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CURRENT STATE OF THE RENEWABLE SOURCES OF ENERGY USE IN SERBIA

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Abstract: This paper reviews the current state of the renewable energy use in Serbia. Further on, the paper describes energy potential and gives examples of the use of solar energy, wind energy, hydropower, geothermal energy, biomass and biogas in Serbia. Extensive body of information is given about support systems and measures of incentives for the investment in the construction and sale of electricity from plants using renewable energy sources. In conclusion, achieved results of the use of renewable energy sources in Serbia and the incentives for their use are presented.

Keywords: solar energy, wind energy, hydropower, geothermal energy, biomass, biogas.

1. INTRODUCTION

Technically exploitable potential of the renewable energy sources (RES) is estimated at about 5.6 million tonnes of oil equivalent (Mtoe) per year as follows: about 3.4 Mtoe of biomass, around 1.7 Mtoe of hydropower, around 0.2 Mtoe of geothermal energy, around 0.1 Mtoe of wind energy, about 0.2 Mtoe of solar radiation energy and about 0.04 Mtoe of biodegradable waste. The Republic of Serbia now uses 35% of the total available technical potential of the renewable energy.

So far the use of renewable energy in Serbia has been based on the production of electricity from large river flows and the use of biomass mainly for households heating and to a lesser extent in industry. According to the available data on the energy balance of the Republic of Serbia for 2009, a share of electricity generated from the renewable energy resources in gross final energy consumption (GFEC) amounted to 9.6% (28.7% in the electricity sector), while the share of thermal energy generated from biomass in GFEC amounted to 11.5% (27.5% in the heating and cooling sectors).

Since 2009 the interest in the use of renewable energy in Serbia has been constantly growing. Increased interest for the construction of facilities using renewable energy began by adopting: the Energy Law (Official Gazette of the Republic of Serbia, no.57/11 and 80/11); Decree Amending the Decree on Establishing the Implementation Program for the Energy Development Strategy of the Republic of Serbia until 2015, for the Period from 2007 to 2012 − Renewable Sources of Energy (Official Gazette of the Republic of Serbia, no.99/09); Decree on Conditions for Obtaining the Status of Privileged Power Producers (Official Gazette of the Republic of Serbia, no.72/09) and the Decree on Incentives for the Production of Electricity Using Renewable Energy Sources and Combined Production of Electricity and Jeat (Official Gazette of the Republic of Serbia, no.99/09). The information mentioned above is published in the Official Gazette of the Republic of Serbia, no.53/2013 [1,2].

At the end of March 2012, the *Electric Power Industry of Serbia* (EPS) signed a Memorandum of Understanding with the representatives of the companies from Spain for the production of electricity from renewable energy sources. In this regard it is realistic to expect progress in the production of electricity from small hydropower plants, wind energy, biomass and solar energy. When signing the Memorandum it was pointed out that *EPS* plans to renovate 23 small hydropower plants in which about 45 million Euro should be invested by the *European Bank for Reconstruction and Development (EBRD).*

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Moreover, a possibility of building new small hydro power plants in Serbia was considered. The Serbian Ministry of Energy has issued about 150 energy permits for the construction of small hydropower plants in Serbia with the total capacity of about 150 MW, 12 licenses for the use of wind power with total output of 1,400 MW and a few permits for biomass power plants [1-4].

2. SOLAR ENERGY

The average value of the global solar irradiation on the yearly basis for the territory of the Republic of Serbia ranges from 1200 kWh/m^2/year in Northwest Serbia to 1550 kWh/m^2/year in Southeast Serbia. Due to this fact Serbia exhibits favorable conditions for the use of solar energy and its conversion into thermal and electrical energy [1,4−11].

Thermal solar energy conversion

During the period from 1978 to 1985 there were several manufacturers of solar radiation flat-plate collectors in Serbia: *Nissal* in Nis, *Sinvoz* in Zrenjanin, *Petar Drapsin* in Novi Sad, *Gosa* in Smederevska Palanka, *Jugoterm* in Gnjilane, etc. However, after 1985 the manufacturers' decline of interest seriously affected the production of solar collectors. Nowadays flat-plate collectors with water are produced by the following companies: *Termovent* in Belgrade, *El-Sol* in Pozarevac, *Jugoterm* in Nis, etc.

Today the companies *ETAZ*, *Viessmann* and *Conseko* in Belgrade, *Magmont* in Pirot, *Energo Pro-Teh* in Zrenjanin, *Termogas* in Senta, *El-Sol* in Pozarevac, *CIM Gas* in Subotica etc., are designing and installing solar energy thermal systems. Solar water heaters and differential thermostats are produced by several private companies in Serbia. The biggest solar energy products trade companies in Serbia are *ETAZ* and *Viessmann* in Belgrade. Quality differential thermostats for low temperature conversion systems are produced by *Enings Ltd.* in Nis.

Solar flat-plate collectors with water are used to heat sanitary water in households, hotels, hospitals, military and other facilities in Serbia. The list of some installed solar systems for sanitary water heating in Serbia is given in Table 1.

Some examples of the installed solar systems in Serbia are given in Figures 1− 4.

Table 1. The list of some installed solar systems for sanitary water heating in Serbia

Solar systems for sanitary water heating	Number of collectors	Year
On the building of the psychiatric hospital in Toponica	10	2010
On the building of the *Health Center* in Pirot	96	2010
On the building of the *Hospital for Special Rehabilitation* in Banja Koviljaca	64	2012
On the building of the swimming pool in Babusnica	240	2012
On the building of the ACC in Kragujevac	198	2012
On the building of the hospital in Subotica	144	2013
On the building of the Special Hospital in Slankamen	80	2009
On the building of the Institute of Orthopedic Surgery *Banjica* in Belgrade	48	2014
On the building of the Gerontology Center in Pancevo	47	2011
On the building of the Hospital in Vrnjačka banja	24	2013
On the building of the home *Heart* in Jabuka	20	2014
On the building of the Gerontology Center in Kanjiža	10	2011
On the building of the Children's Resort *Golija* in Zlatibor	10	2014
On the building of the General Hospital Dr Djordje Jovanovic	200	2009
On the building of the Boarding School Angelina Kojic–Gina in Zrenjanin	20	2009
On the building of the *Cradle* -the disabled youth home in Subotica	160	2009
On the building of the hotel *Danubia garni* at Silver Lake near Veliko Gradiste	30	2011
On the building of the *Food and Catering School* in Cacak	-	2009
On the building of the kindergarten *Lugovi* in Cacak	-	2009
On the building of the *Culture and Sports Center* in Obrenovac	27	2009
On the building of the swimming pools in Obrenovac	40	2009
On the building of the *Disabled Youth Daycare* in Obrenovac	5	2009

Figure 1. Swimming pool in Babusnica, 240 collectors, 2012.

Figure 2. ACC in Kragujevac, 198 collectors, 2012.

Figure 3. Hospital in Subotica, 144 collectors, 2013.

Figure 4. Special hospital in Slankamen, 80 collectors, 2009.

Vacuum collectors for water heating are used in Serbia in several places such as hotels and residential households. On the roof of the *Vojvodina* hotel in Zrenjanin there are ten tube-vacuum collectors.

The first project on the high temperature solar energy conversion in Serbia was realized in Badnjevac, a village near Kragujevac. The project was implemented according to the design of full professor Vladan Petrovic, PhD, and solves two major solar energy problems, the efficient conversion of solar radiation into thermal energy and the thermal energy storage for a longer period of time [1,3,4,6−8].

Photovoltaic solar energy conversion

In the village of Matarova near Merdare, municipality of Kursumlija, on April 23, 2012 the Italian company *Gascom,* in cooperation with the local company *Solar Matarova* from Novi Sad began the construction of 2 MWp PV solar power plants. The construction of the PV solar power plant was finished on August 23, 2013, when a contract with EPS (a power distribution company) on the feed-in tariff for electrical energy selling, was signed. The plant has 8100 polycrystalline solar modules.

PV solar park in the village Velesnica near Kladovo consists of two PV solar power plants, *Solaris 1* and *Solaris 2* (Fig.4). PV solar power plant *Solaris 1*, of 999 kWp, began to be constructed in July 2013 and was completed in November 2013 and commissioned on December 27, 2013. PV solar power plant *Solaris 1* consists of polycrystalline silicon modules 245 Wp, manufactured by *Yingli Solar*. PV solar power plant *Solaris 2*, of 999 kWp, began to be constructed in August 2014, was completed in October 2014 and commissioned on October 24, 2014. PV solar power plant *Solaris 2* consists of polycrystalline silicon modules 250 Wp, manufactured by *Yingli Solar*. Between PV solar power plants Solaris *1* and *Solaris 2* there is a transformer station 35/0.4 kV, with rated power 2x1000 kVA, which allows the distribution of the entire electricity produced in the electrical distribution system [1,3,4,5−9].

More than 200 independent PV solar power plants of 1-60 kWp have been installed in Serbia so far. Moreover, several small rooftop PV solar power plants connected to the grid were installed. The list of some installed PV solar power plants of 1-60 kWp in Serbia is given in Table 2.

Some examples of the installed PV solar power plants in Serbia are given in Figures 5 and 6.

Table 2. The list of some installed PV solar power plants of 1-60 kWp in Serbia

PV solar power plant	kWp	Year
On the building of the private company *Domit* in Leskovac	34.32	2012
On the building of the *Technical School* in Pirot	4.59	2013
On the building of the Faculty of Sciences and Mathematics in Nis	2.08	2012
On the building of the Faculty of Electronic Engineering in Nis	1.2	2011
On the residential house in Batusinac	10	2012
In the village of Cortanovci	10	2012
In Backa Topola	7.5	
In Ralja	4.5	
In the yard in village Blace near Kursumlija	10	2011
On the building of the secondary school in Varvarin	5	2010
On the building of the secondary electro -technical school *Rade Koncar* in Belgrade	5	2010
On the building of the secondary technical school *Mihajlo Pupin* in Kula	5	2010
On the building of secondary technical school in Varvarin	5	2010
On the roof of the daycare center in Bezanijska kosa	3	2012
On the building of the *Elektrovat Ltd*. in Cacak	54.72	2012
On the building of *Mihajlo Pupin Institute* in Belgrade	50	2013
On the roof of the Faculty of Technical Sciences in Cacak	1.05	2008
On the building of the *Faculty of Technical Sciences* in Novi Sad FTS1	9.6	2011
On the building of the *Faculty of Technical Sciences* in Novi Sad FTS2	15.9	2015
On the building of *Elektromehanika Ltd*. in Nis	30	2014
On the building of *Hemofrigo Ltd.* in Leskovac	60	2012
On the building of the primary school *Dusan Jerkovic* in Ruma	3	2004

Figure 5. PV solar power plant FTS2 of 15.9 kWp on the building of the Faculty of Technical Sciences in Novi Sad

Figure 6. PV solar power plant Elektrovat of 54.72 kWp in Cacak (Elektrovat Ltd., Cacak)

Solar Architecture

Several houses according to the passive solar architecture principles have been built so far in Boljevci, Kać, Mladenovac, Belgrade, Sombor, Zaječar, Ljig, Novi Sad, etc. In Boljevci (Srem) there is an ecology glass dome-shaped house, with the front side covered in glass and back side earthbased. The ecology house is constructed as a double shell enabling the air circulation through the house interior and the heat battery. The maximum solar radiation incidence is realized by the combination of the active system (solar collectors) and passive (solar radiation incidence on the south, glass covered side of the house). At the bottom of the house there is a battery heat of 600 tons of stone and concrete. The house is heated by the air circulation from the basement heat store. The house saves around 50% of energy needed for its heating [1,4,6-8].

3. WIND ENERGY

The wind energy potential in Serbia ranges from 8-15 GW. There are several locations suitable in Serbia for the construction and operation of wind generators such as:

− Pannonian Plain - whose wind energy potential is estimated at 2000 MW;

− Zlatibor, Žabljak, Bjelasica, Kopaonik, Divčibare where by measurement one could determine suitable locations for wind energy applications;

− Parts of Eastern Serbia such as Stara Planina, Vlasina, Ozren, Rtanj, Crni Vrh, Deli Jovan, etc., where the average wind speed exceeds 6 m/s. This area covers an area of 2000 km^2 and has a wind energy potential of 2000 MW.

In Serbia, research is currently conducted to assess the wind energy potential in several locations as well as the possibility of building wind generators on them. In Subotica the *Sever* factory in cooperation with the German company Siemens produces generators for wind turbines. So far, several low-power wind generators have been built in Serbia in private sector. In mid-November 2015 in Kula (Vojvodina) the first wind power plant built by the company MK "*Fintel Vind*" was put into operation. Wind power plant in Kula consists of three wind generators with power of 9.9 MW and the height of 178 meters making it the highest in Southeast Europe. In the coming year the plan is to build and put into operation 2 more wind generators near Vrsac, with power of 6.6 MW. Despite the significant potential, Serbia still insufficiently uses the wind energy for electricity production [1,3,10−15].

4. HYDROENERGY

The most important renewable energy resource of Serbia is hydro potential (around 17000 GWh); of which up to date around 10,000 GWh has been used. The installed capacity of hydropower plants in Serbia is 2831 MW, which represents 34% of the total installed electric power resources for electricity generation. Around 9930 GWh per year is produced in these plants, which represents 25.5% of the total annual electricity production in Serbia. An overview and characteristics of some active hydro power plants in Serbia is shown in Table 3.

Table 3. An overview and characteristics of some active hydropower plants in Serbia

TYPE AND POWER OF HYDROPOWER PLANTS IN SERBIA						
Name	No. of generators	Active power (MW)	Type of hydro-power plant	Annual production (GWh)	Lake volume (m³)	Total (MW)
Danube						
Đerdap I	6	176.3	Dam	5489	2800 mil	1026
Đerdap II	10	27	run-of-river	1504	716.5 mil	270
Drina						
Zvornik	4	24	pre-dam - run-of-river	550	89 mil	96
HE Bajina Bašta	4	91.5	pre-dam	1819	340 mil	366
RHE Bajina Bašta	2	307	reversible	501	170 mil	614
Lim						
Uvac	1	36	derivational	-	213 mil	36
Kokin Brod	2	11	pre-dam	-	250 mil	22
Bistrica	2	51	accumulative	-	7.6 mil	102
Potpeć	3	17	pre-dam	-	27.5 mil	51
Zapadna Morava						
Ovčar	1 1	2.2 3.3	run-of-river	-	1.5 mil	5.5
Međuvršje	1 1	2.5 4.5	run-of-river	-	13 mil	7
Vlasina						
Pirot	2	40	accumulative	87	180 mil	80
Vrla 1	2 2	11.2 14.2	accumulative	-	165 mil	50
Vrla 2	1 1	10.7 13.3	accumulative	51	0.1 mil	24
Vrla 3	1 1	12.8 16.6	accumulative	73	-	29.4
Vrla 4	1 1	11.2 14.2	accumulative	63	0.1 mil	25.4

31 small hydropower plants with a total output of 34.654 MW and annual electricity production of 150 GWh are in operation in Serbia today. 38 small hydropower plants with a total output 8667 MW and estimated annual production of 37 GWh are out of service. The small hydro power plants in Serbia are hydroelectric Pod gradom, Vučje, Sveta Petka, Gamzigrad, Moravica, Vrelo, Jelašnica, Turica, Sićevo, Temac, etc. [1,3,10,16-18].

5. GEOTHERMAL ENERGY

By its geothermal resources potential Serbia belongs to the richer countries. In Vojvodina, systematic research began in 1969 when the first hydrogeothermal well Subotica S-1 was drilled. To date, 68 wells have been drilled at the depth of 800-1200 m. Total installed heat capacity of all constructed geothermal systems in Vojvodina amounts to approximately 24 MW, whose use in 1992 saved approximately 5000 tons of oil equivalent. At present only 9% of geothermal energy potential in Serbia is used. Based on the previous research studies one can conclude that most of Vojvodina is promising for the geothermal water temperature of about 90 ° C. The list of some geothermal wells and springs in Serbia is given in Table 4.

Table 4. List of some geothermal wells and springs in Serbia

Location	Temperature (°C)	Efficiency (l/s)	Thermal power and spring potential	
			(MW)	(ten/god)
Banja Koviljača	30	120	5.04	3784
Bečej	36	28.3	5.11	3838
Bioska	37	35	2.5	1876
Bogatić	75.5	37.5	8.74	6563
Brestovička banja	40	10	0.84	631
Bukovička banja	34	26	1.53	1148
Visočka banja	85	44	12.01	9019
Vrdnik	33	22	1.2	902
Vrnjačka banja	34	6	0.35	265
Jošanička banja	78	15	3.65	2744
Kuršumlijska banja	55	20	2.94	2208
Lukovska banja	65	20	3.78	2838
Ljig	32	5	0.25	189
Mataruška banja	43	34	3.28	2466
Niška banja	38	40	3.02	2271
Niška banja	34	20	1.43	1072
Niška banja	37	50	3.57	2681
Novi Sad	36	13.3	0.89	671
Novopazarska banja	52	10	1.34	1009
Ovčar banja	38	50	3.78	2838
Palić jezero	48	12.2	1.43	1077
Pribojska banja	36	70	4.70	3532
Prigrevica banja	51	20.8	2.71	2033
Prigrevica banja	59	9.2	1.51	1132
Prigrevica banja	56	25	3.78	2838
Prolom banja	31	6	0.28	208
Prolom banja	30	6	0.25	189
Rajčinovića banja	36	8	0.54	404
Ribarska banja	44	37	3.73	2800
Ribarska banja	55	10	1.47	1104
Sijarinska banja	72	8	1.75	1312
Smederevska Palanka	50	2	0.25	188
Sokobanja	44	18	1.81	1362
Sokobanja	37	10	0.71	536

Serbia uses only geothermal energy from geothermal and mineral water, mainly in the traditional way, for therapeutic and sports and recreational purposes. The use of geothermal energy for heating and other energy purposes is at an early stage and very modest compared to the potential of the geothermal resources. In Vojvodina, the energy utilization of geothermal waters dates back to 1981. For these purposes 23 wells are used. Water from two wells is used for the production of vegetables in greenhouses. Three wells are used in livestock for pig farms heating, two in leather and textile factories in the manufacturing process, three for heating commercial buildings while thirteen wells are used in spas, sports and recreation and tourist centers. The total thermal capacity of these rigs is 24 MW.

Outside of the Pannonian basin or outside of Vojvodina, geothermal water is used for heating in Vranjska banja, Kuršumlijska banja, Niska banja, Prolom banja, and the most important geothermal resources are located in the area of Mačva, Vranjska banja and Josanicka banja [1,3,10,19−22].

6. BIOMASS

Total biomass energy potential in the Republic of Serbia is estimated at around 3.4 Mtoe and comprises remains or waste in forestry and wood industry, in farming, livestock raising, fruit growing, vine growing and primary processing of fruits. Serbia has relatively high biomass energy potential. Forest biomass accounts for 39.8% of the total energy potential of biomass in Serbia. Of all the forms of biomass, the one most exploited currently in Serbia, in terms of energy, is the wood biomass. In addition, a very important source of biomass in Serbia (particularly in Vojvodina) is plant biomass in agriculture (crop residues from plant, fruit and grape production).

The great potential of biomass in Serbia lies in the agricultural residues and wood biomass. Apart from these two sources of biomass, significant sources can be obtained from the waste of livestock production. The second group of biomass energy crops includes the plants that serve as raw material for biodiesel, bioethanol, etc.

In Serbia, briquettes production started in early eighties. The first presses for the production of biomass were produced in the company *Igman*, later *Unis Igman* Konjic, and were installed in the company *Novi Dom* in Debeljača (Banat). In mid-eighties the program of the Committee on Energy, the Provincial Secretariat of Economy of Vojvodina, encouraged buying briquetting presses for the agricultural biomass amounting to 30% of the grant. Big capacity presses (1.5 t / h) were installed in Banatsko Miloševo (the first pilot plant), Stara Moravica, Senta, Banatsko Karadjordjevo (later transferred to the cooking oil company *Dijamant* from Zrenjanin), Padej and Ilandza. Briquetting unit in Ilandza was provided with a press *Utve* from Kovin. The program of agricultural biomass briquetting failed, however, this technology has survived by briquetting forest and wood biomass, i.e. sawdust. Over the last few years new plants have been opening in Curug, Novi Sad, Backa Palanka, Mladenovo, Ruski Krstur, Sombor, Titel, Vrbas and elsewhere. The construction of the majority of these plants is financially supported by the *Development Fund of Vojvodina* and some banks, providing favorable credit funds.

Four years ago, the process of pelleting wood (sawdust), agricultural biomass and biomass mixtures started in Vojvodina. New plants were set into function in Selenca, Crvenka, Mladenovo, Titel, Backi Petrovac, Sombor and elsewhere.

The price of briquettes and pellets from biomass in our country ranges from 120 to 160 Euro / t in bulk, and a little more for smaller units packages. Briquettes can be found in the following department stores: *Uradi sam*, *Merkur*, *Art dekor* etc., but the pellets are hard to find in the open market. Basically, the pellets are exported to foreign countries (Italy, Austria and other countries). The price of pellets in Europe is 150 to 200 Euro/ton, depending on the package.

In Serbia, there are several manufacturers of briquetting presses: *Dekan*, *Slavija*, *Metal-matik*, *Perović*, etc. Manufacturers of pellet mills are: *Metal-matic, Metalkop, Ostojic, Natural Energy* and others. In Serbia, there are several representatives of the briquetting equipment from abroad: *Nielsen, Comafer* etc., and for pelleting: *CPM, Amandus Kahl, General Dies*, etc.

There are good conditions for the production of briquettes and pellets in Serbia and for their use for private facilities heating, etc. In this connection, it is necessary that the state funding support the construction of modern facilities for the production of briquettes and pellets [1,3,10,23−28].

7. BIOGAS

The waste in the animal production is another source of renewable energy in Serbia. Available quantity of liquid manure in poultry and cattle farms of medium and large capacity allows the production of biogas energy at the level of 42 200 Mtoe. This quantity of liquid manure with the appropriate addition of the agricultural biomass residues realistically

allows the installed capacity of biogas to amount up to 80 MW.

On the basis of the statistical data it can be calculated that Serbia could produce enough biogas to replace about 20% of its natural gas imports, and this only from animal husbandry.

Serbia is also suitable for planting oilseed rape which is one of the most important raw materials for biodiesel production. Yields that are realized in Serbia are 4 tons per hectare on the average, which means that one hectare generates approximately 1 ton of biodiesel. Unfortunately, there are currently no energy plants in Serbia, while the areas under rapeseed are at a very low level. In Serbia, biogas from manure is obtained and used in several places in Vojvodina [1,10]. The first biogas plant in Serbia, with the capacity of 1 MW, was commissioned on October 20, 2012, in Vrbas on *Sava Kovačević* estate. In the next year, the capacity of the plant was increased to 0.5 MW. In addition to these power plants, 3 more biogas power plants are in function in Serbia today: Alltech Fermin (Senta, 16 MW), Lazar Dairy (Blace, 1 MW, 2012) and EnviTech Biogas AG (635 kW, Curug, 2011) [1,29,30].

8. FEED-IN TARIFF IN SERBIA

In the most developed countries of the world the law regulates the possibility of production and sale of the thermal and electricity power generated by the renewable energy sources. Since the production of electricity from the renewable sources, in most cases is more expensive than the energy production from fossil fuels with the use of traditional technologies, the so-called *support systems* i.e. financial and non-financial incentives to invest in the construction of plants using renewable energy sources have been introduced.

A financial incentive measure most frequently used is the increased purchase price of electricity generated, which is carried out mainly by applying two models. The first model is based on a certain amount of electricity produced from the renewable energy sources, the so-called *green energy*, which will be purchased during the year (*Quota System*). The second model includes the application of the defined purchase price for the electricity generated from renewable energy sources (*Feed-in tariff*). In most European countries the model of the defined purchase prices (*Feed-in tariff*) is applied.

In addition to financial measures, countries often adopt additional measures to encourage the production of electricity from renewable energy sources through a reduction or total tax exemption, participation in investments for selected technologies, which represents a strategic development direction of the given country. Encouraging the production of thermal energy from renewable energy sources is now mostly done through the financial support of the capital investments (in the initial phase) and the tax exemption (in the more developed stages of applying incentives) [1,2,31].

The incentive purchase prices of electricity produced from the renewable energy sources expressed in euro-cents per kilowatt hour (c €/kWh) in Serbia, based on the Directive on the Incentive Measures for the Subsidized Manufacturers of Electrical Energy (Official Gazette of Republic of Serbia, no.8/2013), are given in Table 5 [31].

Table 5. The incentive purchase prices of electricity produced from the renewable energy sources expressed in euro-cents per kilowatt hour (c€/kWh) in Serbia, based on the Directive on the Incentive Measures for Subsidized Manufacturers of Electrical Energy (Official Gazette of the Republic of Serbia, no.8/2013)

No.		Type of power plants	Installed power P (MW)	The incentive purchase prices *(c€/kWh)*
1.		**Hydropower plants**		
1.1			≤ 0.2	12.4
1.2			0.2-0.5	13.727-6.633*P
1.3			0.5-1.0	10.41
1.4			1-10	10.747-0.337*P
1.5			10-30	7.38
1.6.		on the existing infrastructure	≤ 30	5.9
2.		**Biomass power plants**		
2.1.			≤ 1	13,26
2.2.			1-10	13.82 – 0.56*P
2.3.			> 10	8.22
3.		**Biogas power plants**		
3.1.			≤ 0.2	15.66
3.2.			0.2-1	16.498 – 4.188*P

No.		Type of power plants	Installed power P (MW)	The incentive purchase prices *(c€/kWh)*
3.3.			> 1	12.31
3.4.		**Animal waste biogas power plants**		12.31
4.		**Landfill gas and communal waste water gas power plants**		6.91
5.		**Wind power plants**		9.2
6.		**Solar power plants**		
6.1.			On the object up to 0.03	20.66
6.2.			On the object 0.03-0.05	20.941-9.383*P
6.3.			Ground-mounted	16.25
7.		**Geothermal power plants**		
7.1.			≤ 1	9.67
7.2.			1-5	10.358-0.688*P
7.3.			> 5	6.92
8.		**Waste power plants**		8.57
9.		**Combined coal production power plants**	≤ 10	8.04
10.		**Combined natural gas production power plants**	≤ 10	8.89

9. CONCLUSION

From the obtained results it can be concluded that in Serbia favorable conditions exist for the use of the renewable sources of energy including: solar radiation energy, wind energy, hydropower, geothermal energy, biomass and biogas.

According to the solar potential, Serbia is among the more favorable locations in Europe. In Serbia, an increasing number of solar systems with flat plate solar collectors to heat water have been installed on the public and private facilities. Vacuum collectors for water heating are being used in Serbia in several places such as hotels and residential households. The first project on the high temperature solar energy conversion in Serbia was realized in Badnjevac, a village near Kragujevac. Recently, Serbia has begun the construction of solar power plants and PV systems with less power to generate electricity in private households. Up to now two larger PV solar power plants of 2 MW (in Merdare and Velesnica), more than 200 independent PV solar power plants of 1 - 60 kWp and several small rooftop PV solar power plants connected to the grid have been installed.

There are several locations suitable for the construction and operation of the wind generators in Serbia. However, despite significant wind energy potential and interests of the domestic and foreign investors for the construction of wind generators Serbia has built only one wind park in Kula, with higher power of 9.9 MW. However, there are several low-power wind generators in the private sector.

The most important source of renewable energy in Serbia is hydropower which provides about 25% of the total electricity produced in the country. The installed capacity of hydropower plants in Serbia amounts to 2831 MW. Serbia is trying hard to build small hydropower plants whose total installed capacity would be 500 MW, and through which 2400 GWh of electricity per year could be produced.

By its geothermal resources, Serbia belongs to the richer countries. Currently, only 9% of the available geothermal energy potential is used, from geothermal and mineral water for the therapeutic, sports and recreational purposes. The use of geothermal energy for heating and other energy purposes is still at an early stage and very modest compared to the potential of geothermal resources.

The energy potential of biomass in Serbia is estimated at 3.4 Mtoe and is composed of the remains in forestry and wood industry, and waste in farming, livestock raising, fruit growing, vine growing and primary processing of fruits. Currently, in Serbia the most used are wood biomass and plant biomass in agriculture. There are also several plants for the production of pellets and briquettes.

The energy potential of biomass in livestock that is suitable for the production of biogas in Serbia is estimated at 42 000 Mtoe. Thus, biogas obtained from manure is used in several places in Vojvodina. There are four biogas power plants in Serbia today. Due to high defragmentation of the farms in Serbia, it is recommended that one plant collects and treats manure collected from several farms.

In the most developed countries of the world the law regulates the possibility of production and sale of the thermal and electricity power generated from renewable energy sources. In Serbia, there are clearly defined laws, conditions and incentives for investing in the construction and sale of electricity from the power plants using renewable energy sources.

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САДАШЊЕ СТАЊЕ КОРИШЋЕЊА ОБНОВЉИВИХ ИЗВОРА ЕНЕРГИЈЕ У СРБИЈИ

Сажетак: У раду је дат приказ садашњег стања коришћења обновљивих извора енергије у Србији. У вези са тим дат је енергетски потенцијал и примери коришћења сунчеве енергије, енергије ветра, хидроенергије, геотермалне енергије, биомасе и биогаса у Србији. У даљем тексту су дате информације о системима подршке и мерама подстицаја за инвестирање у изградњу и продају електричне енергије из постројења која користе обновљиве изворе енергије. У закључку су истакнути досадашњи резултати коришћења обновљивих извора енергије у Србији и мере подстицаја за њихово коришћење.

Кључне речи: соларна енергија, енергија ветра, хидроенергија, геотермална енергија, биомаса, биогас.