Review of photovoltaic modules and systems

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Abstract
The paper presents propositions of commercial solutions for photovoltaic systems, which allow solar energy to be acquired, as well as shows how it can be converted into electric energy. The delineation of the problem and the analysis thereof are intended to introduce a larger public to the subject.

Keywords: **Solar energy, Photovoltaic panels**

I. Introduction

In the past years photovoltaics system has more and more often aroused interest among investors. This basically results from a rise in the costs of electric energy. With the technological progress in the generating of energy by means of photovoltaic systems, investors are more often turning to expensive solutions which are expected to generate savings in the long term. [1].

This article presents the opportunities provided by currently used photovoltaic elements as regards their configuration and the generation of electric energy.

II. PHOTOVOLTAIC SYSTEMS OF ENERGY ACQUISITION

It is in the places of considerable sun exposure that acquiring solar energy and converting it into electricity make sense. The largest amounts of solar energy per square meter are recorded in the moderate zone near a latitude of 40 degrees, the daily time of sun exposure being long. Depending on regions, the intensity of sun radiation in Poland fluctuates between 900 and 1200 kWh/m² [2,3].

In view of this, it is profitable to adjust each detached house in such a way as to generate electricity from solar energy. In order to minimize the cost of installation, it is necessary to use one of the following photovoltaic systems, the choice of which is determined by various conditions.

A. Thin-film photovoltaics (TFPV) – roofing membranes

The use of photovoltaic roofing membranes is the simplest and the most economical energy acquisition solution for an existing building with a roof of more or less complex shape. Figure 1 shows an example. Bituminous SBS membranes, consisting of 2-3 layers put one on another, are attached to flexible thin-film photovoltaic cells. Such a structure ensures that the obtained solar energy is fully utilised so as to generate a maximum amount of electric energy. With low weight and small thickness (approximately 3.4 Kg/m^2, 8 mm), membranes not only have no effect on the structure of a roof, but also adjust to its shape. High flexibility enables them to be installed quickly and easily. Furthermore, considerable strength and puncture-resistance make it possible to walk on them without the risk of causing damage. The advantage of photovoltaic membranes over conventional solar panels lies in the fact that better parameters of energy generation are attained at high temperatures, with poor illumination and in shades. The manufacturer guarantees a performance of 55-60 kW/m² [4].

Fig. 1. Photovoltaic roofing membranes [4]

B. Photovoltaic shingles (Building Integrated Photovoltaics - BIPV)

The BIPV shingles constitute a perfect solution for the buildings under construction and ones where traditional asphalt or metal shingles need to be replaced. One longitudinal photovoltaic panel (0.30×2.19m), made of amorphous silicone, can be substituted for a few conventional shingles and matches them in respect of size and flexibility. Figure 2 presents an example of application. Photovoltaic shingles are characterised by low weight (4 Kg/ m²), and can be nailed directly to roofing, a feature that makes them unaffected by wind (even up to 200 Km/h). The manufacturer guarantees a performance of 30 kW/m² [4].

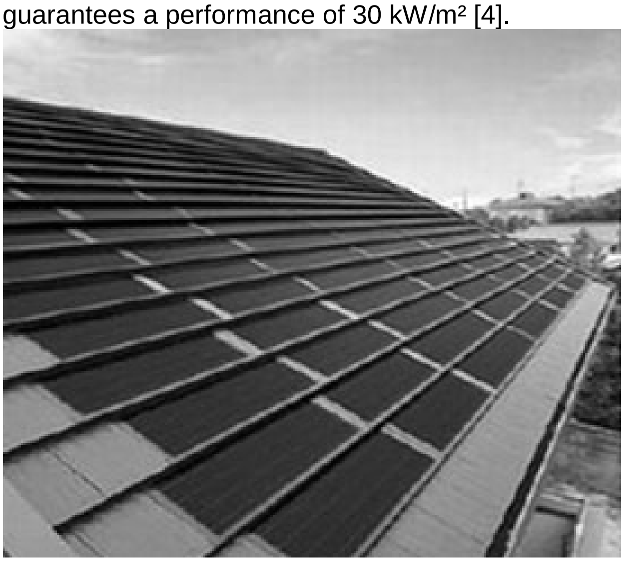

Fig. 2. Photovoltaic shingles [4]

C. High concentration photovoltaics

For various reason, it is quite often impossible to mount the elements of a photovoltaic system on a roof. In such cases it is necessary to use ground, a base which is expensive, above all in cities. High concentration photovoltaics (HCPV) uses lenses or mirrors and systems which face sun so as to concentrate as much light on the photovoltaic surface as possible. Figure 3 presents an example of such a system. Using systems detecting sunlight to ensure proper generation performance at early hours, the HCPV modules are automatically directed towards the sun. The HCPV systems enjoy an economical advantage over other systems, being able to provide better efficiency and making it possible to cut back on semiconductors required by the manufacturing of photovoltaics surfaces. Moreover, much less space is needed for them to be installed, 1 cm² generating as much energy as 500 cm² without the energy concentration system [4,5].

Fig. 2. HCPV photovoltaics modules [4]

III. PRINCIPLES OF CHOOSING A SYSTEM AND ITS EFFICIENCY.

The photovoltaic systems described above were considered only in terms of modules and the installation thereof. The choice of a complete photovoltaic system is determined by many factors, such as:

- area where a cell is to be installed,
- volume of energy to be generated,
- power demand of devices,
- manner of using energy.

With the above criteria it is possible to choose an optimal solution.

First of all, a type of a PV system should be selected, the following being available:

Off-grid solar system (autonomic)

This system is not connected to a public power grid. The generated energy is stored in batteries. It supplies energy to particular receivers, and is found useful when little electricity is consumed, or when it is not possible to connect a power grid. Moreover, the system may be configured in such a way as to connect it to a domestic network so that selected circuits can be supplied with energy. [6].

On-grid solar system (connected to a public grid)

This system is considerably safer and much more cost-effective than the former. It gives away all of the energy it generates to the public grid via a separate meter. The other meter serves to measure the energy taken from the grid. The difference is settled by the customer and the power plant after an invoice has been issued, based on the two metres. Such a solution is most often used by large solar power plants. [7].

Autonomic system connected to a power grid.

Combining as it does the reliability of power supply with economy, this system is most often used. The energy from solar panels is stored in batteries, and converted by an inverter to a voltage of 230V, and then supplied to receivers. If there is a lack of energy from the photovoltaic system, the power supply is switched to the AC public grid. [6].

IV. TIME NEEDED FOR THE RETURN ON INVESTMENT

The time need for the return on investment is directly related to the efficiency of a photovoltaic system, which in turn depends on the sun exposure in a given region. Since the radiation intensity in Poland fluctuating between 900 and 1200 kWh/m² lasts for 1600 hours a year, the efficiency of a system will not exceed approximately 20%. Being unpopular, these systems are expensive, which extends the return time to several years. The investment is close to the limit of profitability, with the durability guaranteed by manufactures of 25 years.

V. CONCLUSIONS

Environmental and direct conversion of solar energy into electricity requires the use of large areas. This problem can be solved by the installing of photovoltaic systems on the roofs of buildings. The multitude of technical solutions available in the market makes it possible to acquire energy wherever substantial solar exposure can be found. Also the manners in which photovoltaic systems work meet the needs of various groups of investors.

Though relatively expensive and quite inefficient on a yearly basis, they constitute a useful, additional source of power supply. A return period of several years is compensated for the confidence that power will be supplied continuously.

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