Parameters Efficiency of Solar Energy

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ABSTRACT

In this work we are interested of the modeling a photovoltaic system and study of the influence of parameters on the performance and the production of energy with a complete system for example the influence of the series resistance and parallel, the number of diodes used ,and the variation of light and temperature on the system. In order to implement a robust and effective system for extract the maximum power from photovoltaic panels, a late harvesting maximum energy and to get a good performance.

Key words: Solar, photovoltaic cell, optimization, Photovoltaic energy, Modeling, Accumulator battery.

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INTRODUCTION

The production of energy is a challenge of great importance in the coming years. Since the widespread use of electricity, the energy consumption has been increasing; it has been tripled since the 1960 s until now. Currently, the major sources of energy from fossil fuels (carbon, oil, natural gas). Since the successive oil crises of the 1970s, the problem of the conversion and storage of energy has led to the research and development of new sources of supply. This interest has increased to forecast inevitably the global exhaustion of fossil energy resources (oil, gas, coal) and energy thermonuclear origin (uranium, plutonium.). Faced with multiple oil, economic crises, climate change due to the greenhouse effect and its impact on the environment [1] [2], Science is naturally interested in (wind biomass, geothermal, tidal power, and solar energy) labeled "renewable" resources. Originally designed to meet the energy needs of the space capsules, photovoltaic solar energy is increasingly used in various terrestrial applications such as lighting, telecommunication (BTS, VSAT). The use of solar energy could provide electricity to isolated locations of electrical networks and avoid the creation of new power lines which usually require heavy investment.

The production of electricity from renewable energy sources provides greater security of supply for consumers while respecting environmental standards for energy. Renewability of energy does not depend on the speed at which the source is regenerated, but the speed at which it is consumed.

The solar photovoltaic (PV) is the direct conversion of light into electricity using solar cells is an attractive and well suited to limited needs alternative. Spite of its ease of implementation, low environmental impact and low maintenance needs, a photovoltaic system is not competitive when demand increases.

I. CONSTITUTION AND CHARACTERISTICS OF PHOTOVOLTAIC GENERATOR PV

I.1. Solar radiation:

The sun is a star among many others. It has a diameter of 1390000 km, about 50 times that of the earth. It is composed of 80% hydrogen, 19% helium and 1% of a mixture of 100 parts [3], it is the energy of nuclear fusion. In the sun provides the power, it is now accepted that the sun is a thermonuclear bomb hydrogen-helium transforming every second 564 million tons of hydrogen into 560 million tons of helium; the reaction taking place in the core temperature of about 25 million degrees Celsius. Thus, every second, the sun is reduced to 4 million tonnes in the form of scattered radiation. Its light at a speed 300000km / s, takes approximately 8 minutes to reach the ground, its spectral distribution of the atmosphere is brought to a maximum for a wavelength of approximately 0.5 µm, the temperature of blackbody the surface of the sun is about 5780 ° k [4].

I.2. The spectrum of solar radiation

Solar radiation is electromagnetic radiation decomposed grain light called photons. Energy of each photon is directly related to the wavelength of energy which is 98% between λ = 0.25 and λ = 4µm, the rest is above 1% and 1% below this range. The spectrum of extraterrestrial radiation is about to issue a black body heated to 5800 ° K [3]. Distribution of energy as a function of the wavelength is [5]:
0.25µm < λ < 0.4 µm: the ultraviolet range (invisible), it represents 7% of the total energy emitted by the sun.
0.4 µm < λ < 0.8 µm: the visible range, it represents 47.5% of the total energy emitted by the sun.
0.8 µm < λ < 4.0 µm: the field of infrared (invisible), it represents 45.5% of the total energy emitted by the sun. The energy radiated by the sun is not evenly distributed to all wavelengths; it passes through a maximum for a given wavelength by law WIEN:

$$\lambda_m T = 2898 \ \mu_m K \quad (1)$$

For $$T = 2800K \Longrightarrow \lambda_m \simeq 0.5 \, \boldsymbol{\mu_m} \quad (2)$$

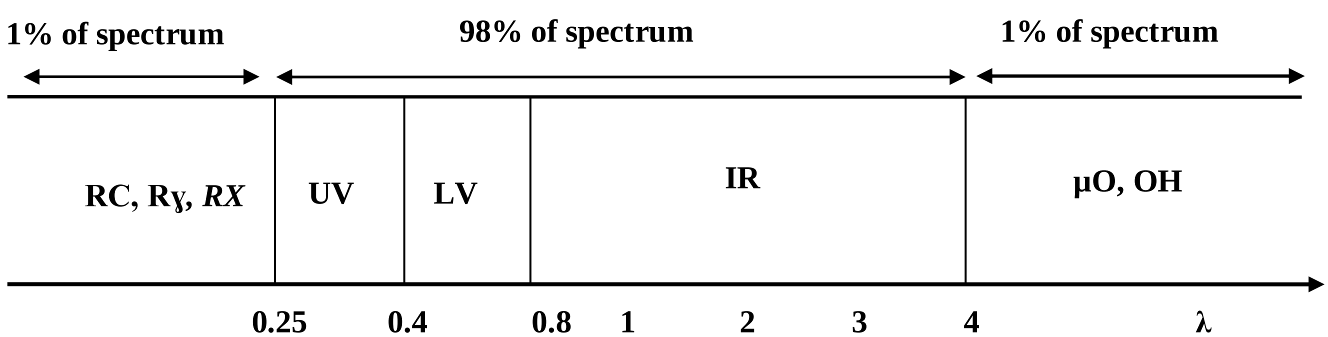


Fig 2: Spectrum of solar radiation

I. 3 Photovoltaic Energy

A photovoltaic (PV) meant to meet a need of electrical energy according to the specific conditions of exploitation. It usually consists of a photovoltaic generator, a storage system, extra auxiliary source (diesel generator, wind turbine, network) interface systems (converters, network) system of control and command (surveillance system, electrical cabinets, electronic card) and a current with a specific purpose use. This application (lighting, refrigeration, pumping, communication) is used in various sectors (health, education, agriculture, energy)

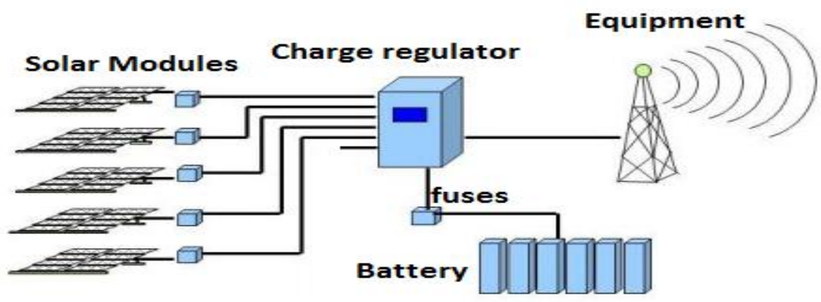


Fig 2: A photovoltaic system to power the BTS

II .PHOTOVOLTAIC SOLAR PANELS

II.1. Interest of solar photovoltaic panels mobile over fixed panels

During the day, the sun moves continuously while a photovoltaic generator is always fixed, thus we may probably lose a considerable amount of energy, which could be available.
In a fixed installation, to optimize the performance is set in the South, the energy delivered by the PV modules is maximum only at noon as shown in figure 3. For, if the PV modules are always facing the sun, it is as if there is always the corresponding condition at noon, the power generated is always the maximum.
The photovoltaic modules placed on sun trackers have an efficiency which increases appreciably compared to fixed installations. The followers of sun available in our range offer tracking of the sun's path following a motor shaft and a seasonal axis manual. They thus generate a higher average power of about 50% of production.

II.2 Presentations compared to a 1 kWp system fixed and follower

In a completely sunny day, a 1 kWp system is well directed, produced 5.5 kWh of energy, while the same system follows in the same light conditions, and produces 11 kWh of energy.

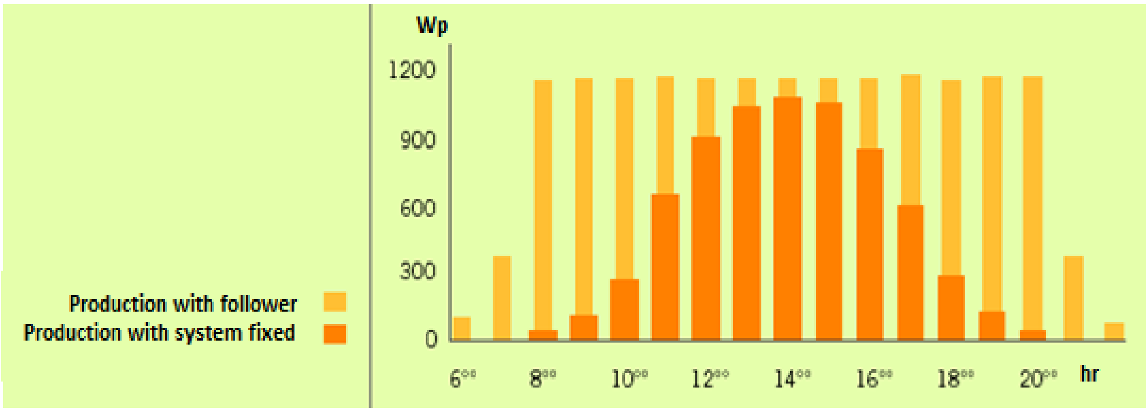


Fig 3: Diagram comparing the output with tracking
and production system with fixed [6]

Premised on these results that express the difference between systems with fixed and another follower which allows us to achieve a follower based on microcontroller end to have good performance, for the production of maximum power.

III. MODELING OF THE PHOTOVOLTAIC FIELD

III.1 Model a diode

The operation of a photovoltaic module is described by the "standard" model to a diode, established by Shockley for a single PV cell is generalized to a PV module by considering it as a set of connected in series or parallel identical cells [7].

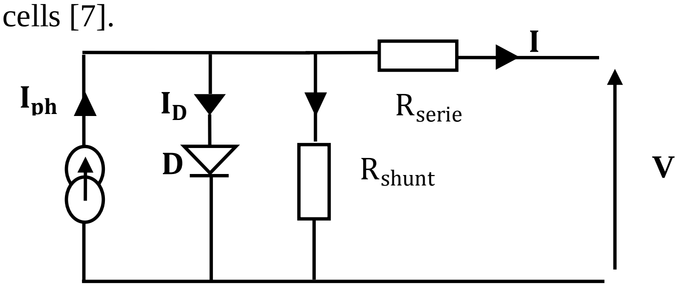


Fig 4: equivalent circuit model of a PV cell with a diode

According to figure 4 the current supplied by the cell is given by the equation (3)

$$I = I_{Ph} - I_s\left[exp\left[\frac{q(V-R_S I)}{AKT}\right]-1\right]-\frac{V+R_S I}{R_{sh}} \quad (3)$$

Where: I: Current supplied by the cell [A]
V: Terminal voltage of the cell [V]
I_{ph} : Photo current [A], proportional to the irradiance E, corrected by T
I_s: Saturation current of the diode [A].
R_s: Series resistance [Ω].

R_{sh} : Shunt resistance [Ω].
q: Charge of electron = $1.602.10^{-19}$ Coulomb
k: Boltzmann's constant = $1.38.10^{-23}\ J/K$
A: Quality factor of the diode, typically between 1 and 2.
T: effective temperature of the cell [Kelvin].

III.2 Model two diodes

There are two diodes to represent the phenomena of polarization of the PN junction. These diodes symbolize minority carrier recombination, on the one hand and the material surface on the other.
In the volume of the material [8]. The diagram of the PV generator is in the case of figure 5.

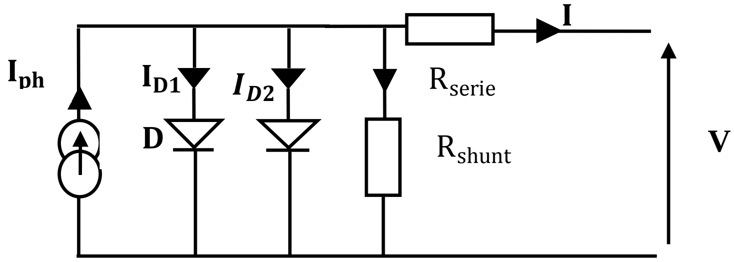


Fig. 5: equivalent circuit of a PV cell model with two diodes

I_{ph} and I_{sh} keep the same expressions as the model for a diode.
The total current is:

$$I = I_{ph} - \frac{V+R_s.I}{R_{sh}} - I_{s1}\left[\exp[\frac{q(V-R_sI}{AKT}] - 1\right] - I_{s2}\left[\exp[\frac{q(V-R_sI}{2AKT}] - 1\right] \quad (4)$$

The dual diodes a slight advantage because it uses the minority carrier recombination in the volume of material.
The model with two diodes is very good if you have a sufficient amount of experimental data to determine the set of parameters. Moreover, to check the validity of the model for other cell types.

IV. MODELING OF A SOLAR PANEL BY Matlab Simulink

From the figures we asked for the simulation of a photovoltaic cell by equivalent diagrams and so we define the parameters end to have the influence of the elements of the system and for this we used the Matlab Simulink as shown in figure 6, allows us to have the following results after compiling programs.

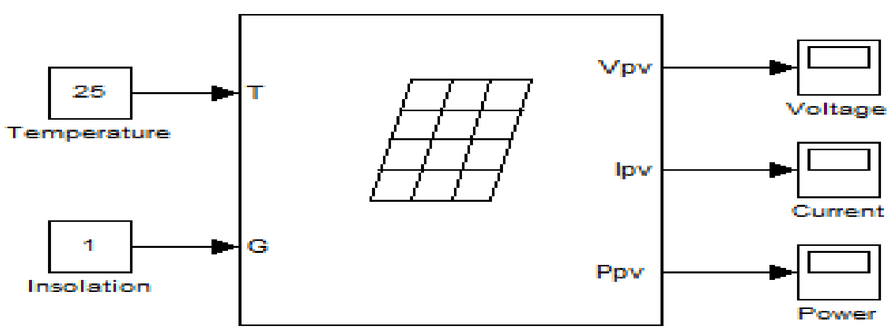
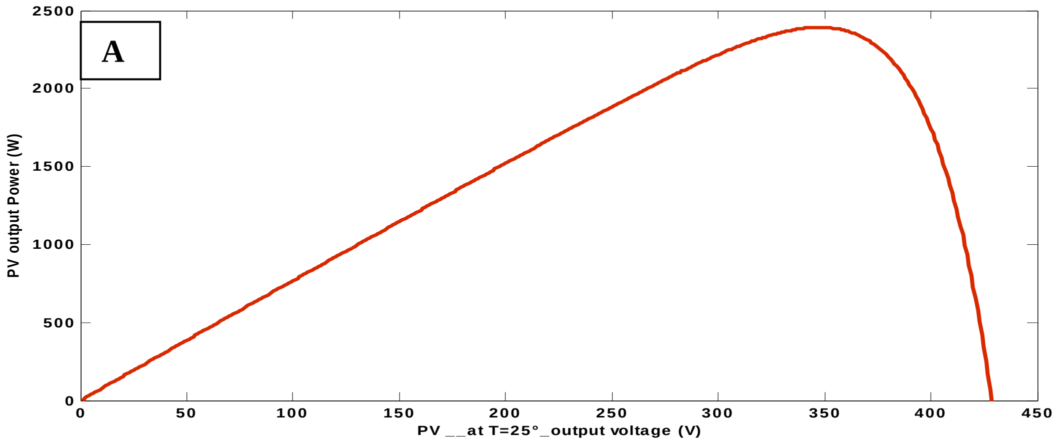


Fig 6: Photovoltaic Model Matlab Simulink

With parameters: $R_S = 0.1125\,\Omega$, $R_{Sh} = 6500\,\Omega$
γ=1 .7404 , $I_{SCR} = 3.45\,A$
$I_{0r} = 4.8842\,10^{-6}$A , $K_I = 0.00128\,A/K$
$T_r = 298.15\,K$, $E_{G0} = 1.7$, $A = 1.8$



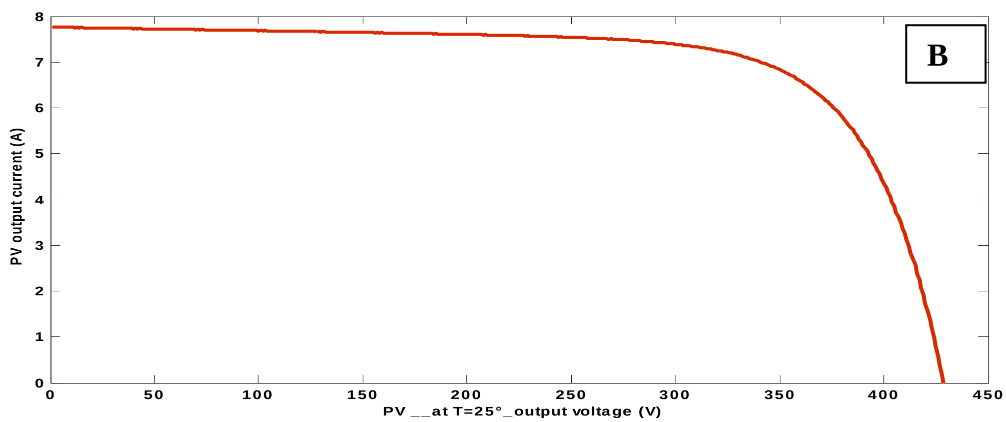


Fig 7: A and B characteristic of a photovoltaic cell
at T=25°c and E=1000w/m^2

It therefore appears that the PV cell is a non-linear current generator. This is a difficult control of photovoltaic systems.

The photovoltaic panel is considered as a power source, and for various values of temperature and solar radiation, it can be observed that the increase of the solar radiation causes an increase in the operating temperature to a maximum generated power, but as the temperature increases the power decreases.

V. FACTORS LIMITING PERFORMANCE OF A PHOTOVOLTAIC GENERATOR

The amount of energy produced by a photovoltaic system is highly dependent electromechanical characteristics of each component of the system, the surface of the sensor fields; the amount of solar energy incident on the surface of the capture of this system of ambient temperature also affects the response of this type of system [9].

V. 1 Influence of series resistance Rs

The series resistance characterizes the losses by Joule effect of the inherent resistance of semiconductor and losses through the gates of collections and bad ohmic contacts of the cell. The contacts semiconductor electrode high resistance appreciably lowers the voltage and output the current which will limit the conversion efficiency [10]. The influence of the characteristic series resistance of the solar cell is shown in figure 8.

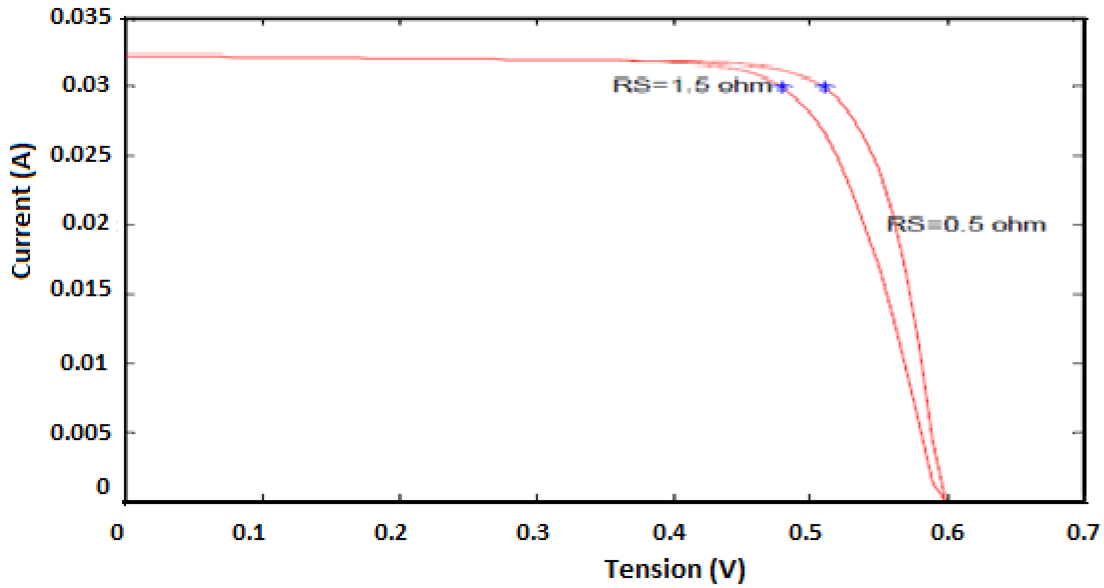


Fig 8: Influence of Rs on the characteristic I = f (V)

The performance of a photovoltaic cell is even more degraded than Rs is high or R_{sh} is low. Figure 8 shows the influence of the series resistance on the I-V characteristic. This influence results in a decrease in the slope of curve I = f (V) in the region where the panel functions as voltage source to right from the point of maximum power.

V.2.The influence of illumination:

The increase of sunlight (light flux) results in a displacement of the characteristic I = f (V) along with the axis of the currents. The increase in short-circuit current is much higher than the open circuit voltage as the short circuit current is a linear function of the illumination, while that of the open circuit voltage is algorithmic [11].

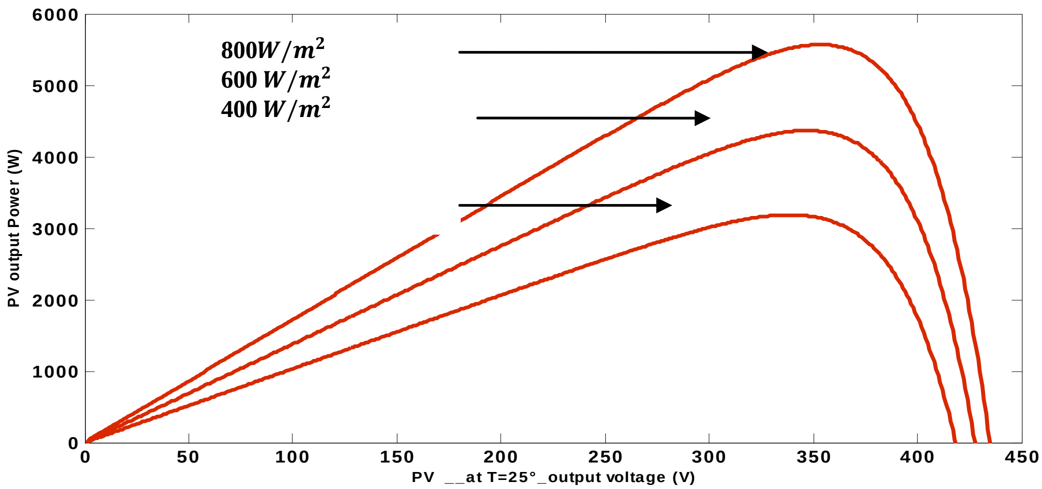


Fig 9: Characteristics GPV at constant temperature T = 25 ° C
and variable illumination

The electrical power produced by the PV generator depends on the illumination it receives on its surface and any lighting value; there is one point where the power of GPV is maximum.

V.3. Influence of the parallel resistance R_p

The parallel resistance; or shunt characterized by the carrier recombination losses due to structural defects of the material and thicknesses of the P and N regions of the load area and space. The existence of cracks and lack of complex structures becomes the seat of comparable physical phenomenon as a parallel resistance R_p. The magnitude of the parallel resistance for a cell if : $R_p = 10^2$ à 10^4 increases with the number of solar cells group and decreases with a parallel connection [12]. The influence of the characteristic of parallel resistance of the solar cell is shown in figure 10.

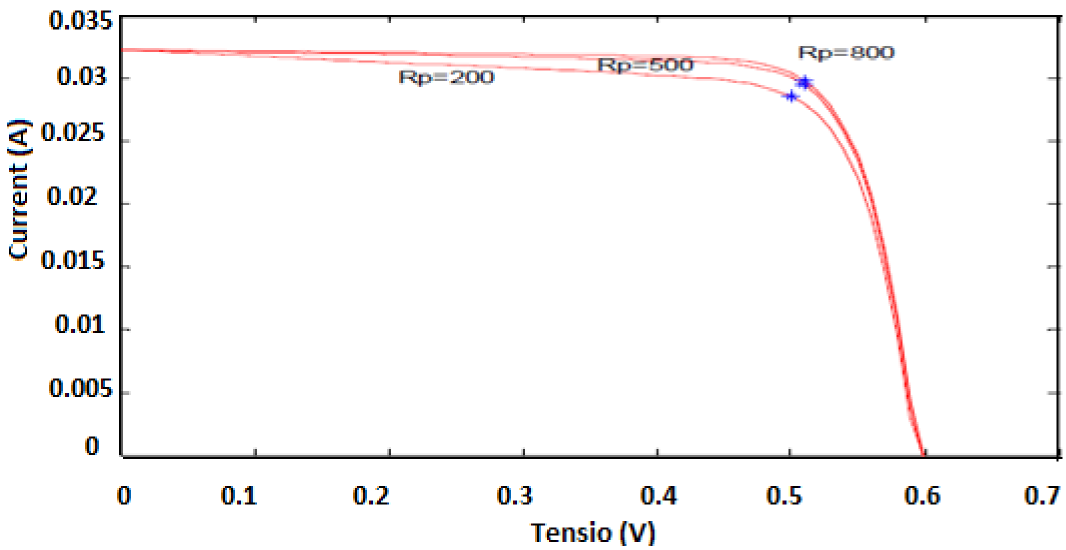


Figure 10: Influence of R_p on the characteristic I = f (V)

The parallel resistance (or shunt) characterized by the carrier recombination losses due to structural defects of the semi conductive material and thickness of the regions and the P and N of charge zone and space (ZCE). The existence of cracks and lack of complex structures becomes the seat of comparable physical phenomenon as a parallel resistance R_p.

V.4.The influence of temperature:

If the temperature of the cell increases, the photocurrent I_{ph} also increases mainly due to the decrease in the width of the forbidden band of the material. This increase is based on the order of 0.01% degree °C The direct current of the junction also increases, but much faster resulting in a decrease of the open circuit voltage of about 2 mV per cell. The decrease in power output is estimated about 0.5% per degree for a module [13].

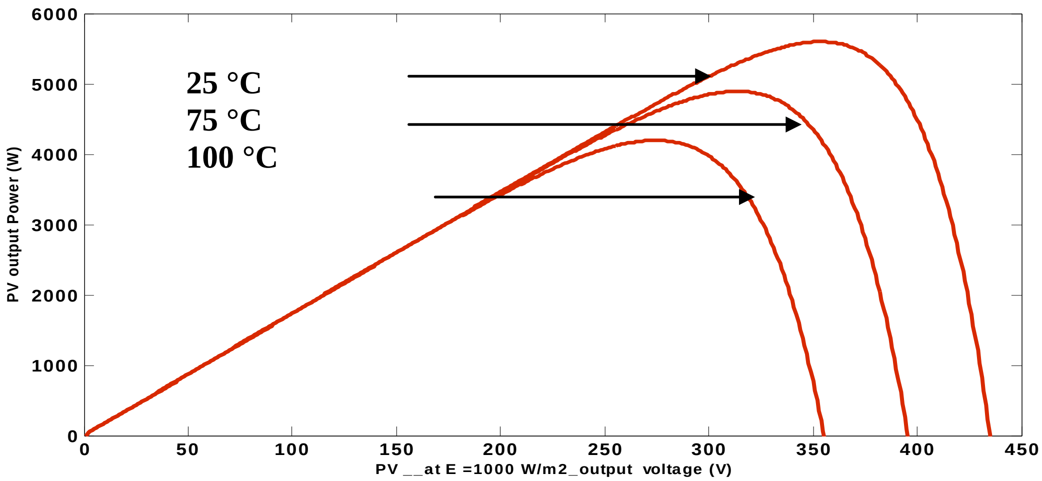


Fig 11: Characteristics of GPV variable temperature and constant sunshine $E = 1000 \ W/m^2$

We observe that when the temperature increases, the voltage decreases, while the current increases and decreases the maximum power point.

VI MODELING STORAGE

VI.1. Principle of the functioning of the batteries

The operating principle of an electrochemical generator is essentially based on the conversion of chemical energy into electrical energy. Any chemical redox reaction, provided it is spontaneous, that is to say, accompanied by a decrease in free energy, is indeed capable of giving rise to an electric current when it takes place under conditions appropriate. For this it is necessary that the exchange of valence electrons is by the canal system to an external circuit. And the free hydrogen combustion produces water and heat energy can give rise to an electric current as the electronic exchange is performed directly in some way by shorting molecular.

Given the variety of types of battery cells and the number of parameters varies very involved, very empirical representation of the behavior of the battery can be established. The storage system used in a photovoltaic installation is a lead storage battery. Until now, there are several models of the battery charge has been proposed. In this study, we used a model can be described by (Bogdan and Salameh, 1996) to calculate storage capacity depending on the power produced by the photovoltaic generator and the load applied [13].

VI.2.General characteristics of batteries

Batteries for photovoltaic systems must have the following qualities:

- ✓ Be strong
- ✓ Have a good charge efficiency and discharge.
- ✓ Have a low internal resistance.
- ✓ Have a low self-discharge rate.
- ✓ Reduced maintenance.
- ✓ Have a lasting service life
- ✓ Have a large reserve of electrolyte.

VI.3.Voltage of battery:

The following model describes the relationship between voltage, current and state of charge. This model based on the wiring diagram in figure 12 [14].

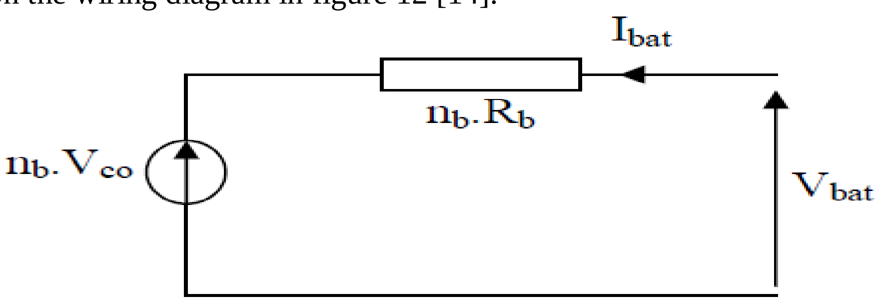


Fig 12: Schematic electric battery.

For n batteries in series, we can write the equation (5) [14]:

$$V_{bat}(t) = n_b.V_{co}(t) + n_b.I_{bat}(t).R_{bat}(t) \qquad (5)$$

Where V (t) is the voltage swing open circuit at time t, and R (t) is the bat battery internal resistance, Ohms, and the open circuit voltage is expressed as a logarithmic function of the state load.

$$V_{co}(t) = VF + b.\log(SOC(t)) \qquad (6)$$

Where VF is the electromotive force, b is an empirical constant.

With : VF=13.250 and b=0.810 (7)

Voc variation depending on the state of charge (SOC) is represented by the following figure 13:

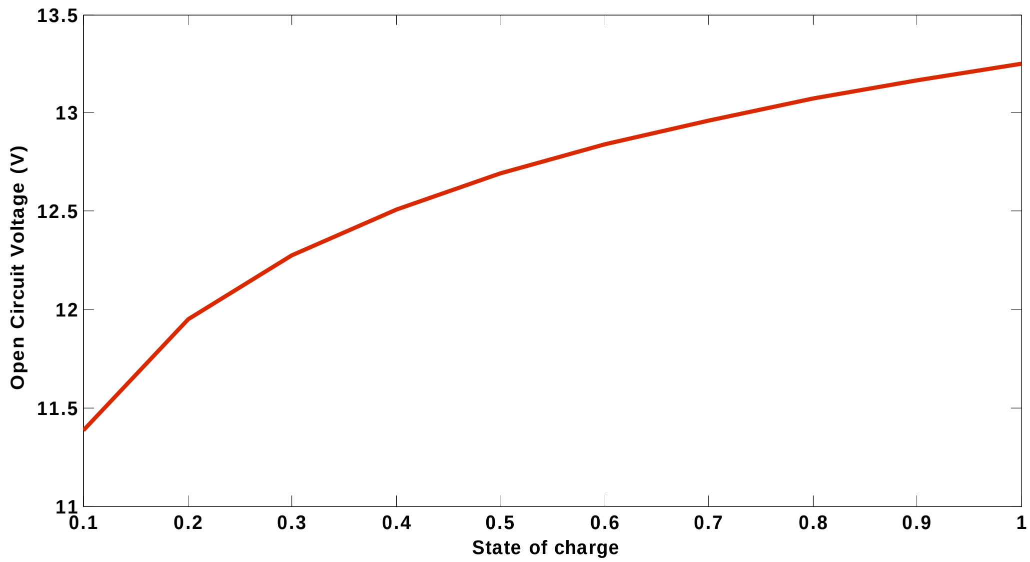


Fig 13: Variation of voltage charging mode depending on the state of charge.

VI.4. Yield of the Battery:

The battery performance is calculated by the following equation:

$$\eta_{bat} = \frac{P_{fourni}}{P_{incid}} \qquad (8)$$

In practice, the yield is assumed to be constant equal to 85% when the nominal voltage is 2V and the capacity of the order of 100A / h. So the power supplied by a battery can be written as follows:

$$P_{fourni} = \eta_{bat} . P_{incid} \qquad (9)$$

P_{incid} : Power of Generator

CONCLUSION

The influences of light and temperature on the power that can be delivered by a PV panel and the series and parallel resistance are important. When the irradiation varies for a given temperature, the short-circuit current I_{sc} varies proportionally to irradiation.

At the same time, the open circuit voltage V_{oc} varies very little. If the temperature increases at constant irradiation, the voltage Voc then decreases as the current I_{cc} increases slightly. From this information, we can estimate that, depending on the operating conditions we will submit the panel, it can be inferred that the power will be able to deliver.

We saw the benefit of mobile solar panel relative to fixed photovoltaic panel, and the performance difference of energy between the two panels which gives the importance of programmable followers PIC by the proposed tracker is implemented a reconfigurable FPGA chip for real-time monitoring to reap the maximum energy with a good yield.

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