Modelling for Classifying Different Shadow of Obstacles on a c-Si PV Panel

Cofinanciado por:

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Abstract

Shadow of Obstacles (SoO) on a PV Panel is classified depending on time with changing pattern of the shadow. Due to obstacles, the performance of a silicon c-Si PV panel reduces by a significant level. Different types of obstacles cast shadow on the panel and interrupt to get irradiation reducing the generated power. The simulation model is implemented in MATLAB/Simulink to observe the changing pattern and variation of output power with changing shadow pattern of the obstacles. The results show identical behaviors. It is clearly viewed in both PV generated I-V and P-V curves. Their pattern of graphs is changed depending on the time for time-dependent obstacles. Graphs pattern is also changed with depending on time-independent obstacles and that does not vary with time. The identification of the behavior of the obstacle is vital to improve the PV system performance. For time-dependent obstacles and for time independent obstacles power decreases in specific quantity depending on the kind of SoO. Specifically, for the time-depending one is also depend on the duration of the SoO.

Keywords

PV Panel, Shadow of Obstacles, Time-Dependent Obstacles, Time-Independent Obstacles.

Introduction

Last few decades the world had a huge technical progress, that makes it more dependent on energy. Existing non-renewable energy sources are not safe for environment and they generate huge amount of greenhouse gases (GHG). People are taking initiatives to reduce these kinds of hazardous GHG by utilizing renewable energy sources. Meeting between all policy maker and all of the countries come to a common point to help the earth to reduce the GHG and the temperature of the world. In the meeting one of the important issues was to use more renewable energy over fossil fuel resources.

Photovoltaic cell (PV) is a simple device that transforms solar energy to electrical energy on the principle of Photo effect. PV is a fast-growing technology all over the world due to its rapid reduction of cost and improving performance in real time. Another important is that it does not emit any GHG during the production time [1-6].

In [7] it is stated that in Libya there are different types of dust patterns in photovoltaic panels. It compares both dust and clean scenario of a PV panel and gives detail of loss analysis due to the dust obstacle. It shows that due to dust the performance of the panel decline a lot and reduces the total performance of a system.

In [8,9] it is described about the shadow effect over series connected monocrystalline silicon solar modules. The result of the simulation shows that due to shadow the performance decrease a lot and also several peaks is viewed in I-V and P-V curves. This introduces the local maxima and misguides the maximum power point tracking (MPPT) system. In [10] it is stated the partial shading effect using five parameters single diode PV model. It also shows that due to shadow the performance of PV reduces a lot.

In [11] it is stated about dust growth on the PV panel and their effect. It introduces the photovoltaic soiling index (PVSI) that try to standardize the health condition of a panel under a different type of scenario and at various location. In [12] it is stated that the relation between obstacles and number of cells affected by the shadow on a PV panel. In this work, MATLAB is used to simulate the scenario.

In [13] it is described both direct and diffuse radiation for PV panels. This work observes the shadow effect of different obstacles' of the city area. 3D city model is used to observe the properties and identify causes of the obstacles that makes shadow. In [14] it is described the shadow effect on PV panels. In this work, it switching matrix technique is introduced to get rid of shadowing effect. And also improve the performance of MPPT techniques.

In [15] it is stated detail analysis of PV panel's performance with shadow effect. It describes that shadow introduces uncertainty to forecast the power of a PV panel.

In [16] discusses bird droppings on PV panel. For a big PV plant this occurrence the performance of the system reduces. This is one kind of shading effect that makes an obstacle for irradiance to reach the surface. This paper simulates the scenario for the silicon monocrystalline solar (c-Si) panel in a laboratory environment. They use a different arrangement of PV arrays connection to increase the performance under bird dropping condition.

In [17] discusses partial shading condition and provides a solution to overcome the local maxima problem. During shadow condition, P-V curve has more than one peak and misguide the MPP tracker to get the maximum power. Because of shadow, more than one peak is observed.

In [18] discusses the shadow over the cell of PV and state of the series and parallel arrangement of the cell under shading condition. In [19] it is described, a simulator that is for simulating dynamic and partial shadow condition for PV panels. It gives the idea about the real scenario when a panel is under shadow condition.

All these literature reviews identify the shadow of obstacles as a negative element that reduce the performance of PV panel and make the system more unpredictable.

This paper, classifieds the SoO dependent on time using I-V and P-V curves, and generalize the shadow and their effects on panels. There are different types of elements such as cloud, dust, bird, tree or damaged cell of PV panel itself reduce the performance of a panel. The simulation model for a PV panel is implemented in MATLAB/Simulink. This is for observing the SoO effects on PV Panels. Dynamic and statistical models are created depending on time using I-V and P-V curves pattern. The simulation outputs give new pattern of P-V and I-V curves. It is very important for identification of a fault in PV panel whether it is permanent or temporary affect. Section 2 models the PV panel using double diode five parameters and describe the SoO. Section 3 presents case studies from the simulation. Finally, conclusions are described in Section 4.

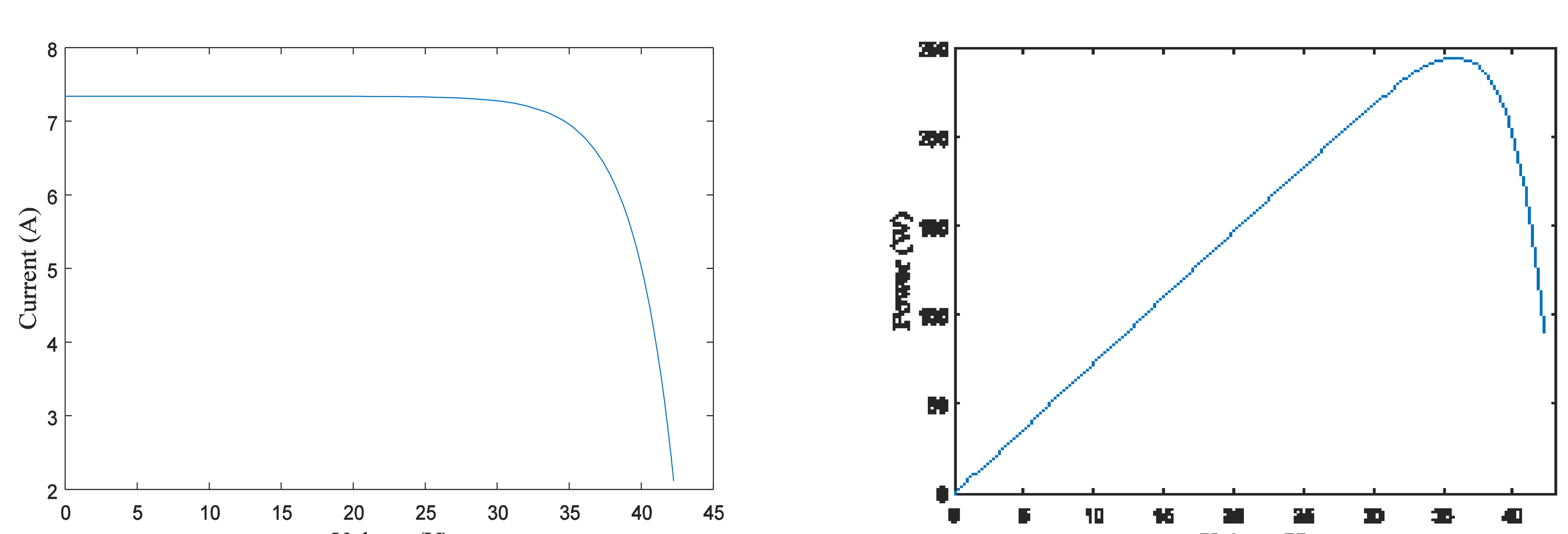

Fig. 2. Different curves at STC condition without SoO: left) I-V curve; right) P-V curve. .

Results

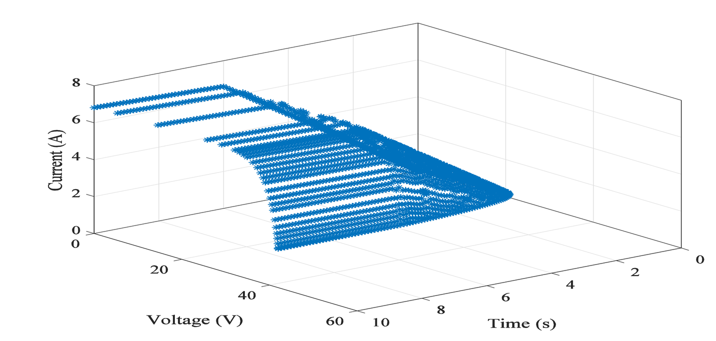

Fig. 3. I-V curves shaded by a time-dependent obstacle.

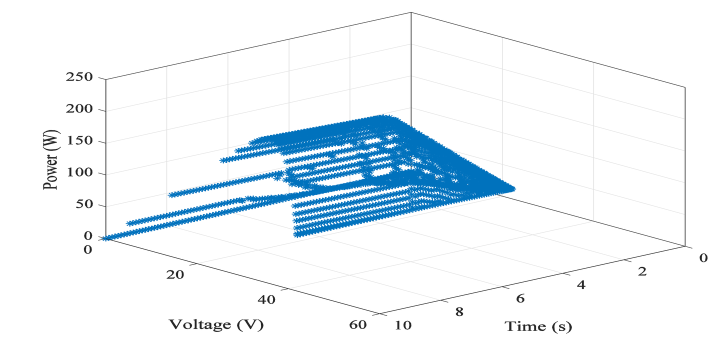

Fig. 4. P-V curves shaded by a time-dependent obstacle.

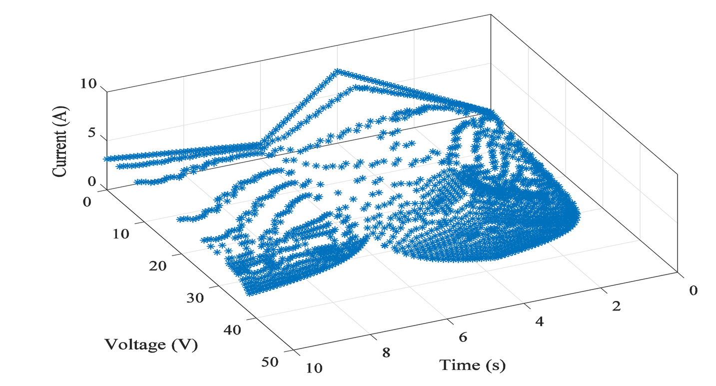

Fig. 5. I-V curves (part of panel shaded) during rapid changing obstacle with time.

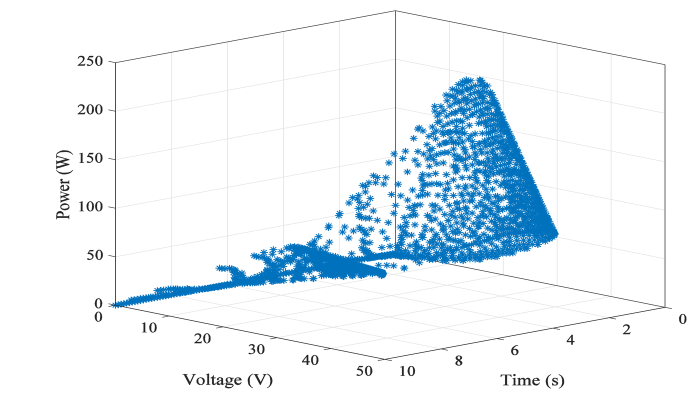

Fig. 6. P-V curves (panel shaded) during rapid changing obstacle with time.

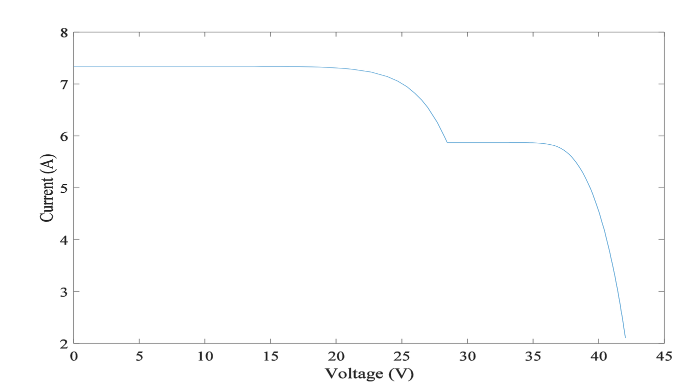

Fig. 7. I-V curve with 20 cells shaded by a static obstacle and 52 cells under STC condition.

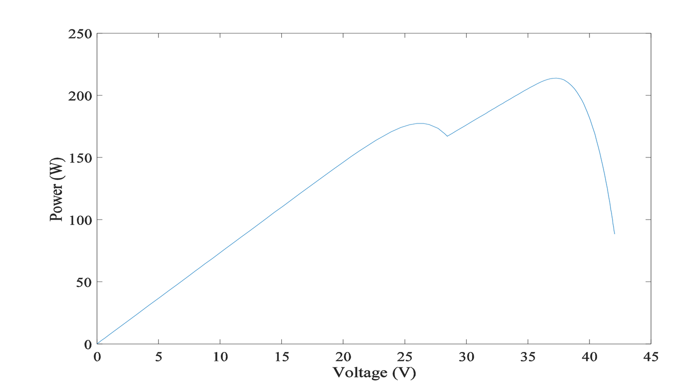

Fig. 8. P-V curve with 20 cells shaded by a static obstacle and 52 cells under STC condition.

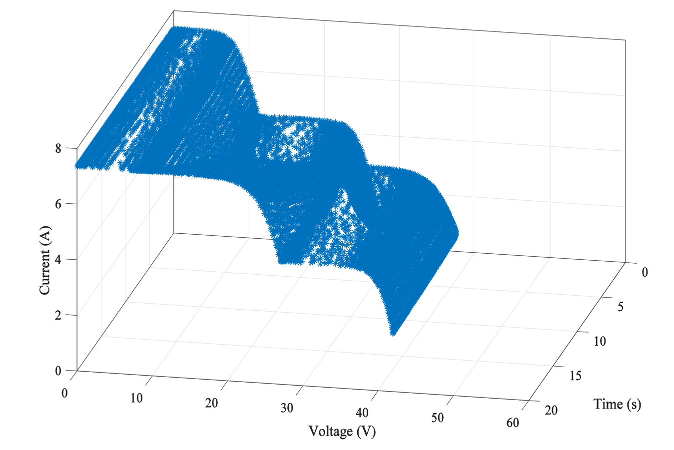

Fig. 9. I-V curve under STC condition, having no error, time-independent obstacle, and time-dependent obstacle.

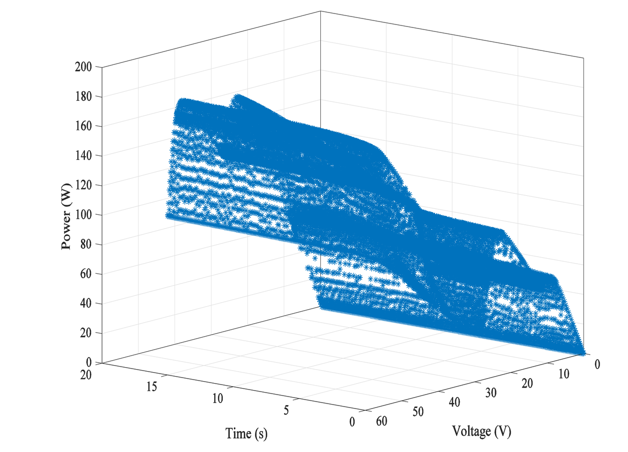

Figure 10. P-V curve under STC condition having no error, time-independent obstacle and time-dependent obstacle.

Conclusion

PV panel depends on the weather variables, which are nonlinear in behavior and difficult to forecast. With the dependent variables, its output is also nonlinear and difficult to predict future output. Shadow of obstacles are the elements that reduce the irradiance to reach the working surface of PV panel and decrease the performance dramatically. Due to the presence of random shadow of obstacles the generation of the system becomes unpredictable. Shadow of obstacles the generalize form that define the fault in panel. Fault always decreases the system performance. It is important and crucial to identify the faults and the solution to overcome them. First step to solve the problem is to identify the problem clearly. For every scenario the percentage of the power loss due to SoO is very on their behavior. In time dependent SoO the power loss is depending on the duration of the SoO. For a specific situation (10 second of dynamic SoO and among 72 cells, 48 cells under SoO) and its decrease the power around 13.9 percent. And for time independent (among 72 cells, 48 cells under SoO) the power loss is 38.5 percent on a specific SoO, but it is permanent till the problem is not solve manually.

The behavior and shape of the obstacles has been classified in this paper. Time-dependent and time-independent shadow of obstacles both decrease the power generation. For Time-dependent shadow of obstacles, it is needed to arrange the cells or other electrical improvement that can overcome the problem and reduce the loss. Time-independent shadow of obstacles needs to be fixed manually or using artificial intelligent machine.

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