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9 Photovoltaic Generation System and Grid Source Connected to Load Using qZ Source

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ABSTRACT

The consumption of fossil fuels is increasingly necessary because of the need for electric power despite the fact that the emission of gas increases pollution and global warming of our planet. Therefore, renewable energies such as solar, wind, hydraulic, etc. are promising solutions that help to overcome the problems with which our world is confronted. In this work, we will present a power structure to harvest the maximum possible amount of energy from a photovoltaic system as a main source of renewable energy. The topology used for the adaptation between the power source and the load is based on qZ source because of its advantages, mainly this type of adapter is used to interface the low direct voltage to high direct voltage to reduce the stages of converters and semiconductor components. The validity of the proposed technique is proven by the analysis of the results obtained from the MatLab / Simulink simulation.

Keywords: Renewable energies , Photovoltaic generator, Grid Source , Grid, qZ Source

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1. INTRODUCTION

During several previous years, research has proven the negative consequences on the environment due to the use of fossil fuels as well as their limit to meet the needs of the population in the near future. Unlike fossil energies, renewable energies are energies with unlimited resources. The sun represents the most abundant energy source, which encourages researchers to direct their efforts to harnessing this source therefore photovoltaic systems are essential as a means of converting solar energy into electrical energy.

It is well know that fossil fuels are used extensively for the production of electricity [1]. Unfortunately, this technology has proven to have remarkable drawbacks, including pollution and the indisputable depletion of fossil resources. In view of this unfortunate finding, research has been launched intensively for the use of renewable energies (RE) as an alternative to fossil resources. However, despite the fact that REs are inexhaustible (abundant) they have the disadvantage resulting from their intermittent nature [2]. Therefore, these installations require the use of the optimization algorithm to extract the maximum power (MPPT) whatever the climatic conditions: irradiation (E) and temperature (T) [3].

Indeed, power converters play a very important role for the conversion of solar energy in photovoltaic systems. So, several researches have been done in order to improve these power converters in techno-economic view, this research studies the possibility of replacing the structure by associating a power converter with an impedant source topology called Z-source [4, 5]. This topology is of DC / DC type, it allows the function of raising the DC voltage of the power source to a higher DC voltage intended for the load.

The aim of this work is to improve the reliability and the efficiency of the production systems of the electric energies with renewable source precisely the photovoltaic system using the Z-source structure. So, in this context we will study the q Z-source structure which is recently introduced [6].

This work is made up of five sections: we start with an introduction. The second section is reserved for modelisation of the photovoltaic generator and qZ source. In the third and fourth sections, the simulation results and discussion are given, respectively. In the fifth section the conclusion is given.

2. STRUCTURE AND MODELISATION

Power generation facilities inevitably consist of static converters necessary for the desired shaping of the energy produced and delivered to consumers. Therefore, despite the remarkable progress in the fields of structures and controls of such converters, However, I do not believe that renewable energy

production facilities continue to require substantial improvements. This work involves studying a power supply structure for a continuous load via the hybridization of two sources, a main source consisting of a photovoltaic generator and an auxiliary source which is a three-phase electrical network where the network voltage is rectified thanks to a three-phase rectifier controlled.

However, since the voltage and consequently the power developed by the photovoltaic generator mainly depend on the meteorological conditions notably, the irradiation (E) and the temperature (T) [6]. We propose in this work to connect the load to the DC bus common to the two sources (main and auxiliary), previously defined through q-Z-source circuit [8-10]. Fig.1 shows the overall structure of the proposed hybridization.

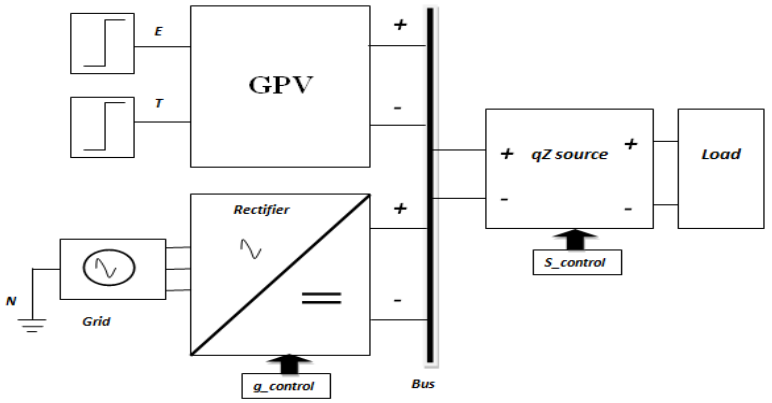


Fig. 1. Global Structure

2.1 Photovoltaic generator

The photovoltaic generator is used to convert solar energy into electrical energy. It is mainly made up of photovoltaic cells connected in series and parallel [11, 12]. The photovoltaic cell equivalent circuit is represented in Fig. 2.

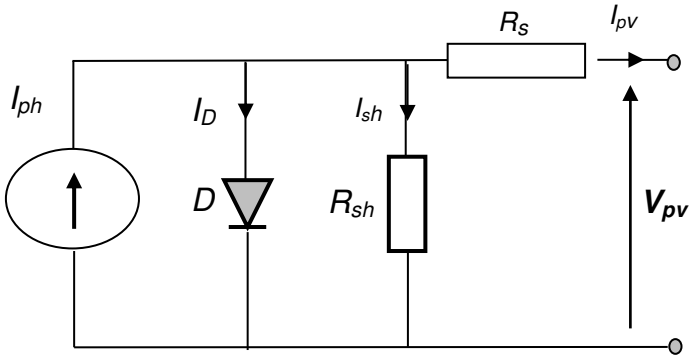


Fig. 2. Electrical equivalent circuit of a photovoltaic cell

Considering Fig. 2, we can write the mathematical model of the photovoltaic module [12, 13]:

$$I_{pv} = I_{ph} - I_d - I_{sh} \tag{1}$$

$$I_{pv} = I_{ph} - I_O(e^{\frac{Vpv+Rs.Ipv}{vtQdns}} - 1) - \frac{V_{pv} + R_s I_{pv}}{R_p} \tag{2}$$

2.2 qZ Source

The Sources dedicated to the production of electrical energy by means of renewable energy sources such as photovoltaic sources generate a variable direct voltage. This section introduces the notion of z-sources which are characterized by the use of LC type impedance network arranged in "X", allowing the simultaneous closing of the up and down switches of the same arm of the converter to accomplish its function of raising the voltage V_{dc} by considering the two operating modes which depend on the short-circuit state or not of the arm of the same arms [14].
A unique feature of "z-source" converters is the "shoot-through" state whereby two solid state switches of the same phase branch can be activated simultaneously. Otherwise, this systems are attractive advantage for photovoltaic systems applications. Fig. 3 shows the quasi-source Z grid.

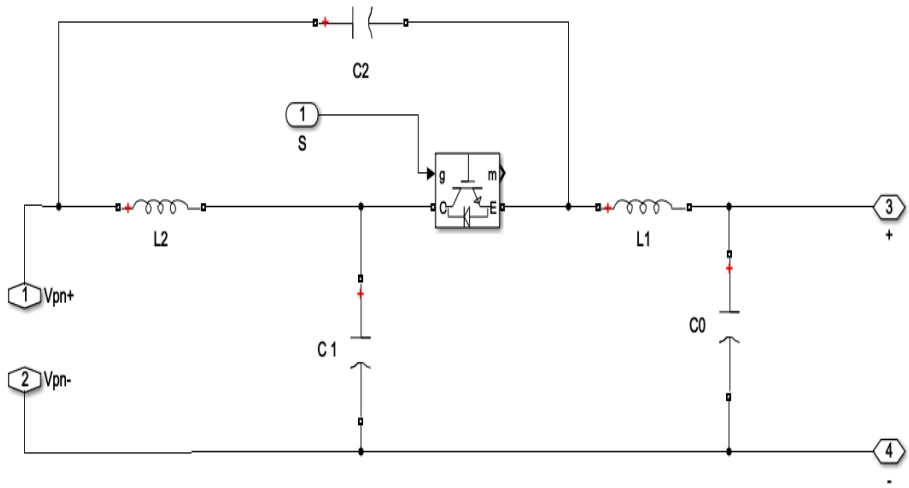
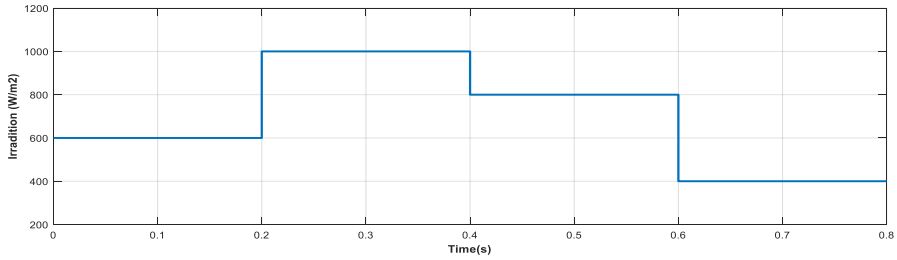


Fig. 3. Quasi-source Z grid circuit

3. RESULTS

Taking into account, on the one hand, the specific operating features that photovoltaic installations are extensively used by climatic conditions, and on the other hand, the place of its installation, in particular an isolated site in this case, scenarios of variations in irradiation and temperature were considered for the analysis of the solar pumping structure proposed in this work.

The performance analysis of the studied structure is carried out under varying levels of irradiation and temperature. The simulation results presented in this section were obtained using the MatLab/ Simulink software. The discussion of these simulations is presented in the next section.



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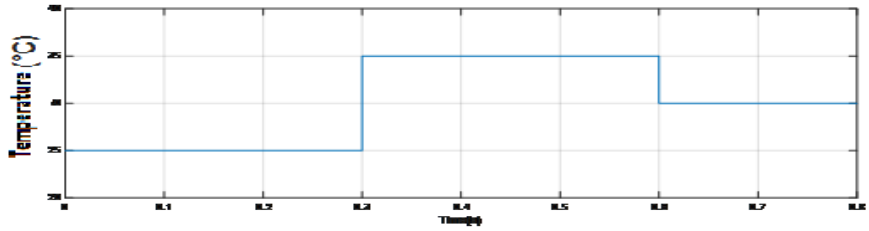
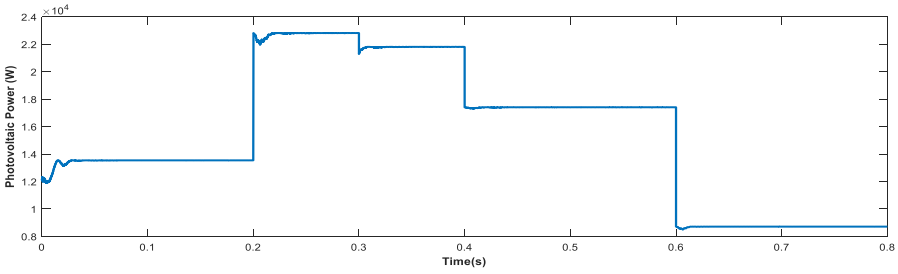


(b)

Fig. 4. Irradiance and Temperature levels



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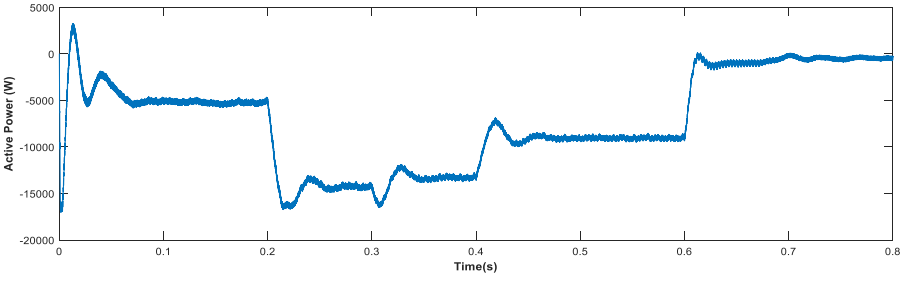

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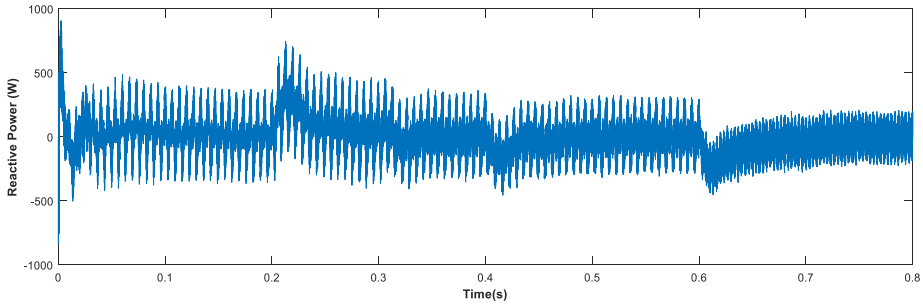
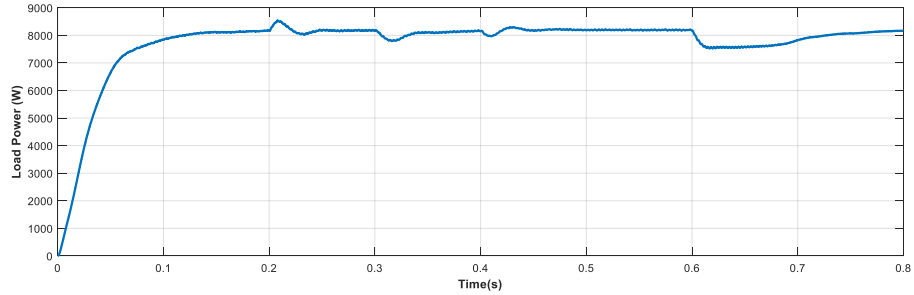


(c)



(d)

Fig. 5. Power of the different components of the chain

4. DISCUSSION

The studied structure (see Fig. 1) was carried out using the MatLab software under different levels of irradiation and temperature for operation over the sun. So, the interest was to analyze how the structure worked under varying weather conditions. hus, Fig. 4 shows that the irradiance varies in levels, i.e. four (4) stages (600W / m^2, 1000W / m^2 (standard irradiance), 800W / m^2 and finally 400W / m^2) corresponding to the different time intervals as shown. Fig. 4a. However, for the same simulation time (0.8s) the temperature undergoes the values (25 °C, 35 °C then returns to 25 ° C) where T = 25 °C is the standard value of the temperature. However, under these conditions of irradiation and temperature in Fig. 5 presents the photovoltaic power (Fig.5a), the active (Fig.5b) and reactive (Fig.5c) of the electrical network and finally the power absorbed by the load (Fig.5d). Under these conditions, one distinguishes, mainly, three (3) intervals relating to the combinations between the instantaneous levels of irradiation and the temperature, thus the photovoltaic installation produces for each interval, the instantaneous powers reach 21.5Kw under standard conditions. . However, the load absorbs around 8Kw. This validates the simultaneity or alternation of operation of the two sources (main and auxiliary) to satisfy the instantaneous power required by the load.

5. CONCLUSION

The chapter proposes a structure for supplying a load through operation between a photovoltaic system and the electricity grid, depending on the levels of irradiation and temperature. The use of such a structure has shown great promise for a water pumping application in geometrically remote locations. Indeed, the qZ source used as interface under the photovoltaic source and load is alternative for renewable energy source applications. The adaptation of the power required by the load and ensured by using a Z Source network. The simulation results are provided to verify the efficiency of the proposed structure.

NOMENCLATURE

k	:	Boltzmann's constant
q	:	charge of an electron
T	:	cell temperature
V_{pv}	:	PV module voltage (V)
I_{pv}	:	PV module current (A)
I_o	:	diode reverse saturation current (A)
I_{ph}	:	light current (A)
Qd	:	ideality factor
R_p	:	shunt resistance (Ω)
R_s	:	series resistance (Ω)
ns	:	number of cells in series
vt	:	vt =kT/q is thermal voltage (V)

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