THE STATE OF BIOMASS ENERGY IN SERBIA

by

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The paper presents a review of the energy potential of different types of biomass residues in agriculture and forestry, and actual state of biomass energy utilisation in Serbia. The estimated values of annual energy potential are: about $1.7 \cdot 10^6$ toe (ton of oil equivalent) in biomass residues in agriculture, comprising crop farming, fruit growing, viniculture and stock breeding, and about 1 million toe of biomass from forestry, including different biomass residues and fuel wood. The total annual biomass energy potential of about $2.7 \cdot 10^6$ toe represents 40% of the total coal energy production in Serbia. Towns located in agricultural regions and in regions rich in forest can satisfy their energy demand for centralised heating systems with biomass residues from the territory of their own municipality. With appropriate energy policy, information campaign, research activities and general regulation in the field of biomass energy utilisation, the share of biomass energy consumption in total energy balance can be significantly increased.

Keywords: *biomass residues, energy potential*

Introduction

In developed countries, renewable energy sources have got an important and publicly emphasized role in helping to solve environmental problems. But, besides helpful effects on the environment, renewable energy sources can help in other aspects, like rural development through the employment of local inhabitants, energy supply diversification, lower energy dependence on imported fuels, increased reliability of energy supply, possibilities for domestic industry to be engaged in development and implementation of renewable energy projects.

Eurepean Union Directive 2001/77/EC for promotion of electricity produced from renewable energy sources gives a relatively wide definition of biomass: *biomass* shall mean the biodegradable fraction of products, waste, and residues from agriculture (including vegetal and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste. But national legislation can define more precisely what is considered as biomass wastes. Commonly, the following is not considered as biomass: mixed municipal solid waste, sewage sludge, textile, paper, cardboard, and waste wood that contains above a certain value toxic components added during wood processing. This approach to definition of biomass was adopted for assessment of biomass energy potential in Serbia.

Biomass in Serbia

A great part of the Serbian economy is based on agricultural production and agriculture related industry. The northern part of Serbia, the province Vojvodina together with territories along river Sava and Danube is flat and pure agricultural area (fig. 1). This region is the main source of agricultural products and biomass wastes as well, especially wastes of crop farming. However, wheat and corn production is present in hilly regions as well, from the north to the south of Serbia. The agricultural biomass wastes are coming from cereals, mostly wheat, barley and corn, and from industrial crops mostly sunflower, soya, and rape seed. In addition, this is the region with many farms of livestock breeding, where liquid manure is considered as biomass waste. Fruit growing is also present in this agricultural area, but the main area of fruit growing is the hilly region on the south, where main types of fruit are plums, apples, cherries, peaches, and grapes.

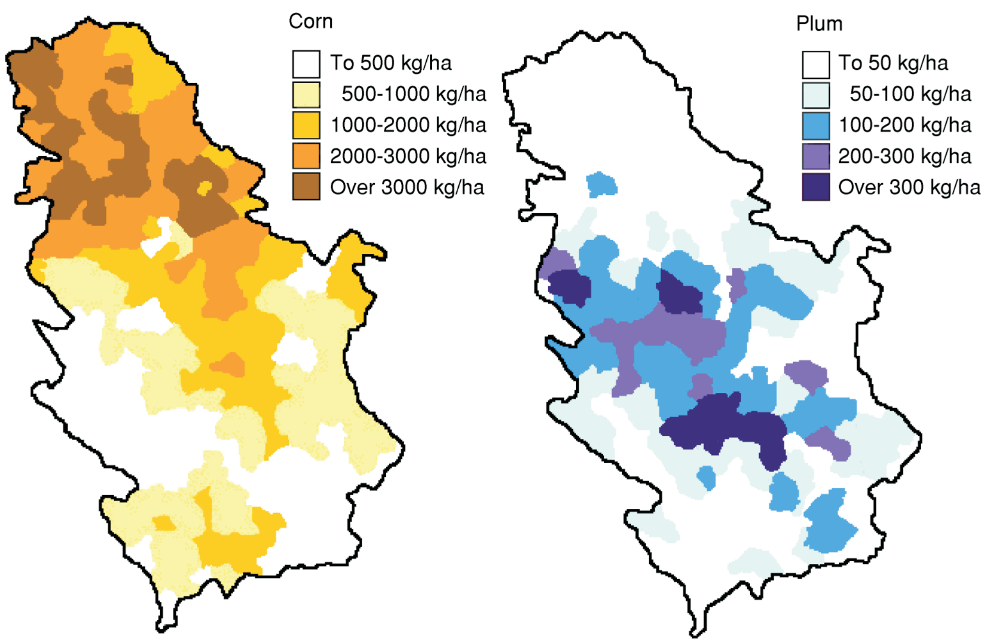

Figure 1. Agricultural area used for corn and plum cultivation [1]

Besides the agricultural area, Serbia belongs to countries relatively rich in forests. Territory of Serbia covers 88,360 km^2, and about 30% is covered with forests, while about 55% of the territory is arable land.

The forest area lies mainly on the south of Serbia, but also to the east and west from the central part of Serbia. In 14 out of 145 municipalities forests cover more than 45% of the territory. In next nine municipalities forests cover 40-45% of the territories (fig. 2). About two thirds of forests are property of state owned public companies, while one third of forests are privately owned. There are deciduous trees mainly. About half of all forests are pure deciduous tree forests, only 5% are pure coniferous tree forests, while the rest of about 45% are forests with mixed deciduous and coniferous trees. Main deciduous forest species are beech and oak, while spruce is the main species in conifers.

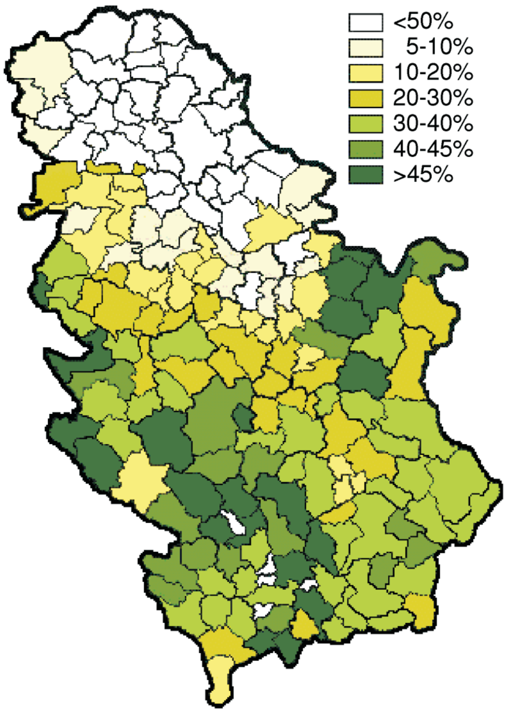

Figure 2. Share of forest area in the total area of communities in Serbia [2]

Agricultural biomass wastes

In order to predict the future energy role of agricultural biomass wastes, it is necessary to take into account the present state as well as trends in the development of agricultural production. The statistical data about agricultural production show that the area of land used for agricultural production has been decreasing for the last ten years, while the yield per hectare of every species has not increased, but in some cases it has decreased as well. The total yield of different agricultural products, whose residues are relevant as energy sources, decreased in the last ten years for about 10%, while production of wheat and grapes has decreased for more than 20% in the same period [2].

Agricultural biomass wastes can be divided in three main groups: those generated in crop farming, fruit growing and livestock breeding. The only biomass waste from livestock breeding is cattle, pigs and poultry manure. This material, in spite of the fact that it is generated directly from animals, is considered as biomass on account of its content, since the real biomass is the main component.

Crop farming residues

On the account of annual production of main cereals and industrial plants in the last few years it is possible to assess the energy potential of crop farming (tab. 1). By using data of the National Statistical Office about annual yield of main species of crop farming and well known values of the mass ratio between grains and residues of every plant, total quantity of crop farming residues is simply obtained. Little more uncertain are values of ratio between biomass residues available for energy purposes and biomass residues that are in use or can be in use for other non-energy purposes, mainly for livestock breeding and chemical industry.

In Serbia, there are many small individual landowners who deal with production of cereals or industrial plants, like sunflower or soya. A great deal of crop farming production, almost 75% is achieved in small or medium size private ownership, while only about 25% of crop farming production belongs to agricultural companies of relatively larger size. These two groups of agricultural producers have somewhat different habits of using biomass residues. Presently, in large agricultural farms much less biomass residues are used for livestock breeding than at small private farms. But, at small agricultural farms, if the owners do not have cattle, from their point of view it is useless to collect biomass residues after harvesting. The reasons are: no need for using biomass residues for cattle breeding, their existing domestic stoves or boilers are not adjusted for burning of large pieces of straw or similar unprepared biomass residues, and there is no market for selling biomass residues. As a result, they often burn down the straw and other biomass residues at the field. In addition, it is not easy for another entity to organise and achieve low cost collecting of biomass residues from many small scattered fields [3].

Table 1. Yield of main species in crop farming and energy potential of their residues [1, 2]

Plant	Area [10^3 ha]	Yield [10^3 t]	Grain /residue	Total residues [10^3 t]	Residues for energy use [10^3 t]	Energy potential [toe]*
Wheat	797.0	2,905.0	1 / 1	2,905.0	1,365.0	Average heating value 14 MJ/kg
Barley	135.0	365.0	1 / 0.8	295.0	180.0	
Rye	8.5	14.1	1 / 1.1	15.5	4.4	
Corn	1,358.0	4,827.0	1 / 1.1	5,310.0	1,140.0	
Sunflower	160.0	280.0	1 / 2.5	705. 0	240.0	
Soya	83.0	160.0	1 / 2	320.0	130.0	
Rape seed	1.4	2.6	1 / 3	7.8	1.6	
			Total	9,560.0	3,060.0	1,023.000

*1 toe – ton of oil equivalent = 41,860 MJ

If intensive crop farming is coupled with intensive cattle breeding, many biomass residues generated in crop farming could be used in the later one. But, the modern way of livestock breeding does not consider extensive use of biomass residues for animal bedding. At large agricultural farms it is more favourable and cost effective to collect biomass residues in bales, and use them without any further preparation in small or medium sized boilers.

Taking into account all aforementioned conditions, it is considered that about half of biomass residues at large agricultural farms can be used for energy purposes, while only about 20% biomass residues generated on relatively small private farms can be used for energy purposes. Values of biomass residues from crop farming for different species and their total energy potential are given in the tab. 1.

Greater amount of biomass residues generated on small agricultural farms can be used for energy if these owners would have appropriate ovens and boilers for burning biomass residues, or if they find an interest to collect residues and sell them. In that case the availability of biomass residues would be increased, and the energy potential would be virtually increased.

The value of $1.023 \cdot 10^6$ toe of energy potential of biomass residues from crop farming can be changed, depending on species that would be sowed in the future. Presently there is a slight trend of replacing wheat with industrial plants.

Besides residues from crop farming for food production, there is a possibility of targeted crop farming for production of biomass fuel. This is the case of rape seed cultivation for bio-diesel production. Rape seed has been already cultivated in Serbia at an area of around 1400 ha only. According to some estimations there is a possibility to cultivate rape seed on 150,000 ha. The yield of rape seed from that area is sufficient for production of about 100,000 t of bio-diesel. The national demand of oil in transport sector is about $1.7 \cdot 10^6$ t.

Residues of fruit growing and viniculture

One of main activity in fruit growing and viniculture is pruning of small branches, and these cut small branches can be available for energy purposes. Total number of registered fruit trees is about $94 \cdot 10^6$. Half of this number are plum trees, about 20% are apple trees and almost 15% are cherry trees, both sour and sweet cherry (tab. 2).

The quantity of pruned branches depends on species and sort of fruit, ranging from 1 kg per tree for some sorts of apple, up to 7 kg per tree for some sorts of peach and plum. The pruning of vine yields from 4 up to 8 t/ha of vineyard, and vineyards cover about 77,390 ha in Serbia [4].

On the basis of these data the total biomass residues from fruit growing amounts about 475,000 t, with average heating value of 14 MJ/kg the energy potential of biomass residues from fruit trees pruning is about 159,000 toe. The energy potential of vine pruning residues is about 155,000 toe.

Table 2. Energy potential of biomass residues deriving from fruit cultivation and processing [1, 2, 5]

Species	Number of trees [10^3 ha]	Fruit production [t/year]	Type of biomass residues	Biomas residues [t]	Annual energy equivalent [toe]
Plum	50,630	382,400	pruning, stones	393,500	132,600
Apple	17,570	198,400	pruning, peel	36,200	10,900
Cherries	12,280	99,500	pruning, stones	55,000	16,500
Pear	7,080	70,000	pruning, peel	14,000	4,300
Peach	4,450	44,400	pruning, stones	35,100	11,700
Apricot	1,900	27,500	pruning, stones	15,500	4,100
Walnuts	2,100	21,500	pruning, shell	55,000	14,100
Grape	77,390	213,000	pruning, peel, seeds	515,000	166,300
					Total : 360,500

Stones of plums, cherries, peaches, and apricots together with peels and seeds of apples, pears, and grapes are wastes derived from processing of fruit. The quantity of these wastes amounts to about 200,000 t. With a relatively modest heating value of 9 GJ/t, the energy potential of fruit processing wastes is about 46,000 toe. This value is relatively small comparing to the energy potential of other fruit residues derived from growing. But an important advantage of these wastes is that they are already collected in every company dealing with fruit processing. Therefore, this energy potential can be a remarkable source of energy in these fruit processing companies. A disadvantage of these kinds of wastes is their relatively high water content. That is why for some wastes, like grape peel and seeds, a pre-drying process will be necessary before these wastes would be used for energy conversion [6].

Additional source of biomass residues in fruit growing and viticulture is replacement of old trees with new ones. This replacement occurs each 10 to 25 years, depending on fruit types that are cultivated. This activity is regular for well organized and maintained orchards. The annual energy potential of fruit trees and vines that are extracted with roots is about 245,000 toe.

The overall energy potential of biomass residues from fruit growing, viniculture and fruit processing is about 605,000 toe.

Biomass wastes of animal origin

Liquid manure deriving from cattle and pig breeding together with poultry litter are potential energy sources as well. Because of high water content (up to 90%) these slurries are usually treated by anaerobic digestion. These wastes are recommended for anaerobic digestion not only for an energy reason but also for getting more suitable and environmentally friendly fertilizers.

Livestock breeding in Serbia comprises mainly cattle, pigs, poultry and sheep. Similar to other agricultural production, livestock breeding had a decreasing trend in the last 15 years. Livestock in large agricultural farms dramatically decreased in that period, namely cattle for 40%, pigs for 20% and poultry for 60% [2].

The major part of livestock is located in small farms, with only a few heads in each. An organised manure collection from these small farms is not likely to be easily technically feasible, and the financial feasibility is uncertain as well. Therefore, in the analysis of energy potential, only manure in medium and great farms is considered as a prospective source of fuel, since manure from these farms does not need to be transported, and can be efficiently treated in anaerobic digestion.

The present state of main species of livestock in medium and great farms is given in the tab. 3. Cattle are almost evenly distributed among flat and hilly regions, while pigs are mainly bred in flat regions. Cattle in these farms, 260,300 heads, produce about 5,270 m^3 of manure, while pigs produce about 4,560 m^3 of manure. With an assumption of a relatively restrictive biogas production of 20 m^3 biogas per m^3 of manure of the both origins, from cattle and pigs, it can be derived that energy potential amounts to 20,140 toe from cattle manure, and 17,500 toe from pig manure. Poultry manure, with the assumption of biogas production of 50 m^3 per m^3 of manure, gives a little lower energy potential of 4,600 toe. Total energy potential of biomass wastes from livestock breeding, from great and medium farms only, is 42,240 toe per annum.

Table 3. Livestock in medium and great farms and energy potential of their manure [7, 8]

Livestock	Location of farms	Number of heads	Manure [m^3/day]	Biogas [m^3/day]	Annual energy equivalent [toe]
Cattle	Flat regions	149,300			
	Hilly regions	111,000			
	Total	260,300	5,270	105,000	20,140
Pigs	Flat regions	1.369,500			
	Hilly regions	285,600			
	Total	1.655,100	4,560	91,200	17,500
Poultry		2.350,000	480	24,000	4,600
				Total	42,240

Forest biomass

Wood-stock in Serbian forests amounts to about $235 \cdot 10^6$ m^3. Registered wood felling in forests is about $2.9 \cdot 10^6$ m^3 [2]. Besides the registered wood felling, an unregistered wood felling exists as well. Estimation is that the total wood felling amounts to about $3.3 \cdot 10^6$ m^3. That figure represents 55% of the annual increase of wood-stock in forests of about $6.1 \cdot 10^6$ m^3. In developed countries of Europe, with well organised forest management, the ratio between the wood felling and the wood-stock annual increase goes up to 75%. With improvement of forest managing, upgrading of the state of existing forests and with development of forest roads, there is a possibility for an increased annual wood felling, based on the existing wood-stock. In addition, there is a national plan to increase area covered by forests from present value of 27.3% to 31.5% till the year 2010, and to 41.4% till the year 2050. These two measures, increasing of afforested area and wood stock and improvement of forest utilisation, will contribute to the increase of energy potential of forest biomass.

According to the statistical data [2, 9] about $1.2 \cdot 10^6$ m^3 or about 50% of production of forest assortments represents fuel wood. The remaining assortments are wood pulp for pulp and paper industry, saw-logs for cutting and wood for different technical purposes. Annual energy value of the fuel wood presently used is 239,000 toe.

Besides fuel wood, as a kind of forest assortments, there are different kinds of biomass residues associated with tree felling in forests and with processing of wood. As results of tree felling about 58% of the total mass of the tree are different wood assortments for the market, for industry, different technical purposes, and for heating as fuel wood. The rest of 42% of the total mass of the tree are different biomass residues which do not have any value at the market (tab. 4). Among these biomass residues there are: bark, small branches, tree stumps. The estimation is that these biomass residues in forests account for about $2.9 \cdot 10^6$ m^3, which has an energy value of 549,500 toe. Leaves and nee-

Table 4. Average share of different categories of wood in the total mass of the tree [10]

Wood assortiment	Share in the total mass [%]	Comment
Round wood	16	For the market
Stacked wood	42	For the market
Bark peeled from wood for the market	4	Left in forest
Residues of wood cutting in forest	9	Partly used
Small branches	11	Partly used
Stumps	18	Left in forests
Leaves and needles	Ignored	–

dles from the trees are not included in the balance, in spite of the fact that their share in the total mass of the tree is from 2 to 4%.

These residues are of different characteristics and usually dispersed in forests. Their collection requires some energy for transportation vehicles. Depending on the terrain, collecting of residues can be easily and thoroughly performed. In some cases, under the present state of forest roads and machinery, it practically can not be done. In any case, one of the main conditions for utilisation of these forest residues are appropriate prices of wood residue-based fuels and existence of the wood fuel market [11].

Residues of wood processing in sawmills, resulting from the production of veneer, boards, and furniture, and residues in pulp and paper and chemical industry, consist of small and large pieces: shavings, chips, cutting edge and bark. Estimated annual yield of these wood residues is about $0.35 \cdot 10^6$ m^3, with energy value of 66,900 toe.

Besides statistically registered forest felling, there is an unregistered tree felling as well. It encompasses not only unregistered tree felling in forests, but also tree felling near local roads, small rivers, channels, and trees surrounding arable land. A rather uncertain estimation indicates that only 60% of the demand for dwellings heating by wood biomass is satisfied by the registered fuel wood, while 40% (160,000 toe) of the demand is satisfied by statistically unregistered tree felling [12].

According to the present utilisation of forests, forest tree felling and wood processing, the total annual energy potential of different kind of wood residues, together with registered consumption of fuel wood, accounts for about $1.02 \cdot 10^6$ toe.

That value of energy potential can be increased by the utilisation of presently not utilised forests, because it is estimated that almost 30% of forests are not utilised.

Another possibility to increase energy potential of wood biomass is to cultivate energy plantations. According to domestic investigations [13], by poplar cultivation it is possible to produce wood biomass with annual energy value of 6.7 toe/ha. With assumption that the production of wood biomass could be accomplished at one third of the land currently out of use (200,000 ha), it means that the annual energy potential of forest energy crops accounts for some 382,000 toe.

State of biomass technologies applied in Serbia

Almost all technologies for biomass energy conversion have been applied in Serbia. Unfortunately, some of them were installed more than twenty years ago and presently are out of operation. The reasons for their non-operational status are poor maintenance and lack of spare parts during the sanctions mainly. In addition, the low electricity prices in Serbia in the last decade of the twentieth century caused a significant number of owners to find that it was much cheaper to use electricity for heating than other technologies of biomass energy conversion.

Different biomass combustion technologies have been applied in Serbia. The fluidised bed combustion technology is installed in several agricultural centres. Since the corn seed production is performed by drying corn grains together with corn cobs, the result of this process are dried corn cobs. These dry corn cobs are used as fuel for the drying process of next corn grains and cobs. In addition, design with complete engineering documentation for fluidised bed combustion of wood wastes, bark and chips, in a pulp and paper company were done. Unfortunately, the economic crisis and lack of funds stopped the implementation of that project fifteen years ago [14].

Fixed grate boilers are installed in several agricultural companies for straw and corn cobs combustion as well, and in some saw mills for saw dust combustion. Unfortunately, many saw mills use fuel oil or even electricity for space heating and wood drying.

In addition, there are two boilers for sunflower husk combustion in some kind of vortex combustors. These boilers are located in two edible oil factories. Unfortunately, other oil factories have not installed sunflower husk combustors.

Some wood processing companies had installed boilers burning wood residues derived from the process. But many of them replaced these boilers with boilers operating on other fuels. The replacement of biomass firing boilers with fuel oil firing boilers was very frequent during economic crisis in the period 1990-2000. The reason for these replacements was not only financial, but also a result of problems with typical manual feeding. In that case the proper operation of boilers largely depends on the operator. Under conditions of decreased level of discipline during the economic crisis, a great number of problems was encountered during operation of these biomass firing boilers [15].

Regarding combustion of biomass in small boilers (up to 200 kW) the situation is very similar. In the last decade, demand for small solid fuel firing boilers for space heating was very low. As a consequence of that, manufacturers did not invest in development of modern solid fuel firing boilers. Therefore, in the last decade and nowadays as well, we can find at the market many types of small boilers declared for biomass and coal combustion [16]. But, these boilers are usually designed for combustion of high quality coal. Therefore combustion of biomass in these boilers is not very efficient. As a good sign, in last few years boilers designed for biomass combustion could be found at the market.

Co-combustion of biomass with coal in existing great coal firing boilers was only an option considered in few studies.

In spite of the fact that the development of gasification process is still in force, mainly for electricity production, a few gasification facilities were installed. Those installations produced gases from biomass, mainly straw, for combustion in existing oil or gas firing boilers. The gasifiers could be treated as some kind of a pre-combustor. Today, no one of these installations is in operation.

Bio-diesel production from rape seed was very intensive during the embargo on import of the liquid fuel. In that period (1992-1997) bio-diesel of not so good quality was produced in five factories in Serbia. Mostly agricultural machines used this fuel, they furnished necessary works in field, but after the season of harvesting finished, their motors had to be repaired. As the embargo ended, the factories stopped with the production and stopped further development of bio-diesel production technology.

Facilities for production of biogas from manure were installed in nine agricultural farms before the crisis started. Some of them did not have a successful starting period, and very soon they stooped operation. Some of them were in operation till the crisis started, and then stooped. The main reasons for their stopping are practically the same as for biomass firing boilers. Nowadays none of these installations is in operation.

Since the market of fuels based on wood residues is very poor, technologies of briquetting and pelletising of biomass residues are not very frequently installed at places where biomass residues emerge. Only several primary processing wood companies have installed machines for production of pellets or briquettes, but they supply only a narrow local market.

From the point of view of energy potential of biomass in Serbia, some value of the potential is hidden in inefficiency of all biomass facilities in operation. If, for example every small boiler fired with biomass would increase its low combustion efficiency by 5%, the consumption of fuel wood for the same demand of heat would be decreased by the 30,000 toe.

Renewable energy sources and energy balance

All types of renewable energy sources are present in Serbia. Biomass, hydro energy, geothermal, solar and wind energy have substantial energy potential. Among them, the biomass has the greatest energy potential of $2.68 \cdot 10^6$ toe. Geothermal energy from existing wells and hydro potential of small water streams have energy potential of about 0.4 and $0.19 \cdot 10^6$ toe respectively. Concerning the wind and solar energy, there are no reliable energy potential data.

With respect to the total annual energy consumption in Serbia of $11.8 \cdot 10^6$ toe, renewable energy sources can replace a lot of fossil fuels. This replacement of fossil fuels is not important for the sake of environmental protection only, but also for national economy and reliability of supply, because two thirds of the liquid and gaseous fuel demand are covered by import.

The importance of energy potential of biomass fuel can be shown by comparison with present annual production of coal in domestic mines and with consumption of imported fuel oil. About two third of electricity generation in Serbia is based on domestic coal, while one third of electricity is generated in hydro power plants. The total annual coal production is about $6.2 \cdot 10^6$ toe. It is less than 2.5 times greater than the annual biomass energy potential. The total annual consumption of liquid fuel is about $3 \cdot 10^6$ tons. Since a great part of this liquid fuel consumption is used in motor vehicles, it can be concluded that total consumption of fuel oil consumed for heating in industry and dwellings can be fully replaced with biomass fuel.

An analysis of consumption of heavy and light fuel oil in public centralised heating systems was done for some selected towns. The selected towns are in agricultural regions or in regions where forests cover more than 45% of the territory of the municipality (tab. 5). Less than 5% of the land cultivated with wheat and corn in these municipalities is sufficient for getting biomass residues for replacement of the fuel oil presently consumed. For towns in the forest area, about 10% of the existing registered forest felling is sufficient for replacement the fuel oil consumed in public centralised heating systems. The registered felling covers only stems greater than 7 cm in diameter, but not forest resi-

Table 5. Consumption of fuel oil in centralised heating systems and necessary area of crop farming or forest from which biomass fuel can be used for replacement of fuel oil [17]

Municipality	Fuel oil consumption [t]	Necessary biomass fuel [t]	Necessary land [ha]
Novi Bečej, Ada, Senta, Kanjiža, Čoka, Kikinda, Novi Kneževac	8,830	30,900	6,000 crop farming
Ruma, Sr. Mitrovica, Beočin	2,020	7,070	1,400 crop farming
Užice, Bajina Bašta	5,600	19,600	15,000 forest
Žagubica, Majdanpek	2,700	9,450	7,000 forest

dues like small branches, peeled off bark and residues of wood cutting in the forest. These residues can reach in volume almost 40% of the registered wood felling. It means that those forest residues of the existing forest felling are sufficient for the fuel oil replacement in the centralised heating systems of the analysed towns.

Energy policy and barriers

There are several reasons for the present condition of biomass utilisation for energy purpose in Serbia. One of the main reasons is unfavourable ratio between prices of different fuels and electricity. During the embargo and great economic crisis from 1991 till 2000, a necessary measure was to drastically decrease the price of electricity. Under that condition, no one was motivated to install biomass firing boilers for heat production. In addition, existing facilities were not well maintained, and provision of spare parts was relatively difficult. Therefore, many of old biomass facilities stopped operation. Today, electricity price is increased to the level of other countries in the transition.

Regarding industry, many companies are in transition phase of their ownership, and the management is not ready to consider measures regarding energy consumption. In addition, companies lack funds for investment, citizens do not have enough money to buy more efficient and in the same time more expensive biomass firing boilers. Sometimes, since there is no developed market for biomass fuel and biomass utilisation facilities, even when some company or individual wants to buy a small to medium boiler, they often do not have offers of efficient and reliable equipment.

Nowadays, with the Energy Law adopted, it is expected that energy policy will provide favourable environment for implementation of new projects of biomass utilisation for energy purposes and for successful revitalisation of old biomass facilities as well. Very often the prices of biomass facilities and biomass fuel are considered as main barriers for greater use of biomass. But, presently in Serbia a lot of available biomass residues deriving in wood and agricultural product processing companies are not used for energy production. In spite of availability of biomass residues these companies very often use other fuels for heat production. In these cases, the price of biomass fuel is practically zero. With the zero price of biomass fuel the investment in biomass facilities can be higher, and an overall analysis shows that the use of biomass is economically justified.

One of important activities for efficient and greater use of biomass fuel will be to inform and educate people, management staff, engineers, citizens and pupils about possibilities, advantages and available technical solutions for efficient use of biomass as renewable energy source. All prospective investors in energy facilities should recognise their interest in using biomass fuel.

Despite the existence of many manufacturers of heating equipment and biomass fuel (briquettes and pellets), the production is not quite well regulated. The regular market requires that the producers comply with the prescribed technical and quality standards. Actual standards are pretty old. Therefore, for improving the quality of equipment for biomass energy utilisation and the quality of the biomass fuel produced for the market it is necessary to establish new standards, and to perform regular attesting of products, with clear information about their technical specification and performance characteristics. In addition, activities of research institutions should be directed to the research and development of biomass energy related equipment and facilities, not only for biomass energy conversion but for fuel preparation as well.

Conclusions

The energy potential of the biomass has a remarkable value compared with the value of energy consumption in Serbia. Ash content in biomass is much lower than in indigenous low quality coal, biomass has practically no sulphur content and it is considered that biomass utilization has zero balance of the carbon-dioxide. With all these characteristics, biomass belongs to clean fuels, and biomass energy utilisation contributes to the improvement of environmental protection. Besides the environmental advantage and the advantage of decreasing the import of liquid and gaseous fuel, utilisation of biomass energy will improve conditions not only in the energy sector. The use of biomass can directly or indirectly affect rural development through local people employment, agricultural production, and forest cultivation.

Recently, in July 2004, the Serbian Parliament adopted the Energy Law. The Energy Law generally gives favourable position and foresees incentives for utilisation of renewable energy sources.

To what extent the biomass energy potential would be efficiently utilized depends not only on energy policy, but on ability and readiness of different stakeholders, investors, manufacturers, research institutions, agriculture and forestry sectors, financial sector, to take a part in an organized way in a programme of sustainable biomass utilisation.

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