Photovoltaic generator connected to the electric grid: Comparative study of data from the sites of Rabat and Meknes (Morocco)

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Abstract

In this paper, a photovoltaic generator connected to an electric grid is considered. A comparative study between results obtained from two different PV plants (Meknès and Rabat sites), during specific days of April 2016, has been conducted. The influence of cells temperature on the electric power injected into the electric grid is highlighted. Cells temperature of Meknès site PV plant is generally higher than that of Rabat along the period of solar illumination. Thus during the month of April 2016, the electric power injected by the photovoltaic cell plant of Rabat site (361.46 kWh) is higher than that of Meknes site (341.30 kWh).

Keywords: *Photovoltaic panels, Electric grid, Solar illumination, Electrical power.*

1. Introduction

Photovoltaic (PV) system is one of the most interesting technologies for the use of solar energy. This is the conversion of light into electricity by using semiconducting materials. This makes it possible to obtain electricity directly and autonomously. The countries with high level of sunshine could fulfill a significant part of their electric energy needs. The geographical location of Morocco allows it to be among the main beneficiary countries in this field [1, 2].

Generally, the performance of the PV systems depends on meteorological conditions (solar radiation and wind speed) and hence cell temperature [3] which could have a considerable influence on the produced electrical power by the photovoltaic module. To keep a good performance level of this system, it is necessary to maintain a low cell's temperature by the use of cooling system [3-5].

The main objective of this paper is to compare solar radiation, cell's temperature and power injected in the electric grid for both Moroccan sites: Rabat (34°00'47'' North, 6°49'57'' West, Height above sea level: 46 m) and Meknès (33°56'53'' North, 5°32'50'' West, Height above sea level: 531m). To reach this objective, the experimental data used here was obtained from the EMER laboratory (Faculty of Sciences, Meknès) and the RTEE laboratory (ENSET, Rabat).

2. Description of the photovoltaic plant

Figure 1 shows the photovoltaic plant localized at the RMRE laboratory (Faculty of sciences, Meknès). It consists of eight PV panels (Figure 1: (1)) facing true south with a fixed tilt angle of 30°. The Sunny Sensor Box is installed onto the PV plant (Figure 1: (2)) to measure the solar radiation and cell's temperature. It gives possibility for measuring wind speed and ambient temperature too. The solar energy is converted into direct current electricity by the PV modules and then into alternating current for the grid via the photovoltaic inverter connected to the panel (Figure 1: (3)). Moreover, the power injector has the function of injecting the produced electricity power (Figure 1: (4)) into the electric grid. In combination with Sunny Webbox (Figure 1: (5)) and any PC, it is possible to collect and to store continuous meteorological and power production data. The Web browser allows us to view, analyze and download all measurements data as well as modify the installation parameters.

Note that the same photovoltaic plant was installed at RTEE laboratory (ENSET, Rabat). So, a comparative study could be carried out.

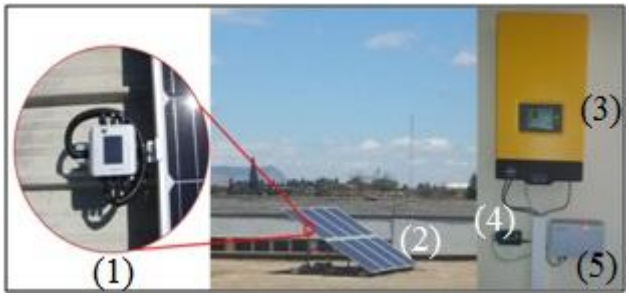


Figure 1: Photo of the photovoltaic plant localized at RMRE laboratory (Faculty of sciences, Meknès).

(1) : Sunny SensorBox. (2) : Photovoltaic panels.
(3) : The photovoltaic inverter. (4) : Power Injector.
(5) : SunnyWebbox.

3. Results and discussion: Comparative study

In this section, solar illumination, daily electric energy injected into electric grid, and cell's temperature are presented. Comparisons of results measured in RMRE (Meknès) and LM2PI (Rabat) laboratories are carried out.

3.1 Daily solar illumination

Figures 2 and 3 show the intensity of the solar illumination during two different days of April (7th and 25th 2016).

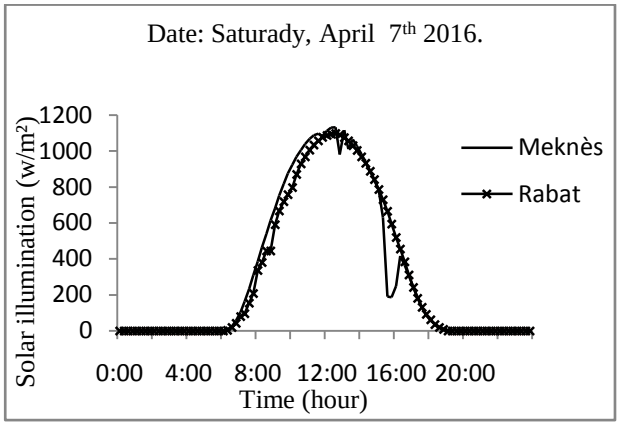


Figure 2: solar illumination measured on Meknès and Rabat sites during the specific day (April 7th 2016).

With the exception of cloudy days, the solar illumination intensity of Meknès site is slightly greater than that of site of Rabat.

3.2 Injected power into electric grid

For the month of April, the injected power into electric grid of the two sites (Rabat and Meknes) is illustrated in the following figure (Figure 4).

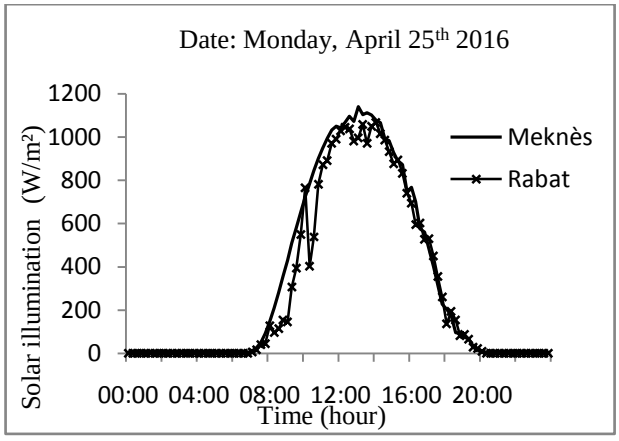


Figure 3: solar illumination measured on Meknès and Rabat sites during the specific day (April 25th 2016).

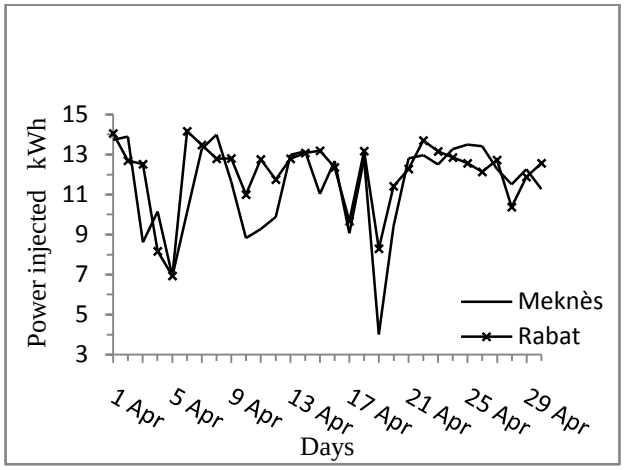


Figure 4: The injected power into electric grid during the month of April.

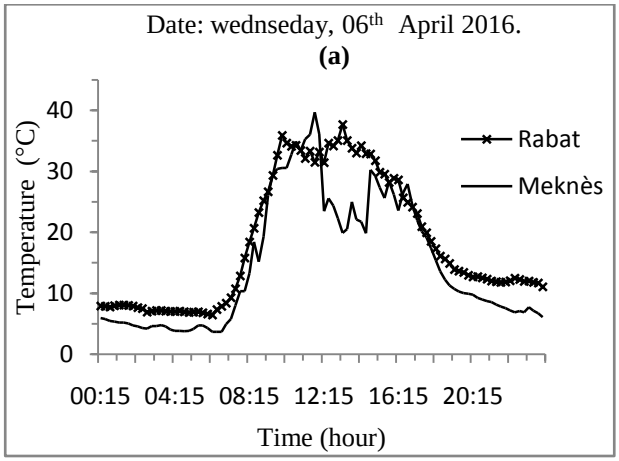
Figure 4 exhibits clearly that, during the month of April 2016, the PV power send into grid has fluctuated because of the cloudy days. In this month, the power injected by the photovoltaic cell plant of Rabat site (361.46 kWh) is higher than that of Meknes site (341.30 kWh), despite the fact that the solar illumination of the Meknes site is more important than that received by the PV panels of the Rabat site. This is essentially due to the increasing of cells temperature (see Figures 5a-c).

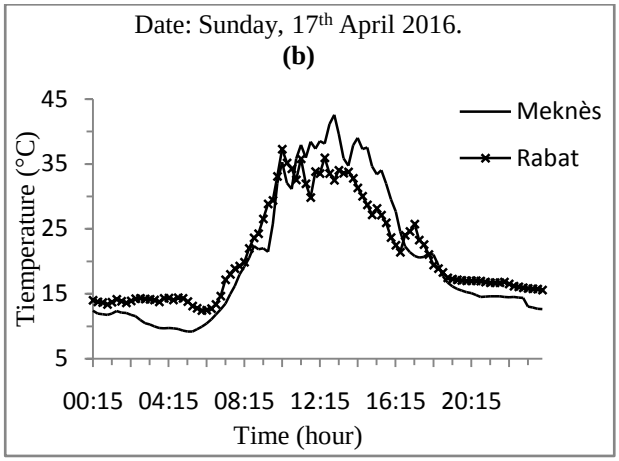
3.3 Daily cells temperature

For the two considered sites, Figures 5a to 5c show the variation of cells temperature during three chosen days of April.

From these results, it is clear that cells temperature of Meknès site is generally higher than that of Rabat along the period of solar illumination, especially from 10 am to the sunset, where an important temperature difference is observed. This temperature discrepancy has an influence on the power injected into the electric grid. In fact; the increasing of cells temperature reduces the efficiency of

PV plant [3] and hence the electric power produced by the panels. This is the explanation of the results presented in the figure 4.





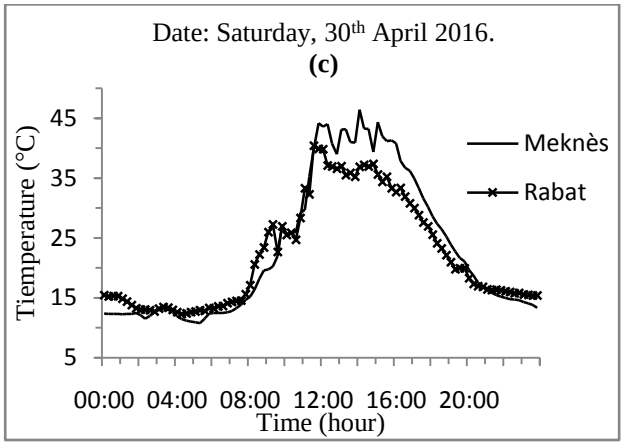


Figure 5a-c: cells temperature variation of Meknès and Rabat sites.

From these results, it is clear that cells temperature of Meknès site is generally higher than that of Rabat along the period of solar illumination, especially from 10 am to the sunset, where an important temperature difference is observed. This temperature discrepancy has an influence on the power injected into the electric grid. In fact; the increasing of cells temperature reduces the efficiency of PV plant [3] and hence the electric power produced by the panels. This is the explanation of the results presented in the figure 4.

To improve the efficiency of the photovoltaic plant of the considered sites (Rabat and Meknès), the PV/T system could be used [3].

4. Conclusion

A photovoltaic generator connected to an electric grid is considered to compare the results obtained from two different Moroccan PV plants (Meknès and Rabat sites). Thus, the following conclusions were drawn:

i) during the month of April 2016, the electric power injected by the photovoltaic cell plant of Rabat site (361.46 kWh) is higher than that of Meknes site (341.30 kWh);

ii) cells temperature of Meknès site is generally higher than that of Rabat along the period of solar illumination.

iii) the increasing of cells temperature reduces the efficiency of PV plant.

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