



## BIOMASS POTENTIAL OF BULGARIAN FOREST-BASED SECTOR FOR ENERGY PRODUCTION

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### Abstract

*There are significant opportunities to gain different kind of energy utilizing of Bulgaria's wooden biomass. At present in Bulgaria fuelwood is with the highest contribution to energy balance from all Renewable Energy Sources (RES) with 3,6 % from primary energy consumption and 7,4% from final energy consumption. The future prospective based on the results obtained show significant technical potential of Bulgarian forest-based sector for woody biomass for energy purpose to reach up to 12% from final energy consumption in Bulgaria in 2020.*

**Key words:** *wooden biomass, logging, wood processing, energy*

### INTRODUCTION

Bulgaria has 4,077 million hectares of forested lands. This corresponds to 34% or over one third of its total territory, while forest fund includes 37% of Country. The forested lands are almost equal to the area of agricultural lands.

The State Forest Fund (SFF) is 77 % from the Country's forest fund, including the forests and lands from the forest fund, which are managed by State Forest Agency (SFA) at Council of Ministers, Ministry of Environment and Waters (national parks, reserves and others) and two Experimental and Training Forestries, managed by University of Forestry. The rest 23% are owned by municipalities, physical and legal persons, religious communities and others. SFA is governmental budget administration with three-level structure and approximately 9500 employees. The regional and local structures of SFA are 16 Regional Forestry Boards, and relatively 141 State Forestries (SF), 37 Game Breeding Stations (GBS), as well as 19 research, seed control, forest protection and other stations. The SFA-system has a share of 0,55 % from the Bulgaria's GDP.

The logging and wood processing industries are close to 100% private and the wood processing industry has 2,2 % from the GDP and 18 000 employees.

The total timber supply in Bulgarian forests amounts to around 590,8 million cubic meters. The mean annual increment of around 14,1 million cubic meters (i.e. 163 m<sup>3</sup>/ha) of timber contrasts with annual roundwood production in 2006 of 5,99 million m<sup>3</sup> (84% from planned in forest management projects), from which 72% are from commercial logging and 28% for local household at stumpage price. The mentioned volume is significantly under annual increment of Bulgarian forests.

Major wood processors in Bulgaria are represented by the sawmill industry, the fiber board and particle board industry, which process around 1,6 million cubic meters annually.

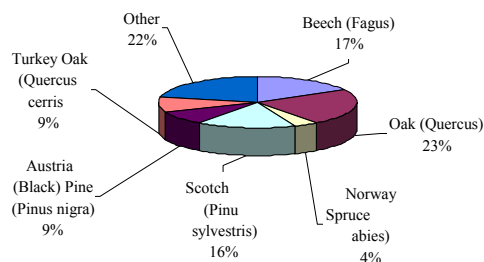
The strategic goals, which have to be reached in the forest-based sector, are focused to the achievement of balance between the economic, ecological and social functions. One of the main priorities that are pointed is increasing the woody biomass for energy.

## 1. CURRENT STATE ANALYSIS

Woody biomass for energy purpose provides both logging and wood processing industries.

### 1.1 Woody biomass from logging

The area of forests for timber is 65,9%, for recreation – 26,6%, while forests in parks and reserves are 7,5% from forest fund. During last 50 years 1,5 million hectare new forests was plantated. Since 1989 the afforestation and reforestation have been decreasing and ranged 5000-7000 ha/year despite planned 12 000 ha/year due to financial reduction and priority of natural regeneration. Key goals are increasing forested areas and increment, as well as reduction of erosion risk. The afforestation is carried out mostly in SFF.



**Figure 1** Main tree species distribution in Bulgaria

Woody biomass from forests can be differentiated as logging residue and fuelwood. Logging residue, consisted of branches, tops and other wood wastes, is a byproduct of conventional logging operations and its advantage is that the extraction costs usually are covered by roundwood production. The volume of logging residue relative to the volume of timber harvested is very variable (see Table 1). The tree species distribution is shown in Fig. 1.

**Table 1** Overview of average timber harvested structure in Bulgarian forests

Product	Coniferous wood	Deciduous wood
Branches	12%	12%
Tops	10%	15%
Fuelwood	5%	15%
Pulpwood	15%	10%
Sawlogs	40%	30%
Bark	10%	8%
Butts	8%	10%
Total for energy purpose:	37%	42%

One of the greatest challenges facing the foresters and forest managers in Europe is regenerating, maintaining, and improving the health and flexibility of forest ecosystems. In many cases, there is currently no commercial effect of the removal of large quantities of small-diameter and low-quality wood. These logging residues, consisted by woody plants, limbs, tops, needles, and leaves, are often byproducts of forest management activities. At present this biomass has little commercial value and removing it requires large expenditures with little or no economic return in the short or even long distances. Many forest managers cannot afford this sort of large-scale economic investment; therefore far fewer forest stands are being treated than needed.

At present the basic product for energy purpose in Bulgaria is fuelwood and there is a significant increase in its utilization during last several years. That phenomenon occurs due to attractive regulated prices in comparison with other fuels. For fuelwood combustion and converting into thermal energy mainly low-budget conventional heating systems with overall efficiency not more than 40% have been used. Generally, household sector is main consumer of fuelwood with 40-45 % of Bulgaria's total population. In 2003 biomass from fuelwood is 3,6 % from primary energy consumption and 7,4% from final energy consumption. At present in Bulgaria fuelwood is with the highest contribution to energy balance from all Renewable Energy Sources (RES).

In 2005 in Bulgarian forests are harvested 3 116 346 m<sup>3</sup> fuelwood and engineering wood, from which 460 105 m<sup>3</sup> are coniferous and 2 181 265 m<sup>3</sup> are deciduous. Relevant large export of deciduous fuelwood and engineering wood – 90 000 m<sup>3</sup> is realized, mainly to Turkey, Greece and FYR of Macedonia.

In 2006 are harvested 5 991 841 m<sup>3</sup> of timber, incl. 3 371 703 m<sup>3</sup> fuelwood and engineering wood. The volume of fuelwood is estimated ca. 2 750 000 m<sup>3</sup> (2 500 000 m<sup>3</sup> deciduous and 250 000 m<sup>3</sup> coniferous timber), which means ca. 590 800 t.o.e. In 2006 is realized export of 126 000 t fuelwood.

Therefore, during last decade the share of fuelwood varies between 44-56% of timber harvested [3].

The analysis of statistical data for the period of 2002-2005 shows that total amount of non-used woody biomass varies from 18,65% (771 000 m<sup>3</sup>) for 2002 to 18,37% (1 296 000 m<sup>3</sup>) for 2005 from the marking timber. Woody biomass utilization is insufficient due to difficulties during collecting, prime processing and transportation. Obviously, only part of real resources can be utilized, namely economic accessible resources. Only at the rate of 45% (41,25-48,75%) of total logging residue at stump and landing can be used for energy production. According to SFA-data during last several years only average volume of 50 000 m<sup>3</sup> (33 000-71 000 m<sup>3</sup>) of logging residue have utilized annually.

Increasing demand of biomass source for energy purpose in Bulgaria may be obtained additionally by replacing crops with Short-Rotation Forests (SRF). A key factor for economic feasibility is mechanization know-how. Protective poplar, black locust, willow and sycamore plantations there are long tradition in Bulgaria and were very popular in the past especially along rivers and in the North of Bulgaria. The plantations were progressively abandoned, but there is a revival in recent years. SFA and 35 communities start a joint project to afforest 3100 ha abandoned and non-forested lands in order to decrease 1 715 000 t CO<sub>2</sub> within the period of 2008-2027. SRF are an opportunity both to energy recovery and to meet needs of wood processing industry with an yield of 0,7-0,9 m<sup>3</sup> per tree. From tops, branches and slash can be obtained approx. 15 gt/ha.

Other volumes of woody biomass may come from biologically and destroyed by fire forests.

## 1.2 Sawmill and furniture industry residue

Before the short review of the wood market during the last few years can be stated overall increasing (almost 2 times compared to 2000) of the demands of timber and shortage of certain timber products, based on the huge internal consumption by the wood processing and furniture industries, for building and for heating. The total volume of roundwood harvested in 2005 is 5 768 000 m<sup>3</sup>, which is 2 % less compared to 2004. The volume of the harvested during the year sawlogs is 1 367 000 m<sup>3</sup>, from which coniferous are 920 000 m<sup>3</sup>. The volume of the deciduous sawlogs is 447 000 m<sup>3</sup>, as in this group during the last few years is realized relevantly large import, which for 2005 is 48 000 m<sup>3</sup>, mainly poplar logs for plywood. The total volume of the harvested in 2005 technological timber for production of wood plates and pulpwood is 1 723 000 m<sup>3</sup>, from which 943 000 m<sup>3</sup> is coniferous and 780 000 m<sup>3</sup> deciduous.

During the last few years Bulgaria exports bigger volumes of engineering timber, mainly for Greece and Turkey – for 2005 it is 343 000 m<sup>3</sup>, from which 133 000 m<sup>3</sup> is coniferous and 210 000 m<sup>3</sup> deciduous.

The total volume of the produced sawnwood is increasing and for 2005 is 1 279 000 m<sup>3</sup>, from which 260 000 m<sup>3</sup> is exported. From the produced timber 828 000 m<sup>3</sup> or 65 % is coniferous timber. Relevant large is the exported part from the deciduous sawmill timber – from 451 000 m<sup>3</sup> produced 27 % or 125 000 m<sup>3</sup> is exported.

The total volume of the produced plywood is relevant the same during the last few years and for 2005 is 50 000 m<sup>3</sup>, as well as in 2005 is registered relevant high import of this product – 30 000 m<sup>3</sup>, mainly from China and Greece, partly from Romania [1].

As a result from new investment projects provided in Bulgarian sawmill and furniture industry the capacity of renewal plants reaches respectively 1 million m<sup>3</sup> for coniferous and 600 000 m<sup>3</sup> for deciduous timber for technological processing.

Wood processing operations provide different kind of residue, mostly suitable for energy purpose. In sawmill and veneer production the rates of residue are 28–46% and - 52-62% respectively and they depend on the size of processed wood materials. In furniture production wooden residue varies between 7 and 23%.

**Table 2 Development of Bulgarian wooden biomass**

No.	Resource	Woody biomass, million m <sup>3</sup>		
		2005	2015	2020
<b>1.</b>	<b>Timber harvested:</b>	<b>3,12</b>	<b>7</b>	<b>8,5</b>
	Coniferous	0,46	2,8	3,4
	Deciduous	2,18	4,2	5,1
1.1	<b>Logging residue</b>	<b>0,07</b>	<b>1,75</b>	<b>2,125</b>
1.1.1	Coniferous	0,02	0,616	0,748
1.1.2	Deciduous	0,05	1,134	1,377
1.2	<b>Fuelwood</b>	<b>2,00</b>	<b>2,78</b>	<b>3,38</b>
1.2.1	Coniferous	0,35	0,42	0,51
1.2.2	Deciduous	1,65	2,36	2,87
<b>2.</b>	<b>Wood processing</b>	<b>2,72</b>	<b>3,29</b>	<b>5,37</b>
2.2.1	Coniferous	1,72	2,24	2,72
2.2.2	Deciduous	1,00	1,05	2,65
<b>3.</b>	<b>Energy value, kt.o.e</b>	<b>89,4</b>	<b>164,6</b>	<b>353,9</b>
3.1.	Logging residue, fuelwood and SRF	65,5	135,8	306,8
3.2.	Wood processing residue	23,9	28,8	47,1

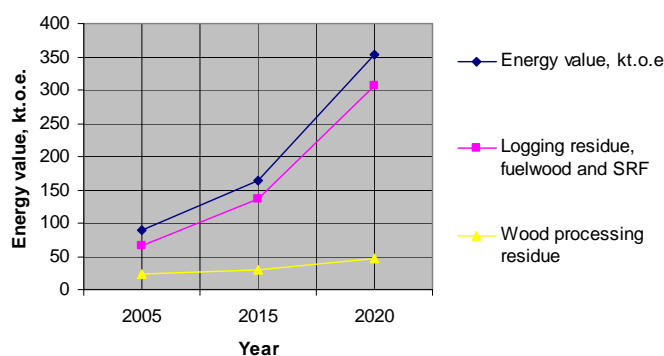
Generally, it can be concluded that nowadays solid residue of wood processing is used for energy purpose in some plants and as residential fuelwood as well. At present only soft residue (slash, sawdust, etc.) do not be used widely. They are real reserve for effective energy utilization, mainly for briquettes and pellets production.

### 1.3 Energy efficiency regulations

Bulgaria's energy sector is stable. The legislative and regulations base includes: Energy strategy of Bulgaria, Energy Act, Energy Efficiency Act, National Long Term Programme for Energy Efficiency (NLTPEE) and a number of regulations, directives and others. The vision for the energy efficiency is toward sustainable and multifunctional management of the forests and the forest territories. With a Governmental Decision, Bulgaria joins the EC Programme "Intelligent Energy for Europe". In the Bulgarian legislation is foreseen stimulation of the energy production from RES and for 2010 is expected a part of 11%. In the NLTPEE the share of biomass is relevant large in the Final Energy Consumption (FEC) – 7,7-7,9%, while the share of biomass in the Primary Energy Consumption (PEC), as stated previously, is approximately 4%. As a main energy component from the different types of biomass, in NLTPEE is the free wooden biomass. Bulgaria is researching and introducing highly efficient energy production systems for utilization of the logging and wood processing residue, and expert assessment is that the useful wood residues are approximately 500 000 m<sup>3</sup> annually. Moreover, there are developed agreements and programmes with other Ministries and organizations, with which annually is ensured a certain volume of wood fuel for social programmes.

## 2. DEVELOPMENT POSSIBILITIES AND FUTURE CHALLENGES

The increase of wood consumption, especially for energy, is world trend which influences and boosts forest utilization in Bulgaria in the future. The opportunities to increase forested lands in the future are estimated in approx. 300 000 ha, incl. 127 000 ha non-forested and the rest - abandoned agriculture lands. That process will be activated additionally by State and international mechanisms of Kyoto Protocol and Bulgaria's sustainable contribution to decrease of CO<sub>2</sub>-emissions.



**Fig. 2 Increase of energy value of wooden biomass**

The forecasts shown in Table 2 point to that volumes of timber harvested can be reach around 7 million m<sup>3</sup> (3 million m<sup>3</sup> from thinnings and 4 million m<sup>3</sup> from regenerative cuts) in 2015 and 8,5 million m<sup>3</sup> (4,2 million m<sup>3</sup> from thinnings and 4,3 million m<sup>3</sup> from regenerative cuts) in 2020 [2]. Expected distribution is 40% coniferous and 60% deciduous timber. That means approx. 1,036 million m<sup>3</sup> coniferous and 1,764 million m<sup>3</sup> deciduous timber in 2015 and relatively 1,258 million m<sup>3</sup> coniferous and 2,142 million m<sup>3</sup> deciduous timber in 2020 for converting in energy. That is increase of energy values of wooden forest-based sector residue with 183% to 164,6 kt.o.e. in 2015 and 396 % to 353,9 kt.o.e. in 2020 compared to 89,4 kt.o.e. in 2005 (Fig. 2). The energy produced from logging residue, SRF and fuelwood is foreseen to prevail over biomass produced by wood processing 4,7 times in 2015 and 6,5 times in 2020.

The enhanced utilization of wooden biomass can boost final energy consumption produced by forest-based sector residue up to 12% in 2020.

### **3. CONCLUSIONS**

The results obtained show significant technical potential of Bulgarian forest-based sector for woody biomass for energy purpose. The great amount of this potential, mainly fuelwood, has been used widely to safe coals, gas, oil and electricity in household.

The potential of wooden biomass can be converted in great extent in Combined Heating Plants (CHP) to steam and hot water for technological purpose, as well as electricity. That kind of energy production is CO<sub>2</sub>-neutral and opens opportunities for trade with quotas in the frame of defined from EC for Bulgaria 42,4 million tons carbon dioxide. Moreover, recently EC announced that probably to 2020 member-countries will be obliged to increase with 20% RES consumption.

The technical potential of a series of great wood processing plants, situated in regions with large-scale logging activity, is a good base to research, design and build CHP. CHP are high-effective due to their productive process is based on year-round generation and utilization of thermal energy and electricity.

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