19h International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2015, Barcelona, Spain 22-23 July 2015

PRACTICAL EXPERIENCES WITH TWO PV PLANTS WITH INSTALLED POWER OF 30 KW AT TWO SITES IN CENTRAL BOSNIA

Nihad Vejzović master, dipl.ing.
Mašinski fakultet u Zenici, Fakultetska 1., BiH

Prof. dr. Nagib Neimarlija
Mašinski fakultet u Zenici, Fakultetska 1., BiH

Doc.dr. Azrudin Husika,
Mašinski fakultet u Sarajevu, Vilsonovo šetalište 9., BiH

ABSTRACT
This paper analyzes the performance, and the ultimate effects of the existing PV solar power plants at two sites (Begov Han in Žepče and Mravići in Doboj jug) in central Bosnia. Both plants have installed capacity of 30 kW, but the expected annual production of electricity is significantly different, as follows: for "SE EMY 1" is 34.56 MWh, and for "SE EMY 2" is 40.93 MWh. Monitoring of operation of the two PV power plants is continuous. In this paper, because of the extensive analysis of the review, daily data for the month of October 2014 are given, and then for the months of October, November and December 2014. Also the data on the installed PV power plants in FB&H, as well as future plans and constraints in B&H related to the construction of PV power plants are given.
Keywords: solar energy, fotopanels, solar power plant, reduction of emissions.

1. INTRODUCTION
In the Federation of Bosnia and Herzegovina (FB&H) so far, there are more than 230 PV power plants registered, while around 30 is constructed, and only 16 of them have the privilege to sell electricity to the grid according to the feed in tariffs which enable quick payback of investments. The surplus fee for electricity from renewable energy, paid by the final customers of electricity, the Federal Government used to purchase energy from PV power plants by ten times higher price than the market price is. JP EP BiH paid electricity produced in solar power plants at a price of 920 BAM/MWh, EP HZHB at a price 736 BAM/MWh. Period of electricity purchasing by subsidized prices lasts 12 years, so that investors in this period investment paid off, however, analysis of the Ministry of Energy, Mining and Industry of the Government of FB&H show that the payback period was up to six years. Therefore, in 2013 feed in tariffs for PV decreased and recently, the whole system is managed by Operator for renewable energy and efficient cogeneration of FB&H.
In early 2012, the FB&H Government has introduced the obligation of issuance of energy approvals which determines whether an energy facility be eligible for the incentive. The new criteria for the use of the funds for incentives from renewable energy sources say that incentives which will be disburse are equal to available funds. Feed in tariffs depends on PV capacities. Recently, 7 PV power plants up to 150 kW, 25 PV power plants up to 30 kW, and 50 micro PV power plants up to 10 kW receive feed in tariffs.
At the beginning of 2014 new investment opportunities has been opened in the PV power plants in FB&H, after adoption of Law on renewable energy sources and efficient cogeneration in FB&H. Operator for renewable energy has been established, located in Mostar. The law eliminated the restriction of signing new contracts, and the FB&H Government in May 2014 adopted the Action Plan

for the use of renewable energy sources by 2020, and formed a new electricity purchase price that is less for 30-40% than the previous one. According to the plan in the FB&H Government will encourage commanded six years a total of 12 MW of installed capacity of PV power plants, which is ten times more than in 2013.

The first PV power plant in the FB&H has built by the company " EcoEnergy " from Kalesija, installed capacity of 120kW and connected to the grid through JP EPB&H in 2012. The company "EMY" doo Zenica has invested in the construction of two PV power plants in accordance with the applicable legal regulations in FB&H. Regulatory Commission for Energy in the FB&H issued authorization for the production of electricity in solar PV power plant "SE EMY 1" in Begov Han installed capacity of 30.00 kW and estimated annual production of 34.56 MWh, which is located in the resort Luke, Begov Han of Žepče and solar PV power plant "SE EMY 2" in the municipality of Doboj jug installed capacity of 30.00 kW and planned annual production of 40.93 MWh [1, 2, 3].

Basic parameters, method of construction and technical characteristics are given in tables and photographs in the further part of this paper. Figure 1 shows the assembly fotopanels type SLA 255 M3A of manufacturer's "Solaris" d.o.o. from Croatian to solar PV power plant "SE EMY 1", Begov Han, Žepče municipality. Table 1 presents the location parameters and technical characteristics of the two solar photovoltaic (PV) power plants.

Figure 1 PV power plant "SE EMY 1" Begov Han, municipality Žepče, [1]

Table 1 Parameters of the location and technical characteristics of solar PV power plants, [1, 4]

No.	SPECIFICATIONS	Unit	"SE EMY 1"	"SE EMY 2"
1	Location	-	Begov Han, Žepče	Mravići, Doboj jug
2	North latitude	-	44° 21“ 00´	44° 40“ 53´
3	East longitude	-	18° 00“ 00´	18° 04“ 03´
4	Renewable Energy	-	solar energy	solar energy
5	Design Object	-	roof	free standing
6	Free surface	m^2	260,30	230,00
7	Number of PV panels	pieces	130	132
8	Surface of the PV panels	m^2	213,20	216,50
9	Type PV panel	-	Eco smart line LX-250P	Eco line LX 250P
10	Manufacturer PV panel	-	Luxor Solar GmbH	Luxor Solar GmbH
11	Dimensions of PV panels	mm	1640x992x40	1640x992x45
12	Number of PV cells in the panel	pieces	60	60
13	The mass of the PV panels	kg	18,00	21,00
14	Installed power	kW	30,00	30,00
15	Annual energy production	MWh	34,56	40,93
16	Nominal level of efficiency	%	11,00	11,00

2. PRACTICAL EXPERIENCE IN PRODUCTION

Practical experience in operation of solar PV power plants, with automatic control and management, has led to the production of indicators which show difference in produced amounts of energy in the aforementioned two PV power plants. They have the same installed capacity, the same technical characteristics of PV panels, minor differences in the number of PV panels (130 for "SE EMY 1" and 132 for "SE EMY 2"), but still created quite a big difference in electricity production in the period October-December 2014. Registered period was the worst period in the area of central Bosnia for solar power plants, because of the low trajectory of the sun, short days and very often the period of cloudy or foggy weather. Due to favorable climatic and geomorphologic position "SE EMY 2" produced higher amount of energy in every month for a total of 5,250 kWh, while the "SE EMY 1" in the reporting period produced 3,139 kWh. In Figure 2 daily amounts of electricity generation in October 2014 in PV power plants "SE EMY 1" and "SE EMY 2" are given. Table 2 shows the amount of electricity generated in the last three months of 2014.

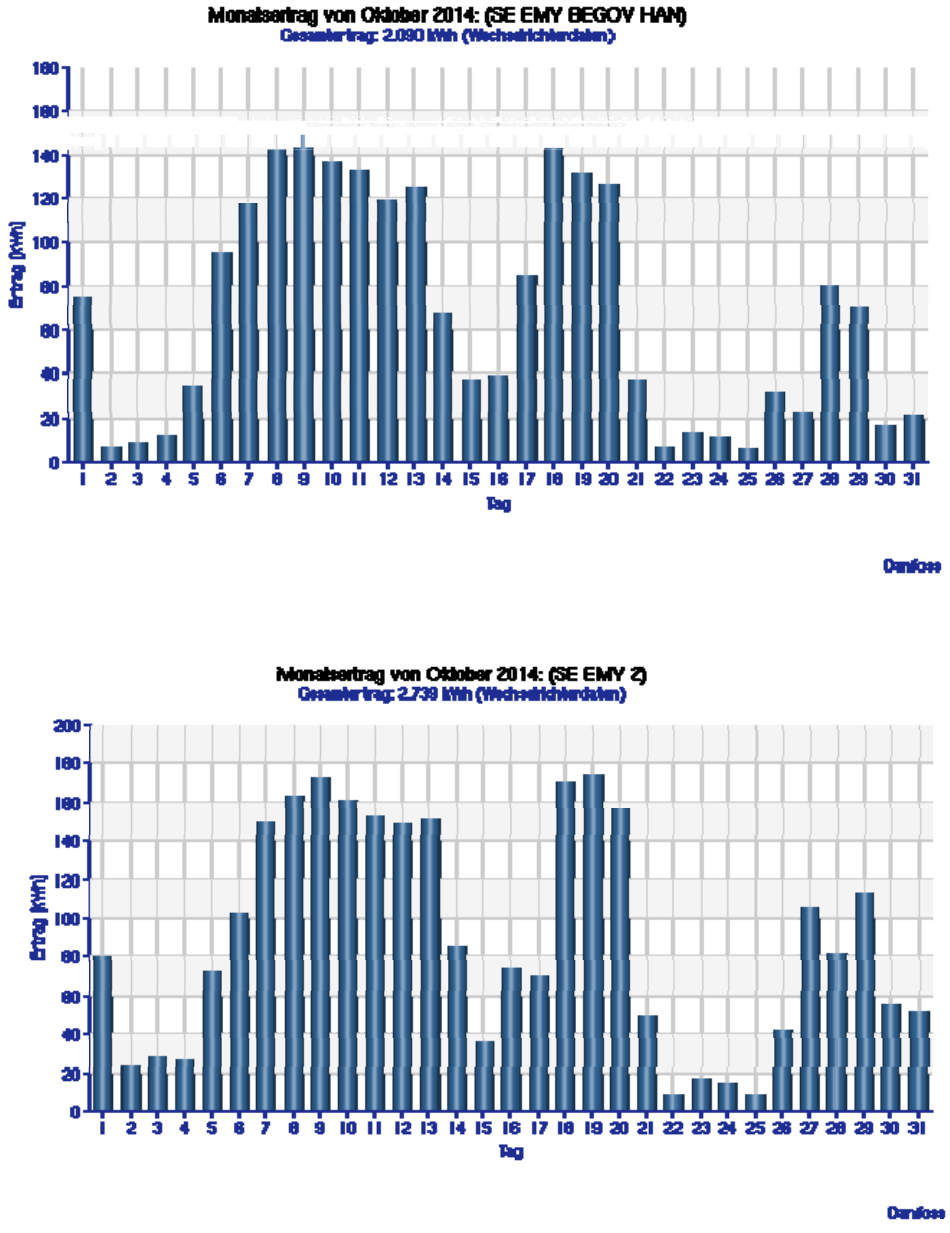

Figure 2 Daily energy production for October 2014 in PV power plants ''SE EMY 1'', Begov Han, Žepče municipality and ''SE EMY 2'', Mravići, Doboj jug municipality, [1]

Table 2 The amounts of electricity generated in PV power plants, [1]

	Month in 2014	UNIT	‘’SE EMY 1’’	“SE EMY 2”
1.	October	kWh	2,090	2,739
2.	November	kWh	815	1,627
3.	December	kWh	234	884
4.	TOTAL	kWh	3,139	5,250

3. CONCLUSION

The charts and tabular data of daily production of electricity in solar PV power plants "SE EMY 1" and "SE EMY 2", when comparing the micro location, expected annual production, installed capacity and actual daily production of two solar PV power plant can be determine the following:

- diagram in Figure 2 clearly shows that the individual days did not generate the same amount of electricity in PV power plants;
- from Table 2 it is clear also that the PV power plant "SE EMY 2" has total production of electricity significantly higher than the PV power plant "SE EMY 1", especially for the months of November and December. The only explanation for that are differences of microclimate conditions;
- data confirms that solar facilities, although the same capacity and technical characteristics, should not produce the same amount of electricity;
- the central Bosnia microclimate conditions change significantly during the day, month and year;
- the presented experience confirms that in the calculation, design and development of solar PV systems it is required to know solar radiation on a tilted surface of a solar panel (receiver) for a specific micro-location.

4. REFERENCES

[1] Vejzović Nihad, *Analiza primjene energije Sunca kao nekonvencionaklnog obnovljivog izvora energije na području zeničke kotline*, (in bosnian), master rad, Mašinski fakultet u Zenici, april 2015.
[2] Zakon o električnoj energiji u FBiH (Službene Novine FBiH 66/13)
[3] Zakon o korištenju obnovljivih izvora energije i efikasne kogeneracije (Sl. novine FBiH 70/13)
[4] Dozvola za rad za proizvodnju električne energije izdata od strane Regulatorne komisije za energiju u FBiH – FERK
[5] Pravilnik o obaveznom udjelu i preuzimanju električne energije proizvedene iz obnovljivih izvora
[6] Pravilnik za mikro-postrojenja obnovljivih izvora energije