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Condition and development of BIOMASS in Serbia

CONDITION AND DEVELOPMENT OF BIOMASS IN SERBIA

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SUMMARY

Biomass is a renewable energy source that can be used as substitute for fossil fuels in the production of heat and electricity. Unlike fossil fuels, combustion of biomass does not increase the amount of CO_2 in the atmosphere, and therefore a positive impact on the environment is achieved.

The current condition of renewable energy sector in Serbia is very bad, although Serbia has good potential for development in this field. For example, the total biomass energy potential in Serbia is approximately 2.7 million tons, which is an amount greater than the total oil consumption in agricultural production in Serbia. Of this about 1.7 million tons lies in the remains of agricultural production and about 1 million tons in wood biomass.

Analysis of the structure of the biomass residues from agricultural production shows that more than half of the resource lies in corn biomass, more than a quarter in the straw of small grains, primarily wheat, and the rest of about 15 percent in the harvest remains of sunflower, soybean, rapeseed or residues of orchards and vineyards. On the other hand, the potential of forest biomass as another important resource of biomass in Serbia lies in the processing of approximately 1.5 million cubic meters of forest growth per year in the form of segments, chips, bark, sawdust and the like.

The third important biomass resource in Serbia, biogas, is made from waste of animal origin. With almost a million heads of cattle, one and a half million sheep, two million pigs and almost ten million poultry, Serbia has the potential to produce as much biogas as can replace about 20% of imported natural gas. It yet has to determine what potential lies in the rational use of about 3 million existing acres for partial semination of plants as well as using the remaining half a million hectares which, for various reasons, are not currently used in Serbia.

Although there is no unique strategy for using biomass in Serbia, and opinions of experts differ, there appears to be consensus about the fact that it is not advisable to use all the biomass for energy purposes, but it would be useful to consider the possibility of using one of its parts. Thus, data that using only one-fourth of the estimated potential for energy production would save the equivalent amount of diesel fuel used in the entire agricultural production in Serbia, speaks convincingly enough to support the needs for further development of procedures and methods for the rational use of biomass.

There seems to be a mature awareness among decision makers that the lack of legal and technical regulations in the field of renewable energy sources, especially biomass, and the lack of incentive funds, are the main problems of development. This is also evidenced by the recently adopted Regulation on incentive funds for preference producers of green energy,

which includes the biomass. Significant use of renewable energy is as an international obligation of Serbia, and it is clear that significant attention will have to be devoted to this sector in the future.

The following measures to increase the use of biomass in Serbia can be recommended:

- *Achieving better cooperation at the level of ministries by establishing the Office, Agency or other relevant bodies for the use of biomass*
- *Allocating direct incentive funds to encourage the use of biomass in the form of special-purpose loans and incentive funds for manufacturing components and equipment.*
- *Promoting research and comprehensive pilot programs of breeding power plants using domestic and international funds.*
- *Considering the possibilities of education required for professional staff for the use of biomass*

INTRODUCTION

Biomass is one of the major sources of renewable energy. The term biomass means living or until recently living materials, of plant or animal origin, which can be used as fuel or for industrial production. In Serbia, biomass is mainly used in the traditional manner and in the form of energy for heating, cooking or heating of hot water. In addition to these forms of use, biomass can be used in cogeneration facilities for the production of electricity and thermal energy, then as a raw material for the production of biofuel, and also in industry for the production of fibers and chemicals.

As a source of renewable energy, biomass can be divided into:

- Wood biomass (sawdust, remains in pruning trees, etc.).
- Harvest residues (wheat straw, corn, etc.).
- Animal waste and remains (animal waste, animal carcasses, etc.).
- Biomass from waste (green fraction of household waste, sludge from the water purifier collector, etc.).

Of all these forms of biomass, wood biomass is currently the most exploited energy. Also, a very important source of biomass in Serbia (especially in AP Vojvodina) is plant biomass in agriculture. When it comes to biomass in agriculture, then, first of all, we think of plant residues in vegetable, fruit and wine production. It is estimated that every year in Serbia a total amount of 12.5 million tons of biomass is produced, of which 9 million tons (72%) in Vojvodina.

According to the EIA (Energy Information Administration) in the United States in 2007 the consumption of energy derived from biomass amounted to 3.6 quadrillion Btu, which was about 3.6% of total energy consumption in that year. Of the total energy derived from biomass, the wood biomass accounts for about 2.2 quadrillion Btu, which ranks this form of renewable energy among the major sources.

Bearing in mind the tendency of the energy sector in the world, and considering the fact that Serbia has significant energy resources of biomass (estimated to be about 2.7 million tons), it is evident that the development of this sector could provide the necessary long-term energy source.

The primary purpose of this document is to show the potential of biomass in Serbia, as well as to answer some of the most important issues concerning the opportunities for further development of the renewable energy sector in Serbia, with a special emphasis on the development of the biomass sector.

BACKGROUND

Key features of the energy sector in Serbia are low energy efficiency (both in production and consumption), obsolete technologies in the manufacturing sector, low level of investment, unrealistically low electricity prices, the low share of renewable energy sources and irrational consumption of practically all forms of energy.

There is a general impression that Serbia has good renewable energy sources, but virtually non-existent information on the cost-effectiveness of using them. All estimates related to the potential of renewable resources are mainly related to the physical and not economic potential.

It can be said that the issue of renewable energy sources is current in all developed countries. The issue of renewable sources is becoming increasingly topical in Serbia, and it will become particularly important in Serbia's accession to the European Union. In Serbia the use of renewable sources in electricity production is rather forgotten and a secondary issue, which is unacceptable given the huge potential for their use (total technical potential of energy from renewable sources is about 160 PJ per year). The process of joining the EU requires adjustment of the energy policy of Serbia and establishing goals for the share of renewable sources in the total electricity production (these objectives must be numerically expressed and with specified deadlines). In practice, these goals are very different, depending on the conditions in the country, and mostly on the existence of large hydropower plants. For example, Bulgaria has set as a goal 22% by 2010, Romania 30%, Belgium 6%, while Austria is aiming to reach 78%. The EU has no specific criteria for the assessment of these goals and the country seeking accession must prove that its goal is reasonable in relation to its natural wealth.

The current share of energy from renewable sources in Serbia is about 6% (including large hydroelectric power plants) and is projected to remain steady until 2015. Energy development strategy by 2015 predicts that the overall share of new renewable sources (excluding large hydropower plants) in the total primary energy consumption should rise from zero to 1.1% in 2015, while the share of total final energy consumption should increase to 1.5 - 2% in the period from 2006 to 2015.

In the area of the application of biomass for combined heat and power energy production, Serbia has significant opportunities, which include the use of briquettes and pellets. The use of wood pellets and briquettes is very popular in countries with large wood processing, but today the focus is moving to the production and use of pellets and briquettes of harvest residues. A wider use of briquettes and pellets for heating households (instead of electricity), however, requires solving a great number of problems, including lack of standards for their production and low price of electricity.

CONDITION OF BIOMASS IN SERBIA

Much potential of biomass in Serbia lies in the agricultural residue and wood biomass, a total of about 2.7 million tons (1.7 million tons in the remains of agricultural production and about 1 million tons in wood biomass). Apart from these two sources of biomass another major source is the residue of livestock production. Another group of biomass sources includes energy plants (e.g. mishantus, fast-growing poplar and the like), and plants that serve as raw material for biodiesel and bioethanol (rapeseed, sunflower, corn, etc.).

The following table provides an overview of the potential of biomass from agriculture in Serbia (Brkić M. and T. Janjić 1998).

Ref.	***Culture***	***Surface (10^3 t)***	***Yield (t/ha)***	***Total biomass (10^3 t)***
1.	Wheat	850	3,5	2975
2.	Barley	165	2,5	412,5
3.	Oats	16	1,6	25.6
4.	Rye	5	2	12
5.	Maize	1300	5,5	7150
6.	Seed corn	25	2,3	86,25
7.	Grain ear *	-	-	1430
8.	Sunflower	200	2	800
9.	Sunflower shell	-	-	120
10.	Soya	80	2	320
11.	Rapeseed	60	2,5	300
12.	Hops	1,5	1.6	7,92
13.	Tobacco	3	1	1,05
14.	Orchards	275	1,05	289,44
15.	Vineyards	75	0,95	71,55
16.	Manure **	-	-	110
	TOTAL:	3055,5		12571,31

Table 1: The potential amount of biomass from the residue of agricultural production in Serbia

* The weight of grain ears is included in the mass of corn

** The weight of liquid manure is not included in the total quantity of biomass

It is estimated that the total potential of biomass from agriculture in Serbia is about 12.5 million tons per year, which in energy terms is about 1.7 million tons. However, according

to the analyses of experts from different fields there is a conclusion that it is not justified to use all the biomass resulting from agricultural production residues for energy purposes. It can be said that among farmers, cattle breeders, technologists, mechanical engineers, economists and other potential users of biomass in agriculture there are conflicting opinions for what purposes it could be most useful to use biomass. Farmers believe that most of the biomass should be plowed, and thus increase soil fertility, cattle breeders in turn argue that biomass should be used for the production of animal feed, thermal engineers believe that biomass should primarily be used to produce thermal energy, etc. On the other hand, it is known that there is biomass in huge quantities, that it is renewed every year and irrationally used. Harvest residue is mostly burned directly in the field, which is prohibited by law.

As a compromise solution it could be regulated that one fourth of biomass should be plowed or as sheet taken back to field, one fourth used for animal feed, one quarter used for heating facilities and one fourth for other purposes (industries of alcohol, furniture, construction materials, paper, packaging, cosmetics and others). In this way, all economic activity would be covered, given that there is biomass from agricultural production residues in sufficient quantities.

From the above analysis it can be seen that the total quantity of biomass residues from agricultural production intended for heating purposes (just over 3 million tons) can save the equivalent amount of about 1317×10^3 tons of light heating oil. Identical mass of diesel fuel is used in the entire agricultural production in Serbia.

Ref.	*Biomass*	*Biomass for combustion (25% of total) (10^3 t)*	*Low thermal power (MJ/kg)*	*Equivalent value of light heating oil (10^3 t)*
1.	Wheat straw	743,75	14	247,92
2.	Barley straw	103,13	14,2	34,87
3.	Oat straw	6,4	14,5	2,21
4.	Rye straw	3	14	1
5.	Corn	1787,5	13,5	574,55
6.	Seed corn	21,56	13,85	7,11
7.	Grain ear	357	14,7	124,95
8.	Sunflower stem	200	14,5	69,05
9.	Sunflower shell	30	17,55	12,54
10.	Soy straw	80	15,7	29,9
11.	Rapeseed straw	75	17,4	31,07
12.	Stalks of hops	1,98	14	0,66
13.	Stalks of tobacco	0,26	13,85	0,09
14.	The remains of cutting in orchards	289,44	14,15	97,5
15.	The remains of cutting in vineyards	71,55	14	23,85
16.	Manure	110	23	60,24
	TOTAL:	3880,57	14,26	1317,51

Table 2: The energy potential of biomass from the residue of agricultural production in Serbia

Agriculture is the production with energy investments that are lower than obtained (produced) energy. Using biomass from the residue of agricultural production increases the degree of energy autonomy of agriculture. In Serbia there is competent personnel potential and production experience to build the plants for the combustion of biomass. Also, there is valuable experience in the exploitation of numerous plants for burning biomass to produce heat.

Another major source of biomass is wood biomass, which exists in Serbia in significant quantities. The tendency in all countries with developed wood industry is to use wood refuse largely for energy purposes. The most frequently used wood biomass for energy is in the form of pellets, briquettes and wood chips. Production of wood pellets is constantly growing and its price on the market is getting higher. The reason for this trend lies in the fact that during the processing of wood remains large amount of biomass which is very valuable as energy. In addition, the technology of the production of pellets has been recently developed that provides better burning in special furnaces and boilers that are constructed to provide a considerably automated way of combustion (such as furnaces and

boilers using liquid fuel or gas). On the other hand, briquetted wood biomass is used in large industrial plants.

The term wood waste means that part of the wood that cannot be used in further processing for the same purpose. However, the tree has so many different applications where the rest could be used, which means that the term waste can be only conditionally used.

The residue in wood processing can be divided, according to size, into:

a) Coarse

- Slabs from logs shortening
- Slabs from timber side while sawing
- Slabs from processing boards in length and
- Slabs from processing boards by width.

b) Small

- Chips (occur with trimming, sawing or milling)
- Chips: bigger (occurs with manual sawing), small (occurs with milling etc.)
- Sawdust (occurs with sawing)
- Dust and
- Wood flour.

c) Bark

- Bark appears as unmeasured waste. If logs are processed together with bark, it increases the volume of large and small waste wherever the logs are processed. If the logs are peeled prior to primary processing, then bark is in particular available, which facilitates its eventual implementation.

According to JP "Srbijašume", the total area of forests and forest land in Serbia is 2.429.642ha. The coverage of forests in Serbia is 27.3%, and varies by some regions: Vojvodina 6.8%, Central Serbia 32.8%, Kosovo and Metohija 39.4%.

Of the total area of forests and forest lands 50.91% is in the state and public ownership and 49.09% in private. Timber stocks in forests of Serbia are about 235 million m^3, or

101.6m^3/ha, and current (annual) volume growth is approximately 6.2 million m3, or 2.67m^3/ha.

Serbia has a huge potential of unused wood sources for energy. The estimated amount of wood biomass in Serbia, which can be used as fuel, is about 1.65 million m3 per year, while the energy potential of forest biomass, left to be dissolved after wood production, is estimated at 15.6 million GJ per year.

However, despite this potential, wood still occupies a low position in meeting energy needs. The main reason for this is a lack of understanding that domestic supply of wood biomass can provide clean energy from renewable sources, as well as additional benefits that wood provides. For Serbia, some of these benefits include increased investment in forest development, which will result in increased economic activity in forestry, increased sustainable management of forests, a significant reduction in the cost of fossil fuels that are imported as well as reducing greenhouse effects, which will occur by using efficient and low-emitting devices and technologies based on wood biomass. With more than 12 million tons of wood waste production per year, Serbia has a future potential to develop its bio-energy sector particularly for electricity and thermal energy production.

The waste of the livestock production also represents a potentially interesting source of renewable energy in Serbia. For the most part the waste of the livestock production is animal waste that can be used as raw material for the production of biogas.

According to statistical data available from the Bureau of Statistics of the Republic of Serbia, the Republic total livestock has:

- 757,000 cattle,
- 47 000 horses
- 1.475 million sheep,
- 1.983 million pigs and
- 9.3 million poultry

One of the main issues in the production of biogas is how much biogas can be obtained from the organic material unit. Since getting biogas depends on many factors, only approximate estimates can be given (the following table).

Organic material	The amount of biogas m3/l
Beef manure	90-310
Pig manure	340-550
Chicken manure	310-620
Stable manure	175-280

Table 3: The amount of biogas obtained from certain types of organic material

For example, the potential of biogas in the AP Vojvodina is estimated on the basis of the data from 66 large cattle farms and 38 large pig farms (the term large farm means a farm that has more than 150 cattle). The total livestock in this sample amounted to 30.000 cattle and 21.000 pigs. This livestock provides about 900.000m^3 of liquid manure annually. If we assume efficiency of 0.35 from this quantity of liquid manure, about 40 GWh of electricity or about 45 GWh of heat can be obtained annually. Produced electricity would be sufficient to meet the consumption of 8.000 average households in Serbia. Also, it would prevent the emission of 9 million m^3 of methane which could also result in the benefit from carbon credits.

On the basis of statistical data, it can be estimated that Serbia could produce as much biogas as to replace about 20% of its imported natural gas, only from the livestock.

In addition to using agricultural residues, wood waste and waste from livestock production, biomass is also available from raising energy plants (e.g. mishantus, fast-growing poplar and the like), and plants that serve as raw materials for biodiesel, bioethanol, and the like.

The total arable land in Serbia is 3.355.019 ha. In AP Vojvodina intensive crop production with the dominant sowing area under maize (over a million hectares) is carried out, followed by wheat with about 500.000 ha. In central Serbia corn is also a common sowing unit, however, unlike the territory of AP Vojvodina, in Central Serbia there are a lot of areas that are neglected. Areas that are currently neglected are potentially interesting for planting of energy crops. For example, the mishantus plant has the potential to yield over 10 tons of dry biomass per hectare per year. The resulting biomass is very caloric, at the level of lignite coal.

The region of Vojvodina is very little forested, and in many areas there is a problem of soil erosion under the influence of winds. Planting fast growing poplar trees would largely solve this problem, and would also provide significant amounts of wood biomass.

The area of 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 on average about 4 tons per hectare (with optimal weather conditions), which practically means that one hectare provides roughly about 1 ton of biodiesel (for one liter of biodiesel).

Unfortunately, at this moment in Serbia energy plant plantations practically do not exist, while the area under oilseed rape is at a very low level.

RECOMMENDATIONS

Although Serbia has a high potential for biomass energy utilization, it is currently at an unacceptably low level. The reasons for such a situation in this sector are numerous, and some of the most important are the lack of incentive measures, low level of awareness of the wider community, the weak economic power of those potentially interested in investing in the sector of biomass (agricultural farms, agricultural cooperatives, wood processing industry and so on) and others.

In order to improve the situation in the sector of renewable sources of energy (and therefore biomass, as one of the major sources of renewable energy in Serbia) the following measures can be recommended:

1. Achieving better cooperation at the level of ministries by establishing the Office or Agency for the use of biomass. Bearing in mind the fact that the exploitation of biomass for energy production at the state level is a multidisciplinary problem that touches directly at least two ministries - energy and agriculture, and indirectly the Ministry for science and education, it is necessary to establish the Office, Agency or another body to deal with immediate and practical problems related to the use of biomass, especially the issues of creating effective climate among the participants in this task by linking and aligning of the relevant ministries. A particular aim of this body would be making Strategy for using biomass and making special rules that would refer only to biomass, as well as influencing the adoption of special laws on the OIE which would resolve, among other things, the problem of using biomass.

2. Allocating direct incentive funds for the use of biomass. The recent adoption of the ''Regulation on incentives measures for the production of electricity using renewable energy sources and combined electricity and heat'' has opened the possibility that the so-called ''privileged'' producers of energy can use biomass or biogas under favorable conditions and thus earn profits on the market. This regulation will certainly help to slowly approach many associated problems, such as continuous collection, transport and storage of raw materials for necessary biomass energy production. Yet there are still no direct incentive measures for subsidized or special-purpose loans for agricultural producers who would, for example, raise energy plants, as well as for the release from customs duties all the equipment used for construction and exploitation of the facilities for the use of biomass.

3. Encouraging research and comprehensive pilot programs for raising power plants in Serbia - The purpose of these incentive funds, which may be provided partly from domestic funds, but mostly from EU funds, would be, one the one hand, transferring

experience from developed countries, and on the other hand understanding the specific problems in the field.

4. Considering the possibilities of education required for professional staff for the use of biomass. In the shortest period possible, it is necessary to educate a number of experts who will address the problem of efficient use of biomass in Serbia. For this to be done effectively, it is necessary to introduce appropriate vocational programs in secondary agricultural schools, as well as at agricultural universities in major regional centers. It is necessary to consider education and training of personnel abroad. To achieve these objectives the support of Ministry of Education and professional bodies within secondary and tertiary education is necessary. Also, in order to secure the necessary funds, a possibility of using international or cross-border cooperation funds should be considered.

RELEVANT LITERATURE

[1] Sustainable Forest Biomass: Promoting Renewable Energy and Forest Stewardship by Jesse Caputo, July 2009.

[2] Study: Potential and possibilities of briquetting and pelleting waste biomass in the territory of Vojvodina, Novi Sad, December 2007.

[3] Bergman, P.C.A., and J.H.A. Kiel. November 2005. Torrefaction for biomass upgrading. Published at 14th European Biomass Conference & Exhibition and, Paris, France, 17-21 October 2005 p. 8.

[4] Biomass Research and Development Board. December 2008. Increasing feedstock production for biofuels: economic drivers, ecological implications, and the role of research. BRDI. 148 p.

[5] Energy Information Administration. 2008 Renewable Energy Consumption and Electricity Preliminary Statistics 2007. Table 1. U.S. Energy Consumption by Energy Source, 2003-2007.

[6] Brkić, M, Alimpić, M, Djukić, Dj: Some possibilities of using non-conventional energy sources in agriculture and food industry. Proceedings of the sixth conference of experts of agricultural techniques Vojvodina, Vojvodina Society of Agricultural Engineering, Dubrovnik, 1979, p. 573-584,

[7] Brkić, M, Janić, T: The collection, storage and briquetting of biomass in agriculture, Proceedings from the first conferences: "The significance and perspectives of biomass briquetting", Ecological Movement of Vojvodina, Belgrade Faculty of Forestry, Federal Ministry for Science, Development and Environment, Vrnjacka Spa, 1996, p. 15-24,

[8] Brkić, M, Janić, T: The possibilities of using biomass in agriculture, Proceedings of works from the second conference: "Briquetting and pelleting of biomass in agriculture and forestry, Regional Chamber of Sombor and "Dacom" from Apatin, Sombor, 1998, p. 5-9,

[9] Ilić, M, Oka S, Grubor, B, Dakić, D, Tešić, M, Martinov, M., Brkić, M, Novaković, D, Djević, M, Kosi, F, Radivojević D, Radovanović, M, Danon, G, Bajić, V, Isajev, V, Skakić, D, Bajić, S, Rončević, S: Energy potential and characteristics of biomass residue and technology for its implementation and utilization in Serbia, the study was conducted for the Ministry of Science and Environmental Protection, Institute of Nuclear Sciences "Vinča", Belgrade, 2003, p. 179,

[10] Danon, G, Bajić, V, Isajev, V, Bajić, S, Oreščanin, S, Rončević, S: Biomass remains in forestry and wood processing and the possibility of growing "energy forests", Chapter 2 of

the study: "The energy potential and characteristics of biomass residues and technology for its implementation and use of energy in Serbia", Faculty of Forestry, Belgrade, JP "Srbijašume", Belgrade, Institute for poplar planting, Novi Sad, 2003, p. 25-56,

[11] RENEWABLE ENERGY IN SERBIA, recommendations, potentials and criteria; Editor: Nataša Đereg; Authors: Nataša Đereg, Zvezdan Kalmar Kranjski Jović, Iomut Apostle, December 2008. Subotica

[12] Energy Sector Issues and Poverty in Serbia, Goran Radosavljević and Vuk Djoković, Center for Advanced Economic Studies, Belgrade, 19 June 2007.

[13] The program of the implementation of the Energy Development Strategy of the Republic of Serbia in AP Vojvodina (from 2007 to 2012), Jovan Petrović, Branka Gvozdenać, April 2007. The Executive Council of APV

[14] Energy Development Strategy until 2015, Ministry of Mining and Energy of the Republic of Serbia, 2005, www.mre.gov.rs

[15] The Regional Secretariat for Energy and Mineral Resources, Tribune "Renewable energy sources - biomass and wind", Novi Sad Fair, 05/11/2008:BIOMASS POTENTIALS AND RAW MATERIALS FOR BIOGAS IN AP VOJVODINA, Professor. Dr. Miloš Tešić, Prof. Dr. Milan Martinov, Faculty of Engineering Sciences, Novi Sad

[16] Data JP "Srbijašume", www.srbijasume.rs

[17] The data of the Statistical Office of Serbia, www.stat.gov.rs