Sahara Solar Breeder Project for Renewable Energy in Algeria

Y. Miloud, M. Mostefai ,A. Miloudi,

University Moulay Tahar of Saida, BP138,En-Nasr, Saida 20000, Algeria

e-mail: miloudyahiadz@yahoo.fr

Abstarct - Solar Breeder Project is a joint Japanese-Algerian universities plan to use the abundant solar energy and sand in the Sahara desert. A solar breeder is a solar power plant that uses its own energy to build more solar power plants of this kind. Such a plant could become not only energy self-sufficient but a major supplier of new energy. Solar cells and modules usually show a gradual performance decline when deployed outdoors and exposed to environmental conditions. For this reason and in the context of the Sahara Solar Energy Research Center; five technologies of PV modules were installed in last December 2013 in the University of Saida to measure the performance characteristics and maximum output power of solar cells and modules. This system continuously acquires current, voltage and power from these five PV modules, which are automatically stored and later analyzed. In this paper a description of the PV measurement system based on outdoor module I-V curve installed in Saida and underground temperature measurement are presented.

Keywords— Sahara Solar Breeder project, PV Module, I-V curve.

I. INTRODUCTION

The SSB (Sahara Solar Breeder) project involves building manufacturing plants in the Sahara desert that would extract silica from the abundant sand and use it to make solar panels. The first solar panels are going to be used to build solar power plants. However, the main object of this project is to build enough plants until the breeding strategy can deliver 100 GW of electricity to provide 50% of the world's electrical power generation capacity by 2050 which would be delivered via a HTSC (High Temperature Superconductor) to transport the produced DC current electricity over 500 Km, figure 1, [1].

However, this paper concerns the assessment of newly installed photovoltaic (PV) modules based upon five different technologies and a meteorological station at University of Saida which is situated at so called gate of the Sahara. These facilities have been initiated for the evaluation of solar and PV capacities of the Algerian desert as part of Sahara Solar Breeder (SSB) Project.

Solar cells and modules usually show a gradual performance decline when deployed outdoors and exposed to environmental conditions. The outdoor Photovoltaic (PV) module systems are set to measure the performance characteristics and maximum output power of solar modules under the natural sun light and weather conditions.

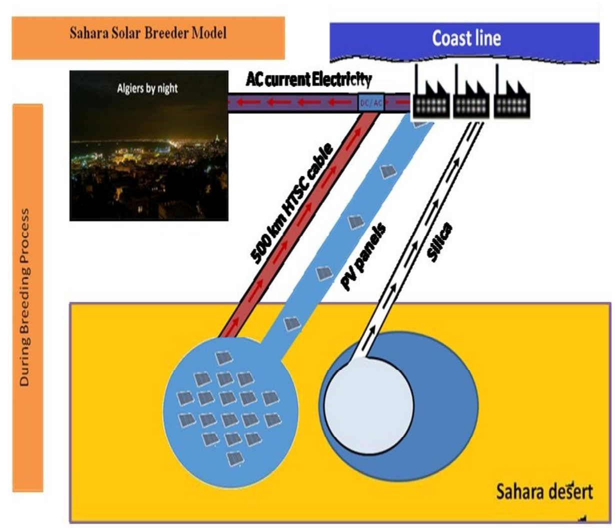


Figure 1. Sahara Solar Breeder Model and transport of the DC current via HTSC

II. PV MEASUREMENT SYSTEM DESCRIPTION

The outdoor photovoltaic (PV) module evaluation system is based on the PV analyzer (PVA11270) developed by Nippon Kernel System Co [2]. The PV analyzer is designed to measure I-V curve and module back-side temperature to evaluate the changing performance of each module under the natural sunlight and weather condition [3]. The outdoor photovoltaic (PV) modules evaluation system consists of [2]:

- ✓ 5 types of PV modules oriented towards the South for an angle of 31°
- ✓ 1 thermocouple placed in back side of each module
- ✓ Pyranometer (Tilted solar radiation same angle as PV panels installed on Automatic Weather Station [4], [5].

Figure 2 shows a photo of the 5 different technologies of PV modules installed in University of Saida (Algeria) and

Figure 2. Photo of the 5 types of PV modules.

Table 1 shows their characteristics.

TABLE 1. Characteristics for the five module types

PV N⁰	Type	manufacture	W (mm)	L (mm)	H (mm)	P_{max} (W)	I_{SC} (A)	V_{OC} (V)	I_{pm} (A)	V_{pm} (V)
1	m-SI	Kyocera	1168	990	36	165	8.53	26	7.9	20.9
2	CIS	Solar frontier	1257	977	35	150	2.2	108	5.47	42.7
3	HIT	Sanyo	1580	812	35	233	5.84	51.5	8.36	24.94
4	Back contact	Sharp	118	990	46	208.5	8.94	30.6	1.85	81.5
5	A_SI/u-SI	Kaneka	1240	1008	40	110	2.5	71	2.04	54

Figure.3 shows the measurement box where is installed the PV Analyzer PVA11270 and PV scanner [2].

The measurement software controls and selectors. I-V curve for each module are measured one by one sequentially. By setting the start, finish time of the day and time interval, the system measures all modules without interruption over a long period of time. Data are collected then either on a memory card installed on the PV analyzer or transmitted to the PC via a LAN cable (Fig. 3), [3].

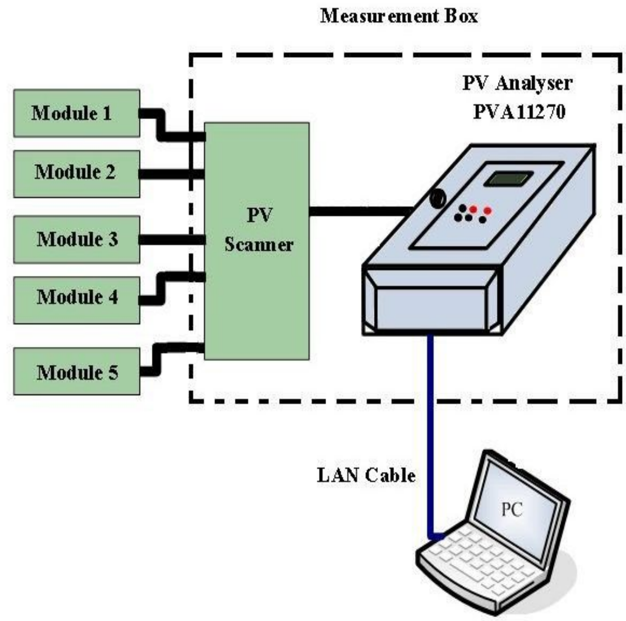


Fig .3 Principle of the measuring system.

III. First Measurement Data

Figure 4. shows the comparison of the temperature variation of the five types of PV modules and the air temperature respectively. The difference is clearly shown between the ambient temperature and the modules temperature. However, we can see that the maximum air temperature is 16 °C while the maximum temperature of the module is 55°C.

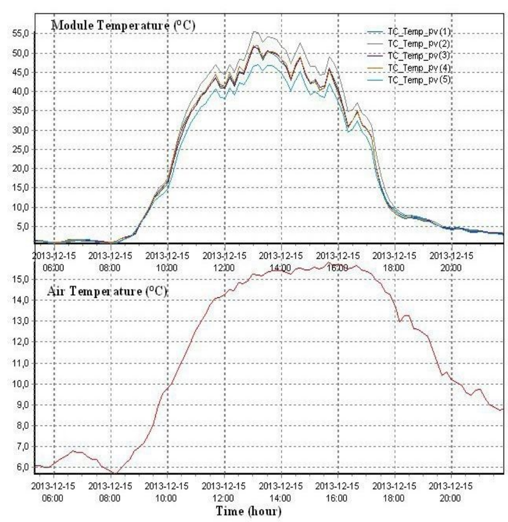


Figure 4. The air temperature and module temperature.

Figure 5 shows an example of I-V curve for the five technologies of modules using the PV analyser software.

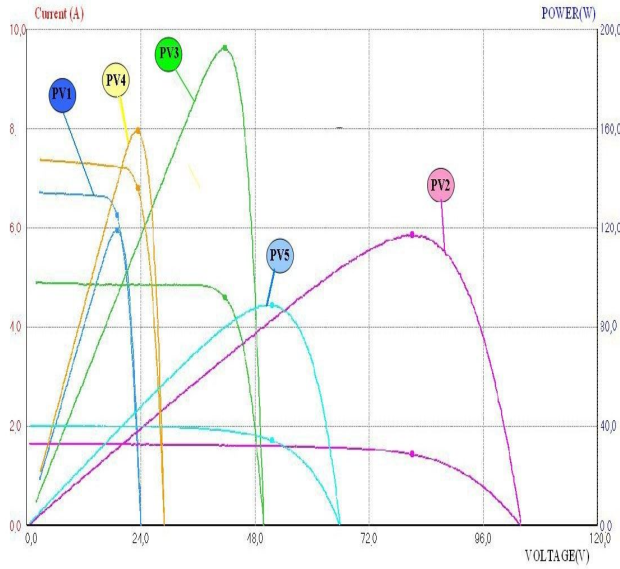


Figure 5. Five technologies of PV modules

Table 2 summarizes the essential of these curves

TABLE 2. The essential readings of the 5 different curves

Module Types	PV N°1	PV N°2	PV N°3	PV N°4	PV N°5
Module Temperature (°C)	48	48.2	48.5	48.7	45
Sun radiation (w/m2)	820	820	820	820	820
Maximal Power(W)	119.31	117.60	192.86	159.43	89.18

Figure 6 shows the average daily energy produced by each panel. This energy is measured for an average time of 8 hours (9h to 17h) between 09 December and 18 December [4].

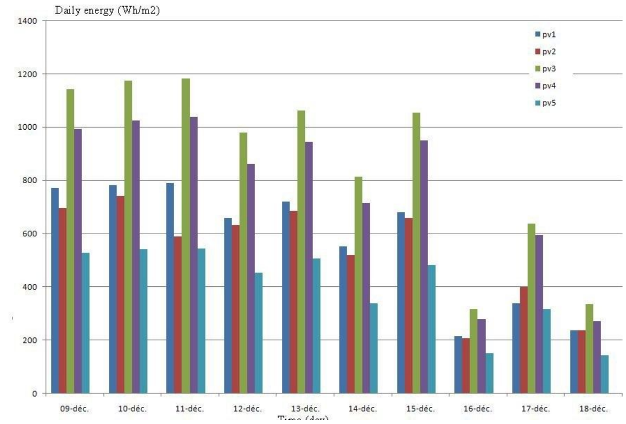


Figure 6 Average daily energy produced by each panel.

In this figure, we can clearly see that the minimum energy is on December 16 for all panels and the average energy received for this day is 1460 wh/m2.

IV. Analysis of Measured Data

Figure 7 shows the average energy produced by each panel and the energy received during 10 days. In this figure, we can clearly see the difference between the energy produced by the five panels.

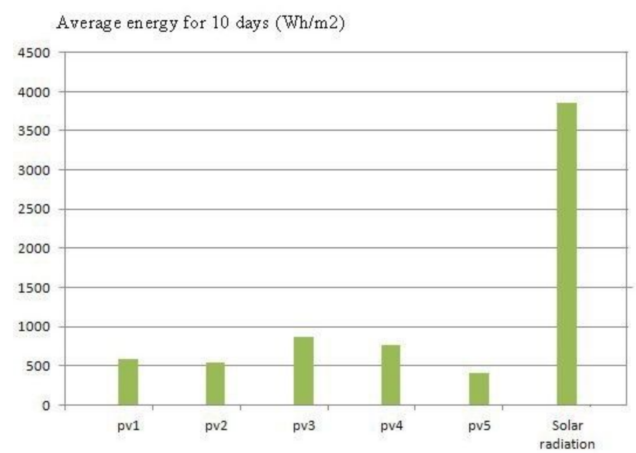


Figure 7. Average energy for 10 days

V. SAIDA UNIVERSITY UNDERGROUND TEMPERATURE MEASUREMENT SYSTEM

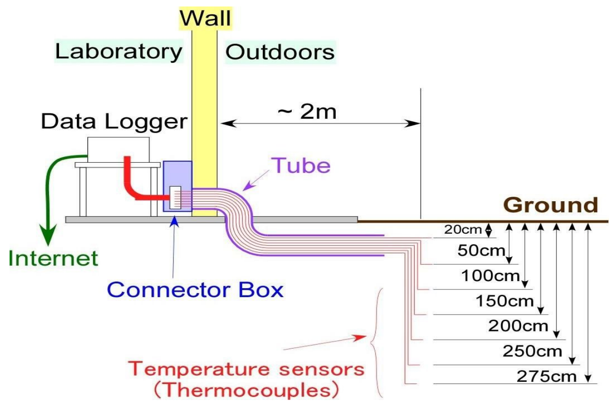
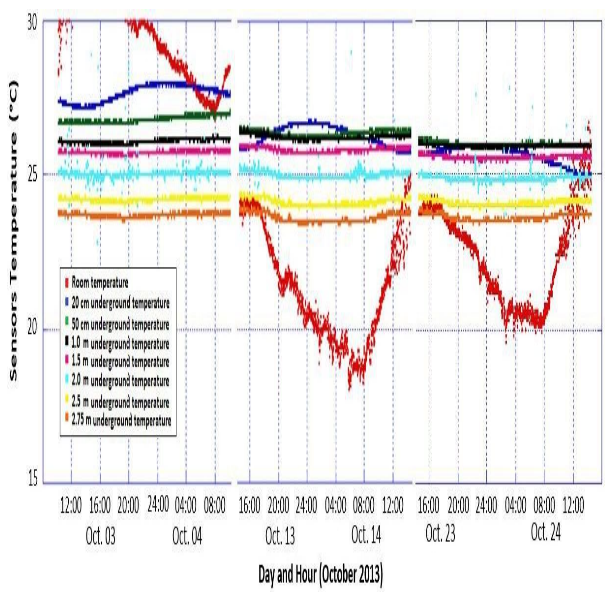


Figure 8. Underground temperature sensors.

Figure 9. Data collection and analysis



The measurement system with data logger was installed on September 2013 at University of Saida, figure 8. The underground temperature sensors were placed at different depth starting from 20cm to 275 cm to measure the temperature. Figure 9 shows some underground temperature data collected on October 3, 13 and 19. According to these results, the temperature is almost constant at a depth of 150cm and that is what we are looking for.

These data will be very useful for the HTSC cables which will be used in Sahara desert to transport the produced DC current electricity over a distance of 500 Km, [5]-[6].

VI. CONCLUSION

In this paper, a description of the outdoor PV measurement system and the fist result recorded are presented.

Solar radiation and temperature are the most important factors that influence the design and construction of solar photovoltaic systems. The measured data shows a variation in the performance of the modules due to weather conditions.

For future work, all relevant variables for 6 months and 1 year like IV curve, module temperature, irradiance which determine and characterize the power output of the modules will be presented. These data will be useful for SSB project to the design and construction of solar photovoltaic systems.

The SSB challenges

1. Construct Si production plants using the Sahara sand silica source.
2. Double the yearly production of silica every two years, to reach half a million tons after 40 years
3. Double the yearly production of PV cells every two years, to reach half a million of 500 Kwp PV after 40 years.
4. Using HTSC cables to transport the produced DC current electricity over 500 km or more.

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