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RESEARCH ARTICLE

INFLUENCE OF METEOROLOGICAL PARAMETERS ON THE PERFORMANCE OF SOLAR PANELS IN THE URBAN COMMUNE OF NZÉRÉKORÉ, GUINEA

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ABSTRACT

Renewable energy use is still a viable option for people when it comes to protecting the environment and promoting sustainable development. This is the reason why some people in the commune of N'Zérékoré have opted for the use of solar panels as sources of energy. Although the use of these solar panels is considered an alternative solution to energy problems, it is clear that the performance of these solar panels after installation is negatively influenced by meteorological parameters such as temperature, humidity and precipitation. This Paper aims to highlight the dependence of meteorological parameters on the performance of solar panels in the urban commune of N'Zérékoré to allow users to make an optimal choice of solar panels on the market. To achieve this objective, a questionnaire survey was first carried out to identify the types of panels sold in the urban commune of N'Zérékoré. Then a method for evaluating the Variation in solar Panel performance by Standardization (EVRPS) was carried out. The results of the surveys showed the presence of 18 types of solar panels in specialized shops. The same trend was observed among users in the 16-neighborhood visited. Among the 18 types, 3 (Ulica mono, Felicity solar and Bosch solar) were respectively dominant in neighbourhoods and shops. Furthermore, we found 90 installations identified in households, 53 of which were functional (59%) and 37 non-functional (41%). Analysis of the results reveals that the performance and productivity of each type of panel strongly depended on temperature, humidity and precipitation. It has been proven that Ulica mono and Felicity solar types were the solar panels suitable to the forest region weather conditions. Therefore, this study suggests the sale and use of Ulica mono and Félicity solar" panels for the inhabitants of the urban commune of Nzérékoré.

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INTRODUCTION

Over the past two decades, there has been a steady increase in the installed capacity of solar photovoltaic (PV) plants across the world. P Photovoltaic installations must operate at their maximum design capacities to ensure a constant and reliable power supply throughout the life of the installation (Hadouch and Hammelna, 2022). Today, the rapid development of industry leads us to be more and more dependent on energy (World Energy Council 2019). The importance of energy in the development of human beings cannot be denied. Even some experts have used energy consumption to assess economic development (Rafindadi and Ozturk, 2015; Rafindadi and Ozturk, 2016; Rafindadi and Ozturk, 2017; Rafindadi and Mika'Ilu, 2019). However, traditional energy sources such as coal and oil are limited and pose a serious threat to living organisms and the environment (Mostefaoui 2015, Kébé 2014). One of the most promising alternatives for solving these environmental problems remains solar energy which, unlike other energy sources, is abundant and clean. On the other hand, it provides the earth with energy greater than global consumption (Ahmar, 2010, Skoczek *et al*., 2008). Solar energy is available in abundance and is a sustainable, clean and promising energy source for electricity generation. Many researchers believe that solar energy will replace fossil fuels in a very short time thanks to a non-polluting and maintenance-free resource that is easy to implement in many applications (Shukla *et al*., 2016a., Mohamed Asim *et al*., 2022). However, the efficiency of solar energy is highly dependent on meteorological parameters such as solar radiation, wind speed, air humidity and temperature (Tahir *et al*., 2020). Khatib *et al*. (2013). Kébé (2014), notes that the research and development of solar panels focuses only on the analysis of radiation, operating strategies, design and sizing of these systems, forgetting certain critical aspects such as external conditions which directly affect the operation of these solar panels. Also, Dorothée (2010), and Benatillah *et al*, (2016), mention that manufacturers do not take into account the environmental conditions in which photovoltaic modules must operate (temperature, humidity, ultraviolet (UV) irradiation, dust, etc.). Saada *et al*., (2015), emphasize that the study of these external parameters (notably meteorological) is very important and cannot be neglected in the behaviour of solar cells. Pingel S. *et al* (2010) studied the potential induced degradation of solar cells and panels. A. Bouraiou *et al*, (2015) assessed the impact of climatic conditions on the performance of photovoltaic modules in a desert environment. In the same context, A. Bouraiou *et al*, (2017) carried out the experimental evaluation of the performance and degradation of monocrystalline silicon photovoltaic modules in the Saharan environment. Specifically for the Nzérékoré region, climatic conditions are dominated by a long duration of precipitation and humidity. These conditions mean that users often experience a change in the performance of their solar panels after installation. Determining the influence of these different external conditions must necessarily involve knowledge of the influence of each parameter on the voltage and intensity (V-I) characteristic of solar panels (Abbassen L, 2011, Assia *et al*, 2015). This article aims to determine the dependence of the performance of solar panels on certain meteorological parameters of the urban commune of Nzérékoré to allow users to choose panels which best adapt to the meteorological conditions of the region.

Temperatures are high with small amplitude variations (annual variations between 15 and 32°C). The lowest maximums are observed during the rainy season. The harmattan has no great influence. Relative humidity is always high with an average maximum of 970/0 (at night). Monthly participation averages are observed in August. The dry season lasts 3 months (December, January, and February). The Götö, Hononyé and Kolyé mountains in alteration with the surrounding vegetation and the other hills give the urban commune a humid climate with a rainy season of 9 months. This rainy season ends around September and October with a strong tornado dragging down the Tilé River. Figure 1 shows the map of the urban commune of N'Zérékoré.

METHODS

The first work consists of a sampling of shops specializing in the sale of solar panels. Then, a sample of neighbourhoods was chosen. In total, 1 market (large city market) and 16 neighbourhoods (see Table below) were selected. The investigations took place over six months (from March to August 2020) in the large market and the neighborhoods of Nakoyapkala, Gbanghana, Mohomou, Commercial, Gonia, Dorota, Tilepoulou, Belle-vue, Angola, kwitèyapoulou, Horoya, Gboyéba, Sokoura, Niaye, Koléyéba and Wéssoua (view Fig. 2).

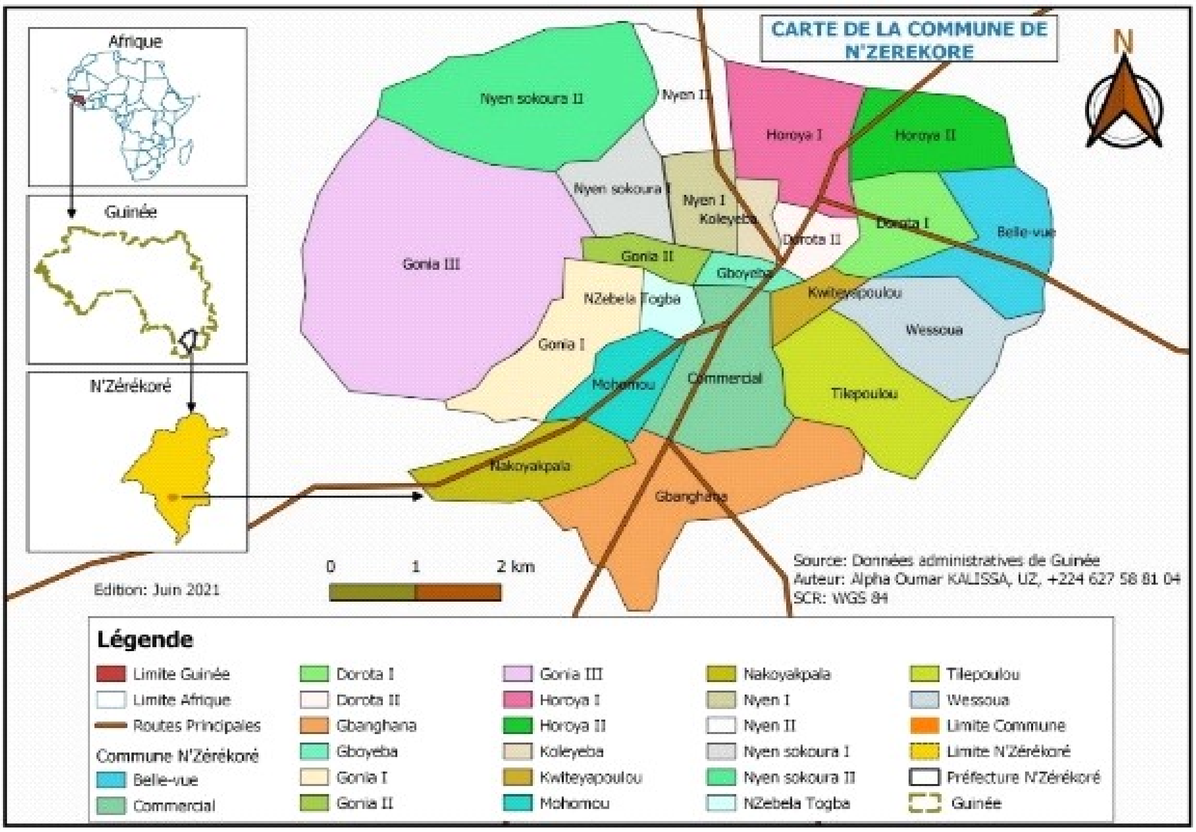

Figure 1. The map of the urban commune of N'Zérékoré

Table 1. The sites studied

Sites studied	Effective
Markets	1
Neighborhoods.	16
Total	17

MATERIALS AND METHODS

MATERIALS

Some Climatographic Situation of the Nzerekore City: The climate of the city of N'Zérékoré is sub-equatorial at altitude.

After choosing study sites, we have proceeded to the choice of shops and households that use the solar panels as a source of energy. A total of 6 shops and 90 installations were visited (Table 2).

Identification of types of solar panels based on their parameters: After investigating chosen shops and households, we identified 13 types of solar panels, three qualities of which were chosen as observation targets.

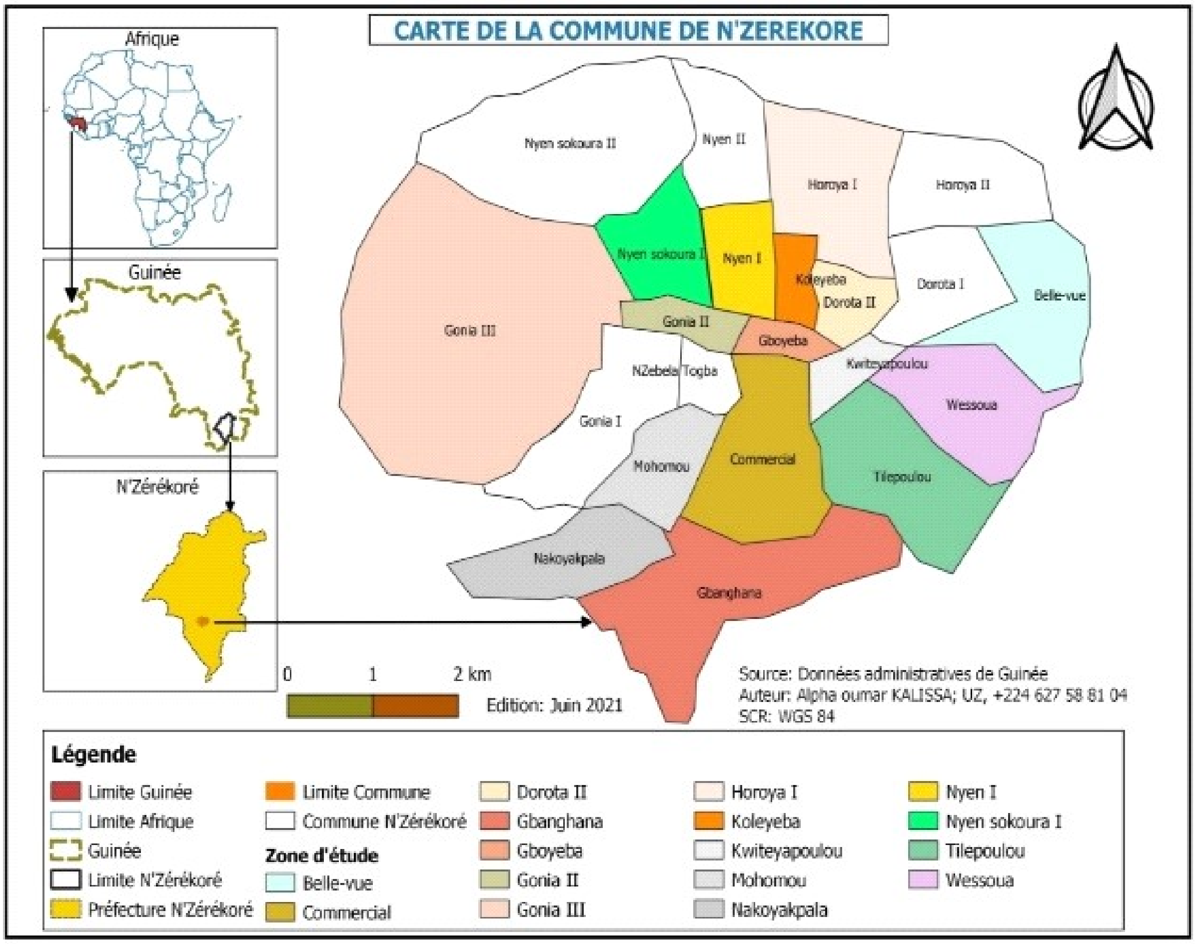

Figure 2. Map of the urban commune of N'Zérékoré

Table 2. Characteristics of the samples investigated

Designation	Effective
Shops	6
Installations	90
Total	96

Table 2. Summary of the types of solar panels encountered in Nzérékoré City

Manufacturer	Technology	Vmax (V)	Vco (V)	Imax (A)	ICC (A)	T°C
Bosch Solar	c-SiM	36,80	36,80	8,45	7,76	15-25
Félicity Solar	Mono Cri	36,72	30,60	9,01	8,50	25
Jarrette Pundru	Mono	37,5	30,0	8,11	8,6	-40+85
Soso PV	C-Si	36,1	30,5	8,73	8,56	+28-85
Ulica	Mono	37,6	30,5	8,70	8,20	5-25
First Solar	Poly-C	30,4	28,3	7,5	7,2	25
Unisolar	A-Si	33,4	47,2	5,45	5,80	25
Frontier Solar	C-Si	31,2	30,1	6,3	6,22	25
Electrical Solar	c-SiM	37,4	38,2	8,78	8,90	25
Germany Solar	Poly-c	34,8	30,24	6,12	6,32	25
HZ Solar	Poly-c	33,6	43,7	5,8	4,70	25
Blue Océan	Mono	36,15	29,4	8,2	5,40	25
Holding Solar	C-Si	32,8	41,5	7,45	7,22	25

These are Ulica mono, Felicity Solar and Bosch Solar. Table 3 shows the 13 types of solar panels and their technical characteristics.

Analyze of meteorological parameters that influence the performance of solar panels: In the opinion of all the users, the changes recorded in the performance and energy production of each type of solar panel vary depending on meteorological parameters such as temperature, humidity and precipitation. To evaluate the influence of these meteorological parameters on the performance, we first define the expression of the performance.

Performance is the ratio between the maximum power and the power at the input of the solar cell.

$$\eta = \frac{P_{\max}}{P_{in}} = \frac{V_{opt}.I_{opt}}{A_{pv}.G}$$

Where:

G: irradiation which represents the light power received per unit of surface (W/m^2)

Apv: Effective cell surface area;

V_{opt} : the optimal tension;
I_{opt}: the optimal current.

For the measurement of voltage and current (V-I), standard test conditions (STC) were carried out. The standard test conditions are characterized by: Irradiance (1000W/m^2); module temperature (25°C); under sun exposure (external measurement). However, precise temperature control and light uniformity remain very difficult to achieve in this case (King et al., 1997). Nevertheless, performing tests under STC conditions is the best way to compare different types of modules under the same conditions (Rosella et al., 2006). This is the reason why we used this technique to analyze the influence of meteorological parameters on the performance of photovoltaic modules in the study area.

RESULTS AND INTERPRETATION

In terms of the main results, we will first show the figures for the frequency of each type of solar panel in the shops and the neighbourhoods studied.

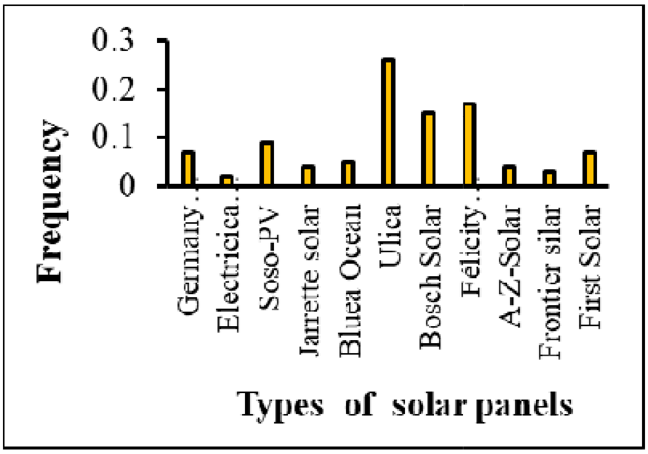

Figure 3. Frequency of types of solar panels marketed in the large market

As shown in the Figure 3 above, Ulica mono type of panels dominate the 6 shops specializing in the sale of solar panels in the large market of Nzérékoré city. Then, Félicity solar and Bosch solar type panels are respectively dominant in each of these shops.

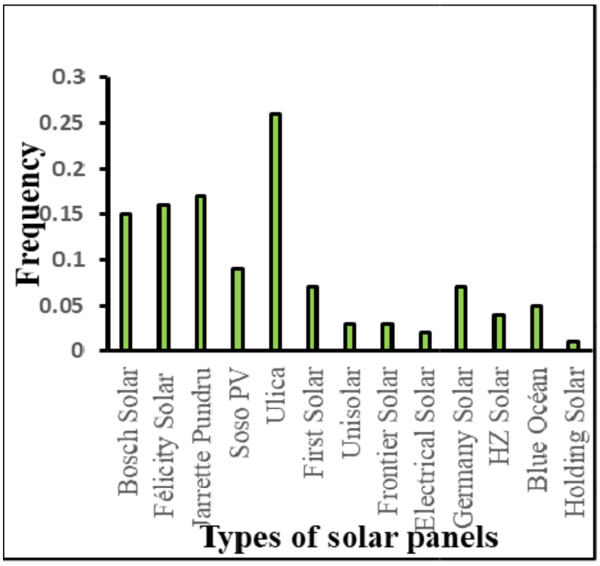

Figure 4. Frequency of type of solar panels recorded in neighbourhoods

As in Figure 3, Figure 4 shows the Ulica mono type is frequently used by the local populations. It is followed respectively by Félicity Solar and Bosch Solar. Among the 90 installations identified in households, 53 are functional (59%) and 37 are non-functional, therefore damaged (41%). Table 3 specifies the effectiveness of these installations.

Table 3. Effective of the investigated installations

Households	Effective	Percentage (%)\
Functional	53	59
Non-functional	37	41
Total	90	100

Influence of meteorological parameters on the performance of solar panels: As the investigations took place in 2020. We will first present the detailed evolution of precipitation, humidity and temperature for the year 2020.

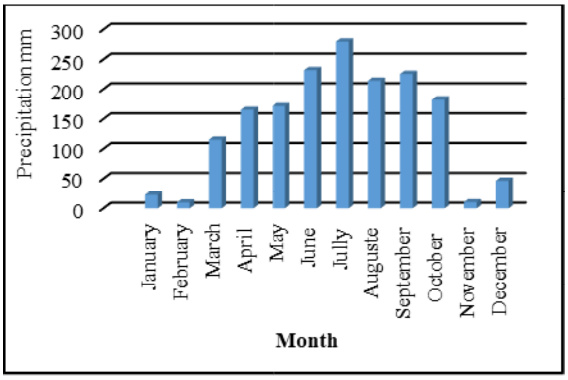

Figure 5. Variation of the precipitation for the year 2020

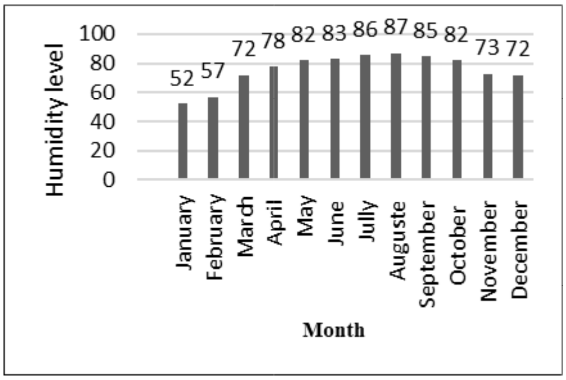

Figure 6: Variation in relative humidity for the year 2020

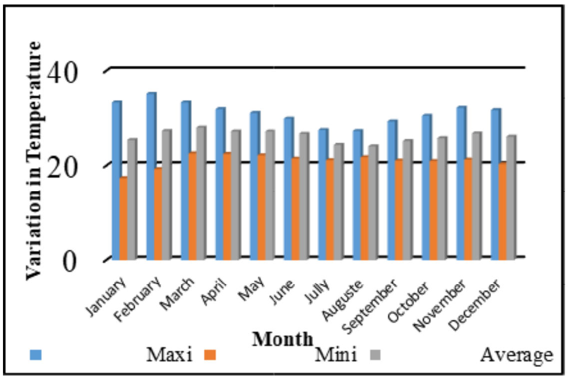

Figure 7. Variation of the temperature for the year 2020

After showing the evolution of the meteorological parameters in the year 2020 in the urban commune of Nzérékoré, the distribution of each type of solar panels in the shops and the neighbourhoods studied, in this subsection, we present the results of the influence of meteorological parameters such as temperature, precipitation and humidity on the performance of solar panels in the urban commune of N'zérékoré. As mentioned above the solar panel parameters influenced are: voltage, intensity and power. Figure 8 shows the influence of the temperature on the voltage, intensity and power.

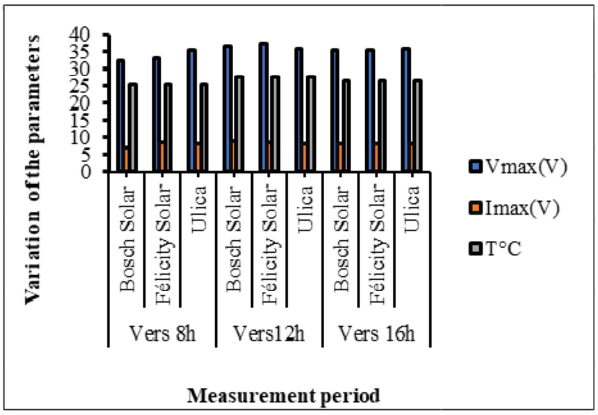

Figure 8: Influence of temperature on solar panel performance

It appears from this figure that the temperature has a different influence on the performance of each type of panel studied. This variation is explained by the fact that the electrical characteristics of these three types of panels are not identical. Indeed, the increase in temperature leads to an increase in voltage (Vmax) accompanied by a slight increase in current (Imax). Another aspect which explains the variation in this temperature lies in the fact that the measurement periods of these panels are different. Figure 9 illustrates the influence of humidity on the voltage, intensity and power. It reveals that the relative humidity under which the three types of panels operate is determined based on data from climatic parameters. Thus, during the measurement of each type of panel, the humidity considered in our grid varies from 73 to 96% (Figure 9).

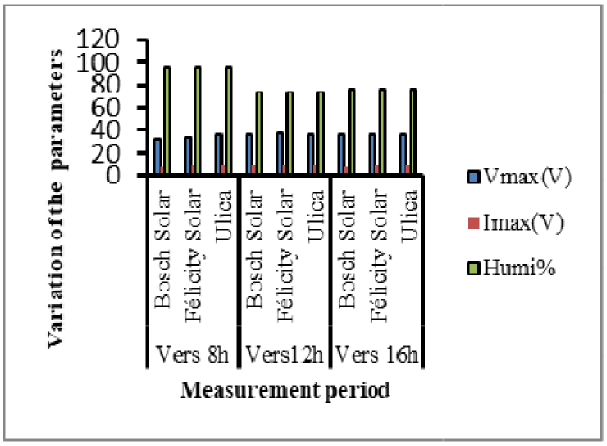

Figure 9: Influence of the humidity on the performance of solar panels

Figure 9 shows that the parameters of each type of solar panel studied change depending on the variation of the humidity of the environment where these panels are installed. This is explained by the fact that, if the humidity increases around 8 o'clock, the maximum voltage decreases. Conversely, when the maximum voltage decreases, the maximum current is reduced. If the humidity decreases around noon, the maximum voltage increases. The results further clarify that this variation highly depends on the performance of each type of solar panel tested. Indeed, during the three test periods, we observed that the "Ulica Mono" type maintained its performance compared to the other two.

Figure 10 shows the influence of precipitation on the voltage, intensity and power parameters. In the urban commune of N'zérékoré, the rainfall indicates the distribution of precipitation over time. So this precipitation is often in a liquid state (rain in particular). They are expressed in millimeters (mm). In fact, for the three types of solar panels tested, the performance is not constant depending on the precipitation.

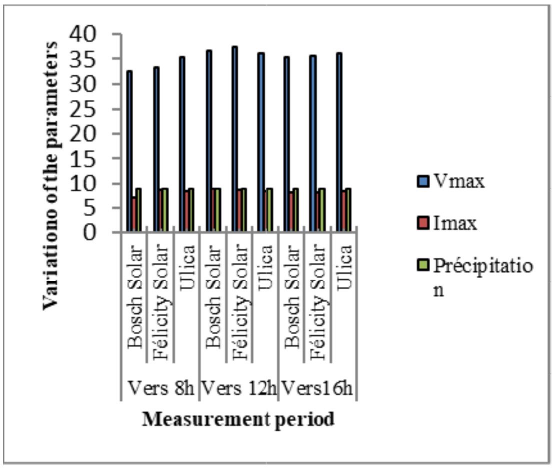

Figure 10. Influence of the precipitation on the performance of solar panels

It appears in figure 10 that during rain, there is a significant reduction in productivity and performance of each type of panel tested. This reduction is explained by the fact that the tests were carried out during periods when the quantity of rain is not identical. Also, during periods of heavy fog or clouds, the same negative variations in current production are observed. The same indicates that the drop in current production is observed when the light intensity of the solar panel decreases (maximum voltage). Conversely, when the maximum solar panel voltage decreases, the maximum current is also reduced. This variation highly depends on the performance of each type of solar panel tested. Indeed, during the three test periods, we observed that it is the "Ulica Mono" type which maintains its performance compared to the other two: maximum voltage (35.4V around 8 o'clock, 36.1V around 12 o'clock and 36.1V around 4 p.m., against (32.6V around 8 o'clock, 36.62V around 12 o'clock and 35.4V around 4 p.m.) for the Bosh solar-type. It should be noted that this modification of the performance of each type of solar panel in the sites where they are installed is often neglected by the manufacturers of the different technologies. Also, there is no indication of the behaviour of solar modules depending on precipitation and humidity.

CONCLUSION

This work allowed to identify the types of solar panels used in the urban commune of Nzérékoré. The three most commonly used types were chosen to assess the influence of meteorological parameters on their performance. The results obtained showed that the following meteorological parameters: temperature, precipitation and humidity modify the performance and productivity of each type of solar panel. These parameters affect following the electrical characteristics: current-voltage (I-V) and power-voltage (P-V). The influence of temperature was demonstrated by measuring the temperature of each solar panel module during its operation in real-time. After the measurement, it was found that the temperature varies from 25°C to 28°C for each of the solar panels (figure 8). We found that the increase in the temperature leads to an increase in voltage (Vmax) accompanied by a slight increase of the current intensity (Imax). For the influence of humidity, it was evaluated under a range of 73 to 96% of each solar panel. We found when the humidity increases around 8 o'clock, the maximum voltage decreases. Conversely, when the maximum voltage decreases, the maximum current is reduced. And when the humidity decreases around noon, the maximum voltage increases. As a result, during the three test periods, we observed that the "Ulica Mono" type maintained its performance compared to the other two. Regarding the influence of precipitación, we found for the three types of solar panels tested that the performance is not constant due to the low illumination caused by the abundance of precipitation as shown in Figure 10 in the study area. Depending on the precipitation, there is a significant variation in the performance of each type of panel tested. We observed that it is the "Ulica Mono" type which maintains its performance compared to the other two: maximum voltage (35.4V around 8 o'clock, 36.1V around noon and 36.1V around 4 p.m., against (32.6V around 8 o'clock, 36.62V around noon and 35.4V around 4 p.m) for the Bosh solar-type.

REFERENCES

A. Bouraiou, Hamouda Messaoud, Abdelkader Chaker et Salah Lachtar, Experimental evaluation of the performance and degradation of single crystalline silicon photovoltaic modules in the Saharan environment, proceedings of the ICE – Energy 132, May 2017

Abbassen L. (2011) «Etude de la connexion au réseau électrique d'une centrale photovoltaïque», Mémoire de Magistère, Université de Tizi Ouzou, Algérie.

Ahmar (2010) "Comparaison de différentes méthodes avancées de traitement de signal pour la détection et le diagnostic de défauts dans les machines asynchrones : Application aux éoliennes Thèse de doctorat soutenue en 2010 Université de BOUIRA. Algérie. 38 pages.

Ahmed Bouraiou, Messaoud Hamouda, Abdelkader Chaker, Moham med Mostefaoui, Salah Lachtar, Mohammed Sadok, Nadir Boutas seta, Mourad Othmani, Attoui Issam, Analysis and evaluation of the impact of climatic conditions on the photovoltaic modules performance in the desert environment, Energy Conversion and Management, Volume 106, December 2015, Pages 1345-1355

Assia Z et Rachid C (2015). Etude de l'influence des différents paramètres sur un module photovoltaïque. Université des frères Mentouri de Constantine. Algérie 1566-Texte de l'article-3174-2-10-20190919.

Benabdelkarim B et Benatillah A. (2016). Etude et simulation de l'effet des paramètres climatiques (température, poussière…) sur les modules solaires en couches minces en région saharien. Université Ahmed DRAIA ADRAR, Algérie.

Dorothée M (2010). Conception et dimensionnement de chantiers photovoltaïques. Mémoire. 32 pages.

HAMADOUCH Mohamed et HAMMELNA Rabie, l'impact des paramètres météorologiques sur le rendement des systèmes photovoltaïques, Mémoire de Master, Ecole Supérieure en Sciences Appliquées de Tlemcen, Algérie, Juin 2022.

Kébé A (2014). Contribution au pré-dimensionnement et au contrôle des unités de production d'énergie électrique en site isolé à partir des énergies renouvelables : Application au cas du Sénégal. Thèse de Doctorat. Université Paris-sud. 22 pages.

Khatib, T.,Mohamed, A., and Sopian, K. (2013). A Review of Photovoltaic Systems Size Optimization Techniques. Renew. Sustain. Energy Rev. 22, 454–465

Malaysian Plan Attainable within the Limits of its Resource? Renew. Sustain. Energy Rev. 49, 1221–1232.

MOSTEFAOUI M (2015). Contribution à l'amélioration des performances des cellules solaires à base d'InGaN. Mémoire de master. Université Abou Bekr Belkaid. Tlemcen. 32 pages

Muhammad Asim1, Muhammad Usman, Jafar Hussain, Muhammad Farooq, Muhammad Irfan Naseer, Yasser Fouad, M.A. Mujtaba and Fahad Awjah Almehmadi, Experimental Validation of a Numerical Model to Predict the Performance of Solar PV Cells, Frontiers in Energy Research, June 2022

Pingel S. and al (2010). "Potential Induced Degradation of solar cells and panels". 35th IEEE PVSC.

Rafindadi, A. A., and Mika'Ilu, A. S. (2019). Sustainable Energy Consumption and Capital Formation: Empirical Evidence from the Developed Financial Market of the United Kingdom. Sustain. Energy Technol. Assessments 35, 265–277.

Rafindadi, A. A., and Ozturk, I. (2015). Natural Gas Consumption and Economic Growth Nexus: Is the 10th

Rafindadi, A. A., and Ozturk, I. (2016). Effects of Financial Development, Economic Growth and Trade on Electricity Consumption: Evidence from Post-fukushima Japan. Renew. Sustain. Energy Rev. 54, 1073–1084.

Rafindadi, A. A., and Ozturk, I. (2017). Impacts of Renewable Energy Consumption on the German Economic Growth: Evidence from Combined Cointegration Test. Renew. Sustain. Energy Rev. 75, 1130–1141.

SAADA N et Abdellah (2015). Mémoire Master. Méthodes d'identification des Panneaux Photovoltaïques. Université Abou Bekr Belkaid. Tlemcen. 22 pages.

Shukla, A. K., Sudhakar, K., and Baredar, P. (2016a). A Comprehensive Review on Design of Building Integrated Photovoltaic System. Energy Build. 128, 99–110.

Skoczek A., Sample T., Dunlop E.D., Ossenbrink H.A. "Electrical performance results from physical stress testing of comercial PV modules to the IEC61215 test sequence". Solar Energy Materials & Solar Cells, 92, 1593–1604, 2008.

Tahir, Z. u. R., Azhar, M., Blanc, P., Asim, M., Imran, S., Hayat, N., et al. (2020). The Evaluation of Reanalysis and Analysis Products of Solar Radiation for Sindh Province, Pakistan. Renew. Energy 145, 347–362

World Energy Council. World Energy Issues Monitors; World Energy Council: London, UK, 2019.

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