UNIVERSITY OF LJUBLJANA
SCHOOL OF ECONOMICS AND BUSINESS

UNIVERSITY OF SARAJEVO
SCHOOL OF ECONOMICS AND BUSINESS

MASTER'S THESIS

AN ASSESSMENT OF THE POTENTIAL FOR WOOD BIOMASS PRODUCTION IN BOSNIA AND HERZEGOVINA WITH A SPECIAL EMPHASIS ON SOCIO-ECONOMIC IMPACT

Ljubljana, February 2020 ADIN BACKOVIĆ

AUTHORSHIP STATEMENT

The undersigned Adin Backović, a student at the University of Ljubljana, School of Economics and Business, (hereinafter: SEB LU), author of this written final work of studies with the title "An assessment of the potential for wood biomass production in Bosnia and Herzegovina with a special emphasis on socio- economic impact", prepared under supervision of Professor Sabina Silajdžić, PhD.

DECLARE

1. this written final work of studies to be based on the results of my own research;

2. the printed form of this written final work of studies to be identical to its electronic form;

3. the text of this written final work of studies to be language-edited and technically in adherence with the SEB LU's Technical Guidelines for Written Works, which means that I cited and / or quoted works and opinions of other authors in this written final work of studies in accordance with the SEB LU's Technical Guidelines for Written Works;

4. to be aware of the fact that plagiarism (in written or graphical form) is a criminal offence and can be prosecuted in accordance with the Criminal Code of the Republic of Slovenia;

5. to be aware of the consequences a proven plagiarism charge based on the this written final work could have for my status at the SEB LU in accordance with the relevant SEB LU Rules;

6. to have obtained all the necessary permits to use the data and works of other authors which are (in written or graphical form) referred to in this written final work of studies and to have clearly marked them;

7. to have acted in accordance with ethical principles during the preparation of this written final work of studies and to have, where necessary, obtained permission of the Ethics Committee;

8. my consent to use the electronic form of this written final work of studies for the detection of content similarity with other written works, using similarity detection software that is connected with the SEB LU Study Information System;

9. to transfer to the University of Ljubljana free of charge, non exclusively, geographically and time-wise unlimited the right of saving this written final work of studies in the electronic form, the right of its reproduction, as well as the right of making this written final work of studies available to the public on the World Wide Web via the Repository of the University of Ljubljana;

10. my consent to publication of my personal data that are included in this written final work of studies and in this declaration, when this written final work of studies is published.

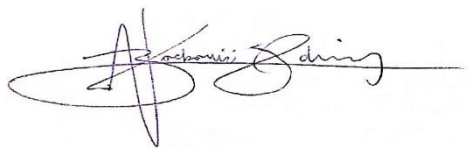
Ljubljana, 05 February 2020 Author's signature: 

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

B&H – Bosnia and Herzegovina

RS – Republic of Srpska
FBiH – Federation of Bosnia and Herzegovina
HB – Herceg Bosna
EU – European Union
USA – United States of America
OECD – Organization for Economic Cooperation and Development
CO2 – Carbon Dioxide
MW – Megawatt
USAID – United States Agency for International Development
UNDP – United Nations Development Programme
EJ – Exajoules
UK – United Kingdom
MMT – Million Metric Tons
UN – United Nations
GDP – Gross Domestic Product
TJ – Terajoules
PJ – Petajoule
km2 – Square kilometre
m3 – Cubic metre
ha – Hectare
PLC – Programmable Logic Controller
S&T – Science and Technology
PCW – Post-consumer wood
KM – Bosnian Convertible Mark

INTRODUCTION

One of the most important factors of economic development of any country and prerequisite of any economic activity is energy, with sustainable access to energy resources being an essential component of sustained economic growth. Economic growth and the subsequent increases in the wealth of a society directly impact volume and patterns of energy consumption. Following positive growth trends, predictions and scaling of economic activities on a global level, total energy consumption in the world, between 2012 and 2040, is expected to increase by 57% (U.S. Energy Information Administration, 2016). More specifically, the consumption of energy in emerging market economies, which are non- Organization for Economic Cooperation and Development (hereinafter: OECD) member countries, will increase by an estimated 71%, while it is estimated that energy consumption of OECD member countries will grow by 18% over the same period (U.S. Energy Information Administration, 2016).

Considering the necessity of securing the zero net carbon dioxide emissions in the near future among industrialized countries, the need to engage into collective policy action to foster energy production from alternative sources including renewable has become an imperative (U.S. Energy Information Administration, 2016). Over the last decade there has been significant increase in the use of energy derived from renewable sources. With an annual increase of 2.6%, renewable energy sources and nuclear power plants are the most rapidly growing energy sources. This trend can be explained with the expected increase in prices of energy derived from fossil fuels, growing emissions of the greenhouse gas during the production of fossil fuel energy and growing fossil fuel risk of dependence. However, it has been predicted that 84% of total energy produced in the world by 2040 will still be from the fossil fuels.

Sources of renewable energy can be found in unlimited quantities (Gradski ured za gospodarstvo, energetiku i zastitu okolisa, 2012). In theory the renewable energy is unlimited, for example, if suitable technology would exist, energy sources which are renewable would satisfy all the energy needs of the Earth.

In the world, the electric energy is mostly generated from fossil fuels (coal 39%, natural gas 20% and oil 7%), next to this, significant share of electrical energy generation has also hydro energy and nuclear energy which account for 16% (Doleček & Karabegović, 2013). Significance of hydro energy and nuclear energy is mostly due to the big conventional hydro power plants. All other non- conventional energy sources have only 2% of share in the world's electrical energy generation. It is important to note, that in recent years, these non- conventional sources of energy have seen significant development and growth.

When it comes to all of the other energy sources, biomass has 62% of share, which is by far the most represented share (Doleček & Karabegović, 2013). Wind energy follows biomass with a share of 22% and geothermal energy has its share of 15%. Some energy sources such as tidal energy, solar radiation energy and other forms of energy are insignificant at the present, due to their poor direct usage. However, it is worth to mention that many scientific researches are being made in the field of technological advancement and development in order to increase the use of these energy sources more efficiently and effectively.

Countries of the European Union (hereinafter: EU), especially Germany, are striving for the further development of renewable energy sources (Doleček & Karabegović, 2013). When it comes to the share in primary generation of energy, it is evident that wood biomass has the biggest share, which is mostly used for heat generation. Next to the biomass, hydro energy follows, which is mostly used for electricity generation. In regards to hydro energy, it can be said that it has the biggest share in the generation of electrical energy, mostly through big hydro power plants. When it comes to current trend of technological development, manufacturing and investment costs, mainly wind power plants and solid biomass power plants (wood pellets, biogas and wood) have the biggest share in the total electrical energy generation (AEBIOM, 2017). Since 2011, the global wood pellets market has an average increase rate of 14% per year. This means that many countries have started producing pellets and using this type of renewable energy source. This has also led to the increase of global wood pellets trade (Thrän, Peetz & Schaubach, 2017).

In recent few years there has been a rising interest in distributed production from renewable energy sources (Doleček & Karabegović, 2013). This rising interest appeared mainly due to the factors such as reducing emission of Carbon Dioxide (hereinafter: CO2), more rational energy use or energy efficiency programs, suitable national energy systems, energy sources diversification and many others. The interest for the implementation of new generating installations is mainly due to the environmental impact factor. Countries that are the part of Kyoto Protocol are required to reduce greenhouse gases emission, for example, countries of the EU are committed to reduce greenhouse gases emission by 8% even though the requirement for developed countries is by about 5%. Hence, the rising interest for renewable energy sources is present in many countries.

One of the most important factors for the development of any country, including Bosnia and Herzegovina (hereinafter: B&H) is energy (Doleček & Karabegović, 2013). Economic and industrial progress is not possible if the policies regarding energy sector of a certain country are not adequate. It can be said that the energy sector is only a ‘tool’ for a certain country to achieve ultimate goals such as clean environment, health of population,

sustainable economy, good living standards and prosperity. EU regards investments in renewable energy sources as essentially congratulatory with sustainable development.

B&H is a very suitable country when it comes to investing in energy efficiency, because in a short period of time, if the current situation of the country is taken into account, B&H has a great potential to generate multiple profits and secure great revenues (Doleček & Karabegović, 2013). Waters are exploited in B&H via hydro power plants; therefore, country is able to generate electrical energy. On the other hand, vast amount of coal is used in order to construct thermal power plants. Thermal and hydro power plants are main sources of primary energy in the country (62% of total primary energy consumption). Theoretically the potential of hydro energy in B&H is around 8,000 Megawatt (hereinafter: MW), 6,800 MW is the technical and 5,800 MW the economic potential. The current installations for hydro energy generation can provide 2,052 MW or, in other words, 53% of the total energy generated which, regardless of how it is greatly unused (around 37% of the total economic potential), clearly indicates the great hydropotential of B&H.

When it comes to the structure of the energy consumption in B&H, coal has predominant place in this structure which is around 45.3%, followed by fluid fuels and wood mass which account for 21% and 20.5% (Doleček & Karabegović, 2013). Forms of energy such as natural gas, electrical energy which is imported and hydro energy participate in this structure of the total energy consumption with around 13.1%. There are vast amounts and opportunities for exploitation of renewable energy sources in B&H. The biggest potential, when it comes to renewable energy sources usage, lies in energy generated by the energy of biomass, geothermal energy, wind and solar energy. B&H is characterized by losses when it comes to process of distribution, generation and consumption of energy.

Many factors indicate that it is a great time to change the existing paradigm in the energy sector of B&H (Doleček & Karabegović, 2013). Since B&H is in the process of signing the international agreements and integrating to the EU, it is a perfect opportunity to follow the current trends of the EU and guarantee sustainable development by using this chance to administer reforms.

The purpose of this thesis is to look more closely at the potential of wood biomass production in B&H. Specifically, the potential of production of wood biomass will be analyzed from the local community and industry-specific perspective. In addition, the identification of main barriers and challenges relating to current trends, scope and characteristics of biomass production in selected municipalities will serve as a basis to explore and analyze important issues that may hinder the potentials for biomass production scaling and growth. Finally, an attempt will be made to develop a conceptual framework to address the socio-economic impact of wood biomass production in this country, hence,

explore how this economic activity may affect and shape various social processes. The principal objectives of this master's thesis are:

- to present a comprehensive analysis of what wood biomass is and to identify its advantages and disadvantages;
- to assess and identify the potential for wood biomass production in B&H based on earlier assessments of available quantities of biomass in B&H and systematic literature review;
- to present institutional and regulatory framework related to wood biomass production;
- to identify key barriers to mobilization and sustainable use of biomass production in B&H;
- to assess local business potential, employment opportunities and industry growth based on an assessment of firm internal capabilities and industry's external environment.

In this master thesis, we used the literature review method in order to identify the potential for wood biomass production in B&H. The same method was used to analyze previous research made on use of wood biomass and the possible use of wood biomass in B&H. Next, we surveyed the literature and gathered relevant data and information related to the plans of biomass management in Federation of Bosnia and Herzegovina (hereinafter: FBiH) and in Republic of Srpska (hereinafter: RS). We briefly reviewed key strategic documents relating to entity government's orientation, mainstreaming and assessment of (possible) use of wood biomass in B&H.

The potential for wood biomass production and assessment of potential socio-economic impact was based on local companies survey. The selection of areas (municipalities) was based on literature reviews which are based on criteria of local communities identified in earlier wood biomass studies. For this part of the thesis the qualitative analysis was conducted. This qualitative analysis includes semi-structured interviews with management of existing biomass producers in selected municipalities.

Apart from primary data collected for the purposes of this analysis we used secondary data on wood biomass collected from organizations such as United Nations Development Programme (hereinafter: UNDP), United States Agency for International Development (hereinafter: USAID), international organizations and from various reliable publications. We gathered and analyzed secondary data and information in order to examine the strengths and weaknesses of the wood biomass, and its possible positive or negative socio-economic impact in B&H.

The thesis is organized in the following way. The first chapter of this thesis provides definitions of bioenergy, biomass resource and wood biomass based on theoretical views. Next to this, first chapter presents social and environmental dimensions of bioenergy as

well as advantages and disadvantages of wood biomass. The focus of the second chapter is on socio- economic impact of wood biomass production in rural areas and health benefits achieved through the use of wood biomass. In the third chapter, vast forest resources and biomass potentials in B&H are presented. Also, in this chapter of this thesis, through the analysis of institutional and legal framework, problems related to forest management and utilization of wood biomass are presented. In the fourth chapter, analysis was made in order to assess the potential for the expansion of further production of wood pellets in B&H. This chapter of the thesis summarizes the main findings of the qualitative research on current pellet production performance and its future potentials, based on analysis of internal and external environment of pellet producers. In this part of the thesis, the main information and data was gathered through in-depth interviews with three representatives of market leading pellet producing companies in B&H. Last chapter describes the pellet industry's growth potential and socio-economic benefits. Conclusion section presents the main findings of our analysis where certain recommendations were given.

1 BIOMASS AS A RENEWABLE ENERGY SOURCE

Energy can be found anywhere, any matter that is alive has some form of energy stored in it, ranging from plants to animals (Rinkesh, n.d.). This energy comes in the form of carbohydrates which include cellulose, sugar and starches. The process of photosynthesis is responsible for the production of carbohydrates. It is possible to generate energy from organic matter, which refers to animal and plant remains and its waste left in the environment. One way to harness energy from organics matter is by creating biomass energy.

Biomass is defined as a renewable and sustainable source of energy which is extracted from organic matter (Rinkesh, n.d.). This form of renewable energy can be used to produce many different forms of power, such as electricity. Many materials such as forest debris, some forms of waste residue, scrap lumber and many other can be used to develop biomass fuel.

The energy that biomass contains is the direct product of the sun; therefore, this is one of the reasons why biomass is considered as a renewable source of energy (Rinkesh, n.d.). Essentially, an organic material made from animals and plants is considered as biomass. When the process of photosynthesis occurs, chlorophyll which is present in plants, absorbs the suns energy by converting the carbon dioxide, which is present in air and water found in ground, into carbohydrates. By burning these plants, the same kind of energy, which was captured form the sun, is released into the air. In other words, in this process, the animals and plants which are burned turn back into water and carbon dioxide, and the captured energy from the sun is released. Therefore, biomass is considered as a renewable energy source because human kind can always produce more plants and crops and with

this, the waste will always be present. It can be said that renewable energy will last forever as long as biomass is produced. Different types of biomass exist, such as wood chips, pellets, plants, corn, crop residues and many other.

Chemical energy is an integral part of biomass; hence, biomass is a perfect renewable energy source that could be used for the production of heat energy (Rinkesh, n.d.). More precisely, when wood is being burned (wood is considered as a biomass fuel), chemical energy, which is an integral part of wood, is released and later on transformed into heat energy. This chemical energy that the wood contains can be further exploited in order to produce electricity. Burning wood can also produce steam which can be used in order to produce this kind of energy. It is important to note that when biomass is used, reduction in landfills and the reduction of waste occurs. Also, people turn to the biomass alternative because it is less expensive when the costs of fossil fuels increase.

One of the most positive facts about the biomass is that it does not contribute towards global warming (Rinkesh, n.d.). As it is well known, plants receive carbon dioxide and later on release oxygen in the air. When plants decompose and when these plants are burned, carbon dioxide is released. However, when these same plants are planted again, they use CO2 which was previously released by the burnt plants. It is clear to say that, if the plants which were burnt are not replaced with the new plants, the biomass does contribute towards global warming.

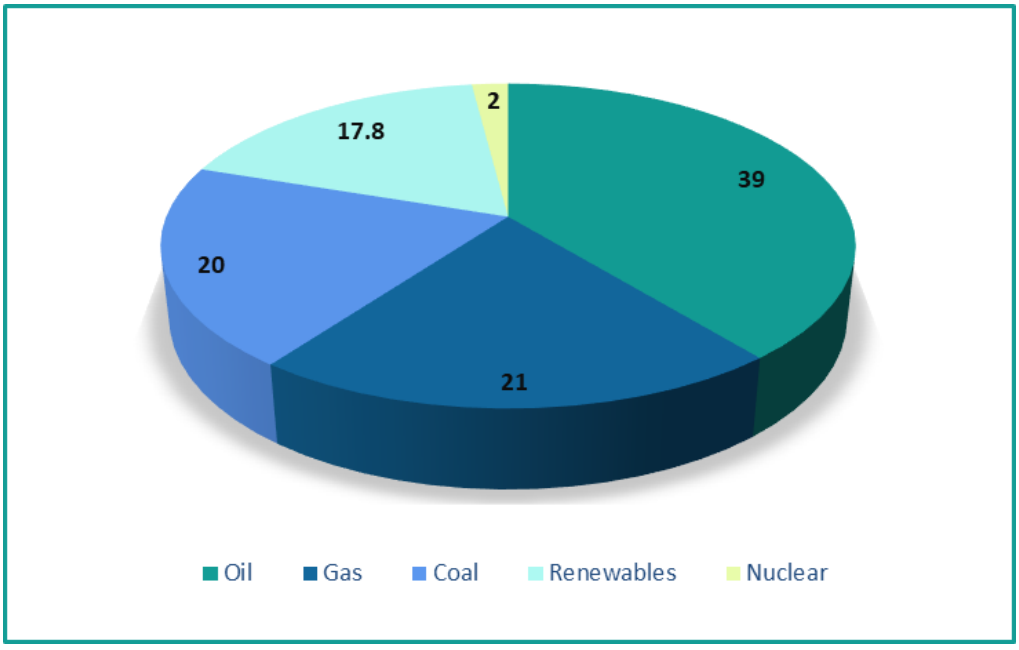
Biomass is considered as a renewable energy source because of two main reasons: waste from plants and animals will always be present and biomass power is carbon neutral (Rinkesh, n.d.). Firstly, it is evident that many countries in the world are making policies which are very strict when it comes to the management of forests, this can only mean that the supply of trees is going to increase. Following simple logic, human kind will always need food in order to survive; therefore, crops and the waste from these crops will be available for a long period of time. Secondly, as mentioned above, biomass power is carbon neutral.

Today, the application of biomass for energy production is taking into account the principles of sustainable development (Đonlagić, 2010). The most commonly used is wood mass that is formed as a by-product or waste and residues that can no longer be utilized. Such biomass is used as fuel in the plants for production of electricity and thermal energy or processed into gaseous and liquid fuels for use in vehicles and households. There are various estimates of the potential and role of biomass in global energy policies in the future, but in all of the scenarios, significant growth and significantly more important role of biomass is predicted. For comparison, it can be noted that in 1990, energy consumption in the world amounted to 376.8 Exajoules (hereinafter: EJ) and in 2050, according to various scenarios, the consumption will rise to 586-837 EJ.

Many countries in the world are abundant with forests, and are covered with vast forested areas, which, if managed sustainably, can produce huge quantities of materials that can be used for the production of renewable energy sources, such as electrical energy or heat (Food and Agriculture Organization of the United Nations, 2004). Bioenergy as a term, refers to any source of energy which is obtained from biological materials or biofuel, i.e. biomass (Ladanai & Vinterbäck, 2010). With the use of bioenergy, reduction of greenhouse gas emissions per produced energy unit is possible. The production of biomass offers possibilities for the creation of new jobs, rural development advancements and for promotion of sustainable management of natural resources (Ladanai & Vinterbäck, 2010).

The gross final energy consumption of energy sources in 2017 increased by 2% in the world when compared to 2016 (World Bioenergy Association, 2019). Most of the energy consumed globally comes in the form of oil and oil products followed by gas, coal, renewables, and nuclear energy. Fossil fuels combined accounted for 80% of the energy consumption globally in 2017. Global gross final energy consumption is presented in Figure 1.

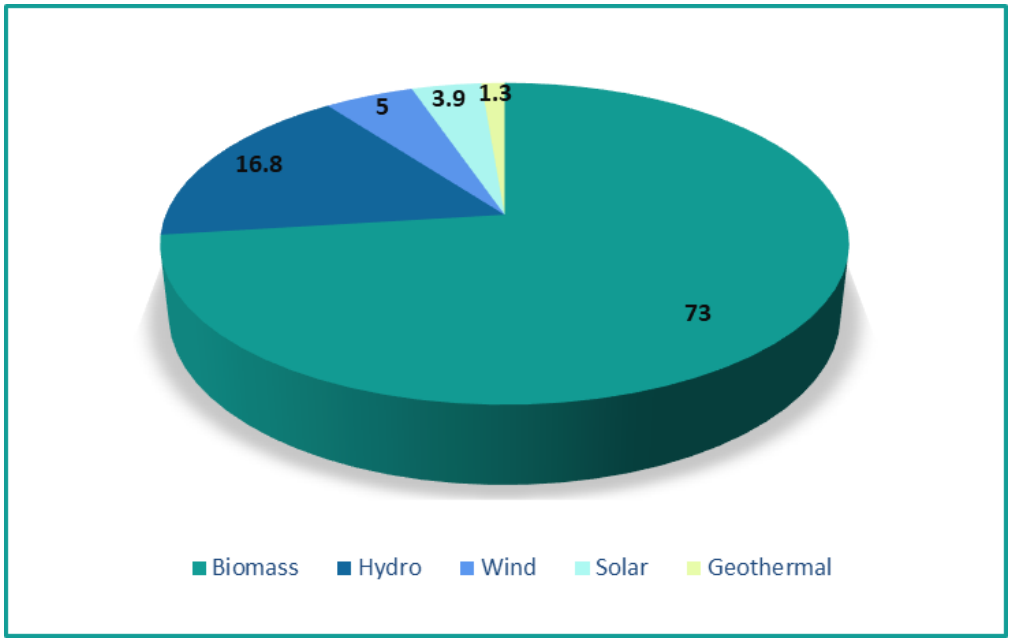
Figure 1: Gross final energy consumption globally in % (2017)



Source: World Bioenergy Association (2019).

As can be concluded from Figure 1 above, the share of renewables consumption was 17.8% (World Bioenergy Association, 2019). When it comes to the share of renewable energy sources in the world's gross final energy consumption, biomass has by far the biggest share, followed by hydro, solar energy, and geothermal energy. Gross renewable energy consumption in the world is presented in Figure 2.

Figure 2: Gross final renewable energy consumption globally in % (2017)



Source: World Bioenergy Association (2019).

1.1 Bioenergy in general

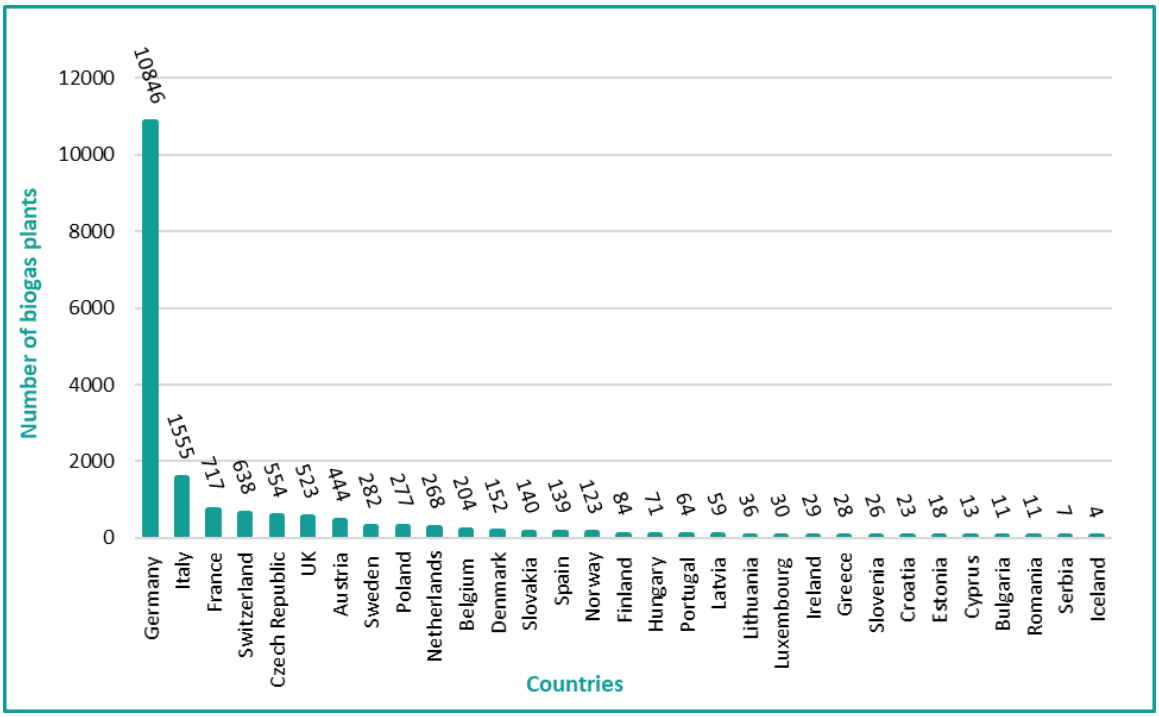
Energy which is obtained through the use of solid, liquid and gaseous biomass products is defined as bioenergy (European Parliament, 2015). As mentioned in the previous part, biomass is a renewable source of energy, and it is made up of numerous products of plant and animal origin. This renewable source of energy can be directly converted into combustion energy and thus produce water vapor for heating in industry and households and to obtain electricity in small thermal power plants. Fermentation in alcohol is the most advanced chemical conversion method of biomass. Biogas produced by fermentation without oxygen present contains methane and carbon, and can be used as a fuel, while other modern biomass energy uses include pyrolysis, gasification and hydrogenation. The main advantage of biomass compared to fossil fuels is lower emissions of harmful gases and wastewater. Additional benefits are disposal and exploitation of waste and residues from agriculture, forestry and wood industry, reduction of energy imports, investment in agriculture and underdeveloped areas and increased security of energy supply. It is predicted that by mid-century the world's biomass share in energy consumption will be between 30 and 40 percent. In 1998, for example, Sweden received 18% of energy from biomass use, and Finland by 10%. According to European Parliament report, biomass energy production will increase by approximately 28% till 2020.

There are three main sources of bioenergy. Those are: biogas, bioliquid and solid biomass (Fletcher, 2017). Biogas is the product of anaerobic fermentation of organic waste,

especially agricultural (containing about two thirds of methane and one third of carbon dioxide), and is used as a fuel.

Biogas can be found mostly in garbage dumps, large farm mops and many other. Nowadays, in Europe, there are approximately 17,376 biogas power plants (Fletcher, 2017). In 2015 the number of these power plants increased to around 3% or, in other words, 542 new powerplants. In many countries the increase in power plants was very significant. For example, in United Kingdom (hereinafter: UK) the increase was recorded to around 77 new power plants (17% growth), in Belgium to around 20 new power plants (11% growth) and in Netherlands to around 16 power plants (6% growth). In 2015, the total amount of energy produced (electricity) in Europe, from biomass power plants amounted to 60.6 terawatt hours. Furthermore, the energy produced is matched to the annual consumption of 13.9 million European households. Currently in Europe, Germany and UK are considered to be the largest producers of biogas.

Figure 3: Biogas plants in Europe in 2015



Source: Fletcher (2017).

Bioliquids are various alcohols or oils which are considered as good substitutes for classic liquid fuels (Flach, Lieberz, Rondon, Williams & Wilson, 2016). Bioliquids are mostly suitable for the use in existing internal combustion engines. Biofuels are made up of two distinct sectors: ethanol (also known as bioethanol) and biodiesel fuel. Bioethanol is used as an additive for gasoline engines and biodiesel as an additive for diesel engines. Some engines allow the use of pure ethanol or biodiesel, but this is limited by state regulations. In EU, the production of bioethanol peaked to around 5.3 billion liters in 2014. Restrictive regulations regarding the imports and the low feedstock prices are two main factors from

which the sector of bioethanol production has benefitted. However, even though the production of bioethanol has expanded, the consumption of this good has fallen. The end result of this in 2014 is the self- sufficiency of the EU when it comes to bioethanol. The bioethanol market was very much balanced in 2015, where the production was 5.2 billion liters which was slightly lower than in 2014. In the terms of energy, 5.2 billion liters were equal to 32.6 million barrels of crude oil. Due to the financial problems, in 2016, the production of bioethanol in EU has continued to decrease. However, it is predicted that the bioethanol production is going to recover and increase in the future. Currently in Europe, France is the largest producer of bioethanol.

Table 1: Production and capacity of the main fuel ethanol producers in EU from 2010 to 2016 (million liters)

Country	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
France	942	846	829	995	975	968	970
Germany	765	730	776	851	920	937	950
Hungary	190	190	291	392	456	637	640
Belgium	315	400	410	451	557	560	560
Netherlands	100	275	451	524	520	520	450
Spain	471	462	381	442	453	494	400
UK	352	89	215	278	329	253	250
Poland	194	167	213	235	181	214	241
Austria	199	216	216	223	230	235	235
Total	**4,268**	**4,392**	**4,658**	**5,000**	**5,250**	**5,190**	**5,050**

Source: Flach et al. (2016).

When it comes to European biodiesel sector, it can be said that it is very diverse (Flach et al., 2016). The capacity of biodiesel plants owned by big multi- national companies in EU is around 680 million liters per annum, and for the plants owned by farmers it amounts to 2.3 million liters per annum. It is expected that the production of biodiesel will increase because new Hydrogenated Vegetable Oil facilities in Italy and France are expected to start their production. Biodiesel facilities can be found in almost every country of the EU, with the exception of Luxemburg, Malta and Finland. When it comes to Hydrogenated Vegetable Oil capacity, in EU, is amounts to roughly 3.4 million liters per annum. Currently in Europe, Germany is the largest producer of biodiesel.

Table 2: Production and capacity of the main biodiesel/ HVO producers in EU (2010-2016)

Country	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Germany	3,181	3,408	3,106	3,307	3,808	3,351	3,350
France	2,295	2,090	2,516	2,476	2,681	2,442	2,215
Netherlands	434	558	1,337	1,562	1,954	1,988	1,990
Spain	1,041	787	545	668	1,016	1,103	1,070
Poland	432	414	673	736	786	795	800
Italy	908	704	326	521	658	665	665
Belgium	494	536	568	568	568	568	570
Portugal	328	419	356	307	325	440	443
Finland	375	253	320	399	409	409	440
UK	227	261	364	648	648	648	650
Others	992	1,611	971	791	488	1,126	1,487
Total	**10,707**	**11,041**	**11,082**	**11,983**	**13,341**	**13,535**	**13,680**

Source: Flach et al. (2016).

Solid biomass can be found in the form of wood waste, wood, bark and many other, which come in various shapes and sizes (Flach et al., 2016). Solid biomass is mostly compacted and made into pellets or chopped and made into chips. This processing is done mainly for easier manipulation. In EU the consumption of wood pellets, in 2016, amounted to 22.2 Million Metric Tons (hereinafter: MMT). In 2018, it is predicted that the consumption of wood pellets will increase to 25 MMT and this makes the EU the largest wood pellet market in the world. EU is also considered as the biggest wood pellet producer in the world, because it currently holds more than 50% of global wood pellet production. Wood pellet production plants in EU are mostly small or medium production plants. Domestic production has grown in many European countries, due to the growing demand, and pellets are mostly produced for the domestic markets for residential heating pellets.

Table 3: Production and capacity of the main pellet producers (2010-2016)

Country	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Germany	1,750	1,880	2,200	2,250	2,100	2,000	2,200
Sweden	1,650	1,340	1,340	1,310	1,490	1,550	1,550
Latvia	615	713	979	1,200	1,300	1,350	1,350
France	465	550	680	750	870	1,000	1,130
Austria	850	940	893	962	945	960	980
Portugal	627	675	700	900	900	900	900
Poland	510	600	600	600	600	600	600
Spain	185	240	250	300	350	475	500
Total	**9,186**	**9,470**	**10,652**	**12,200**	**13,000**	**13,500**	**14,000**

Source: Flach et al. (2016).

Currently in the world, after Canada and the United States (hereinafter: US), Germany is considered as the third largest producer of wood pellets (Flach et al., 2016). Germany has more than seventy wood pellet production facilities that produce 3.5 MMT of wood pellets per annum. Mostly (about 90%), residues of the timber industry are used for the production of wood pellets in this country. Most of the wood pellets produced in Germany are used for heating. Next to the wood pellets, it is important to mention that in EU, briquettes and wood chips are also highly used. By 2020 the consumption of wood chips in EU is predicted to increase to 28 MMT.

1.2 Social and environmental dimensions of bioenergy

Many projects that are related to the bioenergy can be considered as a sustainable development (McGill University, 2019). Sustainable development is defined as a beneficial social and economic development which can limit the negative impacts of that development on the environment. Along with these three factors mentioned, technological availability is also another very important factor. Hence, it can be concluded, that in order for project to be conducted all of the mentioned factors should be taken into account. As with other projects, bioenergy projects should also be evaluated based on the social, economic and environmental benefits or drawbacks.

The projects related to bioenergy can affect the community in which these projects are implemented in variety of ways (McGill University, 2019). The ways in which these projects can influence the community can range from the new employment opportunities to the general improvement of the quality of water.

Bioenergy can be used in many ways, and some of the uses of bioenergy require the use of agricultural residues or dedicated energy crops such as energy crops (McGill University, 2019). In some cases, some agricultural land might be minimally used for the production of food due to the poor conditions of the land, and the production of bioenergy can make this land more usable. However, in other cases, the production of energy crops can have a negative effect when it comes to food security.

When it comes to the social dimension of bioenergy, rising oil prices and the corn ethanol are good examples of social impacts (McGill University, 2019). It is known that the corn is a type of crop which is requires vast amounts of energy, and it requires the use of fossil fuels. Because of this, the rise in prices of the oil barrel increases the costs of the production of corn. The increased price of oil also means the bigger profits for the farmers who produce corn ethanol. When prices of oil increase, under market conditions which are competitive, the transformation of corn supplies is favored, and usually these supplies transform to corn ethanol. This also limits the supplies of crop feedstock. As a

consequence, the supply of corn made for the consumption is limited, hence, global corn prices are affected or, in other words, corn becomes product which is no longer affordable as before.

Some of the social benefits of bioenergy are the following:

1. International conflicts and tensions reduction

Many global conflicts (political or otherwise) that are occurring nowadays are in many cases a direct result of fuel prices fluctuations (Roca, 2017). The use of domestic resources in the production of energy creates the opportunity for stable fuel prices. This use of domestic resources in energy production creates a strong alternative to imported fuel whose costs are constantly fluctuating. For example, when it comes to gas, this could ease up the tensions and create better international climate between Ukraine, Russia and the EU.

2. Energy supply is more secure.

Fuels such as uranium, coal and petroleum (with all of its derivates) are not distributed equally, are not renewable fuels and are great pollutants (Roca, 2017). Because of all of these factors, many countries around the globe are faced with the risk of short-term shortages of these fuels. If the use of appropriate technology is appropriately combined with the local energy resources which are renewable, self- sufficiency and self- supply are possible.

3. The population's quality of life is improved.

Nowadays, mostly lower social classes, are facing new types of poverty, such as the energy poverty. Rise in energy prices creates energy poverty in many countries; therefore, the well- being of many families is directly affected (Roca, 2017). Biomass resources, for example, are the type of resources which are accessible in many localities. By using this type of resources new possibilities, such as maintaining stable prices and creating employment, are created. In addition to employment and generally more promising prosperous future for society, the care for forests and the reduction of fires occurring in forests is also possible.

4. Prevention of depopulation of rural areas.

Nowadays in many countries the density index of large cities is increasing while in rural areas, the density index is decreasing (Roca, 2017). For example, B&H is characterized by a negative migration balance, and in the next decades, continuation of unfavorable demographic trends will especially happen in rural parts of B&H. Among others, these

unfavorable demographic trends are: reduced population, emigration (mostly younger populations), negative natural increase and an increase in the share of the elderly population (Tulić, 2017).

The quality of health and life in general can only get worse when cities are being overpopulated, and organizations, such as the United Nations (hereinafter: UN), is considering taking steps and preventing overpopulation from happening. This is positive for countries that are facing this problem. Nowadays, mostly large centralized companies deal with the generation of energy or, in other words, these companies have a small volume of employees per MW generated in a few plants. With the use of biomass alternative for example, it is possible to shift from a centralized generation model to a distributed generation model. In this model each locality can have its own energy generation plant where clean energy is generated. This distributed generation model boosts employment in localities and supports the use of indigenous resources in the energy production process; therefore, this sustainable model helps the repopulation of rural areas (Roca, 2017).

5. Future generations are secured and are not put at risk

With the use of renewable energy sources, such as biomass which is CO2 neutral, climate changes, which are boosted with the use of fossil fuels, are in this case reduced (Roca, 2017). Inhabitable areas of the world are going to still be inhabitable in the future with the use of renewable energy sources. In the case of nuclear power plants, hazardous waste is generated, which is not the case with renewable energy sources. In nuclear power plants this unhealthy, dangerous and radioactive waste is generated or stored in the subsoil for the later use. In contrast to nuclear power plants, biomass, for example, exclusively generates reusable ash and completely contaminant clean gases. In addition, with the use of appropriate technologies, renewable energy sources, such as biomass, can help keep population away from various risks.

Some of the environmental benefits of bioenergy are the following:

1. Reduction of greenhouse gas emissions

The reduction of greenhouse gas emissions depends on factors such as the way in which the biomass is used and produced (State Government of Victoria, 2017). The type of technology used in the production of biomass is also very important. Generally, greenhouse gas emissions are greatly reduced if biomass, on a larger scale, is converted to heat energy or used for the production of electric energy in modern power plants. Bioenergy could potentially be greater when it comes to the reduction of greenhouse gas emissions than other renewables. For example, many stubble fields are being burnt, and

bioenergy technologies offer the way in which these stubbles can be harvested and combusted in bioenergy plants, which are emission controlled. In this way, the reduction in greenhouse gases is made twice, firstly by reducing the actual burning of the stubbles and secondly through bioenergy production which is a substitution for fossil fuels.

2. Less landfills

Waste streams are used to generate bioenergy (State Government of Victoria, 2017). By using waste streams, contamination risks are reduced and both environmental and economic costs related to landfill disposals are reduced.

3. Better air quality

As mentioned above, stubble field burnings can be converted to the production of clean energy (State Government of Victoria, 2017). Next to stubble field burnings, forest slash and tree pruning are also burnt. The process of burning can be done in a controlled fashion where stubble, forest slash and others can be burned in emission-controlled bioenergy plants. This ensures better overall air quality.

4. Prescribed forest burning alternative

Techniques such as removal of biomass and mechanical thinning can be used to reduce hazardous fuel levels; therefore, they can provide an alternative to prescribed burning of forests (State Government of Victoria, 2017). This is especially beneficial in areas where the risks and costs of prescribed burning are high.

5. Bioenergy crops benefits

Areas that have additional vegetation cover can be used as fields in which bioenergy crops are grown (State Government of Victoria, 2017). For example, when trees are grown (which are harvested and used for the production of wood biomass eventually) in farms, they provide shelter, shade carbon sinks, biodiversity and many other in proper configurations. Next to mentioned benefit, bioenergy crops can be used in business and for the production of domestic renewable energy.

1.3 Biomass resources

Organic material such as animals and plants, both living or in a waste form are considered as biomass resource, or sometimes called bio renewable resource (Sriram & Shahidehpour, 2005). There are two main resources of biomass, and those are waste materials and dedicated energy crops (Alternative Energy Tutorials, n.d.).

A waste material is considered as something which has no value to the user, it is usually not used for anything and is simply thrown away (Alternative Energy Tutorials, n.d.). Waste material can be in a form of discarded industrial waste or municipal solid waste. If organic waste products are not discarded and are used primarily in another process, such as the production of chemicals, electricity, heath, biofuels and other, then these resources can be considered as a biomass.

Waste materials that are considered to be bio renewable resources are: yard waste, food processing waste, animal waste, municipal solid waste, residues from agriculture and many other (Alternative Energy Tutorials, n.d.). It is evident today that there is a shortage in capacity of landfills. Due to the public protests, it is very hard to find new landfill sites. Hence, costs of waste transportation would dramatically increase if the landfills were located away from cities because of the bigger distance present.

It is important to note that the energy produced from bioenergy sources should not be ignored, because, by collecting and using the energy from bioenergy sources efficiently, the demand for energy derived fossil fuel sources, which are non-renewable, will decrease (Alternative Energy Tutorials, n.d.). Additionally, there could be the reduction in waste materials which will in turn save space and decrease landfill areas.

As mentioned above, one of main biomass resources is solid biomass resource and this includes Agricultural Residues, Food Processing Waste, Municipal Solid Waste and Animal Waste (Alternative Energy Tutorials, n.d.).

1. Agricultural Residues are all remains that are left over after the harvest of edible parts of crops such as sugar cane, corn and many others (Alternative Energy Tutorials, n.d.). In other words, these residues are materials that are non- edible. Many of these residues can be converted into bio lubricants and bioethanol. Because they are grown together with the food crops, agricultural residue does not require extra land space, and this is the biggest advantage of agricultural residue.

2. Food Processing Waste is mostly made by manufacturers of cereal bars, alcoholic drinks, frozen and fresh vegetables and many other (Alternative Energy Tutorials, n.d.). The type of waste and residues that these manufacturers produce is called an effluent waste, and it is mostly in the form of watery liquids or dry solids. These residues and waste can mainly be used in order to produce Ethanol.

3. Municipal Solid Waste is all of the items that have been thrown away into the garbage, and are sent to the recycling facilities or collected by dustbin man (Alternative Energy Tutorials, n.d.). Attractive municipal solid waste such as food products, paper and

many other are considered as a biomass source. Some forms of municipal solid waste such as plastic and metal waste in not considered as biomass resource.

4. Animal Waste is considered as sewage sludge and manure that can be found in slaughterhouses, farms, dairies and many other that have animals collected into big facilities (Alternative Energy Tutorials, n.d.). Animal waste can be converted into electrical power at wastewater treatment plants. The reason for this is because human waste found in urban areas, animal waste and liquid sewage all contain gases and chemical energy that can be used in order to produce electrical energy. Also, heath can be produced by the treatment of this kind of waste, because it contains biogas and methane.

Next to waste materials or solid biomass resource, there is also dedicated energy crops which are also considered as biomass resource (Alternative Energy Tutorials, n.d.). Crops and plants that are grown solely for the production of some form of energy are considered as energy crops. At the moment, biomass resource production primarily includes forestry and agricultural byproducts. However, in the case where agricultural by-product or more precisely, agricultural crops are grown only for the purpose of producing the energy (biofuel or biomass resource), the least environmentally harmful plants (when processed) and the most efficient ones are selected. Periodically planted and harvested energy crops, which were previously deliberately grown as biomass resources include: eucalyptus trees, giant reeds, switch grass, energy cane, sugar cane, sorghum and miscanthus.

There are many great benefits that dedicated energy crops can provide, namely, it is a well-known fact that the energy potential of dedicated energy crops has more than five times greater potential for energy production than the energy that is required to grow and produce these same crops (Alternative Energy Tutorials, n.d.). Also, as mentioned above, these energy crops are very much environmentally friendly, and do not contribute to the pollution of the environment. At the same time these crops have a positive effect on the environment. Namely, these crops provide natural habitat for the surrounding wildlife, they can reduce the erosion of the soil and are fully biodegradable.

Fiber, starches and oils are significant components that dedicated energy can contain (Alternative Energy Tutorials, n.d.). These components are energy rich components and dedicated energy crops can contain one or more of these components at the same time. One of the most important factors for the production of energy through dedicated energy crops is their moisture content. During the time of harvest herbaceous grasses and biomass resources have the lowest moisture levels, which presents great advantage over woodier and greener energy crops. Some great sources of herbaceous biomass are rice, sugarcane, food crops, wheat and many other. Crop cultivation residues or by-products such as stems and stalks are also seen as herbaceous biomass.

Biomass feedstock can be produced in greater quantities and in much shorter period of time from tropical grasses, such as miscanthus and switchgrass, than from woody trees (Alternative Energy Tutorials, n.d.). In other words, these tropical grasses are the primary production of herbaceous crops because these crops grow on a much faster rate than woody trees.

Generally, softwoods and hardwoods are two main types of wood energy crops, and these two types of wood form the basis of most biomass resources (Alternative Energy Tutorials, n.d.). Woody energy crops can be found in fast growing plantations and trees; however, it is important to note that wood biomass can be in the form of wood products such as pallets and bulky waste, residue from forestry activities (timber waste) and wood processing (sawdust, wood shavings, industrial wood, etc.). Wood biomass is made into wood chips which are cut off, small pieces of wood biomass. Wood chips are mostly used for heat energy, are environmentally friendly (burners that do not cause pollution) and are highly efficient.

1.4 Wood biomass

In its most basic form, biomass is defined as a renewable organic matter. Wood biomass is defined as an accumulated mass of woody trees and shrubs, bark, roots, leaves or and wood in general which can be found below or above the ground (Urquhart & Boyce, 2016). Wood biomass can also be defined as a by-product of forest management. This form of biomass can be used for the production of electricity, bioliquids or for the production of biochemicals (plastic, adhesive and many other). Generally, energy is defined as a physical magnitude that characterizes the ability of the body (or body system) to do the work, in other words, ability to do work is called energy. Through history, human kind has heavily relied on the use of wood in order to produce energy, hence, this was one of the most common sources of energy. Nowadays, most of the societies rely on fossil fuels as a primary source of energy, and this type of energy source has much more energy per unit of weight. One of the main reasons why wood biomass fuel is not transported over greater distances is because of its low energy density. In other words, much of the energy that the burning green wood produces will be used to remove the moisture, and this is the very reason why the system is not efficient enough. However, wood biomass has many great advantages over the fossil fuels. These advantages are beneficial in many different ways such as social, environmental and many other.

Wood biomass can come from green wood residues made from companies, such as clearing companies, wood waste companies and from logging operations (Urquhart & Boyce, 2016). When it comes to the clean wood residues, these can be extracted from many forest product manufacturers such as pellet manufacturers. These residues can be collected from sawmills as well. Most of these residues are used as a fuel, and are offered

on many different markets. Some sources of wood biomass, which come from municipal waste or construction operation, should be critically examined because they can be mixed with various plastics or chemicals that can later on, when burned, release harmful emissions.

In the past decade wood biomass gained much attention and in the same time created much confusion, because the term wood biomass is not well defined, and usually lead to confusion (Shelly, 2015). It is important to note that the wood biomass is the subcategory of larger biomass category in which both animal and plant materials are included. Both animal and plant materials are considered as biomass and have many uses.

The term wood biomass, in the context of industry and science, is often used to describe wood residues that do not have an exact existing market (Shelly, 2015). These include, waste materials, live trees, manufacturing residues and many other. Only when adequately processed, wood biomass can be adequately used and sold on already existing markets.

Wood biomass can be divided into lignocellulosic biomass and into cellulosic biomass (Shelly, 2015). Any biomass that contains high amount of cellulose in its chemical structure can be considered as cellulosic biomass. Crop residues and agricultural crops are generally considered as two main types of cellulosic biomass. On the other hand, plants such as wood that contain high amount of lignin polymers and cellulose are considered to be lignocellulosic biomass. In regards to this, it can be concluded that wood contains both cellulosic and lignocellulosic elements.

Next to trees which are purposefully managed for biomass market, all materials collected from trees or from forests as tree residues which have accumulated into vast quantities, have hazardous characteristics and create disposal problems are considered as a wood biomass (Shelly, 2015). It is important to note that the waste paper is not considered as a source of wood biomass since it, among other factors, has its own specific market that is not related to biomass. When it comes to wood biomass utilization, it is usually considered as a resource that can be exclusively used for the production of energy, such as electricity and heat, however, this is not the case. Next to the production of energy, wood biomass has a much higher potential in being used to manufacture products of high value such as composite panels and many other.

The availability of wood biomass is great, and wood biomass can come from many different sources. Some of the sources from which wood biomass can be extracted are (Shelly, 2015):

- urban areas, land development areas and construction sites are all non- timber places where, in some cases, unwanted, dead or dying trees can be collected and where wood biomass can be obtained;
- wood biomass in the form of small diameter trees can be collected with forest management harvesting. These small diameter trees are removed because of the variety of reasons. One of these reasons includes general improvement of forest health;
- wood biomass can be obtained in the form of logging and timber harvesting residues made through timber and logging activities. These residues, among other, include small branches, roots, leaves, small trees and many other;
- wood biomass can be found in the form of residues such as sawdust, deformed wood parts and many other, which can be found in the wood manufacturing facilities such as sawmills;
- landfills are in most cases very abundant with wood biomass. This source of wood biomass usually contains wood remains which are made through demolition, construction, operations such as tree removals and many other;
- the management of vegetation such as tangled shrubs and thorny bushes is a good way to find wood biomass. In the process of this management, excess plants and shrubs (wood biomass) are removed in order to prevent wildfire fuel hazard or in order to fulfil certain management goals;
- sometimes plants are grown purposefully in order to collect biomass and offer it to the markets. These plantations for biomass are called dedicated forests, and these are a very good source of wood biomass.

1.5 Advantages and disadvantages of wood biomass

The use of energy from biomass is one of the most effective and most practical ways of producing energy for heating. Sustainable use of biomass generates a number of environmental, economic and social benefits:

1. Wood biomass is a renewable energy source: Since biomass is renewable energy source, or a source of energy that cannot be depleted, it can be said that this is the biggest benefit of biomass energy (Davor, 2015). Biomass availability mostly depends on the availability of plants, hence, as long as there are plants, biomass will be available as renewable source of energy.

2. Wood biomass can be used to create different forms of energy: Biomass is very good for heating, but that is not the only thing that it is good for (Hornung, 2014). Biomass can be used and burnt in its current form or it can be converted into oil and gas in order to produce heat and electricity. Among things that biomass can be used for, as mentioned above, biomass can also be converted into liquid fuels which can be used

for transportation. For example, there is a bus company called ‘The big lemon bus company’, located in UK, which runs solely off of fuel derived from biomass.

3. Wood biomass availability: Biomass is widely available energy source (Davor, 2015). Biomass can be found almost everywhere, and it can be used to produce some form of energy. Availability is one of the greatest benefits of wood biomass energy over fossil fuels. Since fossil fuels are not renewable, and are not going to last forever, people will eventually need to switch to alternative sources of energy. These alternative sources should be widely available and relatively cheap. This is where biomass should step in in order to make a change. When both environmental and economic character of energy sources is taken into account, many experts agree that biomass will be among the best energy sources in the near future.

4. Reduction of CO2 emissions in the atmosphere: Heating systems on wood biomass play an important role in reducing CO2 emissions and its impact on climate change (Hornung, 2014). Biomass is reducing the greenhouse gas emission that gives great impact on global warming and climate change; therefore, it helps prevent negative climate change. Biomass also has some level of emissions; however, these emissions are far lower when compared to fossil fuels, which are currently dominant source of energy. Fossil fuels and biomass fuels are quite different when it comes to amount of CO2 emissions. Carbon dioxide, which is released to atmosphere from fossil fuels, is increasing Earths greenhouse effect and amplifies global warming. On the other hand, when it comes to biomass, all of the carbon dioxide absorbed by plants, for their growth, is going back in to the atmosphere during the burning which occurs in the production of biomass energy. It should be pointed out, which is not the case with biomass, that fossil fuels do not only produce CO2 while burning, but also Sulphur dioxide and oxide, which are very toxic (Davor, 2015).

5. Money saving: Price of biomass is lower in comparison to fossil fuels (Hornung, 2014). The amount of savings when changing to a biomass system, depends on the previously used fossil fuel and the price of biomass used. The savings in fuel costs annually shortens the time of return on investment in a new system which, uses biomass. In the case of identically sized plants that use oil or electric energy for heating, return on investments in the system of biomass is possible from period of 3-4 years, depending on the purpose of the facility (amount of heat used).

6. Reduces the amount of "usable" waste in landfills: using certain types of biomass has a direct impact on the reduction of amount of waste destined for disposal (Hornung, 2014). It is still a common practice that certain residues from the wood industry and forestry are deposited at local and regional dumps, and, in fact, these represent a source

of energy. Reducing remains in stock reduces emissions of another greenhouse gas which, is methane.

It is evident that wood biomass has many great advantages; however, nothing is perfect, and wood biomass is no exception. As it is important to know the benefits of wood biomass, it is also very important to know its disadvantages because that knowledge can also contribute to the more effective utilization of this renewable energy source.

Wood biomass disadvantages are both direct and indirect Disadvantages are mostly related to the production and the use of bio fuel. Although, wood biomass ensures security through the use of locally available fuel, which minimizes the addiction to imported energy sources such as natural gas, electrical energy, oil derivates and other (UNDP, 2017), there are disadvantages when it comes to the very use of the fuel and to the application or production of the same. Some of the key disadvantages of wood biomass fuel are the following:

1. Wood biomass fuel source is not completely clean even though it is carbon neutral (Renewable Resources Co, 2016). Sadly, carbon emissions are not the only emissions that are harmful to the environment and these other emissions are sometimes present when the wood is being burned in order to produce energy. These emissions, which the burning wood releases, can also have the negative impact and pollute the environment. However, these pollutants and their effects on the environment are far less significant when compared to the pollution that the fossil fuels create. Biomass fuels are considered as air polluters by some organizations. Major disadvantage of biomass over other renewable energy sources such as water, is that is not clean of emissions.

2. Next to some harmful emissions, biomass can create another environmental issue which is related to the poor biomass maintenance (Renewable Resources Co, 2016). In order for balance to exist, biomass needs to be replanted after being extracted. This balancing order is the exact reason why biomass is considered as a renewable energy source. However, if not properly managed, it can create widespread deforestation, which is a very negative impact on the environment. This major environmental issue can endanger wildlife and lead to its extinction, because natural habitable areas are destroyed when deforestation occurs. This is considered to be one of the major factors that prevents larger use of biomass fuels because it is feared that the replanting efforts may not be able to follow the increased need for biomass fuel.

3. Even though lower than most of the types of fossil fuels, the extraction costs of biomass fuels are higher when compared to most of the other renewables (Renewable Resources Co, 2016). Some projects related to the biomass are not even considered due to high prices and relatively cheaper alternatives such as wind, solar and water. These

higher costs occur because biomass resource requires to be maintained and needs to be replanted. In addition, the costs of transport and machinery used in the process of extraction can also be more expensive.

4. Space needed for the growth of materials which are used in biomass energy is very big, hence, the availability of space can always create issues (Renewable Resources Co, 2016). Areas such as cities, areas under construction and many other are all spaces that are not available for the growth of these materials. There is also an issue when it comes to the space in which biomass energy power plans can be built, as these power plants need to be close to the areas where materials used for biomass energy are grown (sources of fuel). This close distance dependence is due to the lower transportation and other costs. This is considered as a disadvantage when compared to, for example, solar power, which does not require vast amount of space and can be placed in populated areas. Since population of the planet is constantly growing, the used area could also be used to grow crops, which may be more beneficial.

5. Unlike water and solar sources, biomass source is considered as under- researched and the ways to make biomass more efficient are still not found (UNDP, 2017). In other words, water and solar sources are more efficient, more researched and more developed. This barrier (efficiency and research) needs to be resolved in order for biomass to be more widely used as an alternative fuel source (Renewable Resources Co, 2016). However, energy that has been accumulated from wood biomass is chemical in nature. Its exploitation has no interruptions in work, which is the case with solar or wind energy. Those intermittent renewable energy sources are not constantly available, because of the factors that cannot be directly controlled.

2 WOOD BIOMASS PRODUCTION AND SOCIO-ECONOMIC IMPACT

Wood biomass production can be beneficial in many different aspects, such as economic, environmental and, social. We have reviewed the main effects a wood biomass production can have on an individual country, region or local community. Generally speaking, wood biomass production can have a number of positive impacts including the following (UNDP, 2017):

- it may contribute to regional and local economic and social development as it creates additional value and increases local job opportunities. In particular, it can enhance rural development and offset rural-urban migration by providing new employment opportunities and additional sources of income for rural population;
- by using wood biomass, the flow of money can be more successfully kept in the country or in the local community;

- an increase in investments, profits and accumulated funds may be provided through access to subsidies or preferential fees for the use of renewable energy resources;
- it helps ensure energy security for local population;
- it can induce re-cultivation of soil.

From the broader perspective, the environmental and socio-economic impact of increased wood biomass production is associated with i) better or improved environmental quality; ii) increased (scaling up of) economic activity; iii) better employment opportunities iv) social benefits related to poverty reduction and better distribution of income. In following parts, the main socio-economic impacts associated with wood biomass production are explained in more detail.

2.1 Rural development and growth

In economic terms standard of living is mostly defined by monetary income and consumption level of households (Domac & Šegon, 2005). However, people's standard of living can be defined by other factors such as environment, healthcare, education and many other which have immediate economic value. Many countries such as B&H are suffering from significant levels of outward migration from rural areas, which is mostly occurring because of the high levels of unemployment, poor monetary incomes and poor consumption levels of rural households (Agencija za statistiku Bosne i Hercegovine, 2018).

It has been shown that bioenergy can have mitigation effects on rural depopulation. Many countries in the world are recognizing the value of producing bioenergy products such as solid biomass, bioliquids and biogas. For example, Brazil was one of the countries which has experienced benefits from bioenergy and its mitigation effects on their rural depopulation. Namely, from Brazilian bioethanol programme, in rural areas, 700,000 jobs were created from local bioethanol production (Domac & Šegon, 2005). According to UNDP (2014), the use of biomass for energy production has the potential to intensify in B&H, and that would increase the number of job opportunities in rural areas and positively influence on rural development (UNDP, 2014).

Bioenergy can have positive effects on rural development and growth in more ways than one (Domac & Šegon, 2005). Rural areas can benefit from bioenergy in social aspects, macro level, supply side and demand side. In social aspects bioenergy can increase standard of living, create better living environment and create conditions for a healthier living since the production and use of bioenergy is carbon neutral. In terms of macro level benefits, bioenergy has security of supply. It can ensure regional growth and has high export potential which can be seen with pellet products in B&H and its neighboring countries Serbia and Croatia. From the supply side, benefits range from increased

productivity, enhanced competitiveness, labor and population mobility and improved infrastructure. And lastly, benefits that range from demand side are, as mentioned before, employment, income and wealth creation, induced investment and support of related industries.

Domac and Šegon (2005) claim that from a macroeconomic perspective, bioenergy can contribute to all important elements of rural development such as economic growth through business expansion, employment and import substitution which can have positive economic effects on GDP and other. They also claim that bioenergy is the most intensive technology when it comes to labor, and that it has the highest employment-creation potential. It is important to note that the level at which bioenergy can contribute depends on local demographic and economic conditions (Domac & Šegon, 2005). For example, many rural areas in B&H are in close proximity to forest areas which makes them perfect for biomass production activities.

For example, in the region of Steiermark, Austria, employment level is 15 times bigger since the people of Steiermark have started to utilize biomass as an energy source. The region of Steiermark, Austria, has 10,000 inhabitants, 4,000 households, public and private institutions. The effects of increased utilization of different types of biomass on employment levels in the region and the reginal GDP were also analyzed in the eastern part of Steiermark, Austria. They replaced 2,000 Terajoules (hereinafter: TJ) of energy from fossil fuels to biomass energy. This amount of energy presents 20% of the total heating needs in the region of Steiermark. It has been concluded that the biggest effect in terms of employment and the impact on GDP is achieved through the expansion of the district heating network by the use of wood chips. After the mentioned heating network, the biggest effect is achieved through the production of wood chips and wood pellets. Lastly, the lowest effect is achieved through the cultivation of hybrid grass species used for energy purposes such as Miscanthus giganteus.

According to Lester, Little & Jolley (2015) biomass-based economic development can result in significant increases in employment. Lester et al. (2015) also claim that the wood pellets and biofuel have the potential to generate the highest number of jobs.

It is worth to mention that annually around 60 million man/ years globally are employed in the forestry sector (around 48 million in developing countries and 12 million in industrial countries). This makes forestry and agriculture sector, together with bioenergy related activities, one of the largest employment sources. From these 60 million employed, 20-25 million annually are employed just to collect fuelwood and work in a charcoal production in developing countries (Rosillo, 2003). Overall, biomass has a significant potential for improving the quality of life. This is especially true in rural areas where additional jobs can be created, which in turn creates opportunities for better life (Carneiro & Ferreira, 2012).

Increased job opportunities and better employment can help reduce income inequalities and poverty, especially in rural areas (Rosillo, 2003).

2.2 Reduced emissions and health benefits

Biomass is a low- carbon energy source which is derived from materials such as wood, grasses, corn and other (Viaspace, 2019). By using or burning biomass, heat and electricity can be produced as well as liquid biofuels, bioplastics and other. Since biomass comes from plants which naturally regrow, it is considered as renewable resource.

Fossil fuels such as natural gas, coal and oil transformed the world from society that was mostly based on agriculture to the modern society that we live in today (Viaspace, 2019). These fuels produce heating, electricity and are used for transportation purposes. Besides that, from fossil fuels, petrochemicals are derived which are used in plastics and other industrial products. These fuels are highly used because they have couple of advantages over other fuel types, such as abundance and low cost, reliable and all-day electricity, cooling, heating and transportation fuels. However, one of the major drawbacks of fossil fuels are their limited supplies, and possibility of creating environmental issues.

Fossil fuels such as coal, oil and natural gas release carbon dioxide (CO2) into the atmosphere (Viaspace, 2019). For example, when coil is burned for energy purposes, the carbon is converted to carbon dioxide and hydrogen is converted to water. Energy is made from the carbon and hydrogen. In this process one carbon dioxide molecule is released into the atmosphere. Oil, compared with coal, releases more energy per carbon dioxide emitted. Natural gas has higher energy output in per carbon dioxide emitted than oil or coil.

Unlike coil, oil and natural gas which have chemical formulas CH (Methylidyne), CH2 (Methylene) and CH4 (Methane), biomass has the chemical formula CHO (Aldehyde) which is the most similar to coil but with an oxygen atom added (Viaspace, 2019). The main reason why biomass is considered as a low carbon fuel is because it breathes carbon dioxide from the atmosphere, and stores it in its tissues. It is correct to say that when biomass is burned, CO2 is released into the atmosphere; however, when biomass regrows, it will consume in the process of photosynthesis the exact amount of carbon dioxide that was released previously. This is why biomass is considered as carbon neutral.

In light with this discussion, with the sustainable use of renewable energy sources such as wood biomass, and with the implementation of energy effective measures, among other, the reduction of CO2 emissions will occur which could improve the quality of air, and in turn eases the consequences of climate changes (UNDP, 2017). Excessive harvesting and irrational forest management lead to reduction of areas that are covered with forests. This, in turn, results in excessive production of CO2 which can be found in atmosphere, and

which is unnatural since there is lowered capacity when it comes to the absorption of CO2. If the principles of sustainable forest management are respected the production of energy will have no negative effect on the environment such as excessive emission of hazardous matter, the increase in climate changes and other (UNDP, 2017). There are many examples of change from heating systems that use fossil fuels to heating systems that use wood biomass, and how these changes create cleaner environment effects, apart from considerable money savings when it comes to heating. It has been recorded that the best results are achieved with the transfer to wood biomass fuel, and the implementation of energy effective measures such as installation of heat isolating facade (UNDP, 2017).

Since biomass can improve the environment by its ecological effects. it positively affects the health of human beings and in turn increases the standard of living (Brišević, 2017). Efforts to decrease local pollutants and CO2 emission are considered important factors for better health conditions of local population. Increases in the production and the use of wood biomass as a source of energy can positively contribute to these goals.

3 WOOD BIOMASS IN BOSNIA AND HERZEGOVINA

The total land area of B&H is 51,209 square kilometers (hereinafter: km2), from which 12.2 km2 is sea area and 51,197 km2 is land area (UNDP, 2017). Out of the European countries B&H has one of the most extensive forest areas. B&H is highly covered with forests, more precisely, it has the total of 53% of forest land. From this total percentage of forest land in B&H, about 20% are privately owned forests, while about 80% are state owned forests.

The traditional management of forests, which is mostly present in this country, is not good enough to secure the maximum benefit when it comes to economic, social and environmental aspect (UNDP, 2017). This is particularly evident when it comes to forests which are privately owned.

3.1 Forest resource in Bosnia and Herzegovina

The territory of B&H is largely covered by forests. In view of this, the potential for the production of energy which is based on sustainable use of forest wood biomass needs to be explored. Destructions that occurred during the war in B&H, which lasted from 1992-1995, caused tremendous human losses and destruction of business capacities and infrastructure, which is necessary for the growth of economy and living standards. During the post-war period in B&H the backbone of the economic recovery were the branches (e.g. forestry) which relied on the use of natural resources. For example, in the FBiH in 1999, 54% of exports were: electricity, aluminum and beech logs. In the matter of production and consumption of all types of energy sources, the prevailing type is the

energy produced from coal (45%), then liquid fuels (21%) and finally the wood biomass with a share of 20.5%. Other forms of energy such as imported electricity, hydro energy and natural gas accounted for 13% (Regionalna razvojna agencija za regiju Centralnu B&H, 2012).

Since more than 50% of territory of B&H are forest land and forests, which are one of the most valuable ones in Europe, it can be said that this is the most important natural resource in this country (UNDP, 2014). In B&H there is no strategic commitment for production of energy and materials such as fuel from wood biomass. Hence, wood biomass in this country is mostly used in the form of firewood in order to produce heat energy, although there are possibilities for modern technologies to produce products by processing wood, which are more energy efficient than firewood. It is worth to mention that in the Western Balkans 84% of wood energy is traditionally used as firewood (Asmelash, 2017). Since high use of fossil fuels has a negative effect on the environment, and there is a continuous rising in prices of other energy sources, it is expected that the use of wood biomass for production of energy will intensify in B&H. Having said this, according to UNDP (2014), it is expected that the use of biomass for energy production will intensify in this country, and that the promotion of wood chips, briquette and pallets production will occur. Hence, this would increase the number of job opportunities and would be a great contribution for the development of rural areas (UNDP, 2014).

However, not much research has been made which would define the potential of wood biomass production in B&H (Food and Agriculture Organization of the United Nations, 2015). Only small number of authors have addressed potentials of energy production through wood biomass in B&H and the issues related to energy potentials of renewable energy sources.

Use of wood biomass from forests which are privately owned and all of its problems were thoroughly researched within the project called: „Opportunities for Wood Energy Production from Private Forests in the SEE Countries (WESSPROFOR)", implemented by many Western Balkans countries research and scientific institutions. Despite this, research of the real potential of production of wood biomass in the forestry sector in B&H is still in an introductory stage (UNDP, 2014).

The importance of employing forest resources for ensuring many benefits for the broader community should be recognized by policy makers. For a large number of local communities in B&H, forest resources are the backbone of economy and, in many cases, are the only source of income for many households (Food and Agriculture Organization of the United Nations, 2015). Next to this, many corporations are directly or indirectly involved in the chain production which is mainly based on wood or non-wood forest products (Jovanović, Musić & Lojo, 2008).

Events that occurred during the war and the post war recovery of the economy, mainly based on the use of natural resources, had left some negative impacts on the forest resources in B&H (UNDP, 2014). Negative factors such as uncontrolled logging, pest and forest fires cause degradation of forest resources, and sadly, these factors started to occur on a very frequent basis. Consequence of these negative factors is the reduction of potential of forest resources that provide long-term societal benefits. The negative situation is even more amplified by uncoordinated legislative, institutional and policy frameworks for the management of the forest resources, for which can be said to a certain extent, that its responsiveness is unsatisfactory due to a compounded administrative organization. All of these negative factors are signs to undertake a series of strategic steps and a range of forestry policy tools, in order to preserve and promote strong potentials of forest resource in B&H.

Managing forests in B&H is done in a very traditional way, and is based on more 'close to nature' (ecological) postulates, which is reflected by a way of planning and realization of operational activities in the forestry sector (UNDP, 2014). Thanks to this, forest resources in B&H still have a natural structure. Operational activities in the forests which are used for production are done with the aim to support the cycles of natural restoration of forest compartments, biological diversity preservation and advancement of potentials for rendering functions which are useful.

According to Fostering Interventions for Rapid Market Advancement (2013), the structure of forest areas and forest lands are still based on the information contained in a document called "First Inventory of Forests in Large Areas" which was created in 1968, and which suggests that forest in B&H represent 53% or, in other words, 2.7 million hectares. A Second National Forest Inventory in Large Areas was undertaken in order to collect new information on the forest resources condition in B&H. This document was created between 2006 and 2009. In this document, preliminary data indicates positive changes in more than 500,000 hectares of forest areas. This data indicates that 420,000 hectares of forest areas are inaccessible due to the fear of number of mines placed in the war period. However, in regards to this data, based on ground and vegetation characteristics, it can be concluded that 407,000 hectares are productive forests (UNDP, 2014).

3.2 Available quantities of wood biomass in Bosnia and Herzegovina

From the total forest area in B&H, private forests amount to 19.3%. Glück et al. (2011) claims that the quality of privately-owned forests is lower (mostly coppice woods) when compared to forest that are state owned. It is predicted that these kinds of forests will increase in volume and that the supply of low-quality wood products intended for the production of energy will increase as well.

It is important to note that the amount of privately-owned forests is rising (Fostering Interventions for Rapid Market Advancement, 2013). This is possible due to large migrations from rural to more urban areas of B&H. That leaves more unprocessed agricultural land. Based on official data, it can be concluded that the amount of privately-owned forests in B&H is 143 cubic meters (hereinafter: m3) / hectare (hereinafter: ha), while the amount of state-owned forests is 228 m3/ha.

The production level of the forestry sector highly depends on the variety of international and market factors (UNDP, 2014). In order for the production process to be more advanced and for the forest resource potential to be more effectively used, it is necessary to invest extra funds into the infrastructure, primarily in new forest complexes. Forestry sector, in B&H, from its current activities is not able to allocate sufficient funds in order to invest in the construction of necessary network of forest road infrastructure (UNDP, 2014). In regards to this, forestry sector in this country needs to be externally funded in order to realize the total planned scope of logging. If the planned logging scope is realized the amount of supplied forest wood products would be increased significantly as well.

In the period of 2008 and until 2012, the flow of total production of forest wood products was relatively constant until the year of 2009 where the flow of production has dropped. After the year of 2009, the production of forest wood products has slightly increased (UNDP, 2014). In the period mentioned, it is important to note, that the level of real production was not even close to the allowed scope of cutting. This indicates that, among other things, it has not come to necessary advancements when it comes to systems for using forests, primarily in the context of opening the forest complexes with the primary network of road infrastructure. In regards to this, all facts indicate that when estimating the available amount of forest wood biomass, only the realized produced amount of forest wood products should be analyzed. This kind of analysis will be a true indicator of the real amount of available forest wood biomass, which could be used for the production of energy with the minimal investments in the system of forest resource management.

In the period of 2008 to 2012 the demand of log products for sawmill processing has decreased in the year of 2009. The global market changes are the main reason for this drop-in demand (UNDP, 2014). On the other hand, the demand for the production of firewood products used for the energy production was stable. This data, which indicates the stable demand for the wood products which could be used for the production of energy, only shows how existing forest resources in B&H should be used in order to produce and offer more of these products as a form of forest wood biomass capable of energy production on the market. Naturally, this would require a certain amount of investments. The real amount of produced forest wood products in B&H is presented in Table 4, which could be offered on the market and could be utilized with the minimum investments.

Table 4: Production structure of forest wood products in B&H in 2013

	Logs	Other round wood	Pulpwood	Firewood	Net mass of large wood	Residue after cutting and production of Forest Wood Products	Gross mass of large wood
FBiH	905,830 m3	53,952 m3	248,017 m3	669,375 m3	1,877,174 m3	306,569 m3	2,183,743 m3
RS	862,997 m3	84,811 m3	340,073 m3	560,777 m3	1,848,658 m3	296,765 m3	2,145,423 m3
B&H (Total)	**1,768,824 m3**	**138,763 m3**	**588,090 m3**	**1,230,152 m3**	**3,725,932 m3**	**603,334 m3**	**4,329,166 m3**

Source: UNDP (2014).

In the year of 2012 in B&H, the total offered net amount of finished forest wood products was 3.7 million m3 (UNDP, 2014). In regards to all data presented above, it can be concluded that the amount of wood waste made from the forest wood product production processes and the wood cutting process is approximately 603,334 m3. Sadly, because of many years of poor forest management in B&H, above concluded amount of wood waste (which is actually wood biomass) is usually just left in the forests of B&H, and not used at all. However, certain amount of this wood biomass should be left in the forests, because biodiversity of forest ecosystems and the natural processes should be preserved. On the other hand, certain amount of wood biomass should be seen as an opportunity to offer more forest wood products on the market since this wood biomass is a very good energy producer, and can be sold on the market very successfully. Having in mind how forest management is done in B&H, the biological diversity of forests and all of the characteristics of forest compartments in this country, it is necessary to create and to adopt the methodology which will determine sufficient amount of wood waste that should be left in forest ecosystems with the aim to preserve biodiversity of forest ecosystems, and to preserve ecological stability.

Since the lack of the official data, the potential wood biomass created from the preservation of parks, construction and other similar businesses and activities was not possible to estimate (UNDP, 2014). In B&H, cordwood is considered to be the biggest source of forest wood biomass that is used for the energy production. In 2012, the total production of cordwood was amounted to 1.2 million m3. Significant amount of this product is used in households for the production of heath energy. This product is used in the form of chopped wood, and the high use of this chopped wood in households is the proof that this product has a huge demand on the market, even though market disturbances exist. This forest wood product is used in an inefficient way; however, this forest wood product can be seen as a short-term resource used for the production of energy. If some steps are undertaken, such as raising the awareness related to the significance of effective use of wood, and creating adequate economic instruments of wood policy, consumers could be influenced in a way that would change their habits. This way, new technologies could be used in order to get heat energy. These technologies can be in a form of solid wood-based fuels such as briquettes and pellets.

As mentioned before, big quantities of forest wood biomass are left in the forest compartments (UNDP, 2014). These forest wood biomass leftovers are usually in the form of small residues and breaches, which are made through the process of producing forest wood products. It has been estimated that more than 1.3 million m3 of forest wood biomass leftovers can be found in the forest compartments. This big biomass potential should be used in B&H because additional amounts of wood could be offered on the market. This wood could be used for the energy production. It is very important to note that through the exploitation and usage process, some forest wood biomass should be left in the forests in order to preserve and to further develop biological diversity and the quality of the ground. Wood waste and small branches after the cutting process and the production of forest wood products, on the areas which have characteristics such as wider space (which means better accessibility), and the possibility of using machines in the process of forest exploitation, could be mobilized with minimum investments. On the other hand, on the areas which have bad access to the forest compartments and very troublesome orographic characteristics, the use of the mentioned forest wood products from the economic stand point is very questionable.

When it comes to the wood materials made from furniture, saw timber and veneer production, the quantity is very significant and it amounts to 0.5 million m3 (UNDP, 2014). With the minimal investments, these raw wood materials can be made into products such as briquettes or pellets, which can later on be used in order to produce energy. Wood residue, which is made mostly from the process of production, is used by many sawmill facilities in B&H as a source of energy used for timber drying process or for heating.

It is estimated that around 650,000 m3 of forest wood biomass in the form of stumps can be found in the forest ecosystems (UNDP, 2014). This is considered as a significant amount of wood biomass. Adequate machinery and spacious forest compartments are prerequisites in order to avoid big investments, and to successfully exploit stumps from forest ecosystems. As with the case of small breaches and small residues, certain amounts of stumps should also be left in the forests in order to develop and preserve the stability of forest ecosystems. The reason for leaving certain number of stumps in the forest ecosystems is soil fertility. Through the process of decomposition and decay of these stumps useful and nutritious materials are returned to the ground, hence, the soil becomes more fertile.

Table 5: Available amount of wood biomass for energy production in B&H in 2012

Sources	**Diciduous Trees m3**	**Confifers m3**	**Total m3**
Cordwood for energy	1,228,441	1,711	1,230,152
Residues after cutting and production of forest wood products	261,154	342,181	603,334
Small branches	401,432	314,848	716,280
Residues and waste after production of veneer, furniture and sawn timber	200,843	354,857	555,701
Stumps	334,527	314,848	649,375
Total	**2,426,396**	**1,328,446**	**3,754,842**

Source: Energy Investment Activity (2016).

3.3 Assessment of wood biomass potential and socio-economic benefits in Bosnia and Herzegovina

In countries such as B&H, which are abundant in forest resource both in biodiversity and distribution, forest resource could be the basis of the local economy, and, in some cases, the only source of income in many communities, especially rural. B&H has great potential when it comes to wood biomass, but the workforce for its production is emigrating (Pendek, 2018). The reason for this is that many rural areas in B&H are faced with the emigration. The effect of this emigration is the decreasing number of many local communities, and the final result could be the disappearance of these communities in the future. It is important to note that 1.3 million people left B&H from the collapse of Yugoslavia till now (Šajinović, 2018). From 2013 till now, more than 150,000 people emigrated from B&H (Faktor, 2017). Nowadays, major reason for emigrations is job search (Mujić & Kurtović, 2017). By promoting the production of energy products such as wood pellets made from forest wood biomass, local communities could feel positive effects from the direct employment but also through the support of the supporting industry and related activities (UNDP, 2011). Jobs can be created all through the forest wood biomass value chain starting from forestry, transportation, production, installation and maintenance of, for example, biomass boilers.

Next to the production of wood-based products, forest resources and biomass products are highly used in households. These are used mostly to produce heat in households (88.3% of room heating and 54.5% individual central heating). This indicates that the forest resources represent the biggest source of renewable energy in this country. In the year of 2013, forest resource had a share of 57% in the total use of renewable energy sources in B&H (UNDP,

2017). It is positive to say that this form of energy production is very effective, and there is minimal environmental impact in this process. Wood biomass mostly has a significant role when it comes to firewood, which is mostly used in order to produce heat energy. The forms of biomass such as firewood and wood coal are growing sources of energy in this country. Wood biomass, in some parts of B&H such as east and central Bosnia, has 60% of the share in heating of households. However, the efficiency of traditional boilers and furnaces is on a very low level, and the assembly of new, more efficient boilers and furnaces could decrease the costs and the consumption of wood biomass (UNDP, 2017).It is worth to mention that according to estimations, the potential of forests when it comes to the energy production in B&H is 23.3 Petajoules (hereinafter: PJ) annually. The potential in FBiH is 14.9 PJ, in RS 8.4 PJ and in Brčko District 0.03PJ. The biggest density potential of wood biomass lies in the middle region of Bosnia, which is approximately 1 TJ/km2 (UNDP, 2017).

The production of wood-based products creates many positive economic impacts in B&H (UNDP, 2017). Many companies in B&H are producing wood-based products, such as furniture, or wood derivates, which are one of the main export products of B&H. When it comes to wood processing industry in B&H, it is important to note that it produces significant amounts of wood leftovers made through the processes of wood veneer production, furniture production and construction activities. There is 0.7 million m3 of wood waste produced per year from wood processing industry in this country. Many of the wood processing companies could use these wood leftovers in order to heat their facilities or to dry these wood leftovers. Moreover, wood processing companies could sell their wood waste to companies which would later on use this waste in order to produce pellets or briquettes. Besides standard usability of wood waste, it could be used for the production of heat energy and electrical energy in cogeneration power plants. It is estimated that approximately 80% of existing wood waste could be used in cogeneration plants. In order to reduce the annual expenses for energy (which are about 20% of GDP), further development of potentials of renewable energy sources in B&H, including wood biomass, may be needed. Next to this, more capital should be invested in energy efficiency.

It is important to note that the annual logging in this country is around 4.5 million m3 from which 85% can be found on the market, and from which 15% is not used at all. Hence, the estimated potential of wood biomass in B&H is approximately 1.3 million m3 of wood waste that could be used for the production of wood-based products, production of energy and other (UNDP, 2017). This could in turn create more jobs, reduce the depopulation of rural areas, contribute to the cleaner environment and more.

3.4 Institutional and legal framework with reference to wood biomass production in Bosnia and Herzegovina

One of the main predispositions for the effective and sustainable use of renewable energy sources is good institutional and legal framework of one country (UNDP, 2014). Institutional framework may be defined as a set of laws and regulations which enable and give authority to certain institutions to act. Additionally, the role of institutional framework is to secure the better future for the country's growth. It also ensures good organizational culture and consciousness of quality.

Because of the complexity of institutional framework in B&H, forest ecosystem potential and its current utilization in B&H is imbalanced. When it comes to institutional and legal requirements, they are considered as a major aggravating factor in mobilization of resources for energy production, and are the main reason for insufficient utilization of forest wood biomass and renewable energy sources in B&H.

Institutions define norms, procedures, formal and unformal rules, whose changes create new norms and rules in society. These can in turn affect the creation of new policies. Institutions are usually characterized by their stability, and their rapid change is rare. The simpler and clearer the institutional and legal solutions are, the functionality of different sectors is better. The reason for the poor and ineffective forest wood biomass utilization in B&H, primary lies in the complex institutional and legislative framework, which is decentralized. Institutional and legislative framework is divided between cantons, entities and the state, including other government bodies on the entity level (UNDP, 2014). Competences overlap and vertical coordination among government bodies is poor.

Apparently, political, rather than geographic, economic or other relevant factors shape the institutional framework related to the governance and the use of forest wood biomass in B&H. For illustration purposes, a number of government institutions are in charge of energy and renewable energy sources policy formulation and implementation:

- vast number of ministries in charge of agriculture and forestry, energy, industry and environment, that are dispersed at Entity and Cantonal government levels;
- three public Energy corporations, (Elektroprivreda FB&H, Elektroprivreda RS, Elektroprivreda HB);
- various energy and environmental agencies, including environmental funds at the Entity levels, (e.g. Federal Environmental Fund, Environmental Protection and Energy Efficiency Fund of the RS) as well as number of other government bodies;
- associations and non-governmental organization in charge of forest and wood industry.

In such complex and dispersed institutional framework, the sectors of energetics, agriculture, forestry, environmental protection and rural development need to cooperate and work in close collaboration on horizontal level and vertical level. The coordination between ministries at the Entity and Cantonal levels is necessary in an effort to embark on effective, sector specific wood biomass strategy. Policy implementation requires mutual collaboration that is often constrained with limited financial and human resources. According to UNDP (2014) these sectors need expertise and technical assistance, apart from political will and commitment to develop wood biomass policy objectives. Coordination is required to gather and act on integrated information and knowledge of forest wood biomass potentials and possible ways for its effective utilization. In view of complex and highly diversified governance structure, it is not surprising that no specific strategic document on wood biomass production exists at either level of government. In addition, legal and regulatory environment is likewise complex. Specifically, the existing legal solutions are ineffective. Because of that adopted, relevant strategic documents are not being implemented (UNDP, 2014). These specific issues are discussed later in the thesis.

3.4.1 Key institutions

Administrative and political structures are the most important factors that influence institutional and legislative framework. Following the complex B&H political and administrative structures, when it comes to forest wood biomass and renewable energy sources in general, these structures are divided among state, entity and cantonal levels of governance. In the case of FBiH the governance structure is very decentralised. Competences, roles and responsibilities in policy formulation, implementation and monitoring processes are not clearly divided among different levels of government, yet they are overlapping. This is not the case with RS, which has very centralised governance structures. In order to demonstrate the complexity of key institutions, main government institutions starting from state level to entity level are listed below (UNDP, 2014).

The main government institutions which are competent for the energy and renewable energy sources on the state level are (UNDP, 2014):

1. State Regulatory Electricity Commission.
2. Electricity Transmission Company of B&H.
3. Ministry of Foreign Trade and Economic Relations of B&H (Sector for Natural Resources, Energy and Environmental Protection).

In the above-mentioned government institutions, there are very few activities which are related to renewable energy sources and forest wood biomass. On the other hand, when it comes to the production of energy through renewable energy sources and forest wood

biomass on the level of entities, competencies are divided into many different ministries. These ministries in FBiH are (UNDP, 2014):

1. Federation Ministry of Energy, Mining and Industry, which is responsible for energy related issues.
2. Federation Ministry of Agriculture Water Management and Forestry, which is responsible for agriculture, water management and forestry.
3. Federation Ministry of Spatial Planning, which is responsible, among other, for guiding the development of the use of natural resources.
4. Federation Ministry of Environment and Tourism which is responsible for the growth of tourism.

It is important to mention that the institutions responsible for the forest wood biomass on the level of FBiH are also the Chamber of Economy of the FBiH and Regulatory Commission for Energy in FBiH. The main role of the Chamber of Economy of the FBiH is to assist the Federal government with the preparation and enactment of laws, regulations and economic policy measures that define the economic position of business entities. The main role of Regulatory Commission for Energy in FBiH is to control and regulate the relationship between electricity generation, distribution, supply and customers. When it comes to RS, the ministries which are responsible for the use of forest wood biomass are:

1. Ministry of Industry, Energy and Mining, which is responsible for the industrial development, mining operations and energy related issues.
2. Ministry of Agriculture, Forestry and Water Management, which is responsible for agriculture, water management and forestry.
3. Ministry of Spatial Planning, Construction Industry and Ecology, which is responsible, among other, for guiding the development of the use of natural resources and for the ecological issues.

Clear division of responsibilities among mentioned ministries in B&H is necessary in order to encourage the mobilisation of unused forest resources, and to secure the sustainable use of forest wood biomass. However, as with the majority of economic branches in B&H, the unclearly defined issues of coordination usually lead to overlapping of responsibilities which are related to the renewable energy sources and, more specifically, to the underutilisation of the production and use of forest wood biomass. Moreover, these overlapping responsibilities usually lead to fragmentation of government competences (UNDP, 2014).

3.4.2 Main strategic and legal documents

3.4.2.1 Key strategic documents

Despite many promises, government bodies failed to address biomass sector development and growth potential issues, so far. There exists no sector specific policy, or any other sector specific document such as policy agendas or action plan at any level of government that would address biomass sector development and growth potential issues. Seemingly other policy priorities, as well as complex institutional and legal requirements, are one of the main reasons for insufficient utilization of forest wood biomass and renewable energy sources in B&H (UNDP, 2017).

The main objective for entity and state authorities in B&H should be the development of necessary institutional and legal requirements that will enable sufficient utilization of forest wood biomass and renewable energy sources. Currently, on the state level there are no strategic documents on energy sector; however, in FBiH and RS there are documents in which issues related to renewable energy and wood biomass are only outlined, and are underdeveloped (UNDP, 2014). These documents are:

- FBiH Strategic Energy Sector Development Plan and Program (created in 2009)
- The Draft Strategy for Energy Development until 2030 created in RS

These documents outline the vast availability of wood biomass resource and only recognise its potential. They do not come up with systemic analysis of current industry performance, its growth potentials nor analyse policy dimensions that may help in enhancing wood biomass utilisation. No doubt, these documents should be amended, reworked and should include at least the number of issues related to excessive export of wood from B&H. Apart from environmental problems, the excessive and uncontrolled export of wood creates problems to local processed wood producers, including pellet producers that are having difficulties with acquiring raw materials for their production. If these documents were implemented, B&H would have for the first time, strategic documents that would relate exclusively to the use of renewable energy sources.

3.4.2.2 Key legal documents

Key legal documents which make a wider legal frame for the use of renewable energy sources should include the issues related to wood biomass and other renewables (UNDP, 2014). On the other hand, the implementation of laws that promote the regulatory framework such as the Law on Use of Renewable Energy Sources and Late Cogeneration in FBiH and the Law on Renewable Energy Sources and Late Cogeneration in RS should be implemented in order for renewable energy sources to be properly regulated. The main

purpose of these laws is to promote the production of energy from renewable energy sources, efficient cogeneration and an increased renewable energy use in total energy consumption. These laws also promote the regulatory framework, the development of incentive measures and technical infrastructure for renewable energy sources and more efficient cogeneration.

In order for above mentioned goals to be accomplished, National Action Plan for the Use of the Renewable Energy Sources of B&H should be adopted both by FBiH and RS. An integral part of this plan is the Action plan for the use of renewable energy sources in the FBiH. In this plan, the purpose of national goals, when it comes to using renewable energy sources, is to bind the Federation's objectives on the share of renewable energy sources. Specifically, it binds Federation in total national transport energy, heating and/or cooling and electricity, taking into account the effects of regulatory measures pertaining to improving energy efficiency and saving energy at end-customers, as well as other measures with the purpose of meeting the set goals.

It is also of a paramount importance for the FBiH to adopt the Law on Forests. By implementing this law complications related to the use of forest wood biomass and fragmented functionality of forestry sector in Cantons would be solved (Federalno ministarstvo energije, rudarstva i industrije i privredna/ gospodarska komora Federacije B&H, 2018). By adopting Law on Forests, illegal use of forest wood and corruption related to forest resources, which is present in different cantons of FBiH, might be reduced (UNDP, 2014). According to Kadrić (2019) who is the head of the Department of Forest Management and Hunting in Federal Ministry of Agriculture, Water Management and Forestry, by adopting the Law on Forests the area of forestry would be regulated at the level of the FBiH, which would in turn enable the protection of this natural resource, stop illegal logging and illegal occupation of state forest land. Kadrić (2019) also added that this law has been pending since 2009, and the lack of mentioned law results negatively not only on forestry and timber industry, but also in the implementation of other activities, such as implementation of spatial planning acts at all levels, implementation of significant energy, communication and water management projects, resolving property-legal relations and other.

4 ASSESSMENT OF WOOD BIOMASS PRODUCTION POTENTIALIN BOSNIA AND HERZEGOVINA WITH REFERENCE TO PELLET PRODUCTION

4.1 Methodological remarks

This analysis aims to assess the potential for the expansion of further production of wood pellets in B&H. This section of the thesis summarizes the main findings of the qualitative research on current pellet production performance and its future potentials, based on

analysis of internal and external environment of pellet producers. The main findings of this thesis reflect data and information gathered through in-depth interviews with three representatives of market leading pellet producing companies in B&H. Initially, 5 leading pellet producers were identified and selected to be included in the qualitative research. Companies were identified on the basis of internet search and information gathered from Chamber of Commerce. Aim was to target major pellet producers and exporting companies, with reference to geographical area i.e. aim to cover wide/different geographical locations. The criteria rest on presumption that large exporting companies possess both internal capabilities and firm knowledge of wider, sector specific issues and information that are of particular interest for this research. Considering the geographical dispersion of pellet producing companies and limited operational resources five companies were selected for interviews. Three among these companies participated in the qualitative interviews conducted in summer 2019. Through the internet search, it was concluded that the interviewed companies were amongst market-leading companies and amongst 20 companies that are recognized as certified (EN Plus certified) producers of pellets in B&H (ENplus, n.d.), thus located in three different regions. These regions are: Sokolac, RS, Gracanica, FBiH and Sanski Most, FBiH.

We decided to assess the potential of this product made from biomass because it has huge potential in B&H, which, unfortunately, has not been sufficiently exploited (Sofić, 2017). The aim of the qualitative research was to provide a deeper understanding of issues that the pellet producing industry is facing and to examine the possibilities for its further development and growth. For this purpose, the semi-structured interviews were conducted with representatives of pellet producing companies (Appendix). The interviews were structured to examine: (1) internal capabilities of the companies, including assessment of technical capacity, human resources and management, (2) external environment of the companies with special focus on institutional and policy framework that inhibit industry growth. Next to getting insight into internal business environment, the main focus of the interviews was to get deeper understanding of the external business environment, which includes supply side specifics and policy framework related questions that give insight on how convenient the current policy framework for the pellet producing companies is. The focus of the interview has enabled insight into industry threats and opportunities. The details relating to the structure of interviews, specific questions discussed and their relevance is provided in Appendix. Remarks relating to conceptual background of the interviews conducted is discussed briefly in paragraphs to follow.

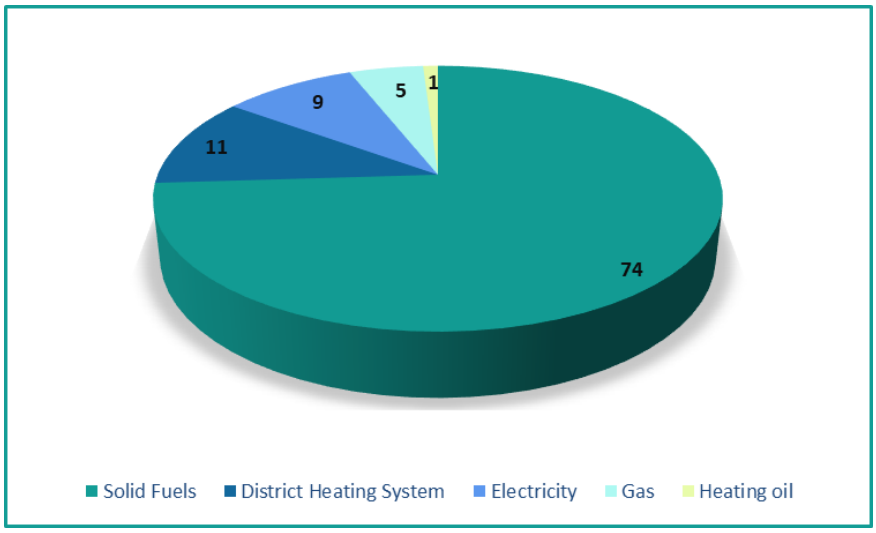
4.2 Sector background

Demand for wood pellets and other biofuels is very high in B&H. Wood pellets are highly used in households. According to research made in 2015, 5.4 million m3 of firewood, 81,656 tonnes of wood pellets (around 20% of total pellet production) and 6,780 tonnes of wood briquettes were consumed in Bosnian households (Glavonjić, Oblak, Čomić, Kalem,

& Lazerević, 2017). In 2015, in B&H, the household total expenses for the supply of wood fuels were €239.8 million, with the largest share of firewood (€226.8 million), followed by wood pellets (€11.6 million) and wood briquettes (€720.9 thousand) (Glavonjić et al., 2017). Currently, in B&H, wood fuels mostly used for household heating are firewood, wood pellets, wood briquettes, logging residues and residues from sawmills (Glavonjić et al., 2017).

According to Glavonjić et al. (2017), and which can be seen in Figure 4**,** in B&H in 2015, 11% of the total number of households used district heating system, 9% used electricity, 5% used gas and 1% used heating oil for heating purposes. Interestingly, 74% of households, or in other words, the largest number of households as mentioned before, used solid fuels such as firewood, wood pellets, wood briquettes, coal, logging residues, residues from sawmills and combinations of solid and other forms of fuels (Glavonjić et al., 2017). In B&H, pellet burning furnaces are devices that are quite new on the Bosnian market and they are mainly one to two years old in households that use these devices for heating (Glavonjić et al., 2017). This refers to the households in all areas in B&H where pellet heating systems are installed on a daily basis. This indicates that the pellet market is constantly growing (Sofić, 2017). Hence, it can be concluded that pellets and pellet technology are still in the adoption phase in B&H, and growing.

Figure 4: Energy used in households for heating in % in 2015



Source: Glavonjić et al. (2017).

Figure 4 indicates that the majority of households use solid fuels for heating purposes followed by direct heating systems, electricity gas and heating oil. When it comes to wood pellets specifically, it can be concluded that the pellets sold in B&H is mostly used by households; however, some businesses are starting to switch to pellets for energy purposes. Many pellet producers are using their own pellets to satisfy their energy needs. Usually, pellet producers are using pellets in order to heat their facilities using pellet boilers. By using pellets, pellet companies are using clean energy solution and are decreasing the costs

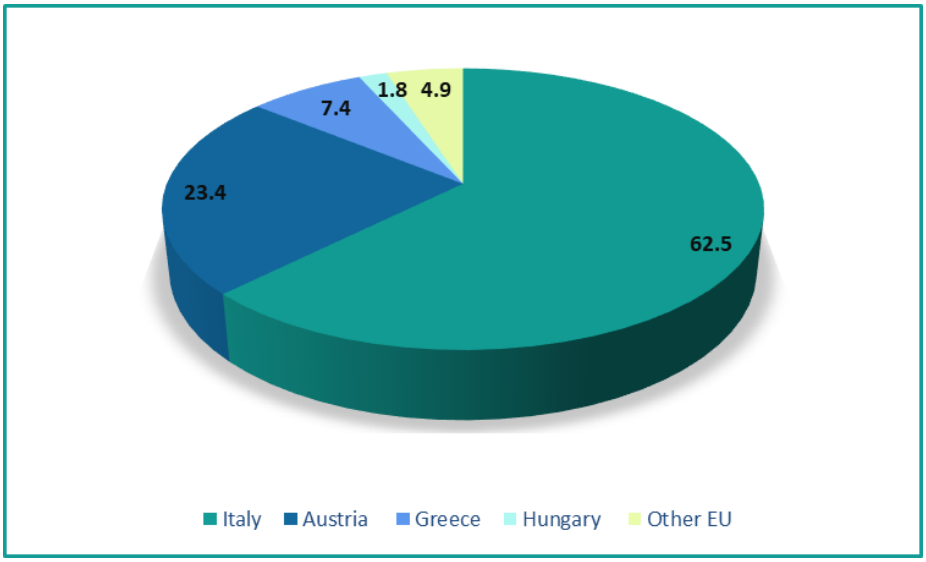
of heating. In general, there are more pellet consumers in the households, although there is an expansion of the installation of pellet boilers in public institutions such as hospitals, health centres, schools and many others.

Although there is potential for the industry growth, the biggest problem is the lack of raw material, which is necessary for the production of pellets. The results of lack of raw materials are higher pellet prices on the market and the industry that cannot further expand in terms of pellet production (Kovač, 2017). These external barriers are further discussed in this research.

There is a growing number of pellet producers in B&H and this indicates that there is a potential for the industry growth and that pellet is desirable product on domestic and foreign markets. Currently, there are more than 40 pellet companies (both certified and non- certified) present on the market (Gagić, 2015). B&H exported 67,815 tons of pellet to the EU in 2012 and 170,389 tons in 2013 making an increase of 151% (USAID, 2014). In 2013, B&H became the second largest non-EU European exporter of pellets after Russia, by surpassing Ukraine, Belarus and Croatia (USAID, 2014). In 2016 B&H produced around 350,000 tons of pellet and exported around 182,000 tons (Glavonjić, 2017). In 2017, by estimations, the total annual production of pellets in B&H amounted to around 300,000 tons.

Pellet production in B&H was initially 100 per cent export-oriented. Nowadays, the average export-import ratio is around 80 per cent export rate and 20 per cent domestic application (Sofić, 2017). If this export-import ratio is applied to the total amount of pellets produced in B&H, which is around 300,000 tons annually, then, approximately 240,000 tons of pellet is exported from this country and 60,000 tons are intended for the domestic market. According to Softic (2017) there is a growing demand for pellets in B&H and domestic manufacturers should produce more in order to satisfy growing domestic demand (Sofić, 2017). In 2013, most of the pellets from the Balkan region was exported to Italy with the participation of 62.5% (Glavonjić, Krajnc & Paluš, 2015). Other counties include Austria (23.4%), Greece (7.4%), Hungary (1.8%) and other EU countries (4.9%) (Glavonjić et al., 2015). This can also be seen in Figure 5.

Figure 5: Export of pellets from Balkan region in % in 2013



Source: Glavonjić et al. (2015).

As previously mentioned, there is a significant number of pellet producing companies in B&H. Next to the growing demand for pellets, accessibility to forests and forest land is another reason why opportunities are seen in pellet production and why pellet production is growing. Forests and forest land are one of the most important natural resources in B&H (UNDP, 2014). They cover more than 50% of the territory of B&H (UNDP, 2014). Most of the forest area is owned by the state while privately owned forests amount to 19.3% of the total forest land. In most of the cases, privately owned forests are of lower quality, which is also mentioned by one interviewee. Due to the poor forest management, much of the biomass (made from cutting wood and other) is left in the forests, which could be one of the reasons for biomass shortage (raw materials) on the market. It is clear to say that some biomass should be retained in forest compartments since biodiversity and natural processes should be preserved (UNDP, 2014). Approximately 1/3 of the small branches, stumps and other wood residue need to be left in the forest and from the remaining 2/3, only half is accessible for collection (USAID, 2016). This excess biomass or residues in the forests can be seen as raw materials that can be used for the production of pellets or directly offered on the market for energy production (UNDP, 2014). This additional source of raw materials can be beneficial to pellet producers since they are faced with the lack of raw materials and cannot expand their businesses. In order for pellet producers or others to use this additional amount of biomass found in Bosnian forests, responsible B&H institutions should introduce systems for the forest management so that biological diversity can be preserved and excess biomass extracted from the forests (UNDP, 2014). The total amount of wood biomass that is leftover and not used in the Bosnian forests, amounts to more than 1.3 million m3, which is a significant amount of unused biomass (UNDP, 2014).

When it comes to forest management, as mentioned above, forests should be managed in a proper way. While collecting excess biomass from the forests, sufficient amount of

biomass should be left in the forest compartments in order to preserve the quality and biological diversity (UNDP, 2014). According to UNDP (2014), the minimum investment is needed in order to collect excess biomass with machines from localities that have good accessibility to the forest area. In the case where localities are characterised with extreme terrains and forest areas are hard to reach, the economy of using biomass is questionable.

Additional source of raw materials made in the process of production of veneer, furniture and sawn timber amounts to a significant amount of 0.5 million m3 (UNDP, 2014). This amount of raw material, with minimal investment, can be used to produce wood-based energy products such as pellets (UNDP, 2014). The example of the use of these raw materials can be seen in the majority of sawmills in B&H, where these raw materials (by-products) are used for the heating purposes (heating facilities for example) (UNDP, 2014). It is worth to mention that around 650,000 m3 of stumps can be found in forest ecosystems in B&H (UNDP, 2014). This amount is considerable and can also be used as a raw material for many industries (UNDP, 2014). The extraction of stumps from Bosnian forests should be managed properly in order to leave forests unharmed since the rotting process of stumps is important for the stability of forest ecosystems (UNDP, 2014).

Table 6: Wood biomass tehnical potential in B&H (2016)

Woody biomass sources	**Conifer trees (m3)**	**Decidous trees (m3)**	**Theoretically available amount (m3)**
Firewood	1,711	1,228,441	1,230,152
Forest residues	342,181	261,154	603,334
Small branches	314,848	401,432	716,280
Stumps	354,857	200,843	649,375
Residues from wood processing industry	314,848	334,527	555,701
Total	**1,328,446**	**2,426,396**	**3,754,842**

Source: USAID (2016).

According to the interviews, pellet producers claim that in B&H one of the biggest barriers for the production of pellets is the lack of raw material. However, from the data collected above, through literature review, it can be concluded that there is plenty of unused biomass in B&H, which could be used for the production of pellets. In B&H, as mentioned previously, the lack of raw materials dictates high pellet prices and limits the production of the pellets. Next to the problems with the lack of raw materials for the production of pellets in B&H, pellet producing industry faces problems with unregulated market, unfair competition, unforeseeable price fluctuations, political favouritism and others that will be discussed in greater detail in sections to follow.

4.3 Assessment of pellet producers' internal capabilities: the case of Bosnia and Herzegovina major pellet producing companies

4.3.1 Companies profile and performance structure

In order to get relevant information about the state of the pellet industry in B&H, interviews were conducted with the general managers of the three selected pellet producing companies, namely the Duga Pellet company, the Trgovir Company and the Final Group company. All of the three representatives agreed to be interviewed, and were delighted to contribute to this master thesis. Below we provide some basic information regarding the profiles of the selected companies.

Duga Pellet d.o.o. is located in the Municipality of Sokolac, RS. Duga Pellet d.o.o. has eighteen workers employed directly in the production of pellets. This company has an annual output of 9,000 tons on average and the annual output per worker is about 500 tons. In Duga Pellet d.o.o. 70% of the production is exported, while 30% is sold in B&H.

Trgovir d.o.o. is located in the Municipality of Gracanica, Tuzla Canton, FBiH. Trgovir d.o.o. has sixteen workers employed directly in the production of pellets. The average annual output of this company is 12,800 tons and the annual output is about 800 tons per worker. Most of the pellets that Trgovir d.o.o. produces are sold in B&H, while 40% of their production is exported to other countries.

The third company called ***Final Group d.o.o.*** is located in the Municipality of Sanski Most, Unsko- sanski Canton, FBiH. 24 workers are employed directly in the production of pellets. The average annual output of this company is 15,000 tons and the annual output is about 625 tons per worker. In Final Group d.o.o. pellets are 70% exported to other countries and 30% is sold in B&H.

Table 7: Company profile and key performance indicators (2019)

Company	Numbers of employees in production	Average annual output level (tons)	Average annual output per worker (tons)	Produced for the domestic market	Exported
Duga Pellet d.o.o.	18	9,000	500	30%	70%
Trgovir d.o.o.	16	12,800	800	60%	30%
Final Group d.o.o.	24	15,000	625	30%	70%

Source: own work.

From Table 7, it can be concluded that Duga Pellet d.o.o. and Final Group d.o.o. are mostly focused on the export, while Trgovir d.o.o. is mostly focused on the domestic market. According to Glavonjić, Krajnc and Paluš (2015), in South East Europe 77.9% of the realized production was exported in 2015. Glavonjić et al. (2015) claim that most of the pellet producers in South East Europe produce 1,000 to 5,000 tons of pellet annually and only 18 producers produce over 30,000 tons of pellet annually. In regards to this research, it can be concluded that the annual output level of the three interviewed companies is much higher than the average South East Europe pellet production capacity.

4.3.2 Assessment of firm internal capabilities

4.3.2.1 Access to labour and human resources

According to interviews made, labour market generally does not provide staff that has acquired specific skills needed to work within pellet producing companies. This is especially true when it comes to accessing specialised workforce, including technicians and workers specialised and trained to perform different tasks related to operating equipment (e.g. machinery) for biomass processing. Another problem, according to interviewees, with the labour is generally low interest or demand of the youth on the labour market to work in pellet producing companies. Access to qualified labour workforce is considered a big problem, especially considering the age structure of the current workforce among the three companies. The low skilled jobs offered are seemingly not attractive to the youth accompanied with limited salaries. This might pose a serious problem for the future industry growth and scaling up of production activities. Access to highly qualified personnel has not been recognised as important issue since the industry rests on minimal knowledge and technology requirements.

According to interviewers, engineers or Science and Technology (hereinafter: S&T) experts are engaged only on project specific basis, mostly relating to consulting activities on new technology acquisition and adoption, and or when problems with machinery i.e. electronics and Programmable Logic Controller (hereinafter: PLC) devices occur (Pirraglia, Gonzalez & Saloni, 2010). More specifically, when it comes to experts and ad hoc experts, pellet producing companies usually do not require highly qualified workers on permanent basis, such as mechanical engineers. In cases where they do hire ad hoc experts, it is mostly to solve issues with electronics and machinery. Generally speaking, this industry is not knowledge-intensive nor is labour intensive.

4.3.2.2 Competitive position on local and international markets

When it comes to the assessment of individual company's competitive position on both domestic and international market, all three companies marked their product performance

as high quality on domestic and average quality on international market. The average performance, when considering the qualitative ranking of the pellet products exported, has mostly to do with the quality of wood and the chemical content of the resource material used in the production process. According to interviews, when it comes to pellets produced in B&H, it is competitive in foreign countries because it can achieve fairly lower and competitive prices while retaining relatively good quality levels. More specifically, International product standards and obtained certificates assure their favourable access to international, namely the EU, market. Even though faced with a lot of unfair competitors (discussed in greater detail in sections to follow), three interviewed companies are highly competitive on B&H market amid high product quality.

4.3.2.3 Production process: technology and efficiency

When considering production technology, it has been claimed that many foreign pellet producing companies often have better and more efficient pellet producing technologies, which ensure better utilisation of input resources and quality, larger scope of production and which lead to economies of scale. According to interviews made, in B&H, pellet companies do not seem to invest much in new technologies. On one hand pellet producing technology can be very expensive and its maintenance capital intensive, while on the other, most companies face limited scope for production expansion due to limited access to raw materials. In other words, there are no major technological breakthroughs that would make their used technologies obsolete, or significantly improve the way in which the pellets are produced. However, new production technology, as argued by the interviews, relies on energy efficiency and is very beneficial in terms of lower energy-costs. High capital investments are needed; however, they are not justified on the ground of limited potential to expand pellets production.

In view of this, all three companies face the problem of underutilised production capacity. The reason for the underutilisation of existing production capacity lies not with limited access to foreign markets or low demand, but primarily with limited access to raw materials. This is why the selected companies are not investing in new technologies that can expand their scales of production or lead to better energy efficiency. These companies cannot produce more pellets due to the lack of raw materials available on the market. For example, with the current technology, one of the interviewees claims that his company has the production capacity of 30,000 tons per year, but they only produce 50% of that capacity. This indicates that pellet companies do not need high output technologies since, with the existing ones, they cannot use the full capacity because of the lack of raw materials.

For this reason, export production has limited potential to be expanded. Expansion of pellet production in other major exporters from the Western Balkan and EU (Serbia, Croatia, etc.) has thus been recognised as potential threat to B&H pellet industry's export growth.

4.3.2.4 Product quality

In order for Bosnian pellet producers to export pellets to the countries of the EU, they should be certified with the ENplus certificate. The quality of pellets in the EU is expressed by an ENplus certificate that classifies pellets into different quality and price categories. The ENplus norm is the only recognized and qualified official standard in the EU. The ENplus certificate is the evidence and guarantee of pellet quality, and it is grouped in classes A1, A2 and B. In B&H, 20 pellet producing companies possess ENplus certificate. One interviewed company has both ENplus A1 and A2 certificates, while other interviewed companies only have ENplus A2 certificate. All of the interviewed companies produce only ENplus A2 pellets because, according to one interviewee, quality of raw materials is not good enough for ENplus A1 pellets. According to interviews, most of the pellet producers in B&H produce ENplus A2 pellets. What distinguishes these two ENplus pellet classes is the amount of ash that remains in the furnace after the burning process. Namely, the more the ash, the lower the production of heat energy. The ENplus A1 class provides premium pellet quality and is intended for use in private households, as it produces the smallest amount of ash and meets all the high standards needed to optimally control the heat in households. On the other hand, the ENplus A2 class produces slightly more ash and is intended for larger thermal plants that can handle more residues after burning pellets. EN plus A2 pellets can also be used in private households.

Although the selected pellet producers are competitive on foreign markets and have acquired EN PLUS A1 and EN PLUS A2 certificates, they note that the industry growth potential is constrained by very limited certification among local domestic producers, especially among small companies. They rather note, that the process of obtaining the EN PLUS certificates is very costly, time consuming and requires financial and operating resources that are not permittable to small and even medium pellet producing companies. Access to financial resources presents the major obstacle. One of the interviewees notices that many small companies are focused on servicing local market needs and do not recognise the potentials from internationalisation. Only few pellet producers possess these certificates, and in order for B&H to be truly included in the international sale of pellets, more pellet producers should secure these certificates (which can be demanding to secure).

4.4 Assessment of the external environment related to the supply side and industry-specific features

4.4.1 Access to raw material

Raw materials can be obtained from multiple sources. Generally, pellets are obtained from different types of wood processing industries/product. These are wood processing industry sector, other wood industry and post-consumer wood.

The wood processing industry produces finished or semi-finished wood products from roundwood (Jong, 2012). This industry sector includes paper and pulp production, wooden panel production, sawmilling and veneer peeling.

Other wood industry produces products by processing goods (semi-finished or finished) made from wood processing industry (e.g. wooden panels and sawn wood) (Jong, 2012). The processing of semi-finished and finished wood products delivers wood residues such as dust, shavings, trimmings, rejections or cuttings. Furniture, packaging materials, construction materials and other wood products are all examples of products made in other wood industry.

Post-consumer wood (hereinafter: PCW) includes all wooden materials that are no longer used by consumers as wooden products (Jong, 2012). Some of the types of post-consumer wood are demolition wood, packaging materials, timber from building sites and used wood from industrial, commercial and residential activities.

When it comes to wood residues, they can be categorised into three types of residues: forestry residues, secondary wood residues, and tertiary residues (Jong, 2012). Since only secondary and tertiary woody residues can be used as a raw material for the industrial production of pellets, primary forest residues, as well as agricultural products residues, are ignored.

The wood processing industry and other wood industries accumulate secondary wood residues (Jong, 2012). The first step of primary wood processing is covered by the wood processing industry sector. This includes veneer peeling, sawmilling, plywood production, wood-based panel production and paper and pulp production. By using roundwood, chips from roundwood and residues from processing, semi-finished and finished wood products are produced in the wood processing industry. Semi-finished and finished wood products in the wood processing industry include sawn wood, plywood, paper and pulp, veneer sheets and other types of wooden panels. Residues (biomass) that are made in the production process of mentioned products are sawdust, lump wood residues, bark, slabs, cutter chips and other.

Other wood industry uses the products made from the wood processing industry in order to produce construction materials, furniture, packaging materials and other (Jong, 2012). As mentioned above, this industry delivers wood residues (biomass) such as dust, shavings, trimmings, rejections or cuttings.

Products produced from the wood processing industry and other wood industry are later on used by consumers which after a certain period of time dispose these products (Jong, 2012). Then, they are considered as PCW that includes all sorts of wooden materials.

In regards to interviews conducted, producers obtain raw materials primarily from public forest companies and secondary from various sawmills. Concluded from the interviews, main supply chains for pellet producers are public forest companies, where pellet producers obtain wood logs and sawmills, where they obtain waste such as sawdust. From the raw materials obtained, the pellets are produced and later on sold on domestic and foreign markets. Wood pellets are usually made from clean conifer sawdust and planer shavings. In B&H, as already mentioned, theoretically there are 555,701 m3 of residues (e.g. sawdust, planer shavings) produced from the wood processing industry. Besides sawdust, planer shadings could be another great source of raw materials and supply chain for pellet producing companies to expand their scale of production. Next to this, 649,375 m3 of stumps are available in Bosnian forests for the production of pellets. However, the approval and the extraction process of these stumps should be done by state-owned, public forest companies. Another source from which pellets can be made are small branches which are left in forest ecosystems, and these amount to 716,280 m3. Extraction of these small branches should be allowed and managed by public forest companies as well. Pellet producers could even negotiate to buy leftovers such as stumps and small branches for a lower price, if not with the public forest companies, than with the owners of privately-owned forests. When all is added together, it can be concluded that 1.9 million m3 of raw materials are almost not used at all.

Pellet production consists of three phases, pre-treatment of raw material, palletisation and post-treatment of produced pellets (Protić, Mitić & Stefanović, 2011). Interviewed companies and many pellet companies mostly have the pre-treatment technology, such as drum chippers, to process stumps and small branches. When it comes to sawdust, pre-treatment can be skipped, so sawdust can be considered as the least demanding raw material to treat in the production process.

Technology cannot be improved since pellet producers are facing problems when it comes to securing the raw materials for the production of pellets, and guarantied quantities of raw materials need to be available, in order to plan production promptly and comply with international exporting standards. Because of the lack of raw materials, pellet producers cannot exploit economies of scale and are ‘forced’ to sell pellet products for somewhat higher prices.

Furthermore, access to raw materials is additionally undermined by underdeveloped supply-chains, and no inter-industry cooperation that hingers use of other wood industry waste and residues is resource input in pellet production. Government coordination is seemingly necessary in order to provide incentives that would enable inter-firm linkages and horizontal supply-chain networking between furniture industry companies and pellet producers, for instance. In such external environments, where access to key input is limited, the production potential of the pellets is inhibited, and so is the exploitation of scale economies. Expansion of inter-industry supply-chains should be considered major policy concern, considering a vast number of wood processing companies, and unknown and unexploited potential of using these industry residues and waste in pellet production.

Pellet producers in B&H are not the only ones who are facing the problem with the lack of raw materials. As noted by interviewers, in Serbia the prices of pellets have become much higher compared to before, due to higher prices and limited access to raw material. Similar to B&H, Serbia faces the lack of raw materials for the production of the pellets. The effect of the lack of raw materials in Serbia created the increased demand in the market since many people need pellets to go through cold winters. In this country, when there are no enough pellets on the market, people buy cheap pellets on the 'black market' from certain resellers (Brakočević, 2017). Next to Serbia, in Croatia pellet producers are also facing the lack of raw materials for the production of the pellets. The amount of raw material that Croatian forests can deliver to woodworkers is limited by natural increase, and growing demand is the result of an increase in processing capacities (Glas Slovenije, 2018). Much more developed countries than Bosnia, Serbia and Croatia are also facing lack of raw materials. Generally, the lack of raw materials (especially for the production of wood pellets) is considered as a major bottleneck for the production expansion and trading of European biomass. Because of this shortage, the import of unrefined or refined biomass in the EU might increase. Main importers would probably be United States of America (hereinafter: USA), Canada and Russia (EUBIONET III, 2011).

Due to the lack of raw materials, the prices of raw materials are rising. As the result, pellets are getting more expensive every year (UNDP, 2016b). Even though pellet prices are higher than before, there is still a high demand for this product. Many buyers buy pellets in advance, or before the winter comes, since at that period, the prices of pellets are lower. It can be concluded that the prices of pellets on the Bosnian market fluctuate every year and that the prices are different in different periods of the year. The example of this is that in 2016, prices of pellets varied from 280 Bosnian Convertible Marks (hereinafter: KM) to 422 KM, which means that the price of pellets fluctuates over the year (UNDP, 2016a).

4.4.2 Access to raw materials and the problem of corruption

According to interviews made, when it comes to pellet industry and political structures, there are sometimes tight relationships and even political favouritisms. Since the majority of forests are owned by the state, some companies can get the advantage of securing raw materials more successfully than others. One interviewee claims that even though he has the contract with public forests where he is guaranteed to get 10,000 cubic meters of forest wood at the end of the year, he only gets 3,000 cubic meters. He claims that contracts do not present any kind of guarantee towards pellet producers, except those who have strong political connections. Sometimes this preferential treatment, or this informal networking at play, can imply huge costs to businesses that are not well connected or have no strong ties with leading political parties. Local governments can directly exercise control over the distribution of raw materials, exercise selection and favour specific companies (in terms of access to raw materials – which is key to industry expansion). This is also related to unfair competition in the sense that there is no transparent procedure, which is also connected to unregulated market.

4.4.3 Market regulation and the problem of unfair competition

B&H has an unregulated market when it comes to pellet industry. According to interviews conducted, there are many companies that do not produce pellets primary or do not produce pellets at all, but are the biggest sellers of pellets in B&H. The example of this is that certain companies, which are not even pellet producers in some cases, sometimes produce artificial crises by buying most of the pellets on the market and not selling it until the demand and prices rise. This kind of behaviour on the market is defined as oligopoly, which occurs because the market is not regulated properly.

This industry is intensive when it comes to competition and more so, pellet producers are faced with unfair competition. This creates problems for many pellet producing companies because sometimes they cannot adequately sell their products on the market. Additionally, because of the many market problems, and the problems with the demand, many pellet producers are forced to dump the prices of their goods in order to save their businesses and to continue to be active on the market. This ‘non-traditional’ price dumping creates problems for many pellet producers, because the prices of their goods are not competitive, hence, selling their goods can be hard. According to one of the interviewees, there are certain unfair competitors on the market that have strong political ties. Since there is no transparency, which is the problem of an unregulated market in securing raw materials, many unfair competitors get a lot of advantage on the market and many pellet producers lose their bargaining power. Mentioned oligopolist companies can also be considered as unfair competitors since they create artificial environments that are only beneficial to them.

When it comes to unfair competition, it can be said that this issue is closely related to the lack of raw materials as well. According to interviews made, there are certain 'politically favoured' companies, that do not deal with the production of pellets but obtain vast amount of raw material used for pellet production every year. This raw material is later on sold to pellet producers at an unreasonably higher price point. This might be the reason why some companies have negative experiences with contracts made with public forest companies, where a contracted amount is not respected, and pellet producers receive lower amount of raw material than what was written in the contract. Because of the rising prices, selling pellets in B&H and even abroad is becoming problematic for the pellet producers.

4.4.4 Access to finance

According to interviewees, pellet companies do not have problems with acquiring loans from banks. Pellet producing companies, as any other companies, get operating capital based on permanent contract relationships with the banks. However, they note that access to loans to finance major capital investment may pose concern. It is important to note that, according to The Central Bank of Bosnia and Herzegovina official statistics as of 2017, the loans to non-financial companies (e.g. public or private manufacturing companies) were higher than those for households in 2017. This indicates that the inclination of banks to give out loans to non- financial companies has increased in 2017, compared to previous years.

4.5 Assessment of the external environment related to institutional and policy features

As mentioned before, entity governments are not doing much to stimulate and create a positive business environment for the pellet producers. When it comes to existing underdeveloped legal solutions, interviewed pellet companies are not satisfied and think that there should be initiatives for clean energy producers from the funds for renewable energy sources that citizens 'fill up' by paying electricity bills and otherwise. It would be very stimulating for pellet producers to have some sort of co-financing from the government, especially when making pellet heating systems for households and public institutions. When it comes to guarantees from local or entity authorities for regular biomass supply, many pellet producers have no guarantees when it comes to local or entity authorities. In the case when pellet producers have certain guarantees, it is only for the annual contracted amounts of raw material and nothing more. In order for pellet producers to have adequate correspondence with authorities, current associations of pellet producers should more effectively coordinate joint actions and demands to appropriate legislative and government authorities. There are few associations that delegate the 'word' of pellet producers. These associations are poorly organized and pellet producers have no benefits from them.

The biggest obstacles and challenges for pellet producing companies in B&H are, as already mentioned, the lack of raw materials and unfair competition. When it comes to lack of raw materials, according to Bašagić, S. (2018) who is the Secretary of the Wood Industry and Forestry Association of B&H, B&H unreasonably exports a lot of wood. This is one of the reasons why domestic industries, such as the pellet producing industry, have problems with obtaining raw materials necessary for production. Excessive export of wood and wood products from B&H is an issue which can only be solved by government authorities. In RS, Forestry and Wood Processing Association of RS suggests a complete ban on logs exports as a solution. In FBiH, Wood Industry and Forestry Association of B&H claims that the introduction of exporting tax is more realistic. The idea of banning exports has already been rejected from the authorities, because of the international agreements. One of the solutions could be the declaration of wood resources as strategic resources of B&H by the authorities. In that case international agreements, when it comes to this resource, would not be valid anymore (Privredna/ Gospodarska Komora Federacije Bosne i Hercegovine, 2017). Currently, no solution has been implemented to solve the issues of excessive export of wood from B&H and the lack of raw materials in B&H (Bašagić, 2018). It is worth to mention that in 2017, in B&H, wood industry realized exports 10.7% more than in the 2016. Export of wood and wood products amounted to 59.8%, and export of furniture and prefabricated timber construction amounted to 40.2%. Export of cut timber made up 27.5% of total exports. Export of plates and veneers made 5.3%, parquet 4.4%, while export of joinery made 5.4% of total exports (Vanjskotrgovinska Komora Bosne i Hercegovine, 2017). In regards to statistics, raw wood and wood product export is on the rise.

It is clear to say that this market is not properly regulated and that authorities should pay more attention to this sector. With all external and internal problems that this industry faces in B&H, pellets are still competitive, not only in countries of EU but also in the region. Reasons for this are lower prices of raw materials (with the highest quality base) compared to other regional countries and greater forest resources than neighbouring countries. The prices of pellets are more favourable (currently not by much) when compared to electricity, gas and fuel oil.

Pellet producing companies can produce enough pellets to meet the domestic demand. However, in order for the use to be increased in B&H, more pellet heating systems should be installed in households, which are the biggest pellet consumers on the market. Government authorities on all levels (state or entity) should stimulate the production of pellets, by revising existing institutional and legal framework, by making more unified decision-making system and by implementing existing and adopting new laws. This should create better business environment for pellet producing companies. All in all, many pellet producers would argue that pellets are not the most promising product of wood biomass in B&H, but rather a final product of furniture industry, because this type of production

requires fewer raw materials. The production of pellets is an accompanying branch related to the production of furniture.

5 THE INDUSTRY'S GROWTH POTENTIAL AND SOCIO-ECONOMIC BENEFITS: CONCLUDING REMARKS

Despite the great potential of wood biomass in B&H, its capacities cannot be utilized under the current institutional and legal framework. As previously mentioned, pellet producers are struggling to acquire the main input for their production, wood biomass. Wood biomass is a key factor for the expansion of their business capacities and for achieving economies of scale. The lack of raw materials makes their current production capacities underutilized, makes their products less affordable on the market, and presents the main aggravating factor for this line of production.

The lack of raw materials is the result of multiple factors, a major one being an unfavourable institutional and legal framework. As mentioned before, underdeveloped legal solutions, overlapping responsibilities, and ultimately poor forest management are factors that make pellet production undesirable. Hence making this industry undesirable in terms of new investments. As a result of bad institutional and legal framework, a space for corruption was created, where various illegal activities are occurring, endangering not only pellet producers but Bosnian forests as well.

In some cases, the key factor in production; the wood itself, is not being fully delivered to pellet producers. This comes as a result of public forests often not respecting contracted quantities of raw materials, which public forests were obliged to deliver to producers. On the other hand, certain companies are receiving regular deliveries of contracted amounts of wood biomass, and according to research, these pellet producers have unofficial ties with certain political structures controlling public forests. To make matters even worse, there are companies, with strong political ties, that acquire vast amounts of raw materials, and pellets over some time. They do so, to create a crisis of supply so that raw materials and pellets acquired, can be sold for an artificially high price once the demand on the market rises.

Unadopted strategic documents, poorly created existing legal documents and non-enacted laws come as results of the government's negligence towards forest resources and wood being excessively exported from B&H. Excess wood biomass in forest compartments cannot be exploited due to poor forest infrastructure where many forest areas are unreachable and some are even covered with mines as a consequence of the war that occurred. It is up to authorities to show care towards forest resources, to reduce the number of illegal activities, to create forest infrastructure, and to assist pellet producers with the development of supply chains. Authorities should create a more favourable environment

for domestic producers which can, in turn, translate to industry growth and socio-economic benefits.
If all the aforementioned problems are solved, industry growth and socio-economic benefits, especially in rural areas, are possible. B&H has a chance to assist pellet producers by creating a more favourable external business environment. In a more favourable environment, pellet producers would have uncompromised access to wood biomass, thereby removing this production bottleneck. If the lack of raw materials is solved, the industry's growth potential would be enabled. Pellet producers would be able to utilize their full production capacities and achieve economies of scale. This would, in turn, make pellets more affordable on the market, enabling more households to be heated on pellets, which pollutes less and is more environmentally sustainable.

With appropriate legal solutions, levels of corruption currently present in the sector, would be resolved. This would allow for a greater level of competition that would encourage innovation in the sector, allowing local producers to become more competitive in the domestic but also in the foreign markets. Enacting and enforcing laws such as the Law on Forests in FB&H, would reduce illegal logging and prevent the export of timber as raw material. This would help in the preservation of Bosnian forests and would enable more raw material on the domestic market.

By adopting existing strategic documents, B&H would be able to create a National Action Plan for the Use of the Renewable Energy Sources, which would, in turn, create a path towards a more sustainable future of B&H energy sector. In the long run, this ensures a cleaner environment by reducing pollution. With the help of international organizations, agencies that would specifically deal with the issues related to public forest sourced wood biomass should be created. In this way, decision making and policy creation processes would be much faster because coordination could be clearly defined not lead to the overlapping of responsibilities and jurisdictions. This would in turn also result in more developed supply-chains, more successful inter-industry cooperation that would advance the use of other wood industry wastes and residues. Government coordination should also provide incentives that would enable inter-firm linkages and horizontal supply-chain networking between furniture industry companies and pellet producers, for instance.

By acknowledging the fact that forests are the main strategic resource of B&H, through legal solutions, the government would create a better forest infrastructure that would protect, maintain and advance the use of forest resources more efficiently. Better forest management would enable excess biomass to be more successfully exploited while some of it would be left in forest eco-systems to avoid jeopardizing ecological stability and biodiversity of forest ecosystems. Having said this, pellet producers would still have more biomass for their production, than they do now.

Rural areas, especially ones that are close to forest resources, would be able to profit through the biomass supply chain. These areas would profit through the collection of excess wood biomass leftovers in the forest, which could be offered on the market, to the production of wood biomass products such as pellets. Next to high business potential, rural areas, with the help of government initiatives, and subsidies, would be able to create their pellet heating facilities which would result in better air quality and population well-being. From the perspective of economics, the population in rural areas would pay less for heating households. This particular example is very desirable given the fact that Bosnia suffers from a very bad economic situation in general. When it comes to wood pellet production and other wood-based production, with government initiatives, rural areas would be able to create pellet production facilities. This would create employment opportunities, higher retention rates when it comes to people migrating from rural areas, brain drain mitigation and encourages rural development in all other fields.

CONCLUSION

Prerequisite of any economic activity is energy and it is one of the most important factors of economic development of any country. Many developed countries in the world are striving to reach 0 net carbon dioxide emissions and are doing so by using renewable energy sources for energy. Countries of the EU are striving for the development of renewable energy sources. EU is considered as the biggest wood pellet producer in the world. B&H's goal is to become a member state of the EU and will be closer to joining the Union if the total renewables take certain part in the total share of generated energy. Economic and industrial growth is not possible if energy policies are not adequate and, with the right policies, it is possible to achieve goals such as clean environment, health of population, sustainable economy, good living standards and prosperity.

Biomass is perceived as a renewable and sustainable source of energy which is extracted from organic matter. It can be found in form of wood waste, wood, bark and many other which come in various shapes and sizes. By supporting biomass products such as wood pellets, B&H can improve the life of its population, prevent depopulation of rural areas, secure future generations, reduce greenhouse gas emissions, decrease landfills, create better air quality and many other. Since B&H is a country with many economic issues, by supporting renewable energy sources, such as wood biomass or more precisely the production of wood pellets, rural development can occur with many employment opportunities created.

B&H is largely covered by forests, more than 50% of territory is made of forest land and forests, and the potential for the production of energy which is based on sustainable use is great. Forest in B&H are 80.7% owned by state and 19.3% are private forests. For the production purposes, most of the biomass (raw material) is purchased from public forests.

Next to biomass that is being exploited, available and unused amount of forest wood biomass sums up to approximately 4.3 million m3. The amount could be even greater, but since the data is insufficient it was not possible to estimate wood biomass amount when it comes to preservation of parks, construction and other similar businesses and activities.

Three companies were interviewed among 20 companies that are recognized as certified (EN Plus certificate) in B&H. All of these three companies seem to have problems with acquiring raw material for their production and possible expansion. This seems contradictory, since B&H is abundant with forest resources and with wood biomass in general. However, institutional and legal framework, which was made by very decentralized and complexed administrative and political structure, led to situation where the raw materials are lacking, and the wood pellet market is highly unregulated. Decision making and policy creating processes are very slow because of the unclearly defined issues of coordination that lead to overlapping of responsibilities and jurisdictions. For the very same reason and because of the complex nature of administrative and political structure, strategic programme and plan in FBiH and the development strategy till 2030 in RS were not implemented, and B&H has no document which is specifically focused on the use of renewable energy sources.

Because of the poor institutional and legal framework, B&H is exporting an excessive amount of wood and wood based raw materials, while on the other hand, local pellet producers are having troubles with securing raw materials. For this very reason, wood pellet market is poorly regulated, and there is a lot of unfair competition and political favouritism present.

Policy priorities, complex institutional and legal requirements are one of the main reasons for insufficient utilization of forest wood biomass and renewable energy sources in B&H. With the right administrative and political structures, which can implement existing plans and change the institutional and legal framework, production of energy from renewable energy sources would be promoted, pellet producers would be encouraged to expand their production capacities and in turn create more job opportunities and better standards of living. Same is true for the rural areas where local population will see new opportunities in pellet production and contribute to their communities. In order to achieve the above mentioned few steps should be fulfilled. These steps are:

1. modification and adoption of existing strategic documents;
2. modification of existing legal documents that make a wider legal frame for the use of renewable energy sources;
3. adoption of entity laws that promote clean energy;
4. adoption of National Action Plan for the Use of the Renewable Energy Sources of B&H;

5. adoption of the Law on Forests in FB&H;
6. creation of agencies that would specifically deal with the issues related to the forest wood biomass;
7. declaring wood resources as a strategic resource of B&H.

Having strategic documents that would relate exclusively to the use of renewable energy sources would be of a paramount importance for B&H. These documents exist and should be amended, reworked, should include issues related to forest resource and finally be implemented. As mentioned previously, these documents are Strategic Energy Sector Development Plan in FBiH and the Draft Strategy for Energy Development until 2030 in RS.
Second step would be to modify existing legal documents that make a wider legal frame for the use of renewable energy sources, which should include issues related to biomass and other renewables. Third step would be to implement Law on Use of Renewable Energy Sources and Late Cogeneration in FBiH and the Law on Renewable Energy Sources and Late Cogeneration in RS because these laws would promote the production of energy from renewable energy sources, efficient cogeneration and an increased renewable energy use in total energy consumption. These laws would also promote the regulatory framework, the development of incentive measures and the technical infrastructure for renewable energy sources and more efficient cogeneration.

Fourth step would be the adoption of National Action Plan for the Use of the Renewable Energy Sources of B&H by both FBIH and RS. This Action Plan would bind the Federation's objectives on the share of renewable energy sources in total national transport energy, heating and/or cooling and electricity.

Fifth step is of a great importance for the FBiH, and that is the adoption of the Law on Forests which has been pending since 2009. By adopting Law on Forests, uncontrolled export of wood, illegal use of forest wood and corruption related to forest resources, which is present in different cantons of FBiH, might be reduced. Naturally, complications related to the use of forest wood biomass and fragmented functionality of forestry sector in Cantons would be solved. This would encourage existing pellet producers to expand their production capacities, because market would be properly regulated. This law would solve many issues that pellet producers are facing and are previously mentioned.

As the sixth step, I would recommend the creation of agencies by adequate ministries in both FB&H and RS that would specifically deal with the issues related to the forest wood biomass and that would have joint and coordinated actions. Issues of coordination, which are usually leading to overlapping of responsibilities, related to the forest wood biomass resource would be solved. These agencies would closely work with pellet producer associations and organizations such as EU and UNDP, as a consulting partner.

In order to ban excessive export of wood that is happening in B&H, wood should be declared by authorities as a strategic resource of B&H. In that case, international agreements would not be valid anymore. Also, introduction of a tax for excessive export would be a good option, because the idea of complete ban of wood exports has already been rejected from the authorities.

REFERENCE LIST

1. AEBIOM. (2017). *Full report*. Brussels: European Biomass Association.
2. Agencija za statistiku Bosne i Hercegovine. (2018). *Anketa o radnoj snazi, 2018*. Sarajevo: Agency for Statistics of BiH.
3. Alternative Energy Tutorials. (n.d.). *Biomass Resources*. Retrieved August 10, 2019, from http://www.alternative-energy-tutorials.com/biomass/biomass-resources.html
4. Asmelash, E. (2017). *The Untapped Potential of Biomass in the Western Balkans*. Brussels: Revelle.
5. Bašagić, S. (2018). *Bh. drvoprerađivači nezaštićeni, trupci uglavnom idu u izvoz*. Retrieved May 28, 2019, from http://www.federalna.ba/bhs/vijest/233697/video-entiteti-zasad-bez-jedinstvenog-stava
6. Brakočević, M. (2017). *Nestašica peleta zbog manjka sirovina*. Retrieved November 02, 2018, from http://www.politika.rs/sr/clanak/372247/Nestasica-peleta-zbog-manjka-sirovina
7. Briševac, M. (2017). *Završni rad, Energetska upotreba biomase*. Rijeka: Sveučilište u Rijeci.
8. Carneiro, P. & Ferreira, P. (2012). The economic, environmental and strategic value of biomass. *Renewable Energy*, *44*(1), 17–22.
9. Davor, H. (2015, 12 October). *Benefits of biomass* [published on blog]. Obtained from https://www.our-energy.com/benefits_of_biomass.html
10. Doleček, V. & Karabegović, I. (2013). Renewable energy sources in Bosnia and Herzegovina: Situation and Perspectives. *Contemporary Materials (Renewable Energy Sources)*, *2*(6), 152–163.
11. Domac, J. & Šegon, V. (2005). *Socio-economic impacts of bioenergy production*. Zagreb: REGEA.
12. Đonlagić, M. (2010). *Obnovljivi izvori energije: Studija o obnovljivim izvorima energije u B&H*. Tuzla: Centar za ekologiju i energiju.
13. EN Plus. (n.d.). *Producer*. Retrieved April 17, 2018, from https://enplus-pellets.eu/en-in/certifications-en-in/producer-en-in.html
14. Energy Investment Activity. (2016). *Izvještaj o trenutnom stanju i potencijalu u B&H za izgradnju kogeneracijskih postrojenja i elektrana na biomasu*. Sarajevo: USAID.
15. EUBIONET III. (2011). *Solutions for biomass fuel market barriers and raw material availability, 16*(6), 4277–4290. Jyväskylä: EUBIONET III.

16. European Parliament. (2015). *Biomass for electricity and heating, opportunities and challenges*. Brussels: EU.
17. Faktor. (2017). *Zabrinjavajuće: Od 2013. B&H napustilo oko 150.000 ljudi, u Posavini je najkritičnije*. Retrieved September 03, 2018, from https://www.faktor.ba/vijest/zabrinjavajuce-od-2013-bih-napustilo-oko-150-000-ljudi-u-posavini-je-najkriticnije-270628
18. Federalno ministarstvo energije, rudarstva i industrije i privredna/ gospodarska komora Federacije B&H. (2017). *Razvoj drvne industrije federacije Bosne i Hercegovine za period 2016- 2025*. Sarajevo: Vlada Federacije Bosne i Hercegovine.
19. Flach, B., Lieberz S., Rondon M., Williams B. & Wilson C. (2016). *EU Biofuels Annual 2016*. The Hague: Global Agricultural Information Network.
20. Fletcher, K. (2017). *European Biogas Association reports 17,376 biogas plants in EU*. Retrieved January 11, 2018, from http://biomassmagazine.com/articles/14141/european-biogas-association-reports-17-376-biogas-plants-in-eu
21. Food and Agriculture Organization of the United Nations. (2004). *Unified bioenergy terminology*. Rome: Food and Agriculture Organization of the United Nations.
22. Food and Agriculture Organization of the United Nations. (2015). *Analiza sektora šumarstva u Bosni i Hercegovini*. Sarajevo: Food and Agriculture Organization of the United Nations.
23. Fostering Interventions for Rapid Market Advancement. (2013). *Mogućnosti korištenja niskovrijednih drvnih sortimenata i konverzija izdanačkih šuma u Bosni i Hercegovini*. Sarajevo: USAID.
24. Gagić, B. (2015, 10 November). B&H: *Trend proizvodnje i izvoza peleta* [Video file]. Retrieved from https://www.youtube.com/watch?v=H53MfLWHlIQ
25. Glas Slovenije. (2018). *Pilanarima nedostaje radnika i sirovine*. Retrieved January 18, 2019, from http://www.glas-slavonije.hr/376995/7/Pilanarima-nedostaje-radnika-i-sirovine
26. Glavonjić, B. (2017). *Development of pellets production and consumption in Serbia and B&H*. Belgrade: University of Belgrade.
27. Glavonjić, B., Krajnc, N. & Paluš, H. (2015). Development of wood pellets market in South East Europe. *Thermal science 19*(3), 781–792.
28. Glavonjić, B., Oblak, L., Čomić, D., Kalem, M. & Lazerević, A. (2017). Wood fuels consumption in households in Bosnia and Herzegovina. *Thermal science*, *21*(5), 1881–1892.
29. Glück, P., Avdibegović, M., Čabaravdić, A., Nonić, D., Petrović, N., Posavec, S. & Stojanovska, M. (2011). *Private Forest Owners in the Western Balkans- Ready for the Formation of Interest Associations*. Finland: European Forest Institute.
30. Gradski ured za gospodarstvo, energetiku i zastitu okolisa. (2012). *Informativna brošura za promicanje obnovljivih izvora energije namijenjena građanima, malom i srednjem poduzetništvu i obrtništvu*. Zagreb: Grad Zagreb.

31. Hornung, A. (2014). *Transformation of Biomass: Theory to Practice*. New York: Wiley.
32. Jong, B. (2012). *The potential of wood residue streams for industrial wood pellet production in the Baltic Countries and Poland*. Utrecht: Utrecht University.
33. Jovanović, B., Musić, J. & Lojo, A. (2008). Energetsk i potencijal drvne biomase u Bosni i Hercegovini. *Šumarska nauka između ekonomije i zahtjeva društva*, *2008*(1), 93–98.
34. Kadrić, K. (2019). *Federacija B&H razvlaštena u upravljanju šumama*. Obtained from https://faktor.ba/vijest/federacija-B&H-razvlastena-u-upravljanju-sumama/50299
35. Kovač, M. (2017). *Drvoprerada u RS: Glavni problem proizvođača nedostatak sirovine*. Retrieved September 23, 2018, from https://www.akta.ba/vijesti/drvoprerada-u-rs-glavni-problem-proizvodaca-nedostatak-sirovine/77123
36. Ladanai, S. & Vinterbäck J. (2010). Biomass for Energy versus Food and Feed, Land Use Analyses and Water Supply. *Report, 2010*(22), 9–45.
37. Lester, W., Little, M. & Jolley, J. (2015). Assessing the Economic Impact of Alternative Biomass Uses: Biofuels, Wood Pellets, and Energy Production. *The Journal of Regional Analysis & Policy, 45*(1), 36–46.
38. McGill University. (2019). *Socioeconomic and environmental impact of bioenergy.* Retrieved May 03, 2019, from https://www.mcgill.ca/bioenergy/impact
39. Mujić, M. & Kurtović, L. (2017). *Masovni odlazak mladih iz B&H: potraga za poslom ili bijeg od stvarnosti?*. Sarajevo: Centar za izborne studije.
40. Pendek, A. (2018). *Potencijala ima, ali je radne snage sve manje*. Retrieved November 23, 2018, from https://www.oslobodjenje.ba/vijesti/ekonomija-i-finansije/biznis-plus/potencijala-ima-ali-je-radne-snage-sve-manje-387067
41. Pirraglia, A., Gonzalez, A. & Saloni D. (2010). *Techno- economical analysis of wood pellets production for U.S. manufacturers, 5*(4), 2374–2390.
42. Privredna/ Gospodarska Komora Federacije Bosne i Hercegovine. (2017). *Apel drvnog sektora: B&H mora spriječiti nekontrolisanu sječu šume i uvesti takes na izvoz sirovine*. Retrieved August 17, 2018, from http://www.kfB&H.com/apel-drvnog-sektora--B&H-mora-sprijeciti-nekontrolisanu-sjecu-sume-i-uvesti-takse-na-izvoz-sirovine
43. Protić, M., Mitić, D. & Stefanović, V. (2011). Wood pellets production technology. *Research and development of energy and environmentally highly efficient polygeneration systems based on renewable energy sources, 2011*(3), 23–26.
44. Regionalna razvojna agencija za regiju Centralnu B&H. (2012). *Environmental Technologies & Renewable Energies in the Balkan Area*. Zenica: Regionalna razvojna agencija za regiju Centralnu B&H.
45. Renewable Resources Co. (2016, 9 December). *The Advantages and Disadvantages of Biomass Energy.* Retrieved March 20, 2018 from https://www.renewableresourcescoalition.org/biomass-energy-advantages-disadvantages/

46. Rinkesh. (n.d.). *What is Biomass Energy?* Retrieved April 22, 2018, from https://www.conserve-energy-future.com/biomassenergy.php
47. Roca, A. (2017). *The social impact of biomass: the importance of energy that improves our quality of life.* Retrieved February 09, 2018, from https://innergy-global.com/en/the-social-impact-of-biomass-the-importance-of-energy-that-improves-our-quality-of-life
48. Rosillo, F. (2003). *The role of biomass energy in rural development.* Retrieved October 30, 2018, from http://www.proceedings.scielo.br/scielo.php?script=sci_arttext&pid=MSC0000000022000000200011&1ng=en&nrm=van
49. Šajinović, D. (2018). *B&H napustilo 1,3 miliona građana*. Retrieved December 01, 2019, from https://www.nezavisne.com/novosti/bih/BiH-napustilo-13-miliona-ljudi/472787
50. Shelly, J. (2015). *Woody Biomass Factsheet*. Berkeley: University of California Berkeley.
51. Sofić, I. (2017). *Pelet, ogromni i neiskorišteni potencijal B&H*. Retrieved November 11, 2018, from http://balkans.aljazeera.net/vijesti/pelet-ogromni-i-neiskoristeni-potencijal-B&H
52. Sriram, N. & Shahidehpour, M. (2005). *Renewable Biomass Energy*. Chicago: Illinois Institute of Technology.
53. State Government of Victoria. (2017). *Benefits of bioenergy*. Retrieved July 05, 2018, from https://www.energy.vic.gov.au/renewable-energy/bioenergy/benefits-of-bioenergy
54. The Central Bank of Bosnia and Herzegovina. (2017). *Annual report*. Sarajevo: The Central Bank of Bosnia and Herzegovina.
55. Thrän, D., Peetz, D. & Schaubach, K. (2017). *Global Wood Pellet Industry and Trade Study 2017*. France: IEA Bioenergy.
56. Tulić, Z. (2017). *Zabrinjavajuće: Stanovništvo B&H se stalno smanjuje i sve više stari, a mladi se iseljavaju*. Retrieved December 12, 2018, from https://www.vecernji.ba/vijesti/zabrinjavajuce-stanovnistvo-B&H-se-stalno-smanjuje-i-sve-vise-stari-a-mladi-se-iseljavaju-1203012
57. U.S. Energy Information Administration. (2016). *International Energy Outlook 2016*. Washington, DC: U.S. Energy Information Administration.
58. UNDP. (2011). *Drvna biomasa za održivu budućnost, Kratki vodič za girjanjena drvnu biomasu*. Sarajevo: UNDP.
59. UNDP. (2014). *Mogućnosti korištenja biomase iz šumarstva i drvne industrije u Bosni i Hercegovini*. Sarajevo: UNDP.
60. UNDP. (2016a). *Analysis of the Benefits of Wood Biomass Fuel Switch Projects*. Sarajevo: UNDP.
61. UNDP. (2016b). *Analiza potencijala drvnih ostataka u B&H, s posebnim fokusom na opštine Srebrenica, Bratunac i Milići*. Sarajevo: UNDP.

62. UNDP. (2017). *Drvna Biomasa, gorivo budućnosti*. Sarajevo: UNDP.
63. Urquhart, B. & Boyce, G. (2016). *Woody biomass energy*. Massachusetts: Massachusetts sustainable forest bioenergy initiative.
64. USAID. (2014). *Wood pellet production in B&H, An Investment Potential Review*. Sarajevo: USAID.
65. USAID. (2016). *Report on current status and B&H potential to build biomass power and cogeneration plants*. Sarajevo: USAID.
66. Vanjskotrgovinska Komora Bosne i Hercegovine. (2017). *Drvna industrija B&H zabilježila rast izvoza za 10,7%*. Retrieved May 02, 2019, from http://www.komoraB&H.ba/drvna-industrija-B&H-zabiljezila-rast-izvoza-za-107/
67. Viaspace. (2019). *Biomass Compared to Fossil Fuels, Solar and Wind.* Retrieved September 14, 2019, from http://www.viaspace.com/biomass_versus_alternatives.php
68. World Bioenergy Association. (2019). *Global bioenergy statistics 2019*. Stockholm: WBA.

APPENDICES

Appendix 1: Summary

Predpogoj za katerokoli gospodarsko aktivnost je energija, kar je eden od najpomembnejših dejavnikov za gospodarski razvoj katere koli države. Številne razvite države, kot na primer nekatere države članice EU, težijo k doseganju ničelnih neto emisij ogljikovega dioksida in pri tem uporabljajo obnovljive vire energije. Cilj Bosne in Hercegovine je postati članica EU, korak bližje članstvu v EU bo, če bo skupni delež obnovljive energije predstavljal določen delež celotne proizvedene energije. Gospodarski in industrijski razvoj ni mogoč, če energetske politike niso ustrezne, z ustreznimi politikami pa je mogoče doseči cilje, kot so čisto okolje, zdravje prebivalstva, trajnostno gospodarstvo, dober življenjski standard in blaginja.

Biomasa je obnovljiv in trajnosten vir energije, ki se sprošča iz organskih snovi. Nahaja se v obliki lesnih odpadkov, lesa, lubja in drugega materiala različnih oblik in velikosti. Bosno in Hercegovino večinoma pokrivajo gozdovi, več kot 50% njenega ozemlja so gozdna tla in gozdovi, potencial za proizvodnjo izdelkov in energije iz biomase, ki temelji na trajnostni rabi, pa je velik. Dostopna in neizkoriščena gozdna biomasa v Bosni in Hercegovini znaša približno 4,3 milijona m3. Čeprav ima BiH velik potencial za proizvodnjo izdelkov in energije iz biomase, iz trajnostne rabe, obstajajo mnoge težave, povezane z uporabo gozdne biomase. Zaradi zapletenosti institucionalnega in političnega okvirja v Bosni in Hercegovini, potencial gozdnega ekosistema in njegova trenutna uporaba v Bosni in Hercegovini nista uravnotežena. Kar zadeva institucionalne in pravne predpogoje, se ti štejejo za veliko oviro pri mobilizaciji virov za proizvodnjo energije in so glavni razlog za premalo izkoriščanje gozdne biomase in obnovljivih virov energije v BiH.

Namen te teze je predstaviti obsežno analizo lesne biomase, podrobneje raziskati potencial njene proizvodnje v BiH ter predstaviti njen potencialni družbeno-ekonomski učinek. Analizirani so bili zlasti potenciali za lokalno proizvodnjo lesne biomase, z vidika določene industrije. Za ugotavljanje potenciala za proizvodnjo biomase v Bosni in Hercegovini je bila uporabljena metoda pregleda literature. Enako metodo smo uporabili za analizo prejšnjih raziskav uporabe lesne biomase in možne uporabe lesne biomase v Bosni in Hercegovini. Recenzirano literaturo najdemo predvsem v akademskih revijah, publikacijah, časopisnih člankih, knjigah in internetu. Prav tako smo uporabili kvalitativno analizo, sestavljeno iz polstrukturiranih pogovorov z vodstvom obstoječih proizvajalcev biomase iz občin, ki so bili izbrane na podlagi pregleda literature. V pogovorih so analizirane notranje zmogljivosti in zunanje okolje izbranih podjetij. S pomočjo pogovorov in pregleda literature je bil zagotovljen dober vpogled v poslovni potencial, zaposlitvene možnosti in potencial razvoja industrije. Poleg tega, v tej tezi so navedene ključne ovire pri mobilizaciji in trajnostni rabi biomase proizvedene v BiH, hkrati pa je predstavljen zapleten institucionalni in regulativni okvir, ki se nanaša na proizvodnjo lesne biomase.

Appendix 2: Interview structure

1. When was your company established?
2. How hard was it to establish a company that deals with the production of pellets?
3. Is the production of pellets the only production activity in this company?
4. Does the labor market offer adequate staff to work in your company? Do you have problems with access to highly qualified workforce and do you have some technological problems inside the company or problems with the placement of products on the market for which you would need to engage ad hoc experts?
5. How many workers are employed directly in the production of pellets?
6. What are installed capacities in your company and how technologically demanding is the processing operation?
7. Can the level of productivity and efficiency in your company be compared to competitors in the domestic and foreign markets?
8. What was your annual output in the last 5 years and what is the output value per worker?
9. Did your company elaborate a strategy for further development and do you have a plan to increase the number of jobs within your organization?
10. Do you invest in new technologies and if yes, what percentage of your income?
11. Are there problems for your existing and planned production with providing a raw material basis (e.g. wood, wood waste)? If you have problems related to procurement, what are the problems and what are the consequences of the problems with purchasing raw materials (costs, time management, delivery quality, product standard)? Were there any obstacles for improvement or solution of certain problems in procurement systems, such as the possibility of coordinating activities.
12. Do you plan to expand your production capacities?
13. Do you think that the demand for pellets in the B&H market offers the possibility of further expansion of your production?
14. Do you think that the domestic pellet production capacity can meet the needs of the domestic market?
15. What are the obstacles to further expansion of production capacities?
16. How much of your output is placed on domestic market and how much do you export?
17. From which sources do you get the biomass resources needed for the production of pellets?
18. Do you have cooperation with other producers from your industry?
19. Do you consider that the measures of the entity governments in the field of planning and creating energy policies are influencing and stimulating on domestic pellet production?
20. Are you satisfied with the existing legal solutions? Also, what measures of system support could make it easier for you to do business?

21. Do you satisfy part of your energy needs by using pellets (e.g. Heating your own facilities)?
22. Do you know how much pellet is used to meet the energy needs of households and how much for business purposes?
23. In your opinion, is there a good potential for further development of this production activity in B&H?
24. Do you have any guarantees from local or entity authorities for regular biomass supply?
25. How would you rate the current conditions for the production of pellets in B&H?
26. Do you think that the pellets that your company produces are competitive as an export products and if not, why not?
27. Is there an association of pellet producers at the entity or B&H level that coordinates joint actions and demands to the appropriate legislative and executive authorities?
28. Do you possess EN PLUS A1 certificate?
29. Is the procedure of obtaining EN PLUS A1 certificate demanding?
30. Are legal regulations well managed and do these regulations help or assist you in any way?
31. What are the biggest obstacles and challenges in your business?
32. How do you assess the level of competition on the domestic market?
33. Do you encounter unfair competition on the B&H market?
34. Is pellet production technologically demanding?
35. How competitive is B&H compared to the countries of region in the pellet production?
36. What are the main advantages of pellets compared to other energy sources?
37. Do you think that pellets are the most promising product of wood biomass in B&H?
38. Do you consider that the pricing of pellet heating is more favorable than other energy sources?
39. How would you rate the current position of this production activity in B&H?

Appendix 3: Feedback

In order to get some relevant market information if production of biomass or, more specifically, the production of pellets in B&H is desirable and profitable, interviews were conducted in different parts of B&H. Namely, three interviews, which contain 39 questions, were conducted with three prominent pellet production companies in different parts of B&H.

First company called *Duga Pellet d.o.o.* whose Director is *Mr. Milos Cvijetic*, is found in the Municipality of Sokolac, RS. Mr. Milos Cvijetic (later on in the text, called, the first interviewee) agreed to be interviewed, so he can contribute to this master thesis.

Second company called *Trgovir d.o.o.* whose former director and current commercialist is *Mr. Vehid Avdic,* is found in the Municipality of Gracanica, Tuzla Canton, FBiH. Mr. Vehid Avdic (later on in the text, called, the second interviewee) agreed to be interviewed, so he can contribute to this master thesis.

Third company called *Final Group d.o.o.* whose member of the board is *Mr. Adis Memic*, is found in the Municipality of Sanski Most, Unsko- sanski Canton, FBiH. Mr. Adis Memic (later on in the text, called, the third interviewee) agreed to be interviewed, so he can contribute to this master thesis.

Question 1:

The first interviewee said that the company for which he works was established in June 2013, and the production of pellets started in January 2014. The second interviewee said that the company for which he works was established in 1995 and the production of pellets started in 2010. The third interviewee said that the company for which he works for was established in 2014. In regards to given answers, it can be concluded that the production of pellets in these companies started not very long ago and that pellet production is something quite new for these companies.

Question 2:

The first interviewee said that it is a very hard process to establish a pellet producing company. He said that it takes a lot of time, money and patience to establish this kind of company compared to other production companies. He also added that the general perception of pellet production is that it is an easy process, but it is not. He also added that machines for pellet production are much more expensive now than they used to be. Second interviewee said that the procedure for establishing a pellet producing company is the same as with any other d.o.o. company. Third interviewee gave the same answer as the second interviewee.

Question 3:

The first interviewee said that it is not the only production activity that his company deals with, namely, his company also deals with the timber sawing activity, production of pellet elements and they are about to start the production of glued panels. Second interviewee also said that, besides of pellet production, his company produces nets and wire products and bitumen insulating tapes. The third interviewee said that, currently, the production of pellets is the only production activity that his company deals with. From the answers given, it can be concluded that the first two companies, which are present on the market for a longer time, have more production activities than just production of pellets, and that the third company which is the youngest among three pellet companies is currently only focused on the production of pellets.

Question 4:

The first interviewee said that it is the 'catastrophe' when it comes to the labor market and that there is no adequate staff to work for his company. He added that there is a lack of workers who are willing to work for this kind of company and other companies that deal with different kinds of production have similar problems. As for the highly skilled workforce, he said that he has no need for such workforce. He added that it is a complex production, but it is not so complex that his company would require some experts. He also added that his company has no need for any ad hoc experts. He claims that practice and experience is the most important quality that he looks for when it comes to new staff. Second interviewee said that labor market offers engineers who have no experience in pellet production. He said that his company offers training programs to them. When it comes to ad hoc experts, he said that they are mainly outsourced in order to solve problems related to electronics and PLC (Programmable Logic Controller) devices. The third interviewee said that there is less and less good staff offered on the labor market for the industry that his company is dealing with specifically. He also added that they engage ad hoc experts when there is a need to solve some technological problems. From the answers given, it can be concluded that the labor market lacks adequate workforce for the pellet producing companies and that there is a need for an ad hoc expert only when it comes to technology related problems.

Question 5:

The first interviewee said that there are eighteen workers employed directly in the production of pellets. The second interviewee said that there are sixteen workers employed directly in the production of pellets. The third interviewee said that there are 24 workers employed directly in the production of pellets and since they are planning to expand their pellet production capacities, they intend to employ 10 more workers in 2019. It can be

concluded from the given answers that approximately 20 workers in average are needed in order to have effective and efficient production of pellets.

Question 6:

The first interviewee said that last year his company has made 11,761 tons of pellet, 10,000 tons one year before and 8,000 two years before. He added that the last year was the best one when it comes to production and he doubts it will happen again in 2019. He said that it is easy to buy machines, when they have money for it, but the problem is to assemble, manage and lead the company. The second interview said that his company has installed capacities in amount of about 30,000 tons. He said that starting production is not possible solely based on securing facilities, machines and sufficient financial resources. The biggest problem is to secure raw material which does not depend solely on the financial means. The third interviewee said that his companies installed capacity is 18,000 tons per year. He added that it is certainly necessary to adapt and acquire certain knowledge and skills in order to adapt production. Based on the answers given it can be concluded that Trgovir d.o.o. has the biggest annual production of pellets, followed by Final Group d.o.o. and then Duga Pellet d.o.o. Also, it can be concluded that the most demanding processes in these companies are the assembly phase, management, having knowledgeable workforce and securing the raw material for the production.

Question 7:

The first interviewee said that they are competitive in B&H when it comes to technological and all other factors, even though there is a lot of unfair competition on the market (who are forced to sell their pellets for lower price otherwise their businesses would fail). He also added that they are sometimes competitive on multiple foreign markets because of the good price and good quality. However, when the prices go too high, they are not so competitive and other companies from other countries usually have better pellet producing technology. Second interviewee said that they consider themselves as one of the leading pellet producing companies in B&H, and when it comes to foreign markets, they lack information about it. The third interviewee said that their productivity level is currently very high when compared to the competition in B&H. He added that he does not have information about competitor's productivity. In terms of foreign competition (primarily the countries of Western Europe), the interviewee said that his company's productivity is somewhat lower because foreign companies have better technology and machines. From the answers given, it can be concluded that all three companies are competitive in B&H, that there is some unfair competition present on the market and that it is hard to compete on foreign markets since competitors from foreign markets are much more technologically advanced.

Question 8:

The first interviewee said that his companies average annual output is 9,000 tons in the last 4 years. The annual output is about 500 tons per worker. The second interviewee said that his companies average annual output is 12,800 tons in the last 5 years. The annual output is about 800 tons per worker. However, the third interviewee said that he will not give out this kind of information, because they consider it as confidential.

Question 9:

The first interviewee said that he plans to increase the number of jobs but not for the pellet production. He is considering to lower down the production of pellets in his company so he can develop other productions. The second interviewee said that his company plans to reduce the number of workers by introducing highly productive machines for the preparation of raw materials. He added that they are already working on this plan. The third interviewee said that his company is planning to increase the capacity to 100 tons of pellet per day or, to put it differently, production of more than 30,000 tons per year and employ another 10 workers. All three interviewees gave out different answers, the interviewee from Sokolac is not satisfied with pellet production in his company, the company from Gracanica wants to reduce workforce, possibly because of the costs reductions in their company and the third company wants to expand its production and hire more people.

Question 10:

The first interviewee said that his company always invests in new technologies on a yearly basis, but not so much for pellets. He said it is not hard to follow technological improvements when it comes to pellets, since the technology is more and less the same all the time. Second interviewee said that approximately they invest about 30-40% of their profits into new machines. He added that it is not necessary to follow new achievements because pellet technology does not demand high-level equipment. The third interviewee said that his company is investing in new technologies every year and that he could not tell me the percentage. He added that it is very demanding and very costly to follow technological innovations in this industry. It can be concluded that all of the companies invest in new technologies, that the technology can be expensive and, in the case of first interviewee, his company is focusing more on the other branches of his business instead of pellet production.

Question 11:

The first interviewee said that his company has less suppliers (it is getting harder to get supplied) of the raw materials compared to before and that the prices of raw materials are

much higher now than before. The reason for this is higher competition (many unfair competitors on the market too) on the market compared to before. He also added that he believes that acquiring the raw materials is not a big problem currently, but that it will become a bigger problem in the future. The second interviewee said that in this business the biggest obstacle is the procurement of raw materials. B&H managed to largely clean its forests of so-called "sick forests", and in the time to come, there will not be enough raw material for the production of pellets. The main problem is the availability of raw materials in the B&H market. The third interviewee said that his company currently has no problems with securing raw materials.

Question 12:

The first interviewee said that he sees no possibility to expand production capacities for the pellet segment of his company. The second interviewee said that his company has capacity to produce 30,000 tons annually and that they work with 50% capacity. Their second line serves as a backup. The third interviewee said that there is a possibility for expanding production capacities within his company.

Question 13:

The first interviewee said that there is a possibility for further expansion of production, because pellets are in high demand. He also added that there are too many pellet companies appearing on the market and, because of that, everybody produces less than before. The second interviewee said that they cannot expand their production because there is a lack of raw materials. The third interviewee said that there is a possibility for expansion.

Question 14:

The first interviewee said that the domestic pellet production can surely meet the needs of the domestic market, because the domestic market is very small. He said that in 2017 he sold 30% of his production in B&H and 70% was exported to other countries. He also added that most of the major producers have to be export oriented, because they have no space to place such quantities of pellet on the domestic market. The second interviewee said that production capacity exceeds the domestic demand and that export of pellets makes about 40%. The third interviewee said that currently production capacities can satisfy domestic demand, but in 2019 he thinks that it will not satisfy the domestic demand.

Question 15:

The first interviewee said that there is too much favoritism in public initiatives. If pellet producer is convenient for some political party, then that producer will most likely get

most of the benefits and initiatives. When it comes to banks, he said that everything is in order. When it comes to quality of the product, he sees no problems. B&H has very good pellets, much better than in Ukraine or Estonia for example, he added. When it comes to regulations, he said that they are very unfavorable for pellet producers. When it comes to certificates, he said that it is not hard to obtain, mostly it is all about paying for the certificate. The second interviewee said that the company for which he works for has all of the certificates, but the only obstacle he sees is the lack of raw material. The third interviewee said that the biggest obstacle for his company is the provision of an adequate amount of working capital in order to organize production on annual basis.

Question 16:

The first interviewee said that his company focuses two thirds of their production on export and one third on the domestic market. The second interviewee said that 60% is export, and 40% is placed on the domestic market. The third interviewee said that 70% is export, and 30% is placed on the domestic market.

Question 17:

The first interviewee said that it is cellulose wood, chips and sawdust. The second interviewee said that it is waste from sawmills and PE wood (Public enterprise 'woods'). The third interviewee said that their biggest supplier is ŠPD Unsko -Sanski Šume.

Question 18:

The first interviewee said that they do not have cooperation with other producers because most of them are unfair. The second interviewee said that they have established communication with other producers and that they exchange their experiences. The third interviewee said that they have some cooperation with other producers of pellets.

Question 19:

The first interviewee said that they do not influence in any way, especially as far as renewable energy sources are concerned. He added that media reports are mostly false. They are saying that entity governments are supportive, which is not true. The second interviewee said that entity government has no strategies at all. The third interviewee said that unfortunately entity government is not doing anything to stimulate pellet production.

Question 20:

The first interviewee said that he is not satisfied and that there are no initiatives. He thinks that the government can do much more to help pellet producers. The second interviewee said that there should be incentives for clean energy producers, from the funds for

renewable energy sources that citizens fill up by paying electricity and otherwise. Pellet manufacturers build clean energy, he added. The third interviewee said that co-financing procurement of pellet heating systems by the state for households and public institutions (schools, hospitals, etc.) could make their business go easier.

Question 21:

The first interviewee said that currently they do not use pellets to satisfy their energy needs. The second interviewee said that all of their facilities have heating that contains pellet boilers. The third interviewee said that they do satisfy part of their energy needs by using pellets.

Question 22:

The first interviewee said that on the domestic market pellets are used mostly by households. For business purposes, there are plenty of bakers who switch to pellets instead of gas and electricity and use it as an energy source. As far as the factories are concerned, some use pellets, but it's a smaller number. The second interviewee said that he believes that there are more consumers in the households, although there is an expansion of the installation of pellet boilers in public institutions (hospitals, health centers, schools, etc.). The third interviewee said that they have no relevant information about this specific question.

Question 23:

The first interviewee said that there was a potential until a large number of producers appeared on the market. He added that he personally would not make the pellet producing company again. The second interviewee said that he thinks this branch has reached its peak, because the expansion of this branch of industry will result in a rise of the raw materials pricing and this will follow with the increase in the prices of pellets. In this case they would not be competitive anymore on the foreign market; therefore, people would start returning to other alternative heating methods in the domestic market. The third interviewee said that he believes that there is a good potential for further development.

Question 24:

The first interviewee said that they have, but only on paper. He added that there are no guarantees when it comes to local or entity authorities, which are not serious. The second interviewee said that they have no guarantees and that authorities are not doing their job at all. The third interviewee said that besides annual contracted amount with ŠPD US Šume, there are no guarantees.

Question 25:

The first interviewee said that there is supply and demand, but there is still competition since a lot of people produce pellets. Generally, the problem will be the raw materials. In his opinion, this is the biggest problem. All raw materials that are used to produce pellets are supplied to Natron company found in Maglaj, they purchase huge quantities annually, he added. Overall, he is not quite pleased with the conditions for pellet production currently. Second interviewee said that in this current situation he sees no future for the pellet production in the next five years. The third interviewee said that on the scale of 1 to 10, the conditions for the production of pellets in B&H are 6, in his opinion.

Question 26:

The first interviewee said that his product is competitive when it comes to quality and price. He added that last summer he had the cheapest pellets and the quality of his pellets and burning of his pellets can be compared with European pellets. The second interviewee said that his pellets are still competitive because of geographical proximity to Slovenia and Italy, in relation to Poland, Ukraine, Lithuania or Russia. He added that he does not know what will happen in the future. The third interviewee said that pellets that his company produces are competitive as an export product.

Question 27:

The first interviewee said that there are few associations, but all of them have no purpose nor function. He added that these associations are poorly organized. He also added that there is some association at the regional level, but it is 'nothing special' and pellet producers have no benefits from it. The second interviewee said that there is an association that was founded under the auspices of UNDP (UNDP), but that it is not doing anything. He added that he himself is currently working to gather pellet manufacturers in order to act on all levels of government. The third interviewee said that that there are no associations whatsoever.

Question 28:

The first interviewee said that his company does not possess EN PLUS A1 certificate but that they do have an EN PLUS A2 certificate. He said that the only difference between EN1 and my EN2 is the percentage of ash. He also added that most pellet producers in B&H have an A2 certificate, they rarely have an A1. The second interviewee said that they possess EN PLUS A1 certificate, but that they do not produce this kind of pellets because of the quality of raw material. He added that they also possess EN PLUS A2 certificate and that they produce this kind of pellets. The third interviewee said that they currently possess an EN PLUS A2 certificate, but that they are in the process of obtaining an A1 certificate.

Question 29:

The first interviewee said that it is not that demanding. The EN Plus organization has people in every country, who conduct training, implement main supervisory audit and share certificates that are monitored and maintained annually. The second interviewee said that it is very demanding, and lasts for several months. He added that the biggest problem is maintaining this quality, i.e. ash is less than 0.7%. The third interviewee did not answer this question since they do not possess EN PLUS A1 certificate.

Question 30:

The first interviewee said that it depends. He said that it is always debatable to talk about regulations, and there are good and bad things about this topic. He said that legal regulations are more harmful than beneficial to pellet producers. The second interviewee said that there are no specific legal regulations that regulate this area of business, and that he has no particular opinion about it. The third interviewee said that his company is satisfied with the current legislations.

Question 31:

The first interviewee said that the biggest internal obstacles are demanding production, failures, maintenance, congestion, fractures and fires. He added that the biggest problem of an external character is the lack of raw materials and unfair competition, which lowers prices when it needs quick money. The second interviewee said that the biggest obstacles and challenges in his business are procurement of raw materials and the sale of pellets. The third interviewee said that the biggest obstacle and challenge is securing working capital.

Question 32:

The first interviewee said that there is a lot of competition on the domestic market, and that the level of competition is rising each year. The second interviewee said that the competition is like any other competition. He said that there are many smaller manufacturers who are on the verge of surviving, and they are lowering the price of pellets in the off-season, but, generally, they do not have competition problems. The third interviewee said that the level of competition is not so high, because the number of producers who have similar capacity as their company, work consistently and their quality requirements are low.

Question 33:

The first interviewee said that they do. He said that there are companies that are suitable for some political interests and are ahead of everyone. As far as price dumping is

concerned, nobody does it as a real dumping, companies do it just to survive on the market. He also added that he has not seen classic dumping on the market yet. As for the special conditions for the procurement of raw materials, he added that there is no such thing, for example, cellulose wood per cubic meter is around 25 Euros everywhere. He also added that, generally, private forests are more expensive than state-owned and only foreign companies can have advantage from private forests, because the prices of those forests are cheaper than in their native countries. The second interviewee said that there is unfair competition. He added that the that the raw material is obtained by companies that do not deal with the production of pellets, and later this raw material is sold to pellet producers at a higher price. The third interviewee said that there is unfair competition, especially when it comes to the sale of poor-quality pellets, which violates the reputation of the industry.

Question 34:

The first interviewee said that it is demanding. He added that there are too many maintenances and breakdowns. He also added that there are huge costs when it comes to malfunctions, every failure is very expensive. The second interviewee said that for his company it is not demanding, but he believes that for some companies it can be too demanding. The third interviewee said that it is demanding for his company.

Question 35:

The first interviewee said that B&H is competitive because it has the cheapest raw material in the region. He added that B&H is a much smaller pellet producer than Serbia and Croatia, for example. As for the potential, every country in the region has similar potential. He also added that Croatia currently has the most developed wood industry in the Balkans. The second interviewee said that he thinks B&H is competitive because it has a lot more forest resources than the surrounding countries. The third interviewee said that B&H is very competitive because it has the highest quality raw material base.

Question 36:

The first interviewee said the main advantage of pellets are their functionality. People do not have to deal with wood cutting. He added that if the pellet prices would be lower, this would present a major advantage of pellets over other energy sources. He also added that the realistic prices of pellets per ton should be around 135 Euros in the summer period and around 160 Euros in the winter period. The second interviewee said that compared to gas, electricity and oil, pellets are cheaper energy source. Also, he added that compared to coal and wood, pellets are simpler to heat and clean. The third interviewee said that compared to wood, pellets are much more efficient and cleaner and compared to fuel oil and natural gas, the price is more favorable.

Question 37:

The first interviewee said that in the wood industry there are many more products that are worth more than pellets. For example, glued panels, furniture and carpentry. He says that he sees greater potential in these products because fewer raw materials are need, there is a greater degree finalization, and the profits are greater. The second interviewee said that he thinks that pellets are not the products with highest potential, and the final production of furniture is the future of the wood biomass industry because there is a larger share of labor and intelligence. He also added that the production of pellets is an accompanying branch in relation to the production of furniture. The third interviewee said that he believes that the pellets are the products with highest potential when it comes to wood biomass in B&H.

Question 38:

The first interviewee said that the prices are more favorable but not by much compared to the other energy sources. The second interviewee said that the prices are more favorable when compared to electricity, gas and fuel oil. The third interviewee said that prices would be more favorable if people would use a good fireplace or pellet boiler and would properly handle them.

Question 39:

The first interviewee said that if the prices of pellets are realistic than it is well positioned, and if we are talking about very high last year's prices, in that case it is not. He thinks that in following years many people will abolish pellets because of the high prices. The demand can be satisfied he added, but the problem is also because artificial crises are made, for example, Hifa company buys everything, stores it, waits for people to start to demand pellets, and then raises prices and sells it. He said that pellets are best supplied in the summer, but the problem is in that period it is exported abroad. Hifa company has no pellet production, and has sold about 50,000 tons of pellet last year. The second interviewee said that the pellets are well positioned, and that it is competitive in relation to gas, electricity and petroleum oil, and has recently been competitive in relation to coal as households increasingly have problems with coal supply at favorable prices. The third interviewee said that pellets are quite competitive compared to other energy products. The procurement of a heating system for pellets is the biggest obstacle in increasing the number of pellet users in B&H.