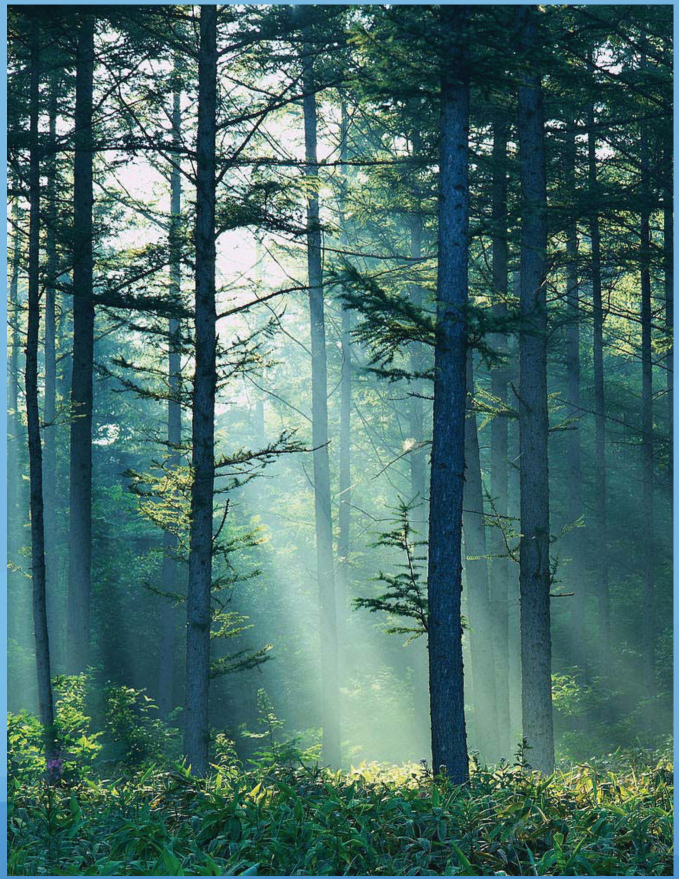
EAST REGION

Study
Utilization of biomass potentials for production of energy in The East Planning Region



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Study Utilization of biomass potentials for production of energy in The East Planning Region

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Introduction

Preface

Energy consumption is an integral part of the everyday life, not only for the individual person, but also for the industry and all segments of society. The demand for energy of all types is constantly rising at the global, regional and national level. At present, the production of energy worldwide is in most part based on using fossil fuel (coal, oil and natural gas) and nuclear energy, making the energy sector the greatest polluter. Aside the environmental and health impacts of energy deriving from conventional sources, there are also economic consequences, primarily due to the constant rise of the prices of raw materials.

Republic of Macedonia lacks significant energy sources, so in most part, energy is imported. Providing energy from renewable energy sources is crucial for providing long-term sustainable development. At present, the share of energy deriving from renewable energies (sun, wind, biomass, etc.) in the total energy consumption in Macedonia is relatively low, which means it is necessary to increase the amount of energy from these sources, which will increase the percentage of their share in the energy balance.

Biomass, as a potential fuel for production of energy, has not been fully explored in Republic of Macedonia. The actual available quantities have not been assessed at the national or regional level. In preparing this study, the Center for Development of the East Planning Region has made the first step towards implementing projects for using biomass for energy purposes. The main purpose of this study is to obtain information on the potentials and possible exploitation of biomass in the East Planning Region.

Team Leader,

Prof. Dr. Strahinja Trpevski

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1. Summary

Biomass, more specifically, wood has been a significant source of energy in all phases of social developments. In the 19-th Century, nearly 90% of the energy came from wood, in the beginning of the 20-th Century, the amount of energy obtained from wood amounted to 50% and in the last decade of the previous century, the use of wood for production of energy decreased significantly and dropped to 5%. With the development of the energy crisis, and the increased awareness on environment protection and the need for reducing the dependence of fossil fuels, the use of this fuel has been constantly rising during the past decade. Biomass, in particular, its use for production of energy, belongs to the group of renewable energy sources. Using renewable energy sources is in line with the principles of sustainable development. In accordance with European Directives, "biomass" is the biodegradable part of products, waste and residue from agriculture (including plant and animal substances), forestry and industries linked to it, as well as the biodegradable part of industry and communal waste.

The Center for Development of the East Planning Region, within the framework of its planning documents (Development Programme 2009 – 2013) [1], has anticipated measures and activities for supporting the development of sustainable energy resources. Agriculture is one of the basic economic activities in this region, and one of the bigger potential sources of biomass. The territory of the East Planning Region is also covered with deciduous and coniferous trees, which are being used for commercial purposes.

For defining the available quantities of biomass that can be used for production of energy, the Center for Development of the East Planning Region has ordered the "Study for utilization of biomass potentials for production of energy in the East Planning Region". In preparing this study, the Team has made use of all analysis, studies and other relevant documents referring to the use of biomass for production of energy in Republic of Macedonia, as well as appropriate literature containing worldwide experiences in this field. The experiences of the developing and neighboring countries have especially been useful. The beneficiary of the Study made all of its relevant documents disposable, (studies, analysis etc.), documents that were also used as inputs in the conducted analysis and activities.

[1] S.C. 6 Providing a healthy environment in the region, priority: **6.2 Sustainable energy usage and production, Measure: 6.2.1 Utilizing the potentials for production of energy from renewable sources, Program: 6.2.1.1** Biomass, wind, sun, geothermal energy (page 72-74 from the Programme)

At the very start, an analysis was performed on the current situation in the East Planning Region, which includes an analysis of the institutional establishment in this sector, a review of the existing legal regulations and the according European regulations, furthermore, a stakeholder's analysis and SWOT analysis. Conclusions and recommendations have accordingly been made based on the results of these analyses.

For the purpose of fulfilling the main project goal, assessments of the total quantities of biomass were also made, by types, and their energy potential was defined. In order to have a more realistic perception of the potential quantities of biomass, a poll was conducted for reviewing the existing manners of using the agricultural residue. The estimated quantities of biomass are given in the table below.

Biomass source	Total tons	Lower heating value	Energy potential GJ	Electricity production GWh
Agricultural residue	34250	13.16 – 14.7	484480	**34**
Remains from woodcutting and wood mass (10%)	16000	8.37- 14.45	218590	**15**
Wood processing residue	4000	18.2 Mj/kg	72800	**5**
Livestock residue	19635 (dry mat..)	21MJ/м^3	12066	**0.977**
Total	**73885**		**787936**	**54.977**

This study provides a review of the experiences from this field in Republic of Macedonia, and a review of experiences from neighboring countries and EU. From the perspective of defining the economic benefits from using biomass for production of energy, an analysis was made on the current feed-in tariffs for electricity produced from biomass in Republic of Macedonia, as well as the countries within the region. Possible technologies for using biogas were also analyzed, and based upon the performed analysis, appropriate recommendations are given regarding the most appropriate technology.

Within the study, the possibilities of cultivating crops for obtaining biomass were also reviewed, and a conclusion was made that the cultivation of rape seems to be most suitable for obtaining biodiesel, on an area of 3500 hectares of land polluted from heavy metals (Probistip). As a result of the climate conditions in the region, and the low inclusion of land-improving irrigation systems, suitable land that covers a sufficient amount of area and that can be used for obtaining biomass through the cultivation of certain crops, has still not been identified. The areas that are nearby water and are suitable for growing appropriate types of trees (willows), are rather small in area and hard to reach, due to the lack of accessible trails, and are therefore not economically viable. Possibilities for using the land for this purpose are very limited, primarily, because of the high fragmentation of land parcels, more specifically the low average of land area each farmer disposes of, and because of the food production, that has an advantage in regards to energy production.

A socio-economic analysis has been conducted, whereby all socioeconomic aspects were reviewed, in particular the impact of this sector's development on employment: creating new jobs, contributing to rural development, health protection, economic development and social aspects. All possible environmental impacts have been defined and their intensity has been determined.

The outcomes of the analysis on the risk and limiting factors are the three identified risk groups: market, operational and financial risks. The following risk factors are also identified: accessibility/providing biomass; quality and composition of biomass; transport and logistics; storage, preparation, and external environment.

Based on the results from the above-mentioned analysis, in the future, the use of biogas for producing of energy in the East Planning Region should develop in the following directions:

1. Production and using biogas in the livestock farms of the region
2. Adaptation of the existing heating system in the public buildings in the region for using biomass (wood chips or pallets) for production of thermal energy, as well as using agricultural and wood residue for production of pellets and wood chips
3. Cultivation of crops that are suitable for production of biodiesel

Based on the directions given on the further development, project concepts have been developed for implementation of seven projects that are to contribute towards increasing the quantities of thermal energy deriving from biomass usage. These project proposals are to be implemented in the next four years, starting from 2011.

The successful implementation of the projects depends on numerous subjects. In general, a public awareness raising campaign has to be realized, in order to increase public trust and awareness that the public can indeed participate actively in activities and measures foreseen for using biomass for energy production. A plan for realizing a public campaign has been prepared within the framework of this Study.

2. Project Region

2.1 Description of the Region

The East Planning Region is one of the eight planning regions in Republic of Macedonia, and includes the basin area of the Bregalnica River. It covers an area of 3537 km^2 and includes the following 11 municipalities: Berovo, Vinica, Delcevo, Zrnovci, Karbinci, Kocani, Makedonska Kamenica, Pehcevo, Probistip, Cesinovo – Oblesevo and Stip.

The Region borders with Republic of Bulgaria to the east, to the north with the North - East Planning Region, with the Vardar Planning Region to the west and with the South-East Planning Region to the south. The total population is 180938.

The climate in the East Planning Region is arid, in most part it arid to dry. This type of climate is characterized with long and dry summers with frequent high temperatures, ranging up to +41°C, and mild and wet winters with little occasions of extremely low temperatures dropping to -22 °C. Average annual rainfalls range from 506mm in the area of Kocansko Pole, to 672mm in the Mlesevski area. Rainfalls are not evenly distributed in terms of quantities and time wise. The highest amounts of rainfalls are in the months April- may, and the minimum is in July-august. The average annual temperature in the flatland area is 12.9 °C, whereas in the Malesevski area it is 8.7 °C. Snowfalls are present from December to March. Fog is a rare occasion in this region, except for the Malesevski area, where in average there are 3-5 foggy days per year. The climate conditions in this region are favorable for agriculture development.

The hydrograph of the East Planning Region is composed of the river network, artificial accumulations, and natural springs, among which are the mineral and thermal waters. The region has two high damns "Kalimanci" and "Kocansko Ezero". The "Kalimanci" accumulation has a capacity of 120 million m3 of water, which is 48% of the total average annual flow of the Bregalnica River. In the drainage basin of the Bregalnica River, there are also other smaller accumulations, such as the Berovo Lake, Petrasevac, Loshana, Gradce, the accumulation in the village of Lishica and other smaller ones. The "Knezevo" damn has also been built, from the "Zletovica" hydro system, and in the third phase of the project HS "Zletovica", three more hydro power plants are planned to be constructed. In the flatland bank area of the region, there are underground waters, which the inhabitants use for their own individual needs by digging wells and placing pumps. Several locations have been identified that are suitable for constructing small hydro power plants (up to five MGWh).

The East Planning Region has significant area of land covered with forests. The total area covered with forests in the East Planning Region is 136.738 hectares, or 13% of the total forestland in Republic of Macedonia, which is 38% of the total territory of the Region. The wood mass is estimated at 4.8 million m3, or 6% of the total wood mass in Republic of Macedonia, whereas the planned cut of the wood mass amounts to 250.000 m3 per year, or 18% of the total amount planned of cuttable wood mass in Republic of Macedonia. Most dominant are the pine forests (f.Pinacae), oak forests (f. Quercacae) and beech forests (f.Fagacae). Because of the many years of intensive exploitation of the oak forests, they are now in the phase of forming new bedding plants, with various densities. The zones with beech forests are located in the mountain area and beneath it. The second zone is disconnected and uncontrolled. The mountain beech forests are better protected, and they are very significant for the forest economy. In the zones with beech forests there are acidophil pine forests, and in the higher area, there is a complex with white pine (sp. Pinus Sylvestra). Several wildlife parks reserves (Goten, Linak, Males, Zrnovska River and Ulonmija River) are located within this region; furthermore, there are natural monumentals (Zvegor, the cave Konjska Dupka, Morodvis, Macevo, Crna Topola, and the Lesnovo volcano crater) and numerous villages.

Among the rich natural and cultural – historic heritages, the archeological site of Vinicko Kale and the archeological site of Bargala are the most distinguished.

3. Analysis of the current situation

3.1 Institutional establishment

In accordance to the Law on Energy, the Energy Agency of the Republic of Macedonia manages and maintains a register of guarantees of origin of the electricity produced from renewable energy sources, as well from highly efficient cogeneration plants. The guarantees of origin of the electricity produced from renewable energy sources clearly specify the energy source from which it is produced, the date and place of production. This guarantee will enable the producer to qualify as an authorized producer of the share of electricity produced from renewable energy sources.

The Ministry for Economy of the RM is responsible for the energy policies, and within this Ministry, there is a Department for renewable energies and energy efficiency. The Regulatory Committee for Energy of Republic of Macedonia adopts regulations and decisions for feed-in tariffs for purchase of electricity produced by privileged producers of electricity, as well as for producers of highly efficient cogeneration plants.

The local authorities are responsible for preparing local plans for implementing renewable energy sources.

According to valid legal regulations, the market operator of electricity is obliged to purchase the total quantity of electricity delivered by the privileged producer. The costs for purchasing the electricity will be invoiced on behalf of the market operator, according to feed-in tariffss. The privileged producer of electricity has to submit a document to the Regulatory Committee, issued by the Energy Agency, confirming that the operator uses renewable energy sources or a highly efficient cogeneration process, in order to obtain feed-in tariffs for production.

The local authorities are responsible for preparing local plans for implementation of renewable energy sources.

From the strategic planning perspective, the final phase incorporates the preparation of the Strategy for renewable energy sources until 2020.

3.2 Law regulations

3.2.1 EU Legal Regulations

The legal regulations of the EU refer to all renewable energy sources. In accordance with the EU Directive (22009/38/EC) for promoting the usage of energy from renewable sources, renewable energy sources are as follows: wind, solar energy, geothermal energy, tidal energy, hydro energy, biomass, landfill gas, gas deriving from wastewater treatment plants and biogases. The legal regulations of the European Union that refer to the production of energy from renewable sources consist of the following directives:

Directive 2009/38/EC on the promotion of the use of energy from renewable energy sources and amending and subsequently repealing the Directive 2001/77/EC and 2003/30/EC. This directive sets the principles, according to which a target is set of a 20 % share of energy from renewable sources in the overall Community energy consumption by 2020, and at the same time sets the national goals of each of the EU member states.

The usage of renewable energy is incorporated in three sectors, as follows: electricity, heating, cooling, and transport. Each of the EU member states has defined national objectives for the share of renewable energy sources in the overall energy consumption. These objectives are given in Table 1.

Other European Regulations

Green Paper. European Strategy for provision of energy supply (COM (2000)769) which defines that in relation to the energy supply, priority should be given to the fight against global warming, by developing new and renewable energy sources.

Biomass – Action Plan (COM(2005) 628). Due to the increasing dependence of EU from fossil fuels, using biomass is one of the key methods in providing energy supply and energy sustainability in Europe. This plan defines the activities needed to be undertaken, in order to increase the demand for biomass, improve the supply, overcome technical bariers and research development.

Table 1

State	% of energy from renewable sources in the overall energy consumption, 2005	targets for % share of energy from renewable sources in the overall energy consumption until 2020
Belgium	2,2%	**13%**
Bulgaria	9,4%	**16%**
Czech	6,1%	**13%**
Denmark	17,0%	**30%**
Germany	5,8%	**18%**
Estonia	18,0%	**25%**
Ireland	3,1%	**16%**
Greece	6,9%	**18%**
Spain	8,7%	**20%**
France	10,3%	**23%**
Italy	5,2%	**17%**
Cyprus	2,9%	**13%**
Latvia	34,9%	**42%**
Lithuania	**15,0%**	**23%**

State	% of energy from renewable sources in the overall energy consumption, 2005	targets for % share of energy from renewable sources in the overall energy consumption until 2020
Luxemburg	0,9%	**11%**
Hungary	4,3%	**13%**
Malta	0,0%	**10%**
Netherlands	2,4%	**14%**
Austria	23,3%	**34%**
Poland	7,2%	**15%**
Portugal	20,5%	**31%**
Romania	17,8%	**24%**
Slovenia	16,0%	**25%**
Slovak	6,7%	**14%**
Finland	28,5%	**38%**
Sweden	39,8%	**49%**
Great Britain	**1,3%**	**15%**

European Strategy for befouls (COM 2006) 34) by which the EU defines the policy for seven strategic areas for development of the production and usage of befouls in the member and developing countries. They are as follows: stimulating the demand for biofuels, ensuring environmental benefits, development of the production and distribution of biofuels, expanding possible sources of biofuel, reinforcing the opportunities for biofuel trade, supporting the developing countries in research and innovations.

Energy from renewable sources – roadmap - renewable energies in the 21-st Century: Creating a more sustainable future (COM 2006) 848). Creating a framework for promoting renewable energy sources. This roadmap is an integrated part of the Strategic European Energy Review.

3.2.2 National legal regulations

The Law on Energy ("Official Gazette of Republic of Macedonia", no. 63/2006, 36/2007, 106/2008) regulates all aspects of renewable energy sources, including the production of energy from biomass. This Law also promotes the utilization of RES.

In addition to this Law, the following secondary legislation has been adopted and has entered into force:

Rulebook on renewable energy sources, in particular, energy deriving from biomass;

Rulebook on the manner and procedure for determination and approval of the use of feed-in tariff for sale of electricity produced by power facilities which as operating fuel use biogas obtained from biomass (″Official Gazette of Republic of Macedonia ″ No. 142/2007).

Based on this Regulation, the Regulatory Committee for Energy of Republic of Macedonia adopted a Decision on the rates of the feed-in tariffs for sale of electricity produced and distributed from power plants, which as operating fuel use biogas obtained from biomass.

The manner in which electricity, produced and distributed from power plants which as operating fuel use biogas obtained from biomass, is purchased and sold, is regulated with the following Regulations:

Regulation on renewable energy sources for electricity production ("Official Gazette of Republic of Macedonia", no. 127/2008);

Rulebook for acquiring of status of preferential/privileged producer of electricity from renewable energy sources (″Official Gazette of Republic of Macedonia ″ No. 29/2009);

Decision on determination of feed-in tariff for sale of electricity produced by power facilities which as operating fuel use biomass which determines the feed-in tariffs for sale of electricity (adopted on 31.03.2010);

The Republic of Macedonia is a signatory party to the Energy Community Treaty, based upon which state parties need to harmonize their individual legislation in accordance to the existing EU legal regulations (acquis communautaire) on energy, environment, competition and renewable energies

The Republic of Macedonia ratified the United Nations Framework Convention on Climate Changes in 1997, and the Kyoto Protocol in 2004. Republic of Macedonia and is among the countries which does not have quantified obligations, anticipated with the above-mentioned international documents.

3.3. Stakeholder Analysis

A stakeholder analysis is e methodology used for providing optimal conditions for realization of certain activities. Having proper information on all stakeholders, and their capacity to contribute or obstruct certain activities, enables certain measures to be undertaken, to make use of their potential or minimize possible negative impacts.

Stakeholders are individuals or institutions that are actively engaged in a certain area, and are included in the implementation of a given project, as well as individuals or institutions with interests that may affect the success of a project, positively or negatively.

The goal of this analysis is to identify all the stakeholders in the area of utilizing biomass for electricity production, by assessing their interest and influence on the potential projects of the stated area.

Defining the process

The process of developing the stakeholder analysis is quite complex and includes several procedures. The procedures that are applied in the process of preparing the stakeholder analysis are given below in Table 2.

Table 2

Procedure	Technique/Tools	Results
Existing documents, strategies and programs	Analysis and evaluation	Identification of stakeholders
Identifying stakeholders	Structuring of the sector / Grouping stakeholders Expertise	List of stakeholders
Tables for analysis	Templates Current analysis	Tables
Analysis of the characteristics	Information, interviews, expertise	Characteristics defined
Analysis of power / leadership	Information analysis Legal regulations	Impact defined
Stakeholder analysis	Data analysis Interviews Reviews Expertise	Analysis prepared

With the aim of facilitating the process of stakeholder identification, the following grouping has been made in eight categories:

1. Governmental institutions – policy makers
2. Implementing agencies, public enterprises
3. Local government, local public enterprises
4. Public sector
5. Private sector
6. NGO sector
7. International agencies and donors
8. Individuals.

The stakeholder analysis is given in Table 3.

Table 3

Sector	Stakeholders	Role/ Activity	Interest	Impact Assessment	Capacity for participation	Related with the area
Government Institutions	**Ministry of Economy**	participant/ active	processes and results	positive / high	moderate	Creating policy for utilizing RES. Defining and implementing measures for production of energy from RES, and programs for supporting RES usage.
	Ministry for Environment and Physical Planning	participant/ active				
	Ministry for Agriculture, Forestry and Water supply	participant/ active				
	Ministry of Local Self-Government	participant/ active				
Implementing agencies and Regulatory bodies	**Regulatory Committee for Energy**	participant/ active	results	positive / high	moderate	Implementing the defined policy. Regulating the market and support in implementation of projects.
	Agency for Financial Support of the Agriculture and Rural Development	participant/ active	results			
	Agency for Development and Investment	participant/ active	processes and results			
	ELEM and MEPSO	supporter/ not included	results			
	PE Makedonski Sumi	participant/ active	results			Opportunities for increasing revenues of enterprises. Opportunities for new employments. Using existing capacities.
Local Authorities and Public Enterprises	**Local Governments**	participant/ active	processes and results	positive / high	moderate	Interested in applying new ways of heating. Development of new industries and creating new jobs. Reducing energy costs.
	Public Enterprises	supporter/ not included	results	positive / low	low	Using waste for energy production. Reducing waste that ends in dumps. Creating new public enterprises in the project area. Using existing capacities in implementation of projects.

Sector	Stakeholders	Role/ Activity	Interest	Impact Assessment	Capacity for participation	Related with the area
Public Sector	**Universities**	participant/ active	processes and results	positive/ moderate	moderate	Development of human resources.
Private Sector	Chambers of Commerce	supporter/ not included	results	positive / low	moderate	Supporters due to the possible development of new enterprises.
	EVN	supporter/ not included			high	Supporting measures for increasing production of energy from RES.
	Agriculture and tourism oriented businesses	supporter/ active		positive / low	moderate	Interested in measures for improving the environment, which would contribute towards development of tourism and agriculture. Possibility for new revenues from selling biomass. Producing energy for individual needs.
	Enterprises for road transportation	Not included		positive / low	low	Would perhaps be interested in using the biofuels, with no interest in the processes.
	Industrial capacities	supporter/ active		positive / high	low	Interest for implementation of projects that would use waste materials for obtaining energy. Reducing operational costs by reducing energy costs.
	Media	supporter/ not included		positive / high	low	Supporting the planning and implementation of measures for increasing energy from RES, public campaign.
Civil Society	**NGO's**	participant/ active	processes and results	positive / low	moderate	Supporting measures for reducing pollution and promoting renewable energies
International organizations and donors	**EU, SIDA,USAID, GTZ, SEKO, EBRD, World Bank Other organizations and agencies**	supporter/ not included	processes and results	positive/ moderate	high	Supporting all measures that contribute to environmental protection and utilization of renewable energy sources.
Individuals	**Farmers**	supporter/ not included	results	positive / low	low	Support and active participation in projects that contribute towards greater incomes for farmers.
	Citizens	supporter/ not included	results	positive / low	low	Support and active participation in projects for more efficient energy use and reducing energy costs.

The stakeholder analysis has shown that the key stakeholders have a positive response on the implementation of measures and activities that can contribute towards greeter utilization of renewable energy sources, which on the other hand, will contribute to the utilization of biomass for energy production. The main stakeholders have a relatively fair level of knowledge, whereas the direct participants, more specifically, the direct beneficiaries of the results of those projects that would contribute to the development of biomass usage for energy production purposes, have rather low knowledge, which points to the fact that there is a need for raising the public awareness on the benefits of this type of energy production. In general, a conclusion can be made, that there were no stakeholders identified giving negative response to the development of this area. However, it is only reasonable to expect certain resistances in the implementation of projects, mainly because of the poor knowledge of the issue, in particular, not having the knowledge and ability to see the useful benefits of these projects. From the perspective of stakeholder participation in the implementation of certain projects, the capacities of the key stakeholders are relatively limited. The positive attitude is especially important, in particular, the support of the donor and international organizations, in the implementation of the projects on using biomass for production energy.

3.4 SWOT Analysis

The aim of the SWOT analysis is to identify the internal and external factors, by evaluating the strengths, weaknesses, threats and opportunities for developing the usage of biomass in energy production. The SWOT analysis enables evaluation of the regional strengths and opportunities that can be made use in creating conditions for developing the usage of biomass, as fuel for energy production, as well as summarizing the weaknesses and threats.

STRENGTHS
▪ Production of grain crops ▪ Extensive agriculture land area ▪ Unused agricultural residue, reaming from reaping and harvesting ▪ Parts of the region are covered with certain forestland areas ▪ Greater part of forestland is owned by the state ▪ Great number of enterprises are dealing with wood processing, which is a possible source of biomass ▪ Urban centers are located within the vicinity of the rural areas, which decrease logistic problems in supplying households and industry with biomass as fuel ▪ Great usage of wood biomass, used for heating purposes ▪ Region has fairly good distributed road network ▪ Initial steps have been made in finding new ways of using biomass, as a fuel for energy production – examining conditions for growing rape for production of biodiesel, production of biodiesel from used cooking oil, production and usage of briquettes ▪ There are livestock farms present, which are a potential for obtaining biogas ▪ Unused agriculture land (polluted) suitable for growing rape for production of biodiesel ▪ Central heating system in Makedonska Kamenica, that is currently not in function ▪ Existing industrial capacities with a need for thermal energy in the production process

WEAKNESSES
▪ Using wood biomass with less efficiency ▪ Lack of a larger producer of appropriate fuel for biomass – pallets, chips ▪ Lack of knowledge on technology for utilizing biomass ▪ Lack of experts for installing CHP systems and other technologies ▪ Small agricultural parcels (fragmented agriculture land) ▪ Poor quality of forests in certain areas of the region ▪ Illegal woodcutting ▪ High price of firewood ▪ Low price of electricity ▪ Insufficient public awareness on the benefits from biomass usage ▪ Resistance on behalf of farmers against cultivating certain crops for the purpose of obtaining biomass or biofuel ▪ Domestic raising or raising animals outside of farms does not allow using waste material for obtaining biogas ▪ Lack of proper web portal for obtaining appropriate information on using biogas ▪ Lack of an irrigation system that enables economically justified cultivation of crops for biomass ▪ No funds or acceptable credits for financing private projects in this area ▪ Lack of appropriate equipment and vehicles for collecting the remains from harvesting and reaping, and their transportation

OPPORTUNITIES
▪ Government has defined policy on supporting the development of renewable energy sources ▪ Donor funds for implementation of projects ▪ Promoting SHR systems ▪ Constant rise in the interest of the private and public sector for using biomass ▪ Public perception on the positive environmental impact, as well as the positive contribution to economic development ▪ Awareness raised on environmental protection ▪ Utilizing the remains from wood mass cutting ▪ The everyday rise in fossil fuel prices ▪ Realizing savings as a result of the reduced import of energy ▪ Development of small businesses (production of pallets, chips, biofuels) ▪ Evaluation of the opportunities by the public enterprise, for increasing revenues by exploiting wood ▪ Target has been set for the share of RES at 21% until 2020

THREATS
▪ Relatively high level of financial resources need for implementation of projects ▪ Limited quantities of wood biomass from local sources ▪ Climatic conditions ▪ Procedures for applying for funds are very complex ▪ Lack of a good financial incentives and subsides for covering part of the investment costs ▪ Competitiveness of energy deriving from other sources rather than from biogas ▪ Agriculture land competition from the perspective of growing food crops rather that cultivating crops for biomass or biofuel ▪ External projects for production of biomass set grounds for mistrust in new projects

Mapping the potentials of various types of biomass

According to European Directives the word "biomass" means the biodegradable part of products, waste and residue from agriculture (including plant and animal substances), forestry and industries linked to it, as well as the biodegradable part of industry and communal waste (organic fraction). The definition itself indicates that biomass, which can be used for energy production, includes various types of materials. Materials with a higher value and for which there is interest in the market, such as high quality large trees (used in the industry), are less likely to be used as biomass from the economic perspective. However, there are numerous residues, by-products and waste materials from organic origin that can potentially be used as biomass, with fairly low costs, or so – called negative costs for using waste, as waste dumping is costly.

In general, there are five types of basic categories of materials that can be used as biomass for energy production. They are as follows:

- **Agricultural waste**: harvesting or processing residue
- **Wood:** from forestry, cultivating and processing of wood
- **Organic waste**: from the foodstuff industry, communal waste and other types of organic waste.
- **Industrial waste and coproducts:** from production and industrial processes
- **Plants for energy**: plants that are specifically cultivated for energy production.

3.5.1 Agriculture

Agriculture is one of the biggest potentials of biomass sources. Within the framework of agronomy, there are two types of biomass sources: growing plants for obtaining biomass and using residues from cultivation and processing of agricultural crops. The opportunity for obtaining biomass by cultivating crops for obtaining biogas should especially be noted, even though, to the time when this Study was prepared, no such crops were being cultivated in the East Planning Region. The opportunities for cultivating crops for biomass are presented in Chapter 5. This part covers the various types of agricultural waste. In the process of using biomass, the agricultural waste is directly used as fuel for energy production, by applying different technologies. There are also the so – called dry residues, more specifically residue that dries naturally (straw, crusts, and stems) and moist residues (livestock residue).

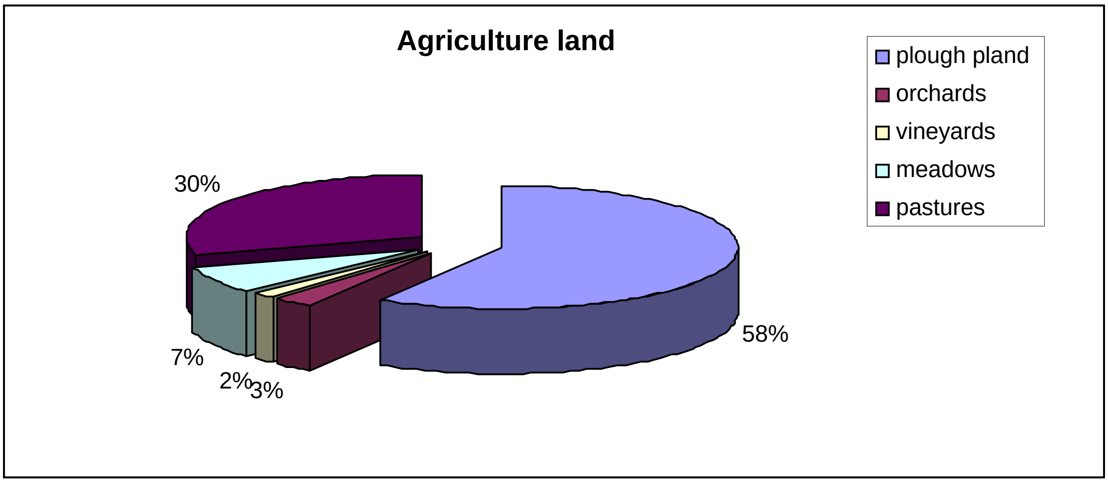
3.5.1.1 Area of agriculture land

The East Planning Region is relatively rich in agriculture land and has relatively favorable climatic conditions for agriculture development, especially for rice production. Table 4 displays data on the agriculture land that is used in the East Planning Region, by municipalities.

Table 4[2], Area of agriculture land used according to categories

Municipality	Total	Arable area					Pastures
		Total	Plough land, gardens	Orchards	Vineyards	Meadows	
Berovo	25784	13309	8679	605	/	4025	**12475**
Vinica	9523	7703	6578	226	298	601	**1820**
Delcevo	13983	10418	8706	921	8	783	**3565**
Zrnovci	1554	1475	1417	31	9	8	**78**
Karbinci	6805	6358	5889	93	296	80	**437**
Kocani	10390	6854	6314	206	133	201	**3533**
Mak. Kamenica	4705	3529	3159	117	/	253	**1176**
Pehcevo	11665	5174	3106	612	/	1456	**6490**
Probistip	10064	7816	6846	141	276	553	**2247**
Cesin. – Obles.	7595	6873	6605	90	85	93	**716**
Stip	11557	10262	9390	145	608	119	**1289**
Total:	**113625**	**79771**	**66689**	**3187**	**1713**	**8172**	**33826**

Picture 1. Percentile share of agriculture land by categories



[2] State Statistical Office, s.l. Agriculture, Agronomy, fruit-farming and winegrowing, 2008

In agriculture, aside from agronomy, organic waste is generated also from livestock. This residue too, can be used as biomass for production of energy, but because this material is actually waste, it is referred to in the section for organic materials from waste.

3.5.1.2 Assessment of the quantities of material that can be used as biomass

Agricultural residue, such as straw, leaves, peels, and stems and branches from fruit farming, can all be used as biomass in energy production. The process of using biomass for energy production includes collecting of the residues, their transportation to the place of energy production, preparation and incineration.

The initial assessment on the quantities of organic material that can be used as biomass, and is also residue from agricultural activities, was conducted based on the methodology of taking the average quantity of the generation of this material, by unit of area (by hectare), and by type of crop. In relation to generating agricultural production residue, it is worthy to point out that there is data on the average rate of its generation, by type and hectare, but differs depending on the data source. The assessment is based on the data according to types of crops that are cultivated in the East Planning Region and crops that are cultivated in the region covered by the project.

Table 5 displays the assessment of all types of agricultural waste, that is, from harvesting various crops.

The percentile share of agricultural waste, i.e., farming, from the perspective of its origin, is shown in Picture 2.

The total estimated amount of quantities of potential biomass originating from agricultural waste is 128 705 tons. However, the available quantities are in reality significantly lower, due to the various uses of this waste, primarily for feeding livestock, obtaining compost and similar, as well as due to the fact that certain portions of this material remain on the fields and are ploughed afterwards, which contributes to soil nurturing and erosion protection.

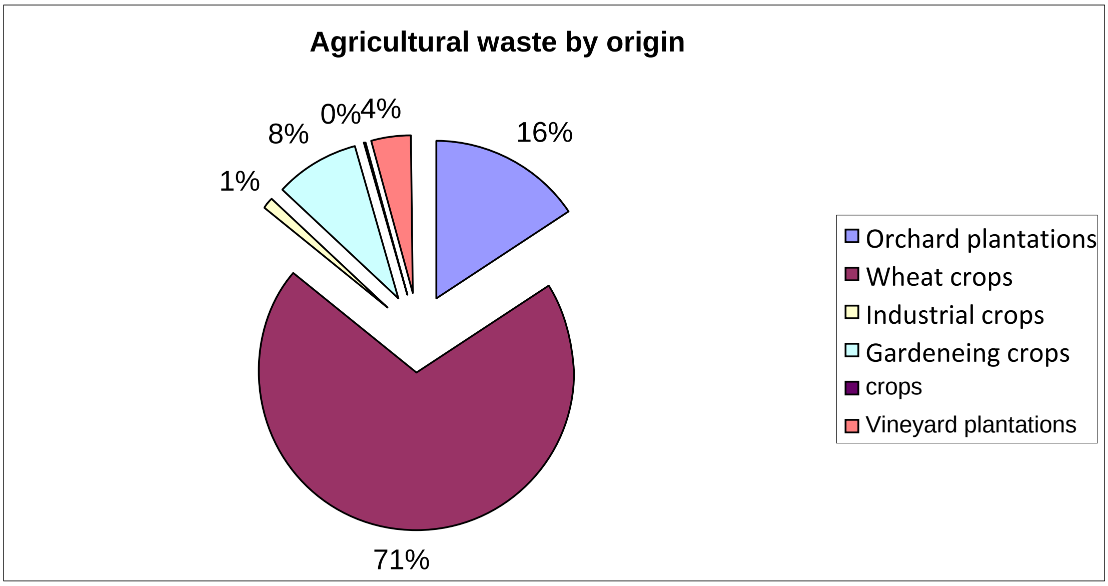
With the aim of having a realistic view of the potential quantities of biomass, for production of energy originating from this material, a poll was conducted during the month of February on 500 respondents, farmers from different municipalities in the region, as well as a poll on agricultural complexes located within the East Planning Region. The results of the poll are given in Chapter 3.6, and are taken into consideration in the assessment of the biogas quantities. The questionnaires are attached in Annex 1 and Annex 2.

Table .5

Crops	Area (hectares)	Waste description and average quantity by unit (in wet condition)	Total waste in tons (dry substance)
Wheat crops			
Wheat	10430	straw, corn stems and other average from 2 to 4 t/hectare **assuming 3 tons per hectare**	**31290**
Corn	3838		**11514**
Barley	10453		**31359**
Rice	2609		**7827**
Other wheat	2700		**8100**
Total	**30030**		**90090**
Industrial cultures			
Sunflower	60	Waste composed of plant tissues after collecting plants, leaves, stems and other Average from 1,8 to 2,2 t/hectare **assuming 2 tons per hectare**	**120**
Tobacco plant	552		**1104**
Other types of plants	335		**670**
Total:	**947**		**1894**
Vegetable crops			
Total:	**301**	Waste composed of plant tissues after collecting plants, leaves, stems and other Average from 2 to 4 t/hectare **assuming 3 tons per hectare**	**903**
Garden-stuff			
Tomatoes	236	Waste composed of plant tissues after thier collection Average from 2 to 2,5 t/hectare **assuming 2,2 tons per hectare**	**519**
Peppers	660		**1452**
Cucumbers	43		**95**
Beans	1058		**2328**
Potatoes	3122		**6868**
Onions	360		**792**
Garlic	159		**350**
Cabbage	499		**1098**
Watermelon	495		**1089**
Other vegetables	110		**242**
Total:	**2886**		**10439**

Crops	Area (hectares)	Waste description and average quantity by unit (in wet condition)	Total waste in tons (dry substance)
Vineyards	1742	Leaves and branches after the cutting Average 3 - 6 t/hectare **assuming 3 tons per hectare**	5226
Fruit	**Number of trees**	**Kg of waste according to type of fruit**	
Type of waste: leaves and branches after cutting has been made			
Apple	147143	14	**2060**
pears	59049	26	**1535**
Prunes	469017	18	**8442**
cherries	23708	19	**450**
Sour cherry	331852	20	**6637**
apricots	10879	25	**272**
peaches	15125	18	**272**
walnuts	15489	25	**387**
almonds	9682	10	**97**
Total:			**20153**
TOTAL:			**128705**

Picture 2.



The table provided in Picture 2. shows that 71% of the potential biomass for energy is originating from the cultivation of wheat crops, as follows: wheat, corn, barley and rice. Because the waste that is generated from cutting vineyards is usually burned in the open, these quantities of biomass are easily accessible. With the aim of defining the potential quantities of biomass originating from agricultural waste, an assessment has been conducted on the available quantities of grain crops, in particular wheat, corn, barley and rice, based on statistical data on the annual production of these crops in the East Planning Region and the coefficient that indicates the production of straw in relation to the grain produced.

Table 6[3], displays the annual production of wheat crops in the East Planning Region.

Table 6.

Municipality/crop	**Average production 2007/2008 in tons**			
	wheat	**barley**	**corn**	**rice**
Berovo	899	490	121	**/**
Vinica	1374	1649	1621	**425**
Delcevo	2707	2253	1243	**/**
Zrnovci	968	898	2645	**30**
Karbinci	3344	4527	1017	**1550**
Kocani	3548	2376	2740	**6350**
Mak. Kamenica	336	720	75	**/**
Pehcevo	988	468	85	**/**
Probistip	3578	2565	475	**20**
Cesinovo – Oblesevo	4010	3388	7191	**7317**
Stip	5195	7428	878	**189**
Total:	**26945**	**26760**	**18089**	**15880**

Table 7 displays the total amount of wheat crops produced according to municipalities and their share in percentages by municipalities.

The analysis of the municipal distribution of the production of the above-mentioned crops indicates that these crops are mainly produced in the Region of Kocansko Pole (76, 6%), more specifically in Stip, Cesinovo – Oblesevo, Karbinci, Kocani and Zrnovci.

[3] State statistical office, agronomy, livestock and wine growing 2007 and 2008

Table. 7

Municipality/crop	Total production/ tons	%
Berovo	1853	**1.8%**
Vinica	4643	**4.5%**
Delcevo	6218	**6.1%**
Zrnovci	6042	**5.9%**
Karbinci	14340	**14.0%**
Kocani	8664	**8.4%**
Mak. Kamenica	1131	**1.1%**
Pehcevo	1563	**1.5%**
Probistip	14545	**14.2%**
Cesinovo – Oblesevo	14736	**14.4%**
Stip	28940	**28.2%**
Total:	**102673**	**100%**

Picture 3. Agricultural waste

Since there is no data on the quantities of straw or residues from the harvesting of corn, these values are only estimations obtained based on straw to grain ratio or corn residue. Table 8 displays these coefficients, for each type of grain separately

Table 8

Type of grain	Straw to grain ratio	Assumed
Wheat	1-1,6	**1.5**
Barley	1-1.45	**1.3**
Rice	2	**2**
Corn	**0.5 – 1.2**	**1**

With the help of the agreed parameters, the total amount of waste, originating from the crops that were reviewed, has been estimated. These amounts are presented in Table 9.

Табела бр.9

Municipality/crop	Waste after harvesting (tons)				
	Wheat	Barley	Rice	Corn	Total
Berovo	1349	636	/	121	**2793**
Vinica	2060	2144	850	1621	**5824**
Delcevo	4061	2929	/	1243	**8262**
Zrnovci	1451	1167	60	2645	**8326**
Karbinci	5015	5885	3100	1017	**22822**
Kocani	5322	3088	12700	2740	**11150**
Mak. Kamenica	504	936	/	75	**1515**
Pehcevo	1481	608	/	85	**2220**
Probistip	5367	3334	40	475	**25030**
Cesinovo – Oblesevo	6014	4404	7317	7191	**17904**
Stip	7793	9656	378	878	**49206**
Total:	**40417**	**34787**	**31760**	**18089**	**155053**

Even though theoretically, the total quantities may add up to 80%, according to experience from other countries, and rules on using agricultural biomass for energy purposes (EU, Croatia), in reality, much smaller quantities of biomass can actually be collected. In view of maintaining the soil fertile and erosion protection, a certain amount of biogas needs to be left on the fields. Usually, this amount is around 30-50% of biomass.

For the purpose of defining the available quantities of biomass that can be used for obtaining energy, the amount of biomass that needs to be left on the field, which in our study is estimated at 2 tons per hectare for keeping the soil fertile and covers 70% of the arable land area, is subtracted from the total quantity of biomass. The minimum quantities of straw for protecting the soil from erosion, due to water and wind, depend on the type and predisposition of the soil and for the needs of our Study, this amount is set at 0.8 tons per hectare. The amount of 0.8 tons/cows has been agreed for the needs of the livestock production. Table 10 displays the amounts that are need to be left on the fields and the amounts needed in the livestock production, by municipalities.

Table10

Municipality	Area with wheat crops	Soil protection		Quantity of livestock production	TOTAL tons
		fertility	erosion		
Berovo	703	1406	562	1837	**3805**
Vinica	1887	3774	1510	1626	**6909**
Delcevo	2591	5182	2073	2938	**10192**
Zrnovci	1022	2044	818	464	**3326**
Karbinci	3909	7818	3127	3177	**14122**
Kocani	3262	6524	2610	1854	**10988**
Mak. Kamenica	477	954	382	1396	**2732**
Pehcevo	693	1386	554	1471	**3412**
Probistip	2268	4536	1814	1954	**8305**
Cesinovo – Oblesevo	4306	8612	3445	1694	**13750**
Stip	6212	12424	4970	1950	**19344**
Total	**27330**	**54660**	**21864**	**20361**	**96885**

It must be pointed out that, the quantities of straw originating from wheat crops needed for the livestock production, are estimated for the East Plannind Region only. The Study assumes that 20-30% of the straw is used outside of the project region. The agriculture land in the East Planning Region is characterized by its high fragmentation into large number of small parcels. These parcels have to be grouped, in order to have efficient collecting of agricultural waste. Having appropriate agricultural accessible roads is also one of the main factors influencing the economic viability of the collection of agricultural waste. Therefore, the estimated quantities that can be collected range from 40-50% out of the total potentially available quantities.

Table 11 displays the potential quantities of biogas originating from agricultural waste, upon harvesting in the East Planning Region.

Table 11

Crops	grains	corn	total
Biomass in tons	20500	10750	**31250**

Aside from the agricultural waste, the East Planning Region produces around 5000 tons of rice peel, generated in the process of rice peeling (20-25 % of the entire rice produced). Part of this residue is used for feeding animals, however, estimations are that 50 – 70% from the total amounts can be used in production of energy.

Picture 4 Rice peel

The energy potential can be estimated based on the lowest energy value of each of the biomass types. Table 12 shows the estimated thermal potential, as well as the potential for electricity production with a 25% utilization and average annual operation of 8000 hours.

Existing technologies for production of electricity, deriving from biomass, have electricity utilization within the boundaries of 21-30%, depending on the technology being used.

Table 12

Type of biomass	**Lower heating value MJ/kg**	**Thermal potential GJ**	**Electricity GWh**	**Installed power capacity of power plants MW**
Straw from wheat crops	13.75	287000	20	**2**
Corn residue	14.7	158000	11	**1**
Rice peel	13.16	39480	3	**0.3**
Total:	**/**	**484480**	**34**	**3.3**

Biomass, which is actually agricultural waste, has a relatively small density, and its viability for electricity production depends on the distance, from where it is being taken from to the place of the power plant. Transportation of biomass is efficient for a distance of up to no more than 50km, with transportation costs running from 0,124 euros/t/km, and with the price of straw transported to the power plant ranging in between 43-55 euros per ton. The price of straw ranges from 30-35 euros/ton, whereas the transportation between 0,15 и 0,2 euros per ton/km.

3.5.2 Forestry

Wood has been a significant source of energy in all phases of social development. In the 19-th Century, almost 90% of energy came from wood, and at the beginning of the 20-th Century, the energy acquired from wood amounted to 50%, whereas in the last decade of the previous century, the use of wood for production of energy has decreased drastically and was only 5%. With the development of the energy crisis, but also with the increasing awareness on environmental protection and the need for reducing fossil fuel dependence, the use of this type of fuel is constantly increasing in the past ten years.

In our country, wood is most often used for heating purposes. In the process of firewood cutting, waste is formed in the form of branches with a diameter of 7cm, tree stumps, etc. for which, until recently, there was no interest on the market at all, and because of this, were left in the forests after woodcutting was made. In nowadays, when greater needs of biomass are expected for energy purposes, the waste that is formed from cutting firewood can be used in production of energy. Currently, this waste in forestry is not used at all or in extremely small portions. The quantity of tiny branches with leafs or needle leafs, which are most often left in the forest after woodcuttings, range from 12-20% of the total tree-trunk biomass. In addition to firewood, processing technical wood is also very significant, from the perspective of creating biomass that can be used in obtaining fuel. In the primary and secondary processing of technical wood, 25 to 48% is left remaining from the primary sawmill processing and 19-31% in the secondary processing of the wood waste.

The total area of forestland[4] in the East Planning Region is 136.738 hectares (13% of the total forestland in Republic of Macedonia) which is 38% of the total area of the region. Table 13 displays the total forestland in the East Planning Region, by types of trees.

The wood mass amounts to 4.8 millions m^3 (6% of the total wood mass in the country), and the planned cutting of wood mass is 250.000m^3 annually (18% of the totally planned cutting quantity of wood mass in Republic of Macedonia). Table 14 presents the quantities of cut gross wood mass, by types.

[4] State Statistical Office, s.p. Forestry, 2008

Table[5] 13

Types of wood	Forestland (hectares)
Pure Deciduous Tree Plantations	**96057**
beech	**37212**
oak (overall)	**55961**
other solid deciduous trees	**2101**
Poplar	**15**
other soft deciduous trees	**768**
Pure Conifer Plantations	**22859**
juniper	**207**
fir tree	**125**
black pine	**20209**
white pine	**1746**
other coniferous trees	**572**
Mixed Deciduous Tree Plantations	**12581**
beech- oak – other deciduous trees	**985**
beech- other deciduous trees	**2460**
oak- other deciduous trees	**7484**
other deciduous trees	**1652**
Mixed Conifer Plantations	**539**
juniper-fir	**27**
black pine-white pine	**512**
Mixed deciduous – coniferous plantations	**4702**
black pine – white pine- other conifer trees	**3235**
other deciduous – coniferous trees	**1467**
Total:	**136738**

[5] State Statistical Office, s.p. Forestry, 2008

Table[6] 14

Type (m^3)		
Technical wood	firewood	residue
73792	108248	26609
Total 207179 m^3		

Picture 5 displays the percentile share of each type of wood from cut gross amount of wood mass.

Picture 5

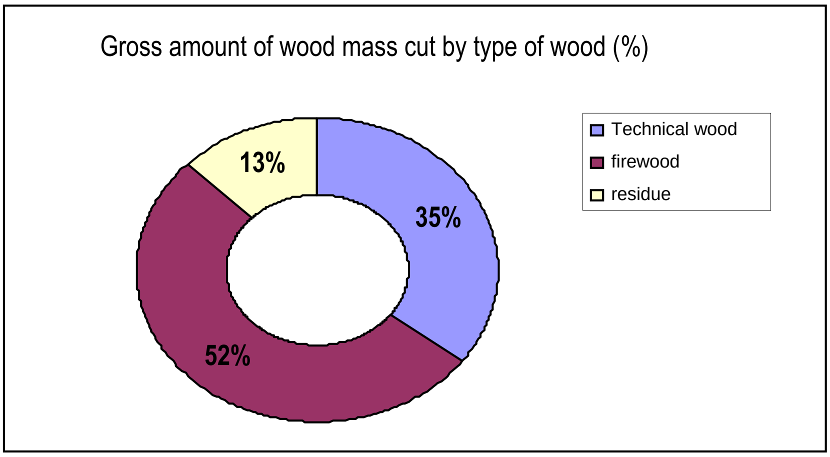


Table 15 displays the gross amount of wood mass cut according to types of trees.

Official data on the quantities of cut firewood in relation to available data on the quantities of firewood that is needed for satisfying the heating needs of the people in the East Planning Region, which are estimated at around 400.000м^3, indicates that around 200.000 to 250.000m^3 of wood needs to be procured annually, on the assumption that certain quantities of firewood come from other regions in Macedonia. In Table 16, the needs for firewood are shown for each municipality separately.

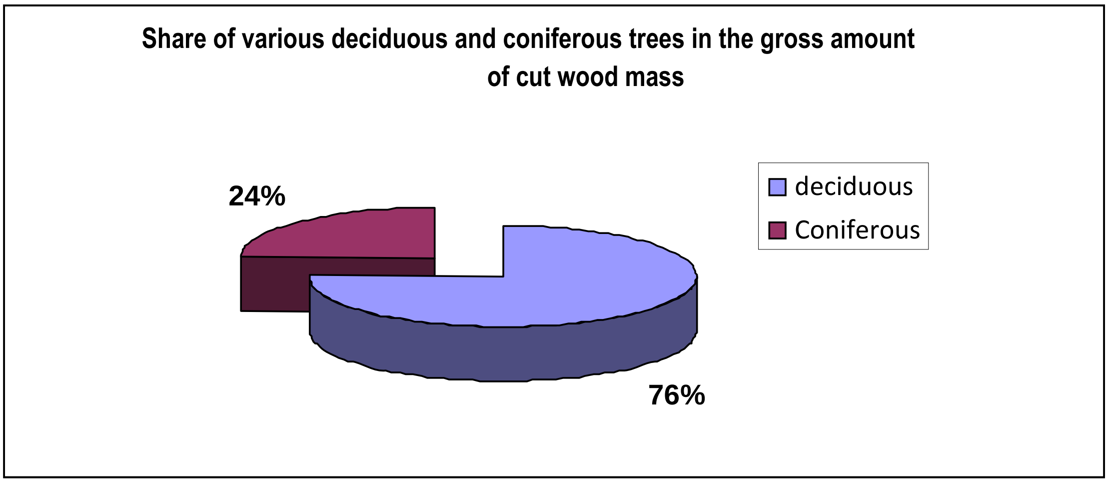
[6] State Statistical Office, s.p. Forestry, 2008

Table[7] 15

Types of trees	m3	Share in the total cut gross amount of wood mass	Share in the cut gross amount of wood mass by type of plantation
Pure Deciduous Tree Plantations	**152005**	**73.37%**	**100.00%**
beech	91149	44.00%	59.96%
oak (overall)	59983	28.95%	39.46%
other studious deciduous trees	54	0.03%	0.04%
poplar	376	0.18%	0.25%
other soft deciduous trees	443	0.21%	0.29%
Pure Conifer Plantations	**45666**	**22.04%**	**100.00%**
black pine	37448	18.08%	82.00%
white pine	8218	3.97%	18.00%
Mixed Deciduous Tree Plantations	**4124**	**1.99%**	**100.00%**
Mixed deciduous – coniferous plantations	**5384**	**2.60%**	**100.00%**

Picture 6 displays the percentage of the gross amount of wood mass cut from deciduous and coniferous plantations.

Picture 6



The official data on the gross amount of cut wood mass has been used in assessing the quantities of potential biomass coming from forestry. The beech and various sorts of oak trees, from the

[7] State Statistical Office, s.p. Forestry, 2008

deciduous group of trees, and the black and white pine from the group of coniferous trees, characterize this region.

The lowest heating value of trees with a moisture of 0% ranges from 16.2 to 21.9 MJ/kg. Table 17 shows the lowest heating value of the various types of dry wood.

Table[8] 16

Municipality	**Needed heating wood m3**
Berovo	**56580**
Pehcevo	**24312**
Delcevo	**55680**
Mak. Kamenica	**23370**
Vinica	**43960**
Kocani	**60405**
Zrnovci	**5525**
Cesinovo – Oblesevo	**12115**
Probistip	**35287**
Karbinci	**8484**
Stip	**75325**
Total:	**401043**

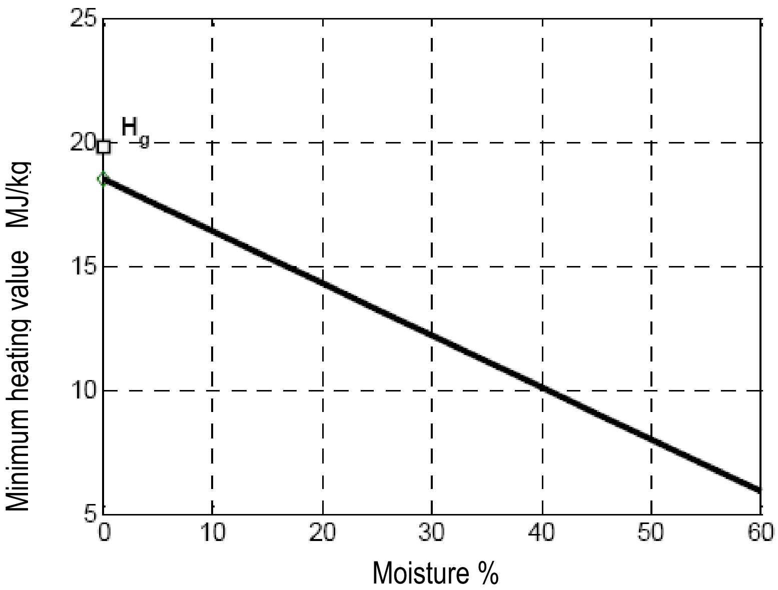
Table 17

Type of wood	Minimum heating value w=0%
Beech	18.82
Oak tree	18.38
Poplar	17.26
Pine	21.21
Juniper	19.66
Fir tree	19.49

[8] Analytical – information publication, Asen Davitkov, 2005

The heating value of wood depends on the moisture of the wood. The percentage of moisture in different types of wood biomass that is used as fuel in energy plants in other countries ranges from 5% to 60%. Picture 7 shows the influence that moisture has on the minimum heating value of the wood that is used as fuel.

Picture 7



In order to precisely determine the maximum and minimum heating value of different types of trees, a laboratory analysis has to be performed. Table 18 shows the minimum heating values of certain types of wood.

Table 18

% of moisture / Type of wood	0%	10%	20%	30%	40%	50%	60%
Beech	18.82	16.69	14.57	12.44	10.31	8.19	6.06
Oak tree	18.38	16.30	14.22	12.13	10.05	7.97	5.89
Pine	21.21	18.82	16.43	14.03	11.64	9.25	6.85
Juniper	19.66	17.45	15.24	13.03	10.82	8.61	6.40
Fir tree	19.49	17.30	15.10	12.91	10.72	8.52	6.33
Residue from cutting with tree crust	**19.2**	**17.03**	**14.87**	**12.70**	**10.54**	**8.37**	**6.21**

According to the information presented in Table 14, 26609 m3 of wood waste is created annually in the East Planning Region, more specifically, wood mass waste that is left in the forest after cutting has been made. This waste, in general, is not used, except for small quantities that are collected by the local population, or is used by the forest management enterprises for heating purposes. The fact that, its very unrealistic to expect that the entire wood waste would be collected, has been taken into consideration in assessing the quantities of this wood waste. This is something that is not fully respected even in the developed European countries, where companies performing the cutting are forced by law to completely take care of the waste, due to high prices of collection of waste in hard to reach mountain areas. It is estimated that 40% of this waste can be collected and used as biomass in obtaining energy. With an average specific weight of 650кг/m^3, the total quantities would add up to 10650 m^3, specifically 7000 tons.

From 7000 tons of wood mass obtained from the waste after the cutting, with average moisture of 50% and minimum heating value of 8.37 MJ/kg, 58590GJ of heating energy would be obtained, that is, a total of 4 GWh of electricity could be produced. With an average 8000 hours of operation, 0.4 MW of such power plants could be installed.

Nonetheless, firewood that is cut and used for heating purposes by the population, can be used as biomass for obtaining energy. In the **"Strategy for energy development of the Republic of Macedonia until 2020" a recommendation is given for not using firewood as biomass for obtaining energy**. Nowadays, the entire quantity of cut firewood is sold and used for heating purposes. Although the current way in which firewood is used is least efficient, introducing a more cost-effective and efficient way of using biomass for obtaining energy requires enormous investment funds, especially for construction of a central heating system in a particular settlement, or part of the settlement. Aside from the investment funds of the potential investor, investments need to be made by the potential users of the heating energy, as well. Makedonska Kamenica is the only settlement with a central heating system, with 350 connections from the potential 1500 that are registered in the town itself.

In fact, now there are no available quantities, in particular, excess amount of firewood that can be used for production of energy from biomass. However, in order to evaluate the energy potential of the total quantities of wood biomass, an assessment has been made on the energy potential of the overall quantities of firewood cut in the East Planning Region. The total quantity of cut firewood is 108248 m^3 per year. Beech trees and different sorts of oak trees are most common types of firewood. The minimum heating value of 14.45 MJ/kg has been accepted, for a moisture level of 20%. The average specific weight of dried wood, with an 18-20% moisture, ranges from 0.69 to 0.96 t/m^3 (assuming 0.85 t/м^3). Dried wood refers to firewood that is left in an open and aired place for 8-9 months. The total quantity of firewood is 92000 tons. The total energy potential is 1.6 PJ, meaning that a total of 110 GWh of electricity can be produced. With an average 8000 hours of operation, 11 MW of such power plants could be installed.

In order to make use of the wood mass for obtaining energy (thermal and electric), it is necessary to firstly process it (pallets, briquettes and chips) so that it can be used. For production of large quantities of pellets, significant investment funds are needed and establishing a system for production and supplying consumers with this type of fuel. A more simple way is the so-called wood chip, which in fact is only chopped wood mass.

Picture 8 Wood chips

Picture 9 Pallets

Necessary equipment must be procured for production of pellets, the so-called chipper, which chops the wood into tiny pieces in the form of ‘chips”. Picture 10 displays how the residue from the woodcutting is collected, whereas picture 11 and 12 show the process of chipping the wood mass, more specifically chipping wood mass with a tractor chipper. This type of processing wood and wood residue enables implementation of smaller pilot projects for utilization of this type of biomass, primarily because of the fairly low investment funds needed for procurement of the necessary equipment.

Picture 10

Picture11

Picture12

The actual disposable quantity of wood biomass in the East Planning Region is 7000 tons coming from residue obtains after cutting has been made and possibly 9000 tons (10%) from the current cutting of firewood, adding up in total of 16000 tons.

The PE Makedonski Sumi, which is the only enterprise managing forests in Republic of Macedonia, has determined prices of firewood. These prices are given in Table 19.

Table 19

Type of wood	Price Franco storehouse - plant (den/m^3)	Price Franco storehouse - plant (euro/m^3)	Price of collected waste after cutting den/m^3	Price of collected waste after cutting euro/m^3
Firewood				
Beech	2870	46.70		
Oak tree	2970	48.30		
Waste after cutting				
Deciduous			400	6.50
Deciduous trees			800	13.00

Based on the performed analysis and evaluations, the price of chips obtained from the waste of wood mass from cutting would range from 32 to 38 euros per ton, with transportation of up to 30 included in the price (Annex 3), whereas chips from firewood are estimated at 56-70 euros, depending on the type of wood and product type (whether it is firewood or chips Franco storehouse) (Annex 4).

Wood processing residue

In addition to the wood mass waste that is left in the forests after cutting has been made, another source of wood biomass that can be used in obtaining energy is the waste obtained from processing technical wood. Table 20 shows the percentage of wood residue depending on the place where the wood is processed.

In the East Planning Region approximately 74000 m^3 of technical wood is cut annually. There are several larger enterprises in this region dealing with wood processing, and based on estimations, these companies process 2600 m^3 of wood and produce 8000 m^3 wood residue. Most of the quantity is used by the companies for heating their own premises, and part of it is used for production of briquettes. Smaller companies, mainly sawmills, process around 4800 m^3 of wood and create 23000 m^3 of wood residue. This quantity can be used for electricity production because the sawmills do not require heat. With an availability percentage of 40%, the total disposable quantity would be 9200 m^3 or 4000 tons. With the lowest heating value of 18.2 MJ/kg, the total energy potential is 72800GJ, meaning that a total of 5 GWh of electricity can be produced. With an average 8000 hours of operation, 0.5 MW of such power plants could be installed.

Table 20

Place of wood processing	Type of wood residue	% from total mass
Primary sawmill processing	sawdust, crust, chunks, chips, splinters	25 - 48
Secondary sawmill processing	sawdust, scrapings, chunks,chips, splinters	19 – 31

Table 21 shows the total quantity of energy that can be obtained by using wood biomass.

Table21

Type of biomass	Lower heating level MJ/kg	Heating potential GJ	Electricity GWh	Installed power of power plants MW
Waste after cutting	8.37 (fresh w=50%)	58590	4	**0.4**
10% from firewood	14.45 (w=20%)	160000	11	**1.1**
Waste from wood processing	13.16 (w=to 5%)	72800	5	**0.5**
Total:	/	**291390**	**19**	**2**

3.5.3 Waste

3.5.3.1 Solid communal waste - organic fraction

Communal solid waste is waste that is collected from households, companies, public institutions, industrial waste that is not harmful and is similar to household waste, waste from public hygiene maintenance, waste from parks, markets as well as waste from construction industry.

Communal solid waste is one of the possible sources of waste biomass, which can be used for electricity production. This type of waste is composed of several different fractions, among which are the fractions of organic waste, paper and wood. In order to be able to use organic waste, as biomass for obtaining energy, it is necessary to separate the organic fractions from the other fractions of communal waste.

Nowadays, in the East Planning Region, there is no primary, neither secondary sorting of communal solid waste. Efforts are made in several cities in the East Planning Region for separating paper and plastics, but the remaining waste is not separated. Just like in the rest of the parts in Macedonia, the entire communal waste ends up in local, municipal landfills, which do not meet the standards for secure sanitary dumping of waste at all. In accordance to the "Strategy for waste" and the "National Plan for waste management", it is expected that in the next several years appropriate waste treatment will begin in Macedonia too. First steps have already been made by adopting the Law on packing and packaging waste, which forces producers to collect and recycle certain percentages of packaging waste. At the same time, initial steps are being made for introducing integral waste management in the East and North-East Planning Region, by establishing regional enterprises for waste management. Even though there is a possibility for obtaining energy through incineration of the entire communal solid waste, because of the small quantity of waste, as well the lack of thermal consumption and developed infrastructure for transmission of the thermal energy, this solution is hardly feasible. An integral waste management system is planned to be established within the next 5- 10 years, and by primary and secondary selection, the communal solid waste will be sorted and recyclable materials separated.

In order to define the quantity of organic waste, an assessment was conducted within the framework of this Study, on the quantity of organic waste, which if it were to be sorted could be used as biomass for energy. Nevertheless, the fact that agriculture is one of the biggest economic branches in the East Planning Region needs to be taken into consideration, whereby composting of the organic fraction of the communal waste and the further use of the compost as fertilizer is also a suitable option for treating the organic fraction of the communal solid waste. In estimating the quantities of the organic fraction of the communal solid waste, the quantities of paper have not been considered, because this material is recycled and a certain amount of it is already being collected.

Assessment of the quantities of organic waste from communal solid waste

The assessment of the quantities of communal solid waste that is produced in the East Planning Region was performed empirically, more concretely, based on the average generation of this type of waste at the annual level. The rate of communal waste[9] generation ranges between 253 and 313 kg/man/year. For the needs of this Study, the rate of communal solid waste generation is set at 283 kg/man/year. The population in the East Planning Region is 181858 inhabitants. Annually, 51446 tons of communal solid waste is produced. Table 22 displays the fractions comprising the communal solid waste and the quantities of each fraction at the annual level.

Table 22

Fraction	Share (%)	Total (tons)
Organic	26.20%	13479
Wood	2.70%	1389
Paper and carton	11.60%	5968
Plastic	9.70%	4990
Glass	3.50%	1801
Textile	2.90%	1492
Metals	2.60%	1338
Harmful waste	0.20%	103
Composite	2.20%	1132
Complex products	0.30%	154
Inert waste	3.60%	1852
Other waste	3.60%	1852
Tiny particles and dust	30.90%	15897
Total:	**100.00%**	**51446**

Annually, a total of 14868 tons of organic degradable waste (organic and wood) is generated, without the quantities of paper waste and textile, as well as the organic fraction of the tiny particles. Even if an integral system for management of communal waste were to be established, collecting 100% of the generated amount of waste is not expected. In the first 3-5 years, expectations are that 40% of the population will be covered by this service, thereby collecting approximately 6000 tons (w=60%) of biomass waste. The lower heating value of this type of biomass ranges[10] from 4.17 (w=60%) to 18.49 (w=0%). The total heating potential is 25200MJ. The energy potential of the

[9] National Plan on Waste Management (2009 - 2015)

[10] Thermal methods of municipal waste treatment- Biffaward programme on sustainable resource use

biomass from communal solid waste is insignificant, therefore it has not been considered in further analysis and solutions. If in the future, composting of this type of waste is initiated in a composting plant, part of the compost produced, which due to its composition is not suitable to be used as fertilizer, could be used as biomass for production of energy in combination with other types of biomass. The lowest heating value is 16.1 -19.3 MJ/kg, depending on the organic material that is composted (whether its wood, livestock residue, plants, etc.)

3.5.3.2 Livestock Waste

Waste, specifically, livestock waste is one more potential source of biomass that can be used for energy production. Livestock waste is composed of stable waste, various tissues and dead animals. This Study assesses the quantities of stable waste that can be used for energy production. This biomass type, for energy purpose, can be used through the biogas obtained with anaerobic fermentation.

Table 23 gives data on the number of stock in the East Planning Region by type of stock, and Table 24 presents data on the average generation of stable waste, by type of stock, as well as potential quantities of biogas. Expert literature regarding the quantities of biogas per ton of livestock waste provides lots of different information on this issue, in particular, values range from 25 m^3 of biogas for fresh waste to up to 450 m^3 biogas per ton of dry substance. The amount of biogas obtained from a unit substance depends on several factors (local, climatic conditions, waste composition, presence of penicillin and chemical elements, thermal isolation of digester, etc.). In order to have an actual definition of potential quantities of energy that can be obtained from this biomass source, minimum values have been assumed.

Table[11] 23

Type of stock/type of sector	Cattle	Pigs	Poultry
Individual sector	28738	48420	204574
Business entities	796	42910	97098
Number of agriculture activities			
Individual sector	4791	14304	11962
Business entities	7	13	6

[11] Source: State Statistics Office, Survey on agriculture, 2007

Using liquid waste from livestock for obtaining biomass is economically viable only for farms. The assessment of the energy potential of livestock waste generated in the East Planning Region is conducted only on the quantities of waste generated by business livestock entities, except in the area of raising cattle, where 10% have been subtracted from the total number of cattle raised by individual people, because the East Planning Region has farms in the individual sector where more than 30 cows are raise. The individual sector, in average, raises around 6 cows, 3 pigs and 18 chickens, and here, individual waste collecting for energy purposes is not cost-effective.

Table 24

Animal	Type of waste	Quantity (kg/den)	Dry (kg/den)	Biogas (m^3 per day)	Biogas per ton of dry matter m^3
Cow	fresh	51	5.4	1.6	**25**
	dry	32	5.6	1.6	
Pig	fresh	16.7	1.3	0.46	**30**
	dry	9.9	2.9	0.46	
Poultry	dry	0.66	0.047	0.017	**35**

The total quantity of energy that can be produced from biogas primarily depends on the percentage of methane in the biogas. The quantity of energy is estimated based on the following factors: methane content of 55%, quantity of dry matter, factor of converting biogas into m^3/kg dry matter, and the energy potential of biogas from 1.7 кWh electricity (30% efficiency) and 2 kWh thermal energy.

Table 25 gives data on the quantity of energy that can be obtained from livestock waste.

.Табела бр.25

Animal	Dry matter waste kg-day – per head	Dry matter total waste tons	Biogas in m^3 per ton of dry matter	Total biogas m^3	Total electricity MWh*	Total thermal energy MWh**
Cow	6.08	8211	25	205276	349	411
Pig	0.39	6108	30	183247	312	367
Poultry	0.16	5316	35	186064	316	372
Total:	**/**	**19635**	**/**	**574587**	**977**	**1151**

* 10 % of the electricity produced is needed for the functioning of the el. plant (digestion)
** 50% of the thermal energy produced is used on heating the digester

3.5.3.3 Other types of waste

There is other types of waste from which biomass can be used for energy. They are as follows: wastewater treatment plants residue (sludge), biogas from landfills, various industrial organic wastes (slaughterhouses, foodstuff, etc), stable waste, as well as production of biodiesel from used cooking oil. In the East Planning Region, more significant quantities of this type of waste are not registered. Still, it must be noted that there is a small private plant for production of biodiesel from used cooking oil, with an annual production of 1 ton. This plant is located in Makedonska Kamenica.

3.5.4 Total quantities of biomass by type and potentials for producing energy

Table 26 presents the total quantities of biomass that are disposable for energy production

Table 26

Biomass source	Total tons	Lower heating value	Energy potential GJ	Production of electricity GWh
Agricultural residue	34250	13.16 – 14.7	484480	**34**
Residue from cutting wood mass(10%)	16000	8.37- 14.45	218590	**15**
Residue from wood processing	4000	18.2 MJ/кг	72800	**5**
Livestock residue	19635 (dry matter.)	21MJ/m³	12066	**0.977**
Total:	**73885**		**787936**	**54.977**

Picture 13

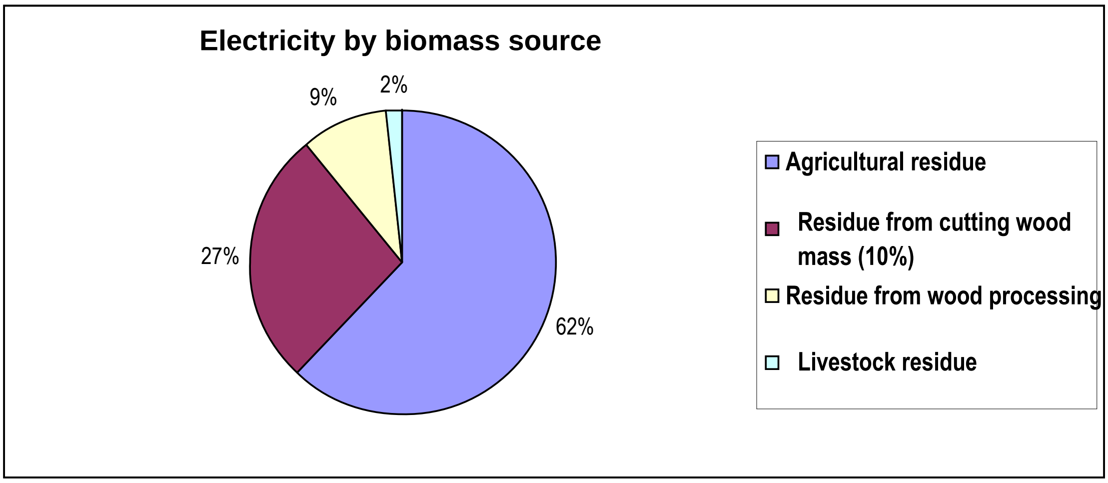
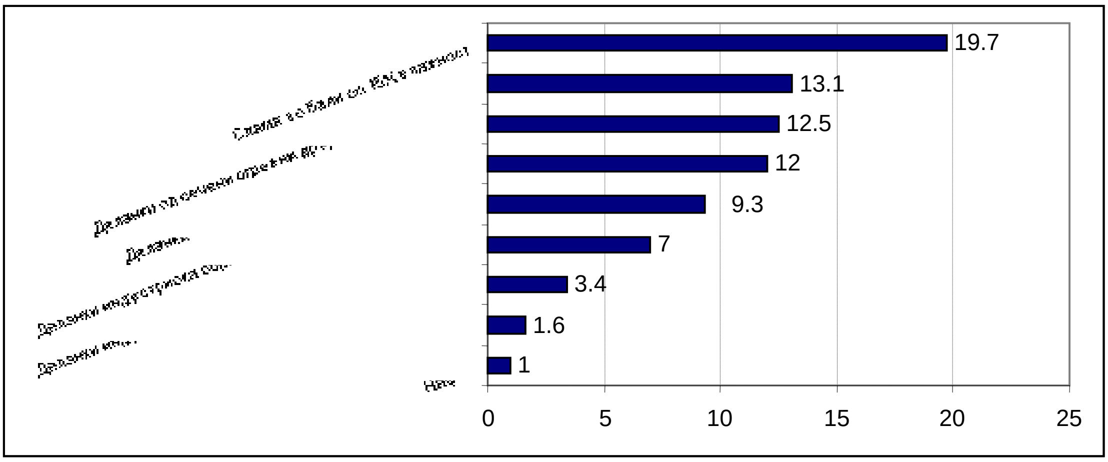


Table 26A, shows the energy characteristics of various fuel types. The volume of the various types of fuel from biomass needed for replacing one cubic meter of oil is given in Table 27.

Table26A

Characteristics	GJ/t	toe/t	kg/m³	GJ/m³
Fuel				
Oil	41,9	1,00	950	39,8
Coal	25,0	0,60	1000	25,0
Pellet with 8% moisture	17,5	0,42	650	11,4
Tiny pieces of wood with 50% moistureт	9,5	0,23	600	5,7
Chips industrial processing of wood with 50 % moisture	9,5	0,23	320	3,0
Chips industrial processing of wood with 25 % moisture	15,2	0,36	210	3,2
Chips from waste from cutting with 30 % moisture	13,3	0,32	250	3,3
Chips from firewood with 30 % moisture	13,3	0,32	320	4,3
Chopped straw with 15 % moisture	14,5	0,35	60	0,9
Straw in bales with 15% moisture	14,5	0,35	140	2,0

Table 27



3.6 Present use of biomass (with results from the conducted poll)

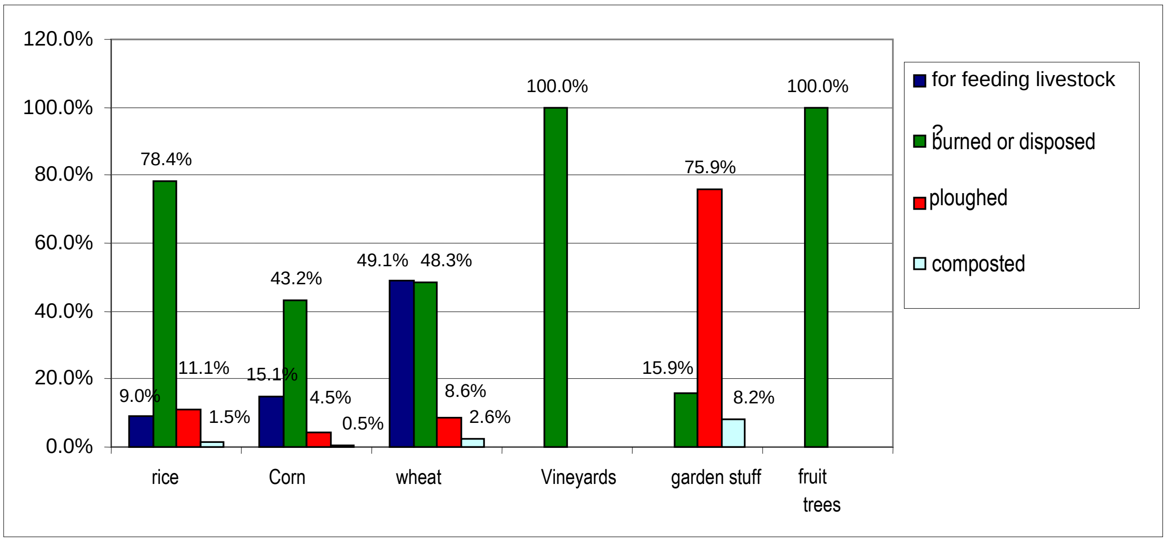
In addition to using wood biomass, in particular, firewood used for heating households and waste from processing wood used for heating of industrial plants, the other types of biomass generated in the various sectors in the East Planning Region, are used in different ways. The generated biomass residue in the foodstuff industry and other types of industry (except for the wood industry), is being composted in small quantity, whereas the other quantities finish in landfills. The organic fraction of communal solid waste, along with the other fractions, finishes in the landfills throughout the entire region.

In defining the potential quantity of biomass, it is necessary to consider the use of biomass coming from agriculture that is agriculture residue (farming and livestock). For this reason, a poll was conducted on farmers in the East Planning Region. The poll includes 507 people dealing with agriculture. It was conducted during the months of February and March 2010, covering 27 rural settlements of all the municipalities located within this region. Special questionnaires were prepared for the poll (Annex 1 and 2), based on which the farmers gave their responses.

The results of the poll show that farmers mainly use the organic residue from grains (except rice) mostly as food for the cattle, and a very small portion for composting, whereas the remaining parts of vineyards and fruit tress is entirely burned in the open. Farmers who raise herbivorous types of animals use the grain residue for feeding the stock, whereas farmers, who do not have cows or have just one or two, burn or dispose the remains from grain, and use a very small portion as food for the cattle. Some farmers compost agricultural residue, even though their number is relatively low. In relation to livestock residue, 98% of farmers raising various types of cattle have answered that they compost this residue and use it as fertilizer or even sell it. A large number of those surveyed answered that that they burn rice residue, whereas residue coming from the cultivation of garden-stuff is ploughed. The results of the poll are given in Picture 14.

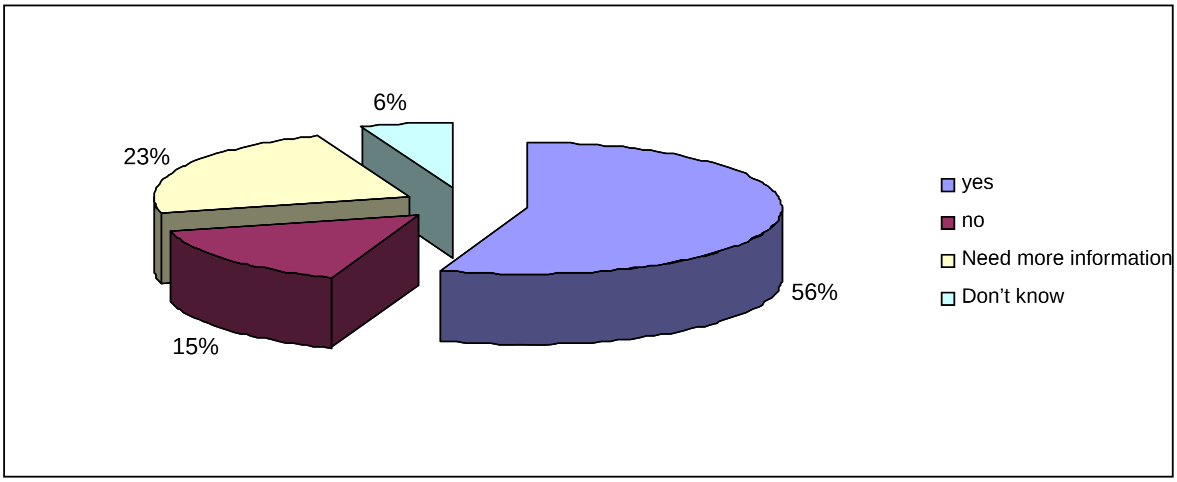
In relation to farmer's interest for cultivating crops for biomass, more than half of the farmers are interested in cultivating these crops, whereas around 33% of the farmers responded that they do not know, or that they need more information. This information indicates that there is a need for performing an awareness raising campaign on the benefits of using biomass for energy purposes, and this would be a necessary step if certain crops were to be cultivated for obtaining biomass for production of energy. Regarding the question would they be willing to sell the agricultural residue, 90% responded positively. The results of the questions are presented in Picture 15 and 16.

Picture. 14

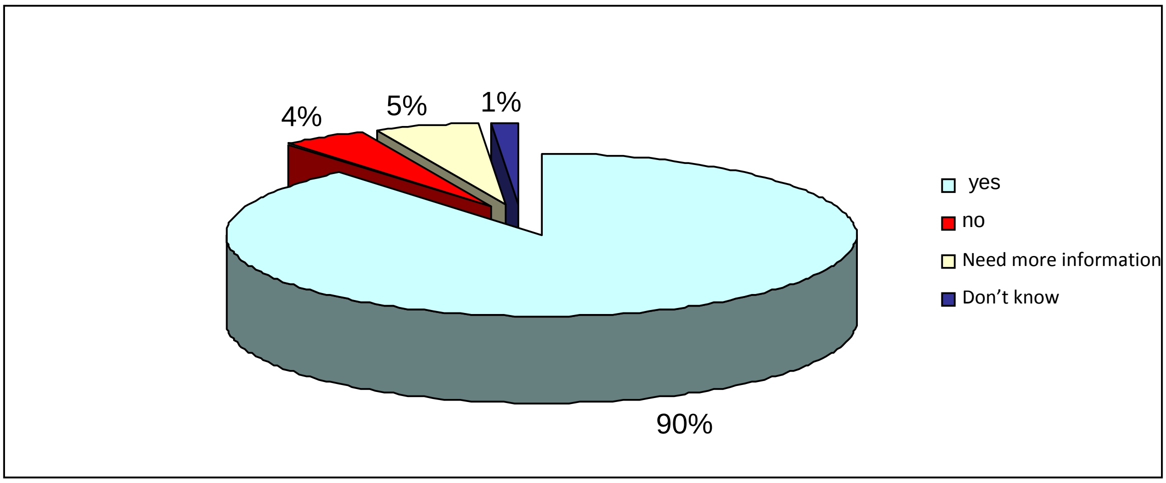


In average, each farmer cultivates 1.1 hectares with 3 various crops in average. This information shows the high level of fragmentation of the agriculture land, which is one of the main barriers for cultivating biomass for energy purposes. The fragmented agriculture land, as well as the cultivation of a large number of crops on a small area, all present limiting factors in collecting and transporting agricultural waste.

Picture 15 Would you be interested in the cultivation of crops for obtaining biomass



Picture16 Would you be willing to sell agricultural residue



Also, 20 wood processing capacities were included in the poll, located in the Malesevski micro region with an average processing capacity of 2500m^3 of technical wood. The results confirmed the initial assumption that these capacities use wood waste for heating their own premises and for obtaining thermal energy for the needs of their technological process, but also that 70% of them produce briquettes or wood waste, which is sold to the citizens for heating purposes.

The poll also included 15 capacities from the foodstuff industry, out of which 10 capacities use the thermal energy for heating their own premises, but also need it for the functioning of the technological process.

3.7 Using biomass for production of energy in Macedonia and the East Planning Region (experiences)

The use of biomass for production of energy in Macedonia is nowadays pretty much spread around. The energy balance of Republic of Macedonia shows that the share of energy acquired from biomass is 166 ktoe (1930 GWh; 6950 TJ), which is 11,5 % of the total consumed primary energy and 9,5% of the consumed overall energy, and regarding the utilization of renewable energy sources in Macedonia, the share of biomass for incineration is 53%. Biomass is especially present in households, by satisfying 30 – 33% of the total energy needs. Approximately 430000 households (76%) use biomass for heating purposes. It should be noted here that there is the so-called unidentified consumption of biomass for incineration. Estimations for this unidentified consumption of biomass for incineration range between 25 to 35% from the registered ones.

In the East Planning Region, which disposes with agriculture land area and forestland in parts of the region, using biomass for incineration is a traditional way of heating homes. Branches from grapevine, branches from fruit, but mostly from the straw, have been noticed to be used for energy purposes. However, a large part of the straw is mainly used as fertilizer, forage and for obtaining cellulose; therefore it is not available for energy purposes.

Almost all industrial capacities processing wood in the East Planning Region use part of the wood waste for their individual needs, more specifically for heating their premises and in the operation of the industrial process. Part of the operators processing wood, produce briquettes as well, and sell part of the wood waste to households as firewood. The wood industry AD "Napredok" from Pehcevo, use their own wood waste acquired in their own production as fuel, and aside from heating their own premises during the heating season, they heat the premises of the Health Care Center in this city. From the total biomass used for energy purposes, wood and coal have a share of 80%.

The existing use of biomass for energy production in the region and in Macedonia is in fact using firewood or waste from wood industry for heating homes or business facilities.

Biogas

The first project on utilizing biogas for production of energy in Macedonia was realized in 1984 in the pig farm of Petrovec, which has the capacity of 3000 pigs. The entire necessary infrastructure was built and the entire system was put in function. Despite the positive initial results, the system was in function for just a few weeks, and due to malfunctions was closed and in time completely neglected. The second project was realized in the pig farm in Delcevo, and this project shares the same experience of being closed in a short period, due to unknown reasons. One project that functions from time to time is the system for production of electricity from biogas in the pig farm near Gradsko, but it has a very small capacity and has been realized only as a pilot project.

The biggest plant in Macedonia for acquiring biogas is the plant for acquiring biogas by digestion of the sludge resulting from the treatment of the communal wastewater in Kumanovo. The wastewater treatment plant has the capacity of 100.000 e.p. The capacity projected for electricity production is 1.700.000kWh at annual level, with a daily production of biogas of 1700m^3. The volume of the digester is 1600 m^3.

Biofuels

In Macedonia several pilot projects have been realized for biofuel, which unfortunately all finished without success. The only company for production of biodiesel in Macedonia was opened in 2007. The refinery is owned by AD “Makpetrol” and has a capacity of 30 thousand tons per year. Unrefined oil from rapeseed is used in the production of biodiesel, which currently is imported. Two new openings have been announce for companies to produce biodiesel, one of which is “Blagoj Gjorev” in Veles which will be extracting oil from sunflower, rape and soy and is planned to have a total capacity of raw material processing of 20000 tons per year and to produce 13000 tons of biodiesel fuel.

On the territory of the East Planning Region, production of biodiesel has been registered from used cooking oil, with an annual production of 1 ton. Within the framework of a pilot project that was being realized in Probistip, research has been made on the opportunities of cultivating rape. A total of 5 hectares have been planted, but due to certain reasons the project was not finalized as previously planned and as a press machine was not provided, not a single liter of biodiesel was ever produced. Results of the assessment performed within the framework of the project, indicate that the yields of rape by hectare are good, that is, cultivating this type of crop is cost-effective.

3.8 Review of the experience of neighboring countries and Europe

The European Union in its strategic documents has determined a target of 12 % share of energy from renewable sources in the overall energy consumption by 2020. The share of biofuels and other fuel types from renewable sources should reach 5.75% in all types of transport fuels. The goal that the EU needs to achieve is a 20 % share of energy from renewable sources in the overall Community energy consumption by 2020. Each EU member state has defined its national targets that need to be achieved until 2020.

At present, all EU member states have production of energy deriving from renewable sources.

The production of energy[12] in EU, deriving from biomass, is given in percentages by type of biomass in Picture 17.

Results show that the production of energy from biomass is increasing each year, not only in EU, but also in other countries in Europe. The annual increase is 13,6% (2006 compared to 2005). The total quantities of biomass that are used for production of energy in the EU member states are displayed in Picture 18.

Table 28

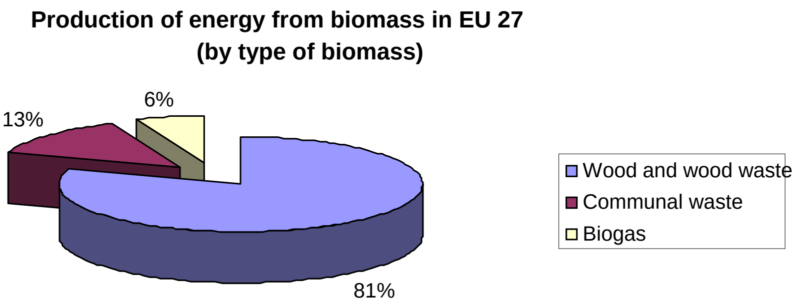
Country[13] (in 1000 тое)	2003	2004	2005	2006	2007
EU 27	72577	77692	81858	87936	96179
Belgium	959	997	1127	1267	1189
Bulgaria	691	737	743	774	711
Check	1394	1743	1803	1973	2210
Denmark	2144	2253	2318	2396	2549
Germany	9954	11361	13039	15834	22118
Estonia	665	678	686	637	735
Ireland	144	171	216	217	218

[12] Source:Eurostat
[13] Source:Eurostat

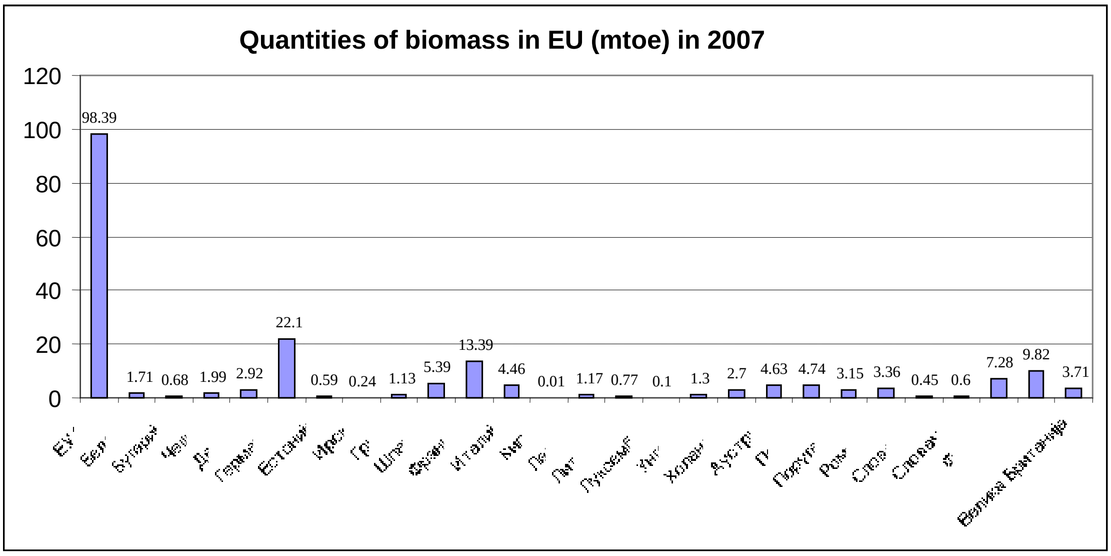
Country[14] (in 1000 τoe)	2003	2004	2005	2006	2007
Greece	945	954	990	1006	1123
Spain	4700	4852	5131	5064	5390
France	12298	12642	12761	12749	13081
Italy	1962	3136	3404	3758	3675
Cyprus	12	9	6	6	12
Latvia	1529	1565	1564	1603	1555
Lithuania	677	706	734	776	766
Luxemburg	51	59	60	63	65
Hungary	818	860	1118	1245	1288
Netherlands	1885	1927	2050	2123	2168
Austria	3681	3815	3947	4171	4430
Poland	3996	4126	4340	4844	4760
Portugal	2842	2877	2931	3011	3174
Romania	2903	3160	3229	3235	3325
Slovenia	460	470	476	462	445
Slovak	331	397	473	501	589
Finland	6979	7364	6878	7651	7353
Sweden	8093	8297	8938	9415	9819
Great Britain	2462	2538	2899	3153	3430
Croatia	381	379	355	412	366
Turkey	5783	5550	5332	5162	5023
Iceland	2	2	3	2	:
Norway	1269	1249	1278	1288	1282
Switzerland	1181	1432	1637	1733	1815

[14] Source:Eurostat

Picture 17



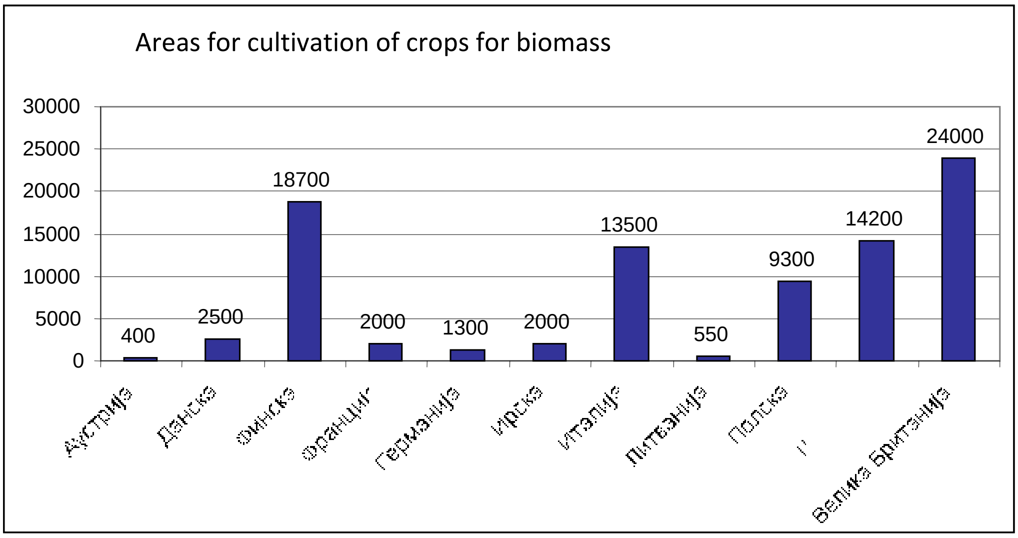
Picture 18



The largest producers of energy from biomass are Germany, France and the Nordic countries. Parts of the countries are cultivating the appropriate crops for acquiring biomass. The area[15] that is used for cultivating such crops is given in Picture 19.

[15] Source: European Commission, DG Agriculture and rural development

Picture19



The production of biogas from various sources of biogas is presented in table[16] 29.

Almost all the countries have increased the production of energy from the biogas systems. The total annual increase is 13.6%. The biofuel consumption in EU for 2006[17] is presented in tons, in Picture 20.

The analyses of the presented information, not only for the countries that are members of the European Union, but also for the countries aspiring for EU membership, indicates that the production of energy from biogas is rising each year, as a result of the positive experience of these countries.

These days, almost all existing technologies are being used for producing energy from biomass in the countries of our surrounding area, such as Serbia, Bulgaria, Greece, Croatia and Turkey. Some of those installations are relatively old and are out of function now. Still, in these countries like in ours, biomass is most often used for heating homes; in particular, it is used as firewood. Besides using biomass in this manner, the most commonly used technology is the production of thermal energy, which is especially used in industrial capacities generating biomass waste. There is an analysis prepared on the potentials of using biomass in energy production for all the countries of our surrounding area. It is interesting to point out that during the fuel embargo on Serbia, some industrial capacities started producing biodiesel for their own individual needs. The agricultural mechanization and the industrial machines that used this fuel were quite old and not adapted for using this type of fuel, so therefore, had to be reconditioned each year, as a result of the

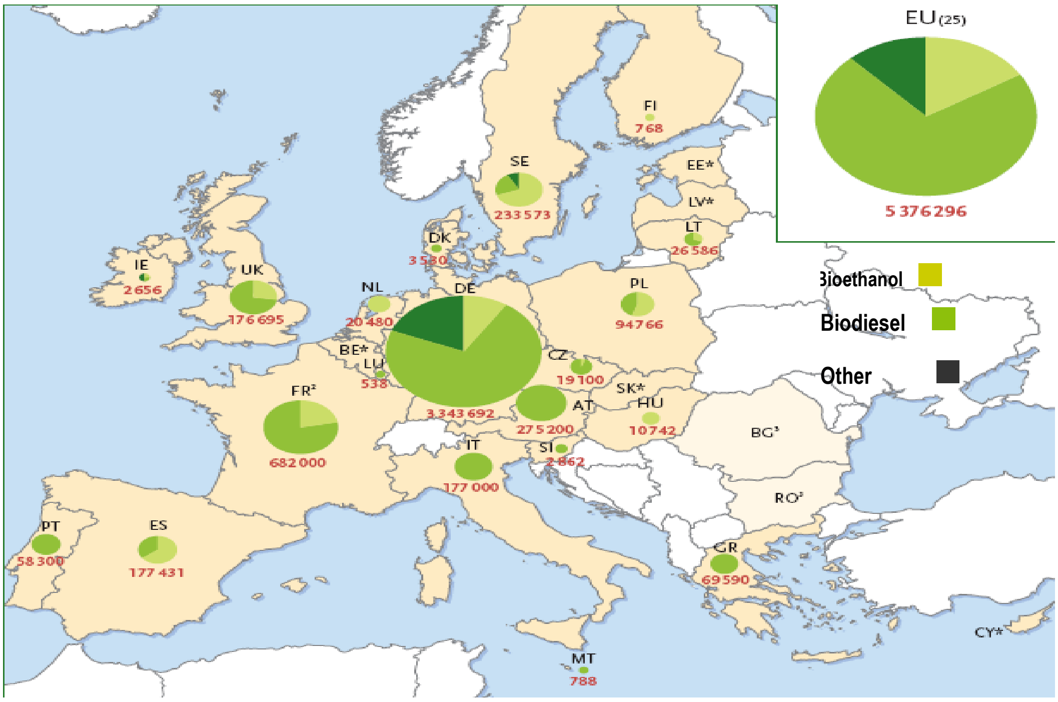
[16] Source: Eurostat
[17] Source:EuroObser, ER 2007

aggressiveness of this fuel. With the termination of these sanctions, these capacities ceased to function. In Serbia, numerous capacities use biomass as fuel. The project implemented by PE Belgradski elektrani is one of the more significant, in terms of introducing the use of biomass for production of energy. Up to now, several thermal power plants have been installed with a total capacity of 24 MW, which use pellets or briquettes.

Table 29

Country (in Ктoe)	2006				2007				% of change
	Landfill gas	Wastewater treatment gas	Other biogas	Total	Landfill gas	Wastewater treatment gas	Other biogas	Total	
Austria	8.3	2.7	19.8	30.8	11.2	3.5	103.4	118.1	283.4%
Belgium	51.1	25.2	7.7	84	50.6	25	7.8	83.3	-0.8%
Great Britain	1421	179		1600	1515	181		1696	6.0%
Germany	573.2	369.8	651.4	1594.4	573.2	369.8	980.2	1923.2	20.6%
Greece	20.5	15.5		36	54.2	15.2		69.4	92.8%
Denmark	14.2	23.3	54	91.5	14.2	23.5	56.5	94.2	3.0%
Estonia	1.3			1.3	1.3			1.3	0.0%
Ireland	24.9	4.8	4.5	34.3	25.4	4.8	4.5	34.7	1.2%
Italy	301.7	0.9	40.9	343.5	310.8	0.9	42.1	353.8	3.0%
Luxemburg			7.4	7.4			8.9	8.9	20.3%
Poland	25.1	25.3	0.3	50.7	27.5	65.8	0.5	93.8	85.0%
Portugal			10.1	10.1			9.2	9.2	-8.9%
Slovakia		4.3	0.6	4.9		4.3	0.6	4.9	0.0%
Slovenia	6	0.7		6.8	6.9	1.1	0.4	8.4	23.5%
Hungary	0.1	4.6	2.4	7.1	0.1	7.3	3.1	10.5	47.9%
Finland	50.9	12.7		63.5	50.9	12.7		63.5	0.0%
France	141	75	4	220	148	75	4	227	3.2%
Netherlands	38.8	50.8	29.4	119	38.8	50.8	29.4	119	0.0%
Czech Republic	21.5	31.4	2.9	55.8	25.2	4.8	4.5	59.9	7.3%
Sweden	10.1	18.7	0.9	29.8	11.3	21	1	33.3	11.7%
Spain	236.5	56.8	23.6	316.9	251.6	56.8	25.8	334.3	5.5%
Total:	**2946.2**	**901.5**	**859.9**	**4707.8**	**3116.2**	**923.3**	**1281.9**	**5346.7**	**13.6%**

Picture 20



Bulgaria as an EU member state, has defined targets that need to be met until 2020. Some of the more interesting projects realized in Bulgaria are: the first big thermal power plant in Bulgaria that uses biomass as fuel was built in the winter center of Bansko in 2009. It has a total capacity of 10 MGW and supplies hotels, private accommodation, residences and administrative buildings with thermal energy; in February, a similar heating system was put in function in the city of Itiman in Western Bulgaria.

The price of heating energy from biomass is significantly cheaper than the price of heating energy obtained from fossil fuel.

3.9 Feed –in tariffs for electricity produced from biomass

3.9.1 Macedonia

Based on the adopted acts given below:

- The Decision on determination of feed-in tariff for sale of electricity produced and delivered by power facilities which as operating fuel use biomass, defines the feed-in tariff for selling electricity (adopted 31.03.2010) and
- The Decision on determination of feed-in tariff for sale of electricity produced and delivered by power facilities that as operating fuel use biogas deriving from biomass defines the feed-in tariff for selling electricity (adopted 31.03.2010).

the purchasing prices are defined of electricity produced from according types of biomass. Within the framework of these decisions, limitations have also been defined regarding the installed capacity of individual power plants for production of electricity for the application of feed-in tariffs. These limitations are up to 3 MW for using biomass and up to 2 MW for using biogas.

In regards to the production of energy from biomass. The following restrictions have been defined for the total capacity of power plants for which feed-in tariffs will apply in Republic of Macedonia:

Type of power plant	Total capacity for which feed-in tariffs are applied (MW)
Cogeneration thermal power plant on biomass	10
Power plants on biogas from biomass with installed power up to 500 kW	2
Power plants on biogas from biomass with installed power more then 500 kW	8

Biomass power plants

The feed-in tariff for sale of electricity produced and delivered by power facilities that as operating fuel use biomass is 11 Euro cents for kWh for power plants with installed power of up to 1000 kW and 9 Euro cents for kWh for power plants with installed power of 1001 to 3000 kW.

Power plants on biogas from biomass

According to existing regulations, power plants on biogas acquired from biomass have the right to use feed-in tariffs in purchasing electricity- 15 euro cents for kWh for power plants with installed power of 500 kW, or 13 euro cents for power plants with installed power of кWh from 501 to 2000 kW. The total installed power of these types of power plants that can use feed-in tariffs is limited to 10 MW.

3.9.2 Countries in the region

Biomass power plants

Tables 30 и 31 show the feed-in tariffs for purchasing electricity produced from biomass.

Table 30

Country	Feed-in tariff [Eur/MWh]	Tariff valid period
Croatia	from 93,6 to 163,2[18]	12 years
Bulgaria	from 82,8 to 109,9	15 years
Greece	73/ 84,6 [19]	/
Slovenia	167 (from 1 to 10 MW) и 224 under 1MW / 108 (from 1 to 10 MW) и 165 under 1 MW[20]	/

Table 31

Country	Feed-in tariff [Eur/MWh]	Tariff valid period
Croatia	from 48,9 to 163,2 [21]	12 years
Greece	73/ 84,6 [22]	/
Slovenia	from 62 to 159/ from 3 to 102 [23]	/

[18] Coefficient which with the index of retail prices and according corrective factors determines the feed-in tariff
[19] Systems connected to the network on land/Isolated systems on islands
[20] Fixed tariffs/ premiums
[21] Coefficient which with the index of retail prices and according corrective factors determines the feed-in tariff
[22] Systems connected to the network on land/Isolated systems on islands
[23] Fixed tariffs/ premiums

3.10 Conclusions and recommendations

The institutional set-up of the energy sector is in accordance to EU requirements, and by that, conditions have been created in our country for development of this area.

Based on the analysis of the existing situation in the East Planning Region, the utilization of biomass for production of energy demonstrates that biomass participates greatly in the production of thermal energy, but the way in which it is used is with very little efficiency. As of this, one of the main outcomes is the lower quality of living standards during the winter period, since most of the population using firewood for heating purposes, when confronted with the decreased economic power, chooses to heat only one to two rooms of their homes during the heating season. This is the reason for the large discrepancy in the quantities of firewood that are cut and sold in the East Planning Region (with calculations on the illegal cutting included) and the estimations on the needed quantities of firewood for satisfying the needs of heating homes, which are acquired on the basis of the average area of the residential units in the settlements in the region, the climatic factors and required room temperature.

The estimation of the quantities of various types of biomass indicate that in the East Planning Region, currently, not enough quantities of biomass are generated in order to enable the construction of a cogeneration plant for production of electric and thermal energy, with a larger capacity. Another limiting factor for the construction of such a power plant is the non-existence of a central heating system for heating households and industrial facilities in the cities of the East Planning Region, with the exception of Makedonska Kamenica. In order for such a capacity to be cost-effective, a heating consumption is needed within the vicinity of the plant itself. Table 32 gives the necessary quantities of biomass for the proper functioning of power plants with various capacities.

It needs to be pointed out that, from the location perspective, most of the agricultural residue is generated in Kocansko Pole, whereas the largest part of waste from wood mass cutting of firewood is generated in the Malesevski region. One of the factors directly influencing the cost-effectiveness of a plant for production of energy using biomass is the distance of the available biomass, as transportation costs are high.

Table 32

Type of plant	Capacity (thermal $_T$ or electric energy $_e$)	Operating hours at the annual level	Necessary quantity of biomass (dry) tons/annually
Small plants	100 - 250 kW $_T$	2000	**40 – 60**
Large plants	250 kW – 1 MW $_T$	3000	**100 – 1200**
Small cogeneration plants (CHP)	500kW $_e$ – 2 MW $_e$	4000	**1000 – 5000**
Medium cogeneration plants (CHP)	5MW $_e$ – 10 MW $_e$	5000	**30 000 – 60 000**
Large cogeneration plants (CHP)	**20MW $_e$ – 30 MW $_e$**	**7000**	**90 000 – 150 000**

If agriculture biomass is to be used the fragmentation of the agricultural land and large number of various crops that in average are cultivated by one farmer, are factors that need to be overcome. One type of biomass source, which is fairly easy to access from the transportation and collection perspective and economic aspect as well, are the existing quantities of rice peel that are currently almost not being used at all for any purpose of what so ever, with the exception of small quantities being used in raising poultry. At present, relatively small quantities are generated and are not factors based upon which a construction can be planned for a more significant capacity. The region has no thermal power plant, therefore the technology for incineration of the biomass in the existing thermal power plants cannot be put to use. Even though it is difficult to predict the future agriculture development in the East Planning Region, if the cultivation of rice were to become once again one of the main agriculture activities, in this case, due to the increased quantities of rice peel, consideration could be given on constructing a plant for production of electric and thermal energy with a relatively small capacity (< 2MWh).

Although the quantities acquired after cuttings have been made, theoretically are quite large, the quantities that are actually accessible are not enough to supply larger energy capacities. This quantity can be used for production of pallets, chips and briquettes, and in this way make use of their energy potential. The quantities of firewood, according to the information available during the preparation of this Study, are not sufficient enough for satisfying the current needs of the citizens neither. Therefore, the construction of a capacity working on this type of fuel would drastically increase the price of firewood, which on the other hand, would decrease the economic viability of the plant itself, which would be against the recommendations of the “Strategy for Development of Energy in Macedonia until 2020” in regards to not using firewood for this purpose. Even though the region disposes with large areas of forestland (Malesevski region), the remaining areas in the region do not have such large areas, whereas part of the forests are totally ruined.

Production of biofuels from the first generation is linked to the cultivation of appropriate crops, except when biodiesel is produced from used vegetable oil.

Currently, there is biodiesel production in Macedonia, and a relatively small producer has been identified in the East Planning Region. In the recent period one pilot project was realized, but unfortunately is still not completed. Even though a great number of the farmers questioned are interested in cultivating crops for obtaining biomass, the small areas owned by the farmers do represent a limiting factor. In direction of utilizing the potentials of cultivating crops for obtaining biomass, it is recommended that support be given to the farmers that are interested in raising such crops, by contacting the biodiesel factory (when it starts with production of biodiesel from rape), enabling professional improvements of the farmers, providing legal support and other measures.

Aside from the negative experiences with biogas, in particular, previous unsuccessful projects, the great number of projects and plants that have been realized and are functioning not only in EU, but also in other parts of the world (India, China, USA and others), are proof enough for the efficiency of using biomass in this manner. On the territory of the East Planning Region, there are several pig farms, poultry farms and farms for cows. The utilization of this type of biomass should not only be analyzed from the aspect of acquired quantities of energy, but only as an opportunity for lowering the high costs for treatment of wastewater coming from farms (pig farms) and treatment of waste from the poultry and cow farms, in direction of respecting the legal obligations for environmental protection. At present, there are biogas plants in the world, and also in our close surrounding area (Croatia), that use not only the liquid waste from cattle farms, but also agricultural residue, that is, combined biogas systems are being constructed. This is a suitable opportunity for the farms located in the East Planning Region as well. The opportunity of utilizing biogas in the plants for treatment of communal wastewater, which are planned to be constructed in the next period, has to be pointed out.

Utilizing the so-called landfill gas, in particular, gas produced in landfills, is something that is currently not being applied at all in our country. In accordance to the second national plan on climatic changes, according to the improved environmental scenario, it is anticipated that on the territory of the East Planning Region collection and utilization of the landfill gas from the landfills in Stip, Kocani and Vinica should start in the next period. Table 33 shows basic information regarding the planned measures.

Table 33

Landfill	Annual decrease in emissions (t CO_2-eq)	Annual costs (САД $)	Total investments	Year applied
Stip (Trstena skala)	15034	42791	348000	2014
Kocani (Belski pat)	4095	11657	94800	2014
Vinica (Leski)	3888	11067	90000	2014

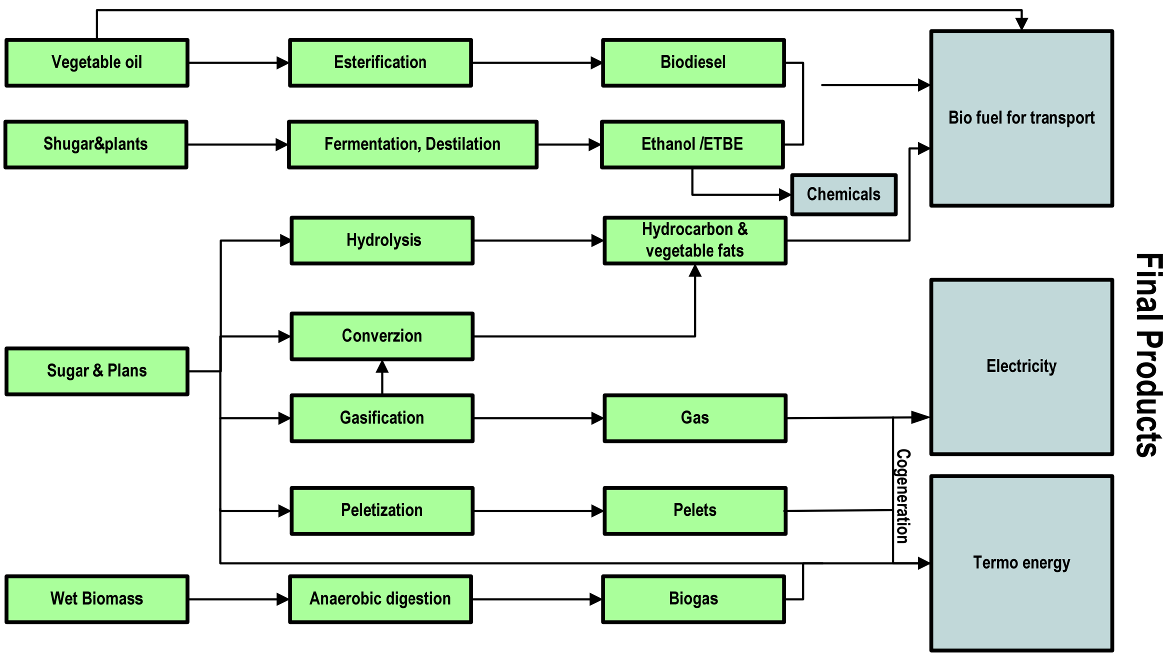
An appropriate analysis needs to be conducted on the use of this type of biogas, as generation of this type of gas is the result of the decaying organic waste that ends up in landfills. The European Directives that refer to the waste, i.e. organic waste and its dumping, require the introduction waste selection, in particular, its separation from the rest of types of communal solid waste and proper treatment, which will greatly decrease the quantities of organic waste that end up in dumps.

The opportunity on obtaining biogas by digestion of the organic fraction of the communal solid waste is one possible solution for treatment of this type of waste. Although currently, there is no selection of this fraction from the other remaining fractions, it is reasonable to expect some sort of selection to be introduced (primary or secondary selection) of the communal solid waste. In preparing the analysis regarding the most suitable treatment of organic solid waste, utilization of this waste for obtaining biogas should also be taken into consideration.

4.0 Technologies for using biomass for production of electric and thermal energy

There are various types of technologies that are used worldwide for utilization of biomass, in particular, for production of energy from biomass. Electricity and thermal energy and transport fuels are just end products of the process of transforming biomass in useful forms of energy. Picture 21 displays the processes of converting biomass into biogas.

Picture 21



4.1 Solid biomass

In the process of electricity production, the most dominant technology is for direct incineration of solid biomass in thermal power plants. The fuel is incinerated in reservoirs, so that steam is produced that afterward expands in the steam turbine, and by that enables electric generators to be powered. In the cogeneration plants, the steam that is generated is also used for covering the heating needs of the industrial processes, or for heating the premises of the facility. In general, there are two types of biomass incinerations. They are as follows:

- independently, in facilities with a small and medium capacity
- incineration of fossil fuels (usually coal), in facilities with medium and high power .

From among the technologies that are mostly expected to be used in production of electricity, special attention should be given to biomass gasification, by using gas for powering gas motors and gas turbines.

From the perspective of the current situation, it can be stated that currently, and perhaps in the near future as well, the most economical method of producing electricity from biomass is by its incineration in contemporary thermal power plants. Relatively low investment costs are needed in for using this method of biomass usage, which in conditions of relatively good prices of biomass, can result in competitive electricity prices. This technology has three different methods of incineration. They are:

- Premixing with the coal,
- Separate chopping of the biomass and putting it in the chopped coal and
- Incineration in a separate incinerator.

Depending on the fossil fuel it is replacing, biomass decreases greenhouse gases. When incinerating smaller quantities of biomass (5 – 10% of the total energy value of the fuel) no larger modifications are needed to be made in the equipment for preparation and transportation of the fuel, neither is the power utilization of the plant decreased. The European experiences, regarding the incineration of biomass that has been performed in several European plants, are in favor of wood biomass. The incineration of biomass coming from straw or other agricultural residue increases the risk of clogging the pipes in the furnaces, and badly influences the composition of the ashes that can otherwise be used in the industry for construction materials.

The capacities of the facilities for biomass self-combustion, on grate or fluidized bed, are determined by the quantities of biomass that can be collected and transported to the location of the facility in a cost-effective manner. In comparison to power plants using coal, power plants using only biomass are more expensive and less efficient. The utilization of electricity of these plants, determined as the ration between the produced electricity and the energy brought in with the fuel, as a rule, is under 20% for plants having the capacity of up to 5Mwe and rarely surpasses 30% with plants of larger capacity.

Newer capacities built after the year 2000, achieve higher utilization than 30%,as a result of applying more advanced technology of incineration, using dry fuel and raising the parameters of the steam (above 100bar and 500^{O}C).

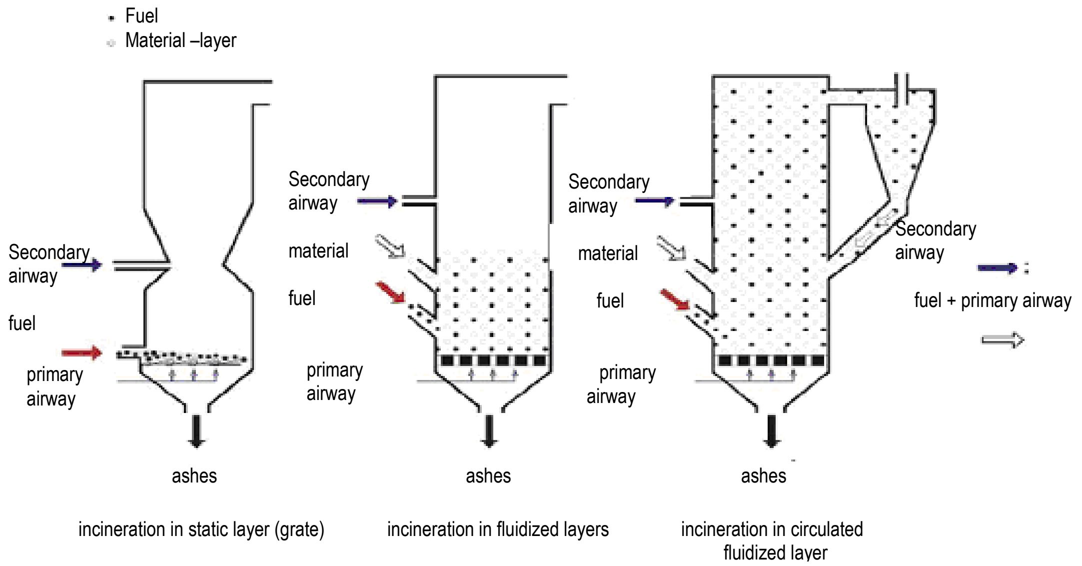
The technology of biomass gasification has still not been established on the market, even though compared to other technologies it enables more efficient usage of solid biomass. Several pilot plants are already functioning for some time now, and based on the experiences acquired, the mass production of large plants that use this technology, has started at the end of 2008.

4.1.1. Technology for biomass incineration

The plants for biomass self-combustion mainly use the following technologies for incineration: incineration of an immovable layer in grate furnaces, incineration in a fluidized bed and incineration in a circulating fluidized bed. The technology of spreading fuel around is very rarely used. Picture 22 provides displays the technologies for biomass incineration.

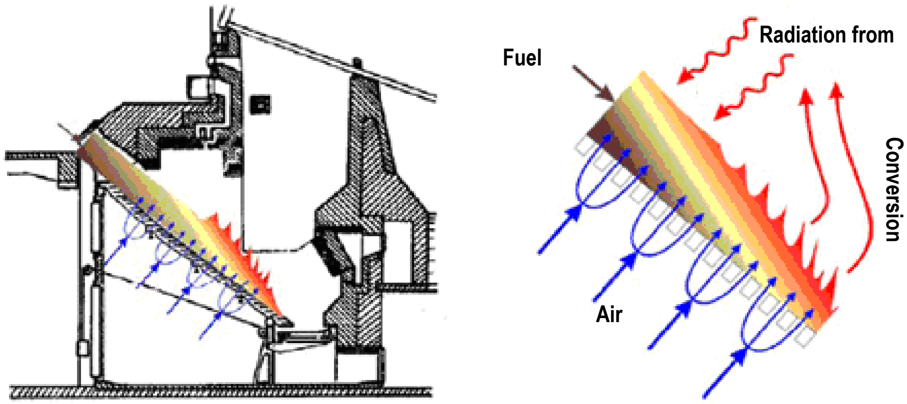
The biomass grate incineration furnace is a developed and standard type of technology, which in its various structures, can be found in the offers of many energy equipment manufacturers. The grate system enables incineration of chips, sawdust, large and small pieces of biomass. It is suitable for incineration of moist fuels, as well as fuels with high concentration of ashes. For quality management of the process, homogeneous fuel distribution must be provided on the entire surface and a balanced inlet of primary air blown underneath the grid. Based on the manner of how fuel the is charged into the furnace, there are grates with bottom and top fuel charging. Grates with bottom fuel charging are suitable for low power plants, and for incineration of biomass containing large quantities of ashes, such as the crust of the trees, straw from grains and grass. This type of system requires an efficient system for removing ashes.

Picture 22 Technologies for biomass incineration



Larger systems employ technologies with an upper fuel charging on grate, which can be differently set-up: horizontal, slanted, chained, immovable, movable only in one direction, rotational and vibrating. The process is performed in several phases: drying, pyrolisis and fuel incineration, and lastly, incineration of the wood coal. Each particle of the fuel passes through all three phases. Picture 22 displays the process of biomass incineration in a system with an upper fuel charging.

Picture 23 Biomass incineration with systems with bottom fuel charging



Contemporary solutions of incineration systems include a movable water-cooled grate, automatic supervision and regulation of the layer height, as well as regulation of the rotation speed of the ventilator for supplying primary air. The primary air is supplied underneath the grate separately in sections, in order to provide an appropriate amount necessary for covering the need of the primary wave in the drying area, in the area for gasification, as well as the incineration area. The regulation of the airway provides a stable incineration process even at lower stress levels, as well as regulation of the necessary ratio of the primary and secondary air, to minimize gas emissions. The different structures of the slanted and vibrating grates with upper fuel charging are used for biomass incineration in plants with a capacity of 5MWt to 120MWt. Picture 24 displays a slanted, water cooled, vibrating grate.

Picture 24 Vibrating slanted grate

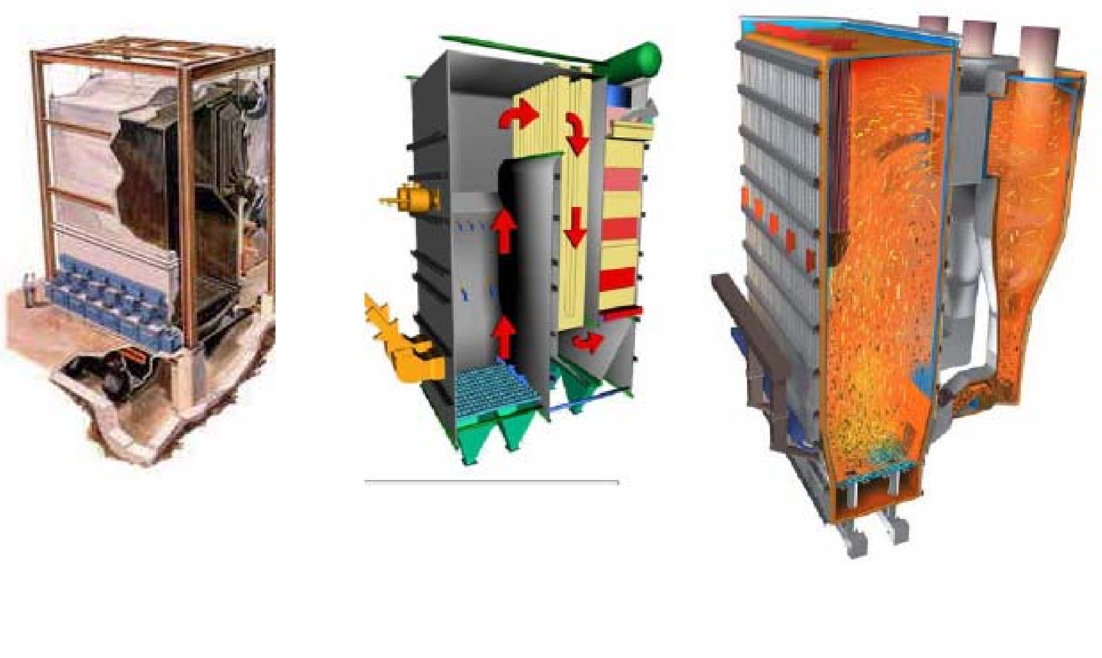
Plants having a capacity of 7 MWt to 20 MWt apply technologies that have a rotational conical grate with bottom fuel charging. Picture 25 displays one such solution.

Picture 25 Rotational conical grate with bottom fuel charging

Furnaces for incineration in fluidized beds have been developed so as to achieve better coal incineration, and for achieving lower gas emissions. During time, this technology has broadened and is used for biomass, as well as other fuel types not suitable for conventional incineration.

Furnaces for incineration in a bubbling fluidized bed (BFB) are suitable for plants with a power of above 10MWt. The bottom of the furnace is covered with a sand bed; underneath it is the distribution plate for the airway. The temperature of this bed is maintained between 800 and 900^{O}C, with the support of a built-in temperature shifter, through which heated steam passes through. The secondary air is supplied through several feeders located at the upper part of the furnace. The air for incineration is pumped gradually in order lower NOx gas emissions. The fuel covers no more than 1-2% of the bed and before the initial amount of fuels is fed, the bed needs to be previously warmed. The advantage of this technology is the opportunity for incinerating particles with different sizes and moisture level, as well as using a mixture of different fuels. In comparison to older structures of furnaces for incineration with grates, this technology enables more homogeneous conditions for incineration, and by that lowers emissions of gasses. Picture 26 displays furnaces for incineration with grates, in bubbling fluidized bed and in circulating fluidized beds.

Picture 26 Incinerator furnace with grate, in bubbling fluidized bed and circulating fluidized bed



Analysis of technologies for incineration

Analysis has been made on the technologies presented and the advantages and disadvantages for each one have been defined, as well as the needed investment and operational funds by unit of produced energy.

The advantages and disadvantages have been defined for each type of technology that has been analyzed. The type of technology that will be implemented in a given plant all depends on the location, i.e., characteristics of the location, availability of various biomass types, degree of biomass preparedness, degree of trained human resources, size of installed capacity and especially the environmental impacts. Nonetheless, the selection of the incineration technology will mostly depend on the size of the plant. For smaller capacities, incineration plants with grates or bubbling fluidized bed are more suitable, whereas for capacities above 20 Mwe the technology with circulating fluidized bed is more convenient. The comparison of the investment and operational costs always leads to selecting the less expensive technology of incineration on grate, because contemporary models of this technology in comparison to incineration with fluidized bed are almost identical from the aspect of its utilization and from the aspect of harmful gas emissions. In the specific local conditions, the selection of the more expensive technology for incineration in fluidized beds can only be justified if the planned location foresees incineration of other fuel types.

Table 34

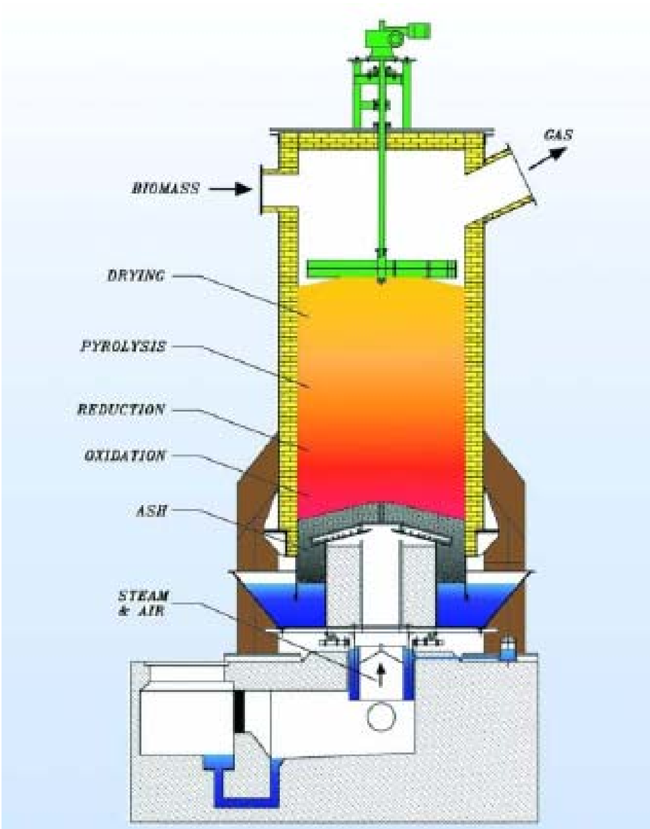
Technology	Advantages	Disadvantages	utilization %		Costs €/kWh		Unregulated emissions g/kWh		
			Reservoir	Individual	Investments	Operational costs	Nox	Sox	CO
Incineration with grate	- Proven technology - Lower investment costs for plants <10 MWt - Less quantities of ashes in the exhaust fumes - More complete incineration of ash particles - Efficient power even at lower loads - Lower sensibility to dirt compared to their technologies	- Fuels can not be mixed - Additional measures are needed for decreasing NOx - The larger quantities of oxygen in the exhaust fumes lowers utilization level - Incineration condition are not homogeneous like in other technologies - Sensitivie to changes in moisture level of fuels and size of particles - Lower utilization level	65 – 85	7 – 12	2000 – 2300	11 – 15	0,2 – 0,4	Depending on the fuel	0,3
Incineration with bubbling fluidised bed	- Lower investment cost for plants <10 MWt - There are no movable parts in the chamber for incineration - The gradual airway decreases the generation of NOx - Felexibllity in regards to the size of particles, moisture content and mixing different types of fuel - Efficiency is increased with a lower airway	- High operational costs - Large quantities of dust in exhaust fumes - Special technological measures are needed for powering lower loads - Moderate sensitivity to splatters - Erosion in pipes in the heat modifier		8 – 14	2200 - 2700	12 – 16	< 0,2		0,15
Incineration with circulating fluidized bed	- There are no movable parts in the chamber for incineration - The gradual airway decreases the generation of NOx - Felexibllity in regards to the size of particles, moisture content and mixing different types of fuel - Homogeneous conditions for incineration in the furnace - Additives can be easily added - Efficient maintaining of S in ashes by adding sufficient amount of Ca	- High investment and operational costs - Large quantities of dust in exhaust fumes - Special technological measures are needed for pwering lower loads - Loss of bed material along with ahes - Sensitive to splatters - Pipe corrosion, limited size of particles - High price							

Biomass gasification

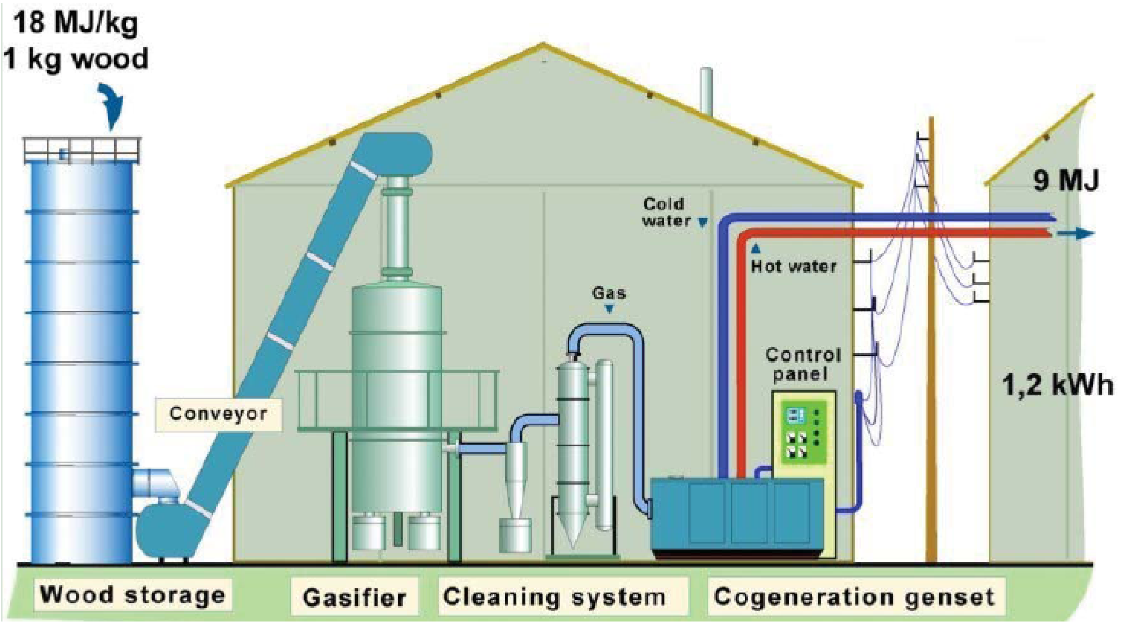
Biomass gasification is in fact a technology that is an alternative to the classical type of biomass incineration processes. This technology enables broadening of the opportunities for using biomass. During this process, solid biomass is transformed into fuel or reactor gas that is used afterwards in powering the gas turbine or gas motor that is used in the process of electricity production, and in the processes of chemical synthesis in producing ethanol or other biofuels.

The process of biomass gasification is performed in several phases. The first phase includes drying the fuel at a temperature of app. 200°C, followed by the second phase – pyrolisis, which in fact is heating without the presence of oxygen at a temperature of up to 500°C, next is the third phase – oxidation, performed at bed temperature of 900°C. Picture 27 displays the process of biomass gasification.

Picture 27 Biomass gasification



During the process of gasification, the biomass is firstly heated and dried, whereas the necessary heat in this phase is acquired through incineration of smaller quantities of biomass. During pyrolisis, which initiates at 200°C, the evaporating particles evaporate. The steam is composed of carbon monoxide, methane, carbon dioxide, evaporating tar and water. The solid residue from the fuel is charcoal that is transformed into reactor gas with the support of the gasification elements (water, oxygen, carbon dioxide and water steam are most commonly used). Charcoal reacts with the oxygen contained in theses elements producing reactor gas composed of carbon monoxide, hydrogen and methane. In using air as an element for gasification, inflammable gases amount to about 40% of the total volume of the reactor gas, and the rest is carbon dioxide and nitrogen. The reactor gas contains various quantities of harmful matters as it passes out of the diluter, such as nitrogen and sulfur containing compounds, tar and ash particles, therefore, its cleaning is essential. Cleaning is not necessary if the gas is directly incinerated in the furnace. Picture 28 displays a plant for production of thermal and electric energy by using the gasification technology.



The technology of gasification has still not been fully commercialized. There are numerous technological solutions that differ in regards to the place where the gasification element is added, and on the direction of the flow of this element. Current or counter-current reactors with gasification on immovable grates are the most suitable type of reactors for cogeneration biomass plants. Even though the plants that use this technology have greater electricity utilization, they still do not have greater market application. The reasons for this can probably be found in the content of the reactor gas that is directly depends on the type of biomass that is used and the applied technology of gasification. Moreover, one of the reasons is the need for removing all harmful matters, which imposes additional costs.

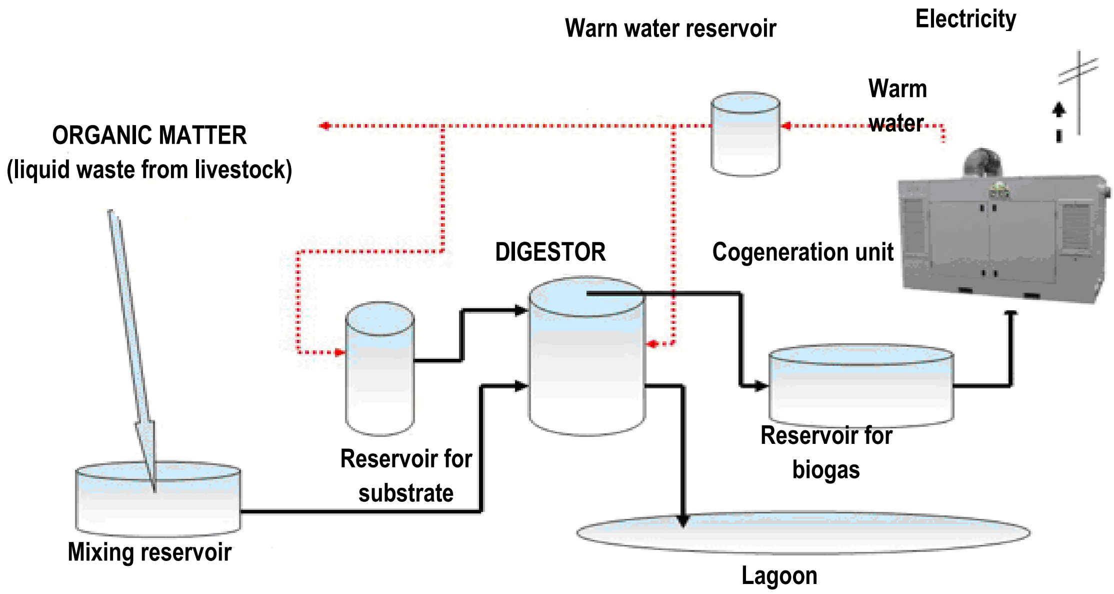
4.2 Biogas

Biogas is created as a result of the breakdown of organic matter, due to the reaction of microorganisms in anaerobic environment, more specifically, environment pertaining no oxygen. This is a process that occurs every day in nature. The technology for biogas production is based on this natural process of organic matter breakdown, during which organic matter (liquid or solid) is stored in a so-called digester, where the process of organic matter decay takes place and biomass is formed. Biogas is composed of methane 15 – 55% and carbon dioxide 45 – 85%. The ratio of these two gases directly depends on the conditions in which biogas is created. Biogas contains a higher percentage of methane has a higher energy value. Other comprising elements of biogas are hydrogen sulphate, ammonia and nitrogen. Biogas, usually, contains relatively high levels of moisture. The most commonly used biogas is the one obtained through a controlled process of anaerobic digestion and so-called landfill gas, obtained in landfills through the construction of an appropriate system for collecting this biogas. Biogas obtained from wastewater, waste from raising animals, agricultural residue, in anaerobic digesters contains a high level of methane, sometimes even up to 55%. Picture 29 displays the process of biogas production with an anaerobic digestor.

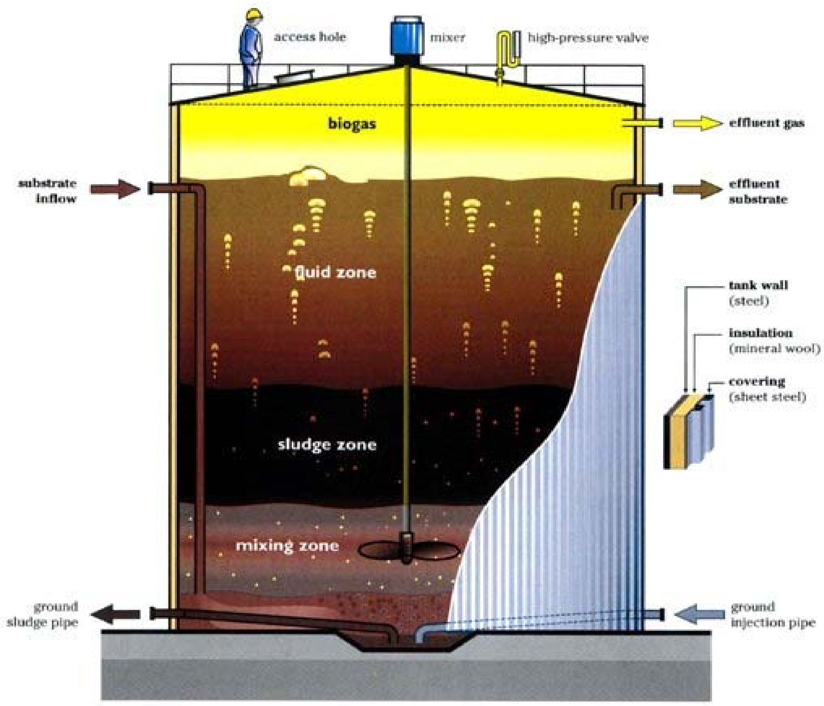
In the process of producing biogas, a large number of microorganisms participate in the complex process of decomposing organic matter, such as: carbohydrates, fats and proteins in the end products of methane and carbon dioxide. The process itself is performed in three phases. The first phase – hydrolysis, the microorganisms, supplemented with enzymes, decompose the organic matters into simple components, such as sugar and amino acids. The process of fermentation is performed in the second phase, during which alcohol is produced, fatty acids, hydrogen etc. In the final phase, methanization is carried out with specific microorganisms (methanogens) that require a specific environment. These microorganisms grow slowly and die when in contact with oxygen. In order to successfully complete the process, these microorganisms need an appropriate temperature, i.e., acidic environment (PH) and other suitable conditions.

The technology for biomass production has been adapted to the previously described biological process. The manner in which the entire process of biomass production will be carried out depends on the process of providing an appropriate environment for these microorganisms. The acquired biogas, with an appropriate treatment, can be further used for obtaining thermal energy, furthermore as transport fuel or can be used in cogeneration plants for production of electric and thermal energy. Picture 30 displays the technical solution for acquiring biogas from wastewaters coming from livestock farms. A pilot project has been realized in a pig farm in Gradsko by applying the technical solution presented below.

Picture 29 Process of biogas production



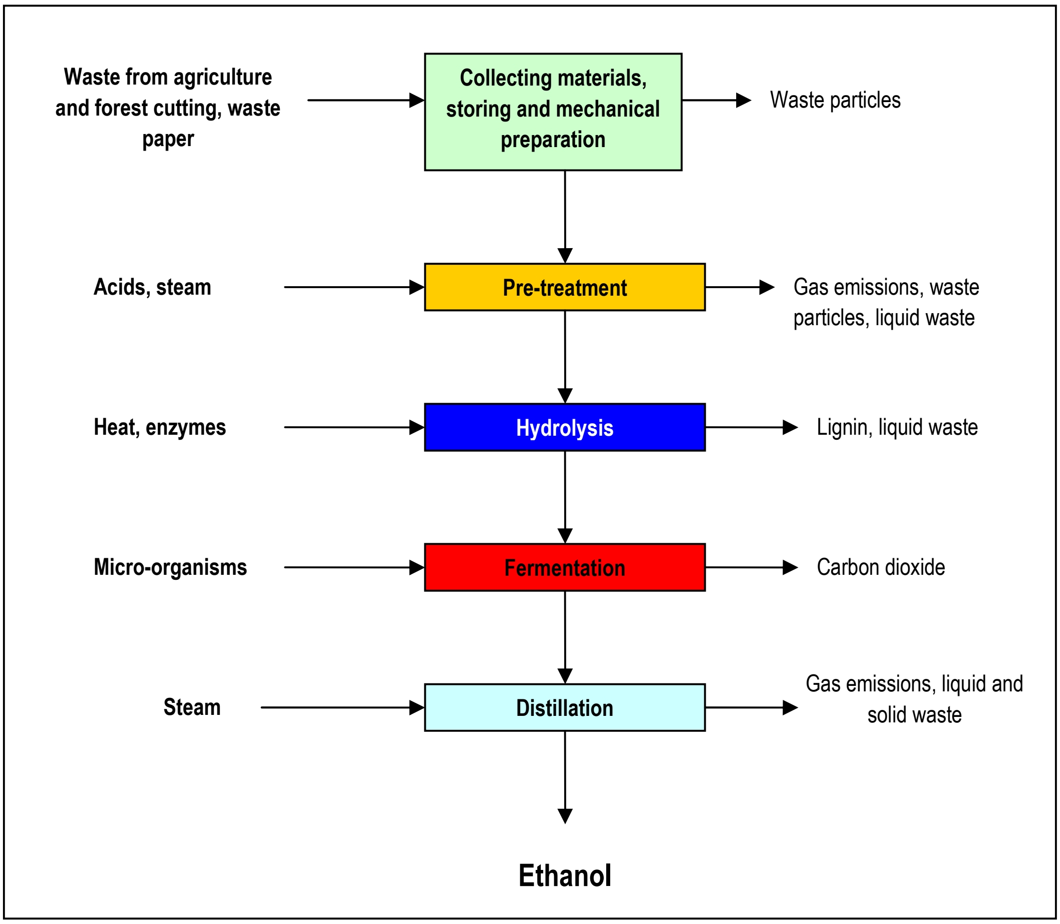
Picture 30 Production of biogas



4.3 Biofuels

Currently, the following types of biogas exist: conventional biogases (first generation) comprising of biodiesel and bioethanol, and the second generation of biofuels. The technology for production of biodiesel and bioethanol is described further below in this study, whereas the technologies for production of the second generation of biofuels is still in the phase of pilot projects and has not been sufficiently explored. Agricultural crops are used in the production of the first generation of biofuels, crops that are mainly used in feeding the livestock, but because land is needed for their cultivation, they are competitive with the food production, which indirectly influences the food production.

Technologies for obtaining biofuels from the second generation

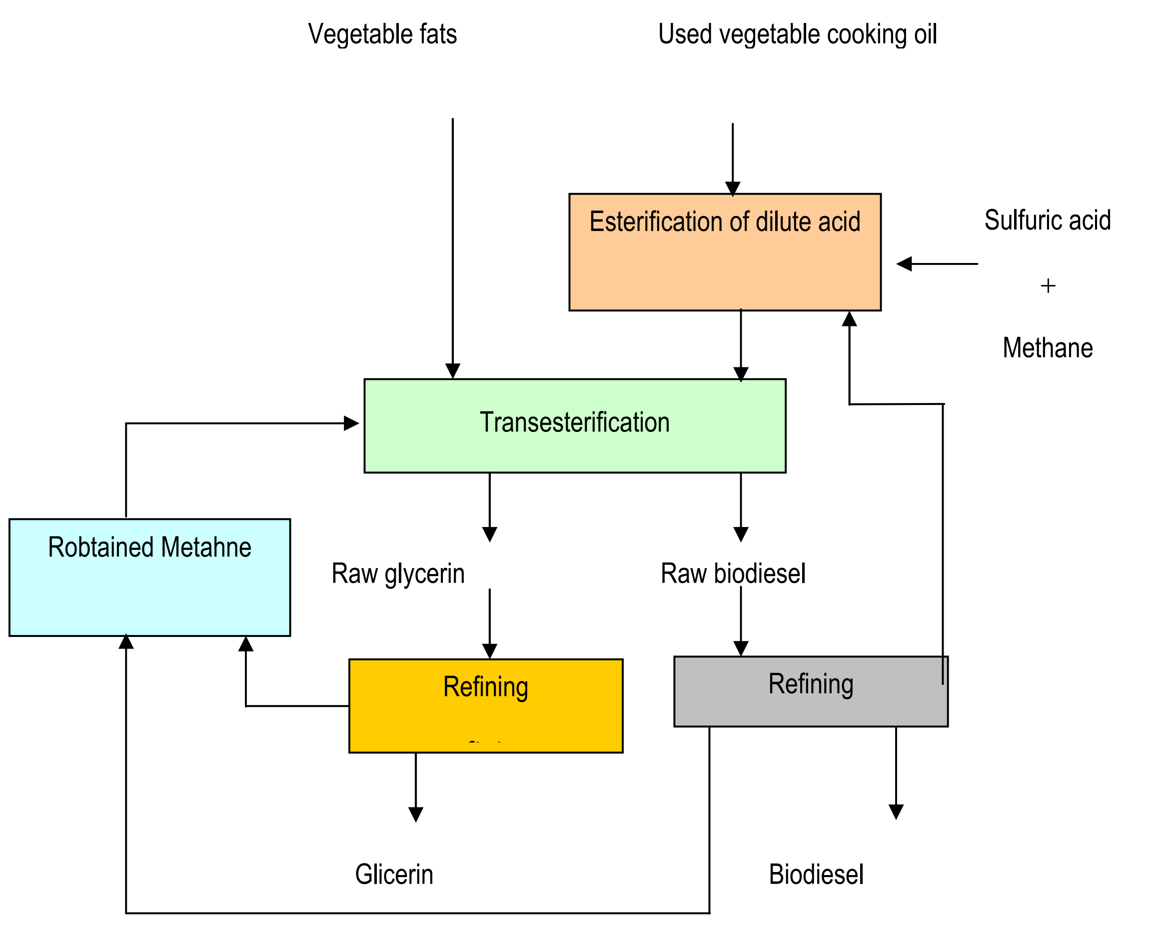


The second generation of biofuels can be obtained from almost any form of biomass. It can be acquired from waste remaining from cuttings or from agricultural residue and its production is not competitive to the production of food or livestock food. The technologies for production of the second generation of biofuels, currently, are still in the pilot phase of exploring, they are complex and very expensive; however, they do use inexpensive raw materials. Thermo-chemical processes that gasify wood and afterwards synthesize the gas into engine fuel, more specifically, the sub-processes, gasification, gas separation, synthesizing and others, are already being used in other industries, the only thing needed is to integrate them.

4.3.1. Biodiesel

In the production of biodiesel, used or newly produced vegetable fats or animal fats that are non-toxic and biodegradable, can be used as raw materials. The process itself is carried out in the following way: the fats and oils are chemically treated with alcohol (methane is most commonly used), in order to form chemical compounds known as FAME (fatty acid methyl esters).

Basic technology for production of biodiesel



Biodiesel is the title given to these esters when they are used as fuel. Glycerol (used in the pharmaceutical and cosmetic industry) is obtained as a by-product in the process of acquiring biodiesel. Currently, there are several technologies for esterification. During the process of biodiesel production, the oils and fats are filtered and treated in order to remove the water and other needless elements. If free fatty acids are present, they can either be removed or transformed into biodiesel with the support of preparative technologies. The treated oils and fats are mixed with alcohol (usually methane) and a catalyser (usually soda hydroxide). The oil molecules (triglycerides) are seperated, forming metlister and glycerol, which are then seperated from one another and are refined.

4.3.2 Ethanol

Ethanol (alcohol) is produced by fermentation of biomass that is rich in carbohydrates, such as corn, through a process very similar with producing beer. It is mostly used as a fuel additive for reducing gas emissions that cause smog (as carbon monoxide).

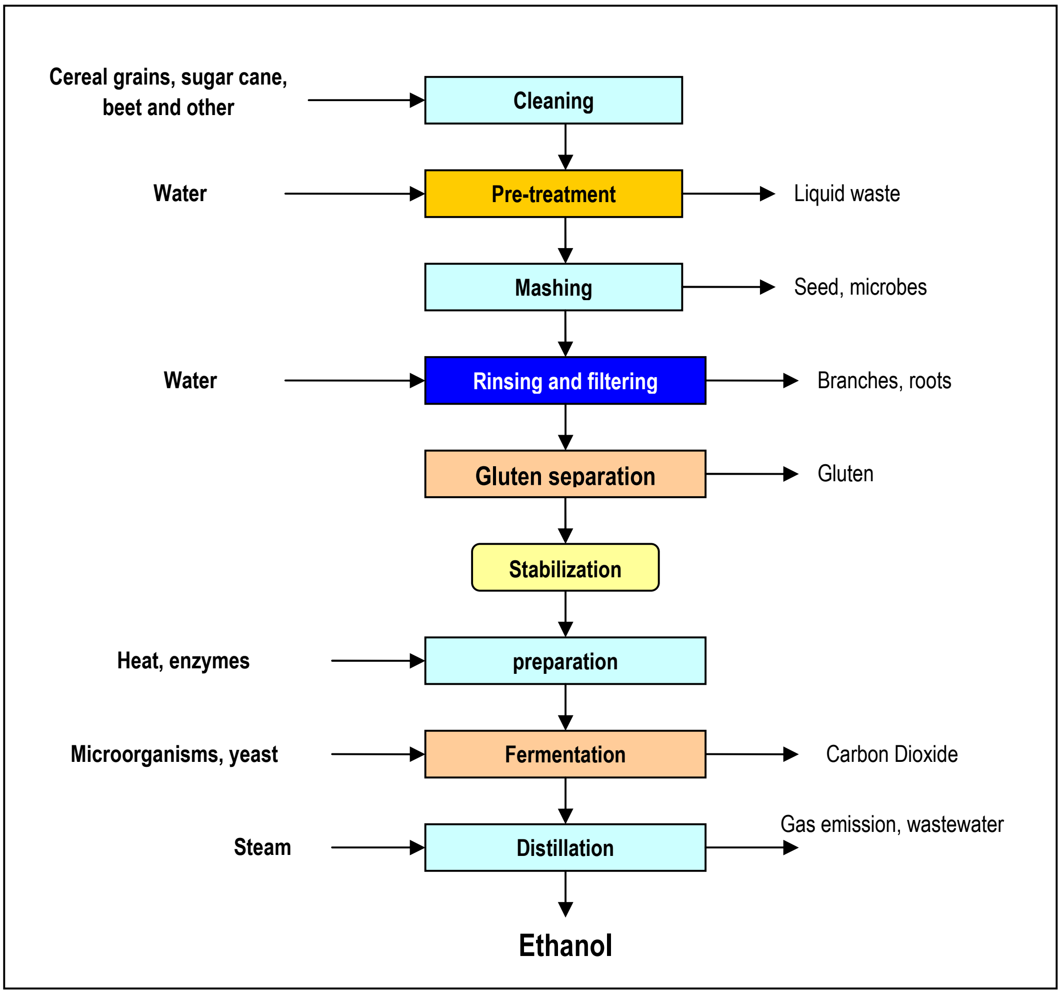
Fermentation is a biochemical process that converts the sugars into ethanol (alcohol). The opposite to the process of obtaining biogas, where there is anaerobic digestion, this process is carried out with presence of oxygen, in particular, this is a process of anaerobic digestion. In the process itself, specific types of enzymes are used that convert grain cereals (corn, wheat, etc) into sugars. Some plants, such as sugar canes or sugar beets, naturally contain fermentable sugars. Ethanol has a higher-octane value than ordinary fuels.

4.4 Proposed directions for technologies

The analysis made on technologies for using biomass as fuel in the production of energy, which are currently available on the market, as well as the analysis of the existing situation in the East Planning Region, specifically, the assessment on the quantities of biomass that is generated, indicate that the most suitable option is to move towards utilization of the biomass for production of thermal energy, and possibly using small plants for incineration of the biomass for cogeneration production of electric and thermal energy (CHP – Combined heat & power).

Utilizing biomass for producing thermal energy requires fairly low investment funds. The simplest way is to change the existing boilers, i.e., reservoirs of the existing central heating systems of certain buildings. However, appropriate fuel also needs to be provided, that is, provision of chips or pallets, as well as appropriate equipment for transportation of the fuel, a system for supplying the fuel to the boiler and to the place of storing the fuel. The production of chips is relatively simple and is described in Chapter 3.5.2, whereas the production of pellets is rather complicated, but the advantage of pellets is the possibility for other types of dry biomass to be used besides the wood biomass. Picture 31 displays a heating system that uses pellets.

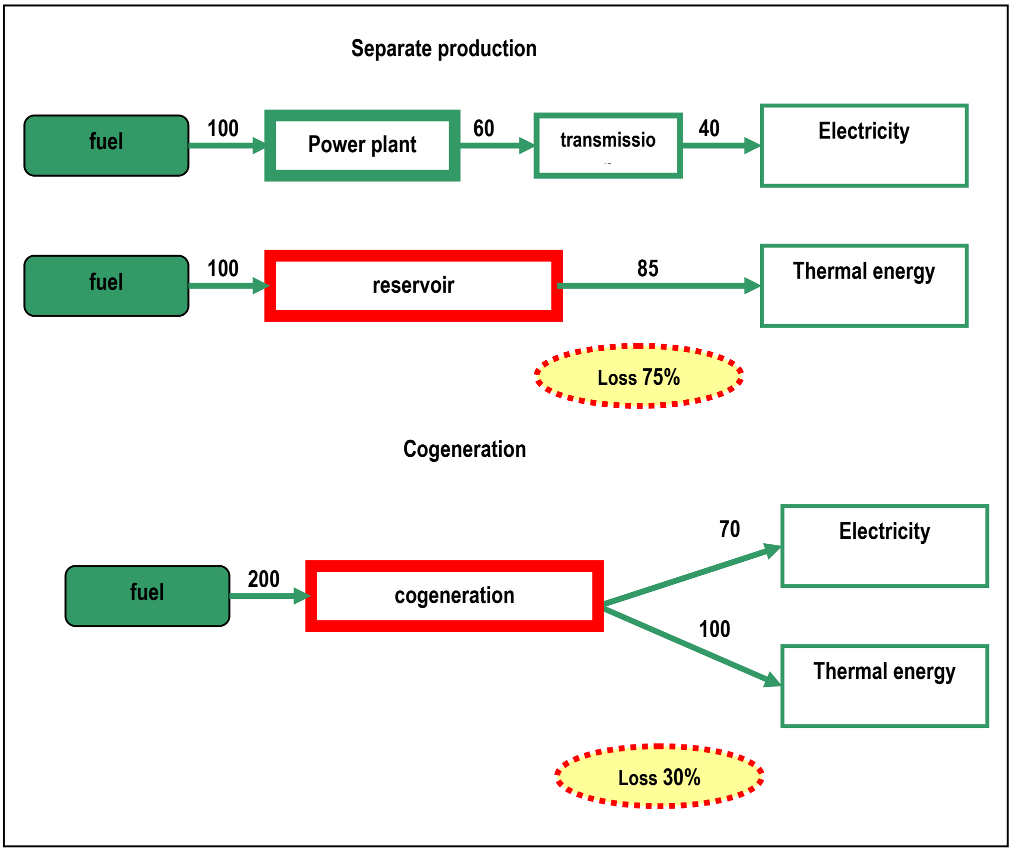
Technology for obtaining ethanol



Cogeneration production of electric and thermal energy is economically most worthwhile, especially, because of the great degree of utilization. Picture 32 displays the losses created in the production of electric and thermal energy, and in the cogeneration production. However, in order for this type of technology to be cost-effective, continuous production and usage of both types of energy is necessary, in other words, there must be a need for both types of energy. The sale of electricity is ensured for throughout the entire year, no matter if it is to be used for individual purposes, or to be sold to the electric energy operator. According to the legal regulations, the operator is obligated in buying the entire electricity produced, at prices determined by the Regulatory Committee.

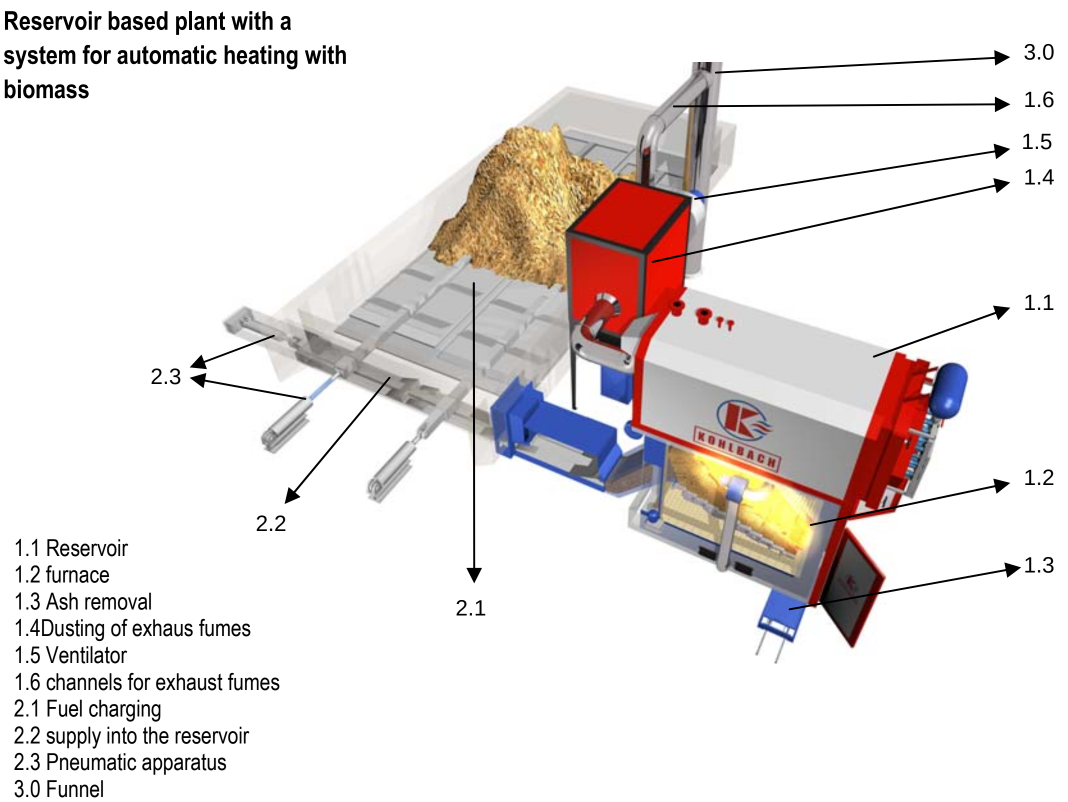
Picture 31 Heating system using pellets with a separate and prefabricated storehouse

Picture 32



On the other hand, the sale of thermal energy is limited, more specifically, this type of energy is distributed locally. During the heating season, there is a need for this type of energy, but during the rest of the year, there is no need for this type of energy. This is the reason why cogeneration production of energy from biomass is recommended, it is used only in industrial plants, which due to their technological process, have the need for certain quantities of thermal energy all year round. Determining the size of the capacities of these plants will depend on the need of thermal energy. According to the poll results, the foodstuff industry is a suitable industry for these types of plants. Picture 33 displays the system for cogeneration production of energy.

Picture 33



The following text below outlines the main reasons limiting the opportunity for construction of cogeneration plants with a capacity of 1MW:

- thermal energy consumption is a problem when it is produced in larger quantities. Distribution of thermal energy over 1 MW would be a problem, because in order to achieve economic viability of the plant economy, the thermal consumption has to be within the surrounding area (maximum distance of 5 km);

- the size of the plant has to be proportional to the demand for thermal energy, and to dispose with an appropriate infrastructure for distribution of thermal energy. The costs for connecting the plant with the thermal consumption can largely exceed the investment costs for the plant itself, and in the later phase, the operational costs can contribute towards reducing the economic gain of the plant;
- plants with larger capacities demand larger quantities of biomass, and according to the assessments on the quantities of biomass in the East Planning region, as well as the recommendations on not using firewood for these purposes, the East Planning Region does not dispose with sufficient quantities of biomass; and
- by increasing the necessary quantities of biomass for the operation of one capacity, risks also rise regarding the continuous supply of biomass.

5. Possibilities for production of biomass

For the purpose of reducing greenhouse gas emissions, support to the sustainable and responsible growth of the biomass market is constantly increasing. The goal is to achieve growth in biomass production by a more strengthened and sustainable approach of managing space and land, which would contribute towards multiple benefits in environmental protection. The production and processing of biomass can be CO_2 neutral (the quantity of CO_2 that is released during biomass utilization as an energy resource, is equal to the quantity of CO_2 that is absorbed during plant growth).

5.1. Cultivating plants for obtaining biomass

Types of cultivations

One of the basic methods of cultivation is the short rotation coppice (SRC), where low-stem plants rotate in a short period of time. With this type of cultivation, plants are planted densely, usually willows that have high yields or occasionally even poplars, which is used (picked/cut) in cycles of a 2-5 year period, most often in a period of 3 years. These plantations can be used in a period of 30 years before planting will be needed again, but the period depends on the plant productivity. The entire process of cultivating and harvesting biomass is shown in the following picture.

These types of plants are planted in the springtime, by using seed material produced from a professional cultivator of seeding material, specialized for this purpose. In average, these plants grow relatively fast and in a period of three years will grow up to 4m high. During the winter period, the trees are pruned in order to stimulate parallel and increased growth from the basic stem. In general, upon 3 years of pruning, the plant is picked, usually in the winter period again. These plants are picked with equipment that is specialized for this purpose, and what is specific about these plants is that aside from the planting, the rest of the processes can be performed with conventional agricultural machines. The expected yield for the first harvesting is from 7 to 9 t dry wood mass per hectare, for the period of one year (depending on the quality and preparation of the soil, the weed control, as well as weather conditions). In the second and third harvesting, if the locations are suitable, yields can range from 8-12, usually 9 t dry wood mass by hectare, for the period of one year. Poplar has a lower degree of branching in comparison to the willow; however, in some locations it may give excellent results, similar to the yields of the willow tree.

Locations suitable for cultivating plants for obtaining biomass

As perennial plants, the previously mentioned types can survive up to thirty years and grow up to 7-8m high before they are cut. Special attention should be given to the possibility of influencing overhead or underground distribution lines (electricity, communications etc.), landscape values, archeological sites, wildlife in the surrounding area, as well as influencing the everyday practices and communications of the local population. Attention should especially be focused on enabling access to the necessary mechanization, which is why it is recommended to leave at least 4.5m, whereas 7.5m is the optimal width between the openings and the area intended for handling of the engaged mechanization. In an ideal situation, the location for storing and handling of the already collected material should be within the vicinity of the location for cultivation, so as not to decrease the benefits in the transportation of the unprocessed material.

Conditions for cultivating plants for obtaining biomass biomass

The main factors determining the successful cultivation of these types of plants are access to irrigation water, weed control in the phase of primary growth, light and temperature. The willow, as a species, can survive even floods, but not being under water for a longer period. The annual rainfall of 800mm is considered as ideal. It is recommended that the plantations be located up to no more than 100 meters above sea level.

These species can grow on various types of soil, ranging from hard clay to sandy soil. Surfaces with clay or sand that have sufficient amount of moisture are ideal places for growing this type of culture. With clay soils, problems regarding plant growth may occur in the early phase, but in the subsequent phases, this soil is an ideal place for growth. In places where this soil is dense and highly compacted, removing 30-40 cm from the upper layer of the soil might be required so that growth these crops can be enabled. The pH value of the soil should be between 5.5 to 7.5, and the index of phosphorus and potassium should be 2.

Erosion

Eolian erosion can occur in the initial phase of growth, as well as washing away of the upper layer of the soil, but all this can be avoided through specific methods of planting, setting-up terraces etc. As plants develop, the possibility for soil erosion does decrease significantly.

Planting

In the process of planting, previous soil processing is vital for the proper growth and development. Agrochemical treatments for weed control are recommended once to twice prior to the start of the planting season (spring).

Planting

If deemed necessary, additional treatment can be carried out 10 to 15 days prior to the start of the planting phase. Adding lawn fertilizer can be beneficial, especially if it is put on “infertile” soil, where it will be soaked up and the moisture preserved. However, guidelines must be followed regarding good practices in agriculture so that the total plant needs of nitrogen are not exceeded, thereby preventing environmental pollution by potential “washing” of the soil. New plantations should have pest control, as the plantation is considered to be in a vulnerable phase until the period of the first cutting.

Seedling material

Fostering plants for obtaining biomass is not limited only to certain plant species and subspecies. However, certain willow and poplar types show high yields, regular and normal growth and resistance or tolerance to diseases.

The most commonly used seedling materials are trees from a one-year's growth, collected in the period between December to March, with a length of 18 - 20 cm and density of 9mm. If they are not planted immediately, they need to be stored at a temperature of -2 до -4° C, where if damp and cold, they can be stored for several weeks. From among other plant species used in producing biomass, local seedling material and seeds can also be used.

The planting process can begin as early as February, and if temperature conditions are favorable, can last until June, still, late plantings may not adapt to the winter conditions in the first year of growth. In addition, late planting also means using stored seedling material collected a lot earlier in the year.

Design of the plantation

The design of the plantation is the next most significant factor, after location, for determining the impact that the "energy" plant has on the environment. It is necessary for the plantation to completely blend in with the existing scenery of the area.

These "energy" plants are usually planted in double rows of 0.75m apart from one another, whereas the space left between these pairs is 1.5m. This space allows the standard agricultural machinery to carry out the necessary activities.


Plantation for obtaining biomass

Equipment for planting

The willow tree is planted with a special machine that can place 2, 4 and 6 rows of trees at a time. Trees high from 1.5 to 2.5m are fed manually into the machine that cuts them, and then the machine, which afterwards evens out the soil around the planted tree seedling, plants these tree seedlings 18 to 20 cm long, vertically. The usual commercial standard number of seedlings by hectare is 15000 seedlings.

General guidelines for cultivation

Introducing an annual management cycle

Each planted seedling will produce 3 -4 new ones reaching a 4 m height, depending on the existing location conditions. In the first year of cultivation, no fertilizers are needed. The “energy” plants need to be “protected” from weeds, pests and diseases, especially during the first year.

Cutting (pruning)

During the first winter after the planting has been made, the willow tree is usually cut 10 cm above the ground, in order to stimulate growth of more trees. This process should be carried in late winter, as much as possible, but before buds begin to sprout. Standard tools or machinery is used for cutting, aiming at making a clear cut so that the plant or its roots are not damaged at all. Herbicide can be applied after the pruning has been made, in order to prevent weeds from growing. However, herbicide should be applied before buds begin to sprout, so that the plants are not damaged.

Fertilizing

Sludge coming from wastewater treatment plants that has been treated, can be used in fertilizing these types of plantations. Estimations are that maximum 250 kg/year of sludge can be applied in one hectare of organic nitrogen. Having in consideration that these plants have a small need for nitrogen, it is not applied during and after the planting.

Liquid fertilizer can be effectively applied only in the first season and partially in the second, and later it will be almost impossible due to the size of the trees.

The fertilization can be done also through the irrigation system, if it is adapted for this kind of purpose.

A more suitable solution is applying composted wastewater sludge, as the compost is dissolved slowly and the plant absorbs in average about 70kg nitrogen annually per hectare, during the entire growth period (3 years).

It must be pointed out that various poplars and willow trees have different nutriment and water needs; therefore, attention should be given to their proper supply, based on previously determined dynamics based on its characteristics and needs.

In nitrogen sensitive areas, "energy" plants have positive influence, in that they lower the nitrogen quantities that spill over to that area. In such areas, these plants contribute more in effectively reducing the flow of nitrogen in comparison to planted agricultural land, or meadow.

Cutting (collecting)

Cutting wood mass, in general, is performed in 3-year cycles, after pruning has been made. Cuttings are carried out in the winter, after the falling of leaves and before buds begin to sprout on the trees, in particular, from mid October to the beginning of March.

"Energy" plants can be collected/picked as trees, sticks or "chips"

- Trees –with a length of up to 8 m directly cut from the plant
- Sticks – cut from trees with a length of 5-15cm and
- Chips – material cut into 5x5 cm pieces

Harvesting biomass

When direct cutting is involved, or cutting in sizes of "chips", there could be possible losses in the energy value of the material itself, as well as the possibility for development of fungus or bacteria type of spores that can lead to lower biomass quality. Good ventilation of the place where the material is stored is essential, which often reduces the economic benefits of the entire process.

In the process of cutting and storing the material as sticks, the space between them allows for natural ventilation, thereby avoiding reduction in the energy value. Still, depending on the demand, the sticks can be cut in the size of “chips” before they are delivered to the requesting side.

Ordinary cutting of the trees is not greatly in use, because the trees are quite big which complicates their collecting and storing. There are certain methods that anticipate bending of the trees and cutting them at 2.5 m lengths and storing them, and before they are delivered, they can even be cut into sticks or “chips”.

Carbon and energy savings

These plants can replace the conventional fossil fuels, as they absorb carbon dioxide from the atmosphere and at the same time-release oxygen from their leaves in the phase of photosynthesis. In addition, bearing in consideration those only small quantities of fossil fuel will be used on the land during the preparatory phase, cutting and transporting of the material, leads to the conclusion that these plants, as an energy source, are almost neutral in relation to environmental pollution and carbon dioxide emissions.

The energy value of the biomass on a dry basis is 18 MJ/kg, meaning that 20t of dry biomass can replace 8t of coal. Biomass can then be used together with coal in coal furnaces, ranging from large electricity production plants to small plants producing heat.

5.2 Cultivation of plants for biomass in the East Planning Region

One of the main problems that occur when using biomass for energy purposes is the long-term provision of the necessary quantities of biomass. This problem can be solved by raising fast growing plants (willows, poplars, elm trees) for producing biomass. Agricultural land, but also forestland that is not overgrown, are both suitable for raising these cultures. Estimations show that about 2000 hectares would be needed for plants having a capacity of 2 MWe, assuming that 8t/hectare of dry mass would be obtained from the cultivation of the fast growing cultures. The estimations have been conducted based on the following assumptions:

- 30% electricity utilization of the plant
- approximate biomass heating value is 3,8MWh/t (with a 20% moisture) and 5 MWh/t (for dry matter) and
- average annual return of 8 $т_{с.м.}$/hectare

The land on which these crops are to be cultivated, usually, should be close to the plant that will be built, more specifically; the land area should be located within a circle with a radius of 6km, assuming that 20% of the total area is covered with “energy” plants on a total area of 10000 hectares. There is a noticeable difference between the circle of collecting biomass when cultivating biomass crops, and the usage of agricultural or wood waste as biomass. This is mainly with the goal of reducing transportation costs and increasing the economy of the plant.

From the perspective of an available land for cultivating fast growing cultures, in the East Planning region there are no possibilities for cultivating such crops. According to the data from the 2007 Census of Agriculture, over 110000 separate parts of used land have been registered, or in average, that is 6 hectares per parcel. This represents a problem in cultivating biomass crops. At the same time, the East Planning Region, i.e., the agriculture is quite well developed and this region is one of the regions that produce significant amounts of agricultural products for the Republic of Macedonia. Introducing this type of industrial agriculture (biomass production) will lead to reducing the agricultural land area used for producing food, and by that, reducing the amount of food products. This would lead to rise in prices of food and the need for higher import. Based on the information[24], the East Planning Region does not have any greater agricultural land areas that are not in use.

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[24] Source: State Statistical Office of R.Macedonia, 2007 Census of Agriculture

The only areas of land available for cultivating fast growing cultures for biomass have been identified in the nearby area of the Municipality of Probistip, which cover a total area of 3500 hectares. This land area is polluted with heavy metals and is not being used now. Nevertheless, due to the lack of an irrigation system, this area, according to previous investigations, is suitable for cultivating rape (winter crop). Fast growing cultures require water that cannot be provided to these locations because of the climatic conditions and the lack of an irrigation system.

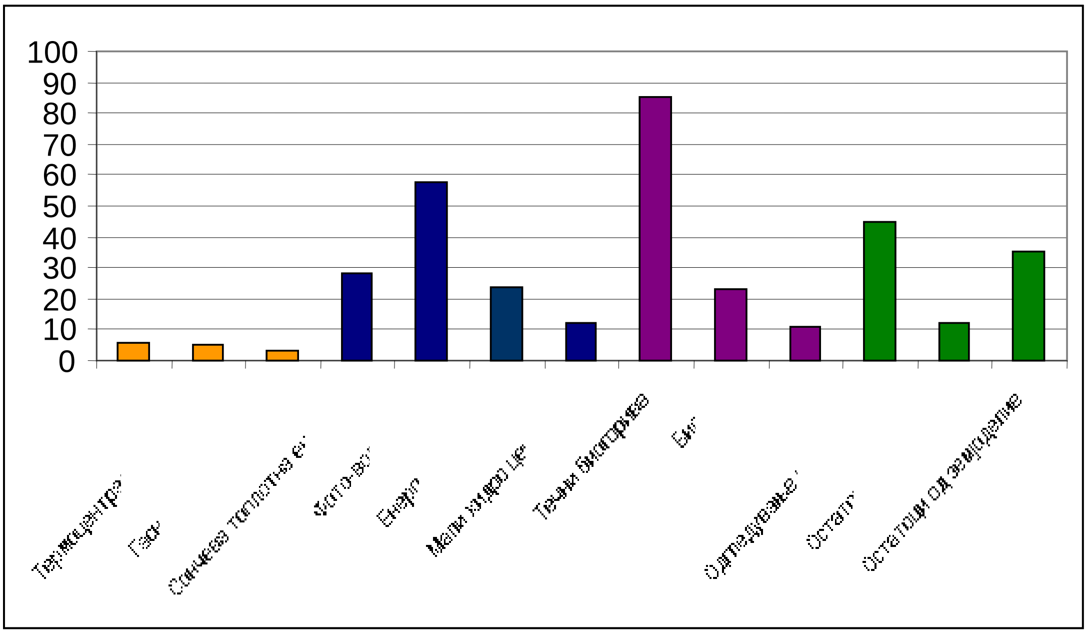
6. Socioeconomic aspects

With the goal of making a complete assessment on biomass as an energy source, socioeconomic aspects must be taken into consideration. The utilization of biomass creates new jobs; it increases local and regional activities and provides additional revenues. In realizing projects for introducing or broadening the use of biomass for energy production, the socioeconomic aspects and environmental impacts must be taken into consideration, so that the actual efficiency of the project can be determined.

Employment

The determination that biomass can create many new jobs is extremely outspread. New jobs are created throughout the entire process of using biomass, starting from its production or procurement, through transportation of biomass to the energy plants, its conversion into energy, distribution and marketing. Biomass usage is one of the labor-intensive sectors among the renewable energy sources. The new jobs that are created vary in levels, from those requiring highly skilled preparations (engineers), to administrative workers and working positions for unqualified workers in the process of production and preparation of the biomass. From the perspective of bioenergetics projects, the term employment includes three different categories. (1)Direct employments, as a result of preparation, construction and production. In regards to bioenergetics systems, this refers to the total employments deemed necessary for cultivating certain crops, construction, operation and maintenance of the plant for production of energy and biomass transportation. (2) Indirect employments are jobs that are created in the accompanying sectors, that are linked to the chain of biomass usage, such as equipment production, maintenance, services, and etc. (3) Lastly, there are so-called induced jobs, created for a longer period of time as a result of the successful realization of biomass projects, that push forward others in considering investing in this sector. Picture 34 shows which job positions are required in energy projects for 100GWh.

Picture 34 Job positions required for production and maintenance for 100GWh



Rural development

Bioenergy is a decentralized option for energy and its use has a positive impact on rural development, by creating businesses and new jobs. In addition, from the social aspect, biomass projects promote rural development in that they maintain the existing jobs in the agriculture and wood industry, they provide possibilities for learning and transfer of knowledge, and they introduce new skills and provide training and educational possibilities. The use of cogeneration plants with small capacities enables using the biomass that is accessible in rural areas, and thereby enables development of a new industry for the rural areas.

Health

By replacing fossil fuels with fuels obtained from biomass, the amounts of harmful substances and greenhouse gas generations are reduced. For example, as we all know, the small particles that are generated when the diesel in the motor vehicles driving around the cities is incinerated can cause the number of respiratory diseases to increase. However, using old methods of biomass incineration in energy production plants can also generate particles that are harmful to human health. Therefore, it is very important that attention be given in selecting a technology that will be used for biomass incineration. Contemporary technologies, in most part, reduce the generation of these particles. Even older technologies for incineration, with relatively low investments, can achieve an appropriate level of control on the generation of these particles, thereby meeting the EU standards on emissions of harmful substances into the atmosphere. For the crops that are being cultivated for obtaining biomass, very small amounts of agrichemicals are used. This can be used in reducing the amounts of agrichemicals per hectare, through good management of the cultivation of various types of crops. The current way in which wood biomass is used, i.e., firewood, by thousands of families, also causes health problems to the local population as it generates smoke and carbon monoxide, whereas contemporary furnaces using biomass as fuel, be it biodiesel, bioethanol, biogas, pallets or chips, do reduce the harmful effects to human health.

Economic development

Using biomass as fuel in small plants or furnaces for heating individual houses and facilities, such as schools or hospitals, or for drying certain products, heating greenhouses or heating livestock farms, very often contributes to reducing energy costs. Using biomass in large plants that provide central heating, electricity for individual needs or for selling, or liquid biofuels that are used for transportation, contributes to lower fossil fuel dependence, but also to the economic development of the region, as they produce a new product, in particular, create higher added value. For example, in the wood industry, by using biomass in the process of wood drying, energy costs decrease and the capacity for drying the wood increases leading to higher added value of the processed wood.

By respecting the principles of energy efficiency and sustainable usage of energy sources, and applying measures for environmental protection, from the economic development perspective, the use of biomass for production of energy is one of the factors contributing significantly to higher economic development. The use of biomass greatly contributes towards realizing the following macroeconomic development goals:

- increased production of goods and services (increased GDP),
- increased employment (biomass is an extremely work-intensive technology),
- stable energy prices on the free market, as biomass is a local energy source not attached to global influences
- decreased import, in particular improved trade balance

The increased usage of biomass from various sources, in the long-term, can provide relatively large quantities of energy at fixed prices. The use of biomass for energy implies that energy costs (mainly heating energy) are also kept locally, more specifically, that the financial funds circulate at the local or regional level. In this way, risks are minimized in regards to increasing energy prices, which are directly linked to global changes and prices. Smaller energy plants, which are of local and regional significance, succeed in returning their investments for a relatively short time and impose small risks for investors. In places where new technologies are applied, knowledge and experience are not concentrated only in one place, but is rather disbursed among numerous domestic professionals, which leads to increasing the level of technical and scientific culture of the community.

Social dimension

Social implications arising from biomass usage can be divided into two categories, those regarding the increase in living standards and those regarding the increase of social cohesion and stability. Introducing one type of energy source that leads to new employments, and by those new revenues in a specific area, could have an influence on various social and cohesion trends in the local or regional community (higher unemployment rate, rural depopulation etc.). Certain rural settlements, even more, areas in the East Planning Region, are endangered by the high rate of migration, which questions even their physical existence, because the number of inhabitants is below the biological sustainability. Therefore, considering the importance of biomass for rural areas, even bionenergy plants with a fairly low capacity can have a positive influence on the rural labor market, by direct employments and thorough the support to accompanying economic branches. In this respect, energy supply is no more a source for impoverishment of certain areas, but rather a source for earning incomes and a factor of social stability, thus creating preconditions for the survival of rural communities.

The realization of biomass projects usually also include measures and activities for raising awareness on the benefits of using biomass. Education and easy access to information on problems regarding the supply of sufficient quantities of energy, climatic changes and generation of greenhouse gasses could increase awareness and encourage companies, communities and also individuals to undertake activities in regards to environmental protection. In the long-term period, this can lead to changes in the attitude of the population and result in changes in the way energy is used, but also to higher investments by the local population in the area of biomass use (changes in the manner of heating). In the past several years, the interest of the local community has been growing in regards to undertaking responsibility for environmental protection. Biomass usage enables numerous opportunities for improving quality of life in rural and in urban areas. For many impoverished regions around the world, where there is no electricity, the use of biomass and obtaining biogas in traditional ways will provide social benefits by providing heat and light.

However, the cultivation of crops for biomass can also have negative social implications, primarily, due to the land that is needed for raising such crops. Even though for the farmers the cultivation of these crops means that everything produced will surely be sold, at relatively stable prices, nevertheless, food prices will rise as a result of the reduced agricultural land that is used for cultivating crops for food and reduced agricultural production. Because of this, careful planning is needed in regards to adapting the agriculture, especially in regions lacking sufficient agricultural land area. Sustainable usage of agricultural land in certain regions, allows for the food needs to primarily be met. Some crops that are cultivated for obtaining various biomass fuels provide cleansing of the contaminated soils by absorbing the heavy metals in the soil.

7. Environmental impacts

The usage of biomass, as fuel for production of energy, entirely satisfies the principles of sustainable development and because of the positive environmental benefits; this type of energy is called "green" energy. The various uses of biomass provide quite a broad spectrum of positive environmental impacts.

One factor pertaining to the key reasons for using biomass in producing energy is the positive impact on the environment, especially in regards to the balance of global greenhouse gas emissions. Nevertheless, biomass production and its use are not entirely neutral in relation to the generation of greenhouse gas emissions. In analyzing the advantages of using biomass, it is necessary to make a comparison with the classic sources of energy. Biodiesel fuels are degraded four to five times faster than classic diesel fuels. For example, using biomass decreases the generation of greenhouse gas emissions in comparison to ordinary diesel. The comparison in CO_2emissions in the production of 1 kg diesel and in production of 1 kg biodiesel, indicates that ordinary diesel emits 4.01 kg CO_{2eqv}, whereas the production and usage of biodiesel emits 0.9126 CO_{2eqv},/kg biodiesel, and 0,314 CO_{2eqv}/ kg residue from rape and 0,42 CO_{2eqv}/kg glycerol. The amount of toxic, cancerous chemical substances produced in the incineration of methyl esters is much lower in comparison to diesel fuels. Acquiring diesel from used vegetable oil greatly reduces air pollution. This primarily refers to the protection of surface and underground waters. At the moment, due to the lack of a communal wastewater treatment plant, the largest part of this type of waste in the East Planning Region finishes in the rivers in which the wastewaters flow into, thereby polluting them and endangering not only the water biodiversity, but also the agricultural land areas. Part of the farmers uses water from surface watercourses for irrigation.

As previously mentioned, currently a large portion of the agricultural waste is burned in the open, namely, at the place where it is created. Even though being neutral from the perspective of carbon dioxide, i.e., the amount of released CO_2 is identical to the amount of CO_2 absorbed during their growth, still the smoke and odor that is formed when this waste is burned does pollute the air. Emissions of harmful gases are generated even in the process of planting, cultivation, harvesting, transportation and biomass processing. The greenhouse gas emissions depend on the method of cultivating and harvesting the plant, the location, method of processing and transportation. Emissions of NOX, i.e., amount of nitrogen, which biofuels contain, are one of the main disadvantages of this type of fuel. These amounts depend on the use of fertilizers that boost the yields of these crops. Nitrogen oxides are gases that cause the greenhouse gas effect 300 times more than CO_2. Table[25] 35 presents the results from the elementary analysis on the composition of the various types of biomass.

Table 35

Element	Chemical symbol and unit measure	Wood chips	Wood crust	Straw	Waste wood
Ash	A % с.м.	0.9	3.5	5.6	**3.2**
Carbon	C % с.м.	50.4	50.31	45.82	**48.28**
Hydrogen	H % с.м.	5.91	5.79	5.38	**5.54**
Oxygen	O % с.м.	42.65	40.12	42.65	**41.53**
nitrogen	H % с.м.	0.12	0.24	0.58	**1.4**
Sulfur	S mg/kg с.м.	242	499	981	**835**
Chlorine	Cl mg/kg с.м.	56	202	3597	**696**
silicon	Si mg/kg с.м.	1317	3936	14791	**4068**
Calcium	Ca mg/kg с.м.	3195	11287	3105	**4846**
Magnesium	Mg mg/kg с.м.	395	1351	867	**994**
Potassium	K mg/kg с.м.	907	2368	6603	**875**
Sodium	Na mg/kg с.м.	61	176	547	**1002**
Zink	Zn mg/kg с.м.	35	115	23	**405**
Lead	Pb mg/kg с.м.	1.1	2.1	0.8	**149.3**

Precaution is needed in using construction wood waste as biomass for energy. This refers to the waste coming from the demolishment of existing facilities, replacing inner and outer carpentry, as well as various wood floors and other construction products. Heavy metals, such as copper, chromium and lead are very often found in the protective applications and paints that are used in the building industry. Therefore, if this type of waste is to be used for incineration in boilers, environmental protection measures must be undertaken, primarily in relation to the handling of the

[25] Development of bioenergy projects and biomass supply, IEA

ashes that remain after incineration, as well as appropriate filters for the exhaust fumes. Table[26] 36 shows the gas emissions of various types of fuel and different technologies for biomass use.

The current method of organic waste treatment, coming not only from the industry but also from households, is in contrary to the contemporary methods used in treating this type of waste. Almost all of the waste ends in landfills and thus causes negative impacts on the environment. With its decomposition, methane is released (CH_4), a greenhouse gas that is 21 times more harmful than carbon dioxide. By using this type of waste, no matter if it\s for obtaining biogas or for incineration, the negative impacts on the environment are greatly reduced.

By acquiring biogas through digestion of wastewater coming from pig farms or from the manure coming from cow farms and poultry farms, the negative environmental impacts are greatly reduced by the farmer method of raising cattle. The pollution of waters occurring because of the current way in which waste waters coming from farms are treated, and the emissions of methane produced with manure decomposition, are all reduced by using the anaerobic digestion technology. In addition, this technology reduces the formation of unwanted odor that is always present in the lagoon type of wastewater treatment.

Bioenergy projects affect the environment throughout the entire process of its realization, from the start of its conceptualization, in particular its development, all the way up to the use of the energy plant. Table 37 presents the environmental impacts created during the construction and operation of a plant using biomass as fuel for production of energy.

[26] Study on DTI URN 03/836 and: Comparing energy systems, special report for World Energy

Table 36

Fuel	Carbon content (%)	Direct carbon emission from incineration		Direct CO_2 emission from incineration		App. life cycle of CO_2 emissions(with production)[27]		Average annual CO_2 emission from heating an average house (20,000 kWh/yr)		
		kg/GJ	kg/MWh	kg/GJ	kg/MWh	kg/GJ	kg/MWh	kg	kg savings compared to oil	kg savings compared to gas
Coal	75	26	94	95	345	**134**	**484**	9680	-2680	-4280
Oil	85	20	72	73	264	**97**	**350**	7000	0	-1600
Natural gas	73	19	69	70	253	**75**	**270**	5400	1600	0
LPG gas	82	18	64	65	234	**90**	**323**	6460	540	-1060
Electricity (plant with large capacity of wood chips)	-	160	576	584	2100	**16**	**58**	1160	5840	4240
Electricity (plant with large capacity of wood chips - gasification)	-	80	286	292	1050	**7**	**25**	500	6500	4900
Wood chips (25% moisture)	37.5	27	96	98	354	**2**	**7**	140	6860	5260
Wood chips (25% moisture) boiler	37.5	27	96	98	354	**7**	**25**	500	6500	4900
Wood chips (10% moisture)	45	26	95	97	349	**4**	**15**	300	6700	5100
Wood chips (10% moisture) boiler	45	26	95	97	349	**9**	**33**	660	6340	4740
Hay –biomass (15% moisture)	38	26	95	97	348	**1.5 to 4**	**5.4 to 15**	108 to 300	6892 to 6700	5292 to 5100
Biogas (60% CH_4 40% CO_2)	56	19	67	68	246	**-**	**-**	-	-	-

[27] Life cycle analysis data from: "Carbon and energy balances for a range of biofuels options" Elsayed, MA, Matthews, R, Mortimer, ND.

Table 37 Possible environmental impacts

Area	Possible impact	Impact – size	Time of occurrence
Air	Dust from movement of motor vehicles Gas emissions from vehicles	Insignificant to small	During construction During plant operation
	Emissions of harmful gases from the plant (dust, NO_X, SO_X and CO)		
Noise	Intensive noise within the construction site and around it	Very small and local	During construction
	Incidental noise around the working area		During plant operation
Surface water	Depending on the location of the facility, a great amount of sediments may settle in the nearby surface waters (if such exist)	small, insignificant	During construction
	During rainfalls, these waters may overflow from the construction site and flow into the nearby surface watercourses		
	During intense rainfalls, the surface waters near the plant could be polluted, due to inappropriate storing of waste or harmful materials	Very small	During construction During plant operation
	Pollution of untreated communal wastewaters	Insignificant when appropriate measures are undertaken	
	Thermal pollution caused by discharging of the water used for cooling	Moderate to significant if control and monitoring are not being performed	During plant operation
Soil and underground water	Higher level of construction site erosion	small	During construction
	Pollution of soil and underground waters caused by leakages of chemicals, fuels and oils	Very small and local. The risk from leakage will decrease if all necessary preventive and control measures are undertaken.	During plant operation
Ash management	Positive impact if it is used as fertilizer	Small to moderately positive	During plant operation

Area	Possible impact	Impact – size	Time of occurrence
Waste and harmful material management	Soil and underground water pollution from fuel, waste and chemicals	Minimum if appropriate waste management is applied	During construction During plant operation
Biodiversity	Habitat and wildlife damage	Small	During construction
Land use	The transformation of the non-agricultural land to agricultural land for cultivating crops for biomass, can have a long-term influence	Moderate to high if control mechanisms are not undertaken and spontaneous development is allowed in this field	During plant operation
	Competition in regards to the land that is needed for cultivating crops for food		
Increased traffic	Risk to the inhabitants (accident) from increased traffic on local roads	Small to moderate with appropriate mechanisms undertaken	During construction During plant operation
	Increased traffic to the plant and the areas from which biomass is collected		

8. Risks and limiting factors

The risks that have been identified, in particular, that exist when using biomass for obtaining energy, can generally be divided into three basic groups. They are as follows:

- Market risks – risks that are out of the entire process of using biomass, but risks that can have an enormous influence on the production of energy,
- operational/business risks – risks within the process itself, i.e., business and
- financial risks– risks within and out of the process.

These risk groups are typical for almost all bioenergetics projects, but the likelihood of a risk to occur and its impact on the life cycle depend on the size of the plant, specifically from the proper sizing of the plant capacities for using biomass for obtaining energy. Nevertheless, the specifics of the region where these plants would be located must not be undermined or ignored. In order to minimize or eliminate the possible influences that an occurring risk can impose, it is necessary to identify all the potential risks that can occur during the realization of a project, but also during the plant operation.

In general, identification can be made of the risks linked to the following factors:

- accessibility/biomass supply,
- quality and biomass content,
- transportation and logistics,
- storing and preparation and
- external environment.

In the realization of projects for utilization of biomass for energy, the risk increases proportionally with the planned capacity of the plant.

From the perspective of minimising or eliminating the possible negative impacts from an occurring risk, a systematical approach must be taken in identification and management of the risks.

Problems in implementation of projects for utilization of biomass

The implementation, more specifically, management of a project for utilization of biomass, includes the following phases: planning, execution and functioning, due to the particularities of these types of projects, some specific points need to be considered regarding the fuel and funds (investment and operational). Based on previous experience, generally, the heating systems that use biomass in most cases are oversized. The size of the system has to be defined in accordance with the size of the facility that is planned to be heated and how old it is, that is, in accordance with the approximation of the heat losses and the amount of heat needed. Oversized systems do not function in the optimal point; they have a high efficiency and higher level of fuel consumption. That is why proper sizing of the biomass systems is so essential, not only from the technical aspect, but also from the economic aspect. A specific aspect for the biomass usage is the storage of fuel. The fuel storage facility has to be properly sized, as an oversized storehouse can cause fuel fermentation, if the fuel is moist and is not used on time. It is typical for the biomass heating system to be used for covering the basic load, whereas existing oil or other type of system (boiler) covers the maximum loads. If 50% of the necessary maximum power were to be installed, they would cover 80% of the total need for heat.

9. Guidelines for development and project concepts

The provision of sustainable development in a particular region, primarily means sustainable utilization of the available resources. The production of energy from renewable energy sources is crucial not only for the development of the energy sector, but also for the entire development of the East Planning Region and for the Republic of Macedonia. The Programme[28] for development of the East Planning Region anticipates measures for promoting the development of this sector.

The limitation of the installed capacity of the energy power plants that use feed-in tariffs for each of the various types of energy are shown in Picture 38.

Picture 38

Power plants	Total capacity for which feed-in tariffs are applied (MW)
Cogeneration thermal power plants on biomass	10
Power plants on biogas from biomass with an installed power of 500 kW	2
Power plants on biogas from biomass with an installed power more than 500 kW	8

The maximum limits of using feed-in tariffs for plants that are using biomass as fuel, are determined based on the (limiting) potential for the entire territory of Republic of Macedonia and is set at 10 MW for the entire system, that is, 2 MW for each individual facility.

One of the limiting factors that needs to be considered in planning the development of this sector are the recommendations for adopting secondary legislation (that is supposed to be adopted in the future), which will need to precisely limit the application of feed-in tariffs only on wood (forest and industrial) and agricultural waste, i.e., to disable the use of firewood for production of electricity (and heat) in cogeneration plants by feed-in tariffs. These limitations due not refer to production of thermal energy.

In accordance with the Strategy for energy development in Republic of Macedonia, the use of biogas is planned to increase in the future, in regards to production of electricity and the use of biomas waste for combined production of electric and thermal energy. Possible construction

[28] S.C.6 Provision of healthy environment in the region, priority: **6.2Sustainable usage and production of energy, measure: 6.2.1 utilization of the potentials for production of energy from renewable sources, Programme: 6.2.1.1** Biomas, wind, sun, geothermal energy (pages 72-74 from the Programme)

includes a total of 5 – 10 MW with an annual production of 25 – 50 GWh until 2020, and 10 – 14 MW with production of 50 – 70 GWh until 2030 година.

The Strategy anticipates the total power of these plants to be 7 – 10 MW until 2020 with a production of 20 – 30 GWh annually, i.e., 10 – 15 MW until 2030 with production of 30 – 45 GWh.

The planned utilization of the biomass for incineration that will be used as thermal energy until 2020 is less than 10% higher than the 2006 consumption, when estimating both the registered and unregistered consumption. For the period until 2020, the unregistered consumption is expected to gradually decrease and pass into the registered consumption. By this, the total consumption for the period 2006-2020 will increase for only 10%, which is at the level of the available potential, even though the registered consumption will rise over 40%. According to the basic scenario of the Strategy for energy development[29], in the year 2020 the consumption of biomass for incineration that will be used as thermal energy will amount to 236 ktoe (2740 GWh).

In the scenario with intensive measures for energy efficiency, pertaining to the Strategy for energy development, the anticipated growth rate in regards to the consumption of biomass for incineration, in the period 2006-2020, is only 5,7%, for the amount of 227 ktoe (2640 GWh) for the year 2020.

The basic scenario of the Strategy anticipates a moderate decline in the consumption of biomass for incineration that will be used until 2030 as heating energy to the amount of 218 ktoe (2540 GWh). The scenario with intensive measures for energy efficiency foresees that, in the year 2030, the consumption of biomass for incineration, for the above-mentioned purpose, will be 226 ktoe (2630 GWh), which is practically the same as the one from the year 2020. The second scenario anticipates a more massive introduction of furnaces for biomass incineration, with a high profitability degree before 2020, whereas the basic scenario foresees a more massive introduction after the year 2020.

When taking into consideration the biomass waste for combined production of electric and thermal energy, then the consumption of biomass for incineration will amount to 244 - 249 ktoe (2840 – 2900 GWh) in 2020. This is an increase of 12-14 % in the consumption of biomass for incineration, for the period mentioned. The total consumption of biomass for incineration is planned at 252 - 258 ktoe (2930 – 3000 GWh) for the year 2030.

In line with the EU Directive 2009/28/EC, the share of renewable energy sources in the consumption of the overall energy in transportation is planned at least 10% for the year 2020. The proclaimed target can be estimated through the share of biofuels in the consumption of petrol and diesel fuels in transport. The forecast for the consumption of biofuels in the transportation of

[29] Стратегија за развој на енергетиката во Република Македонија за период 2008-2020 со визија до 2030, МАНУ, Скопје, 2009

Republic of Macedonia, until 2020, is that the consumption will rise at annual rate of 1 % and in 2020 will amount to 56 ktoe/annually. In fulfilling the obligation of the Directive for the share of renewable energy sources in the overall energy consumption in transport, biofuels will participate in the amount of 48 – 56 ktoe (560 - 655 GWh) until the year 2020. The share of biofuels until 2030 is estimated at a minimum rate of 20% in the total consumption of petrol and diesel fuels in transportation, meaning that their share should amount to 145 – 163 ktoe (1700 - 1900 GWh).

Having in consideration the information from the Strategy, and in accordance to the results of the assessment on the potential quantities of biomass in the East Planning Region that are given in Table 39, and the limitations on using only wood and agricultural residue, i.e., waste for production of electricity, a conclusion can be made that the opportunities for construction of a cogeneration plant in the East Planning Region are limited, not only from the perspective of the available quantities of biomass, but also from the perspective of using the thermal energy throughout the entire year. The economic viability decreases when such a plant functions only in the winter period. In addition, due to the lack of a central heating system in any of the larger settlements, except for Makedonska Kamenica, as well as the current economic situation, plans should not be made for construction of a larger capacity for production of electric and thermal energy, within the next 5-year period.

The results of the 15 capacities that were surveyed from the foodstuff industry show that in 10 of them, the thermal energy, in addition to the heating needs, is also needed for the functioning of the technological process throughout the entire year. The quantities of thermal energy range from 800 to 3500 kW per month, which indicates that they are with small capacities. These quantities increase during the winter months. In the East Planning Region there are no larger industrial capacities demanding larger quantities of electricity for the needs of their technological process.

An analysis has been conducted on the necessary investment funds needed for a cogeneration plant that would operate on forest biomass. The characteristics of the analyzed plant are as follows:

Production:

- electricity 400KW
- warm water for heating 1000 KW

Fuel:

- wood chips with a maximum moisture up to 30%
- fuel storehouse with a capacity up to 10 м^3
- fuel consumption 6000 t/annually

Construction area required for construction of the facility:

- net 20m x 20m = 400 m^2
- gross 35m x 35m = 1225 m^2

Employed:

- one in a shift
- total of 4 employees

Investment costs: 1, 9 million euros (1, 2 million euros extension of existing reservoir).

Table 39

Type of biomass	Electricity GWh	Installed power of power plants MW
Hay from grain products	20	**2**
Corn residue	11	**1**
Rice husk	3	**0.3**
Total agricultural residue	**34**	**3.3**
Waste after cutting	4	**0.4**
Wood processing residue	5	**0.5**
Total from wood residue and waste	**19**	**2**
TOTAL:	**53**	**5.3**

For the purposes of providing economic viability, consumption of thermal energy must be provided throughout the entire year. Current conditions in the East Planning Region do not allow for provision of thermal consumption, primarily, due to the lack of central heating systems in the cities and the lack of larger industrial capacities. The investment costs of the smaller cogeneration plants range from 4500-5000euros/ KW of installed power in power plants. Looking from today's perspective, the installation of this type of plant is not recommended for the East Planning Region. With the development of technologies for utilization of biomass, that is, with the efficiency of these technologies improving, these types of plants will have to be taken into consideration in the future when planning the development of the East Planning Region.

The East Planning Region should direct its potentials for using biomass for production of energy towards the following:

1. **production and utilization of biogas in the livestock farms of the region,**
2. **conversion, i.e., adaptation of the existing heating systems in the region's public facilities for using biomass (wood chips or pellets) for the production of thermal energy, as well as for production of chips or pellets and**
3. **cultivating crops suitable for production of biodiesel.**

Investments are needed for the development of a particular sector. Several pilot projects need to be implemented in order to support investments in this sector, in which the municipalities would be involved and the Center for Development of the East Planning Region. These projects will demonstrate the benefits from using biomass not only to the investor, but also to the wider community. At the same time, public awareness needs to be raised in regards to the benefits of using biomass for obtaining energy, by conducting a continuous public campaign that would be more informative in the beginning phase, and later with the implementation of the pilot projects and results perceived, would be focused on presentation of results, so as to attract investments.

Through the implementation of the pilot projects, initial experience and the knowledge necessary for the development of this sector will be acquired. This Study has identified seven projects, for which key activities have been defined and tasks divided for performing those activities, timeframe has been developed, an assessment has been made on the project budgets, and identification has been made on the possible risks and restrictions. Indicators have also been defined so that the success of each project can be monitored. The following projects are proposed:

1. Completing and expanding the project for production of biodiesel in the Municipality of Probistip.
2. Project for production of wood chips.
3. Project for production of pellets.
4. Transforming a boiler from an existing central heating system in a municipal building/and or public facility (wood chips fuel)
5. Transforming a boiler from an existing central heating system in a municipal building/and or public facility (fuel pellets - wood or combined).
6. Prefeasibility study for direct combustion of biomass in the existing thermal power plant in Makedonska Kamenica in combination with coal.
7. Feasibility study on biogas in Berovo pig farm (or feasibility study for using biogas in the poultry farm in the village of Morodvis).

The project concepts are attached in Annex 5, separately for each project of the proposed pilot projects

10. Plan for implementation of a public awareness raising campaign

The use of biomass for production of energy contributes to improving the environment, as well as in creating conditions for sustainable development. The implementation of the projects in this area usually depends on several factors. With the goal of providing sufficient quantities of biomass, especially biomass coming from agriculture, measures must be undertaken for raising awareness on the benefits of this type of biomass usage, and for a campaign that will enable all stakeholders to define and realize their own interests in the entire process. In addition, it is important that support be given to the private initiative in this sector, to achieve cost-effectiveness in the future production of appropriate fuel (pellets or wood chips). With the implementation of the pilot projects and presentation of their results, it is reasonable to expect that they will initiate a certain number of private initiatives for adaptation of the existing central heating systems or other types of heating systems in private facilities.

The citizens, and people around the world do react to changes that influence there everyday habits and practices. It is normal to want to know why such changes are being made, what outcome is expected for the citizens, as well as for the society as a whole, what are the benefits and other similar questions. The citizens in the East Planning Region are no exception. In general, conducting a public awareness raising campaign is crucial for building the public trust, as well as for raising the awareness on public active participation in the activities and measures planned for the process of using biomass in production of energy. The Center for Development of the East Planning Region should undertake activities for production, organization, coordination, public promotion and distribution of a media educational public campaign. The existence of various groups and needs, as well as different and changing situations all requires the campaign to be adjusted and focused towards realization of the objectives. The public campaign should be conducted through the institutions, organizations, the educational system and the NGO sector, including the media (electronic and printed).

The success of the entire campaign depends on all these factors. With the aim of ensuring long-term results of the campaign, it is especially important for the competent institutions and organs to visit the target groups, and include the educational institutions from the very beginning.

PLAN FOR IMPLEMENTATION OF ACTIVITIES

The entire campaign should be coordinated by the Center for Development of the East Planning Region and is proposed to be implemented in the following manner:

1. contacts and training for all stakeholders,
2. coordination of all stakeholders,
3. provision of promotional material in the area of biomass (guidelines, manuals, flyers, brochures),necessary for bringing the biomass area closer to the target groups,
4. educational campaign of target groups,
5. informing and engaging the local media on the public campaign, with a special focus on following the projects that are being implemented and results achieved,
6. preparation and presentation of reports and
7. organizing public debates, debate shows, expert lectures, and press conferences.

The success of a campaign depends on many factors. Effective planning is the key to the success of a project, and by that to any public campaign. Therefore, a separate project needs to be prepared with a budget and timeframe for the realization of the public campaign. The project should include the following activities:

- defining a slogan;
- organizing public debates;
- preparation of printed material for distribution. This material includes:
    - flyers
    - brochures with frequently asked questions and
    - questionnaires,
- promotional video clips for broadcasting on local television stations;
- information and texts in printed media;
- radio jingles for broadcasting on local radio stations;
- maintaining good relations with the local and national media and using every opportunity possible for sending information to the press, organizing press conferences, etc.;
- establishing and promoting a “Bioenergy Day” in the region;
- preparation of a database;
- design of a web page and
- using the web page as a tool for achieving the highest possible transparency in relation to the projects being implemented.

11. Project implementation timetable

P.бр.	Project	Location	Proposed time for realization (year)	Project beneficiary	Comments
1	Completing and expanding the project for production of biodiesel	Probistip	2011	CDEPR and ULSG Probistip	/
2	Project for production of wood chips	Malesevija	2011-2012	CDEPR and ULSG	Parallel realization with project no. 4, app. same time of project completion
3	Project for production of pellets – two sub-projects	Pehcevo Cesinovo - Oblesevo	2012-2014	CDEPR and ULSG	Parallel realization with project no. 5, app. same time of project completion
4	Transforming a boiler from an existing central heating system in a municipal building/and or public facility (wood chips fuel)	Berovo	2011-2012	CDEPR and ULSG	Parallel realization with project no. 2. After its completion it can be replicated in other ULSG
5	Transforming a boiler from an existing central heating system in a municipal building/and or public facility (fuel pellets - wood or combined).	Pehcevo (1) Kocani (2)	2012-2014	CDEPR and ULSG	Parallel realization with project no. 2. after project completion it can be replicated in the other ULSG

Р.бр.	Project	Location	Proposed time for realization (year)	Project beneficiary	Comments
6	Prefeasibility study for direct combustion of biomass in the existing thermal power plant in Makedonska Kamenica in combination with coal.	Makedonska Kamenica	2012	CDEPR and ULSG Makedonska Kamenica	To wait for the results from the feasibility study that is being prepared
7	Feasibility study on biogas in Berovo pig farm (or feasibility study for using biogas in the poultry farm in the village of Morodvis).	Berovo or Zrnovci village of Morodvis	2011-2012	Private sector	/

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List of abbreviations and acronyms

EPR	East Planning Region
CDEPR	Center for development of the East Planning Region
EU	European Union
EC	European Commission
RM	Republic of Macedonia
CEPP	Cogeneration energy production plant
OG	Official Gazette of Republic of Macedonia
MEPP	Ministry for Environment and Physical Planning
MASA	Macedonian Academy of Science and Arts
SWOT	Strength, weaknesses, opportunities, threats
IWM	Integral waste management
NPWM	National Plan on waste management
SWM	Strategy for waste management
CCCB	Cycle of cultivating crops for biomass
RES	Renewable energy sources
ULSG	Units of local self-government
PF	Pig farm
PF	Poultry farm
CF	Cow farm
DM	Dry matter
HS	Hydro system
EEA	European Environment Agency
SD	Sustainable Development

Units of measurement

	MJ	kWh	koe	Mcal	Nm^3
1 MJ	**1**	**0.278**	**0.024**	**0.239**	**0.029**
1kWh	**3.6**	**1**	**0.086**	**0.86**	**0.107**
1koe	**41.87**	**11.63**	**1**	**10.01**	**1.25**
1Mcal	**4.187**	**1.163**	**0.1**	**1**	**0.125**
1Nm^3	**33.50**	**9.306**	**0.80**	**8.00**	**1**

Chemical symbols

CO carbon monoxide

CO_2 carbon dioxide

CO_2-eqv. carbon dioxide equivalent

CH_4 methane

N_2O nitrous oxide

Nox nitrogen oxide

SO_2 sulfur dioxide