SOLARNA ENERGIJA: SVETSKI TREND U POGLEDU FOTONAPONSKIH SISTEMA

SOLAR ENERGY: WORLDWIDE GROWTH OF PHOTOVOLTAICS

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Primena alternativnih izvora energije predstavlja rešenje globalnog problema zagađivanja. Među obnovljivim i alternativnim izvorima energije (geotermalna energija, hidroenergija, biomasa, energija vetra, energija morskih talasa…) svakako značajno mesto zauzima i energija sunca. Solarna energija je čista energija, bez emisije štetnih gasova i ulaganjem u implementaciju solarnih energetskih sistema može se otkloniti problem zagađenja životne sredine. Primenom solarnih sistema u domaćinstvima, velikim trgovačkim centrima itd. obezbeđuje se delimično ili potpuno napajanje ovakvih objekata. Solarna energija, posebno fotonaponske (PV) ćelije, predstavlja jednu od najbrže rastućih grana industrije u svetu u poslednjih nekoliko godina. S tim u vezi, ovaj rad predstavlja kratak pregled aktuelnog stanja u proizvodnji i primeni fotonaponskih (PV) solarnih sistema.

Ključne reči: *solarne ćelije; solarni energetski sistemi*

Application of alternative energy sources is a solution to the global problem of pollution. Among renewable and alternative energy sources (geothermal energy, hydropower, biomass, wind energy, sea-wave energy…), sun's energy plays an important role. Solar energy is pure energy, without emission of harmful gases, and investments in the implementation of solar energy systems the problem of pollution of the environment can be eliminated. Solar systems application in households, large shopping centers etc., partial or complete power supply of these facilities is ensured. Solar energy, especially photovoltaic (PV) cell, is one of the fastest growing industries in the world over the last few years. In this regard, this paper presents a brief overview of the actual photovoltaic (PV) system production and implementation.

Key words: *solar cells; solar energy systems*

1 Introduction

Solar technologies are an extremely promising renewable resource. The benefits of renewable energy are reflected in the fact that they are inexhaustible, accessible to all, have a small negative impact on the environment affect and influenced the development of energy security and independence of the countries.

A Photovoltaics (PV), also called solar cells, are electronic devices that convert sunlight directly into electricity. PV presents one of the fastest-growing renewable energy technologies.

The annual PV capacity addition in 2018 was more than the total cumulative installed PV capacity installed until the mid of 2012. China became leading producers of photovoltaic cells as shown in Figure 1 [1]. The PV industry in China is growing at a faster rate than in any other country in the world. China added more solar PV capacity in 2017 than the world installed in 2015 [2].

In the European countries (example Germany) renewable sources delivered about 38% of the total net power consumption in 2017 and PV covered about 7% of Germany's electricity demand in 2017. In Germany, in 2017, about 19 Mt of CO_2 emissions were avoided due to 38.4 TWh PV electricity consumed. In 2018, Germany accounted for about 9% (45.4 GWp) of the cumulative PV capacity installed worldwide (515 GWp) [3].

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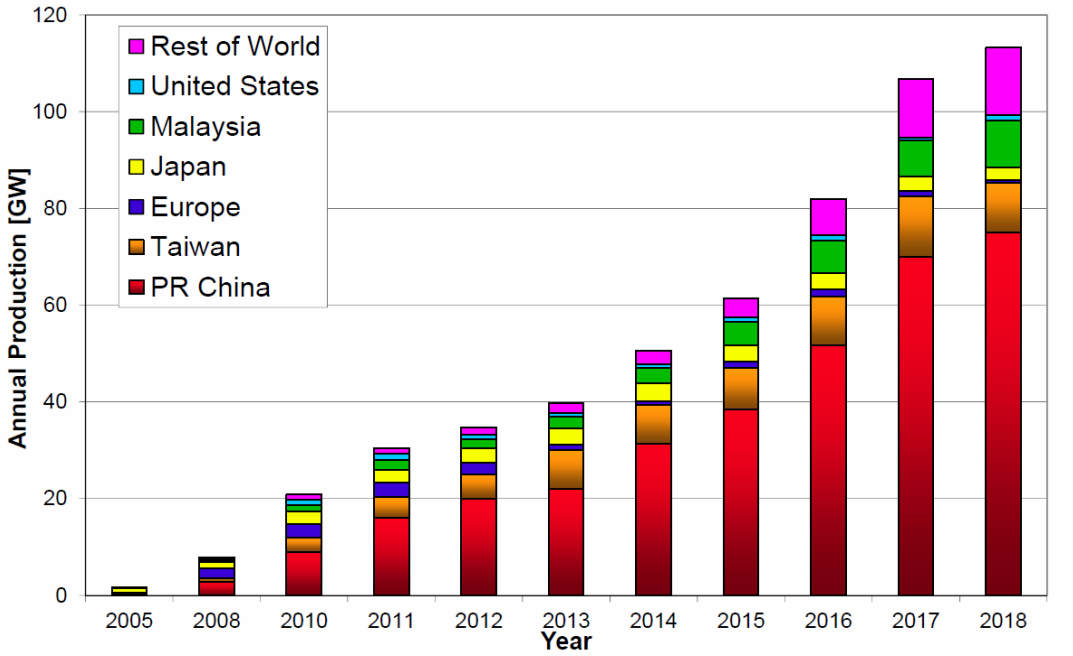

Figure 1. World photovoltaic (PV) cell/module production from 2005 to 2018 [1]

2 PV Technology

A wide range of PV materials are available worldwide. The main focus of researchers is based on the improving the materials for the production and commercialization of PV systems and great attention is paid to the features of PV cells, modules and systems in order to improve their performance [4-5].

Solar panel manufacturers have to constantly look for better solutions year by year. There is a wide range of PV cell technologies on the market today usually classified into three generations, depending on the main material used [6-8]:

First-generation PV technologies: crystalline silicon cell - monocrystalline (Mono c-Si), polycrystalline (Poly c-Si) and Amorphous Silicon Cells.

Second-generation PV technologies: thin-film solar cells - there are basically three primary types of thin film solar cells that have been commercially developed: Amorphous silicon (a-Si and a-Si/μc-Si); Cadmium Telluride (Cd-Te); Copper-Indium-Selenide (CIS) and Copper-Indium-Gallium-Diselenide (CIGS). Thin-film solar cells could potentially provide lower cost electricity than c-Si wafer-based solar cells.

Third-generation PV technologies - due to high costs of first generation of solar cells and toxicity and limited availability of materials for second generation of solar cell, a new generation of solar cells appeared. Third-generation solar technologies include: OPVs, perovskite solar cells, copper zinc tin sulphide (CZTS), dye-sensitised solar cells (DSSCs) and quantum dot solar cell.

According to data [3], high concentration multi-junction solar cells achieve an efficiency of up to 46.0% in the laboratory (Figure 2).

The goal of research on every new generation of PV is to reduce costs and improving efficiency over the previous generation.

3 Types of Solar PV Systems

Solar PV systems can be classified based on the end-use application of the technology. Two main types of solar PV systems are: grid-connected (or grid-tied) and off-grid (or stand alone) solar PV systems [9].

On-grid systems are solar PV systems that only generate power when the utility power grid is available. Those systems are simplest systems and the most cost effective to install. Off-grid solar PV systems are applicable for areas without power grid. Currently, such solar PV systems are usual-

ly installed at isolated sites where the power grid is far away, such as rural and away areas. An off-grid solar PV system needs deep cycle rechargeable batteries in goal to store electricity for use [9].

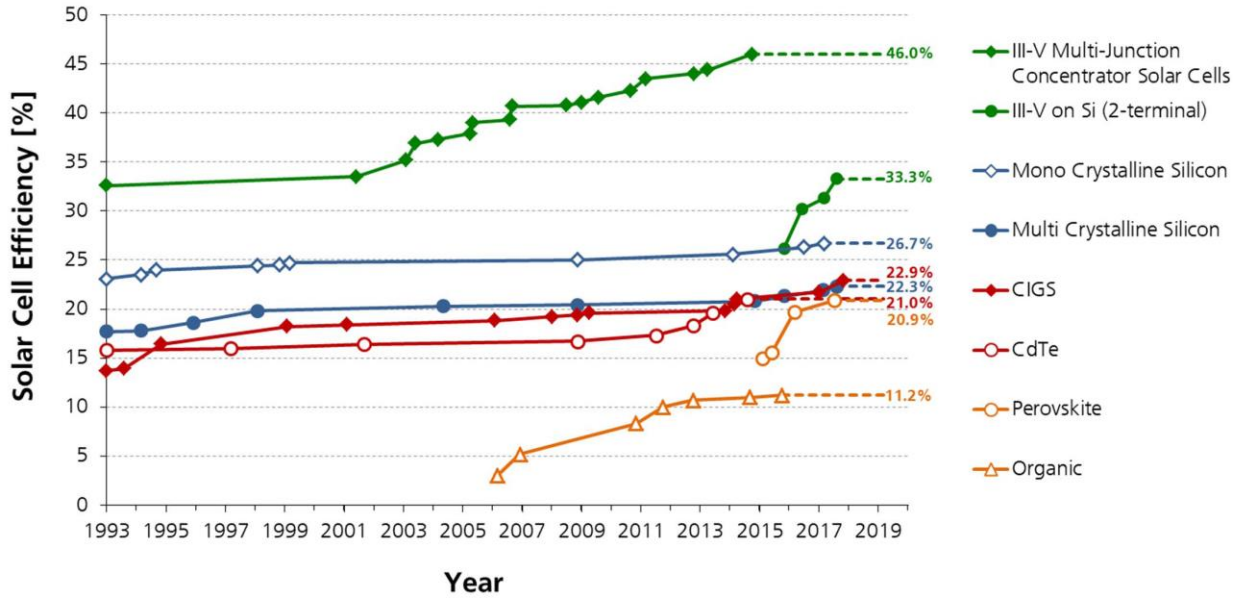

Figure 2. Development of laboratory solar cell efficiencies [3]

The cost of solar PV system depends on many factors: system configuration, equipment options, labor cost etc. An application of the PV technology, building integrated photovoltaic (BIPV) systems, has attracted great interest in the past years [9]. More cities in the world are powering streetlights with solar energy.

For home solar power systems, the most common grid design uses flat PV modules/panels. These devices can be fixed or able to follow the movement of the sun. The price for PV rooftop system for a typical 10 to 100 kWp were around 14,000 €/kWp in 1990 (in Germany). A significant reduction in the price of this system is evident at the end of 2018 - such systems cost 1,070 €/kVp in average [3].

3 Conclusion

Solar is one of the fastest growing power generation sources. The performance of a solar (PV) cell is measured in terms of its efficiency in converting sunlight into electricity. Various solar cell materials are available, which vary in conversion efficiency. A small solar or photovoltaic system can be a reliable producer of free electricity for commercial and home use.

4 Acknowledgement

This paper is a result of the projects No.34 025 and 172 060 funded by Ministry of Education, Science and Technological Development of the Republic of Serbia.

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