



BIOMASS AVAILABILITY IN THE TERRITORY OF REPUBLIC OF MACEDONIA

**Enabling activities for climate change mitigation through
biomass utilization under CDM projects**

University of Tuscia of Viterbo, Italy:
*Federico Chiani, Chiara A.R. Corradi, Lucia Perugini,
Valerio Rappuoli, Riccardo Valentini*

University of Cyril and Methodius of Skopje, Macedonia:
Elizabeta Angelova, Ljupco Nestorvoski

January 2010

Index

1	Preface.....	3
2	Introduction	3
3	Technological Considerations	5
4	National context	8
4.1	National electricity production and consumption	10
4.2	Forestry sector: an overview	12
4.2.1	Regional forest type distribution	12
4.2.2	Current management of forest	13
4.2.3	Main institutions related to forestry.....	16
4.3	Agricultural sector: an overview	19
4.3.1	Structure of agricultural holdings	19
4.3.2	Agricultural production: main products and residuals	21
4.3.3	Main institutions related with agriculture.....	26
5	Methods and materials.....	28
5.1	Data collection	28
6	Potentiality of forest by products for energy production.....	29
6.1	Current scenario.....	31
6.2	Potential scenario.....	31
6.2.1	Review and optimization of management plans	33
6.2.2	New forest areas	34
7	Potentiality of agriculture by products for energy production	35
8	Potential biomass power plant establishment.....	39
8.1	Frequency of agro-forest by-products	40
	Conclusions	41

1 Preface

With the ratification of the Kyoto protocol (2004), the Republic of Macedonia started the process of opening its boundaries to foreign investments for GHG emission reduction in the country, gaining access to additional funds linked to project based mechanism, technology transfer and therefore contributing to its sustainable development. In this context, Republic of Macedonia and Italy have started in August 2005 an exchange programme aimed at sharing experiences in the areas of environment and sustainable development focusing on the Kyoto Protocol. Since then, several activities related to promoting investments in the country have been undertaken by the Italian Ministry of Environment, Land and Sea. The present study is aimed to fulfil the need of assessing the potentials of the exploitation of biomass for energy production, in order to attract investors interested in energy projects under the Clean Development Mechanism of the Kyoto protocol.

The study was undertaken by the Department of Forestry Science and Environment of the University of Tuscia (Viterbo, Italy) together with the University of Cyril and Methodius of Skopje (Faculty of Agricultural Science and Food and Faculty of Forestry).

2 Introduction

Scientifically the terms “Biomass” includes any type of material of biological extraction, that’s to say, linked to coal chemical process. Hence we refer to any substance directly or indirectly deriving from chlorophyll photosynthesis. Of course, this definition includes a very wide and differentiated kinds of matter. It is usually excluded oil, natural gas, coal (and their by-products) due to their nature of unsustainable source of energy.¹ Biomass, as renewable source of energy, is to be considered one of the most relevant substitute for fossil fuel both in developed and underdeveloped countries. Biomass can produce electricity, liquid and gaseous fuels for transportation, for the industry, and even for residential use, as well as a variety of useful chemicals, including those currently manufactured from petroleum. The main source of biomass are:

- Forest residues (including imperfect commercial wood, dead wood etc.) and wood processing wastes;
- Agricultural residues and food processing wastes;
- Fuel crops;
- Animal wastes;
- Urban organic wastes.

According to a recent study by ITABIA² (Italian Biomass Association), on the average, the world energy production and consumption from biomass ranges from 10 to 12%. EU White Paper has forecasted an increase in primary energy consumption from biomass up to 135 Mtoe (Million tons oil equivalent) within 2012. This allows European Union for reducing emissions of greenhouse gases (GHG) and reducing its dependence on imported

¹ See Italian Biomass Association, *Le biomasse per l'energia e per l'ambiente: rapporto 2003*, p. 2, A.I.G.R., *Potenzialità energetiche da biomasse nelle regioni italiane*, 1994, p. 4.

² V. Bartoletti, *Disponibilità di biomasse sul territorio italiano e aspettative reali di sfruttamento*, ITABIA, 2003.

conventional energy sources that is constantly increasing (White paper foresees that EU dependence will reach 70% by 2030). The European Union White Paper purposes in the field of renewable energy consumption within 2010, are the following:

Table 1: Renewable energy consumption in the European Union (Mtoe/year)

Source	Year 2010
Biomass	135,0
Hydro-electric	28,8
Geothermal	5,2
Wind	6,9
Photovoltaic systems	4,0
Solar thermal systems	0,3
Total	182,2

Source: ITABIA, Le biomasse per l'energia e per l'ambiente: rapporto 2003, p. 5.

It is worthwhile noting that biomass should reach 74% of the whole EU renewable energy consumption by 2010. Unfortunately the wide lack of systematic studies about the biomass availability in most of European Countries makes actual potential of energy production by biomass uncertain. In recent years GEONARDO Ltd, a consultancy company based in Budapest, has developed a series of projects in Central Eastern Europe in environmental engineering and resources management. Among its projects, CEUBIOM³ (Classification of European Biomass Potential for Bioenergy Using Terrestrial and Earth Observation) seems particularly attractive as far as biomass energy is concerned. The project activities started in March 2008 and they are expected to be finalized at the end of 2010. During this period the strategic objectives to accomplish are:

- Develop a common methodology for gathering information on biomass potential using terrestrial and earth observations;
- Disseminating information, best practices and methodology on using earth observations in the assessment of biomass potential;
- Raise awareness of the scientific community and the public for the use of EO on estimating biomass potential.

³ Republic of Macedonia is a partner of Consortium.

3 Technological Considerations

It is possible to upgrade biomass to obtain fuels that are identical to, or have properties close to, those of fossil fuels. This minimises the need to adapt end-use technology, but does have associated costs and energy losses. An alternative is to reduce the moisture content, increase the heating value and modify the physical form in which biomass is used, while adapting end-use equipment to the fuel produced. This also entails associated costs and energy use and a different technological approach. The present relevant technologies for producing energy by biomass are the following⁴:

Combustion

Combustion is the complete oxidation of a fuel to carbon dioxide and water. With solid fuels, the mineral content will generate ash while other minor components (such as sulphur and nitrogen) contribute to formation of potential atmospheric pollutants. Biomass energy system needs some preliminary steps (i.e. it could be necessary to dry the fuel) for increasing combustion efficiency. Many different types of grates and primary and secondary air inputs to various *combustion zones* can be used for increasing efficiency. Alternatives to grates include systems where the fuel is entrained in a moving gas stream that allows for handling a wider range of fuels. The hot combustion gases are a source of heat that must be recovered for use through heat exchangers.

Electricity generation

The types of machines used most widely are three-phase alternators driven by an engine or turbine known as the prime mover. Power stations that burn solid biomass or wastes generally use steam turbines. The overall efficiency of any type of biomass power plant is significantly increased if the heat produced is also used. In such combined heat and power plant water may be heated by steam extracted from the turbine, or from condensation water through heat exchangers. Heat may also be recovered in smaller systems from the water used to cool internal combustion engines.

Biological processes

Anaerobic digestion is a process that occurs in the absence of oxygen catalysed by a mixed population of bacteria that break down the polymers found in biomass to realise biogas, a mixture of carbon dioxide and methane. Biogas may also include highly toxic and corrosive gases (i.e. hydrogen sulphide). The process occurs in several stages. First, polymers such as cellulose, starch, proteins and lipids are hydrolysed to sugar, amino acids, fatty acids etc. These are then converted to a mixture of hydrogen gas, low molecular weight acids (primarily acetic acid) and carbon dioxide, in the process of acetogenesis. These are then reacted together to generate methane, in methanogenesis.

Thermo-chemical processes

The main thermo-chemical processes (direct combustion apart) that have been applied to biomass are gasification and pyrolysis. Both processes involve heating the feedstock in the presence of less oxygen than is required for complete combustion and can produce a mixture of gas, liquid and char. There are several physical characteristics of biomass that

⁴ Most of technological considerations are from: European Commission, *Biomass: An Energy Resource for UE*, 2000.

affects its yield: a) rate of heating; b) the highest temperature reached; c) the way in which off-gases react with hot solids; d) the amount of water (as steam) e) the presence or absence of other substances that may act as catalysts.

Gasification and pyrolysis differ on the basis of how the heat generated is used. In the former process heat is produced by partial combustion of part of raw material, whereas in pyrolysis an external source of heat is used.

Fast pyrolysis is an high temperature process in which small particles of biomass are rapidly heated in the absence of oxygen. This causes the feed material to decompose to generate vapours, aerosols and some char. After cooling and condensation a dark viscous liquid is obtained, which has an heating value of about 50% of that of conventional fuel oil. This bio-oil can be substituted for fuel oil in combustion system or engines for heat or electricity generation. If upgraded, using hydrogenation or catalysis, it may produce liquid fuel with specifications close to those of petroleum-derived fuel oils enabling it to be used in vehicles powered by diesel engines.

The direct combustion represents largely the most mature technology for producing energy by biomass. Of course the technological choice between biological and thermo-chemical processes depends on physiochemical proprieties of biological materials. Roughly speaking, the latter are more suitable for materials that have:

- an high C/N ratio (> 30);
- a low rate of moisture ($< 30\%$);

Differently biological processes (anaerobic digestion) are to be considered a better solution. Wood and all its by-products, the most common lignocellulosic crops by-products (pruning residues, corn straw etc.), and some of production wastes (husk, fruit stones etc.) have the former properties. Water crops, some crops by-products, (*i.e* leaves and stalk of beets, potatoes etc.) and manures, having a low C/N ratio and a high rate of moisture, are suitable for biological processes. However, during collection, the rate of moisture is affected by several factors such as period that products or by-products remain uncollected, weather conditions during collection, their chemical structure, time of collection etc. According to a modelization⁵, the fast pyrolysis seems to be the least expensive option at small scale (under the assumption of model, up to 5 MW_e) than combustion and gasification, but this is only true in the long run as the relative novelty of this technology faced with the latter, implies and higher start-up capitals. On the contrary, the combustion guarantees a shorter time of return since lower capital costs (taking into consideration the learning factors and current costs). However the electricity production costs linked to different technologies vary only slightly at all capacities. Hence the technological possibilities eventually count for the final decision. In this view decoupling⁶ is one way that fast pyrolysis system can distinguish itself from the competition, whilst maturity of technology is a point in favour of combustion.

⁵ A.V. Bridgwater, A.J. Toft, J.G. Brammer, *A techno-economic comparison of power production by biomass fast pyrolysis with gasification and combustion*, «Renewable and Sustainable Energy Review», 6 (2002), pp. 181-248.

⁶ “decoupling is the separation in time or space of the conversion and generation stages of the biomass to electricity system. Decoupling is only available for fast pyrolysis systems where it is viable to store and transport the intermediate energy carrier since it is a liquid. Conversely the steam produced in a combustion system must be used immediately in the steam turbine and a low heating value fuel gas cannot be stored or transported for long distances economically. Combustion and gasification systems must therefore be used in close-coupled configurations where the conversion and generating stages occur concurrently and at the same site.” *Ibidem*, p. 191.

Combined Heat Power

Cogeneration (or CHP: Combined Heat and Power system) is a suitable solution for all industrial and public fields of use where consumption of both heat and electricity is significant. Conventional power generation plants usually dissipate the heat generated using cooling towers, wasting a considerable amount of energy. With CHP, this heat is used for domestic or industrial space heating or for process heat.

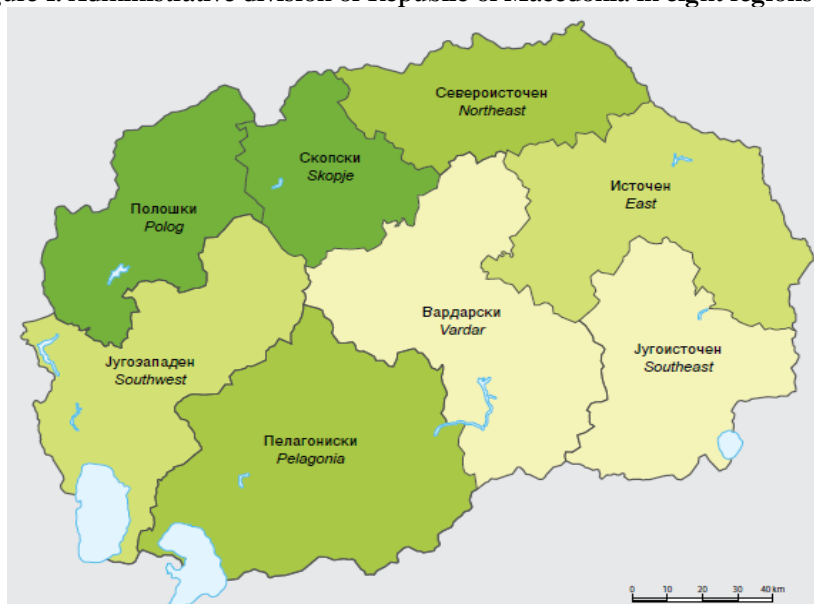
Decentralised CHP technologies offer the advantage of domestic fuels exploitation, including poor quality fuels, biomass and wastes. EU and Kyoto policies promote decentralised CHP in accordance to energy development, since it offers the means to improve energy efficiency, reduce energy intensity and vastly increase the share of clean, durable and renewable energy use (www.biomassenergycentre.org.uk). CHP also constitutes an economically attractive way to cover power, heat and cooling demands of industrial utilities, the agricultural and the residential sector, and it can provide developing countries with more sustainable and less damaging means towards economic growth (<http://bios-bioenergy.at>). Several decentralized CHP plants based on biomass consumption are already in operation over Europe and Balkan countries, having as technology predominantly applied the steam turbines. In general, decentralized CHP systems based on gasification processes have not reached market introduction yet. Nevertheless this technology shows a considerable potential in terms of technological development and reduction of costs, allowing the CHP systems to be more and more competitive.

The main problem with the use of crops and wood residues for energy purposes is the availability and the alternative potential destination of land use. In general, the costs associated with growing a crop or establishing a tree plantation are related to the area under cultivation. Other problems derive from difficulties in harvesting and storing residues, this is especially true when the available time for harvesting is particularly short. Transportation costs are determinant in the overall costs of biomass energy, so at the present district heating and CHP systems seem to be to most convenient.

4 National context

The Republic of Macedonia became independent from the former Socialist Republic of Yugoslavia on September 8, 1991. Its political system is a parliamentary democracy. On December 4, 1997 Macedonia ratified the UFGCC (United Nation Framework Convention on Climate Change – Rio de Janeiro 1992) and became an equal member of the Convention five months later (April 28th, 1998). In 2003 a first National Communication was prepared in order to report country's conditions regarding climate change issues. Concerning the administrative Macedonian arrangement, the country is divided into 84 municipalities that have a large autonomy in terms of competence and financial potential⁷. More recently Republic of Macedonia has been divided in 8 Statistical regions; they are solely for legal and statistical purposes. The regions are: Eastern, Northeastern, Pelagonia, Polog, Skopje, Southeastern, Southwestern, and Vardar.

Figure 1: Administrative division of Republic of Macedonia in eight regions, 2006



Source: *Regions of Republic of Macedonia*, Republic of Macedonia: State Statistical Office, 2007

The country surface is 25.713 km², of which plains cover 19,1%, mountain terrains 79% and water bodies the remaining 1,9%. The agricultural area covers around 25% of Macedonian territory, protected natural regions 6.6%, forests almost 39% of the national territory. The average annual precipitations range between 500 and 1000 mm.

The structure of industry is mainly based on mining, metallurgy, refinery, metals manufactures, non-metallic mineral products, food products, beverages, tobacco products and textile. After transition the industrial production has dropped, due to political and economic transformations and the loss of former Yugoslav market. According to data of 2005, the gross value added for each regions is represented in tab 2 (assuming a rate of exchange of 61,3 MKD for 1 €):

⁷ See *Macedonia's First National Communication*, Ministry of Environment and Physical Planning, Skopje 2003, p. 20.

Table 2: Regional GDP (in Thousands of Euro)

Region	GDP	Agr. (%)*	Ind. (%)**	Serv. (%)
Vardar	294.313	20,76	41,77	37,46
East	252.581	19,71	35,51	44,78
Southwest	287.864	9,04	32,55	58,40
Southeast	314.921	44,98	19,87	35,15
Pelagonia	480.621	21,29	41,01	37,70
Polog	289.547	17,43	26,60	55,97
Northeast	167.766	23,02	22,42	54,56
Skopje	1.876.800	1,94	26,36	71,70
R.O.M.	3.964.413	12,78	29,65	57,58

Source: *Regions of Republic of Macedonia*, Republic of Macedonia: State Statistical Office, 2007

* Include: agriculture, hunting, forestry and fishing;

** Include: industry, electricity and construction

Around 50% of GDP is concentrated in Skopje Region, where the 25% of population lives. The average GDP per capita for Republic of Macedonia amounts to € 2.295,53. The agricultural area has slightly been decreased from 1.319 kha during 1984-1994 period to 1.280 kha in 1999. Around 650 kha are agricultural arable land and almost as many are permanent pastures. The total forest area covers around 1.000 kha.

Table 3: Land use (1998)

Category of land	Ha	%
Cultivable area	658.000	50,62
1. Arable land and gardens	550.000	42,31
2. Orchards	21.000	1,61
3. Vineyards	32.000	2,46
4. Meadows	55.000	4,22
Pastures	640.000	49,23
Ponds, reed, beds an fishponds	2.000	0,15
TOTAL	1.300.000	100,00

Source: Ministry for the Environment Land and Sea of Italy, Assessment of Projects' Potential in the Field of Renewable Energy Source, Energy Efficiency and Forest Management, in the Framework of CDM Foreseen by the Kyoto Protocol in the Republic of Macedonia, 2008, *cit p 23*.

Table 4 Forest area

Category of land	Ha
Forest area	
1 forest lands	1.095.000
2 forests	835.055
2a coppice forests	545.000
2b high forests	256.484
Plantations	144.000
Shrubs	19.000
TOTAL	1.258.000

Source: Public Enterprise Makedonski sumi s.r. – direct interviews

In the last years the cultivable area has constantly decreased - mainly due to land erosion - and arable land as well - due to abandon of land. (see below, *section 4.4*)

- Soil conditions

Soils in Republic of Macedonia are classified in 7 soil types according to their quality:

I. class: alluvial, alluvial-colluvial, and meliorated hydromorphic soils: meadow, gley, and peat soils 197 702 ha. (7.68 %);

II. class: vertisols and chernozems 94 700 ha. (3.69%);

III. class: rendzinas, cinnamonic forest soils, and colluvial soils 451 942 ha. (17.56 %);

IV. class: luvisols, pseudogleys, and regosols 195 629 ha. (7.60 %);

V. class: rankers and brown forest soils 1 117 583 ha. (43.49 %);

VI. class: rendzinas on hard limestone and dolomites and brown soils on hard limestone and dolomites 314 385 ha. (12.23 %);

VII. class: litosols and halomorphoc soils 199 359 ha. (7.75 %).

The soil types from the first four classes are agricultural land (arable land and pasture); soils within the next two classes are mainly under forests and pastures, while soils from the seventh class are unproductive soils.

4.1 National electricity production and consumption

The Republic of Macedonia is one of the Southern East European countries with the lowest level of energy resources. It has no natural gas and fossil fuel resources limited lignite reserves. At the present, the lignite fired thermal power plants (TPP) produces about 85% of the total electricity, the rest is covered by the hydro power plants. The lignite fired TPP is located in Bitola and Oslomej, the liquid fuel plant is in Negotino.

As far as the distribution of electricity production and consumption across the eight regions, here are presented the 2006 data:

Table 5: regional energy production and consumption

Region	Prod. capacity (MW)	Electricity consumption (GWh)	
		households	industry sector
Vardar	332	216	709
East	15	200	43
Southwest	254	306	53
Southeast	2	218	147
Pelagonia	679	376	180
Polog	217	402	609
Northeast	0	213	28
Skopje	84	1.117	675
Rep. Of Maced.	1.583	3.048	2.444

Source: *Regions of Republic of Macedonia*, Republic of Macedonia: State Statistical Office, 2007

The biggest share of electricity production belongs to Pelagonia Region where the Bitola TPP is located. The other major electricity providers are Vardar and Southwest Region where Negotino liquid fuel and Oslomej lignite TPP are respectively located. The total system's electricity generating capacity available is around 1.500 MW.

According to forecasts (MELS 2007)⁸, and with the perspective that in the next future an increase of power demand between 3 and 4% per year is foreseen, it is possible to expect that after 2013, the shortage of domestic energy supply will approximately range from 7000 to 8500 GWh (whether or not Negotino plant works, respectively), that amounts to around 72% - 87% of power demand.

In order to fill this gap of energy sources, a number of actions are planned in Macedonia, in order to construct new power systems, and a number of power plants based on renewable sources. Among others there are:

- 1) One thermal plant (lignite) in Bitola, of about 210 MW. Similarly it is planned the realization of another thermal plant in Negotino, of about 300 MW, in addition to the existing oil power plant. For the new plants is supposed to use lignite coming from the opening of new mines within the Macedonian territory, at high costs and with very high environmental impact at ecosystem and landscape levels.
- 2) A gas Combined Heat Power plant (TETO) is in a final phase of realization with a capacity of 210 MW, and one more is planned for 2013.
- 3) Finally two more hydropower plants are planned to be built, having a capacity between 50-200 MW.
- 4) An increase of the capacity of the existing gas pipeline, having a capacity of 800 million m³ per year, and with the possibility of increasing the capacity up to 1,200 million m³

On the other hand, it is necessary to take into account the future closure of TPP plant in Oslomej, expected for 2018. A similar situation will occur for Bitola plant, which reactors function is going to be extended up to 2025ⁱ.

In this context, the introduction of renewable energy sources, such as biomass power systems, wind power and solar, can be considered an important and sustainable alternative with very high promising potentials and with lower environmental impacts compared to mine opening.

Energy from biomass could represent an opportunity in order to fulfil a part of Macedonian future power demand, reducing the dependence upon abroad, also realizing CDM project thus reducing emissions. Unfortunately Republic of Macedonia is lacking of updated information and systematic survey about biomass availability. The only available data traces back to a study prepared by MANU (Macedonian Academy of Sciences and Arts) in July 2000, and a study by Haskoning in 2001. These studies, quoted by the PHARE programme (2006), report the following data about the overall energy potential of biomass and municipal waste in Macedonia:

Table 6: estimate of energy production of Macedonia, from organic residues

Energy Resource	Theoretical Potential (GWh)	Percent of State Energy Balance	Technical Potential (GWh)	Percent of State Energy Balance
<i>Forest and Forest Residues</i>	6.000	20	2.660	8,87
<i>Agricultural Residues</i>	2.000	6,67	286	0,95
<i>Municipal wastes</i>	830	2,77	415	1,38
TOTAL	8.830	29,44	3.361	11,21

Source: *Regions of Republic of Macedonia*, Republic of Macedonia: State Statistical Office, 2007

⁸Assessment of projects' potential in the fields of renewable energy source, energy efficiency and forest management, in the framework of Clean Development Mechanism foreseen by the Kyoto Protocol in the Republic of Macedonia. Ministry for the Environment Land and Sea of Italy. May 2007*cit.*, p. 13.

Irrespective of considerations about the carefulness and updating of data, most promising use of biomass for energy purposes seems deriving from forestry and agricultural crops by-products, while industrial wastes are far to be evaluated.

4.2 Forestry sector: an overview

The total forest area (forests and forestry land excluding protected forests in the Republic of Macedonia) is 1.091.857 ha, out of which forests are 835.055 ha, and the rest (256.447 ha) is forest land. With the help of the Afforestation Fund, more than 140.000 ha of bare lands were planted and it was achieved an incensement of the total afforested area with index of 1,6. It means that annually the forest area increased of 1,6% from the existed total forest area⁹. Out of the total forest and forest land area, 8% are not included in the forestry management plans. The increasing of the forest area (551.000 ha in 1946 year to 965.560 ha in 2006 year) is due to evidencing and including into the forestry management plans the non managed forests, (forests that were not included into the organized management until then) and due to the huge afforestation of new non-forest areas. The discrepancy on the data of forests and forest land appears because of different sources of the data: Ministry of Agriculture, Forestry and Water Economy (MAFWE), Public Enterprise "Macedonian Forests" (PEMF) or State Statistical Office of the Republic of Macedonia, basically because different methodology of data collection and their preparation.

90.1% of the total area is state owned forest, and includes 92.2% of total wood reserve. Private owned forests are 9.8% (94.146 ha) of the total forest area, and their portion of the total wood mass is 7.8%¹⁰. Forests in private ownership are scattered on small plots and are low-productive in terms of timber mass. These forests are largely defoliated and degraded because their management in the past was not performed according to the forestry principles. There are approximately 220.000 plots of an average size of 0,4 ha owned by approx. 65.000 households in all Macedonia. Regarding the purposes of private forests utilization, it depends on forests quality, size of the forest area etc. Sometimes it is for subsistence purposes, sometimes for selling to domestic market. There are, moreover, many unclarified issues of a legal and proprietary nature¹¹.

4.2.1 Regional forest type distribution

Macedonian forests are almost represented by nine main species: *Fagus sylvatica*, *Quercus petraea*, *Quercus pubescens*, *Quercus cerris*, *Quercus coccifera*, *Carpinus orientalis*, *Ostrya carpinifolia*, *Abies alba*, *Pinus nigra*. These species are distributed to constitute pure broadleaved forest type (471.138 ha), mixed broadleaved forests (~239.744 ha), pure coniferous plantations (~70.812 ha), mixed coniferous forest types (~8.350 ha) and mixed broadleaved/coniferous (~45.009 ha). North-East, South-East, Polog and Skopje regions have very small mixed forest with coniferous. Pelagonia and South-west regions have about a 10% of conifers and 90% of broadleaves, East and Vardar regions have 70% of broadleaves and 30% of conifers.

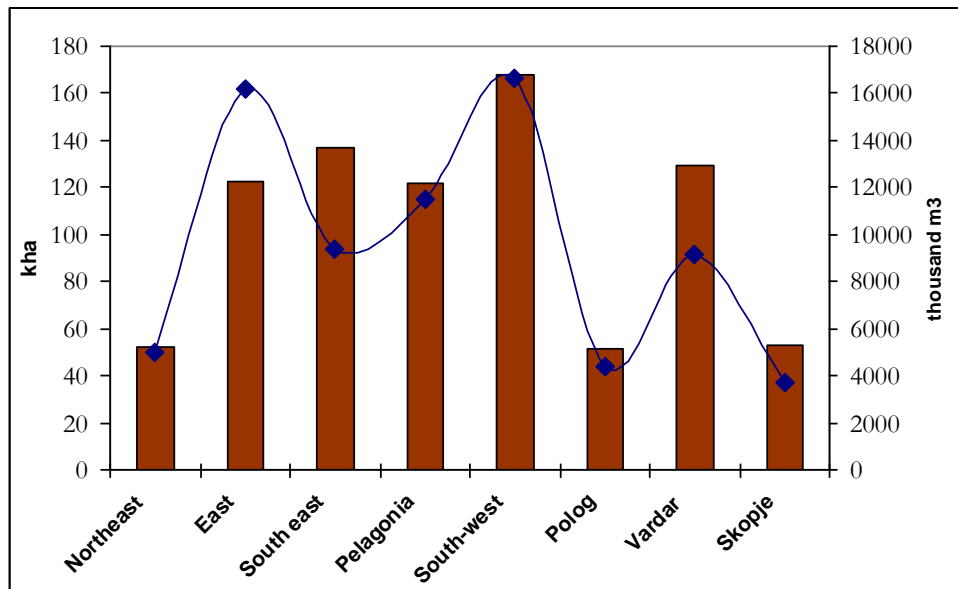
⁹ Statistical yearbook of Republic of Macedonia 2007, PE "Macedonski sumi", 2008

¹⁰ Strategy on development of agriculture, forestry and water utilization in Macedonia, 1996.

¹¹ See note 10

The regions with major cover of forest are: South-west (167.574 ha), South-east (137.266 ha) and Vardar (129.354 ha). Pelagonia and East regions have almost the same forest land, with about 122.000 ha. Skopje, Polog and North-east have the lowest forested area, ranging between 51.000 and 53.000 ha.

Figure 2: Regional distribution of forest area (bars), in kha; wood reserve, in thousand m³ (blu line)



Source: Makedonski sumi s.r –direct interviews

4.2.2 Current management of forest

The allowed annual available cut in the Republic in Macedonia in the last 10 years is about 1.230.000 m³, out of which around 62% every year are planned for utilization, and only around 51% of the annual allowed cut is harvested (around 83% of planned). From the produced special forest products, 80 to 85% of harvested wood is fuelwood. Almost all of the timber production is for domestic sector, and all of the fuel wood is for domestic use. According to the purpose, 92% of the forests have economy character, 2% are protective forests and 6% national parks. According to its quality, forests with high quality are 30,4% and coppices are 69,6% of total forest area¹².

In this scenario the most important problems related to the protection of Macedonian forests are: frequent forest fires, an increasing illegal cutting due to unfavorable social and economic conditions, and a rise of climatic change-forest dieback. The Public Enterprise of Macedonian Forests manages all privately and stately owned forests in Republic of Macedonia. The public enterprise for forest managing, is a public ownership on the territory of the Republic of Macedonia “Makedonski sumi” s.r., funded on the basis of a Decision of the Government of RM No. 3028/1 on 15.12.1997 (Official gazette of RM No. 65/97). It started functioning on 01.07.1998 as a legal successor of the former enterprises for forest management¹³. There are 12 sectors and services in the frame of the PEMF and they are: sector for silviculture, protection and forest ecology; sector for

¹² Strategy for sustainable development of forestry in the Republic of Macedonia, 2006.

¹³ Strategy for sustainable development of forestry in the Republic of Macedonia, 2006

commercial working; sector for development, investments, plan and analysis; sector for economic and financial matters; sector for forests utilization and primary wood processing; sector for legal, personnel and general affairs; sector for forest management planning; sector for hunting and hunting tourism; service for marketing and information; service for internal audit; service for forest guarding; IT service.

Around 3.000 people are employed in the forestry sector, of which, in the year 2004, 2.709 are in the PEMF, around 100 are in the ministry of Agriculture, forestry and water economy¹⁴, around 150 in the Forestry police, and the rest are in the National parks, and in the various NGO and other organizations. From all of them, around 700 are forestry engineers, around 900 are forestry technicians, and the rest are loggers, cutters and other necessary staff.

Forestry in Macedonia is an economy branch that participates in the Gross National Product, together with agriculture, with around 10%, out of which 0.3 - 0.5% forestry and between 1,5-2% wood processing industry. There are not included here the multifunctional goods from forests and the contribution of non-wood forestry products, because of non relevant data. The contribution of the forest industry (primary and secondary wood processing, furniture, paper and celluloses...) is 2,5-3%¹⁵. However, in this moment Macedonian forestry is in a very bad economic situation. Among various reasons, the most important is an improper organization into PEMF (it means that organizational structure into PEMF and internal regulations doesn't provide sustainable and profitable management with Macedonian forests), illegal logging and unsuitable sanctions. According to Nikolov (2004), illegal cutting is estimated around 30% of annually fulfilled harvests, and this assessment might be underestimated.

4.2.2.1 Timber resources

Wood can be considered an important source of energy, due to the quantity and the quality of the forests. Forests cover more than one third of the total territory of the Republic of Macedonia. Nevertheless, forest reserves are mostly highly degraded: short trunked offsprings trees degraded together with small quantity of conifers, results in relatively low timber mass, and low annual growth per unit of lands, especially if compared to forests of Central and Northern Europe. The most abundant species are beech (*Fagus sylvatica*) and oaks (*Quercus sp.*).

As it is reported by Macedonski sumi, the total wood reserve of Macedonia is about 75 millions m³ with an annual increment of 1,6 million m³. According to the national forest management plan, the allowed annual harvest is established around 65-70% of annual increment. On the other hand, the statistics of last 10 years, show that the cutting plans do not fulfill the allowed threshold of harvesting. For a number of objective and subjective reasons, the realized cuts are limited to an average rate of 70-80% of planned amount. Among various reasons there are: inaccessibility of forests owing to poor quality and few road connections; insufficient mechanization of operations; unfavorable topographic conditions; low interest in certain kinds of timber.

In general, 80% of the harvested wood is firewood, and 20% is characterized by logs for industry. This percentage can slightly change region by region shifting from 70% of firewood and 30% of commercial wood, to 90 % and 10%, respectively, in the regions with lower quality of forests. The total timber harvest is used for annual production of:

¹⁴ Annual statement for year, 2004

¹⁵ Statistical yearbook of Republic of Macedonia 2006

industrial timber (18%), fuelwood (72%), scraps (10%). Industrial timber is mainly absorbed by the domestic wood processing industry, the capacity of which is around 150.000m³. Only about 10.000 m³ of industrial timber (logs) is placed in the foreign market (5% of total production) (Nikolov N., 2004).

Taking into consideration that the total allowed annual cut is more than 1.094.000 m³, and that only the 50-60% is annually fulfilled, the quantity of wood still available for energy purposes is very high (see chapter 5 for more details).

Table 7: Quantity of allowed, planned and realized cut, in the years 1998-2007

Year	Allowed cut (m ³)	Planned cut (m ³)	%	Fulfilled cut (m ³)	% of allowed	% of planned
1998	1.275.896	854.748	67	682.668	53,5	79,9
1999	1.163.757	816.177	70	733.280	63,0	89,8
2000	1.270.970	777.652	61	797.602	62,8	102,6
2001	1.265.333	782.198	62	515.192	40,7	65,9
2002	1.280.163	756.805	59	527.941	41,2	69,8
2003	1.237.824	726.679	59	654.296	52,9	90,0
2004	1.232.480	730.371	59	626.884	50,9	85,8
2005	1.225.791	694.482	57	587.944	48,0	84,7
2006	1.235.509	704.636	57	604.869	49,0	85,8
2007	1.116.177	746.635	67	583.077	52,2	78,1
Average	1.230.390	759.038	62 %	631375	51,4%	83,2%

Source: Makedonski sumi s.r. - direct interviews

4.2.2.2 Non-timber resources

Except fuel wood and timber, there are some wild fruits and nuts exploitable from the Macedonian forests. These consist mainly of high mountain fruits, the most important of which is the blueberry (*Vaccinium myrtillus*), a product used chiefly for export (in 2001, 83.284 kg, worth \$86.196). In recent years, there has been an increase in the collection of juniper berries (*Juniperus communis*) for the production of essential oils. The main production of wild fruits is, after berries, Dog rose (*Rosa canina*), Raspberry (*Rubus idaeus*), blackberry (*Rubus* spp.), Cornelian cherry (*Cornus mas*) and Blackthorn (*Prunus spinosa*). Wild apples, pears and cherries are used as ingredients in the fruit teas very much in demand for export. In addition, the collection of Chestnuts (*Castanea sativa*) is very widespread, with approximately 250.000 kg collected per year, intended mostly for the home market. The richness and heterogeneity of species and ecosystems are the most striking features of the biodiversity of the Republic of Macedonia. This situation is a result of Macedonia's specific geographic position, climate, geology, geomorphology, hydrography, soil and other characteristics, such as the changes which occurred during past geologic periods (e.g., from the end of Tertiary through the ice age, with its glacial and interglacial phases). A huge number of relict species and ecosystems are the result of these changes, which continue to have an effect on the recent flora, fauna and fungi. According to recent data, the imposing number of more than 18.000 *taxa* of flora, fauna and fungi - 900 of which are endemics – express Macedonia's rich biodiversity. The presence of more than 260 plant assemblages also shows the great diversity of ecosystems¹⁶.

¹⁶ Study for biodiversity in the Republic of Macedonia, 2004

4.2.3 Main institutions related to forestry

The Government of the Republic of Macedonia administers the forests and forestlands of state ownership through the following institutions:

- Ministry of Agriculture, Forestry and Water Economy;

The State Inspectorate of Forestry and Hunting functions as a body within the Ministry of Agriculture, Forestry and Water Economy, controls and supervises the enforcement of the Law on Forest, Law on Hunting and all other laws and law binding acts that are in the function of forestry and hunting. The Forestry Police as a sector within the Ministry of Agriculture, Forestry and Water Economy protects the forests in accordance to the Law on Forests.

- Ministry of Environment and Physical Planning;

In the framework of the efforts aimed at integration into the modern trends of environmental protection in Europe and wider, and also as an important segment of the process of reforms, the Government of the Republic of Macedonia established the Ministry of Environment (Law on Amendment and Supplementing the Law on Public Administration Bodies", Official Gazette of RM" No.63/98).

Article 122-a of the Law on Amendment and Supplementing the Law on Public Administration Bodies defines the following competencies of the Ministry:

- state of the environment monitoring;
- proposing of measures and activities aimed at water resources, air and ozone layer protection, protection against noise, radiation, conservation of biological diversity, geological diversity, national parks and protected areas;
- remedial of polluted parts of the environment;
- cooperation with scientific institutions for development of standards and regulations to regulate environment protection;
- development of self-financing system from independent sources, types and levels of environmental charges and other payments;
- cooperation with civil associations, civil initiatives and other forms of civic activity; inspection supervision in the field of its scope;
- other activities specified by law.

Within the framework of the Ministry of Environment and Physical Planning, functions State Inspectorate for protection of the environment that controls all legal and physical entities in the part of protection of the environment.

- Public Enterprise "Macedonian Forests";

The PEMF for its work refers directly to the Macedonian Government but its legal work is controlled from MAFWE. Taking into consideration the fact that the forests are natural good of public interest and the forest managing is activity of public interest, by Article 17 from the Forest Law the core activities are determined, which are: silviculture, protection and utilization of the forests, and with their execution, the enterprise should provide permanent preservation and constant enlargement of the forest value, as well as permanent enlargement of their increase and generally useful functions.

- National Parks;

There are tree national parks protected by law in Macedonia.

- The Pelister national park is the oldest, obtaining this status in 1948. The five-needle (Pelister) pine, the only such variety in the world, covers an area of about 12,500 hectares.
- The Mavrovo national park, covering an area of 11,750 hectares, was declared as such in 1949. In 1952 it was enlarged to 73,100 hectares. Some 27,000 hectares are forested. It is presumed that it includes more than 1,000 types of higher plant forms, about a 100 of which are extremely rare or endemic to the Balkans.

- The slopes of Mount Galichica, situated between Lake Ohrid and Lake Prespa and covering an area of 22,750 hectares, were declared a national park in 1958. Nineteen different forest communities have been discovered here. This indicated that the vegetation in this park is very rich, including several extremely rare types of flora.

- Public Enterprise "Jasen"

The Jasen forest reserve was proclaimed in 1958. It covers an area of 24,000 hectares and stretches across the mountain massifs of Suva Gora, Suva Planina and Karadzica. This reserve comes into the category of special natural reserves protecting many species of flora and fauna and other natural rarities.

All these institutions have a good collaboration about all joint issues regarding forest and forestry. Some of the relations are in agreement with exist low obligations and some of them are as a result of long term collaboration. One more reason for that is the fact that a big number of employed engineers, especially in the National parks and P.E. "Jasen", are forestry engineers.

Box 1

Major references related to forestry data

- *Utilization of the wood biomass from thinning of the artificially forest cultures*. Symposium: Management of the bare land, Veles, 1992, K. Krstevski, Lj. Nestorovski.
- *Wood as an energetic material and its contribution in the energetic balance of Republic of Macedonia*. Symposium: Rational forest management and wood utilization in R. Macedonia, Skopje, 1993, K. Krstevski, Lj. Nestorovski.
- *Biomass of the artificially planted cultures as an energetic resource in R. Macedonia*. Symposium: Management of the artificially planted forests and stands, K.Palanka, 1997, K. Krstevski, Lj. Nestorovski.
- *Forest biomass as an energetic resource in R. Macedonia*. International symposium: 50 years of the Faculty of Forestry - Skopje, Skopje, 1997, K.Krstevski, Lj. Nestorovski
- *Comparative analysis of the anatomic and technical properties of the beech wood (Fagus moesiaca) from generative and vegetative origin*. Specialized publication "Engineering", Skopje, 1998, M. Nacevski, Lj. Nestorovski
- *Comparative analysis of the energetic values of the forests, as an renewable resource, and the possibilities for utilization in R. of Macedonia*. Lj. Nestorovski, PhD thesis, Skopje 2003
- *Analysis of the energetic value of the beech wood*. GZ[FS br. 39, Skopje 2004, Lj. Nestorovski, M. Nacevski, Z. Trajanov.
- *Wood density of the planted black pine stands*. GZ[FS br. 41, Skopje 2006, M. Nacevski, B. Iliev, Lj. Nestorovski.
- *Analysis of the energetic value of the firewood*. GZ[FS br. 41, Skopje 2006, Lj. Nestorovski, M. Nacevski, Z. Trajanov
- *Analysis of the energetic value of some oak species*. International symposium 60 years Faculty of Forestry, Ohrid, 2007, Lj. Nestorovski, K. Krstevski, M. Nacevski, Z. Trajanov
- *Contribution towards energetic potential and possibilities for forestry biomass energy utilization from coppice forests in some countries of south-eastern Europe*. Lj. Nestorovski, P. Trajkov, and others. Silva Balcanica, Sofia, 2009,.
- Makedonski sumi s.r. interviews
- Morgia Andrea. *Le potenzialita' della biomassa nel Lazio*. Servizio Studi di Sviluppo Lazio, 2005
- Nikolov N., 2004. Joint UNECE/FAO *Workshop on illegal logging and trade of illegally derived forest products in the UNECE region*. 16-17 September 2004, Geneva, Switzerland
- Pellizzi G., Riva G., Fiala M., 1994. *Potenzialita' energetica da biomasse nelle regioni italiane*. Pratica 00073. ENEA-AIGR, Aprile 1994

4.3 Agricultural sector: an overview

Macedonian agriculture is characterized by less favorable climatic and soil conditions compared to most of EU countries. Almost 75% of the territory of Republic of Macedonia is situated above 500 m a.s.l. and only 2.9% lies below 200 m a.s.l. The territory of the country is characterized by high slopes and elevation; 79% of the territory is characterized by reddish and mountain terrains, 19,1% of plain terrains and 1,9% water bodies. Important environmental limits of Macedonian agriculture are: drought, high summer temperatures, low winter temperatures, low fertile soils and erosion. Macedonian agriculture is also characterized by the large fragmentation of holdings and the large numbers of people engaged in the sector. Although these limitations, agriculture has a significant potential for economy of the Country.

4.3.1 Structure of agricultural holdings

Sources from Ministry of Agriculture forestry and water economy in the Final report on Agriculture and rural development Cohesion project – Environmental assessment project (2007) state that about 80% of cultivated land is farmed by approximately 180,000 private family that are becoming increasingly commercially-oriented. The remaining percentage is farmed by 136 agricultural enterprises. Agricultural growth is largely determined by a growing but fluctuating crop sub-sector, with livestock making a stable but smaller contribution to agricultural productivity.

The absence of a Farm Registry is an additional impediment that disables the conducting of structural researches on a farm level. Last agricultural census was in 1960'es. Final preparations for conducting Agriculture Census are in progress by the State Statistical Office. The Census shall provide data on agricultural land and tillage areas, livestock population figures, agricultural production, agro technical measures, machinery and equipment, facilities in the economy, forestry, fishery and labour. The data gathered from the census shall constitute a basis for establishment of Farm registry. The initial structural farm research was conducted in 2009 in accordance with the timescale of the long-term development of the agricultural statistical system. But no data are available from this research, yet.

Due to the lack of agricultural census and farm register it is hard to say number of subsistence farmers. The majorities of farms are small family holdings that function at a subsistence level, with low yields and variable, often poor, output of goods and services that are largely non-tradable. Consequently, they generate very little or no cash income to supplement their needs. In addition, these farmers have very little incentive to move beyond subsistence as they have limited access to finance and business services. This finding is not in accordance with statement of Ministry of Agriculture Forestry and Water Economy that private family farms are becoming increasingly commercially oriented, but it seems as more realistic scenario.

The majority of individual holdings have a very fragmented, “chess-board” structure, which is illustrated by the fact that average arable land plot size is 0,2 ha (Georgievski 2006) and average farm holding is about 2 ha. Until 1988, the maximum amount of land a rural inhabitant could own was 10 hectares. There is currently no farm size restriction. Average farm sizes now are 2.5 to 2.8 hectares, and these family farms are typically separated into

several non-contiguous parcels. Land scarcity and lack of security have furthered this fragmentation, and land market activity has generally not resulted in consolidation.

4.3.1.1 Status and trends in land ownership

In Macedonia, the State has been reluctant to privatize all agricultural land for fear of a reduction in productivity, even though productivity level of state owned farms was not very high in most cases. Nevertheless, 65,5 % of the total area of arable land or 83,2 % of total number of parcels of arable land in Macedonian is privately owned and is farmed privately. Presuming the former percentage, about 451.702 hectares of arable land are held privately. [Georgievski 2006].

Non-privatized land is state owned and farmed in large *agrokombinats* or by smaller socially owned farms. The socially owned farms and *agrokombinats* are decollectivized but only non-land assets are privatized. The state owned agricultural land is designated by law as a public resource and the state retains title to this agricultural land pursuant to the Law for Transformation of Enterprises, which manages the agricultural lands. The users of the non-land assets (privatized agricultural enterprises) usually obtain contracts for the lease of the state owned land. Part of state owned agricultural land (cca 20%) is also offered for lease to other private farmer's through tender procedures. Usually land is leased on 30 years period. According present legislation state owned agricultural land cannot be privatized.

The process of re-privatization (previously private owned land collectivized during communist period) is still ongoing, but close to the end and there are possibilities for some minor changes in structure of the agricultural land ownership. Anyhow only small changes are possible, because state owned land, what is not subject of re-privatization according the law cannot be privatized.

Pastures are dominantly state owned. 87,4 % of pasture area is state owned and only 12,6 % are private, even though number of parcels in private ownership is bigger. The state owned pastures are managed by Public enterprise for pastures. Data about pastures in the country are hardly available and hardly published. It is hard to say ratio of lowland/highland pastures neither private nor state owned. Large percentages of pastures, are man-made pastures with low productivity, established by deforestation in the past. Yield of the pastures is very low (various sources 270-400 kg of hay per ha)

4.3.2 Agricultural production: main products and residuals

In the Republic of Macedonia, the crops cultivated over the country can be divided into a few relevant categories, covering the most of agriculture lands and livestock productions: cereals, orchards and fruit, vineyards, industrial crops and forage. Here below are reported annual productions of main products and related byproducts, according to local sources.

It is worth to mention that data used in this study can be different with other sources published at national level. The choice of the source finally used was agreed with local partners.

- CEREALS

Agricultural production in Republic of Macedonia is mainly focused on cereals with special emphasis on winter wheat, as most important cereal in the country, aiming to achieve self-sufficiency in wheat production. Cereals production cover more than 200.000 ha, that is about the 50% of cultivated lands, and more than 1/3 of total arable lands. There is a decreasing (Table 9) trend of production from year 2000 to year 2005: the sown area with cereals lowered from 221.235 to 189.337 ha (Table 8.) Then, in 2004 it was registered a rise of production. Despite of this, the Republic of Macedonia does not produce enough grain to meet the consumption needs of the people and animals. Production of wheat meets around 2/3 of the domestic demand. Usually, around 40%-50% of the produced quantity of wheat is traded on the internal market. In 2004, a total of 117, 5 thousand tones (33% of the production), was offered and purchased as a market surplus which comes partly as a result of the abandoning of the direct price support. The rest of the produced quantities are consumed within the agricultural economies themselves, while a considerable part is intended for animal feed.

The statistical data on agriculture in the Republic of Macedonia 2007, show a total production of wheat equals to 218.076 t (Table 10) with the highest production in Pelagonia region and an average national production (from 2004 to 2007, Table 10) of about 300.000 t. Pelagonia is the region where it is concentrated the largest agriculture area, covering the 24.8% of the total area. On the other hand, the Skopje region has the least agricultural area, only 5.8%. In the same year the highest production of maize, 38.379 t, was registered in the Polog region, equals to the 32% of national production.

Table 8: Area planted with cereals in ha

Year	wheat	Rye	barley	oats	maize	Rice	total
2000	121.669	5.845	49.988	2.374	37.488	3.871	221.235
2001	117.496	5.465	49.950	2.107	33.768	1.524	210.310
2002	102.774	3.945	49.883	2.589	34.873	1.868	195.932
2003	104.300	4.437	46.946	2.230	34.150	3.013	195.076
2004	101.607	4.546	44.975	2.408	32.913	2.888	189.337
2004/2000	-16,5%	-22,2%	-10,0%	1,4%	-12,2%	-25,4%	-14,4%
2004/2003	-2,6%	2,5%	-4,2%	8,0%	-3,6%	-4,1%	-2,9%

Source: Agricultural Report, Ministry of Agriculture, Forestry and Water Economy, 2005

Table 9. Trend of yields of cereal crops in the period from 2000 to 2004 (kg per hectare)

year	wheat	Rye	barley	oats	maize	rice
2000	2.472	1.412	2.213	1.095	3.382	4.773
2001	2.132	1.749	1.855	1.120	3.563	5.204
2002	2.641	1.809	2.658	1.525	4.124	4.739

2003	2.177	1.365	1.789	1.085	4.051	4.293
2004	3.522	2.295	3.328	1.715	4.364	5.168
2004/2003	+61.8%	+68.1%	+86.0%	+58.1%	+7.7%	+20.4%

Source: Agricultural Report, Ministry of Agriculture, Forestry and Water Economy, 2005;

Table 10: Production of cereals from 2004 to 2007 in ton

Crop	Year of production				Average
	2004	2005	2006	2007	
Wheat	356.825	333.880	293.326	218.076	300.526
Barely	148.892	136.891	135.053	106.635	131.868
Corn	141.875	148.234	147.494	118.378	138.995
Rice	14.676	12.570	13.949	15.355	14.138

Source: Statistical Yearbook . Statistical Office of the Republic of Macedonia

In this study we have considered the quantity of by-products that are generated from the production and the processing of the several kinds of cereals, and that could be available for energetic purposes, as residues unused for other scopes.

Almost 100% of the whole cereal production remains in Macedonia. So it is possible to consider the entire quantity of by-products available for energetic production. A considerable quantity of cereals is imported but as semi-finished products. It means that all the by-products of the imported cereals do not enter in Macedonia. At the moment just the 20% of the cereal by-products are used, the rest remains on the place of production and is not used for any purpose.

For energetic production, considering the cereals by-products as a possible kind of “fuel” for biomass plants, it is important to consider the frequency of the availability of them.

The frequency of cereals by-products is of about 4 months per year in the period June-September. The table 11 shows the primary production of the most important cereals, the different quantities of and the relative by-products. The weight is expressed in tons, on wet basis (fresh weight : f.w.). Cereals contains from 8% to 10% of water.

Table 11: Primary production and relative by-products of cereals in t f.w.

	Wheat	Barley	Corn	Rice
Primary production (seed)	300.526	131.868	32.312	14.138
Byproduct (BP)	210.000	120.000	25.300	5.000

Source: 2007 Annual Agriculture and rural development report. 2008. Ministry of Agriculture, forestry and Water Economy.

- ORCHARDS and FRUITS

The production of fruits in Macedonia is almost constant over the years, with apple production as main activity in this sector (Table 12). In Table 13 is possible to see the quantity of all the by-product derived by the production of fruits. At this point, there is an important consideration to do about that. In fact, in this study, only the annual by-products of fruits are considered, but a more deep analysis of the by-products production could be carried out considering also the total turnover of every kind of fruit species. It means that, on the basis of the single kind of orchard considered, every 20-25-30 years also the wood of the old trees should be considered as a by-product that can be used for energetic purposes. Frequency of the annual by-products is during the whole year even if most of the activities are in July-August and all the residuals are not used at all.

Table 12: production of fruits (t f.w.) from 2004 to 2007

Fruit	Year of production				Average
	2004	2005	2006	2007	
Walnut	3.672	4.511	5.527	4.786	4.624
Almond	1.460	1.380	1.450	1.500	1.448
Sour cherry	7.324	5.532	6.037	7.034	6.481
Cherry	4.017	4.358	3.960	4.966	4.325
Pear	7.058	8.892	9.728	8.235	8.478
Peach	12.045	11.041	10.532	10.461	11.019
Plum	25.815	25.254	29.745	27.773	27.146
Apricot	4.476	2.964	3.561	3.531	3.633
Apple	82.414	86.217	95.826	152.089	104.136

Source: Statistical Yearbook . Statistical Office of the Republic of Macedonia

Table 13: production of fruits and related byproducts (BP) expressed in tons, and 20% humidity

Type of product	Fruit species								
	Walnut	Almond	Sour cherry	Cherry	Pear	Peach	Plum	Apricot	Apple
Primary production	4.624	1.448	6.481	4.325	8.478	11.019	27.146	3.633	104.136
BP in t (seeds)	2.127	898	324	216	42	881	1900	290	312

Source: Statistical Yearbook . Statistical Office of the Republic of Macedonia

- *GRAPE WINE*

Grape wine production is very important and rather stable over the last ten years (Table 14), with about 26.000 ha nowadays.

Table 14: Production of grape and processed grape from 1997 to 2007

Year	Production of grape/t	Processed grape/t
1997	258.360	161.700
1998	248.630	158.200
1999	250.060	170.100
2000	238.600	148.510
2001	255.080	168.120
2002	230.720	140.610
2003	170.830	110.030
2004	251.180	175.120
2005	254.210	160.070
2006	257.430	172.420
2007	209.701	151.610

Source: 2007 Annual Agriculture and rural development report. 2008. Ministry of Agriculture, forestry and Water Economy.

The grape production gives a large quantity of by-products (Table 15) that can be divided in 2 categories. In fact is possible to consider seeds and scales (BP1) and all the others not used parts of the grape (BP2). The frequency of both the by-products is of two months per year (September and October). BP2 is not used at all, and just a 5% of BP1 is used for animal feeding (as the Table 15 shows, it can be quantify as about 600t per year).The amount of tons has to be considered not dry, it means that there is a 60% and 28% of water in BP1 and BP2 respectively. All the data collected come from a large quantity of interviews that have been done to the most important grape producers in Macedonia, so

even if they are not collected using regional or geographic criteria, they give about the 95% of the total national annual production.

Table 15: quantity of biomass from the processed grape in 2007 and quantity of related BP

Farms	Processed/t	Biomass/ t		Total
		BP1	BP2	
Skovin – Skopje	15.000	1.275	525	1.800
Zegin – Veles	9.000	710	290	1.000
Povardarie – Negotino	15.000	1.275	525	1.800
Tikves – Kavadarci	13.000	1.065	435	1.500
Demir Kapija - D.Kapija	6.000	497	203	700
Vizba Valandovo – Valandovo	7.000	568	232	800
Rigo – Gevgelija	12.000	994	406	1.400
Vinarija – Ohrid	4.000	355	145	500
Lozar – Bitola	2.000	213	87	300
Strumica – Strumica	10.000	852	348	1.200
Imako – Stip	10.000	852	348	1.200
Ezimit – Stip	3.000	284	116	400
Dzumajlija – Lozovo	10.000	852	348	1.200
Kokino – Kumanovo	4.000	355	145	500
Other	30.000	2.677	1.073	3.700
REPUBLIC OF MACEDONIA	150.000	12.780	5.220	18.000

Source: 2009. Interviews.

- INDUSTRIAL CROPS

Among the industrial crops cultivated in Macedonia, tobacco is the most important one, followed by sunflower and poppy (see table 16). In 2007 the production of tobacco was about 17.000 ton with major production in Pelagonia, too¹⁷.

The frequency (Table 17) of BP of tobacco is from September to October, frequency of poppy is in July and for sunflower is from August to September. The produced byproducts are not used at all and they remain on the place of the production. Humidity of BP of tobacco is between 40-60%, of poppy is 10% and of sunflower is 15%.

Table 16: Production of industrial crops from 2004 to 2007 in t f.w.

	Year of production				Average
	2004	2005	2006	2007	
Tobacco	17.717	18.490	17.507	17.132	17.712
Poppy	62	91	89	161	101
Sunflower	7.764	6.711	6.016	3.579	6.018

Source: 2007 Annual Agriculture and rural development report. 2008. Ministry of Agriculture, forestry and Water Economy.

Table 17: Production of byproducts from industrial crops (t)

Product/t	Production		
	Tobacco	Poppy	Sunflower
Primary production	17.712	101	6.018
BP	5.313	54	1.240

Source: 2007 Annual Agriculture and rural development report. 2008. Ministry of Agriculture, forestry and Water Economy.

¹⁷ Annual Agriculture and rural development report, 2008. Ministry of Agriculture, forestry and Water Economy

- LIVESTOCK PRODUCTION

Livestock production is mainly carried out in the mountain areas on the northern, western and eastern borders in a belt that is between 10 and 80 km. wide. The zones for livestock production border the areas of agricultural crops, thus increasing the interaction from the aspect of usage of the agricultural by-products for feeding the livestock.

Historically, livestock breeding is the dominant activity, except the pig breeding that used to be carried out on large state farms. During the last decade, with the reduction and transformation of the big agro-complexes, the owners' structure of the livestock production farms has not changed to a great extent. Such a development basis contributed to maintain the structure of livestock production farms as predominantly private holdings. In other words, the current structure of livestock production in the Republic of Macedonia consists of a large number of individual farm producers whose production is mainly for their own consumption. Only a small number of commercially oriented family farms, are on the rise and big specialised livestock production enterprises, but their number is nevertheless in decline.

In the year 2004 there was 254.803 cattle, 1.432.369 sheep's, 158.231 pigs and 2.725.298 poultry. The most dramatic change is in the number of sheep as their numbers reduced by 25% in the last 7 years. This big reduction is due to the problems with the marketing of the lamb meat in the period 1996-1998 due to the spread of foot-and-mouth-disease within the national sheep flock.

According to the data from 2004 the individual agricultural farms own 96% of the total number of cattle, 96% of the total number of sheep, all goats, horses and bee hives. Remaining 4% are owned by agricultural enterprises. The enterprises, as legal entities that deal with the organised livestock production participate with 37% of the total number of poultry and 39% of the total number of pigs. The remaining part is owned by individual farms¹⁸. The reasons of decreasing number of animals are very different. Among others are: WTO membership and pressure of animal products from abroad, decreased price of milk and meat domestic processors offer to farmers, insufficient domestic production of forage and fodder, decreased irrigation areas especially for forages, low and badly targeted incentive measures, and so many other reasons. According to agricultural report 2005, in 2004 the number of cattle showed a marked decline of 2% in comparison with 2003 which was a decline bigger than the average decline of 1.7% in the period 1997-2004. The reduction of the number of cattle in 2004 came as a result of the reduced birth rate, that is by 6% lower than in 2003.

Forage production is oriented to alfalfa as major crop (Table 18). As it is a forage production it does not give any considerable quantity of by-product, therefore we have not considered this crop for energy purposes.

Table 18: Production of Alfa alfa from 2004 to 2007 in ton

	Year of production				Average
	2004	2005	2006	2007	
ALFAALFA	113.012	121.528	125.832	114.130	118.626

Source: 2007 Annual Agriculture and rural development report. 2008. Ministry of Agriculture, forestry and Water Economy.

Finally in Macedonia there is a significant production of vegetables, a very popular practice in the country occupying a huge area (more than 50.000 ha) and providing big production.

¹⁸ Agricultural report, 2005

Major crops are potato, green pepper, tomato etc. This kind of production has not been investigated in this study because the focus was pointed to the crops providing dry organic and lignin-cellulosic residues, only.

Contribution to national economy and employment;

The contribution of agricultural sector to national economy is estimated on about 12%. Data presented in the answers to the questionnaire for the preparation of the European Commission's Opinion on the application of the Republic of Macedonia for membership of the European Union, Part Economic Criteria shows that this value vary from 9,8 to 11,7 % in period 1997-2003. Taking into account the value of the agri-food industry, the value of the entire Agri-complex ranges from 15% to 20% of the entire Gross Domestic Product. This value is also reported in table 3 from more recent sources (2007).

Data presented in Report for Agriculture in 2005, Published by Ministry of Agriculture, Forestry and Water Economy show that in 2006, 16,8% of total employed people was engaged in agricultural sector. Last agricultural census was done in 1964 and there is not real data for estimating real employment in agricultural sector, because a lot of women are engaged in agricultural activities even though they are not considered as employed persons. The same report estimated that about 100.000 people are full time engaged in agriculture and additional 20.000 persons are part time engaged in agriculture what is war more than official data of 87.608 people in 2004. It means that even 16, 8% of total employment in the country is underestimated number.

4.3.3 Main institutions related with agriculture

The institutions at national level that can influence mainstreaming of Environmental issues in agricultural sector are:

- Parliament of Republic of Macedonia that adopts Laws and Water master plan.
- Government of Republic of Macedonia adopts programs for use of the funds for protection and improvement of environment and nature; found public enterprises, create intersectorial bodies, adopts NEAP etc.
- Ministry for agriculture, forestry and water economy (MAFWE) creates and bears the general agricultural policy. The Ministry is competent for the agriculture and rural development, forestry and hunting, fishery, animal and plants health care, water management. It is organized in 5 sectors, 4 administrations and two state inspectorates for agriculture and forestry, with a total of 400 employees. The Hydro-meteorological Directorate, which is an institution within the MAFWE, has a total of 207 employees; it is responsible for control of low conductance. MAFWE is responsible for leasing of state owned land, concession for hunting and forest cutting. Despite this Ministry of Agriculture, Forestry and Water Economy is organized with local branches distributed in 32 old units of local government.
- Ministry for environment and physical planning (MEPP) is responsible for quality of waters, soils and for genetically modified Organisms. Also MEPP is responsible for EIA, SEA and other integrated approaches for protection of environment.

There are other important public institutions (Public Administration for Land Surveying, Public Enterprise Macedonian Forests, Public Enterprise for Pastures, and Public Enterprise for Physical Planning) that are of importance for this issue. Also there is

Intergovernmental bodies for each topic of Rio Conventions (National Biodiversity Committee, National Committee on Climate Change, National Committee on Desertification and Land Degradation – in stage of establishing). On local level there are units of self government with their structures (mayor, local parliaments and units that deal with agriculture and environment).

Box 2

Major references related to agriculture data

- Final report on “Macedonia: Agriculture and rural development cohesion project - Environmental assessment report. Ministry of agriculture forestry and water economy. Skopje, 2007
- Georgievski K, 2006. Land consolidation and land development in Macedonia, proceedings of Regional Workshop on Land Consolidation and Land Development, Prague, (http://www.fao.org/Regional/seur/events/landcons2/landcons_en.htm)
- Filipovski, G. 2003. Soil Degradation as a component of the environment in RM, Macedonian Academy of Science and Art Skopje.
- Spatial Plan of the Republic of Macedonia. Skopje, 1998
- Spatial Plan of the Republic of Macedonia Skopje, 2003.
- Agricultural Report, Ministry of Agriculture, Forestry and Water Economy. Skopje, 2005
- Answers to the Questionnaire for the preparation of the European Commission's Opinion on the application of the Republic of Macedonia for membership of the European Union, Part Agriculture. Skopje, 2005
- Answers to the Questionnaire for the preparation of the European Commission's Opinion on the application of the Republic of Macedonia for membership of the European Union, Part Economic Criteria Skopje, 2005
- Answers to the Questionnaire for the preparation of the European Commission's Opinion on the application of the Republic of Macedonia for membership of the European Union, Part Environment. Skopje, 2005
- *Regions of Republic of Macedonia*, Republic of Macedonia: State Statistical Office, 2007
- 2007 Annual Agriculture and rural development report. 2008. Ministry of Agriculture, forestry and Water Economy
- Pellizzi G., Riva G., Fiala M., 1994. Potenzialita' energetica da biomasse nelle regioni italiane. Pratica 00073. ENEA-AIGR, Aprile 1994
- Zulloa L., Fiorese G., Gattoa M., Guarisoa G., Consonnic S., 2005. Stima della disponibilità di biomassa e alternative di utilizzo energetico: un'applicazione alla provincia di Piacenza. 15th Meeting of the Italian Society of Ecology. Turin, 2005

5 Methods and materials

The present survey intends to assess biomass availability in Republic of Macedonia by using national existing literature, data, or by specific questionnaires. The National Action Plan (NAP) – as a part of First National Communication – took high heed to biomass amongst renewable energy sources (RES), considering small district heating systems as an efficient solution and combined heat and power plants as the best solution for small rural settlements.¹⁹

The present survey is focused on district level, that is to be considered the most favourable compass for producing energy, by utilizing biomass with a low rate of moisture (<30%) within a relatively short radius of transportation – it obviously depends upon collection costs and concentration of biomass in the area, but generally speaking radius around plants would be within 30 km.²⁰ The degree of final data aggregation has been fixed at regional level (NUTS3)²¹. Different methodologies are applied to the three sectors.

According to data collected by Prof. Angelova, for agriculture sector some difficulties have been encountered to find data at regional level. In fact the regional division of Macedonia is a recent innovation in the geographical politic and administrative division of the Republic. This has meant that the statistical investigation done in the past have only data at national level. This situation is different from the forestry sector. In the distribution of the agriculture production there is more variability, year by year, with respect to the distribution of the forestry, characterized by long rotation cycles.

Therefore data provided refer to regional scale for forestry, and to national scale for agriculture. Data represent agriculture averaged productivities from 2004 and 2007. Data referred to vineyards and to forests, come from the averaged values of national production registered between 1997 and 2007.

5.1 Data collection

In order to evaluate the availability of by-products coming from agriculture and forestry sectors, in this study we have considered: the quantity of main product that is yearly produced, the main by-products and the secondary by-products, when existing.

For herbaceous crops and fruits it is considered the ratio by-product/main product. This ratio represents the quantity of by-product that is achievable for each unit of main product.

¹⁹ *Macedonia's First National Communication*, cit., p. 118.

²⁰ *Potenzialità energetica da biomasse nelle regioni italiane*, A.I.G.R., 1994, p. 6.

²¹ “Nomenclature of Territorial Units for Statistics “ (See European Parliament Regulation 1059/2003 and following changes). NUTS nomenclature is addressed to EU Member States in order to provide data on a basis of a unique division of territorial units on regional level. However countries that have received the candidate country status must provide data organized according to Eurostat nomenclature. At this regard Republic of Macedonia adopted a new NTES (Nomenclature of Territorial Units for Statistics) based on the following 5 hierarchy levels: 1 and 2 are national levels; 3 consists of 8 non administrative units grouping administrative units (municipalities) of lower level; level 4 consists of 84 municipalities; 5 consists of 1776 settlements.

It can vary for the same crops, depending on several factors: edaphic condition, cultivar, period of harvesting, efficiency of machinery etc. (ENEA ,1994). The quantity of residues from forestry sector and potentially available for biomass plant are calculated on the basis of forestry data provided by Makendonski sumi and the national forest management plan. According to the cutting plans, in this study are finally considered for forests: timber cuttings from of forest coppices and high forests annually realized; allowed and planned timber harvesting foreseen on yearly base.

Starting from basic data by forestry and agriculture sectors, and by using the necessary calculation parameters (wood density, humidity, calorific value, percentage of by products etc.) searched in the existing literature and official documents , the main output produced are:

- An estimation of total bio-residues produced by harvestings and wood processing industries;
- An estimate of by-products achievable from main crops and food processing firms
- The share of it that could be used to producing energy

Other information has been obtained by direct interviews to local firms, or achieved indirectly trough local statistic and publications, too.

6 Potentiality of forest by products for energy production

According to the forest management plan in Macedonia every year the realized exploitation of wood is partial with respect to the foreseen allowed quantity (see table 7). The exploitation cutting that is carried out every year, reaches almost the maximum quantity of allowed cuts only for high quality wood. In some cases, the exploitation rate of industrial timber exceeds the permitted threshold, too, as it is highlighted in the table 19.

The commercial wood obtainable from harvesting is of two kinds: the conifer logs (*Abies alba* and *Pinus nigra*) which are cut in certain dimensions and then used as construction wood, and floors. On the other hand, the beech logs (*Fagus sylvatica*) are cut into standard sized boards, steamed and dried, and finally exported. The yearly amount of harvested wood is about 150.000 m³ (see table 19). The same amount was reported by Nikolov, in 2004. The quantity of wood residues that are available each year is about 20% from conifer logs and 35% from beech logs. But all these residues are re-employed: around 10.000 m³year⁻¹ of by-products are used for production of briquettes for heating. The rest is used from the saw mills in the process of steaming and drying logs, as well as for heating the plants itself. By-products from commercial wood are therefore mostly re-employed directly in the sawmills for a first step processing industry (the source is by direct interviews)²². In general, the current existing Macedonian sawmills are very small: the averaged yearly amount of wood they process is around 2000-3000 m³ per year. The harvested wood is transported to the sawmills where the commercial wood is cut, dried and then directly exported, since in Macedonia there are no industries of furniture.

On the other hand, the quantity of harvested low quality wood used as firewood, is about the fifty percent of the yearly allowed amount (see table 7). The whole quantity of

22

1. Saw mill “Tri Mil”, The owner Chedomir Risteovski, July 2009, Skopje
2. Saw mill “BC Transkop” – Owner Todor Cikarski, Jun 2009, Berovo
3. Saw mill “Bording “ - Owner Marjan Kostadinov, July 2009, Vinica
4. Ambalaza “Kabran” - Owner Zoran Kabranov, Jun 2009,

harvested firewood is used for the domestic heating. The registered total consumption of energy for households was 3048 GWh in 2007, according to the regional statistical yearbook of Macedonia, 2007. Firewood harvested comes from: planned previous cuts (cleaning and thinning), as well as from low quality coppice forests of oaks (*Quercus pubescens*, *Quercus cerris*, *Quercus coccifera*, *Carpinus orientalis*).

Because of the scarce commercial value of fuel wood, the remaining percentage of allowed low quality wood is not harvested in most of regions, and the wood is left in the forest (see table 19). The cause of this mismanagement is due to a lack of investments in the forestry sector to support a correct silviculture, able to follow the existing forest management plan. As an example, cleaning, thinning, pruning, protection cuts and regeneration cuts are currently not done because it is a too expensive work, with no market demand.

In contrast, exploitation of firewood is only the 70% of allowed quote. If there were a rentable market for this kind of wood, a lot of activities in the coppice forests and young conifer plantations would be done in order to improve their present condition. All this quantity can be seen a good potential for energy production ranging between 150.000-200.000 m³ of wood (difference between realized and permitted quotes from table 7) each year.

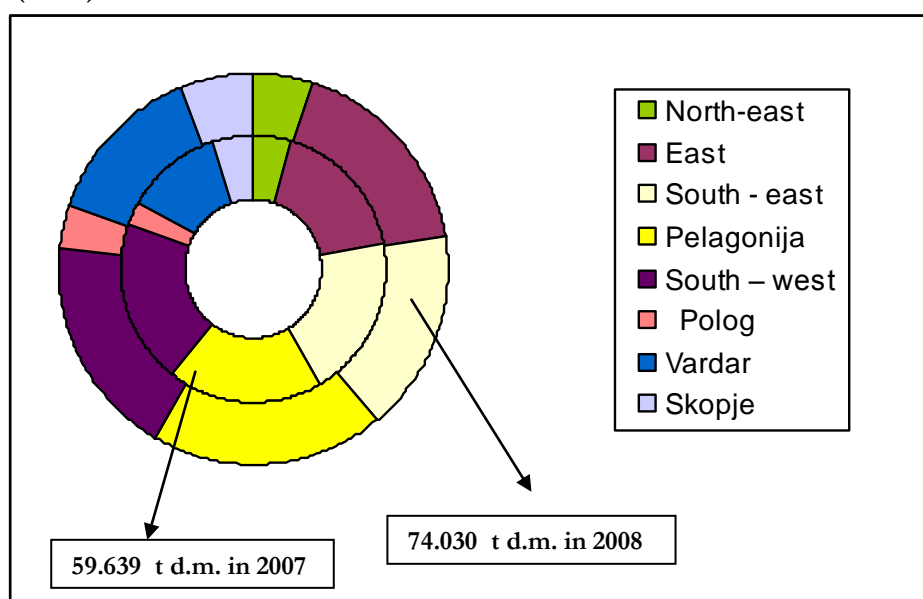
Table 19: percentage of harvested valuable timber and firewood in 2007

Regions	type of forest	Planned cut year 2007		Realized cut year 2007		% of harvested logs	% of harvested firewood
		logs (m ³)	fire wood (m ³)	Logs (m ³)	Fire wood (m ³)		
North-east	100% broadleaves	7423	40826	6312	22059	85,0	54,0
East	70%broadleaves 30% conifers	35197	90036	40366	59563	114,7	66,2
South - east	100% broadleaves	23845	102198	28901	86830	121,2	85,0
Pelagonia	90% broadl; 10% conifers	23191	120470	18022	91944	77,7	76,3
South – west	90% broadl; 10% conifers	26272	141141	19856	96061	75,6	68,1
Polog	100% broadleaves	922	27033	671	15667	72,8	58,0
Vardar	70%broadl; 30% conifers	25757	49209	27139	41171	105,4	83,7
Skopje	100% broadleaves	2135	26099	810	28719	37,9	110,0
Total		144742	597012	142077	442014		

6.1 Current scenario

Under the current scenario the situation of Macedonia is like that the by-products coming from industry processes of beech and conifer logs are not available since they are recycled directly during the first step of processing, by the sawmills. At the same time, firewood harvested is currently used for domestic heating as whole and therefore not available for new biomass plant, neither with residues. The harvested wood currently used for domestic is about 635.000 m³/year, as shown in table 7. The materials for a potential establishment of a biomass plant therefore need to be considered achievable from the quantity of wood that currently is not harvested.

Figure 3: realized wood cut in 2007 (smaller circle) and 2008 (external circle), (t d.w).



Source of data: Makedonski sumi s.r. – direct interviews

6.2 Potential scenario

If we take into consideration a cost-effective exploitation that fulfils the 100% of yearly planned cuts, we would get the 14% of biomass harvested from beech logs and 18% from conifer logs as by-products that would become available for energy purposes, since the existing sawmills would not use this additional residues. At the same time, the fulfilled harvest of firewood would not find a real market, and would become available as material for biomass plant, too [information gathered by interviews].

So, if we look at the wood reserve of each region, that is variable with the species composition, and we suppose that the form of management fulfils the planned cuttings, we can calculate the potential of energy achievable from wood, at regional scale. The results are referred to two different years: 2007 versus 2008. 2007 represents a “normal year” of harvest activities, whilst 2008 has been considered one year with unusual higher cutting rate.

The calorific value and wood density used are calculated as an average among the main species existing in each region, and therefore are slightly different.

Table 20: energetic potential achievable in 2007 and 2008 from efficient exploitation of forest according to the management plan (realized matching planned amount)

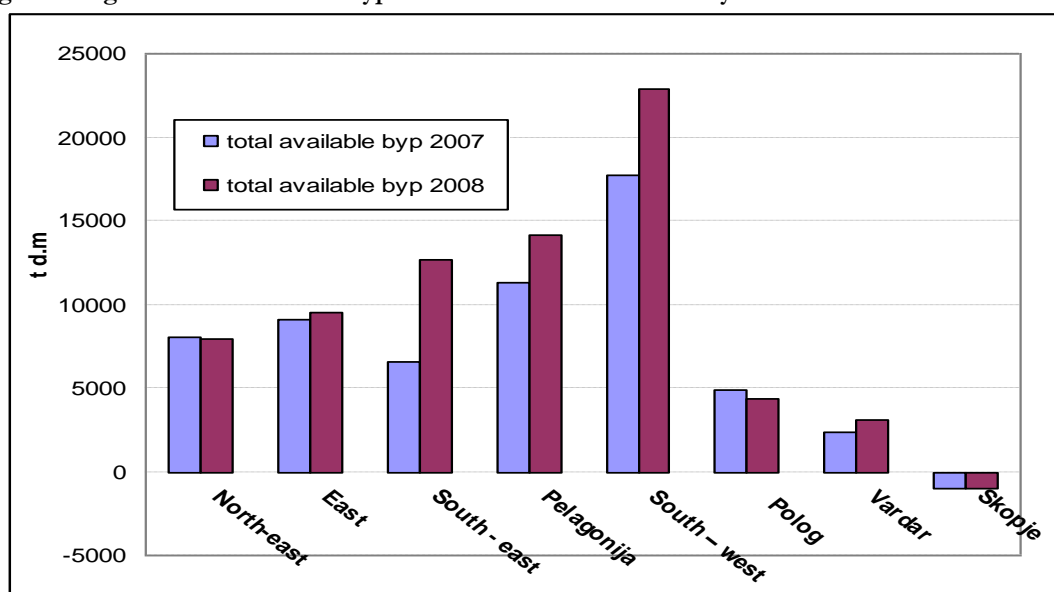
REGIONS	Total available BP in 2007 <i>kg d.m.</i>	calorific value <i>kWh/kg</i>	energetic potential <i>GWb</i>
North-east	8.096.009	4,1	33,2
East	9.128.230	4,35	39,7
South – east	6.575.199	4,1	27,0
Pelagonia	11.271.532	4,35	49,0
South – west	17.715.358	4,35	77,1
Polog	4.877.978	4,1	20,0
Vardar	2.407.794	4,35	10,5
Skopje	Nd	4,1	nd
TOTAL	60.072.099		256,4

Year 2007

REGIONS	total available BP in 2008 <i>kg d.m.</i>	calorific value <i>kWh/kg</i>	energetic potential <i>GWb</i>
North-east	7.983.245	4,1	32,7
East	9.504.950	4,35	41,3
South – east	12.654.631	4,1	51,9
Pelagonia	14.202.645	4,35	61,8
South – west	22.873.060	4,35	99,5
Polog	4.327.917	4,1	17,7
Vardar	3.092.599	4,35	13,5
Skopje	Nd	4,1	Nd
TOTAL	74.639.045		318,4

Year 2008

Figure 4: regional distribution of byproducts available from forestry sector



The situation of Macedonia for the years 2007 and 2008 is the following: according to the management cutting plan, fuelwood and residues from industrial logs provide a potential of energy between 256 and 318 GWh per year, depending on the biomass annually harvested. These results are based on the assumption that all the additional fuelwood harvested would not find a suitable demand and market, and therefore the same amount could be considered available for a potential biomass power plant.

The regions providing the major quantity of forest biomass in both years, are: South-west and Pelagonia, with a contribution of 31 and 19% of byproducts, respectively, that is 50% of total available sources of wood. These regions register the major extension of forest but at the same time a low exploitation rate of wood resources within the allowed cutting plans, compared to the other regions. South-west in 2007 harvested only the 58% of planned cutting, and Pelagonia about 68%, therefore the results shown in the table 20 show a possible amount of available by-products if a more efficient harvesting were carried out, according to the forest management plan.

In figure 2 it is shown that also Vardar region hosts a significant percentage of forest (129.350 ha), almost like Pelagonia and East regions. Nevertheless, the available amount of wood for energy purposes in Vardar results limited. Looking at figure 4 it results that the current high exploitation cutting is almost matching the planned amount, making this region less attractive for the establishment of biomass plant, than South-west and Pelagonia, where there is still available a huge amount of exploitable forest. In these two regions are also located a number of wood-processing industries which provide residues from log cuts (28 sawmills, or 24% of all processing firms of Macedonia). Other sawmills are spread in relevant number mainly in South-east and East regions (25 and 38 sawmills, respectively). From these latter regions, therefore it is expected a significant amount of wood processing residues that, if not used directly by them, could feed potential biomass power plants.

As last consideration, it is shown in figure 4, that for both the years 2007 and 2008, Skopje region overexploited its wood resources, compared to the permitted cutting plan, therefore with no significant contribute of extra-residues for energy purposes.

To be very conservative, if we assume that 20% of estimated allowed wood reserve is not exploitable for energy purposes because of various reasons (difficult access, unsuitable location, etc.) the remaining available wood exploitable reserve would provide about 230 GWh per year, or 230.000 MWh per year

6.2.1 Review and optimization of management plans

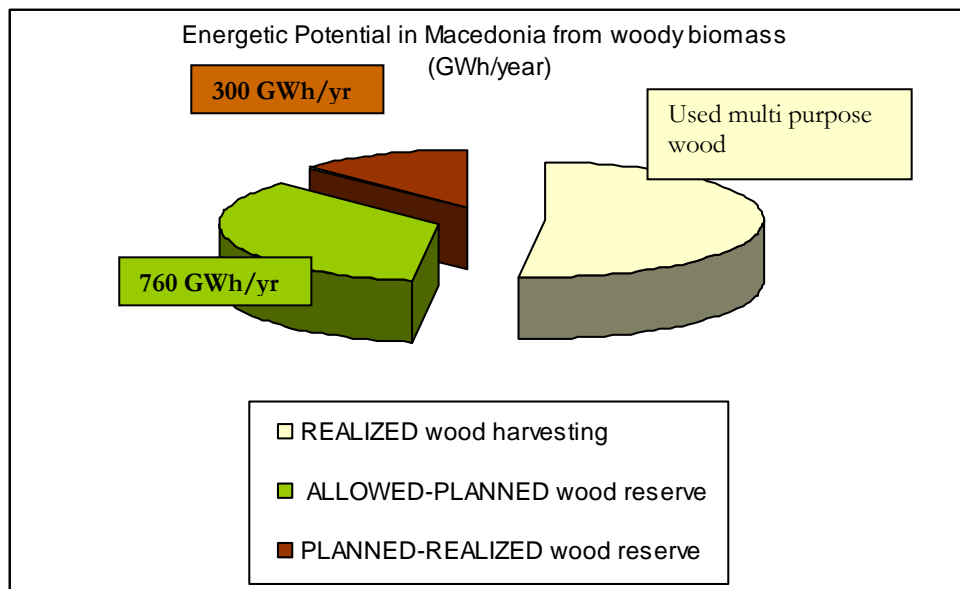
All these results provide an estimate of byproducts from forestry sector that would be achieved if realized cuttings would entirely match the planned silvicultural management plans. If we then consider that the planned cuttings every year comply with the 62% of allowed cuttings (about 760.000m³ of wood), there is an additional percentage of wood residues that could be extracted for energetic purposes (about 470.000 m³ of wood byproducts), if allowed cutting were completely harvested according to an efficient forest management plan. This additional amount could provide about 760 GWh per year of energy from renewable wood resources.

If we take into consideration that the national electricity production capacity in 2006 was 1.583 MW and that the gross national electricity consumption in 2007 was 8.989 GWh²³, the contribution of biomass to the national demand would be significant (8,5%

²³ State Statistical Office's data, 2009

considering 760 GWh from 100% harvested allowed cuts). In the figure 5 it is shown the quantity of energy achievable by if harvesting were optimized, compared to the quantity of wood currently cut and used for different purposes (energy and industry).

Figure 5: Energetic potential of Macedonia from forestry (GWh/year). White section indicate yealry realized cut and considered unavailble as biomass for energy. The other 2 sections represent the energy achievable from currently unused forest wood and by-products.



6.2.2 New forest areas

In a perspective of further optimization of biomass source for energy purposes it is worth to consider the forested lands that currently are not covered by forests. According to table 4 of this text, the difference between forested lands and existing forests is about 260.000 ha. In a very optimist scenario, if we suppose that from this area it is achievable an additional amount of by-products from short cycle forest species, the gain of biomass for energy purposes would rise again.

Just as an example, if we consider that 1 ha of poplar plantation can provide about 40 ton/yr, an area of 5.500 ha (that is 2,1% of forested land with no forest cover) could provide 220.000t of biomass per year, that is enough to feed a biomass plant of 20MW of power²⁴. As alternative to a mono-specific plantation, this area could be managed by afforestation/reforestation activities by using local species that at the end of rotation cycle can provide the biomass for energy purposes. Another alternative is the plantation of short rotation forestry species. Of course this choice needs to be very well evaluated, in order to avoid any risk of contamination of biodiversity and richness of Macedonian natural landscapes. Marginal areas can be the more suitable for this possible option.

²⁴ source: Servizio Studi Sviluppo Lazio, 2005

7 Potentiality of agriculture by products for energy production

All the residuals coming from agricultural processing can be considered as organic matter for the production of Energy. At the moment, in Macedonia, only a very small part of all the agriculture residuals is used for some reason (most of all for animal feeding). All the rest is not used. For this reason in this study we have investigated the energetic potential of dry organic matter residues of main agriculture products.

- *CEREALS*

According to the statistical data of 2007, it has been possible to calculate the total quantity of the by-products generated from all the agricultural activities related to the production of cereals. Most of this by-products are formed by straw, stalks and other similar part. Of the total production of cereals, the most important contribute to the availability of by-products is given by the wheat that could give an Energetic potential production of about 700 GW per year, if properly managed with residues.

Table 21: Cereals BP and related energetic potential.

	BP	BP/Product ratio	humidity	actual use	potential BP availability	calorific value	Energetic potential
Cereal	t f.w.		% on wet basis	%	t/yr d.w.	MJ/kg d.w.	GWh/yr
Wheat	210.000	0,70	0,1	0,2	151200	16,49	692,5
Barley	120.000	0,91	0,1	0,2	86400	16,24	389,7
Corn	21.478	0,18	0,1	0,2	15.464	17	73,0
Rice	5.000	0,35	0,1	0,2	3600	15	15
TOTAL	360.300				259.416		1.170

- *ORCHARDS and FRUITS*

The production of fruit in 2007 gave about 7.000 ton of fresh matter of by-products (most of them represented by seeds). As is possible to see from the table 22, considering that these by-products are not used at all, and they contain an average of 20% of water (except for the wood from pruning), even more than 5.000 tons of dry matter could be available for energetic purposes. From the following table is also possible to notice that the most important contribution to the energetic potential is given by the wood coming from the winter prunings. In fact about the 70% of the BP that could be use are formed by the wood.

Table 22: Fruit BP and related energetic potential.

	BP	BP/Product ratio	humidity	actual use	potential BP availability	calorific value	Energetic potential
FRUITS	t f.w.		% on wet basis	%	t/yr d.w.	MJ/kg d.w.	GWh/yr
Walnut	2.127	0,46	0,2	0	1.702	20,85	9,9
Almond	898	0,62	0,2	0	718	20,85	4,2
Sour cherry	324	0,05	0,2	0	259	20,85	1,5
Cherry	216	0,05	0,2	0	173	20,85	1,0
Pear	42	0,00	0,15	0	36	20,85	0,2
Peach	881	0,08	0,2	0	705	19,62	3,8
Plum	1.900	0,07	0,2	0	1.520	22,08	9,3
Apricot	290	0,08	0,2	0	232	20,85	1,3
Apple	312	0,003	0,15	0	265	20,85	1,5
Wood from pruning	26.880		0,5	0	13.440	18	67,2
Total	33.870				19.050		99,9

Although there are no direct data available to quantify the wood (trunk and branches) that could be used for energetic purposes at the end of the rotation cycle of fruit trees, a rough estimate can be done. When fruit trees are 25 years old, the productivity is very low and that all the orchards need to be replaced with new young trees. According to data from Italian orchards [ENEA 1994], the wood achievable from cutting trees can range between 20 t/ha for almonds and walnuts, and 75-100 t/ha from peach, apple and pear trees, depending on the wood density of each species. Also grape plants are replaced, usually every 30-35 years and the average wood exploitable from vineyards is around 20 t/ha. Taking into consideration that the vineyards are occupy around 25000 ha and that orchards are produced on about 13000 ha²⁵, the wood exploitable at the end of rotation cycle could be a huge amount (about 35.900 t d.w). If we assume tha all this wood is already used by farmes, and we consider only a 10 % of wood residues unsued and recyclable for bимass power plant, we would obtain an additional amount of 3600 t d.w, at the age of 20 year (that means 180 t d.w/year).

- WINE GRAPE

In Macedonia more than 25.000 hectares of arable lands are used for the grape production. The production of by-products, for this reason, presents considerable values even if is due mainly to the annual pruning (Table 23). In this case, the most part of by-products are constituted of wood with a high calorific value (18 MJ/kg), that can bring to a potential production of about 240 GWh per year.

Table 23: Grape and wine production BP and related energetic potential.

²⁵ Source: 2007 Annual Agriculture and rural development report. 2008. Ministry of Agriculture, forestry and Water Economy

	BP	BP/Product ratio	humidity	actual use	potential BP availability	calorific value	Energetic potential
Crop	t f.w.		% on wet basis	%	t/yr d.w.	MJ/kg d.w.	GWh/yr
seeds and skin	12.780	0,09	0,6	0,05	4856	7,7	10,3
other parts	5.220	0,03	0,28	0,05	3570	8	7,9
wood from pruning	78.815		0,4	0	47.289	18	243
TOTAL	96.815				55.715		261,3

- INDUSTRIAL CROPS

The contribution of the industrial crops to the potential energy production is very low (Table 24). This is due to several reasons. First of all Macedonia presents a small production above all the national area; then, about the 20% of the available by-products is already used for other purposes and, finally, as this crops have a small percentage of wood or seeds, they present an high rate of humidity, so the finally dry weight of the by-products is too low and, consequently, the contribution on the production of energy can be not considered.

Table 24: Industrial crops BP and related energetic potential.

	BP	BP/Product ratio	humidity	actual use	potential BP availability	calorific value	Energetic potential
Crop	t f.w.		% on wet basis	%	t/yr d.w	MJ/kg d.w.	GWh/yr
Tobacco	5.313	0,30	0,5	0,20	2125	16,1825	9,5
Poppy	54	0,53	0,1	0,20	39	16,1825	0,1
Sunflower	1.240	0,21	0,15	0,20	843	16,1825	3,7
TOTAL	6.607				3.007		14

- Total by products Production

The main contribution to the potential production of energy, according the several kind of agriculture by-products investigated, is given by the cereals. More than the 75% percent of the GWh per year could be potentially produced by the residuals coming from the production and from the cereals processing. Investigating the other results of the by-products analysis is possible to see from the Table 25 that the only other considerable contribution to the potential energy production is given by the grape with about the 17%.

Table 25: Total potential production of energy from agriculture by-products.

Product	BP	potential BP availability	Energetic potential
	t f.w.	t/yr d.w.	GWh/yr
Cereal	360.300	259.416	1.170
Orchards	33.870	19.050	99,9
Grape	96.815	55.715	261,3

Industrial crops	6.607	3.007	14
TOTAL	497.592	337.188	1.545

In conclusion, Republic of Macedonia, could have available a very large amount of organic matter from agriculture to use for biomass plant. The quantity is really large and it could bring to the theoretical generation of 1.500 GWh of electricity. As already told, this is only a theoretical estimation based on the maximum total of residuals that could be calculated on the basis of the statistical agriculture analysis.

It is also important to consider that there are a lot of unofficial information that could affect part of the total calculated. For example, in some cases there are not official information on the utilization of by-products, so in this study, the entire quantity is considered for the potential production of energy, but it is not possible to exclude the possibility that part of these residuals are, instead, used for humane purposes (domestic warming, animal feeding, etc.).

Nevertheless, if we assume that even the 30% of estimated biomass availability from agricultural residues can be realistically exploited for energy purposes due to difficulties of harvesting, storage, etc., we still have a large amount of biomass that could be employed for renewable power plants.

A last evaluation needs to be done considering the ecological and environmental sustainability of exploitation of residues. In fact it is important to ensure that a consistent part of these materials should remain in the fields (croplands and forests), in order to protect the recover of the soils, and the accumulation of organic matter in the first layers of the soil, for the equilibrium of forest and agriculture ecosystems.

The use of biomass as renewable and clean energy must take into account the problem of impoverishment and desertification of soils, if most of organic material is exported from the fields.

8 Potential biomass power plant establishment

The size and the number of potential biomass power plants that could be installed in the territory of Macedonia, can vary depending on the quantity of available biomass, and the distances from where the residues are produced and the power plant. In general biomass plants are profitable when are located at relatively limited distances from the areas where biomass is produced, in order to contain costs of transportations but also greenhouse gas emissions from vehicles.

From this point of view, the network of roads in Macedonia is well developed, and the distances are not very big. In all the regions of Macedonia, from the harvest point in the forest and the nearest city there is an average distance of about 37,5 km (maximum distance 67 km). This information is important to be considered when thinking a possible location of one or more biomass plants, together with the possibility to choose already existing plants or buildings, for the establishment of a biomass power plant.

Looking at the territory of Macedonia, the regions where is highest the presence of forests and availability of wood resources for energy purposes are: South-west, South-east, and Est, but for agriculture residues is mainly Pelagonia region. Therefore, considering macro-areas where to locate potential biomass power plants, East and South-east is a first potential zone, and South-west with Pelagonia, is the second macro area (Fig. 6).

Figure 6: The circles indicate potential macro-zone where to locate a biomass plant. Black circles are located in areas with a high rate of annual forest residuals. Moreover, the green one is in Pelagonia, the region with the highest agriculture production and byproducts availability.



A part the regional location of potential biomass power plants, it is strategic to think that it could be more convenient to establish several small biomass power plants at community

level, rather than big power plants at regional level, in order to satisfy local power demand and by reducing problems and costs of transportation.

As an example, the implementation of small scale CHP power systems might be a strategic choice to be considered for the rural and urban communities of Macedonia, at least in the regions registering the highest production of forest and agriculture residues.

8.1 Frequency of agro-forest by-products

One of the main issues need to be considered next to the potential availability of biomass for energy purposes, is the periods in which these by-products are available for the running of a biomass plant. To be cost-effective the power plants should run all the year long, but agriculture can provide residues only a few months per year.

Forestry has fewer problems, since the availability of wood ranges from 6 and 12 months, so can cover most part of the year. On the other hand, for agriculture is important to consider the storage of by-products for periods of 300 days, in many cases, since production of residues is limited to the seasons of main products harvesting (2 months per year for cereals and fruits in summer; 2-3 months wood from pruning in winter). Fortunately, dry biomass can easily preserved and stocked in proper conditions with less costs and less problems than humid organic residues. So it is worth to think about storage points in strategic locations between the sites of productions and the biomass power plant. The planning of this infrastructure need to be considered from economic point of view, but also considering environmental and landscape features of the territory.

Observing the distribution during the year of the production of main and relative by-products in the following table (table 26) is possible to see what is available every month.

Table 26: months of production of the several main products and by-products .

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
cereals						X	X	X	X			
orchards	X	X	X	X	X	X	X	X	X	X	X	X
grape									X	X		
industrial crops							X	X	X	X		
wood from forests*	X	X	X	X	X				X	X	X	X

* It is here assume d that on average, harvest activities are not realized in summer, and byproducts are available, only in minimal part

On the basis of this distribution, and according the total annual value of GWh that every agriculture production could potentially create, it is possible to realize a theoretical calculation of the amount of GWh that can be produced month by month using only the by-products produced in the same month (table 27).

Table 27: theoretical production, month by month of the several main products and by-products .

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
cereals						292,5	292,5	292,5	292,5			
orchards	8,3	8,3	8,3	8,3	8,3	8,3	8,3	8,3	8,3	8,3	8,3	8,3
grape									130,6	130,6		
industrial crops							3,5	3,5	3,5	3,5		

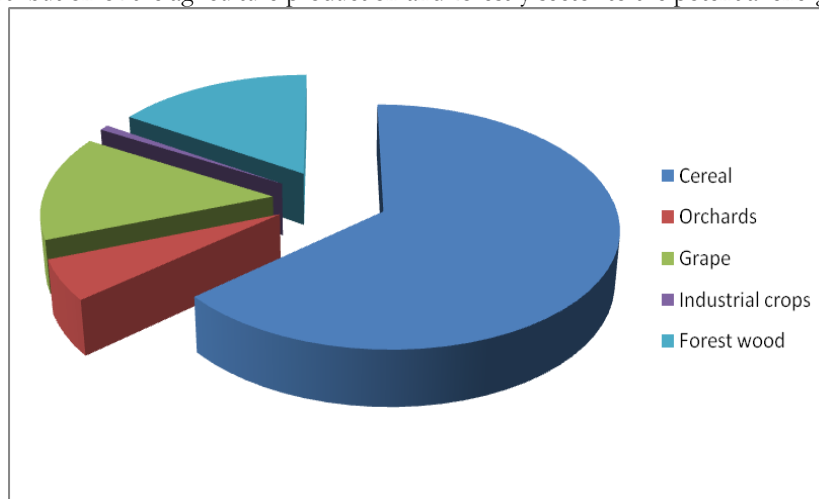
wood from forests	31,8	31,8	31,8	31,8	31,8				31,8	31,8	31,8	31,8
TOTAL	40,1	40,1	40,1	40,1	40,1	300,8	304,3	304,3	466,7	142,4	40,1	40,1

From this analysis is possible to understand that the period with the highest availability of by-products is from June to October. In fact in this period there is the overlap between the productions of by-products coming from grape and the ones coming from the cereals. Those two are, in fact, the most productive cultivations. Forest residues and wood are almost available over the year, compensating the seasons when agriculture do not provide t big quantities of materials.

Conclusions

The potential of using dry biomass for energetic purposes is shown to be very high for Republic of Macedonia. Despite the low productivity of forests and agriculture, the estimates carried out during this study show a potential high contribution of biomass from agroforestry sector as renewable energy, ranging of a maximum of about 1700-1800 GWh per year. The contribution of agriculture to biomass is 80-85% with cereals and orchards providing most abundant residues. On the other hand, forest exploitation would be able to provide between 15-20% of total estimated energy gain, considering only the currently unused wood that would become available if management and harvesting activities were optimized. Nevertheless, to be realistic and to comply to this scenario, a significant improvement of actions in both sectors needs to be stimulated by local policy and by the international projects.

Figure 7: Contribution of the agriculture production and forestry sector to the potential energy production.



Indeed for a small country like Macedonia, that currently produces internally a limited quantity of energy but at the same time has a very low annual consumption (about 8900 GWh), the role of biomass for renewable energy become strategic for the Country, at local and regional scale. Further analysis should be performed for a detailed economical assessment of the opportunity for the implementation of activities finalized to the biomass exploitation.

This study underlines that it could be a good opportunity for the Republic of Macedonia but a deep logistic assessment with the study of all the possible actors (government,

industry, stake holders, etc.) involved in the realization of one or more biomass plants should be done because those are aspects that need to be considered at the same level of the biomass availability.

¹ Second Communication for CC, section 5.