

## BIOMASS FROM AGRICULTURE AS RENEWABLE ENERGY SOURCE IN THE REPUBLIC OF MACEDONIA

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### Abstract

The use of biomass energy, besides providing efficient waste disposal and energy production, protects our environment. Biomass is the oldest source of energy that man has used, and represents a collective term for various, most diverse products from agriculture. Renewable energy sources are one of the crucial components of the sustainable development, giving rational economic, ecological and social effects.

Due to favorable climatic conditions, Republic of Macedonia has significant potential to use biomass byproducts from agriculture. According to the energy balance for 2000, the biomass contributed with 7.6 percent of the gross national consumption and covers about 12.7 percent of the total national energy consumption. Using alternative sources of energy has important role because of increasingly demanding environmental standards, as well as the obligation to reduce greenhouse gas emissions. From the legal and institutional aspect, the basic elements for renewable energy sources are provided in the Law on Energy (Official Gazette of the Republic of Macedonia No. 63/2006, 36/2007, 106/2008), which, among other things, promotes the utilization of renewable energy sources. About 76% of households in the Republic of Macedonia use biomass for heating and 80% of biomass used in the country is fire wood. Crop residues are underutilized, and grape pruning residues are used rarely and in certain regions. Orchard pruning residues are concentrated in few regions and can be used for production of energy.

Republic of Macedonia theoretically could have available a very large amount of agricultural biomass for energy production. Expected ecological, economic and social benefits of biomass byproducts from agriculture are investigated.

**Key words:** *Renewable Energy, Biomass, Agriculture, Environment, Sustainable development.*

### 1. Introduction

Biomass is the biodegradable fraction of products, waste and residues from biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste [1]. Biomass is a renewable energy source that has gained significant importance in the production of heat and power in the world. This is an organic matter of animal and plant origin that will help different processes turn into usable energy.

The energy of plant origin is represented by a process of photosynthesis accumulated energy, which with light transforms into chemical energy. During photosynthesis, the plant uses carbon dioxide from the air and water in order to produce carbohydrates that are the basic building elements of biomass. In this way, the solar or solar energy accumulates in the structural bonds structural components of biomass. This energy can be exploited in various ways. The use of biomass or fuel and waste materials derived from biomass as a source of energy requires their incineration and release of heat that generates electricity generators. The energy accumulated in biomass is of a chemical nature, and in its exploitation there is no interruption of work, as is the case with the solar or wind energy. From this aspect, biomass has more fossil fuel characteristics than a renewable source, with an understandable reason that fossil fuels are actually fossil forms of biomass. Historically, biomass was the primary source of energy for mankind mainly in the form of wood used for heating and cooking, while in the industrial revolution the primacy took over the fossil fuel [2].

Biomass of plant origin is a product of the process of photosynthesis in plant organisms. Biomass of animal origin occurs as a product - the remainder of the animal's feeding process. This is how the term is very broad, but the basic concept is that biomass is constantly

consumed and renewed, in the circle of circulation of matter and the leaking of energy in nature. A man with his activities increases the amount of biomass circulating in the environment. In agricultural production, there remains a large amount of unused biomass.

In the agricultural production process there is a significant amount of bio-waste: residues when cutting trees, vines and olives, straw, corn, sunflower and stalks. Republic of Macedonia is predominantly agricultural land, possesses great potential for using biomass originating from agriculture, forestry and wood processing industry.

## 2. Biomass from agriculture as renewable energy source in the Republic of Macedonia

### 2.1 Legal and institutional aspect of biomass as renewable energy sources in the Republic of Macedonia

From the legal and institutional aspect, the basic elements for renewable energy sources are provided in the Law on Energy (Official Gazette of the Republic of Macedonia No. 63/2006, 36/2007, 106/2008), which, among other things, promotes the utilization of renewable energy sources.

This Law stipulates that the Energy Agency of the Republic of Macedonia issues guarantees for the origin of electricity produced from renewable energy sources and from highly efficient cogeneration plants, maintains a register of guarantees. In the guarantee for the origin of electricity generated from renewable energy sources, the energy source from which the electricity is produced, the date and place of production shall be specified. The guarantees will enable the electricity producer to qualify as a preferential producer for the amount of electricity produced from renewable energy sources [3].

The Energy Regulatory Commission of the Republic of Macedonia adopts Rulebooks and Decisions on preferential tariffs for the purchase and sale of electricity produced from preferential electricity producers, as well as for producers of highly efficient cogeneration plants. The following Rulebooks have been adopted:

- Rulebook on the manner and procedure for determining and approving the use of a preferential tariff for the purchase and sale of electricity produced

from electric power plants using biogas from biomass (Official Gazette of the Republic of Macedonia No. 142/2007).

- Rulebook on renewable energy sources for electricity generation (Official Gazette of the Republic of Macedonia No. 127/2008);
- Rulebook on issuing guarantees of origin of electricity produced from renewable energy sources (Official Gazette of the Republic of Macedonia No. 127/2008);
- Rulebook on acquiring the status of preferential producer of electricity produced from renewable energy sources (Official Gazette of the Republic of Macedonia No. 29/2009).

In addition, since the Energy Regulatory Commission is in charge of determining feed-in tariffs and the conditions for their use in the Energy Law, an amendment may also be envisaged with which the Regulatory Commission, instead of the Energy Agency, would be responsible for issuing solution for preferential producer and running of the Register of these plants [3].

### 2.2 Biomass from agricultural production

Republic of Macedonia owns 1.263.200 ha of agricultural land, which represents 49.1% of the total area of the country. Agricultural land includes: arable land, orchards, vineyards, meadows, pastures, as well as the areas under ponds (Table 1).

The cultivable agricultural area covers 511,600 ha with the following structure (81% arable land and gardens, 12% meadows, 4% vineyards and 3% orchards). Crop production is divided into five main groups: production of cereals, industrial, fodder, horticultural crops, as well as fruit growing and viticulture (Table 2).

In the Republic of Macedonia production of cereals are of great importance although it is not sufficient and don't cover the needs. Wheat is the most prevalent crop within the investigated period of five years. According to the average data under cereals in Macedonia, there were a total of 164,000 hectares of cereals, of which 78,448.6 ha were under wheat, under maize 30,722.6 ha, under barley 41,532.2 ha, rice 4,944 ha, under rye 4,031.4 ha and under oats 3,003 ha. The production of wheat grain is about 253,905.6 tons, rye 9,109 tons, barley 123,104.6 tons, oats 5,682 tons, maize 133,299 tons and rice 27,620.2 tons (Table 3).

**Table 1. Agricultural area by categories of use\* [7]**

Year	Agricultural area*	Arable land and gardens*	Orchards*	Vineyards*	Meadows*	Total*	Pastures*	Ponds and fishponds*
2012	1,261	413	15	22	59	509	751	1
2013	1,261	413	15	22	59	509	751	1
2014	1,263	413	15	23	60	511	751	1
2015	1,264	415	16	23	59	513	750	1
2016	1,267	417	16	24	59	516	750	1
<b>Average</b>	<b>1,263.2</b>	<b>414.2</b>	<b>15.4</b>	<b>22.8</b>	<b>59</b>	<b>511.6</b>	<b>750.6</b>	<b>1</b>

\*In '000 hectares.

**Table 2. Arable land by categories of use\* [7]**

Year	Arable land and gardens	Sown area					Plant nurseries	Fallow land and other
		Cereals	Industrial crops	Vegetable crops	Fodder crops	Total		
2012	414	163	27	51	35	276	1	137
2013	413	168	25	51	36	280	1	132
2014	413	163	26	53	36	278	1	134
2015	415	162	24	53	38	277	1	137
2016	417	168	22	52	39	281	1	135
<b>Average</b>	<b>414.4</b>	<b>164.8</b>	<b>24.8</b>	<b>52</b>	<b>36.8</b>	<b>278.4</b>	<b>1</b>	<b>135</b>

\*In '000 hectares.

**Table 3. Area and production of cereals [7]**

Year	Wheat		Rye		Barley		Oats		Maize		Rice	
	Area (ha)	Prod.	Area (ha)	Prod.	Area (ha)	Prod.	Area (ha)	Prod.	Area (ha)	Prod.	Area (ha)	Prod.
	Sown	Total (t)	Sown	Total (t)	Sown	Total (t)	Sown	Total (t)	Sown	Total (t)	Sown	Total (t)
2012	79,750	214,963	3,767	7,288	41,123	90,384	2,632	3,898	29,198	115,928	4,656	24,361
2013	81,756	258,960	3,760	8,898	42,234	125,565	2,789	5,215	31,032	131,043	4,865	27,921
2014	76,861	287,954	4,380	11,402	41,202	153,055	2,878	6,033	30,493	136,930	5,174	30,500
2015	73,979	201,218	3,760	7,747	41,763	101,677	3,107	5,652	31,807	133,771	4,985	30,527
2016	79,898	306,433	4,490	10,210	41,339	144,832	3,609	7,612	31,083	148,823	5,040	24,792
<b>Av.</b>	<b>78,448.8</b>	<b>253,905.6</b>	<b>4,031.4</b>	<b>9,109</b>	<b>41,532.2</b>	<b>123,102.6</b>	<b>3,003</b>	<b>5,682</b>	<b>30,722.6</b>	<b>133,299</b>	<b>4,944</b>	<b>27,620.2</b>

The production of industrial and fodder crops in the period from 2012 to 2016 is shown in Table 4. Average value are: 17,819.6 ha under tobacco with average production 26,490 tones and 4,158.6 ha under sunflower and average production of 6,526 tones. Although Macedonia's climate allows large production of fodder plants, due to the high costs it is not so attractive for Macedonian farmers. The trend in the production of fodder maize has shown a slight increase over the last five years. Clover was planted on 3,512.4 ha, alfalfa on 19,481 ha fodder peas hay on 1,467.4 ha and fodder maize on 4,092.4 ha average value. The average production is 15,241 tons of clover, 116,505.8 tons of alfalfa, 4,657.8 of fodder peas hay, and 102,456.8 tons of fodder maize (Table 4).

Viticulture together with wine production contributes about 17 - 20% of agricultural GDP. The wine, after tobacco, is the second most important product in terms of the export value of agricultural products. The vineyards in the Republic of Macedonia are of unfavorable age structure. There are many reasons for that such as: fragmented areas of production that are the result of the long-lasting "grinding" of the arable land, the tradition of informal relations in the land market and a long period of low investments More than 60% of the vineyards are older than 15 years, and they should be renewed with certain investments. Vardar and South-east regions have the largest share in vineyards.

**Table 4. Area and production of industrial and fodder crops [7]**

Year	Tobacco		Sunflower		Clover		Alfalfa		Fodder peas hay		Fodder maize	
	Area (ha)	Prod.	Area (ha)	Prod.	Area (ha)	Prod.	Area (ha)	Prod.	Area (ha)	Prod.	Area (ha)	Prod.
	Sown	Total (t)	Sown	Total (t)	Sown	Total (t)	Sown	Total (t)	Sown	Total (t)	Sown	Total (t)
2012	19,656	27,333	3,752	4,765	3,306	12,565	19,229	115,692	1,625	4,836	2,249	44,467
2013	19,178	27,859	2,481	3,832	3,392	12,933	19,404	113,195	1,527	4,468	2,816	63,732
2014	17,757	27,578	5,122	9,268	3,593	17,203	19,739	130,768	1,432	5,582	3,561	90,392
2015	16,128	24,237	5,542	8,499	3,544	15,784	19,405	111,143	1,484	4,193	5,136	119,985
2016	16,379	25,443	3,896	6,266	3,727	17,720	19,628	111,731	1,269	4,210	6,385	193,708
<b>Av.</b>	<b>17,819.6</b>	<b>26,490</b>	<b>4,158.6</b>	<b>6,526</b>	<b>3,512.4</b>	<b>15,241</b>	<b>19,481</b>	<b>116,505.8</b>	<b>1,467.4</b>	<b>4,657.8</b>	<b>4,029.4</b>	<b>102,456.8</b>

**Table 5. Vineyards and production of grapes [7]**

Year	Area of vineyards (ha)	Numbers of grapevine plants in '000		Production	
		Total	Grape bearing	Total in (t)	kg per vine
2012	20,948	80,713	79,160	240,461	3
2013	21,109	83,610	82,354	292,075	4
2014	22,726	85,986	84,481	195,888	2
2015	22,918	86,313	84,781	324,769	4
2016	23,192	87,668	85,950	333,319	4
<b>Average</b>	<b>22,178.6</b>	<b>84,858</b>	<b>83,345.2</b>	<b>277,302.4</b>	<b>3.4</b>

**Table 6. Area and production of fruits [7]**

Year	Apples		Pears		Plums		Cherries		Apricots		Peaches	
	Trees*	Prod.	Trees*	Prod.	Trees*	Prod.	Trees*	Prod.	Trees*	Prod.	Trees*	Prod.
	Total	Total (t)	Total	Total (t)	Total	Total (t)	Total	Total (t)	Total	Total (t)	Total	Total (t)
<b>2012</b>	4,451	187,171	385	6,937	1,657	35,444	218	5,539	160	4,503	463	8,987
<b>2013</b>	4,467	112,929	387	7,265	1,679	38,902	220	6,037	167	3,968	490	11,034
<b>2014</b>	4,038	95,684	426	6,195	1,689	33,101	198	6,324	182	4,619	560	11,558
<b>2015</b>	4,082	136,931	415	9,016	1,735	41,477	215	6,248	202	3,255	586	12,006
<b>2016</b>	4,166	101,088	447	7,207	1,772	33,684	244	5,574	210	3,471	618	12,108
<b>Av.</b>	4,240.8	126,760.6	412	7,324	1,706.4	36,521.6	219	5,944.4	184.2	3,963.2	543.4	11,138.6

\*In '000.

Vineyard plantations account for about 4% of the total arable land. Total harvested area of vineyards in hectares in 2016 is 23,192 and total number of bearing vines is 85,950 (Table 5). Areas under vineyards, wine grape varieties account for 70%, of which white varieties are 40% and colored 60%. About 25,000 farms are involved in viticulture, of which about 70% are individual holdings, and 30% are agricultural firms. The grapes are mostly produced in the Vardar region. It is followed by the Southeast and Northeast region. The assortment of table grape varieties includes several classes from many wounds, to very late table grape varieties.

The cultivation of fruits is most common in the western parts of the country, which are characterized by favorable climatic conditions for growing fruit crops. Production of apples is the main branch of the fruit sector in the Republic of Macedonia. In recent years, there has been a noticeable increase in the number of apple trees with average value of 4,240,800. The most significant regions for the production of apples are the lake (Resen-Ohrid), where about 90% of the total quantities of apples are produced. Plum production is second in importance in this subsector and is characterized by increased production. The average values of fruit production is shown in Table 6.

### 2.3 Ecological, economic and social benefits of biomass from agriculture

In the Republic of Macedonia by utilizing the potentials of agriculture, annually about 1,500 GWh of energy can be obtained. The most energy is obtained from the cereals - 1100 GWh, which represents 75% of the total energy, from the grapevine is obtained 260 GWh, and the percentage is about 17%. From orchards, can be produced potential energy around 100 GWh, and from industrial products around 14 GWh energy. Due to favorable climatic conditions, Republic of Macedonia has significant potential to use biomass byproducts from agriculture. According to the energy balance for 2000, the biomass contributed with 7.6 percent of the gross national consumption and covers about 12.7 percent of the total national energy consumption [4].

The European Commission considers that the largest energy savings can be achieved in the following areas: construction of residential and commercial facilities, with potential savings estimated at 27 ~ 30%, in the manufacturing industry by 25% reduction and transport, with a potential savings of 26%. This reduction in energy consumption corresponds to a total savings of 390 million tons of equivalent oil each year or 100 billion euros a year of savings by 2020. It is estimated that these savings will reduce CO<sub>2</sub> emissions of 780 million tons per year [5].

Biomass is one of the renewable energy sources capable of making a large contribution to the future worlds' energy supply. Although the actual role of bio-energy will depend on its competitiveness with fossil fuels and on agricultural policies worldwide, it seems realistic to expect that the current contribution of bio-energy of 40 - 55 EJ per year will increase considerably. A range from 200 - 300 EJ may be observed looking well into this century, making biomass a more important energy supply option than mineral oil today [6].

### 3. Conclusions

-With the increase in the population, the quantity of waste grows. The need for food is growing, and thus the agriculture is growing and the waste from the processing of agricultural products increases.

-Biomass can serve as an adequate solution to most of the problems that the world faces about energy.

-If we use all organic residues from agriculture, forestry, and even municipal waste, we will significantly reduce the problem of waste, and at the same time we will get energy that can be used for different purposes.

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