Investigating the Impact of Solar Cells' Partial Shading on the Maximum Power Point Performance by Simulation at ACEESD-UR Laboratory

Justin PALUKU BIHAMBA; Thierry RUKUNDO KABEYA; Pacifique PAMOJA KANYAMUGENGA

Abstract:- Solar energy has become the most attractive among renewable energy systems. As the world's energy demand still increases, many countries are investing in solar power generation. As solar energy is seasonal and depends on sun rise the only requirement is to receive acceptable irradiation to generate power. Shading occurs when clouds, buildings, or any other obstacle makes solar irradiance to do not reach solar modules. In this paper review, we will develop some experiments based on simulations of solar performance at different shading patterns. The experiments were made at ACE-ESD (African Centre of Excellence in Energy for Sustainable Development) under UR (University of Rwanda), college of Science of Technology in the city of Kigali.

Keywords:- *Solar generation, MPP, shading, irradiance.*

I. INTRODUCTION

In the situation of expanding need for energy, solar energy is preferred due to being pollution-free and trustworthy among all other renewable energy resources. The global deployment of PV installations has registered a large increase in the last years, at the end of 2016, the global installed capacity surpassed 300 GW of electricity accounting for more than approximately 1.8% of the global electricity consumption.[1]

Solar photovoltaic power generation reduces under shading conditions. The shading occurs due to clouds, birds, buildings, poles, trees, and dust. The reduction of solar photovoltaic efficiency by incomplete shading relies onthe shading example and area of shaded modules.[2][3]

In this paper we made some experiments to analyze how solar cell shading affectsits maximum power point. These experiments have been made at the ACE-ESD laboratory (African Centre of Excellence in Energy and Sustainable Development) under the University of Rwanda-College of Science and Technology.

II. DEVELOPMENT

The first experiment objective was to determine, without shading, the MPP tracking of the inverter's operating point. We needed to assemble the circuit following the layout and wiring diagram.

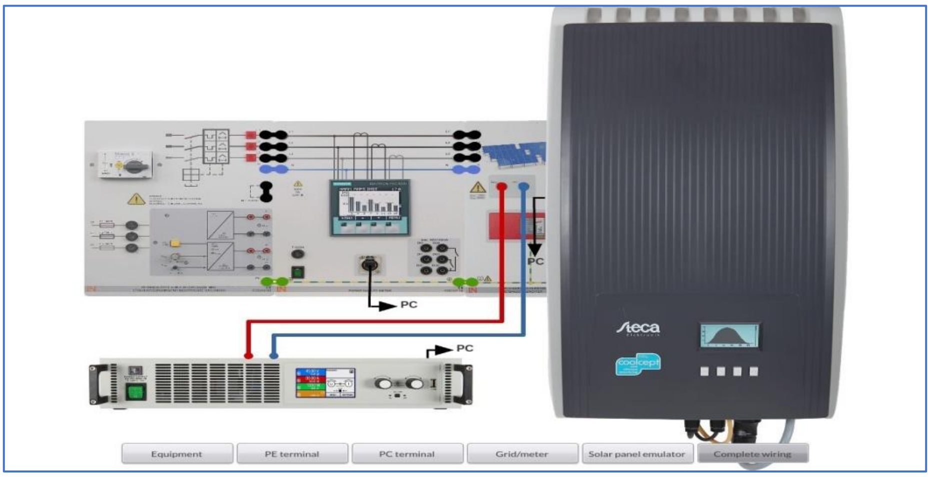

Fig. 1: Wiring diagram of the circuit

In the "Solar Panel" virtual instrument, activated via the POWER button, we performed thesettings shown in the table below and waited until the PV inverter had synchronized itself with the grid and supplied the maximum power.

SHADOW [%]	0%
SHADED MODULES	0
IRRADIANCE [%]	100%

With these parameters, we got the characteristics below for the graphics.

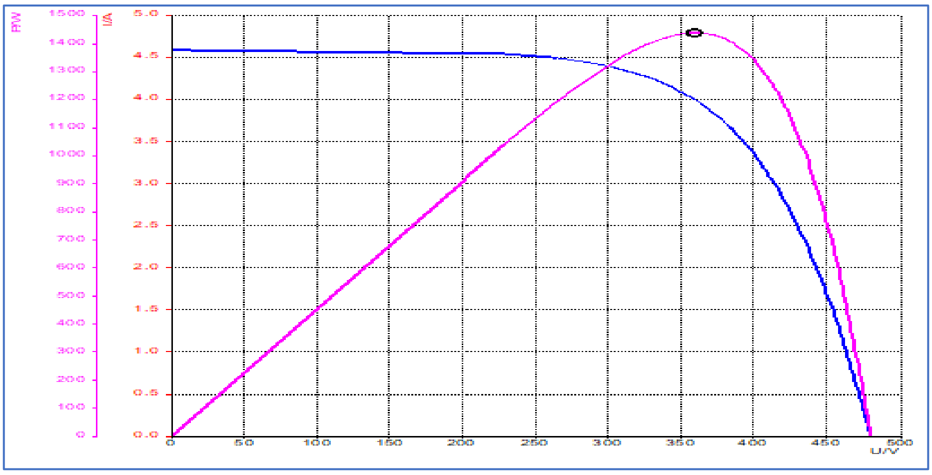

Fig. 2: It showed that the MPP tracking without shadow, with 100 % irradiance gives the DC active power amounts to 1440 Watts.

For the second and third experiments, we reduced the irradiance to 80% and 50% and repeated the measurements in each case. We got the graphics shown next and we observed the voltage and current in the three different cases.

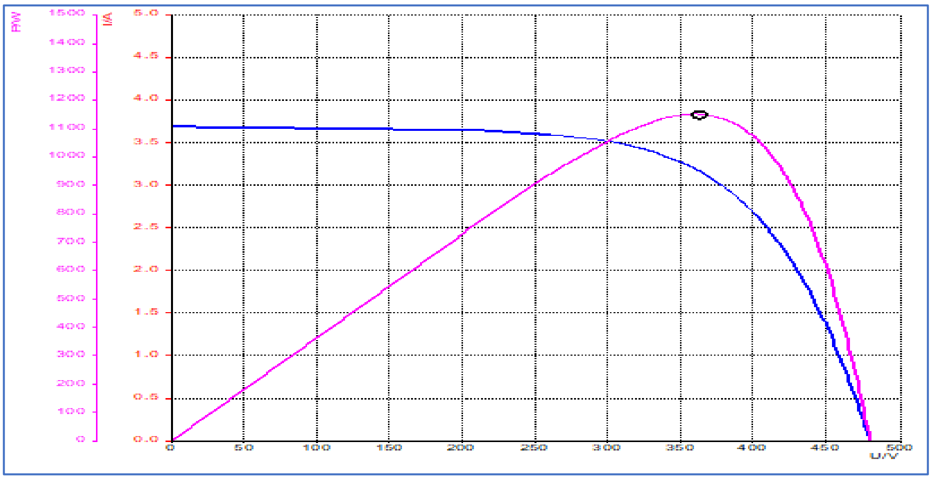

Fig. 3: The MPP tracking without shadow, with 80% irradiance, the DC power was 1152 Watts.

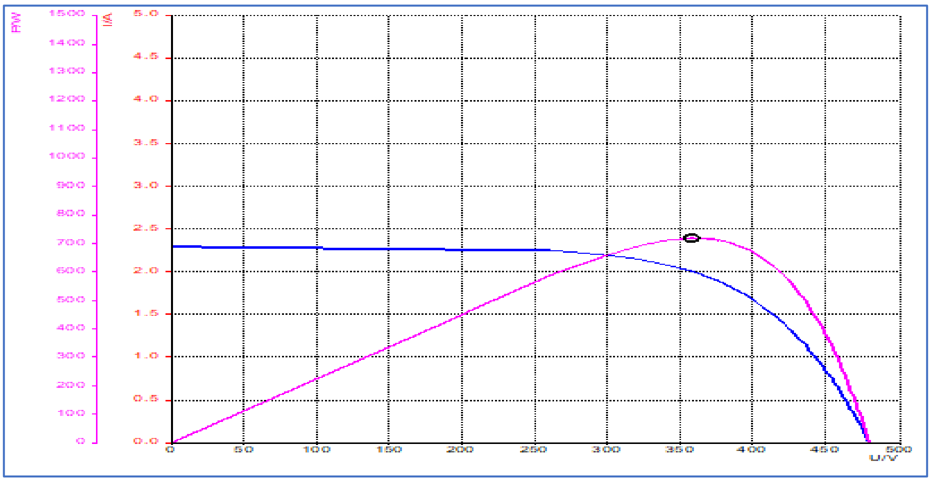

Fig. 4: The MPP tracking without shadow with irradianceat 50%, the DC power gives 720 Watts.

With these three experiments, we concluded that the Maximum Power Point varies depending on irradiance value even if there is no shadow. That is why tracking the operating point is needed to operate the PV inverter at its maximum power point. It is also known that temperature and radiation spectrum can affect the MPP value. After observing the current and voltage in the three cases we concluded that the direct voltage remains almost constant over a wide range and the direct current drops with decreasing irradiance.

ISSN No:-2456-2165

The next experiments simulated consisted ofMPP tracking of the inverter's operating point at different shadings of the solar generator. We kept the irradiance at its maximum value (100%) and shaded 2 solar modules at different shading values (20%, 50% 80%, and 100%) andrepeated the measurements with 5 shaded modules. We had the following graphics characteristics.

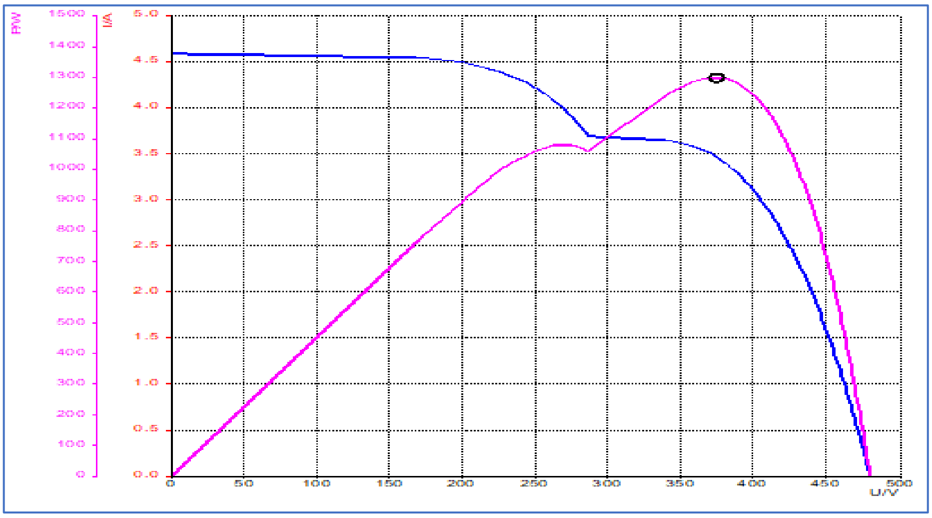

Fig. 5: 2 shaded modules, 20% shadow

Then we settled the shadow to 50% and 80% and copied the resultant characteristics to the placeholders provided.

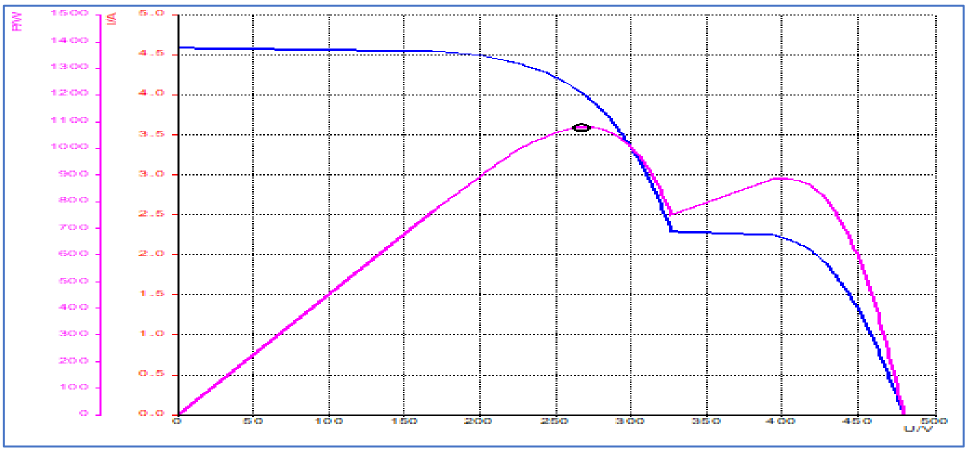

Fig. 6: 2 shaded modules, 50% shadow

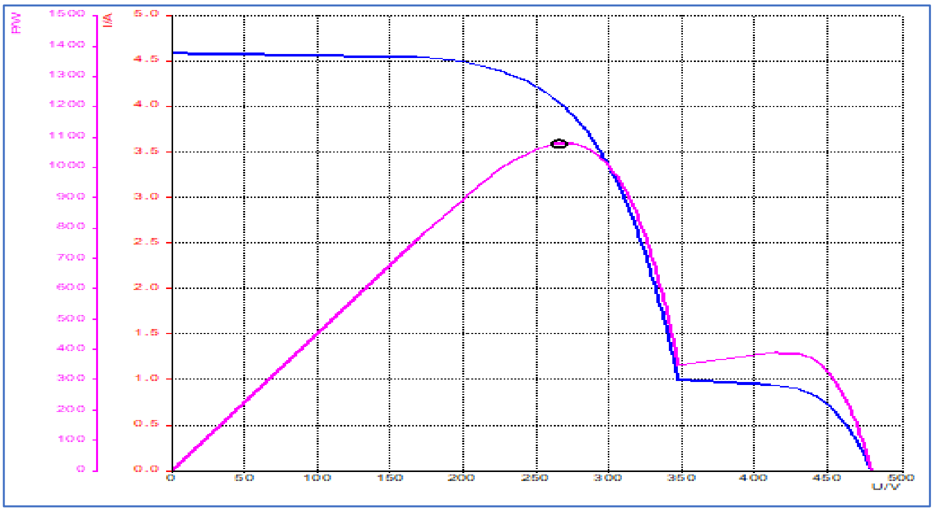

Fig. 7: 2 shaded modules, 80% shadow

After we shaded 5 modules and repeated the measurements (Irradiance at 100 % with different shadow levels).

ISSN No:-2456-2165

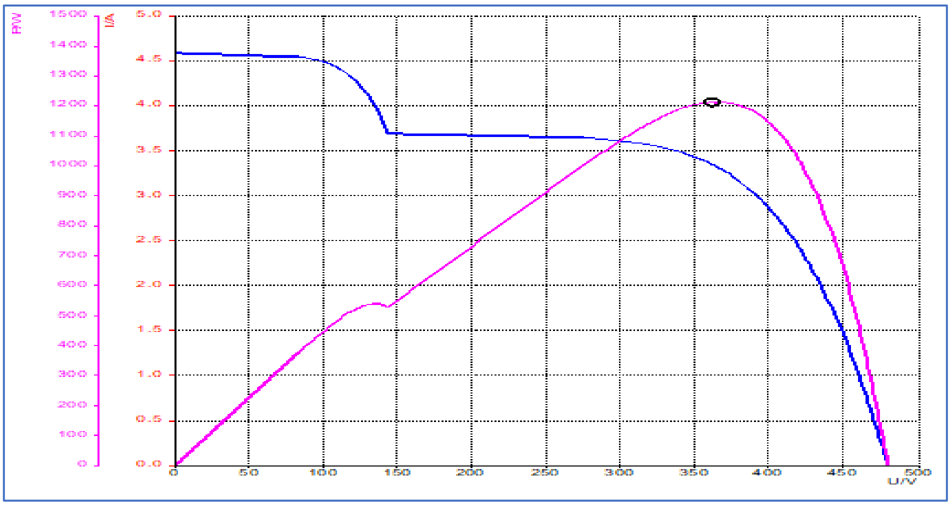

Fig. 8: 5 shaded modules, 20% shadow

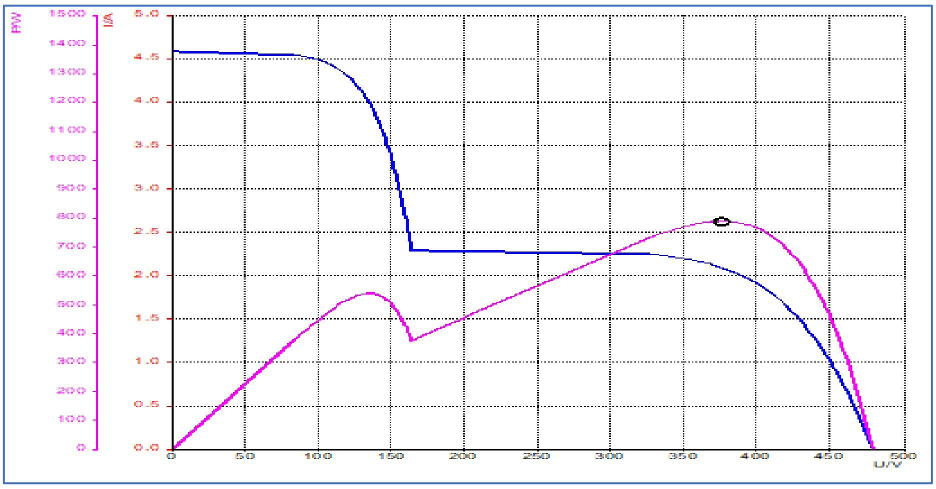

Fig. 9: 5 shaded modules, 50% SHADOW

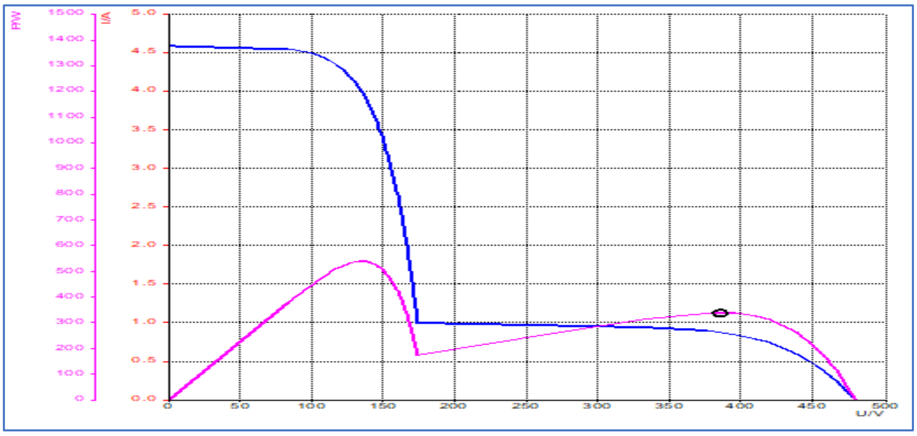

Fig. 10: 5 shaded modules, 80% shadow

We got the last graphic with 100% shadow as shown next:

ISSN No:-2456-2165

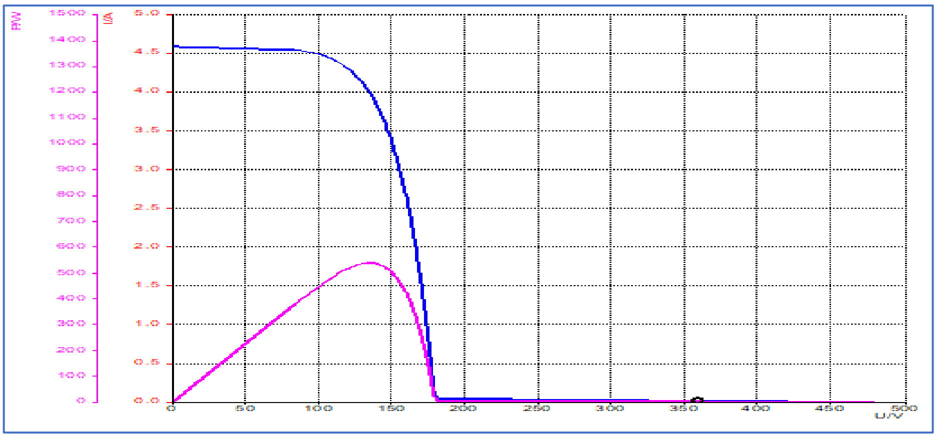

Fig. 11: 5 shaded modules, 100% shadow

III. CONCLUSION

In this paper, some simulations and their graphics were developed in the ACEESD-UR laboratory. The experiments were done first without shading at different irradiance values (100%, 80%, and 50%). At these different values, we found the DC active power at 1140 Watts, 1152 Watts, and 720 Watts. We concluded that irradiance affects the MPP value.

For the second part of our experiments we shaded 2 modules and saw the characteristics of the graphic at different shading values (20%, 50%, and 80 %), we concluded as follows:

- About the search for the maximum power point, an intelligent search algorithm ensured that the correct MPP is approached even in the case of shaded modules.
- Solar modules in shadow affect the flow of current and therefore the power.

Then we shaded 5 modules and got the graphic at 20%, 50%, 80 % and 100 % shading values. By analyzing the obtained result, we concluded as follows:

- 100% shading of 5 solar modules makes the PV inverter switch off automatically after a certain time.
- The search algorithm was not able to find the maximum power point at a shadow of 80% and 100% because the PV facility's maximum power point was located outside the inverter's MPP voltage range.

REFERENCES

[1]. D. Pera et al., “Investigating the impact of solar cells partial shading on photovoltaic modules by thermography,” vol. 700, pp. 1979–1983, 2017, doi: 10.1109/PVSC.2017.8366497.

[2]. V. Darmini and K. Sunitha, “Comparison of Solar PV Array Configuration Methods under Different Shading Patterns,” 2017 Int. Conf. Technol. Adv. Power Energy (TAP Energy), pp. 1–4, 2017.

[3]. M. Mughees, A. Rasheed, and K. Daniel, “Impact of Shading, Dust Accumulation, and Temperature Rise on the Performance of Solar PV : The Case of Pakistan,” 2020.