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MPPT String Arrangement and Production Improvements in String Inverters

Hale Bakır[1],

[1]*Department of Electronics and Automation, Sivas Cumhuriyet University, Sivas, Turkey*
halebakir@cumhuriyet.edu.tr, ORCID: 0000-0001-5580-0505

***Abstract*— Today, as the demand for electrical energy increases, the demand for renewable energy, which is a clean energy source, continues to increase. Solar inverters used in solar power plants are devices that convert DC power to AC. Solar inverters are divided into three groups as central inverter, micro inverter and string inverter. String inverter model is used in this study. It has been determined that as a result of incorrectly connecting the string cables during installation and workmanship in the string inverter, the solar inverter does not work at full capacity and full efficiency cannot be obtained at its output. A problem experienced during the connection and installation phase causes inefficiency in the system and inability to get full efficiency from the inverter. For this reason, in this study, MPPT string cable arrangement, which is connected incorrectly in a string inverter, has been carried out and the production has been increased to 96.72 kW.**

***Keywords*— Efficiency, Electrical energy, MPPT string cable, String inverters**

I. INTRODUCTION

With large-scale industrial technologies and increasing population, the demand for energy consumption is increasing [1]. The tendency to renewable energy sources is increasing due to the increase in energy consumption in the world and the damage caused by fossil fuels to the environment. Solar energy has an important place among renewable energy sources, which are clean energy sources [2]. One of the most important structures in renewable energy is solar inverter (photovoltaic inverter). The purpose of the solar inverter is to convert the DC power from the solar panel to AC power in the most efficient way. In addition, thanks to solar inverters, the solar power plant can be monitored and maintenance and service processes can be managed in the light of the analytical information provided by the inverter [3]. In literature, the reliability of these PV inverters is evaluated under various static and dynamic scenarios using MATLAB/Simulink and real-time prototype [4]. The performance of different inverter types were analyzed via various measurement and simulation methods [5]. Series-connected PV modules strings connected in parallel are investigated under different conditions by using a MATLAB Simulink simulation model [6]. One of the most important features of the solar inverter is the conversion efficiency. This value is an indication of how much of the energy produced as direct current is converted into alternating current [7]. Solar inverters are divided into three groups as central inverter, micro inverter and string inverter. String inverter model was used in this study. Comparisons continue to be made to determine the comparative performance characteristics of inverters in real, outdoor conditions [8]. The PV industry continues to seek opportunities to reduce losses associated with site condition and inverter design [9].

In order to get the maximum productions /most efficient from the photovoltaic inverter, some important parameters need to be considered. For example: Minimum DC input voltage, maximum DC input voltage, starting voltage, MPPT operating voltage range and MPPT string arrangement. These parameters give technical information about the inverter and allow to choose the most suitable inverter model for the project. In this study, it has been determined that as a result of incorrectly connecting the string connections during installation and workmanship in the string inverter, the solar inverter does not work at full capacity and full efficiency cannot be obtained at its output. For this, an increase in efficiency has been achieved by arranging mppt string in string inverters. In solar inverters, mppt string arrangement is of great importance for efficiency.

II. MATERIAL AND METHOD

A. String Inverters

String inverters are one of the main components of solar energy systems and are often used in homes, businesses and industrial facilities. These devices have a separate maximum power point tracker (MPPT) for each string and monitor the output of each string, ensuring the most efficient operation of the system. In such cases, the “Shadefix (Shade management software)” feature, which is standard in SMA inverters, can be activated and maximum energy production can be achieved even in shaded situations [10].

Figure 1 shows the two main power blocks of the string inverter. The first is the DC/DC power stage. It converts the variable string output into a stable high voltage DC link suitable for the DC/AC inverter stage.

This DC/DC stage is a Maximum Power Point Tracking (MPPT) converter. This DC voltage is converted to AC voltage for the grid [10].

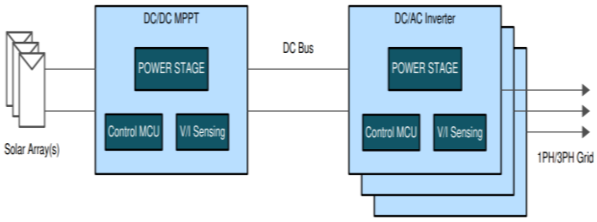

Fig. 1 Solar string inverter block diagram

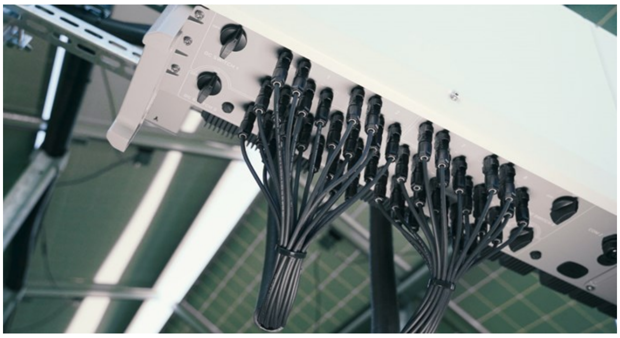

Fig 2. MPPT string cables of string inverter

B. *Advantages of String Inverters*

It often come with a remote monitoring system to ensure the systems are functioning properly and monitoring. These systems monitor the inverter's operating efficiency, power output, and other important parameters, making it easy to detect and fix problems quickly.

The disadvantage of String Inverters is the string arrangement, which is not connected correctly and causes maximum efficiency from the inverter. If it is not connected properly and equally, it gives errors and full efficiency cannot be obtained from the inverter at the output. Figure 2 shows MPPT string cables.

C. *Result and discussion*

The number of strings determined in the study is 20 for each inverter. Each MPPT has numbers from 1 to 6. sequence names for each MPPT are labeled with letters A to D. The faulty connection is that 4 Strings are connected to the first 4 MPPT and only 2 strings from the last two strings are connected. According to this connection, each 4X17.5 + 2X12.1 = 94.2 kW each inverter will be able to produce 94.2 kW max DC according to this calculation. The maximum it can produce is 90.12 kW on May 27. Figure 3 shows the maximum inverter output value. The MPPT string arrangement work was performed on all inverters in the invested site on May 31st. this is a case in point of installation, labor and engineering. 4 strings to the first 2 MPPTs and 3 strings to the others are connected.

Each inverter will produce a maximum of 6X17.5=100.5. While the 1st and 2nd MPPTs have 4X6.05 =24.2 kW dc panel power, the others have 3X6.05 =18.15 kW in the 3rd, 4th, 5th and 6th MPPTs. As can be seen from the graphs below in Figure 4, the inverter maximum output value has increased to 96.72 kW.

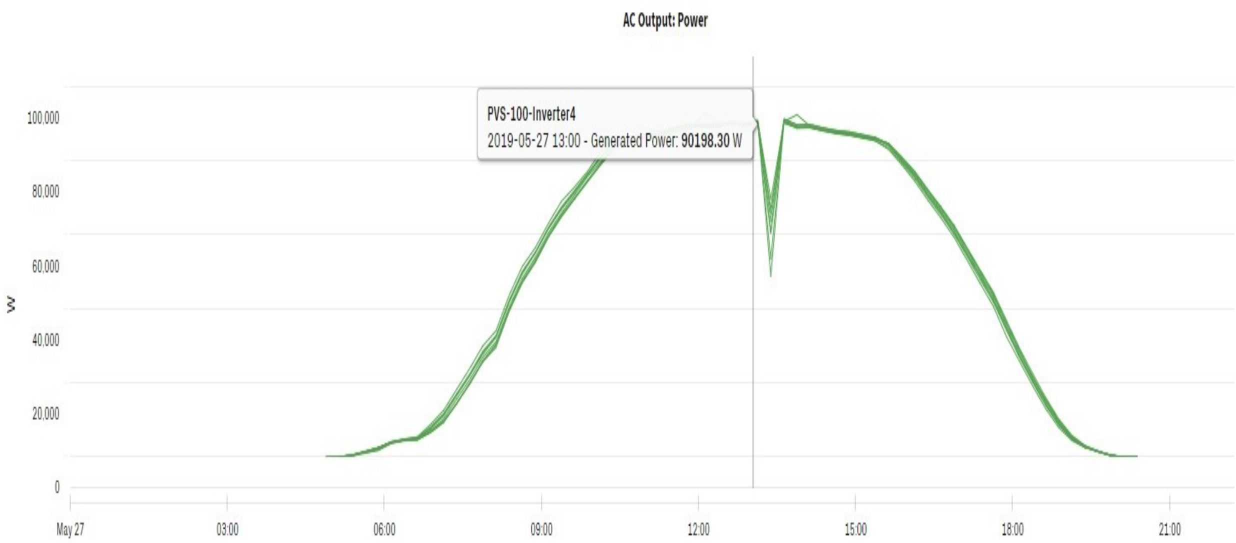

Fig. 3 Maximum inverter output value in the faulty connection

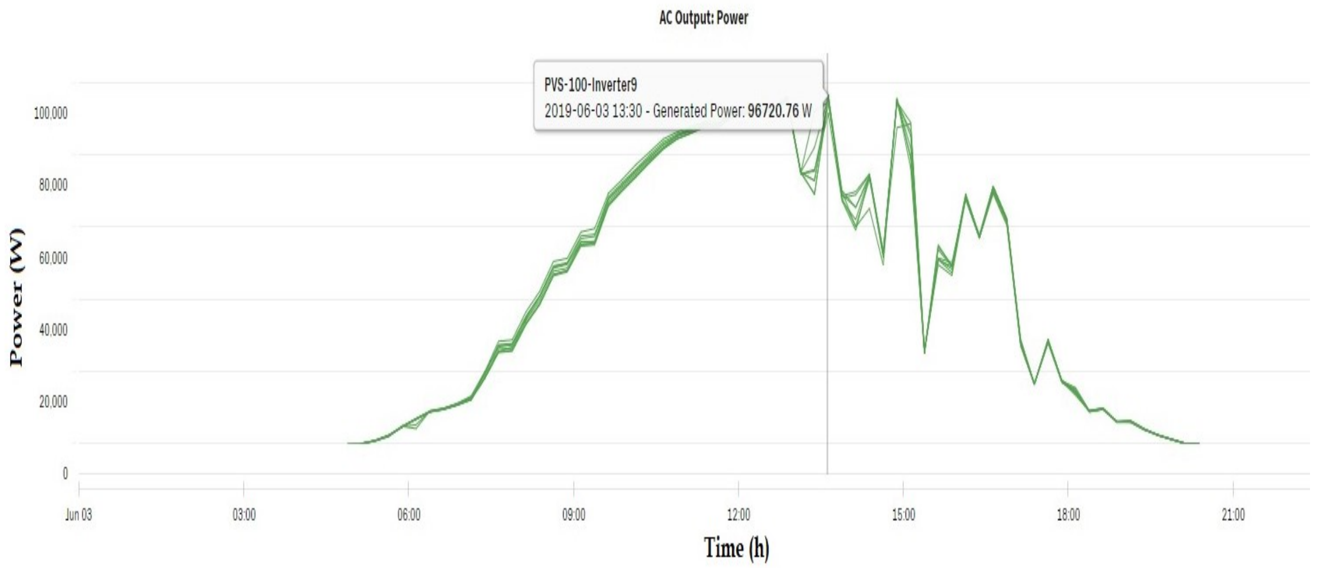

Fig. 4 Maximum inverter output value in the correct connection

III. CONCLUSIONS

Solar inverters are of great importance in solar power plants, which have an important place in renewable energy. A problem experienced during the connection and installation phase causes inefficiency in the system and inability to get full efficiency from the inverter. In the study, it was determined that full efficiency could not be obtained from the inverter output when the examination was made according to the situation where there is a string error. Incorrect connection made; 4 strings to the first 4 MPPTs and 2 strings to the others are connected. As can be seen from the graphs, the maximum output value of an inverter increased from 90.12 kW to 96.72 kW by connecting 3 strings to other MPPTs with 4 strings of the first 2 MPPTS connected.

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