SOLARNA ENERGIJA U SRBIJI

SOLAR ENERGY IN SERBIA

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Razvoj obnovljivih izvora energije je od izuzetnog značaja za svaku zemlju. Srbija ima znatno veći broj časova Sunčevog zračenja nego većina evropskih zemalja, a najbolji uslovi su u jugoistočnom delu naše zemlje. Najveći deo tehnologija obnovljivih izvora energije se direktno ili indirektno napaja iz Sunca. Direktno korišćenje energije Sunca podrazumeva korišćenje solarnih panela ili kolektora pri čemu se solarna energija pretvara u toplotnu energiju i kao takva se uglavnom koristi za zagrevanje vode. Drugi vid direknog korišćenja solarne energije jeste koncentrisanje solarne energije u jednu tačku u kojoj se tečnost zagreva i kao takva se koristi za proizvodnju električne energije. Korišćenje energije Sunca ostvaruje se i primenom solarnih ćelija, odnosno pretvaranjem solarne energije direktno u električnu energiju.

Ključne reči: *obnovljivi izvori energije; solarne ćelije*

The development of renewable energy sources is extremely important for every country. Serbia has a significantly higher number of hours of solar radiation than most European countries, and the best conditions are in the southeastern part of our country. Most renewable energy technologies are directly or indirectly powered by the sun. Direct use of solar energy implies the use of solar panels or collectors where solar energy is converted into thermal energy and as such is mainly used to heat water. Another type of direct use of solar energy is the concentration of solar energy in one point where the liquid is heated and as such is used to produce electricity. The use of solar energy is also achieved by using solar cells, ie by converting solar energy directly into electricity.

Key words: *renewable energy sources; solar cells*

1 Introduction

Solar energy is a renewable and unlimited source of energy. Therefore, the development of solar technology is extremely important. Using this type of energy can ensure the production of hot water and electricity from renewable energy sources without the emission of harmful gases into the atmosphere. There are two types of solar systems that are used for the production of electricity:

- Photovoltaic modules that convert solar energy into electricity (the atoms emit electrons at the absorption of luminous energy and thus creating photoelectric effect) and
- Solar energy is focused on mirrors and concentrators at the point of maximum production of heat energy from which electricity is produced by using conventional methods (steam turbine or otherwise).

Photovoltaic cells or PV cells can be producer in many different ways as well as from a many different materials. The most common material for solar panel construction is silicon which exibit semiconducting properties [1]. Several of these solar cells are required to construct a solar panel and many panels make up a photovoltaic array.

In effect, there are three main types of PV cell technologies which are the most common in the world market: monocrystalline silicon, polycrystalline silicon and thin film. Due to high cost, high-efficiency PV technologies, including gallium arsenide and multi-junction cells, are rarer, but on the other hand, they are ideal for use space applications as well as in the in concentrated photovoltaic systems The actual PV cell technologies include Perovskite cells, dye-sensitized solar cells and quantum dots as well as organic solar cells [2].

Concerning PV module production in 2019, China (main land) holds the lead with a share of 66%, followed by Rest of Asia-Pacific & Central Asia (ROAP/CA) with 18%. Europe contributed

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with a share of 3%; USA/CAN contributed 4%. In 2019, Europe's contribution to the total cumulative PV installations amounted to 24% (compared to 25% in 2018). In contrast, installations in China accounted for 36% (same value as the year before) [3]. PV Module Production by Region - Global Annual Production is presented in Figure 1.

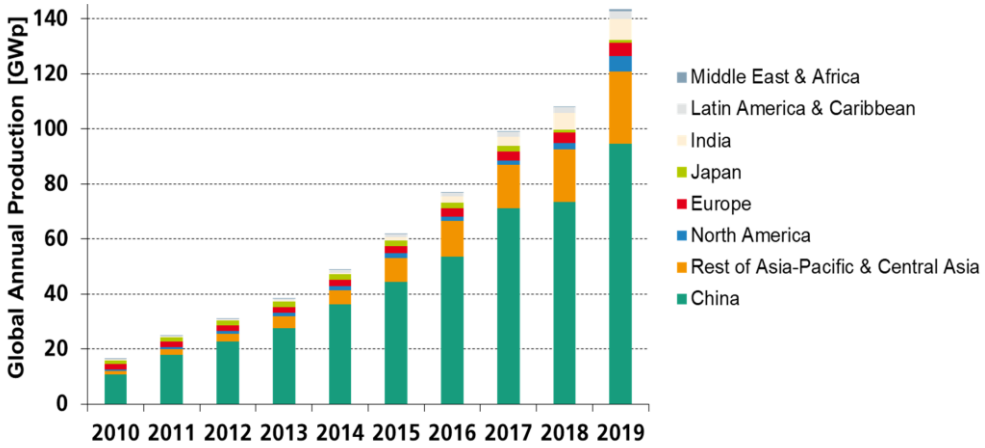

Figure 1. PV Module Production by Region - Global Annual Production [3]

2 Solar energy in Serbia

The number of hours of solar radiation is significantly higher in Serbia than in many European countries (between 1500 and 2200 hours per year) [4]. The assessment of the solar energy share in the total RES potential is 0.64 millions toe annually (16.7%) in Serbia. The most favorable conditions are in the southeastern part of the country. At the annual level, the average value of global radiation energy for the territory of the Republic of Serbia is 1200 kWh/m²/year. In north western Serbia, the average value of global radiation energy is up to 1550 kWh/m²/year. In the central part of Serbia, this value is about 1400 kWh/m²/year. The degree of radiation utilization depends on the characteristics of the built-in heat receiver, so that the average value of available useful energy in the Republic of Serbia is about 700 kWh/m^2 per year [5]. The average daily energies of global radiation on the horizontal surface in Serbia are presented in Figure 2 [6, 7, 8].

For the first time, the Government of the Republic of Serbia provided the opportunity for the construction of solar power plants in Serbia through subsidies with the by introducing the By-law on Feed-in tariffs for the production of energy from renewable energy sources and combined heat and power generation from 2009. Also, the government further increased the capacity and reduced the subsidized price through two new Regulations from 2013 and 2016 [9].

The currently prescribed quotas of the Government of the Republic of Serbia for solar are 10 MW, and it is divided as follows:

- 4 MW for solar power plants on facilities, with half of this power provided for small solar power plants up to 30kW, and the other half for solar power plants from 30 to 500 kW;
- 6 MW is prescribed for solar power plants on the ground.

3 Solar plant

Investment in larger solar power plants can lead to profit. On the other hand, for construction of such plant, it is necessary to meet technical, administrative and financial conditions and obtain a series of permits and approvals issued by competent state authorities. According to unofficial data, about 15 000 m^2 of solar collectors are installed annually in Serbia. In Kikinda, the first phase of the solar power plant was built in October 2015.Regarding all renewable sources it can be said that solar parks are the most active in Serbia from all renewable sources and 8.5 MW of these investments have been implemented since the planned 10 MW [8]. This one plant in the Kikinda is one of the largest and the second largest in Vojvodina and the fourth in Serbia. The incentive purchase price of electricity from solar energy is on average 20 eurocent·kWh^{-1} [10].

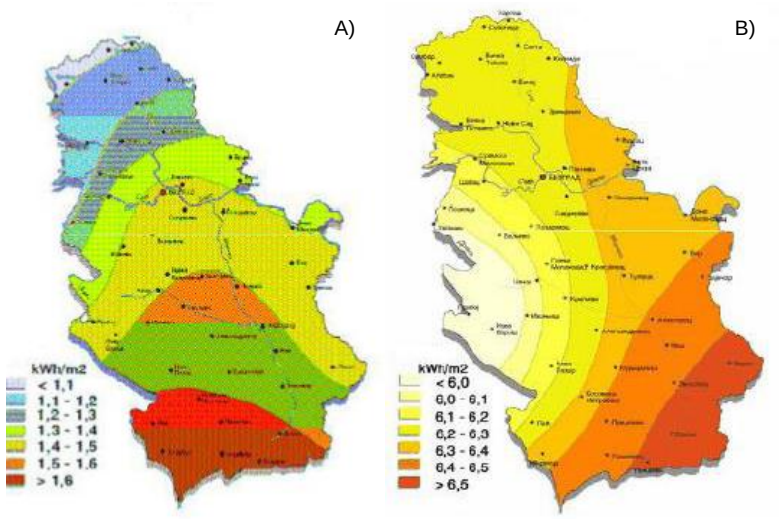

Figure 2. Average daily energy of global radiation on the horizontal surface in Serbia A) January, B) July [6,7]

Average purchase prices of electricity produced from renewable energy sources is presented in Table 1.

Table 1. Average purchase prices of electricity produced from renewable energy sources [10]

Type of power plant	*The price of the installed power (Euro·kW^{-1})*	*Average purchase price (eurocent·kWh^{-1})*
Small hydroelectric power plants	2000	9
Wind power plant	1000	9.5
Solar power plant	2000	20

4 Conclusion

Solar energy represents the energy potential of the Republic of Serbia, which can be used for the production of heat or electricity. The Republic of Serbia has favorable climate conditions for use of solar energy. Developments in the world in the field of electricity production have dictated that many plants used solar energy in the next years. Serbia's energy resources in renewable sources are a potential that needs to be used, both for the development of the local economy and society, and for energy efficiency in the country.

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