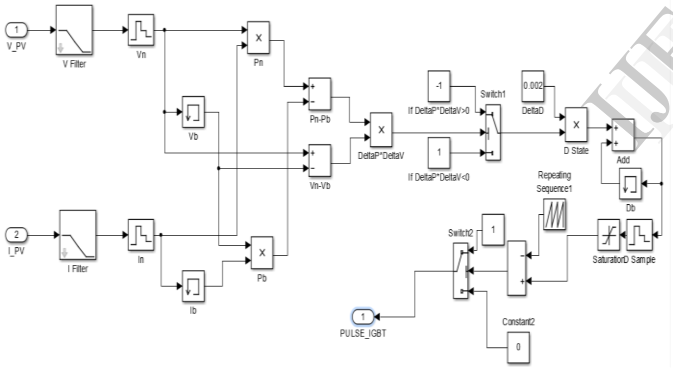

Fig. 4: MPPT algorithm to control the pulse IGBT Photovoltaic Systems

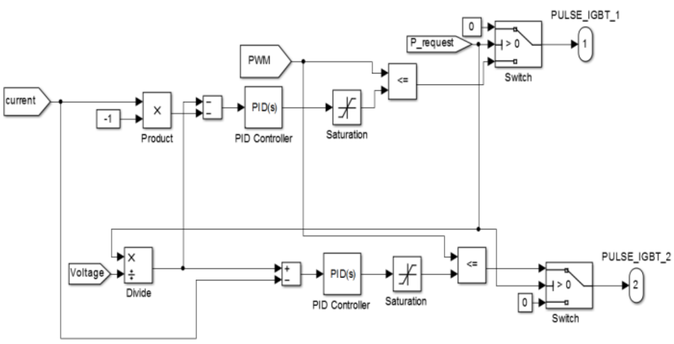

Fig. 5: Control circuit model of the Buck Boost DC micro-grid side

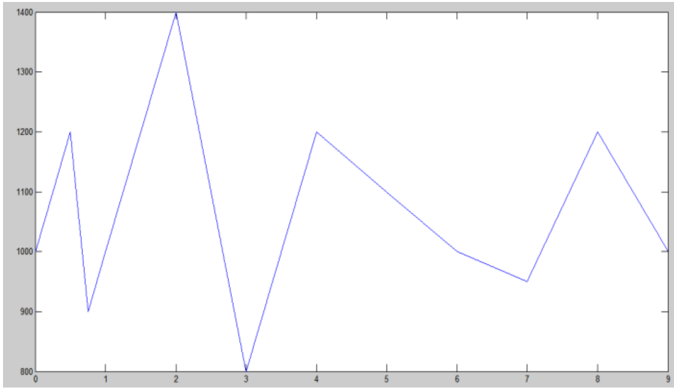

Fig. 6: The amount of sunlight (irradiation)

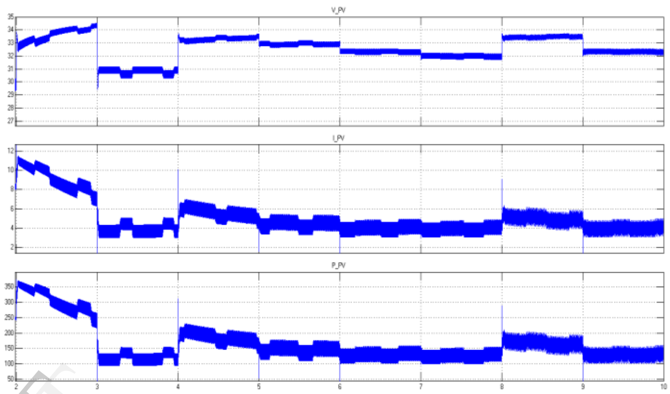

Fig. 7: power, voltage and current produced by the photovoltaic system

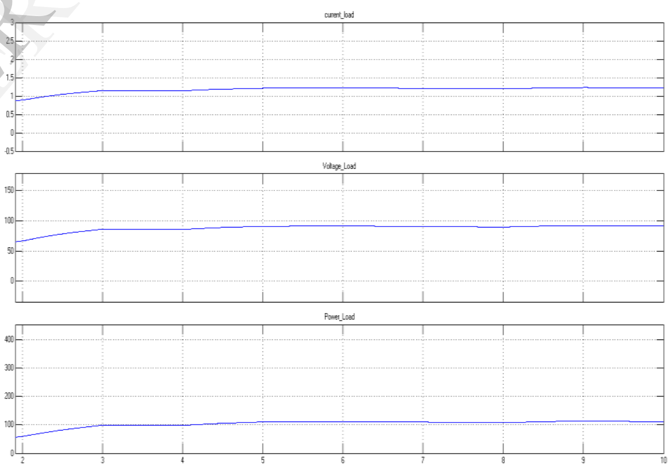

Fig. 8: power, voltage and current in microgrid side

V. CONCLUSION

Photovoltaic system with maximum power point tracking to match the highest electrical efficiency with maximum power is available. In this research, we compared changes of the irradiation levels carried out in the real conditions. The analysis is considered with the parameters given in Table 1. Method introduced by original model is carried out in MATLAB / SIMULINK. The method is considered for the algorithm efficiency to achieve the maximum power point in Static loads and different variations of discrete and continuous irradiation sunlight.

Table. 1. Parameters of the Pv system under study

Time = [0 0.25 0.5 0.75 1 2 3 4 5 6 7 8 9] Second		
Irradiation =[1000 1100 1200 900 1000 1400 800 1200 1100 1000 950 1200 1000]		
Voc = 21.827 **v**	Temperature = 297°	ISC = 5.07A
Rs = 0.502Ω	a =0.015	R1=1 Ω
L= 0.01 H	C1= 2e-3 F	C= 40e-3 F
R2= 0.75Ω	R3= 0.78Ω	C2= 42e-3 F
C3= 1.6e-3 F	R4= 0.3125Ω	L1= 0.001 H

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