

BIOMASS BRIQUETTING – POTENTIALS AND PERSPECTIVES IN ZAJECAR REGION, SERBIA

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***Abstract:** In conditions where fossil fuels is less, and their negative impact on the environment is growing, the attention professional and the general public should be directed to potentials of that are renewable energy sources.*

Biomass is the most significant renewable energy source in Serbia with an estimated market potential of 134 PJ/yr from wood and agricultural wastes. The Republic of Serbia, with technical wood and agriculture biomass potential than 3,2 Mtoe, can considerably raise the share of biomass in national final energy consumption, as well as that increase and achieve the 27 % share of energy from renewable source in gross final energy consumption, as specified in Directive 2009/28/EC and National Renewable Energy Action Plan (NREAP) of Republic of Serbia [1].

This paper gives an overview and an analyses of the potential and the possibilities of utilisation of wood and agriculture biomass in Zajecar district, Eastern Serbia.

***Keywords:** biomass, wood, agriculture, Eastern Serbia, Zajecar district.*

1. INTRODUCTION

Republic of Serbia has significant potential for renewable energy source in the form of small hydropower, wind and solid biomass.

Biomass represent a significant potential energy resources and an important renewable energy source that could replace fossil fuels. Data on quantities of biomass are often blurred, because it is a large dispersion of biomass. The first estimate of biomass residues was done in 1979 [2]. Based on the available data, it was found that the annual amount of biomass produced in Serbia is totally 26,4 million tons or 9,68 million tons of biomass from agricultural production (the rest of the production of grain), 600 thousand tons of fruit growing and wine production (cut off), 14,1 million tons of livestock production

(manure), 771 thousand tons of forest and wood processing and 1,2 million tons of municipal (organic) waste [2, 3].

The overall estimated annual wood and agriculture biomass potential in Serbia is approximately 11 million tons or 3,2 Mtoe. The predominant source of biomass in Serbia is agriculture (55%) with the rest coming from woody biomass. The degree of use of forest biomass is 66,7%, and agriculture biomass is only 2%.

It is believed that 30 to 40% of the total estimated amount of biomass can be used to produce heat and electricity. Other biomass can be used to increase soil fertility, fodder production, as well as for other purposes. Part of the plant production may be directed to the production of gas.

Serbia could replace 25% of their total energy produced with biomass facilities [4].

2. OVERVIEW OF THE ZAJECAR DISTRICT

The Zajecar district is a geographical region around the Timok River, which is located in the east of the Republic of Serbia.

The Zajecar district covers four municipalities (Boljevac, Zaječar, Knjaževac and Sokobanja) with a total area of 3.623 km². It has a population of 119.967 (2011 census). The Seat of the District is in the City of Zaječar.

Territory of the Zajecar district is mainly highland, with about 213.575 ha of agricultural land, which accounts for 59 % of the total territory and is less than the corresponding of the national average (63,7%).

Also, 54,7% of total agricultural area composed of fields, 40,1% meadows and pastures, 3% orchards and 2,2% vineyards. The most developed fields are cattle and livestock breeding, crop farming, fruit growing and viticulture.

Forests cover 131.233 hectares – about 5% of the total forest fund of the Republic of Serbia. In the state-owned is 41,6% and in the private owned is 58,4%. Forest area of the Zajecar district is 36,9%, and the optimal percentage of forest cover is estimated at around 45%.

Trends of economic development of the Zajecar district lead from crafts and semi-industrial processing of agricultural products over coal exploitation (textile factory, leather factory, brewery, quartz sand mine and coal mine) to the modern plants and high output rate.



Figure 1. Location of the Zaječar District in the Republic of Serbia

3. POTENTIAL OF WASTE BIOMASS IN ZAJECAR DISTRICT

3.1. Potential of wood and foresty biomass

Forest eco-systems represent an indispensable factor of the living environment and preserving of ecological balance in nature, a renewable natural resource and significant economic potential.

Forestnest of Zajecar district is around 37 %, with the largest forest area in the municipalities of Boljevac and Knjaževac, and that more than 40.000 ha [5]. Forest coverage is, when compared on a global

scale, similar to world forest coverage which accounts for 30 %, but it is considerably lower than the European 46 %.

Forested areas by municipalities and the energy potential of wood biomass briquettes in Zajecar district are shown in figure 1 and table 1 [5].

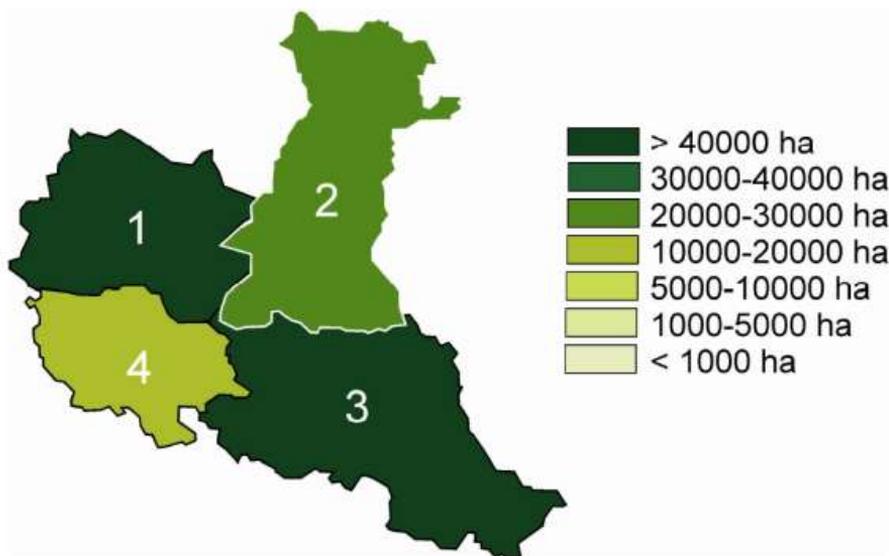


Figure 1. Forest area by municipalities in the Zajecar district [5]
 1 - Boljevac, 2 - Zajecar, 3 - Knjaževac, 4 - Sokobanja

Table 1. The energy potential of wood biomass in Zajecar district

District/ Municipality	Total forested area, ha	Cutoff tree				Used technical wood, m ³		Wood waste, m ³	
		Total, m ³		Technical wood, m ³		Deciduous	Conifers	Deciduous	Conifers
		Deciduous	Conifers	Deciduous	Conifers				
Zajecar distict	131.233,23	132677	2461	17	45	22555	1107	12631	476
Boljevac	41.154,56	65025	534	21	90	13655	481	7647	207
Zajecar	28.332,59	11134	0	27	0	3006	0	1683	0
Knjaževac	42.420,98	34256	703	10	18	3426	127	1918	54
Sokobanja	19.325,10	22262	1224	10	42	2226	514	1247	221

The total potential of Zajecar regions for the production of wood briquettes in 2012, amounted to 13.107 m³. The amount of wood biomasse waste can provide 8.650 tons of wood briquettes whose combustion can get 155.712 GJ of heat or 0,0037 Mtoe.

The percentage share of wood waste biomass by municipalities in the Zajecar district is shown in Figure 2.

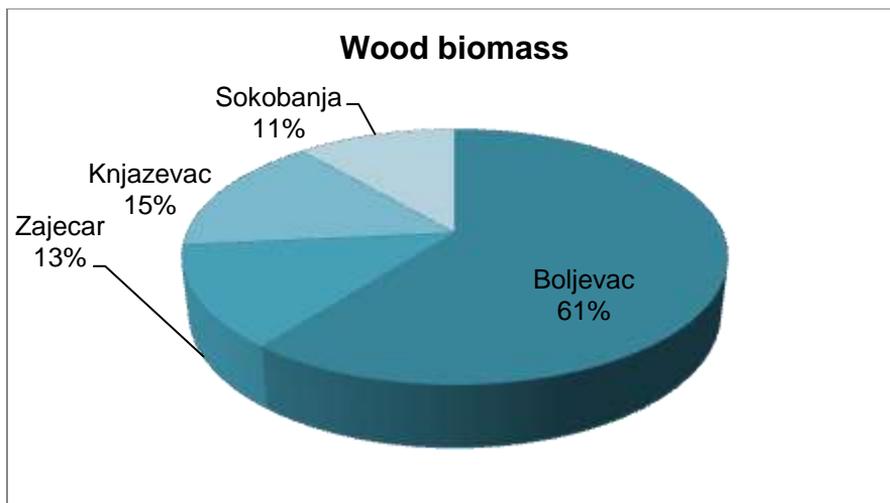


Figure 2. The percentage share of wood waste biomass by municipalities in the Zajecar district

The greatest potential for heat production in Zajecar district municipality has Boljevac, which potential is about 61 % compared to the total potential of the Zajecar district. Lower potential have the municipalities of Zajecar and Sokobanja with about 10 % share in the possibilities of production of thermal energy from biomass.

Also, the potentials of state forests are mainly used, while the potential of private forests are remarkable but not used enough. The calculated theoretical energy production of briquettes in the Zajecar region is 5 % of the total energy in Serbia.

3.2. Potential of agricultural biomass

Based on the data of the total sown area, total production, average and total yield of field crops are calculated the amount of waste biomass in the Zajecar district in 2012, which are shown in Table 2.

Table 2. The energy potential of agricultural biomass briquettes in Zajecar district

District/ Municipality	Yield / Biomass	Corn	Wheat	Rye	Barley	Oats/ Oat	Triticale	Other cereals	Sunflower	Total
Zajecar district	Share, %	52,25	35,42	0,52	4,89	2,22	2,67	0,14	1,89	
	Total, ha	19347	13113	194	1810	823	987	50	698	37022
	Average yield,t/ha	2,6	3,1	2,7	2,5	1,7	3,0	1,6	1,5	
	Total yield, t	50849	41150	532	4576	1412	2960	82	1021	102582
	Biomass, t	55933,9	41150	532	4576	2118	2960	82	2552,5	109904
Boljevac	Share, %	47,22	39,72	0,69	5,94	3,05	3,38	0	0	
	Total, ha	2448	2059	36	308	158	175	0	0	5184
	Average yield,t/ha	1,8	3,1	1,9	2,5	1,5	1,3	0	0	
	Total yield, t	4487	6316	69	777	234	220	0	0	12103
	Biomass, t	4935,7	6316	69	777	351	220	0	0	12669
Zajecar	Share, %	54,48	31,89	0,51	4,18	2,00	2,97	0,26	3,67	
	Total, ha	10355	6061	97	795	381	565	50	698	19002
	Average yield,t/ha	3,5	3,4	3,4	2,7	1,8	3,4	1,6	1,5	
	Total yield, t	35927	20540	330	2163	700	1921	82	1021	62684
	Biomass, t	39519,7	20540	330	2163	1050	1921	82	2552,5	68158
Knjazevac	Share, %	48,66	43,62	1,10	3,55	2,41	0,67	0	0	
	Total, ha	2703	2423	61	197	134	37	0	0	5555
	Average yield,t/ha	1,4	2,6	2,2	2,1	1,7	3,0	0	0	
	Total yield, t	3727	6403	133	422	224	110	0	0	11019
	Biomass, t	4099,7	6403	133	422	336	110	0	0	11504
Sokobanja	Share, %	52,75	35,30	0	7,00	2,06	2,88	0	0	
	Total, ha	3841	2570	0	510	150	210	0	0	7281
	Average yield,t/ha	1,746	3,070	0,000	2,380	1,693	3,376	0	0	
	Total yield, t	6708	7891	0	1214	254	709	0	0	16776
	Biomass, t	7378,8	7891	0	1214	381	709	0	0	17574

* - Calculated according to the formula: yield culture F (F = 1.1 for corn, oats / oat = 1.5, wheat, rye, barley, triticale, other cereals = 1, sunflowers = 2.5)

In the Zajecar region is sown, approximately the same area under vegetable crops, which is about 38.000 ha. The highest average proportion of arable crops sown makes corn (51 %) and wheat (36 %), while all other cereals account for 11 %. Also, in this district cultivated sunflower, but in a modest share of 2 %.

The total amount of agricultural biomass in 2012 was 109.904 t, where it will be able to produce 1.538.656 GJ of heat, ie 0,0367Mtoe. The percentage share of agriculture waste biomass by municipalities in the Zajecar district is shown in Figure 3.

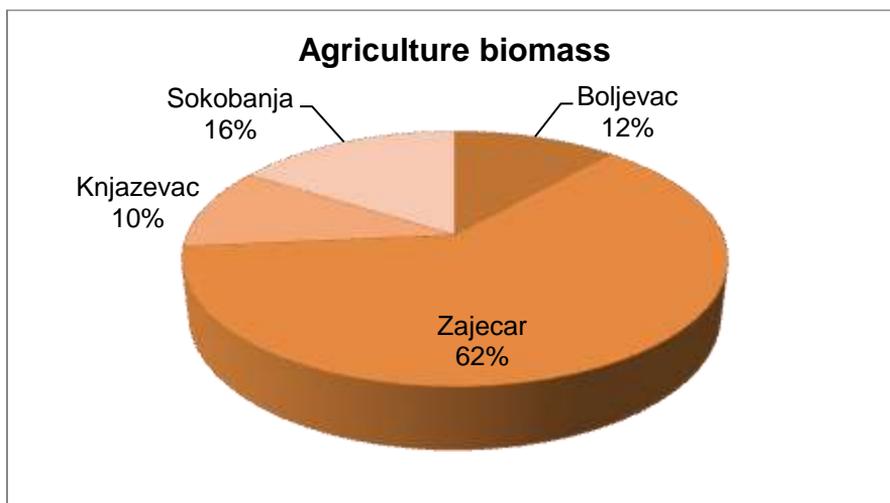


Figure 3. The percentage share of waste biomass from agricultural crops by municipalities in the Zajecar district

Waste biomass from agricultural crops consists of the largest percentage, more than half of the biomass of corn, and the remaining part is the straw of wheat.

The total theoretical energy potential of waste biomass from crop farming in Zajecar district has the largest share of municipalities Zajecar (about 62 %) and the lowest is the municipality of Knjazevac.

4. BIOMASS BRIQUETTING

Activities to reduce greenhouse gas (GHG) emissions and the dependence on fossil fuels, to develop the economy and energy availability for rural and developing populations, have led to the promotion of biomass as sources of feedstock for energy supply chains.

The most significant use of biomass is in warming up households and buildings by using briquettes and pellets from biomass, which is environmentally and economically feasible.

Biomass briquetting is a process that clearly falls into environmentally clean technologies. Briquetting the waste biomass from agriculture, forestry, and other branches of production that generate such waste is processed into a finished product, ie. briquette. Briquette compared to their raw material (biomass) has great advantages in energy purposes [6].

The comparative advantage of briquettes in relation to the exploitation and consumption of coal can be, among other things, consider the following [7]:

- amount of ash after combustion is 2-7 times lower in briquettes,
- sulfur content in the product obtained from biomass is about six times lower, which means that the same number of times to be less release of sulfur dioxide during combustion, which is certainly an important moment for a sustainable healthy environment,
- products humidity is lower, compared to some types of coals, for 2 - 5 times,
- calorific value of briquettes obtained from various organic substances, is 15.500- 20. 560 KJ/kg, which corresponds to the calorific value of brown coal,
- raw material for the production of briquettes is high quality, it is everywhere in our environment and does not significantly affect the price of the product,
- obtaining this product is without the participation of a binder (glue) which significantly contributes to the cheapening of the production process and improve its value in terms of environmental protection.

Technical and technological process for the production of energy from biomass briquettes in the world and in our country has been resolved, so the question of its efficiency and competitiveness compared to other energy sources less debatable. Most are briquetted sawdust. Methods of briquetting and pelleting of agricultural biomass are in us still at the stage of trial operations. Gradually develops the market briquettes in Serbia. Cost of briquetted biomass with us is 110 to 120, and in Europe 150-180 euros/tonne.

5. CONCLUSION

The Republic of Serbia is one of the top European countries by the available amount and unexploited biomass. Technologies for its use are available, environmentally friendly and do not belong to high technology.

Biomass, as a clean and cost-effective fuel option, has tremendous potential for application in Zajecar district. Necessary know-how about most of the biomass energy technologies already exists. There is just a need to allocate necessary resources for improving these technologies and plan their widespread dissemination.

The total potential of Zajecar regions for the production of wood briquettes in 2012, amounted to 8.650 tons of wood briquettes whose

combustion can get 155.712 GJ of heat or 0,0037 Mtoe. The total amount of agricultural biomass in 2012 was 109.904 t, where it will be able to produce 1.538.656 GJ of heat, ie 0,0367Mtoe.

The calculated theoretical energy production of briquettes in the Zajecar region is 5 % of the total energy in the Republic of Serbia.

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