Monitoring of a Photovoltaic Field with Electrochemical Storage

LAOUFI Amina Maria[1, *], *KHELFAOUI Rachid*[2], DEENNAI Benmoussa[3]

[1] Electrical engineeringdepartment, Smart Grids & Renewable Energies Laboratory. Béchar (08000), Algeria.
[2]ENERGARID Laboratory, P.O.B 417 Route de Kenadza, Bechar (08000) Algeria.
[3]Renewable Energy Development and their Application in the Sahran Areas Laboratorty, Bechar, Algeria.

* Corresponding Author:*amina.maria49@gmail.com*

Article Info

Article history:

Received 12 March, 2020
Revised 13 April, 2020
Accepted 03 June, 2020

Keywords:

Batteries.
Electrochemical storage.
Photovoltaic solar energy.
Solar kit.
Solar panel.

ABSTRACT

Energy is necessary for development whether social, economic or even military. The production of energy by photovoltaic systems is very variable that depends enormously on the climatic conditions. That is why it will be necessary to think to store this energy to reuse it during night and days "without sun". Adding the storage element that makes it easier to use later. In this work, an experimental study on the test and the monitoring of the photovoltaic field will be presented with a storage system in the Sahara in the south of Algeria, namely electrochemical storage using storage batteries.

I. Introduction

The imperative role of electricity is defined by its socioeconomic impacts, especially in Western Europe and China (due to its ongoing developmental growth forecasted). Indeed, the activities involved in the energy sector increase the employment and reinforce the social cohesion of all citizens. Besides, the activities involved in the energy sector foster the collective actions of citizen’s initiatives and governmental policies towards environmental sustainability, materials exploitation, issues on land use – such as degradation and desertification of soils – legislatively protected ecosystems, terrestrial carbon sequestration, climate change mitigation, and low-cost mass production techniques [1]. Electrification of remote and rural isolated areas with the national grid is not always possible, being cost-prohibitive. Therefore, many off-the-grid communities have been using diesel engines as their main power source [2]. In the last decade, the incentivisation of renewable source generation systems has received significant appreciation [3].

The ongoing research in the field of renewable energy and solar private development showed that solar energy is a good choice because it is produced by the sun. Although it is a permanent source, it may be absent in some cases, but we need all the day to solve this problem, it is recommended to think of finding a way to store the energy released by the sun. [5]

Fillali Mustafa et al [6], present a simulation by using the Atlas-Silvaco to show the role of doping the lower window layer on the performances of tandem CS in InGaP / GaAs with a tunnel heterojunction. The results show that the conversion efficiency obtained for the tandem slar sell without the window layer of the lower cell is around 22.1823%. And for the same cell and with a window layer the yield amounts to 24.2343%. The conversion efficiency reaches its maximum value stabilizes from the value of $8x10^{18}$ cm^{-3}.

Energy storage is deemed as one of the solutions for stabilizing the supply of electricity to avert uneconomical power production and high prices in peak times [4]. Over the past few decades, differences in supply and demand in electricity grids have already had to be matched. To store the excess capacity at night and ensure availability during high consumption hours, energy has been stored in the gravitational potential using hydropower plants for many decades [5]. Previous studies in this field confirmed that electrochemical storage will be a very important part of energy systemsfuture. There are several energy storage technologies that are based on batteries. In general, electrochemical energy storage possesses a number of desirable features, including pollution-free operation, high foth and back efficiency, flexible power and energy characteristics to meet different grid functions, long cycle life, and low maintenance. Batteries represent an excellent energy storage technology for the integration of renewable resources [6].

The storage of photovoltaic solar energy is ensured by electrochemical batteries. This is a subject that occupies thoughts in industrialized societies. Energy needs are constantly increasing because the production of renewable energy represents a challenge of great importance for years to come.

In this work, we had an experimental study for monitoring of the photovoltaic field with a battery storage system in Bechar; So we installed the solar panel TE 1500 photovoltaic panel from Total Energie type polycrystalline ʿSi ʾin the terrace of the laboratory, and The battery is EROSKI type and it is an automatic car battery. all this is connected to the charge regulator ’steca’ as shown in figure 1 and also by a thermocouple to monitor the effect of the charging and self-discharging process on the temperature of the solution inside the battery.

Table 1 shows the parameters of the photovoltaic panel, the battery and the regulator.

Table 1. Parameters of components of the system

Parameters	Values
PV panels voltage	33.8V
PV current panels	4.4A
PV panels power	150W
PV efficiency	11.1%
Battery voltage	12V
Battery capacity	65Ah
Regulator voltage	12/24V
Regulator current	10A

The remaining part of the paper is arranged as follows: Section 2 discusses the protocol experimentale; Section 3 results and discussion while Section 4 concludes the paper

II. Protocol Experimentale

We presented a description of the experimental setup for each experiment and the photovoltaic modules used. It includes a solar kit installed at the University of Bechar. The photovoltaic panel is installed on a 10-meter-high roof facing south. It is connected by cables on the ground floor, and it is characterized by an electronic load.

II.1. Characteristic I (V) and P (V)

In our experience we used:

- TE 1500 photovoltaic panel from Total Energie type polycrystalline Si.
- Two (02) rheostats,
- (02) two multimeters: one to measure the voltage and the other to measure the current.

We installed the module on the 10-meter-high terrace of the south-facing research laboratory. We brought the wires down to the laboratory which is on the ground floor. First you have to test the whole solar kit which has not worked for a long time. Based on the geographical location of BECHAR, the ideal angle of inclination is 31.6 °.

II.2. Characteristic charge and battery self-discharge

The TE1500 panel is used for charging and self-discharging with a battery and charge regulator to regulate all that and for monitor the effect of the charging and self-discharging process on the temperature of the solution inside the battery we put a thermocouple inside it.

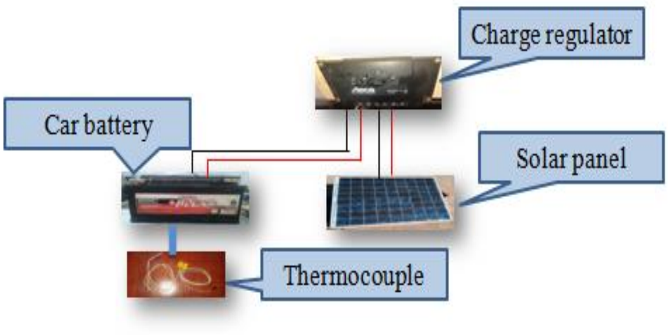


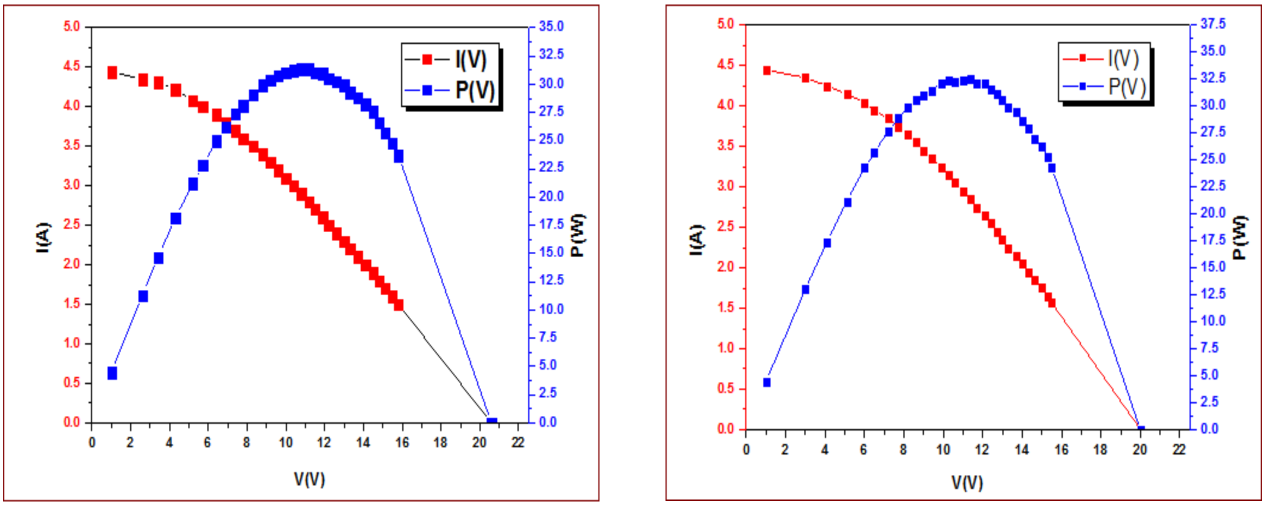
Figure 1. The battery charge and self-discharge characteristic test bench.

III. Results and discussions

III.1. Characteristic I (V) and P (V)

Figure 2 shows the different characteristics of several days at different wind speed, radiation and temperature; but as we have seen there, it is an error in our graph which is in the short current circuit that the voltage is not zero.

The maximum power for February 11 and 12, 2018 is 31.36W and 32.49W respectively. The ambient temperature for these two days is 11.2 ° C and 14.2 ° C. (Namely that these characteristics are not precise, the means do not allow such precision).



11/02/2018 at 11:30 AM; Ws= 3.4m /s
R= 733w / m²;T= 11.2 ° C.

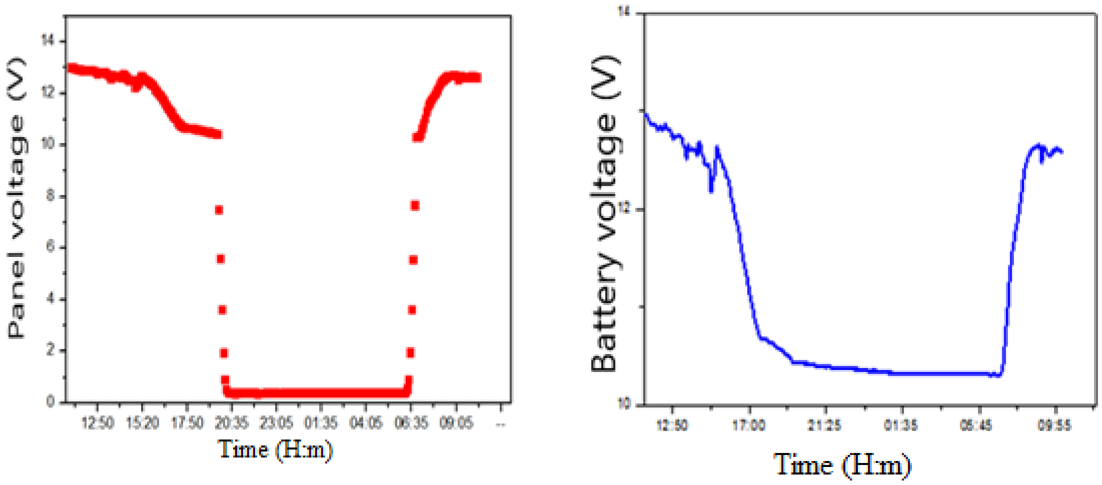
12/02/2018 at 11:30 W_S=3.1m/s
R=731w/m² T=14.2°C.

Figure 2. Characteristic I(V) and P(V).

III.2. Characteristic charge and battery self-discharge

Figure 3 presents (a) the evolution of the panel voltage and (b) the evolution of the battery voltage respectively as a function of time approximately 24 hours. The maximum voltage of the panel and the battery during charging is estimated at 13.38V and 13.28 V and the minimum voltage during self-discharge of battery is 10.29 V. The unusual decrease in the battery voltage in self-discharge, which is estimated at 3 volts, it is due to several reasons: the battery is for cars, it is not a solar battery. Also, the battery was used befor and it's not new.

As we see the voltage of the battery and the panel are almost exactly identical, this means that the regulators are doing well. And about the panel voltage during the night is 0.45 V, this is mainly due to the quality of the panel. A slight return from storage can give rise to this phenomenon.



(a) the evolution of the panel voltage (b) the evolution of the battery voltage

Figure 3. The evolution of the panel voltage and the battery voltage as a fuction of time.

Figure 4 shows the evolution of the battery temperature and voltage as a function of time for 24 hours. The maximum battery temperature during charging is 42.9 ° C and the minimum temperature during self-discharge is 13.8 ° C. We find that the temperature is directly influenced by the battery voltage. When the battery is charged, the voltage augments so the temperature has risen. And when it was self-discharging we observed that there was a decrease around 2V and the temperature decreased a lot to13 ° C from 43°C when it was charging.

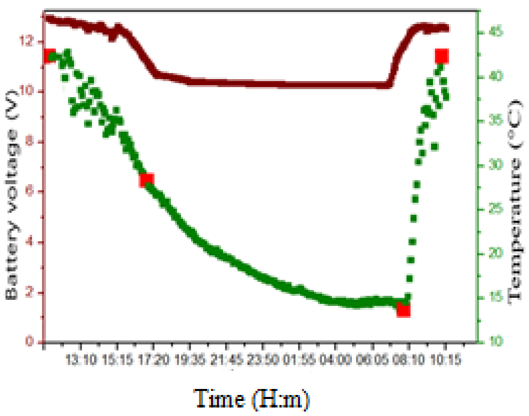


Figure 4.The evolution of the battery temperature and voltage as a function of time.

IV. Conclusion

The battery voltage is affected by many factors, the temperature ambient, pressure, vibrations, or movement of the battery if it is located in a non-fixed location. In this paper, we monitored a photovoltaic field with electrochemical storage and we find that the temperature is directly influenced by the battery voltage. As the battery voltage decreased, the temperature decreased. During the voltage increase, the battery temperature increased. The characteristics of charge and self-discharge of a battery that we made at the University Tahri Mohammed of Béchar did not give the desired results giving the absence of the means for monitoring the experience of the discharge. We were satisfied with the results of the battery self-discharge. In the upcoming studies, we hope to be able to monitor the current battery and ambient temperature, battery capacity.

References

[1] G. L. Kyriakopoulos and G. Arabatzis, “Electrical energy storage systems in electricity generation: Energy policies, innovative technologies, and regulatory regimes,” Renew. Sustain. Energy Rev., vol. 56, pp. 1044–1067, 2016, doi: 10.1016/j.rser.2015.12.046.

[2] E. Banguero, A. Correcher, Á. Pérez-Navarro, F. Morant, and A. Aristizabal, “A review on battery charging and discharging control strategies: Application to renewable energy systems,” Energies, vol. 11, no. 4, pp. 1–15, 2018, doi: 10.3390/en11041021.

[3] A. A. Bayod-Rújula, A. Burgio, Z. Leonowicz, D. Menniti, A. Pinnarelli, and N. Sorrentino, “Recent Developments of Photovoltaics Integrated with Battery Storage Systems and Related Feed-In Tariff Policies: A Review,” Int. J. Photoenergy, vol. 2017, 2017, doi: 10.1155/2017/8256139.

[4] B. Zakeri and S. Syri, “Electrical energy storage systems: A comparative life cycle cost analysis,” Renew. Sustain. Energy Rev., vol. 42, pp. 569–596, 2015, doi: 10.1016/j.rser.2014.10.011.

[5] Benatiallah D, Bouchouicha K, Benatiallah A, Harrouz A, Nasri B. Forecasting of Solar Radiation using an Empirical Model. Algerian Journal of Renewable Energy and Sustainable Development, 2019, 1(2),212-219. https://doi.org/10.46657/ajresd.2019.1.2.11.

[6] Fillali M, Dennai B, Gani A. Contribution of the Doping of the Lower Window Layer to Improve the Performances of the Tandem Solar Cell. Algerian Journal of Renewable Energy and Sustainable Development, 2019, 1(2),136-143. https://doi.org/10.46657/ajresd.2019.1.2.3.

[6] S. C. Mueller, P. G. Sandner, and I. M. Welpe, “Monitoring innovation in electrochemical energy storage technologies: A patent-based approach,” Appl. Energy, vol. 137, pp. 537–544, 2015, doi: 10.1016/j.apenergy.2014.06.082.

[7] B. Dunn, H. Kamath, and J. M. Tarascon, “Electrical energy storage for the grid: A battery of choices,” Science (80-.)., vol. 334, no. 6058, pp. 928–935, 2011, doi: 10.1126/science.1212741.

How to cite this paper:

Laoufi A.M, Khelfaoui R, Deennai B. Monitoring of a Photovoltaic Field with Electrochemical Storage. Algerian Journal of Renewable Energy and Sustainable Development, 2020, 2(1),51-55. https://doi.org/10.46657/ajresd.2020.2.1.7