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Mouhoub Birane, Abdelghani Chahmi. Comparative Study And Simulation Analysis For Two Models Of Autonomous Application For Photovoltaic System. 1st International Symposium on Materials, Energy and Environment January 20-21st; 2020, El Oued, ALGERIA, Jan 2020, El-oued, Algeria. hal-02452300

HAL Id: hal-02452300

<https://hal.science/hal-02452300>

Submitted on 23 Jan 2020

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Comparative Study And Simulation Analysis For Two Models Of Autonomous Application For Photovoltaic System.

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Abstract: In this paper, we present a comparative study, analysis, and evaluation of a model of autonomous kit with electrochemical storage and autonomous kit with the wire of sun. by using the maximum power point Tracking efficiency of photovoltaic with different DC-DC converter topologies for photovoltaic Application. It provides different improvements to the electrical architecture. In fact, we present a new alternative for improving both the performance of photovoltaic (PV) systems and the efficiency of the energy conversion This solar system represents the complete chain simulation in MATLAB / SIMULINK. Thus, we looking at the matching connection stage between the GPV, MPPT regulator, solar battery, circuit breaker, the DC load represents by an LED bulb. In addition, we using a new additive block represented by a voltage probe, current probe. Likewise, we will see the effect of the absence of MPPT regulator on the overall performance of PV system. The development of electronics in the field of power production, which makes the trade-off between power and cost level on the one hand and new control techniques on the other hand, allows us to better manage the environment our problematic on isolated site. One of the main components is the load DC and AC. The new trends in this area are the use of economy solution by using renewable energy. The simulation results show that this control (by use components of direct connected solar "Load DC", and with storage electrochemical "Load AC") gives us a good agreement performance in terms of electric product necessary in our saharan country especially in public lights.

Keywords: Photovoltaic Generator, Maximum Power Point Tracker MPPT, performance, power, DC-DC, DC-AC Converters.

I. INTRODUCTION

Renewable sources of energy acquire growing importance due to its enormous consumption and exhaustion of fossil fuel. Renewable energy is abundant, free, sustainable, and clean and can be harnessed from different sources in the form of wind, solar, tidal, hydro, and geothermal and biomass [1]. Energy supplied by the sun in one hour is equal to the amount of energy required by the human in one year [2]. Photovoltaic

energy system has gained wide popularity in the past decade as one of the renewable energy sources due to the possibility of depletion of conventional energy sources and its high cost as well as its negative effects on the environment. The choice will involve a bigger or smaller energy production and efficiency as well as an importance difference in the cost. For this reason, it is important to know different types of architecture in order to choose the correct PV architecture for each PV installation [4] [3].

Solar energy could be one of the significant sources as an alternative energy for the future. In regard to endless importance of solar energy, it is worth saying that photovoltaic energy is a best prospective solution for energy crisis [4]

The architecture of the power converter is important in a PV system. This structure determines the main characteristics of the photovoltaic installation, as the amount the PV modules need for the PV system and its type of connection. The effect of the partial shadowing or mismatch between PV modules in the energy production will also depends on the type of the architecture. Nevertheless, the price and cost of the PV also depends on the choice of the architecture. [5].

II-MATHEMATICAL MODELING OF THE PV MODULES

A solar cell constitutes the basic unit of a PV generator which, in turn, is the main component of a solar generator. The electrical analysis of the PV cell includes a source which is the sun and unique equivalent electrical circuit which includes diode and series and parallel resistances. A solar cell equivalent electrical circuit can be represented by a one-diode model as shown in fig.1:

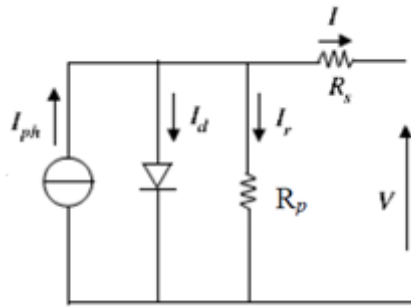


Figure. 1: General model of PV cell in a single diode model

Solar cell can be represented by photocurrent source, a diode, a parallel resistor also called shunt resistor (R_p) expressing a leakage current and a series resistor (R_s) describing internal resistance to the current flow.

The PV cell electrical characteristic under solar irradiance (G) is given in terms of PV cell output current (I) and PV cell voltage (V). Refers to figure 1 and based on the first law of Kirchhoff, the basic equations which describing electrical characteristics of the PV cell model

The relation between the array terminal current and voltage is the following:

$$I = I_{ph} - I_D - \frac{V + I R_s}{R_p} \quad (1)$$

$$I = I_{ph} - I_0 \left[e^{\frac{q(V + I R_s)}{nKT}} - 1 \right] - \frac{V + I R_s}{R_p} \quad (2)$$

$$I_{ph} = I_{SC} \frac{\phi}{1000} \quad (3)$$

Where: I and V are the output current and output voltage of the photovoltaic cell, I_{ph} is the generated photo-current, I_0 is the diode's reverse saturation current, n the diode ideality factor, R_s and R_p the series and parallel resistance (respectively), and T is the absolute temperature in Kelvin. The equation also contains the elementary charge constant q ($1,602 \cdot 10^{-19} \text{C}$) and the Boltzmann constant k ($1,380 \cdot 10^{-23} \text{ J/K}$).

A solar cell is the building block of a solar panel. A photovoltaic module is formed by connecting many solar cells in series (N_s) and parallel (N_p). The output power available from the PV generator is given by:

$$P_{pv} = N_s * V_{pv} * N_p * I_{pv}$$

We consider N_p as the number of cells connected in parallel and N_s as the number of cells connected in series, the relationship between the output current and voltage is given by [6]

$$\begin{aligned} I_{ph \text{ final}} &= N_p I_{ph} \\ I_0 \text{ final} &= N_p I_0 \\ n \text{ final} &= N_s n \\ R_s \text{ final} &= \frac{N_s}{N_p} R_s \\ I &= N_p I_{ph} - N_p I_0 \left[e^{\frac{q \left(\frac{V + I R_s}{N_s} \right)}{nKT}} - 1 \right] - \frac{N_p}{R_p} \left(\frac{V}{N_s} + \frac{I R_s}{N_p} \right) \quad (4) \end{aligned}$$

The equivalent circuit for the solar module arranged in N_p parallel and N_s series is shown in Figure 2.

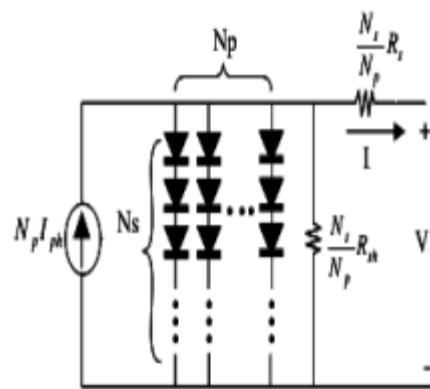


Figure. 2: Equivalent circuit model of generalized PV .

III. ANALYSIS OF DC / DC CONVERTER

In this paper we describe and analyze a new way to measure characteristic curve by using DC-DC converters. The switching power converter DC-DC are widely used in photovoltaic systems to transform DC power between a voltage and another, and are also used in maximum power point tracker (MPPT).

The goal of the DC optimizer is to extract the maximum power possible from the PVG, placing the MPPT in a distributed way.

The DC-DC converters concerned in this study are step-up voltage converters known as Boost converters. The electrical schema of the boost converter is reminded in the fig. (3).

Nowadays, there are two widespread and cost-effective technologies suitable for the implementation of the proposed converter switches: MOSFET and IGBTs because both technologies are available for the intended operation voltage, current and frequency.

In this study concerned of Si-IGBT (Insulated Gate Bipolar Transistor) switched mode converter able to produce a dc

output voltage that is greater in magnitude than the dc input voltage [7].

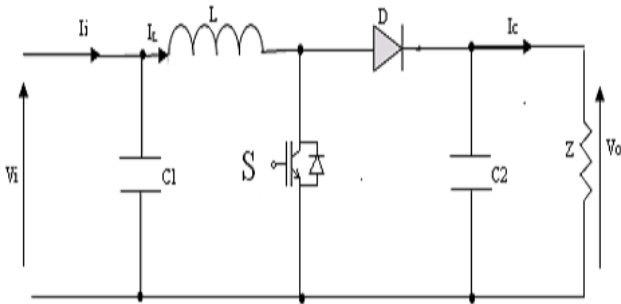


Figure.3. Electric structure of the boost power converter

The boost converter is one of the simplest DC-DC converters. In a DC transformer the relationship of transformation can be controlled electronically by changing the duty cycle of the converter in the range [0, 1]. The relationships used for the design are the conventional relationship between the output voltage, the input signal and the duty ratio [8]:

$$V_{OUT} = \frac{1}{1-\alpha} V_{in}$$

Study continuous state: Replacing derived signals with zeros, we can replace the converter signals by their average values, and it will simplify the system of equations:

$$\begin{cases} I_L = I_i \\ I_o = (1-\alpha)I_L \\ V_i = (1-\alpha)V_o + r_L I_L \end{cases} \quad (5)$$

Conversion and performance report:

Using the relations (5), one can calculate the conversion ratio

$$\begin{aligned} M(\alpha) &= \frac{V_o}{V_i} = \frac{1}{(1-\alpha) + \frac{r_L I_L}{V_o}} = \frac{1}{1 + \frac{r_L I_o}{(1-\alpha)^2 V_o}} \frac{1}{1-\alpha} \\ &= \frac{1}{1 + \frac{r_L}{(1-\alpha)^2 Z}} \frac{1}{1-\alpha} = \eta \frac{1}{1-\alpha} \end{aligned}$$

$$\text{Where } \eta = \frac{1}{1 + \frac{r_L}{(1-\alpha)^2 Z}}$$

Represents the efficiency of the converter

Note that the η performance not only depends on the complex load Z of the converter and parasitic resistances of the components, but it also depends on the cyclic α report. Thus it is recommended that the Boost provides good performance, not to exceed duty cycles higher α to a certain value, determined by the quality of the inductance and the filler used.

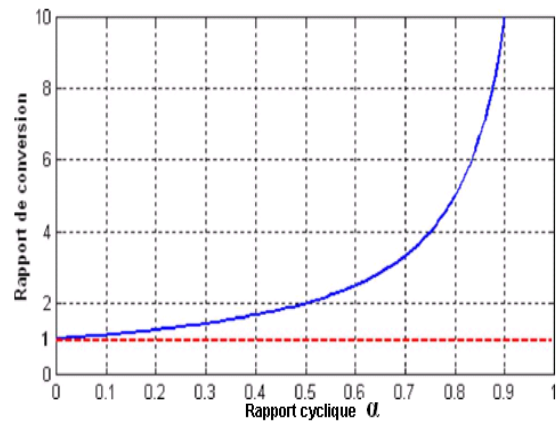


Figure. 4. Allure of the conversion ratio as a function of duty cycle α .

The interconnecting different structures, new tasks that only with one converter cannot be achieved are reached. For instance, Many type of association can be envisaged, the series and parallel connection of converter involve a major power transfer capability. The series connections increase the voltage. The parallel connections are used to increase the current.

IV. DC-DC CONVERTER CONTROL

The DC-DC converter control strategy consists in extracting the maximum power of the PV array by determining the optimal input voltage reference. The voltage reference is set by using a MPPT algorithm which tracks the evolution of the PV array power in order to find the optimal voltage reference. [9].

The use of DC optimizers to extract the maximum photovoltaic energy is more widely used. These structures are placed next to the PV module, and they extract the maximum energy from the PV module in a distributed way. According to photovoltaic use forecast studies. [10].

The last proposed architecture to optimize power transfer, is to use a matching stage DC / DC controller with MPPT This

management architecture corresponds to a discrete architecture. In fact, each given field will have its own floor of adaptation to exploit the power available at the terminals of PV. Thus, approaching as close to the source of production, it is hoped to produce maximum power. The diagram in Fig.5 thus shows the principle of power control.

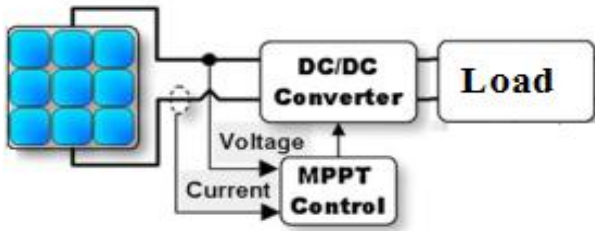


Figure.5. Simplest electrical scheme block of a typical power conversion chain.

The main goal of a MPPT control is to automatically find at each time the VOPT and IOPT of a PV array and then to allow it to operate at its PMPP under given temperature and irradiance. Best MPPT control algorithms have to be fast, stable, robust, and efficient. MPPT methods, commonly used in widespread applications, are currently reported in the literature [11].

V-.BLOCK DIAGRAM OF TWO MODELS PROPOSED

A- Model equivalent of autonomous photovoltaic system type of over the sun:

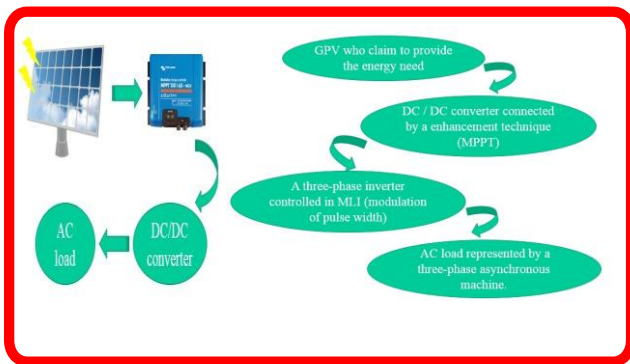


Figure 6. Autonomous photovoltaic system type of over the sun.

B- Model equivalent of Autonomous photovoltaic system with electrochemical storage:

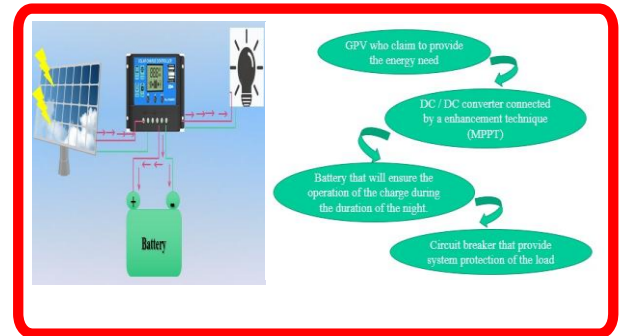


Figure 7. Autonomous photovoltaic system with electrochemical storage.

VI. SIMULATION RESULTANTS AND DISCUSSION:

A- Simulations of solar DC load in MATLAB / SIMULINK

In the first topology we have used the PV panels and one converter. The converter is controlled with an MPPT controller, figure 8 represented the Simulation of DC load in Simulink/MATLAB.

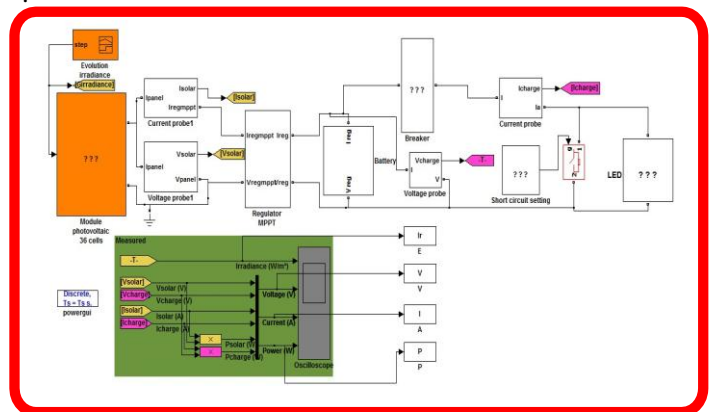


Figure.8. Simulation of DC load in Simulink/MATLAB.

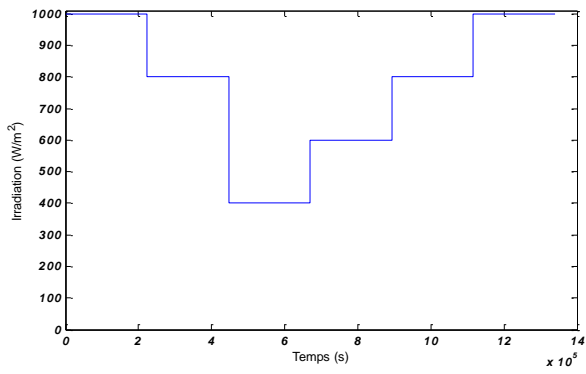


Figure 9. Solar irradiation.

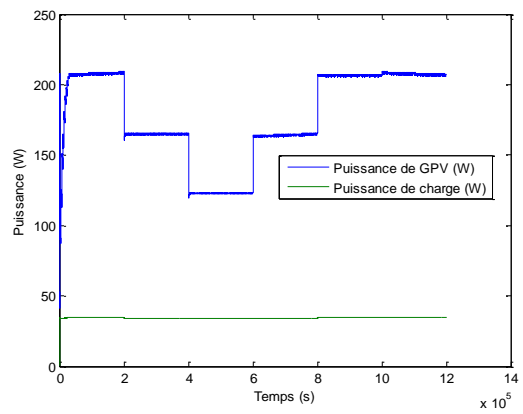


Figure 12. Power of Gpv.

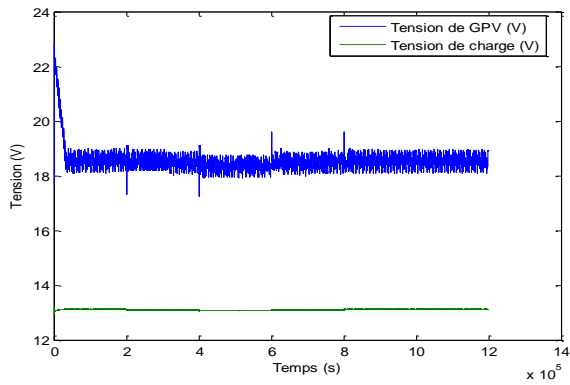


Figure 10. Gpv voltage.

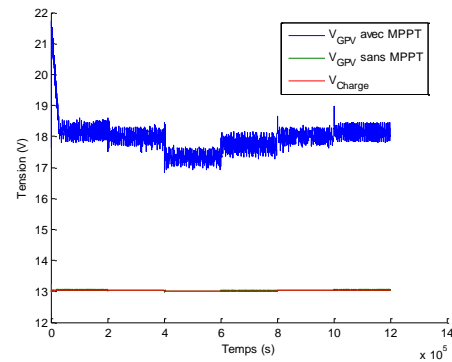


Figure 13.a. Gpv voltage with and without MPPT regulator.

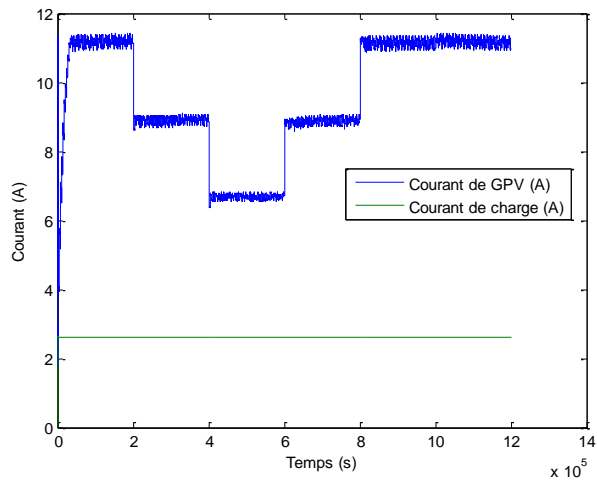


Figure 11. Gpv current.

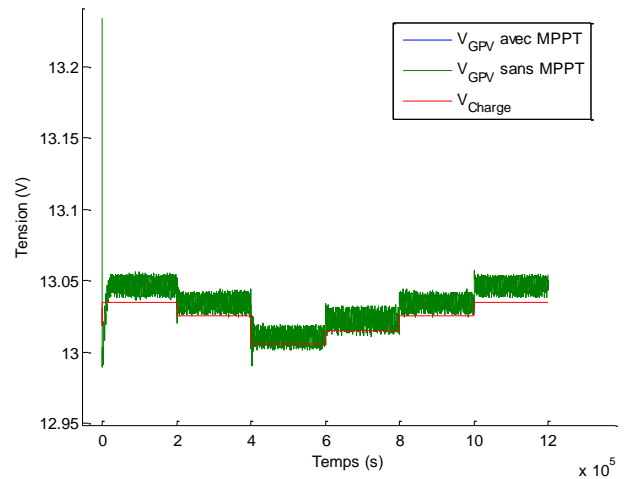


Figure 13. b. Gpv voltage with and without MPPT regulator.

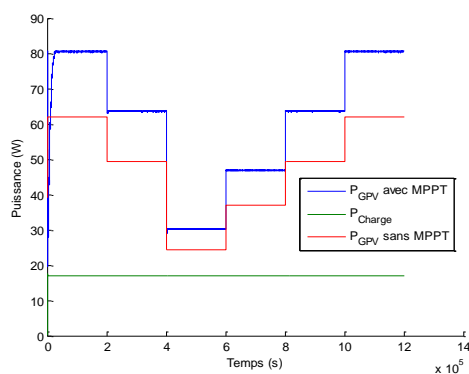


Figure 14. Gpv current with and without MPPT regulator.

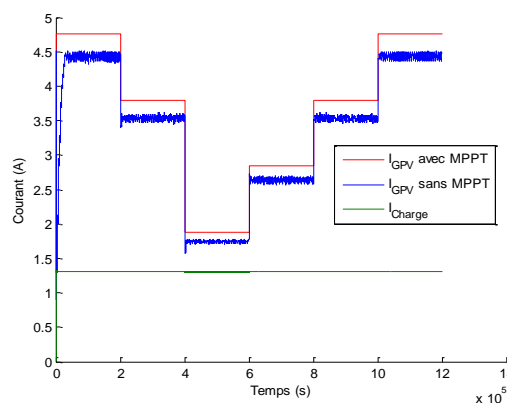


Figure 16. Simulation of of AC load supply.

B- Simulations of solar autonomous solar kit in MATLAB / SIMULINK

In the second topology ,the application of our work of this kind of solar model adapted by the AC load is numerous especially in isolated sites. Typical applications for the DC voltage solar source represented by n PV generator to form a unit producing a high continuous power compatible with the usual electrical equipment, is connected with a Boost chopper characterized by ($L = 100 * e-3$ (H) , $C = 1000 * 10-6$ (F)), controlled with the same duty cycle and the controls are shifted by $1 / n$ period. The frequency of the input current of an interlaced Boost becomes n times that of the control signals. The frequency of the currents of the source and the load then becomes twice the switching frequency of the switches. In addition, the ripple of the input current is reduced with respect to the current ripple in the inductances due to the interleaving of the currents of each of the phases. Finally, the value of the output capacitance is reduced compared with the increase in the frequency of the current in the load. A three-phase PWM controlled inverter (pulse width modulation) and one measure to measure the voltages of each phase with AC load represented by a three-phase asynchronous machine.

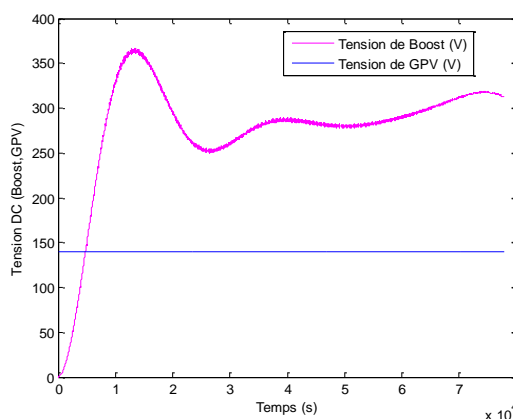


Figure 17. Voltage of DC (boost).

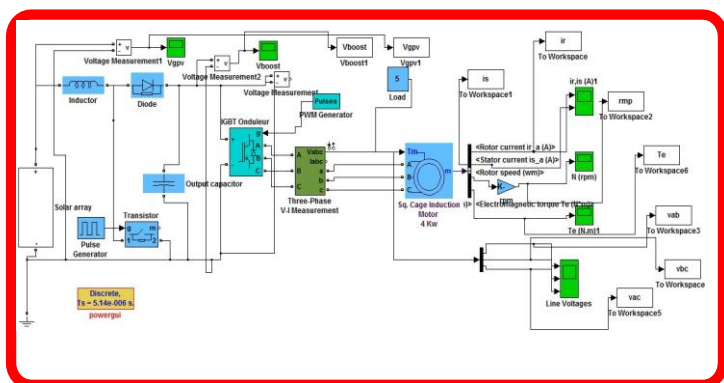


Figure 15. Gpv power with and without MPPT regulator.

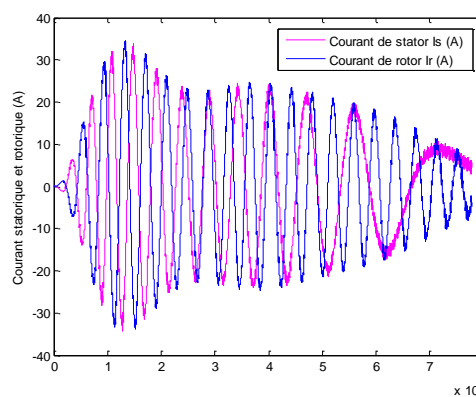


Figure 18. Stator and rotor current.

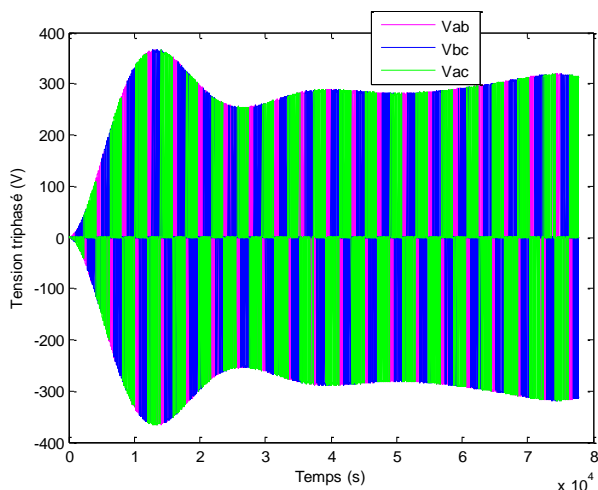


Figure 19. Simple voltages V_a , V_b , V_c .

we have modeled and simulated under a Matlab / Simulink a DC voltage source DC field first directly connected to the load and then when the boost converter is inserted. It appears that the proposed boost significantly improves the performance of the dynamic state of the DC voltage source GPV. So we have to improve the work by inserting an inverter that converts the DC boost current into an alternating current that can be used for supplying AC loads. Figure 17, shows the DC voltage of the boost converter It is distinguished that the output voltage of the boost converter has increased because it is used as much as the voltage elevator, for a better design of a boost converter capable of seeking the power maximum for any variation of sunshine thanks to its MPPT command.

Figure 18, represents respectively the curves of the stator and rotor current, rotor speed and the electromagnetic torque. The objective of the study carried out in this section is to establish a functional diagram whose simple supply voltages allow us to determine the electrical, electromagnetic and mechanical quantities as a function of time under dynamic conditions for motor operation. The speed increase is almost linear at the beginning of the start. To ensure a stable operation of the device, must maintain a rotation speed close to synchronism. The machine has a fixed number of poles and must therefore operate over a very limited speed range (slip less than 2%). Oscillations of the instantaneous torque are noted when powering up for a short time. Thus the torque rises to 15 N.m. Figure 19, shows the result of the output voltage of the inverter, it can be seen from the simulation curves that the waveform of the voltage is sinusoidal and can supply the load (three-phase asynchronous machine).

VII .CONCLUSION

In this paper different topologies of photovoltaic system were discussed, where PV array configuration is significantly affecting the overall system efficiency. In our study, we focused on simulation results for two models of an autonomous system. First aim, we proposed an stand-alone kit with electrochemical storage by public lighting, we have been able to demonstrate that an 80w photovoltaic generator ensures the charge even with the lowest values of solar radiation, and we have concluded as well as in the favorable values of the radiation (1000 W/m^2) it can light four lamps at the same time. Second aim present by autonomous kit over the sun without electrochemical storage, we produced a sinusoidal signal from the good coupling between the circuit components. (DC source, boost converter, three-phase inverter).

In this paper, different photovoltaic converter topologies are analyzed, the purpose of Solution PV is to design and optimize architectures of the energy conversion chain, monitoring, and control strategies from the PV module to the utility grid in order to increase the reliability of installations pointing out the advantages and drawbacks for each of them. The output power delivered by a PV module can be maximized using MPPT control system. It consists of a power conditioner to interface the PV output to the load, and a control unit, which drives the power conditioner for extracting the maximum power from a PV array. In this paper, a MPPT system has been proposed and tested by simulations in MATLAB's Simulink toolbox, for simulation.

Finally, this work can be extended in several directions including: Integrates the system with other MPPT methods and comparing their results. Real implementation of these topologies is also a challenge that can increase the efficiency of real PV systems and their output power.

As a perspective to this work, we think and try to find solutions like hybridizing two models of an autonomous system for improving PV system performance in the future.

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