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Photovoltaic solar plants in the Republic of Srpska - current state and perspectives

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ABSTRACT

This paper focuses on the current state and perspectives of the application of PV solar plants in the Republic of Srpska. Further, the paper provides information on the PV application in Europe, geographical position, solar potential and Renewable Sources of Energy (RSE) legislative in the Republic of Srpska. Special attention is drawn to a 2.08 kWp PV solar plant installed on the building of the Academy of Sciences and Arts of the Republic of Srpska (ASARS) in Banja Luka. Experimental results obtained researching the influence of the climate conditions on the performance characteristics of PV plant on the ASARS building in Banja Luka in 2014 are given as well. It was found that the annual mean value of the energy efficiency of PV plant on the ASARS building in Banja Luka was 14.77% and that with the increase of the ambient temperature it decreased. The annual mean value of the performance ratio of PV plant was 95.9%, of the capacity factor 11.7% and of the specific yield factor 84.57 kWh/kWp. The presented results can be useful for the people working on the theory, planning, constructing, design and/or application of the PV based electricity generation systems in the Republic of Srpska.

Contents

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1. Introduction

Energy is a vital need of the economy and citizens, a generator of the development in the technological, scientific, educational and economic terms. Energy suppliers all over the world must expand energy in a way that is secure, clean, affordable, and environmentally responsible. Solar energy is an important and inexhaustible resource directly influencing economical and environmental development in any given country. Solar energy constitutes the most abundant renewable energy resource available and, in most regions of the world, its technically available potential is far in excess of the current total primary energy supply in those regions. Solar energy technologies could help address energy access to rural and remote communities; moreover, energy security and climate change mitigation are a key tool to lowering the worldwide carbon emissions. Connection between energy, economy and ecology is a very important element of the economic and political stability of each country and the Republic of Srpska as well. Energy is a milestone in the development of civilization and is included in all important documents of the European Union addressing economic development, energy efficiency, poverty reduction and the environmental issues. According to the European Union's Strategy, by the year 2020 a share of the renewable sources in the total energy production will have been 20% [1–8].

Photovoltaic (PV) energy power systems are considered to be the most dominant technology among renewable energy technologies primarily because it is unlimited and the cleanest energy of the solar power systems. Many studies show that PV systems will have an important share in the electricity of the future. PV solar plants contribute to a more efficient use of any given country's potentials in the electricity production, reduction of greenhouse gas emissions, decrease of import and use of fossil fuels, development of local industry and the creation of new jobs. Over recent years investments into research, promotion, development and production of the PV systems and their components have been increasing. Up to now several thousands of PV solar plants power of 1 kW to several hundreds of megawatts have been installed. PV industry is being increasingly represented in the national energy strategies of the large number of countries. There is ever growing number of countries using PV solar plants for the commercial purposes [1–11].

The role of energy sector of the Republic of Srpska is to support growth and development of the country's economy taking into account environmental protection and the increased use of renewable energy sources for heating and electricity generation. In line with the above mentioned, the use of PV systems for the electricity generation has been more and more in the focus of attention, particularly with regard to the application of the photovoltaic systems in combination with other sources of energy for electrification of the facilities and settlements [11–15].

Besides, the Republic of Srpska has legal conditions for the installation and use of PV solar plants but its Solar energy sector and particularly the one in Bosnia and Herzegovina (B&H) are insufficiently developed. Thus the Republic of Srpska becomes largely inferior to the neighboring and the developed countries in investigations of the PV conversion of solar radiation and the PV systems application. There is no structure of professional and academic organizations dealing with solar energy since most of them do it as a secondary activity. The private businesses either are not structured to interact with the academic, professional and institutional sectors. Within the solar sector the technology which is most developed in B&H is the solar thermal (companies, universities, etc). Available literature provides scarce information and rare studies that present all the factors affecting efficiency and the operation of the entire PV system. Up to now there were no investigations, in real conditions, of the meteorological parameters influence on the performance of the on-grid PV solar plants in the Republic of Srpska [11–15]. In this paper, current state and perspectives of the PV solar plant application in the Republic of Srpska, and the experimental results of the performances analysis of the 2.08 kWp PV solar plant installed on the ASARS building in Banja Luka are described.

2. PV application in Europe

A dramatic increase in the energy consumption worldwide and in the European Union (EU) since the Industrial Revolution has incurred a dependence on the external energy sources that could reach 70% in 2020. Fortunately, there is a growing social awareness of the negative environmental impacts of the fossil fuel energy as well as the environmental problems related to the use of nuclear energy. This new social conscience of the environmental problems and possible solutions will directly affect energy challenges in the future signifying a reduced fossil fuel energy consumption and an increased production of the renewable energies, or energies generated from the natural resources [16]. Therefore, renewable energy use is growing at a much faster pace than the rest of the economy in Europe and worldwide. This and the dramatic oil price increase in 2005 have lead to a remarkable re-evaluation of the renewable energy sector by politics and financing institutions. Despite the discrepancies between the European Union and the USA's climate change policies, renewable energies will play an important role in the implementation of the Kyoto Protocol and the worldwide introduction of the tradable green certificates. Apart from the electricity sector, renewable energy sources for heat generation and the use of the environment friendly bio-fuels in the transport sector will be increasingly important in the future [17].

Since the inception of the Kyoto Protocol adopted in 1997 and entered into force in February 2005, countries worldwide have adopted different measures for the emission reduction such as electricity generation from the renewable energy sources these being free from greenhouse gas (GHG) or CO_2 emission. Legislation and financial incentives have been provided by some governments to encourage and ensure good returns to the investors in the renewable energy sector [18].

Among various renewable energy technologies today PV attracts considerable attention due to its potential to contribute a major share of the renewable energy in the future. Photovoltaic has experienced remarkable growth in recent years due to both technological improvements resulting in cost reductions and government policies supportive of the renewable energy development and utilization. In effect, PV was the first source of electricity installed in Europe in 2012 [3,19]. With a cumulative installed capacity of over 29 GW, the European Union is leading in PV installations with more than 70% of the total worldwide 39 GW of the PV electricity generation capacity at the end of 2010 [17].

The paper [20] claims that the main European country for the electricity production from PV panels is Germany, which in 2011 amounted a cumulated capacity equal to 24,875.0 MW, accounting for 48.5% of the total capacity in the European Union (Table 1).

In 2012, at least 28.6 GW of PV power was installed in the world, bringing the cumulative PV capacity to around 96.6 GW at the end of 2012. In Europe, PV systems for a total rated power equal to 17.27 GW were installed in 2012, below 22.13 GW of 2011, bringing the PV cumulative capacity to 69.6 GW. German remains at the forefront, with 7.604 GW of the installed PV power in 2012, followed by Italy (3.647 GW), France (1.079 GW), the U.K. (0.925 GW) and Greece (0.912 GW). Spain, despite an impressive growth over recent years (especially in 2008), is ranking third in Europe for the cumulative PV capacity (4.706 GW) lagging behind