PHOTOVOLTAIC PANELS - APPLICATION OF NANOMATERIALS

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Abstract
In the last decade, nanomaterials have become a topic of major interest. These materials are important in terms of their size, have a high potential for industrial applications as diverse as: electronic applications, bioengineering, energy industry, environmental, chemicals. Photovoltaic cells are the main applications of nanomaterials in energy and environmental protection domain. These cells are encapsulated in photovoltaic panels, which are the main elements in composing a solar system that produces electricity. Photovoltaic panels are devices that transform solar energy into electricity. This production problem resulting phenomenology is given by the random nature of the source of solar and unpredictable weather changes. Therefore a photovoltaic system remains conditional on both its reliability and hazard rate and primary energy supply. This study shows the description, properties and application of photovoltaic panels.

Keywords: photovoltaic panels, solar energy, nanomaterials

1. INTRODUCTION
Nanotechnology is building and deployment of functional structures projected from atomic or molecular scale with at least one characteristic dimension measured in nanometers. Their dimension is enables them to present it with new and significantly improved the physical, chemical, and biological properties and processes due to their size. When the structural characteristic are intermediate between isolated atoms and bulk materials in the range of approximately 100 nanometers, objects often have physical attributes substantially different from those displayed by either atoms or bulk materials. In the last decade, nanomaterials have become a topic of major interest. These materials are important in terms of their size, have a high potential for industrial applications as diverse as: electronic applications, bioengineering, energy industry, environmental, chemicals.[1] The main challenges of using nanomaterials and nanotechnology in the energy sector are: solar energy, power generation using solid electrolyte cells, thermoelectric or piezoelectric materials, storage of energy using new portable batteries, energy transport using high-temperature superconductors, the application of nanotechnology in the extraction and efficient processing of fossil fuels and nuclear fuel, but also in nanobiotechnology applications in energy efficient exploitation of mineral resources [2]. Photovoltaic cells are the main applications of nanomaterials in energy and environmental protection domain. A solar cell consists of two or several layers of semiconductor material, the most commonly is silicon. These layers have a thickness of between 0.001 and 0.2 mm and are doped chemical elements to form junctions "p" and "n". The structure is similar to that of a diode because the silicon layer exposed to the light will produce an "agitation" of electrons in the material and will generate an electric current.

The cells, also called photovoltaic cells, typically have a very small surface and current generated by a single cell is small but mixing series, parallel, these cells could produce currents sufficient to be used in the practice. For this, the cells are encapsulated into panels that offers mechanical resistance and to weathering. The solar panels consist of solar cells. Because a photovoltaic cell produces no enough energy that could be used efficiently, it needs more cells, which are connected in series - parallel, forming a photovoltaic panel. Photovoltaic solar panels are produced in different dimensions with different powers. Solar panels can be connected and them in turn in series - parallel form of higher power systems.
A solar system which will be connected to a single solar charger should have the same type, the same manufacturer, the same orientation and tilt and should not be partial shade. If this is not possible will be used multiple chargers. In most standard photovoltaic panels, strings of 36 or 72 cells are connected in series. [3].

2. EXPERIMENTAL PROCEDURE

In this paper we study the situation of a photovoltaic system installed on “Politehnica” University of Timisoara, with educational role for students who study in this university. Also, this study represents a base for those which aim to install photovoltaic systems in west part of Romania. All geographic positions have different characteristics depending on solar radiation. It has an important role together with the power and the angle of photovoltaic system that will be installed. In view of expanded support provided by governments worldwide for renewable energy, there are many applications which can determine the needs of specific geographical panel. EU provides by Photovoltaic Geographical Information System the geographic information system for photovoltaic systems on site (http://re.jrc.ec.europa.eu/pvGIS/), an application which can determine the panel that we need for a specific geographic area based on expected energy consumption. [4] Performance of photovoltaic panels is dependent on the temperature and the angle of photovoltaic panels which will be installed. The dependence of photovoltaic system by temperature and solar irradiation on summer and winter period is presented in this paper [5]. The photovoltaic panels represent the heart of the system, because they transform the sun’s rays in electrical energy. The photovoltaic panel is composed of several individual photovoltaic cells which are connected serial or parallel using a metallic material. The energy produced by a photovoltaic panel is influenced by the number of cells within a panel and how these cells are arranged within the panel. If the cells are connected in parallel, the total current is the amount current of all connected cells and is the same with that is produced by one cell. When the cells are connected in series, the total voltage is the amount of the voltages from each individual cell and the output current is the same with that is produced by one cell. The photovoltaic cells may be arranged in a mode to produce a specific voltage and current to satisfy the specific power. Photovoltaic cells are usually arranged in a mode to produce voltages in steps of 12. Therefore, most panels on the market are 12 volts, 24 volts, and even 36 volts. Photovoltaic cells can be arranged in a panel to produce a specific voltage and a specific current to satisfy electrical needs. Through multiplication of output voltage with output current could be calculated the total electricity produced. The photovoltaic system dimension is imposed by quantity of energy necessary daily and the quantity of energy available at the location indicated.

3. RESULTS AND DISCUSSIONS

In this study is presented the situation for a photovoltaic system installed on “Politehnica” University of Timisoara. This system was installed in March 2011, the surface of photovoltaic system is of 16.06 m2 and the electrical energy is introduced in the public network. This system has 14 photovoltaic panels installed serial. The location of this system is presented in Figure 1. [6].
First step in this study was to know the yearly sum of global irradiation at optimum angle for all system. The yearly sum of global irradiation at optimum angle of 45 degree is presented on Figure 2. The yearly global irradiation for Timisoara is 1500 [kWh/m²] at an angle of 45 degree.

The power of this system is measured every day on winter and summer period in 2012, in dependence with temperature and total solar irradiation on surface that is installed with a 45 degree face toward South. A comparison power resulted is also presented below. The temperature measured on site in winter period: December 2011 until February 2012 is presented in Figure 3 and the temperature measured on summer period (June - August 2012) is presented in Figure 4. [7].
As is observed in Figure 3, the minimum temperature measured on site in winter period was -7.6 [°C] on 6th January 2012 and the maximum was measured on 4th December 2011 and the value was 1511 [°C].

As is observed in Figure 4, the minimum temperature measured on site in summer period was 21.7 [°C] on 6th June 2012 and the maximum was measured on 26th August 2012 and the value was 40.8 [°C].

The total solar irradiation on a surface tilted with 45 deg. faced toward South during the winter period: December 2011 until February 2012 is presented in Figure 5 and the total solar irradiation on a surface tilted with 45 deg. faced toward South during the summer period (June - August 2012) is presented in Figure 6. [6]. As is observed in Figure 5, the minimum total solar irradiation on a surface tilted with 45 deg. faced toward South measured on site in winter period was 15.5 [Wh/m2] on 5th December 2011 and the maximum total solar irradiation on a surface tilted with 45 deg. faced toward South was measured on 27th February 2012 and the value was 951.7 [Wh/m2]. Also, the minimum total solar irradiation on a surface tilted with 45 deg. faced toward South measured on site during the summer period was 58 [Wh/m2] on 22th July 2012 and the maximum total solar irradiation on a surface tilted with 45 deg. faced toward South was measured on 29th August 2012 and the value was 1010 [Wh/m2]. This situation is presented in Figure 6.
Variations of power during the winter and summer are presented in Figure 7 and Figure 8. The values in winter period are from 0[kW] (in 4\textsuperscript{th} – 6\textsuperscript{th} January 2012) until 2.2[kW] in 22\textsuperscript{th} February 2012. For summer period the values varies until 0.25[kW] (in 25\textsuperscript{th} July 2012) until 2.05 [kW] in 24\textsuperscript{th} August 2012.

A summary with these information is presented in Table 1 – “Temperature, total solar irradiation on a surface tilted with 45 deg. face toward South and the power collected during these experiments “. [7].
Table 1: Temperature, total solar irradiation on a surface tilted with 45 deg. faced toward South and the power collected during these experiments

<table>
<thead>
<tr>
<th>Factors measured</th>
<th>Measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On winter period 2011-2012</td>
</tr>
<tr>
<td></td>
<td>Minimum</td>
</tr>
<tr>
<td>Total solar irradiation [Wh/m²]</td>
<td>15.5</td>
</tr>
<tr>
<td>Temperature [°C]</td>
<td>-7.6</td>
</tr>
<tr>
<td>Power [kW]</td>
<td>0</td>
</tr>
</tbody>
</table>

4. CONCLUSIONS

Monitoring the temperature, total solar irradiation on a surface tilted with 45 deg. face toward South and the power collected during these experiments was performed during summer and winter period. With this experiment we will answer, also, at question if photovoltaic systems are useful for society. It is important to use solar panels, because photovoltaic power offers many other advantages: simplicity of operation, low maintenance costs and lower environmental impact.

In conclusion, laboratories worldwide develop solar technologies with greater efficiency. Disadvantage of these high efficiency photovoltaic panels is the high cost of production. This resulted to the development of thin film panels (thin film) which have a lower yield, but their cost is low.

LITERATURE