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Monitoring of Photovoltaic System

Aldi Mucka[1], Andi Hida[2], Boris Cfarku[3]

[1, 2, 3]Polytechnic University of Tirana, Faculty of Electrical Engineering,
Bul. "Dëshmorët e Kombit" Square "Nënë Tereza", No. 4, Tirana, Albania

Abstract: ***In recent years, a growing attention, both by the authorities as well as the companies of the electricity sector, had been dedicated to energy production from renewable energy sources. Solar energy is assumed to have more favorable technical and economic perspectives. In this paper will be treated monitoring of a photovoltaic plant with installed power of 1.5kWp. The system will be used for practical exercises in the framework of the course on Photovoltaic Systems and for research of the influence of outdoor conditions on its behavior. The plant was installed on the roof of the building of Faculty of Electrical Engineering. To achieve continuous monitoring, the plant is connected to the grid with a grid inverter. Results obtained from the monitoring of this system will be use the following for further study of the possibility and potential of electricity production from solar energy in Albania.***

Keywords: Photovoltaic-systems, Grid-inverter, Renewable-energy, Distribution-system, Solar-energy

1. Introduction

Recent years the demand for electricity is growing more and more. Obviously, to meet the electricity needs of our consumers, we must respond with the increase of new energy sources. Nowadays, there are different ways of producing electricity and many of them have found wide application.

In the context of global warming, ozone layer deterioration from different gas emission, mainly carbon dioxide CO_2, many countries worldwide have developed sanctioning policies for such entities emitting gases and favorable policies to promote clean and renewable energy. So, the issue of preserving the environment today is taking a primary role. Recent technologies used for electricity production are through: photovoltaic cells using solar energy, wind farms using wind energy, hydropower plant using water potential, geothermal plants, biomass and exploitation of ocean energy (waves). In this way there is a need for process recognition and the study of these systems. This paper will describe the monitoring of a photovoltaic system with 1.5kWp installed power. The photovoltaic power station is installed on the Faculty of Electrical Engineering roof and is built for practical and research studies in the solar energy production domain. To obtain continuous data, PV plant is connected to the power grid distribution system with a grid-inverter. The Panel system is composed of 10 modules with installed power of 150 Wp, which are connected in series. The Results obtained from the monitoring of this system will be used for further studies on the potential and possibility of producing electricity from solar energy in Albania

2. Photovoltaic Systems

This section gives a brief functional and identification of settings, qualities characteristic of the elements that make up a Photovoltaic Plant. Usually the basis of a PV plant is the generating unit, where the electricity is produced, while the basic element of the generating unit is the photovoltaic cell.

A typical PV cell produces less than 3 W to 0.5 V DC, and then to have more power generated these cells should be connected with each other under certain series and parallel configuration. But it is known that PV panel produces electricity only in the radiation period. If you have to supply a load in the night hours then it is necessary to have a system where the energy may be stored such as an accumulator battery, etc. Through this system we will supply the load even during cloudy days, during this time the panel does not produce electricity. So, it is necessary to install rechargeable batteries, and according to their cycles they will be charged and discharged all the time. But to keep the batteries in their optimal operating conditions we should not let them to be overcharged and over discharged. For this we have to implement a regulator that whenever the over-charge or over-discharge of the battery reaches a certain value (given by us), it acts in disconnecting the battery. In addition, if we have to supply AC loads then we should put an inverter in the scheme that will make the conversion from DC to AC voltage. If a backup system is present in the scheme it is needed another controller, ex: a diesel generator which will be connected whenever PV panel does not produce or generate the necessary power. In cases when the PV plant is connected in parallel with the grid again it is necessary an interface circuit or a controller that disconnects our PV plant from the grid whenever it loses stability. Besides the components mentioned above we have other support elements such as: wires, fuses, circuit breakers, surge arresters, grounding system, etc. Together the entire elements compose a "Photovoltaic System".

There are two schemes generally used for a typical photovoltaic system:
a) PV Plant with inverter and battery
b) PV Plant with Grid inverter

The first system is low cost to install and is used in cases when it is isolated (island system) from the distribution network. Their disadvantages are that it requires maintenance for batteries, and requires additional equipment for its monitoring process. While the second system has an expensive installation due to the relatively high cost of grid inverter, but it has great advantages: it is direct connected to the grid and is easily monitored with the friendly use of grid inverter software.

3. Description of 1500Wp PV System

On the roof of Faculty of Electric Engineering there are three different types of PV panels: Monocrystalline PV panel with 1500Wp rated power (Figure.1), Polycrystalline PV Panel with 720Wp installed power, mounted in a fixed platform and a rotating solar photovoltaic panel with 220Wp rated power. Below it will be analyzed the monitoring of the monocrystalline PV Panel.

Figure 1: 1500Wp Photovoltaic panel

For the first time, the PV panel has been installed in the scheme with inverter and battery, supplying power to some small loads in Dynamic Analysis Laboratory and some other loads in High Voltages Laboratory. The panel consists of two strings, each composed of 10 modules. The modules are connected two by two in series and then all related doubles formed in parallel with each other. These wires go down from the roof to the first floor, where the loads and other auxiliary equipment, control, monitoring are located. These wires connect to the relevant regulators to charge the batteries. The regulators depending on the charge status of the batteries and internal logic will decide where to transfer more energy to the batteries or more to the inverter. The disadvantage of this system was that it requires additional equipment to monitor and continuing maintenance of batteries. These were precisely the reasons that led us to choose another way of monitoring through a single monitoring device that collects and then process data called grid inverter. The Grid inverter brand “FIMER” has 1.75 kW rated power and gives us communication possibilities with the PC. Then through software interface is possible monitoring the photovoltaic plant. To realize the connection of the panels we needed to do some changes in the scheme of connection modules in order to adapt the input voltages of grid inverter. (Range: 110 V- 430 V). To realize this, all strings were connected in series with each other.

In Figure.2 is show electric scheme of PV plant connected to the grid.

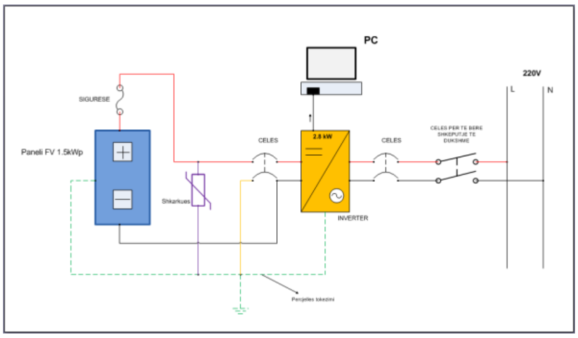

Figure 2: PV panel 1500Wp scheme connected with grid

PV panel consists of 20 modules 75 Wp type monocrystallin all connected in series. Its terminals are connected to the input terminals of the grid inverter. 220V Output of grid inverter is connected to the grid to directly inject power produced by the PV panel. The inverter via a RS232 port will send its data to a PC to display the collected and processed results. This data then can be stored in an archive in PC memory. Regarding the detailed presentation, we have constructed graphs and processed results that will be shown in the following paragraph, which will explain the monitoring procedure in details.

4. PV Plant Monitoring

In this part we will show the results of the monitoring program and the opportunities for displaying and processing data. With this software, you can see in real time the power and the energy that is injected in the grid (produced by the PV plant). Below is shown a daily graph. It shows the amount of energy that is produced from the PV plant during this day (7.2 kWh), instant power (74 W), and the graph of power produced by the panel throughout the day. The chart belongs to July 15, 2013.

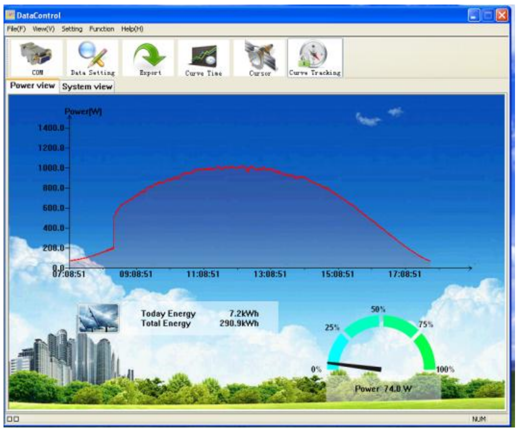

Figure 3: Daily graph of power produced by the PV Plant

This program also offers the possibility of exporting the data into an Excel file enabling further data processing. Below is the density of solar radiation and electrical energy produced by PV plant on July 15, 2013.

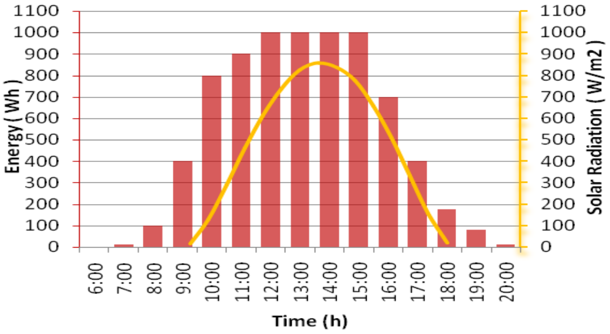

Figure 4: Solar radiation and energy produced of PV plant on July 15, 2013

Looking at the graphs of solar radiation and energy production we notice that the forms of graph are nearly similar. Energy produced is not constant but it depends on solar radiation and the position of the sun into the skyline.
The software gives us the opportunity to build graphs of the energy produced during a month. The following chart shows the energy produced on July 2013.

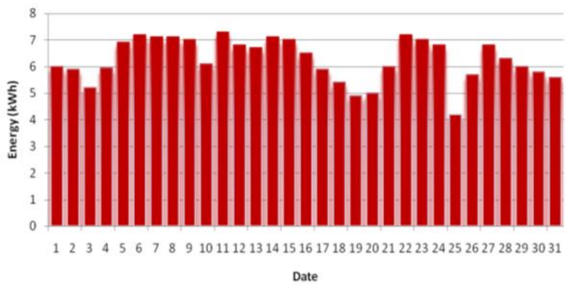

Figure 5: Energy produced on July 2013

In the Table 1 is provided the produced energy for five months since the installation of the PV monitoring system. From the first day of use of grid-inverter, total energy produced by the PV system is about 1056 kWh power which is injected to the grid and laboratory equipment.

Table 1: Month energy produced by PV Plant

Month	June	July	August	September	October
Energy kWh)	222.7	236.2	227.6	201.3	168.2

From all the above descriptions the idea and the purpose of the build of photovoltaic plant is to demonstrate how photovoltaic systems work, and to help students in practical woks and scientific research on these systems.

5. Conclusions

The study and the description of photovoltaic power stations are important for their control and supervision. Monitoring these systems behavior conducts in understanding their different problems. Albanian power system is actually based almost totally on Hydropower production, and for this is always putting his confidentiality in doubt. This system meets about 70-80% of the total demand for electricity. In these conditions, we can say that the main challenge of Albanian power sector is the diversification of energy sources and energy self-sufficiency for local resources, thus reducing dependence on imports. According to measurements of solar radiation, carried by the Hydro-meteorological Institute, and the station latitudes where measurements were made results that our country has an exposure to solar radiation, which varies from 1200 kWh/m2 in the north-east up to 1600 kWh/m2 western area. Most of Albania's surface obtains a solar radiation of 2200 hours/year, while in specific years, the average goes up to 2400 hours/year. The number of sunny days in our country varies from 240 to 260 days, with a maximum of 280 days. Area Myzeqe, Vrina and Vurgu are favored regions for solar radiation from 2400 hours / year. From the monitoring results we see the average electricity produced by the plant is about 200 kWh per month, approximately half of the electricity consumption for a family in Albania. For this reason, it is suggested to develop encouraging policies to use of photovoltaic systems by reducing the higher cost of installation.

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Author Profile

Aldi Mucka received the B.S. and M.S. degrees in Electrical Engineering from Faculty of Electrical Engineering of Polytechnic of Tirana in 2008 and 2010, respectively. From 2010 he works as lector in Department of Power Systems in Faculty of Electrical Engineering. During this time, he has got deep study in field of control and operation of electrical power system. He now is work as first Lector at Department of Power Systems.

Andi Hida received the B.S. and M.S. degrees in Electrical Engineering from Faculty of Electrical Engineering of Polytechnic of Tirana in 2010 and 2012, respectively. From 2013 he works as lector in Department of Power Systems in Faculty of Electrical Engineering. During this time, he has got deep study in field of renewable energy control and operation of electrical power system.

Boris Cfarku received the M.S. degrees in Electrical Engineering from Faculty of Electrical Engineering of Polytechnic of Tirana in 1982, respectively. From 20083 he works as lector in Department of Power Systems in Faculty of Electrical Engineering. During this time, he gets deep study in field of Operation and control of electric network, and operation of electrical power system. He now is work as first Lector at Department of Power Systems.