A STAND-ALONE SYSTEM ENERGY HYBRID COMBINING WIND AND PHOTOVOLTAIC WITH BATTERY STORAGE

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Abstract *:* Stand-alone systems using renewable energy origin, such as wind energy and photovoltaic (PV) energy with storage battery banks are commonly origin to supply faraway houses. In this paper Stand-alone hybrid wind-PV complex with battery storage is scrutinize. It is advance to Endeavour squirrel-cage induction generator (SCIG) in wind subsystem. PWM rectifier is origin to control the SCIG. In order to make function the hybrid system under the best conditions climatic we used like stages adaptation the converter buck/Boost, and the voltage control type feedback loop voltage (FLV). The proposed system is attractive because of its simplicity, ease of control and low costs. Entire explanation of the present hybrid structure with the outcome of all-inclusive simulations which calculate reveal the availability of the propound arrangement in this paper. Simulation reaction is provided in the paper to exhibit the potential of the system Index Terms – Component, formatting, style, styling, insert.

I. INTRODUCTION

Renewable energy from wind and solar photovoltaic are the most ecological type of energy to use. They are based on a neat and efficient modern technology, which offers a shine of hope for a future based on sustainable and pollution-free technology. The importance of using renewable energy system, including solar photovoltaic and wind has been fascinated much these days, because the electricity demand is growing rapidly all over the world. Therefore, there is an essential need for renewable energy resources, and formulated as a national strategy for the development of renewable energy applications. Renewable energy sources, such as wind energy and photovoltaic (PV) energy, are used by stand-alone systems supplying secluded houses. These sources are of intermittent nature and, therefore, the stand-alone systems should include storage battery banks. The storage battery banks retouch the credibility of these systems because the excess energy is stored in the battery bank, when the available energy is not sufficient, this energy is delivered to the load. Wind energy and photovoltaic energy have admirable characters. Consolidating wind energy and photovoltaic in one system (hybrid system) increases the credibility of this system and reduces the storage batteries. The general configuration of stand-alone hybrid wind - PV system with battery storage is shown in Fig. 1, where the generator used by the wind subsystem is a permanent-magnet synchronous generator (PMSG)

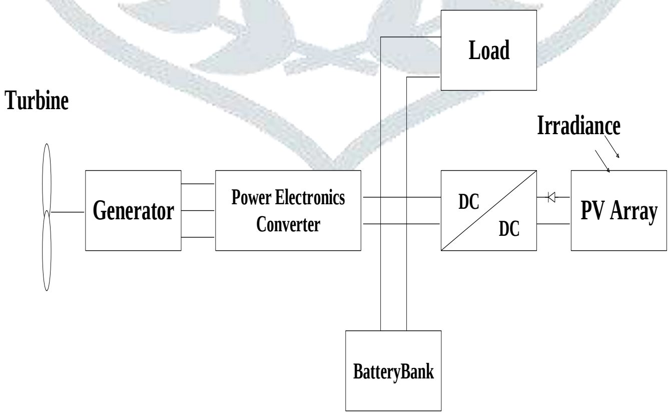


Fig.1: General Configuration of Stand-alone hybrid Wind-PV System

By combine wind turbines and photovoltaic arrays with storage technology to master the movements of the production facility it is possible the high outputs production factors. To obtain a constant power an effective energy storage is necessary. The power delivered by wind and solar should be easily converted into energy stored. This transformation can be realized by a bank of battery or energy capacitor system (ECS). The battery bank or ECS meets the daily fluctuations of the load. A hybrid energy system combining wind and PV array production system is presented in this paper to ensure continuous power to the stand-alone load.

To control the flow of power to the load, two individual converters Buck / Boost DC-DC are used. A simple and cost control with the DC-DC converter is used to regulate the terminal voltage of the load by controlling the duty cycle signal controlling the switch of the converter used (chopper Buck / Boost).

I. MODELING OF PV CELL

The use of equivalent electric circuits makes it possible to model characteristics of a PV cell. The method used here is implemented in MATLAB programs for simulations is The same modeling technique also applicable for modeling a PV module. The convenient model of a PV cell is shown as an equivalent circuit below that consists of an ideal current source in parallel with an ideal diode. The current source stand for the current generated by photons (often denoted as Iph or IL), and its output is constant under constant temperature and constant incident radiation of light.

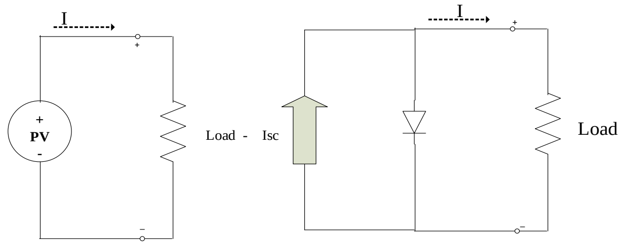
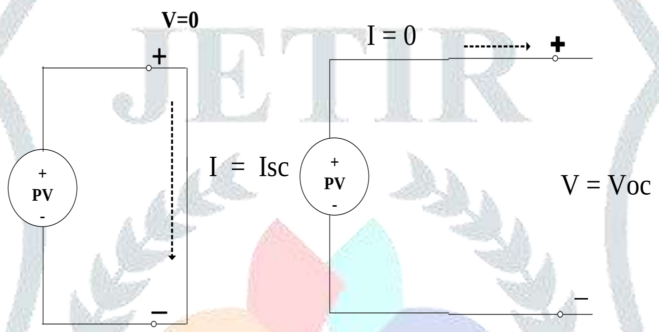


Fig.2 PV cell with a load and its simple equivalent circuit

There are two key parameters often used to describe a PV cell. As shown in figure, Shorting together the terminals of the cell, the photon generated current will follow out of the cell as a short-circuit current (Isc). Thus, Iph = Isc. As shown in Figure, when there is no connection to the PV cell (open-circuit), the photon generated current is shunted internally by the intrinsic p-n junction diode. The open circuit voltage(Voc) is given by this. The PV module or cell manufacturers usually provide the values of these parameters in their datasheets.



Short ckt current (B) Open ckt current

Fig.3 Diagrams showing a short-circuit and an open-circuit condition

The output current (I) from the PV cell is found by applying the Kirchhoff¡¦s current law(KCL) on the equivalent circuit shown in Figure above.

$$I = Isc - Id \qquad (1)$$

Where: Isc is the short-circuit current that is equal to the photon generated current, and Id is the current shunted through the intrinsic diode. The diode current Id is given by the Shockley¡¦s diode equation

$$Id = I0(eqvd/KT-1) \qquad (2)$$

Where: Io is the reverse saturation current of diode (A),
q is the electron charge (1.602×10^-19 C),
Vd is the voltage across the diode (V),
k is the Boltzmann’s constant (1.381×10^-23 J/K),
T is the junction temperature in Kelvin (K).
Replacing Id of the equation (1) by the equation (2) gives the current-voltage relationship of the PV cell.

$$I = Isc – Io (eqvd/kT-1) \qquad (3)$$

Where: V is the voltage across the PV cell, and I is the output current from the cell.

The reverse saturation current of diode (Io) is constant under the constant temperature and found by setting the open-circuit condition as shown in Fig. Using the equation (3), let I = 0 (no output current) and solve for Io.

$$0 = Isc – Io (eqvd/kT-1) \qquad (4)$$

$$Isc = Io (eqvd/kT-1) \qquad (5)$$

To a very good approximation, the photon generated current, which is equal to Isc, is directly proportional to the irradiance, the intensity of illumination, to PV cell. Thus, if the value, Isc, is known from the datasheet, under the standard test condition, Go=1000W/m^2 at the air mass (AM) = 1.5, then the photon generated current at any other irradiance, G (W/m^2), is given by:

Isc lG = (G/G0) Isc lG0 (6)

Figure below shows that current and voltage relationship (often called as an I-V curve) of an ideal PV cell simulated by MATLAB using the simplest equivalent circuit model. The discussion of MATLAB simulations will appear in below. The PV cell output is both limited by the cell current and the cell voltage, and it can only produce a power with any combinations of current and voltage on the I-V curve. It also shows that the cell current is proportional to the irradiance

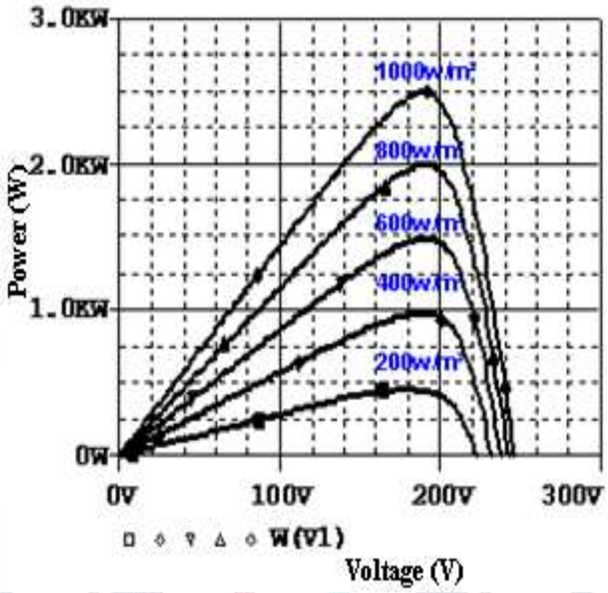


Fig.4 P-V characteristics of PV module

WIND SUBSYSTEM CONTROL

The figure 5 represents the synoptic diagram of the controlled system by a voltage regulator that is based in our case on a wind generator that depends on wind speed and feeds a resistive load (Rs):

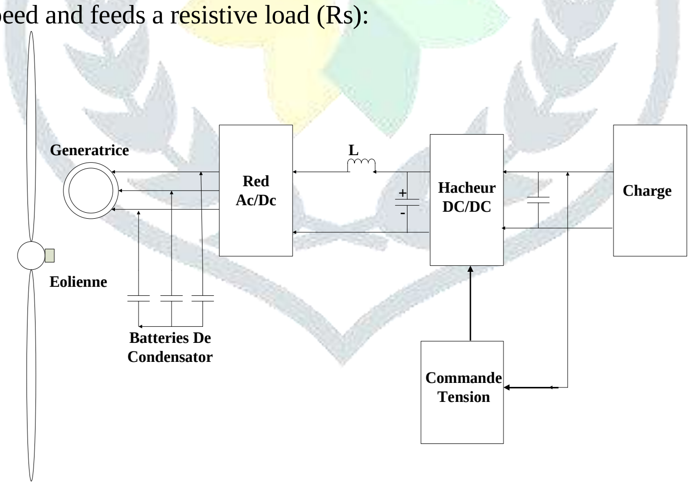


Fig.5.Synoptic diagram of a wind system whose functioning is controlled by a voltage regulation.

Rectifier simple diodes of PD3 type to convert AC voltage into DC voltage.

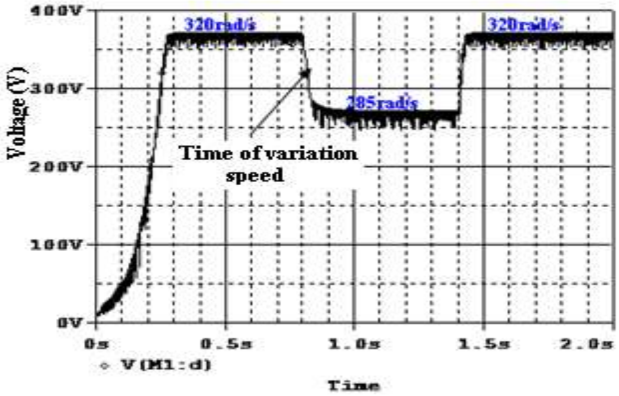
A LC filter constitutes of an indicator L in series with a capacitor C.

A quadripole of adaptation which is a converter of energy of the reducing transformer Buck/Boost type for applications 311V.

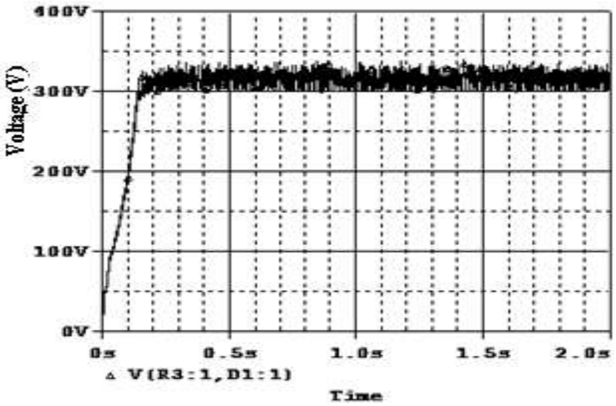
The voltage control that allows regulating the required tension at the load terminals when there is a change in the wind speed. Its regulation principle is depended on the automatic adjustment of the duty cycle at the proper value to obtain the required voltage at the output.

The output voltage of the converter (Buck/Boost) is maintained at a constant value (311V) even if there is a decrease and/or an increase the input voltage.

The analogical control is effective and performance; it enables a convergence of the system after a time less than 290ms.



(a)Input voltage



(b) Output voltage

Fig.6 The input and output voltage of the converter DC-DC for a variation of wind speed

PROPOSED HYBRID SYSTEM

The figure represents the topology of the hybrid energy system consisting of a wind system which is based in our case on an asynchronous machine of power 1.5kw and the PV array 2.5kw. Through their various DC-DC converters, the two energy sources are connected in parallel to a common DC bus line. The load can be connected to the DC bus line. Each source has its individual control. The diodes D1 and D2 (MUR8100) permit only bidirectional current source to DC bus line, thus interrupting each source from acting like a load on each other. The respective diode will automatically disconnect that source from the system because of the event of malfunction of any of the energy sources, To feed stand-alone DC load (resistive), the output of the hybrid production system goes to the DC bus line. As shows the system configuration shown in figure.8. The bus line is put at a fixed voltage of ( ) and output DC voltage from each source is controlled independently so that both production systems receive a fixed voltage ( ). 220* 2 220* 2

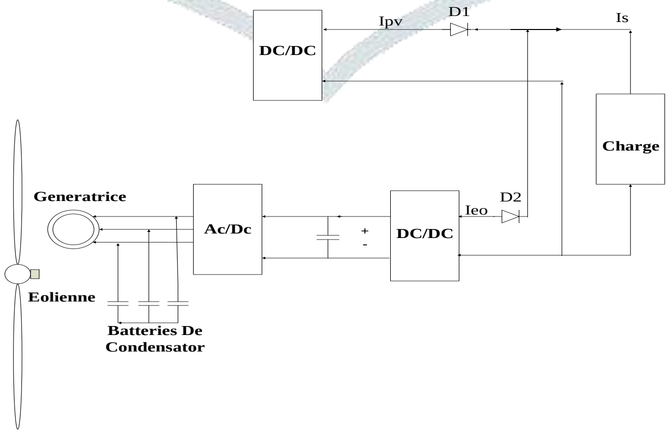
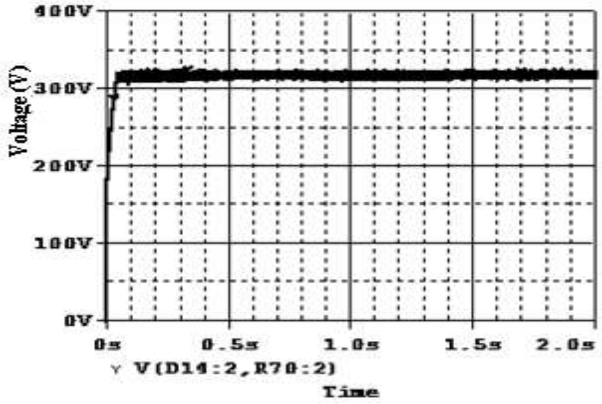


Fig.7 Synoptic diagram of the hybrid system.

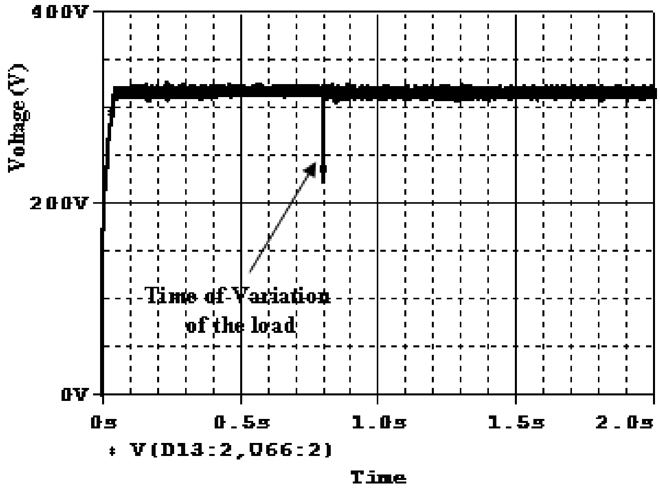
Once all the elementary models validated (wind & PV), we carried out the coupling of the two chains [5.6.7], as presented on the figure 8.

The simulation of the conversion hybrid (wind & PV) in the has been made for a variation of illumination from 1000W/m² up to 600W/m² and with a variable speed wind of 320rad/s up to 285rad/s.

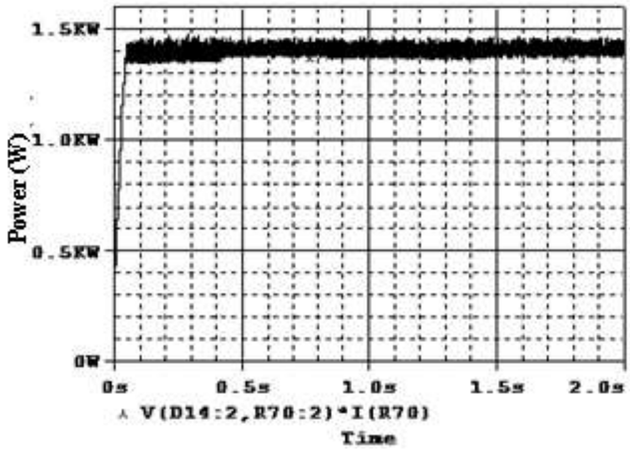
The whole of the results obtained watch that: the voltage at the load is maintained at a constant value (311V) and the two systems (photovoltaic and wind) energy pumping at the same time in any weather conditions (irradiance, wind speed).



(a) Voltage with the load



(b) The voltage of the load with a variation of the load



(c) Power with the load

Fig8: Voltage and power to the load

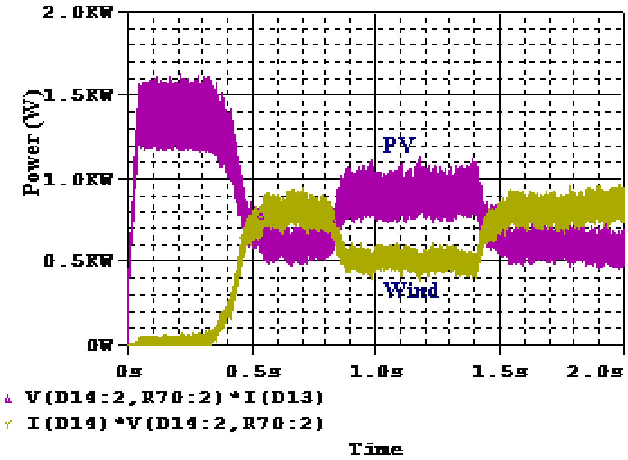


Fig9 : Power at PV and wind level

CONCLUSIONS

In this article we simulated in the operation of the PV system, of the wind system and the hybrid system. The adaptation of PV and wind generators to the load is obtained by interpolating between the PV generator (wind) and load DC-DC converter (Buck / Boost). The converters used are controlled by analogical control voltage (FVL). This control function is to instantly set the output voltage of the Buck / Boost converter despite variations in illumination and/or wind speed. We have shown that the control performs its role properly at simulation level. . The overall results of detailed simulations that determine the feasibility are given to demonstrate the availability of the hybrid system proposed in this paper.

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