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Study in Forest Biomass as an Alternative Fuel

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1. SUMMARY

Increasing demand and existing prices of wood have drawn the attention at the policy level to improve mapping of different sources and uses of wood.

The same method of wood biomass was also applied on a regional level, in the study "Feasibility Study on Wood Waste Utilization in Serbia".

This study is addressed to decision-makers in the field of renewable energy, forestry and wood-based industries. The objective is to assess the current role of wood energy and its future potential to help to achieve political goals on renewable energy and climate change.

The focus of the assessment presents situation in the Kosovo.

Pellet/briquettes information

Pellets and briquettes are produced by the same raw material, but pellet are better for fuel because of its dimensions and small size, which allows for precisely regulated fuel feed.

Wood pellets are wood small cylindrical pieces made of wood waste such as wood chips and sawdust. These raw materials are shredded and compressed under extremely high pressure, using no glues or other additives. Lignin, the wood's own natural 'glue' is the only binding agent.

All pellets/briquettes are from biomass materials, those are, product of commonly grown plants and trees. The most common residential pellets are made from sawdust and ground wood chips, which are waste materials from forestry, trees used to make furniture, lumber and other products. Resins and binders (lignin) occurring naturally in the sawdust hold wood pellets together, so they usually contain no additives. Nut hulls and other materials are pelletized in some areas, and unprocessed shelled corn and fruit pits can be burned in a few pellet stove designs. Its price may depend on the waste biomass most available to pellet mills in Kosovo.

Benefits of wood pellets:

- Wood pellets are a carbon neutral heating fuel
- Wood pellets come from forestry wood waste and wood processing residues
- Using wood pellets, stimulates our economy and creates a green jobs
- Modern fuel combustion is extremely clean-burning system, with extremely low emissions
- Using biomass for heat is more efficient than allocating those same resources to make electricity or bio-fuels

Pellet fuel is renewable energy, environmentally safe and has positive economic impact:

What are the common characteristics of pellets?

Although the chemical constituents and moisture content of different biomass materials vary, wood biomass has better thermal values. The previous studies has identified common characteristics and developed fuel standards. These voluntary industry standards assure as much uniformity in the final product as is possible for naturally grown materials that become processed, but not refined fuel.

Pelleting/briquetting process means compacting wood materials in a convenient form, which has significantly less volume than the starting material (raw material), where process the volume of biomass is reduced 10-12 times. Density of briquettes and pellets is 800 to 1200 kg/m^3. Low thermal power of briquettes or pellets are similar as that of coal (14 to 17 MJ/kg).

What fuel advantages do pellets offer?

The first appeal of pellets is their convenience. Bags of pellets stack compactly and store easily. A ton of pellets can be stacked in an area as small as four feet wide long and high, an area about half the space needed for a cord of wood. Bags of pellets can be stored in a small area of a dry garage, basement, utility room or shed.

Pellets are also convenient because they load easily and cleanly into the stove hopper. Loading the hopper is normally required only once a day and may be even less frequent when the stove is used on low settings.

The small size of pellets allows for precisely regulated fuel feed. In turn, combustion air can be regulated easily for optimum burn efficiency since the amount of fuel in the burn pot is predictable and consistent. High combustion efficiency is also due to the uniformly low moisture content of pellets (consistently below 15% compared to 20 to 60% moisture content in cordwood). Uniformly low moisture, controlled fuel batches and precisely regulated combustion air means high heat output and a very low level of unwanted emissions.

Other environmental benefits besides clean burns result from the use of pellet fuels. As a biomass fuel, pellets offer the advantages of sustainable energy supplies through renewable raw materials. In addition, pellets are a by-product, not a primary user, of these renewable materials. Using pellets also helps reduce the costs and problems of waste disposal. As part of the heating tradition, pellet burning offers the enjoyment of fire viewing and active participation in providing winter comfort in the home.

Promotion use of biomass!

In Kosovo there are opinions that do not contribute utilization of wood biomass, such as opinions that the natural gas the economically most cost-effective source of heating, then is electricity, the use of coal, fire wood, etc.

Production of pellets in Kosovo!

Pellets production in Kosovo is in the initial stage.

The aim of this study is to collect necessary dates and experience of using the briquettes and pellets as an alternative fuel, to determine the situation in Kosovo, which is located in relation to the countries of the region and Europe and to define the following direction, specifically the direction of further development the techniques and technology of using the briquettes and pellets..

Kosovo is country with forest land surface of 464.800 ha or around 42% of the total area. Municipalities with the highest coverage of forest and forest lands are Peja, Decan, Istog, Mitrovica, Kamenica, Kacanik, Prizren, Dragash, Leposavic and Ferizaj.

Total calculated wood stock in Kosova forests is around 53 mil.m^3 [1]. There is a lot of wood, which annual growth (increment) is around 1.3 mil.m^3. Available annual cut is around 900.000 m^3 or 66% of annual increment, but currently, because of week organizational and management structure, annual cutting is fare below. Based on this available annual cut, wood waste from tree harvesting will be around 400.000 m^3 annually or 42%.

Kosovo Forest Agency (KFA), every year usually harvests about 250.000 m^3 or about 18% of annual growth, which is the smallest percentage of the annual growth using in the region. Forest harvesting utilization rate in Kosovo is very low compare with utilization forest increment in the region, which is between 50% and 75% in the region and Europe. Based on demands and prices, much more wood could be harvested. Another reason for this low forest harvesting is because of very high illegal cuttings, which are present in around of 69 % of total forest area of that (40% in public and 29% in private forest).

[1] FAO Forest Inventory 2002/2003

The wood volume illegally harvested is calculated in amount of 500.000 cubic meters annually [2] and in this area has more forest waste, because they are not controlled. Illegal cutters take only a small part of trees and rest of about 85% remains in the forest. Wastes from illegal logging in those areas is estimated based on concrete simple plots, which are accumulated for at least ten years.

The wood demand in Kosovo is around 1.3 million m³ annually, and is provided by legal and illegal cuttings in our forests. Theoretically, wood waste from this cutting, is about 500.000m³ annually.

In forest areas under illegal cutting, utilization rate is very low. From measurements performed by our team, results are the same, or at least 330.000m³ (reconciliation of the data) annually.

In some companies, practically all wood waste is used in either board production or as a fuel to produce heat, but other wood processing companies don't use its wood waste. They throw wood waste in trash.

In a well organized company, practically all wood waste is used in either board production or as fuel to produce heat and electricity. However, some wood processing companies in Kosovo have available wood biomass, but they don't use in proper way. Instead, they either spread the waste around their property, or simply push it into rivers, discarding a potentially valuable energy producing resource.

In European Union price of pellets is about 150 €/ton (wholesale price). This makes pellet production very attractive to Kosovo producers. In Kosovo labor cost is low, price of wood wastes from forestry and wood processing companies is also low, and other obligations are low too. The high price of pellets in Europe would probably drive up the price of pellets in Kosovo. That, combined with the previously described conditions, is probably obstructing the utilization of wood pellets in Kosovo.

Standing value of technical beech woods is in average of 25 €/m^3, whereas average price of standing fuel wood is around 11 €/m^3, while the price of hardwood waste is about 6 €/m³ in forest.

A tractor trailer with sawdust and residues from sawmills (about 2.5m^3) costs 20€ or 8 €/m^3 of very qualitative raw material. Price of wood residues in wood processing plants is similar or it is for free.

[2] RIINVEST "Forest Industry Challenges of development and Balanced Use" Final report, 16-th of January 2008, page 34

With simple mathematical calculation, the price of pellets will be 49 €, lower than if compared to 81 €/ton in the EU countries. The investment cost for pellet plant is relatively low. The main operating costs are transport of raw material from forest and wood processing plants. The price of pellets in Kosovo is more than 100 €/ton, because is imported from Serbia, while in EU countries is between 220 and 260 €/ton (retail price).

Now in Kosovo the price of one cubic meter (stacked volume) of fuel wood is around 30-40 €.

Demands of household heating in Kosovo are about 1.3 mil./m^3 of fuel wood, which demand cause illegal cutting.

Present age of Beech and Oak low canopy forest in Kosovo is very high. That is reason to present soma data of Beech species: One cubic meter of beech sawdust has about 600/700kg, whereas one cubic meter of briquettes is energy equivalent with 4m^3 or 5.79 stacked meter, with price of 204.4 €. The price of pellets and briquettes is much cheaper (about 100€ /t) and it is cleaner for use.

Energy value of pellets obtained from wood residues is about 19-20MJ/kg or compared 2kg of pellets replace by 1 liter of light oil or 0.9l propane butane gas.

The market for biomass pellets could easily become more viable for the domestic households. In a price comparison of different fuels in Kosovo, wood pellets priced of 100 € per ton would be the cheapest fuel. Further, the different types of coal usually used in Kosovo are priced about the same as firewood.

One ton of wood pellets can replace almost two tons of lignite coal, or a little less than half a ton of fuel oil. Using wood waste in such a productive manner will benefit local communities in forested areas with job creation in wood harvesting, collecting and transporting wood waste. Employment of local people in wood pellets producing and wood waste utilization for heating and other purposes will bring significant economic benefits to the community.

2. INTRODUCTION

This short study presents a review of the energy potential of wood biomass from forestry and wood processing, and actual state of biomass energy utilization in Kosovo. The estimated of annual energy potential is at least 430.000m³ annually of biomass from forestry and wood processing.

Towns located in regions rich in forest, can satisfy their energy demand for centralized heating system with biomass residues from the territory of their own municipality. With appropriate energy policy, information campaign, research activities and general regulation in the field of biomass energy utilization, the share of biomass energy consumption in total energy balance can be significantly increased.

In developed countries, renewable energy sources have got an important and publicly emphasized role in helping to solve environmental problems. But, besides helpful effects on the environment, renewable energy sources can help in other aspects, like rural development through employment of local inhabitants, energy supply diversification, lower energy dependence on imported fuels, increased reliability of energy supply, possibilities for domestic industry to be engaged in development and implementation of renewable energy projects.

European Union Directive 2001/77/EC for promotion of electricity produced from renewable energy sources gives a relatively wide definition of biomass: biomass shall mean the biodegradable fraction of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste. But national legislation can define more precisely what is considered as biomass wastes. Commonly, the following is not considered as biomass: mixed municipal solid waste, sewage sludge, textile, paper, cardboard and wood waste that contains above a certain value toxic components added during wood processing. This approach to definition of biomass was adopted for assessment of biomass energy potential in Kosovo.

This study analyzes the opportunists in Kosovo, present wood residues for pellet production, assesses the competitiveness of different sectors for utilization of wood waste, and recognizes the main stakeholders regarding prospective production and transportation chain of pellets, and the economic feasibility of the production of wood pellets.

Information and dates for drafting this study are gathered from Ministry of Agriculture, Forestry and Rural Development (MAFRD): Forestry Department (FD), Kosovo Forest Agency (KFA), Non governmental organizations, different associations, and other public institutions such as FAO, SIDA, USAD, and GTZ... Existing wood wastes data’s are calculated through field measurement.

3. PRIMARY BIOMASS RESOURCE SUPPLY ANALYSIS

A great part of country is covered with forests. Municipalities such as Decani, Peja, Istog, Zubin Potok, Leposavic flat in forest area. This region is the main source of forestry wood products and wood biomass wastes, especially wastes from forests of Decan region, where most of conifer logs comes from illegal cuttings, and their residues left in the forest in last ten years.

Wood processing industry in Kosovo is based on primary wood processing (sawmills). In this part of the study will be displayed the amount of forests in Kosovo, which belongs to countries relatively rich in forests.

Current forest area in Kosovo is 464.800ha or 42% of the total area, where 60% is public, while 40% are forests with private owners Broadleaves trees dominate with 90%, by species beech and oak, while 9% are conifers, where dominate spruce, fire and pine species. During the time there were some activities about a forestation and reforestation in country level.

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Figure 3.1 Kosovo Relief

3.1 Opportunies for Increasing Wood Production

Previously provided score of forest condition are the basic for forestry development strategy which aims:

- to improve the quality and quantity of forest stands
- to increase the forest surface
- to plant fast growing trees plantation, like poplar and willow
- infrastructure investment in forestry, especially in the opening amount forestry communications, they would be able to use the entire amount of forest space. This would create opportunities for using of full annual growth, what today it is not possible, because of lack of forest infrastructure

3.2 Forest Wood Potential in Kosovo

Forest and forest lands in Kosovo have surface of 464.800 ha or 42% of total Kosovo's area. Wood volume in forest is 53mil.m³, with annual growth 1.3mil.m³.

Municipalities such as Decani, Peja, Istog, Zubin Potok, Leposavic are very rich in forest. Opening of forest roads can be used this allowed annual cut from 900.000m³/year or about 69% of annual growth. Based on this available annual cut, wood waste from tree harvesting can be little less then 400.000m³ annually.

Forest area in Kosovo municipalities:

	Municipality	Public forest (ha)	Private forest (ha)	Total area (ha)
1.	Decan	14.291	4.732	19.023
2.	Dragash	4.815	1.523	6.338
3.	Ferizaj	8.734	4.137	12.907
4.	Fushë Kosovë	1.059	331	1.390
5.	Gjakovë	16.442	10.311	26.753
6.	Gjilan	10.851	13.384	24.235
7.	Drenas	3.255	7.219	10.474
8.	Istog	14.323	6.371	20.694
9.	Kamenicë	8.708	11.686	20.394
10.	Kaqanik	12.219	5.150	17.369
11.	Klinë	6.536	5.032	11.568
12.	Leposaviq	17.258	10.250	27.508
13.	Lipjan	8.727	4.227	12.954
14.	Malishevë	6.554	7.286	13.840
15.	Mitrovicë	9.637	10.687	20.324
16.	Novobërdë	1.262	1.517	2.779
17.	Obiliq	754	399	1.153
18.	Pejë	16.934	8.774	25.708
19.	Podujevë	13.535	12.431	25.966
20.	Prishtinë	9.462	18.895	28.357
21.	Prizren	17.400	7.465	24.865
22.	Rahovec	4.373	3.228	7.601
23.	Shtime	2.925	3.451	6.376
24.	Shterpcë	8.731	1.600	10.331
25.	Skënderaj	3.407	11.819	15.226
26.	Suharekë	8.059	7.011	15.070
27.	Viti	8.055	1.881	9.936
28.	Vushtrri	4.464	5.966	10.430
29.	Zubin Potok	9.104	11.669	20.773
	Total forest area (ha):	**251.886**	**198.432**	**450.318**

Table 3.1 Dates from Kosovo Cadastre Agency

The main species are: broadleaves – beech and oak and conifers, which includes spruce, fire and pine.

Table 3.2 Age and types structure of public forests in Kosovo:[3]

Forest age class	Structure types					Total	
	Without trees	Conifer trees	Broadleaves trees	Mixed trees	Without dates	ha	%
0 – 20	4.400	400	75.400			80.200	29
20 – 40		3.200	45.400	400		49.000	18
40 - 60		3.800	26.400	1.000		31.200	11
60 - 80		3.400	23.200	400		27.000	9
80 – 100		1.600	5.400	200		7.200	3
100 – 120		1.000	3.800			4.800	2
120 - 140		1.400	2.000			3.400	1
No data					76.080	76.080	27
Total	**4.400**	**14.800**	**181.600**	**2.000**	**76.080**	**278.880**	**100**

FAO Forest Inventory 2002/2003

Table 3.3 Age and types structure of private forests in Kosovo:

Forest age class	Structure types					Total	
	Without trees	Conifer trees	Broadleaves trees	Mixed trees	Without dates	ha	%
0 – 20	2.200	600	45.600			48.400	26
20 – 40		1.000	59.400			60.400	32
40 - 60		1.400	40.200	400		42.000	23
60 - 80		800	13.600	400		14.800	8
80 – 100		400	6.400			6.800	4
100 – 120			2.000			2.000	1
120 - 140			2.000			2.000	1
No data					9.520	9.520	5
Total	**2.200**	**4.200**	**169.200**	**800**	**9.520**	**185.920**	**100**

FAO Forest inventory 2002/2003

The tables indicate that in Kosovo 185.920 ha or 40% of total forest area are private forest, while the 278.880 ha ore 60% are public forests.

There are some protected zones, protected species of flora and fauna. There is one National Park “Sharr” with surface of 39.000ha which is located in territory border with Republic of Macedonia and four municipalities: Prizren (19.500ha), Shterpce (15.210ha), Suhareka (2.730ha) and Kacanik (1.560ha). Management and organizational structure of this Park are unclear, even that during the time has been some activities taken from Ministry of Environment and Spatial Planning (MESP).

[3] FAO, Kosovo Forest Inventory, 2002/2003

Figure 3.2 Borders of National Park ‘Sharri’

Table 3.4 Forest wood resources in Kosovo:

	Total wood volume in forest	Annual volume increase	Wood cutting	Cutting/increase
	m^3	m^3	m^3	%
oak	9.675.000	389.000	45.049	11.59
beech	15.963.000	436.000	180.196	41.33
other broadleaves	21.838.000	351.000	1.423	0.41
spruce	2.979.000	123.000	15.956	12.97
black pine	2.019.000	61.000	1.058	1.73
other conifers	545.000	7.000	85	1.21
total	**53.019.000**	**1.367.000**	**243.767**	**17.8**

Only pure stands of species.

Annual harvesting Plan for 2008, in public forest were 102.634m^3, while in private forest were 141.133m^3 ore in total 243.767m^3.

The annual growing utilization is about 18%, while average annual growing utilization in the region and in the Europe is between 50% and 75% of annual growing. By the term good infrastructure, the dominant meaning is a widely developed network of forest roads covering all forest areas. By improving the infrastructure in forests, Kosovo will have greater potential for sustainable use of wood from forests.

Table 3.5 Annual growth of trees by species:

Species	Public forest (m^3)	Private forest (m^3)	Total volume (m^3)	Percent of total volume (%)
Oak	99.000	290.000	389.000	4.0
Beech	320.000	116.000	436.000	2.7
Other broadleaves	75.000	76.000	151.000	4.1
Spruce	73.000	7.000	80.000	5.1
Red spruce?	27.000	16.000	43.000	3.1
Black pine	60.000	1.000	61.000	3.0
Other conifers	6.000	1.000	7.000	3.0
Broadleaves in unvisited area	180.000	20.000	200.000	3.3
Total (m3)	**840.000**	**527.000**	**1.367.000**	**3.4**

Total annual growth is 1.367 million m^3, of this: 840.000m^3 in private forest and 527.000 m^3 in public forest. Through improvement of forest infrastructure, annual cut could be around 900.000m^3 or 66% of annual growth.

Currently, Kosovo does not have land set aside specifically for energy crops, but research and analysis show that land which is not suitable for conventional agricultural crops would be suitable for planting poplar trees. These forests could be used as energy crops, as so-called short rotation species. This area in the plains regions near rivers and channels has an estimated of about 50.000 ha. This is an additional opportunity for the increasing wood biomass sources.

Average volume stock in public forest is 100.5m^3/ha, while in private forest is 77.7m^3/ha. Average of volume stock in Kosovo forests is 91.1m^3/ha with average annual growth of 3.0 m^3/ha.

Table 3.6 Reforestation and a forestation per years:

Year	2004	2005	2006	2007	2008	2009
Aforestation (ha)	18	390	196	67	512	830

Main species suede for forestation and reforestation were Black Pine and Spruce.

3.3 Forest Wood Potential in the Region (Albania, Montenegro, Serbia, Croatia, Bosnia and Herzegovina)

A comparison of the basic dates related to wood resources between countries in the region (Albania, Montenegro, Serbia, Croatia, Bosnia & Herzegovina), shows that Kosovo has the smallest potential of forest wood. The forest area in Kosovo is the smallest in surface with 464.800 ha. Among those countries, Kosovo is the most densely populated, and this fact decreases the value of forest area per capita down to 0,221 ha. This area is small when compared to the values of other countries, which are at least double that area.

Table 3.7 The forest wood resources in the region:

	Kosovo	Albania	Montenegro	Serbia	Croatia	Bosnia and Herzegovina
Country area (ha)	1 106 667	2 874 800	1 381 200	7 747 400	5 654 200	5 119 700
Population (million)	2.1	3.4	0.62	7.5	4.44	3.98
Forest area (ha)	464 800	1 502 200	621 000	1 980 000	2 485 000	2 700 000
Forest wood volume (million m^3)	53	72	70	205	300	502
Annual increase (million m^3)	1.36	0.4	1.75	5.23	8.00	14.86
Forest area (%)	42.0	32.8	45,0	25.6	43.9	52.7
Forest area per capita (ha)	0.221	0.442	1.002	0.264	0.560	0.678
wood cutting (m^3/year)	250 000	223 900	631 000	2 585 000	5 300 000	7 250 000
Ratio cutting/volume increase (%)	18	55.9	36	49.4	66.2	48.8
Wood cutting per capita (m^3)	0.105	0.07	1.018	0.345	1.195	1.031
Consumption of fuel wood (m^3/year)	1 300 000	500 000	175 000	1 415 000	1 500 000	1 459 000
Consumption of fuel wood per capita (m^3)	0.62	0.16	0.282	0.182	0.169	0.367

The state of energy sector in Albania

During last 15 years, Albania is faced with the free market economy, which is characterized by a growing need for energy. Social-economic developments during the last two years did not reflect a very favorable situation in the energy sector, which is mainly based on the hydropower. During last decades the capacities of energy production in Albania have not changed, although demand for energy has increased. Therefore, Albania is now facing the challenge to expand its energy production, not only with hydropower but also from other sources. In this context, the forest sector in Albania could play a modest role for providing renewable energy in order to fulfill the demands of our society for energy. However, it is important that the principles of sustainable forest management are obeyed, to ensure the long-term availability of wood as resource, and the sustainability of this energy source.

Albania has two main sources of energy: the first is hydropower from rivers, used mainly to produce electricity (electricity from hydropower is regarded as a clean form of energy because it does not directly cause pollution to the atmosphere) and the second source is oil/gas.

Primary energy sources for domestic use in Albania:

- Electric power…….58.5%
- Gas……..15.4%
- Kerosene……...2.5%
- Firewood……23.4%
- Others……...0.3%

After electricity, fire wood consumption is the main heating source. Most of the fire wood is used in the rural areas, where around 400.000 families live, representing 55% of Albania's population of 3.1 millions (Instat 2005).

Table 3.8 Forest resources in Albania:

Description	Area (ha)	%	Volume (m3)	%
High forests	295.000	31	59.910.000	82.7
Coppice forests	405.000	43	12.130.000	17.0
Shrub forests	242.000	26	200.000	0.3
Total	**942.000**	**100**	**72.240.000**	**100**

In Bosnia and Herzegovina the total volume of all forests is about 502 million m^3, while the annual growth is about 14.8 million m^3 (5.5m^3/ha).

In Croatia the total volume of forests is about 300 million m^3, while the annual increase of volume is about 8 million m^3 (3.22m^3/ha).

Regarding the cutting increase volume rate ratio, which means the degree of forest utilization, Croatia have the highest value (66.2%), Kosovo has the lowest value (18%). This is by reason of illegal wood cutting in Kosovo, which are about 500.000m³/year.

Consumption of fuel wood per capita in Kosovo is much higher (0.619m³/capita) than in other countries, because of lack of other energy sources.

Consumption of fuel wood in Kosovo is equal with annual growth, but this supply is made by illegal cutting. Also based on measurements performed in field, annual cutting of forests in Kosovo is equal to the annual growth.

The great share of the fuel wood in the total wood cutting in Kosovo could have implications for prospective production of wood pellets. Assuming that the volume of forest residues is approximately the same form harvesting of fuel wood ore technical wood.

3.4 Wood Processing Industry in Kosovo

Kosovo have about 500 companies dealing with wood processing and furniture production. The majority of them (172) are sawmills, and others joinery and furniture. The majority of wood imports into Kosovo are wood-based panels, sawn softwood and furniture.

Export of wood products from Kosovo, practically don't exist. All wood production is dedicated for domestic purposes.

The majority of wood processing companies are sawn wood producers, producers of windows and doors, and producers of furniture. The existence of a 172 sawmills is the result of available raw materials, relatively low investment costs to start the production, and a short payback period of the investment.

All wood processing companies are privately owned, with the majority of domestic material. Existing law and regulations currently enable significant preferences for foreign investors, such as free duty and on the import of machines and equipment, incentives for employing new workers, different tax benefits, etc. After the adopting of pending new laws, it is expected that these benefits would even be greater.

Wood residues from wood processing industry are:

- Primary wood processing 110.500m³ annually
- Finally wood processing 4.500 m³ annually.

Wood residues in primary wood processing

We calculate the amount of wood residues from sawmills, according to their processing capacity, existing data and direct collection data from visiting them. This is done to obtaining accurate dates.

In generally, each sawmill in Kosovo have average capacity of 1.600m³ annually or in total, about 275.000m³ annually.

Utilization in sawmills is about 60 %(average utilization for conifers and broadleaves), that means the amount of wood residues is about 110.500m³ annually.

This is confirmed by visits done sawmills, where from 4-10m³ processed, wood residues have this results.

These wood residues sold with price:

- a track with sawdust cost 20 € or 8€/m³ (36€/t), because 1m³ of sawdust = 0.22ton
- another wood processing residues cost about 6 €/m³ (27€/t)

Photo 3.1 Wood residues in sawmills:

3.5 Wood Production

A mature tree consists of a trunk, branch wood, thin branch wood and a stump. Wood production in Kosovo is expressed by wood cutting. The term "wood cutting" in official statistical bulletins implies the total volume of wood including all commercial assortments and wood wastes. Legal wood cutting every year in Kosovo is about 250.000 $m^{3.}$

Major cuts in the forest of Kosovo came from forest enterprises and citizens in private forest. Forest enterprises realizing cutting by the regular annual plans in public forest, that the gain with tender.

In private forest, private forest owners every year apply for forest utilization in their forests. Then these private parcels confirmed by Kosovo Forest Agency personnel who perform tree market for cutting.

Every year, cutting which take in public and private forest is about 40:60 in advantage for private forests. For example in 2008 wood cutting in public forest were 102.634m^3, while in private forest were 141.133m^3.

The wood processing industry and other enterprises don't have any share in wood cutting. Wood processing companies are privatized, but even don't work in forest utilization, but this makes other companies licensed by government for forest utilization.

But in Kosovo, in wood production also affect illegal cutting, which are several times higher than annual planning cutting. Measurements of these cuts are never done, but from some analysis in FAO Forest Inventory 2002/2003, public forest is attacked by illegal cutting in 40% and private forest in 29%. This is area of 320.721ha.

In another hand, wood consumption for fuel is about 1.3mill.m^3 annually, while the total legal cutting is about 250.000m^3 (fuel wood and technical wood), and import of fire-wood don't exist. Imported wood here is only technician conifers trees in limited amount, which are for sawmills supplied.

From this can be concluded, that supply the population with firewood and supply of sawmills with technician wood is done by illegal cutting in forest, expressed numerically:

Wood demand:

- Fuel wood ……..1.300.000 m^3
- Technician wood……...200.000 m^3 (supposed that the rest of 75.000 m^3 is imported)

- Total: 1.500.000 m^3

Most of this demand is provided by our forests, by legal and illegal cutting.

Regarding tree species felled in forest, the greatest share has been beech from pure standing, reaching 74% of the total volume of wood cutting in forests. Poplar trees are not very frequent in Kosovo, but this species has been planted more in the last few decades, especially along water channels, large rivers, and roads, and in forests as well. Now poplar trees have remarkable share in total volume of wood cutting and in the total forest area.

The following products are the results of the tree cutting process: saw logs for cutting and the production of different types of technical wood, fuel wood, and other types of wood. About 80% of the wood cutting from public forests is used as fuel. The other is used as construction wood, and also for windows, doors and furniture.

Table 3.9 Utilization of forest:

		Wood cutting (m^3)	Forest area (ha)	Utilization of forests (m^3/ha)
total		**243.767**	**464.800**	0.52
broadleaves		226.668	371.840	0.61
	Beech	180.196		
	Oak	45.049		
	Other	1.423		
conifer		17.099	46.480	0.37
	Spruce	15.956		
	Pine	1.058		
	Other	85		

The data on wood cutting are from 2008. Data for forest area are from FAO Forest Inventory 2002/2003.

3.6 Wood Waste in Forestry

From the gross volume of cutting trees produce two groups of assortments: technical wood and stacked wood. During their processing get the rest that remains in forest.

In addition to these two assortments there are wood residues, which usually remain in forests. On average, about 90% is round and stacked wood, while about 10% is wood residue just from cutting. Beside these categories, in forest remain stumps and thin branches. In addition, there are leaves and needles with the share in total tree volume on average of 2%, but its volume is neglected in the analysis.

In developed countries of Europe, with well organized forest management, the ratio between the wood felling and the wood-stock annual increase goes up to 75%. With the improvement of the forest managing, upgrading of the state of existing forest and with development of forest roads, there is a possibility for an increased annual wood felling, based on existing wood-stock.

According to the statistical data, about 80% of production of forest assortments represents fuel wood. The remaining assortments are wood for saw-logs, to be processed for different technical purposes.

Besides fuel wood, as kind of forest assortments, there are different kinds of biomass residues associated with tree felling in forests and with processing of wood. As results of tree felling about 58% of the total mass of the tree are different wood assortments for the market: for industry, different technical purposes and for heating as fuel wood. The rest of 42% of the total mass of the tree are different biomass residues which do not have any value at the market. Among these biomass residues there are: bark, small branches, tree stumps.

Analyzing wood waste in forest after cutting, get results that the trees consist of several categories: technical wood 24%, fire wood 34%, bark of trees 4%, forest residues with skin 9%, thin branches without skin 11% and stamps 18%. Creating this balance is not calculated tree leaves and conifers, which is 1.5 – 4.0% of total wood volume.

From these data we can see that the total volume of trees in technical wood and fire wood is 58%, while the rest of 42% leaves in forest. Structure of forest residues is: leaves and conifers 4.7%, stamps with skin 41.2%, thin branches 24.6% and ends of the tree with sawdust/wood chips 29.5%.

The estimation is that these biomass wood waste in forest account for the least 330.000m^3 annually.

These residues are of different characteristics and usually dispersed in forest. Their collection requires some energy for transportation vehicles. Depending on the terrain, collection of wood waste can be easily and through performed. In some cases, under the present state of forest roads and machinery, it practically can not be done. In any case, on of the main conditions for utilization of these forests wood wastes are appropriate prices of wood residue based fuels and existence of the wood fuel market.

Table 3.10 Wood residues in forestry are presented:

Wood	Public forest	Private forest	Average	Comments
Technical round wood	24	8	16	commercial
Stacked wood	34	50	42	commercial
Bark of round wood	4	4	4	remain in forests
Forest residues with bark	9	9	9	remain in forests
Thin branches with bark	11	11	11	remain in forests
Stumps with large roots	18	18	18	remain in forests
Total	100 %	100 %	100 %	

Thin branches are typically branches with diameter less than 7cm.

The volume of usually unutilized parts of the tree containing bark, thin branches and stumps, amounts to about 42% of the total tree volume. This means that according to the present wood cutting in forests (supposed 1.3mil.m³), usually at least 500.000 m^3 of wood residues (theoretically).

These residues are very different in size and shapes, and are very dispersed over a large area. Regarding the quality of biomass, these forest residues can be used as an energy source. Which part of residues would be used mainly depends on the types of terrain, the forest infrastructure, and the distance of the site for residues utilization.

In practice in Kosovo, the ratio between wood volume cutting and wood volume increase in forests is about 18% on average. Countries with developed forest infrastructure and good forestry management have up to 75% utilization of wood volume increase in forests. This is realized due to forestry plains regions, where it is easy to reach every part of forests, it is possible to utilize up to 75% of wood cutting residues. But in natural forests in mountain region, with very steep slopes, with forest infrastructure in bad conditions, and where it is necessary to protect the soil against erosion, the percentage of volume of forest residues that can be extracted is lower. With better forest infrastructure and with appropriate prices for forest residues, a much greater volume of forest residues would be utilized than is the present case.

If all wood residues in forests were theoretically summed up, they would add up 500.000 m^3. However, one part of wood residues is collected and sold as wood wastes. In addition, stumps are not always removed from the soil. Poplar trees are usually young with relatively shallow roots, and after felling the tree the stump is usually removed. But beech and oak trees are usually older and have deeper root, therefore their stumps are usually left in the forest.

The Kosovo Forest Agency shall a forestation in public forests with conifers every year, but they a forestation are not maintained and often fail. In public forest naturally a forestation is sufficient due to favorable forest bonity in our forests.

Moisture of forest wood waste is between 40% and 60%.

3.6.1 Measurement of Wood Waste in Forest

A team of three people in group, in one day per forestry unit (municipality) has performed measurements of wood waste in one ore two forestry parcels. For this carefully updated selection of parcels where measurements will be carried out, which will provide reliable values for that forestry unit.

From 06.11.2009 to 28.12.2009 measurements are performed in 6 Forestry Regions (figure 3.3), with 29 Forestry Units (municipalities) in utilization plots by Kosovo Forest Agency Annually Exploitation Plan ore forest areas under illegal cuttings.

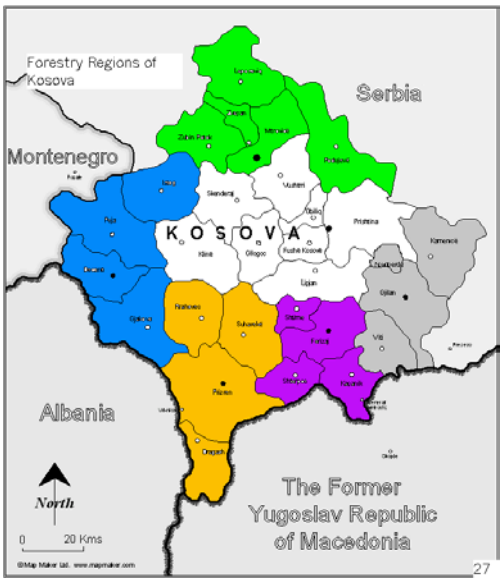


Figure 3.3 Forestry Regions of Kosova.

Measurements are done making the selection of a parcel which is used according to the annual plan or in plots in areas under illegal cutting, and usually conducted in one ore two parcels, and that in some parts where cuts are performed. In part of the parcels which have cutting of higher intensity and in parts of the parcel with lower intensity ore practically without cutting.

This is performed in selected area from 200m2 (20 x 10m) to 500m2(10 x 50m), depending on the terrain. There were measured all the parts of trees not withdrawn, such as: part of round wood which has remained in forest, parts of stacked wood, bark, residues of wood cutting, branches and stumps which nevertheless remained in the forest, then the area in which measurements are carried out is multiplied by the area of the parcel in which measurements are performed.

Measurements are done in 8-10 different places of forest parcel and that close to the forest track, where the wood cutting is intensive, in a defined distance(about 10-50m) from the track and deep in forest(more than 50m of track), where access to cutting is smaller. Then these measurements in some parcels points, average values are derived from these measurements.

Close to the track, legal and illegal cutting is intensive, because access to trees is easier and in the average is about 5-8 times greater than the inside 30m of track.

Photo 3.2 Wood waste close to the track:


In utilized plots by the annual plan and controlled by Kosovo Forest Agency personnel, waste values are in normal conditions or about 45% of the final mass in broadleaves trees, whereas in forestry plots under illegal cutting, especially of spruce illegal cutting in the municipality of Decani, has more wood waste or about 92% of the total mass of trees.

Illegal cutters in conifer forest give only small part of tree, the rest remain in forest.

Wood waste has more near the forest tracks, because and tree marking is intensive there, while and illegal cutting are too intensive near the tracks especially in conifers in Decan, Peja and Istog, but in the highlighted illegal cutting have encountered even in Kacanik, Kamenica, Suhareka, etc.

Explanation of biomass wood waste tables – column number:

1. Forestry Unit (municipality) where is done measurement of wood waste.
2. Management Forestry Unit inside municipality.
3. Forestry parcel ore place inside Forestry Unit, where is performed wood waste measurement.
4. Amount of wood waste in a particular area (m^3) after measurement.
5. Surface of area inside Forestry Parcel where is done measurement (ha).
6. Intensity of wood wastes per hectare (m^3/ha).
7. Percent of intensity of wood waste in column 6 in all Forestry Unit. This is based on Annual Forest Managing Plan - Utilization Plan for Forestry Parcels, illegal cuttings in municipality is based on dates from Annual Registration of Forest Damage, Forestry Garden Diary and Stump Book, where are presented dates of illegal cutting and their volume. Finally is done the observation in field of these dates.
8. Average wood waste per Forestry Unit (m^3/ha).
9. Average wood waste in municipality x forestry surface of municipality (m^3).

1. Regional Forestry Office in Peja:

	Forestry Unit	Measurement in Unit	Place ore parcel	Measurement wood waste (m^3)	Surface of measurement area (ha)	Intensity of wood waste per ha in measurement area (m^3/ha)	Percent of this intensity of wood waste in Forestry Unit (%)	Average wood waste per Forestry Unit (m^3/ha)	Volume of wood waste (m^3)
	1	2	3	4	5	6	7	8	9
1	Peja	Kopranik	84 Milishec	86.25 57.76	4 1	21.56 57.76	3.2	1.27	32.649
2	Decan	Bjeshka e Strellcit Lloqan-Decan	'Guri i Nuses' 'Zymerdan' 77	270.25 67.50 42.2	4 2 1	67.56 33.75 42.2	4.2	2.01	38.236
3	Istog	Radusha	Jerebi	112.50	3	37.5	3.3	1.24	25.661
4	Gjakova	Maja	10	181.58	5	36.3	1.1	0.38	10.166
5	Klina	Klina	131	28.56	3	9.52	2.9	0.28	3.239
Total volume of wood wastes annually:									**109.951**

Table 3.11

In Peja Region measurements are done in Management Unit 'Kopranik' place Prevare, plot 84 and in place Milishec with spruce specie, while in Forest Unit of Decan, measurements are done in Management Unit 'Bjeshka e Strelcit' in place 'Guri i Nuses' and 'Zymerdan' and in Forest Unit 'Lloqan-Decan' in plot 77, with beech specie. In those forestry units, wood wastes after illegal cutting are extensive.

Practically wood waste looks like in photo 3.3:





In 4 ha in place ‘Guri i Nuses’ wood wastes after illegal cutting are 270.25m³ in 4ha, in ‘Zymerdan’ wood waste are 67.5m³ in 2ha. In beech forest plot 77, wood wastes are 42.2m³ in 1 ha.

In Forestry Unit in Istog, measurements are done in Management Unit ‘Radusha’ in place Jerebi, spruce specie, also under illegal cutting, where in 3 ha wood waste are 112.5m³.

Wood waste in areas under illegal cutting, in conifer and broadleaves forest in Decan, Peja and Istog, are extensive. Round technical wood and all part of trees remained in forest unutilized (photo 3.4):

Photo 3.4 Wood waste in forest – whole tree parts.

In those areas under illegal cutting, especially in the forest of Decani, wood residues after cutting are about 92% and this high percent of wood waste is explained such as follows:

- Round wood have 16% of total mass, but illegal cutters take only part of round wood, the rest remain in forest unused, ore about 8 % of round wood.
- Stacked wood in conifer forest left in forest (42%).
- Bark peeled from wood for the market left in forest (4%).
- Residues of wood cutting in forest (9%) left in forest.
- Small branches (11%) left in forest.
- Stumps (18%) left in forest.

As seen, in conifers under illegal cutting in Decan, Peja and Istog region, utilization of wood mass is about 8%, while 92% left in forest unutilized (photo 3.5):

Photo 3.5 Unutilized wood wastes

In Gjakova Forestry Unit, measurements are done in Management Unit ‘Maja’, plot 10, beech/oak specie. Volumes of wood waste are 180 m³ in 5ha.

In Klina Forestry Unit, measurements are done in Management Unit ‘Klina’ plot 131, oak specie. Measurements are done in surface of 3ha of this plot, and wood waste in this area has volume 28.56m³ in three hectares.

2. Regional Forestry Office in Ferizaj:

	Forestry Unit	Measurement in Unit	Place ore parcel	Measurement wood waste (m^3)	Surface of measurement area (ha)	Intensity of wood waste per ha in measurement area (m^3/ha)	Percent of this intensity of wood waste in Forestry Unit (%)	Average wood waste per Forestry Unit (m^3/ha)	Volume of wood waste (m^3)
	1	2	3	4	5	6	7	8	9
1	Ferizaj	Nerodime-Jezerc	55	166.48	4	41.62	1.8	0.75	9.680
2	Kacanik	Ahishta	2 9 Strazhe	49.5 138 19.86	1 2 0.5	49.5 69.0 39.72	2.0	1.05	18.237
3	Shtrpce	Kashtanjeve	7	80.8	2	40.4	0.7	0.28	2.892
4	Shtime	Shtime	2	88.4	2	44.2	0.8	0.35	2.231
Total volume of wood waste annually:									**33.040**

Table 3.12

In Ferizaj Region measurements are performed in Management Unit 'Nerodime-Jezerc' plot 55, where in three different localities of this plot are measured wood waste after exploitation. In area with surface 4 ha in this plot, wood waste are 166.48m³.

In Kacanik, measurements are performed in Management Unit 'Ahishta', plot 2; 9 and near places Strazhe, in private forest, in beech areas under illegal cutting.

In plot 2 and 9, wood waste in 3 ha under measurement are 118.5m³, while in another place near village Strazhe 19.86m³ are in 0.5ha (photo 3.6):

Photo 3.6

In Shterpce in Management Unit ‘Kashtanjeve’ unit 7, in beech forest, measurements have results 80.8m³ in surface of 2 ha.

In Ferizaj Regional Office wood waste after exploitation is 54%, while the rest of 46% left in forest unused:

- Round wood (16%)…….....for the market
- Stacked wood (38%)……....for the market
- Bark peeled from wood for the market (4%)……left in forest
- Residues of wood cutting in forest(9%)……left in forest
- Small branches (11%)……...left in forest
- Stumps (18%)……...left in forest

3. Regional Forestry Office in Gjilan:

	Forestry Unit	Measurement in Unit	Place ore parcel	Measurement wood waste (m^3)	Surface of measurement area (ha)	Intensity of wood waste per ha in measurement area (m^3/ha)	Percent of this intensity of wood waste in Forestry Unit (%)	Average wood waste per Forestry Unit (m^3/ha)	Volume of wood waste (m^3)
	1	2	3	4	5	6	7	8	9
1	Gjilan	Zhegoc	57	123.9	3	41.30	1.2	0.48	11.875
2	Novo Berd	Kllabukar	36	64.3	2	32.15	1.3	0.43	1.194
3	Kamenice	Guri i Zi	38	104.58	3	34.86	2.2	0.77	15.703
4	Viti	Kopilace	67	48	1.5	32.00	1.8	0.57	5.663
Total volume of wood waste annually:									**35.404**

Table 3.13

In Gjilan Region, measurements are performed in Management Unit 'Zhegoc' in plot 57, beech forest. In this plot with surface of 3ha, after exploitation by Annual Plan, wood waste are in volume of 123.9m^3, while in Novo Brdo in Management Unit 'Kllabukar', plot 36, beech/oak forest with surface of 2 ha, wood waste has results 64.3m^3.

In Kamenica in Management Unit 'Guri i Zi' plot 38 with surface of 3 ha, beech forest. Measurements in this plot have results 104.58m^3.

In Viti, in Management Unit 'Kopilace' plot 67, beech forest. Wood waste is 48m^3 in about 3ha surface (photo 3.7):

Photo 3.7

In Gjilan region, wood waste in field after exploitation is 42%.

4. Regional Forestry Office in Mitrovica:

	Forestry Unit	Measurement in Unit	Place ore parcel	Measurement wood waste (m^3)	Surface of measurement area (ha)	Intensity of wood waste per ha in measurement area (m^3/ha)	Percent of this intensity of wood waste in Forestry Unit (%)	Average wood waste per Forestry Unit (m^3/ha)	Volume of wood waste (m^3)
	1	2	3	4	5	6	7	8	9
1	Mitrovica	Javor-Lisac	88	68.5	1.5	45.67	2.2	1.00	20.324
2	Vushtri	Sllakovc	9	92.3	2	46.15	1.9	0.88	9.178
3	Skenderaj	Qyqavice	12	28.5	2	14.25	2.6	0.37	5.634
4	Leposavic	-	-	-	-	-	-	-	27.508
5	Zubin Potok	-	-	-	-	-	-	1.00	20.773
Total volume of wood waste annually:									**83.417**

Table 3.14

In Mitrovica Region, measurements are done in Management Unit 'Javor Lisac' in plot 88, which is beech specie. In this plot wood waste are 68.5m^3 in 1.5ha measurement area, while in Vushtri in places Sllakovc, beech specie, volume of wood waste is 92.3m^3 in 2 ha. In Skenderaj, forest of Qyqavica is measurement, where in area of 2 ha wood wastes are 28.5m^3.

For security reasons measurements were not conducted in the northern part of the country, and this in Leposavic, Zvecan and Zubin Potok, but the necessary data are received by the Kosovo Forest Agency in Mitrovica Regional Office and these data may be valid.

Photo 3.8:

Wood waste in Mitrovica region is about 45% of total mass.

5. Regional Forestry Office in Prizren:

	Forestry Unit	Measurement in Unit	Place ore parcel	Measurement wood waste (m^3)	Surface of measurement area (ha)	Intensity of wood waste per ha in measurement area (m^3/ha)	Percent of this intensity of wood waste in Forestry Unit (%)	Average wood waste per Forestry Unit (m^3/ha)	Volume of wood waste (m^3)
	1	2	3	4	5	6	7	8	9
1	Prizren	Koretnik I Lubinje Prevalla	90	123.88 65.34 0	3 1 0.5	41.29 65.34 0	0.7	0.38	9.449
2	Suhareke	Koka e Ahut	46	80.55	4	26.85	2.0	0.54	8.222
3	Dragash	Koretnik II	9	285.2	5	57.04	1.1	0.63	3.993
4	Malisheve	Bjeshka	6	35.28	1.5	23.52	0.9	0.20	2.768
5	Rahovec	Koznic-Zatric	84	32.28	2	16.14	1.1	0.18	1.368
Total volume of wood waste annually:									**25.800**

Table 3.15

In Prizren Region, measurement is done in Management Unit 'Koretnik I' plot 90, with surface of 3ha, pine/spruce specie and in place near the village Lubinje, with beech specie. Wood waste in this area after forest exploitation is 123.88m^3 in Koretnik I and 65.34m^3 in Lubinje, while in place Prevalle, where practically don't exist wood cutting, wood residues are practically zero. In Suhareka, measurement is done in Management Unit 'Koka e Ahut' plot 46 with surface of 4ha, beech specie, and wood wastes are 80.55m^3.

Photos 3.9 from Suhareka/Koka e ahut, Prizren-Lubinje and Prevalla (practically without wood cut):




Photo 3.9

In Dragash, measurements are done in Management Unit 'Koretnik II' plot 9, pine specie with surface of 5ha, where wood waste has volume of 285.2m^3. In conifer forest utilized by annual plans, like here, wood mass which left in forest have high value.

In this plot, wood wastes are about:

- Round wood 12%.....for the market
- Stacked wood 20%.....for the market
- Bark peeled from wood for the market 4%.....left in forest
- Residues of wood cutting in forest 9%.....left in forest
- Small branches……..left in forest
- Stumps 18%.....left in forest

Wood wastes in this plot, utilized by annual plan in pine forest in Dragash are 68%.

Round wood which left in forest is presented and in photos 3.10:


Photo 3.10

In Rahovec, measurements are done in Management Unit 'Koznik-Zatric', plot 84, oak specie with surface of 2ha where wood wastes are 32.68m^3, while in Malisheva, in Management Unit 'Bjeshka' plot 6 with surface of 2ha, wood wastes are 35.28m^3.

6. Regional Forestry Office in Prishtina

	Forestry Unit	Measurement in Unit	Place ore parcel	Measurement wood waste (m^3)	Surface of measurement area (ha)	Intensity of wood waste per ha in measurement area (m^3/ha)	Percent of this intensity of wood waste in Forestry Unit (%)	Average wood waste per Forestry Unit (m^3/ha)	Volume of wood waste (m^3)
	1	2	3	4	5	6	7	8	9
1	Prishtine	Prishtina II	32	78.92	4	19.71	2.4	0.47	13.328
2	Podujeve	Murgull-Bellosice	90/91	158.16	4	39.54	2.2	0.87	22.590
3	Lipjan	Lipjan	8/9	63.3	3	21.1	1.1	0.44	5.699
4	Drenas	Spanc	3	36.14	2	18.07	1.5	0.27	2.828
5	Fushe-Kosove	Fushe-Kosove	6	29.02	2	14.51	1.4	0.20	278
6	Obilic	Obilic	4	33.16	2	16.58	1.7	0.28	323
Total volume of wood waste annually:									**45.046**

Table 3.16

In Prishtina Region, wood wastes are numerous especially in Podujeva, municipality with extensive illegal cuttings, were wood waste are 39.54m^3/ha, while in Prishtina Forestry Unit wood waste have value of 19.71m^3/ha in measurement area. Other municipalities have a smaller share of wood wastes in field (photo 3.11):

Photo 3.11

In table 3.17 are presented wood waste from our measurements in country level:

	Regional Office	Surface (ha)	Average wood waste (m^3/ha)	Volume of wood waste (m^3)
1.	Peja	103.746	1.06	109.951
2.	Ferizaj	46.983	0.70	33.040
3.	Gjilan	57.344	0.62	35.404
4.	Mitrovice	94.261	0.88	83.417
5.	Prizren	67.714	0.38	25.800
6.	Prishtina	80.294	0.56	45.046
	Total:	**464.800**	**0.71**	**332.658**

Table 3.17

From dates from table 17, wood waste in 6 Forestry Regions, are **332.658m^3** annually.

3.6.2 Wood biomass from pre-commercial forest treatments.

According 'Sustainable Management of Forest' – European Union CARDS program for Kosovo, March.2007, in point 4.1.5 Founding Support Program of Silvicultural Forest Rarity Pre-commercial Treatment, 102.000ha of public forest require rarity treatment, this is 36% of total area of public forest, which need treatment.

In private forest, about 93.000ha need rarity treatment, which is 50% of total area of private forest.

Rarity Forest Treatment, except in support of sustainable forest management, will provide employment of local community in collection, and timber of small size which serves as biomass raw material, and reduce pressure on forest areas under illegal cutting.

3.7 Production of different kinds of wood products

Production of Sawn wood

Sawn wood represents the most significant forest product of the wood processing industry in Kosovo. Sawmills comprise 70% of the total number of wood processing companies (500), and sawn wood accounts for 37.2%.

The majority of other mills have an annual capacity of 1.500 to 2.500 $m^{3.}$ Many mills are located in rural areas, near the forest area. They the most make the processing of spruce and beech.

From the spruce produce the wood profiles, which serve in house building and for production of doors and windows, while from the beech produce the elements for parquet production and elements for furniture.

Softwood sawn timber is one of the rare wood products whose production cannot totally meet domestic needs. This is reasonable, considering that coniferous trees represent only 9% of Kosovo forest reserves. Domestic production covers about 20% of overall softwood sawn timber consumption, while the rest of the needs are covered by imports from Montenegro and from Bosnia and Herzegovina.

Production of windows, doors and furniture

In Kosovo about 150 registered firms deal with production of doors and windows. Most of them are small enterprises. There are 48 dealing with production of furniture. Most work for domestic needs. Export is negligible.

3.8 Wood Residues in Wood Processing Industry

From the use of wood processing divides the:

- mechanical wood processing
- chemical wood processing

We will deal only with mechanical wood processing, because in Kosovo now don't exist chemical wood processing.

Input material in mechanical processing is logs for saving, logs for veneer production, wood forms and splinter. Mechanical processing products are divided into two major groups:

- primary wood processing
- finally wood processing

In primary wood processing, wood billet be reproduced in rectangular – based forms. These are products that represent the basic material for production of final products (boards, rods, beams, veneer, wood panels, etc). In final processing we get the finished product.

Wood processing produces three main types of wastes in different sizes: bark, coarse waste (from cutting round wood), and fine waste (wood chips, sawdust, and wood dust). A typical sawmills produces between 50% and 65% of main commercial products. The rest are residues. Depending on the quality of residues, for example, whether bark has been pulled off, residues can be used as an energy source. Based on annual saw processing in sawmills of 260.000m^3 annually, wood residues are about 110.500m^3 annually and this:

- wood chips 31.300 m^3
- sawdust 13.800 m^3
- coarse wood wastes 41.900 m^3
- bark 23.500 m^3

In total: 110.500 m^3

Used the term 'wood residues' in wood processing refers to the part of wood that can not be used in further processing and which serves as raw material for pellet production.

Moisture of wood residues in sawmills is between 40% and 50%.

Balances in Wood Processing

Each mechanical wood processing is directed to the production of certain assortments and products and has a balance of production, ore use of input of raw material.

Primary Wood Processing

Trunk brought from the forest usually is without skin. The main product of primary wood processing is timber.

In table 3.18 is presented use coefficient of input material in primary wood processing:

Input material – wood logs	Percentage (%)	
	Hard broadleaves	Soft broadleaves and conifers
The main product – timber	50	65
Wood residues	50	35
coarse	24	12
wood chips	18	14
sawdust	8	9
Total (The main product and wood residues)	100	100
Bark	14	14

Table 3.18 Bark is additional residue.

For different wood products, different processes are used, and different ratios result between the volume of the commercial main product and the volume of wood residues during production.

A typical sawmills produces between 50% and 65% of main commercial products, while the rest are wood wastes. Based on annual saw processing in saw logs of 270.000m^3/year, wood wastes in sawmills were about 110.500m^3 in annually.

Finally Wood Processing

In finally wood processing the dried timber, appropriate actions will be converted to final product. In following table is presented exploiting the timber mass of typical domestic product.

In general, the volume of wood residues is usually about 50%. For example, during production of wood products, such as furniture or windows, the volume of wood residues is over 50%.

Final wood processing, furniture production, and production of windows and doors uses dried sawn wood. The level of residue depends on the type of finished product and applied technology.

Input material is timber measured in m3:

Total raw material – timber	Volume participation (%)
Finally product	35
Wood waste	65
Total (Finally product and wood residues)	100

Table 3.19

Table 3.20 contains the typical share of commercial main product and different residues when sawn wood is used:

Total raw material – timber	Volume participation (%)
Finally product	35
Wood waste	
after cutting	57
after final works	3
refused products	5

Table 3.20

In wood processing companies wood production is about 30.000m^3 annually. Wood residues there were no more than 15% of total production or about 4.500m^3 annually.

In conclusion, the greatest volume of wood wastes for pellet production comes from wood cutting in forests and from sawmills. Other wood processing companies, especially small ones, are also sources of wood waste.

The total annual volume of residues available for pellet production is estimated at about 430.500m^3, and consists of about 300.000 m^3 residues from forestry, about 110.500 m^3 from sawmills, and from all other wood processing companies not more than 4.500 m^3, because wood residues after saw logs production descended once.

Beech and oak are the most common species in Kosovo forests. About 80% of the total cutting volume is beech and oak trees, with spruce and pine species in third place. Taking into account that the density of dry beech and oak is 0.58 t/m^3 while that of conifers is 0.38 t/m^3, and that pellets contain about 10% moisture, it follows that from the available volume of wood residues, about 200.000 tons of wood pellets can be produced annually.

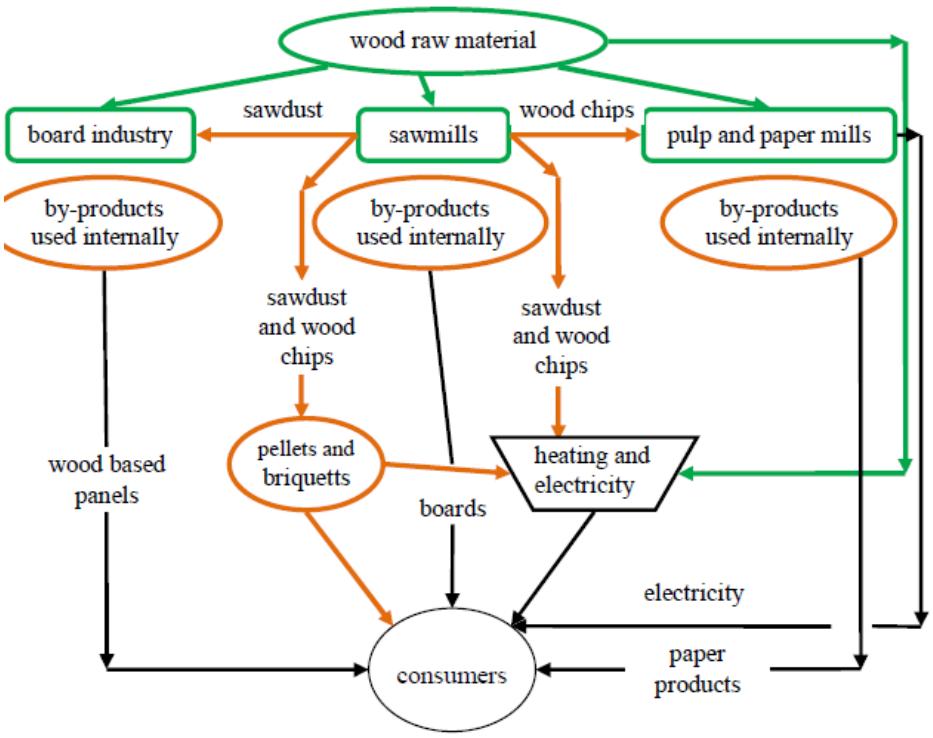


Figure 3.3 Flow of forest wood products and by-products within the wood processing industry

Based on the estimated available volume of wood residues, the planned afforestation rate, the necessary development of forest infrastructure (such as forest roads) will be the main competitive process, the potential for wood pellet production can be estimated (Table 3.21).

There are two scenarios for 2015: the first is based on the current state of forest infrastructure, which means only 18% of forest utilization. In that case, total wood cutting would be slightly increased only by afforestation in the previous period.

The second scenario is based on improving forest infrastructure with new and better existing roads, which would lead to higher wood cutting volume, bringing the rate of forest utilization to 50% in region countries or and 75%, as it is in developed countries.
It is assumed that in 2010/2011, there theoretically expected to be a production capacity of 200.000 t (using 400.000 m^3 residues).

This is now only theoretically expected, because for this pellet production need a better forest infrastructure, modern technologies for wood waste collection, processing and transport and a pellet plant with very high capacity.

With no forestry improvements, the total installed capacity of pellet plants can be 200.000 t by 2015, and 400.000 m^3 of wastes would be used for this production.

If forestry utilization is increased from to 75%, the available volume of residues would be increased to 600.000 m^3, which would enable total wood pellet production of about 300.000 ton per year.

Estimation of wood wastes volume as resource (m^3) and demand in future:

	Actual (18%)	2010 (18%)	2015 (50%)*	2015 (75%)
Resource				
Forest wood waste	300.000	300.000	287.070	430.605
Sawmills residues	100.000	100.000	120.000	150.000
Finally processing residues	4.000	4.000	6.000	10.000
User for:				
Wood pellets(t)	0	200.000	200.000	300.000
Fuel wood	1.3 million	1.3 million	1.3 million	1.3 million

Table 3.21 *Here is provided utilization of forests without illegal cutting, and for that reason the wood waste are under the now values with very high illegal cuttings.

Consumption of fuel wood is more or less independent of wood pellet, because pellet production will be exported, and that for economic reason of producers and not existing of biomass boilers now in Kosovo.

It is assumed that consumption of fuel wood would not increase in the next years. This assumption is based on expectations that wood residues and wood pellets would have lower prices than logs, and that logs would be used for production of different products which would bring more income than fuel wood.

Moisture of wood residues in finally wood processing is between 6% and 9% in furniture, and about 12% in windows/doors production.

3.9 Energy potential of wood residues

Fuel characteristic of wood

Thermal prosperities of wood were presented in table 3.22:

Wood species	Upper thermal power (MJ/kg)		Density (kg/m^3)	
	Wood	Skin	Wood	skin
Beech	18.82	18.00	680	580
Oak	18.36	19.70	650	425
poplar	17.26	18.00	410	412
Red spruce	19.66	21.20	430	340
Spruce	19.46	21.00	410	460
Pine	21.21	20.62	580	300

Table 3.22 From the table we can se that the conifers have higher thermal power of the broadleaves wood, because of resin material in conifers.

In the table 3.23 is presented thermal prosperities of wood depending of the wood moisture:

Fuel	Moisture	Upper thermal power	Efficiency fireplace inserts	Useful heat
	%	MJ/kg	%	MJ/kg
Wood	0	19.8	80	15.8
	10	17.8	78	13.9
	40	14.5	74	12.1
	70	12.0	72	8.6

Table 3.23

3.10 Possibility of growing of trees plantation for energy needs

Another possibly to increase energy potential of wood biomass is to cultivate energy plantations. According to some investigations in region countries, by poplar cultivation it is possible to produce wood biomass with annual energy value of 6.7 toe/ha.

With assumption that the production of wood biomass could be accomplished forestry land which is currently out of use. Plantation for the production of wood biomass need to establish in order to obtain alternative resources for energy needs.

Most important effects of the production and use of biomass obtained in specialized plantations are:

- in finding new energy resources, which are of particular importance for developing countries, because it reduces their dependence on oil imports, and this facilitates the national budget.
- creating new markets for sales of secondary raw materials forestry
- to create new jobs for community

While raising energy plantation, biggest technical challenge is determining the appropriate length of production cycles.

Proper selection of species for the establishment of energy plantation, conditioned by many factors:

- eligibility type set targets for achieving management
- rapid increase in volume and height
- costs of raising plantation
- resistance to external influences
- speed and placement and billing products on the market

Previous experience in the use plantation for the production of wood biomass in Europe, pointed to the advantages of certain types, bio-ecological for the establishment of energy plantation of degraded habitats. When selecting species besides bio-ecological characteristics, a key criterion for selection of the energy value of the obtained materials.

In Kosovo, for the production of biomass plantations in the best results will be achieved with forms like poplar, spruce, pine and alder, which confirmed their potentially value for biomass production in neighboring countries.

Detailed production potential in these species growing in plantations for biomass production, improved technology and the use of their establishment, will reduce the pressure on other sources of energy.

4. MODERN TECHNOLOGIES FOR THE PRODUCTION OF PELLETS AND BRIQUETTES FROM WOOD BIOMASS

Biomass briquetting/pelleting without connective funds.

Given by the economic importance, is foreseen that the use of biomass for different purposes, from renewable raw materials, will be more intensive. Biomass could reach up to the most distant customer. It is necessary to compress the same material in the best shape and size for handling, transport, storage and preservation. This biomass material become commodities for the market, and would be available to multiple users.

Briquetting or pelleting biomass reduces its volume, manipulation and transport costs. Pressed materials require much less storage space and these materials have the greater resistance of the biological processes, increasing efficiency in the process of combustions etc.

Potentially quantities of wood biomass for pellet or briquette production from our forests are at the least 330.000m^3 annually.

Briquette can be produced mainly in two types of presses: mechanically with a capacity of 250 to 1500kg/h ore hydraulic (mobile or moving) with capacity of 50 to 200 kg/h.

Mechanical presses require installed power of 20 to 60 kW, accommodation in a closed space with size 5 x 10m to 20 x 70m and require a solid foundation, while the hydraulic presses are much more flexible, have significantly lower demand for energy (6-10kW) require little area 5 x 5m and must consolidate the surface and can be placed on the movable base together with the chopper and drying.

Technological process of biomass briquetting/pelleting

Briquettes give form from pressing fragmented particles of wood materials without connective, under very high pressure and temperature, where the pressure of the tool presses is from 150 to 200 bars, which turns biomass in briquettes. In production process moisture of raw material should be between 10 and 18%.

Briquettes/pellets are calorie biofuels, because they have thermal power from 15 to 18 MJ/kg (the same as coal). Density of briquettes is between 1.100 and 1.400 kg/m^3.

Technology and technical process for the production of energy from wood biomass briquettes is practically chosen. In support of the implementation of energy briquettes as alternative types of fuel, in addition of rechargeable sources of raw materials (biomass) of each year, that situation has the positive environmental effects of their use. Ash from biomass can be used as a very good mineral fertilizer.

Experiences of other countries in the use of briquettes and pellets

All wood materials such as branches of trees, bark, leaves and stumps represent useful energy sources. The main problem of these materials is their large volume compared to the mass, properties for handling, storage and transport, but working with them is not difficult. This problem will be overcome processing of this material chipping and drying, then its suppression under very high pressure to produce energy briquettes or pellets. The finally product has a high density, and of course, high thermal value.

Wood pellets are improved fuel wood, which are produced from wood chips, sawdust, bark, etc.

The main advantages of this process are:

- increase the energy value remains
- lowering the volume of biomass storage
- the possibility for easier handling, transport and reduction of its cost
- increasing energy density with the decrease in volume

Pellet production

Generally, production of pellets has three basic steps:

- storage of raw materials
- drying of raw material to approximately 18% moisture
- production of pellets

The production process is done in three stages:

- raw material, after grinding to a suitable length, must insert in the pellet machine storage,
- pressing the material in pellet machine,
- cutting of pellets to the desired length,

New technology of production of pellets is particularly comprehensive:

- reduces the consumption of energy during pellet production,
- this process is patented, and has high productivity during production. Produced pellets have high quality.

5. CURRENT MARKET ANALYSIS

5.1 Present Volume of Wood Waste Utilization for Fuel in Industry and Residential Sectors

Industry in Kosovo is generally in a transition period, which means not only transition in ownership, but also transition in the number of employees, renewal of production, change of production programs, looking for new markets or trying to return to the old ones. As a result, from year to year, the main parameters of production in a single company have been changing.

In principal, before privatization process, wood processing factories had boilers using waste biomass as a fuel. However, it should be pointed out that many boilers are old, usually over 20 years, and that many of them have been out of operation for the last several years.

With the process of privatization, many of the wood industry plants are privatized and they can to adapt to new condition. They have been working with old technology which is now invalid and must be renewed. The largest wood processing companies in Kosovo have not reached the optimal rate of production to date, or even the past production rate. Typically, production does not exceed 20% of installed capacity. The problem is outages of equipment, lack of investments for new equipment, poor quality level of products, and probably an inability to be competitive in the market with products they can produce.

The typical solution is to obtain additional biomass wastes from small enterprises, sawmills that do not use biomass furnaces or boilers, and where a problem with disposing of wood wastes such as sawdust exists. Currently, this cooperation between large and small companies is good, since everyone resolves their problems. But this solution is viable only when small enterprises are relatively close to large ones.

In Kosovo, there are only a few large wood processing companies, and more than 500 small ones. This means that many of the small enterprises should use wood waste resulting from their own production process or solve this issue in another way. Unfortunately, many of them just deposit wood wastes in their surroundings, or dump them in the closest river.

5.2 Current and Expected Demand for Wood Waste in Kosovo

Wood waste in forests and wood residues in wood processing industry are a significant surplus and not serve for anything. In forest they inhibit the growth of seedlings and young trees, favor the forest diseases and not serve for anything, while in wood processing companies they only inhibit the production process, if it not used for its heating system.

Until today there was no significant producer of wood pellets in Kosovo, and demand for fire wood is annually about 1.3 million m^3. In the last years, in regional countries has been greater interest for pellet production, where several prospective producers announced the start of wood pellet production, in the first half of 2008 and 2009 with capacity of 18 000 t, 30 000 t and 100 000 t per year, while others plan to start production in 2010. Generally, several small and large investors made the decision to start wood pellet production, based on the possibility of their export, and on an assessment that they could generate revenue from the international market.

Population which is heated with electricity should explain that, to create electricity is created twice losses, one during the conversion of thermal energy into electricity in TPP and another in consumption, where the electricity is converted to the thermal energy. Losses are created during the conversion of energy from one to another.

Additional reason for the practically non-existent demand for wood pellets in Kosovo is that there are no domestic producers of stoves or small boilers. Equipment for wood pellets, not only stoves and boilers, but feeding systems, can be purchased from Serbia, Croatia, Slovenia or from developed countries such as Austria, Italy or Germany. But such equipment is expensive for a typical customer in Kosovo and cannot be sold in desired quantities.

The current price for fuel wood in Kosovo is about 30 €/stacked meter, because fuel wood here sold as 'stacked meter'. One stacked meter is real 0.69m^3 of fuel wood. Demands of household heating in Kosovo are about 1.3 mil./m^3 of fuel wood, which demand is cause of illegal cuttings.

Presetting of Beech and Oak low canopy forest in Kosovo is very high. That is reason to present some data's of Beech species: One cubic meter of beech (dryer) has 580 kg, whereas one cubic meter of pellets/briquettes is energy equivalent with 4m^3 or 5.79 stacked meter, with price of 204.4 €. The price of pellets and briquettes is much cheaper (about 100 €/t) and it is cleaner for use.

The current price of beech wood in public forests, given by the Kosovo Forest Agency with tender is in the range 6.0 – 11 €/m^3 calculated as standing timber. Cutting and transportation costs are not included. The price of wood wastes in public forest given by the Kosovo Forest Agency should be around 6 €/m^3 or 10.50 €/t.

At the present, there are no domestic market for wood pellets and briquettes in Kosovo. In fact, here was briquettes production at last 30 years, but never pellet production. The real price of pellets in Kosovo will be around 100 €/ton and with this price and producers should be pleased, because that's profit is good.

The market for biomass pellets could easily become more viable on the domestic front. In a price comparison of different fuels in Kosovo, wood pellets priced at 100 €/ton would be the cheapest fuel. Further, the different types of coals usually used in Kosovo are priced about the same as firewood.

The present ratio between prices of different fuels in Kosovo, generally favors wood-based fuels. The comparison of heating costs by different fuels, shows those wood-based fuels is the cheapest solution. The price of pellets for customers in Kosovo is assumed to be about 100 €/ton, including transportation. VAT is added to that price, resulting in the retail price of 85 €/ton.

Prices of different fuels in Kosovo and the cost of heat (table 5.1):

	Retail price*		Heating value		ή conversion	Cost of heat			
Brown coal	120	€/t	18.2	GJ/t	0.81	5.7	(€/m^2)	30.5	(€/MWh)
Lignite dry	100	€/t	17.2	GJ/t	0.78	5.3	(€/m^2)	28.5	(€/MWh)
Lignite raw	55	€/t	9.2	GJ/t	0.75	5.6	(€/m^2)	30.0	(€/MWh)
Light fuel oil	956	€/m^3	37.9	GJ/m^3	0.86	19.6	(€/m^2)	105.6	(€/MWh)
Heavy fuel oil	422	€/t	39.7	GJ/t	0.86	8.3	(€/m^2)	44.5	(€/MWh)
Natural gas	0.40	€/m^3	0.0333	GJ/m^3	0.92	8.2	(€/m^2)	44.4	(€/MWh)
LPG	1.050	€/t	46.0	GJ/t	0.92	16.5	(€/m^2)	89.3	(€/MWh)
Fuel wood in Prishtina	44	€/m3	14.0	GJ/t	0.75	5.8	(€/m^2)	31.2	(€/MWh)
Fuel wood in Kamenica	29	€/m^3	14.0	GJ/t	0.75	2.9	(€/m^2)	15.6	(€/MWh)
Wood pellets	100	€/t	18.0	GJ/t	0.78	4.1	(€/m^2)	22.2	(€/MWh)
Electric energy	40	€/kWh	0.0036	GJ/kWh	1.00	10.2	(€/m^2)	54.9	(€/MWh)

Table 5.1 Prices for electricity and natural gas are not retail prices, as there is a special tariff system for these kinds of energy. VAT is afterwards included for obtaining *cost of heat*. VAT for all energy carriers is 18%, except for natural gas and wood it is 8%. Price for the installed electric power is 6.6 €/kW for customers connected at low voltage distribution system, excluding householders.

Because of different prices of fuel wood in Prishtina and Kamenica, wood pellets would be more expensive than fuel wood in Kamenica, where fuel wood has a price of 20 €/stacked meter or 29 €/m^3, but cheaper than fuel wood in Prishtina, where the price of fuel wood is 30 € /stacked meter or in real m^3: 44 €/m^3.

The most expensive solution for heating is heavy fuel oil and LPG, and heating in coal is relatively close with pellets and fuel wood.

In the domestic market, wood pellets can replace fossil fuels used for heat in different sectors such as industry, residential and agriculture.

With production of 200.000 ton/annually, wood pellets can totally replace coal and heavy fuel oil in residential sector.

5.3 Current Wood Waste Utilization in the Region

Forest wood wastes resulting after timber cutting, which are only partially used, while the utilization of wood wastes from the wood processing industry varies depending on the technological level of companies in that sector.

Until 1992, there were four producers of chipboard in Bosnia & Herzegovina, but currently any of them are operating. Furniture production companies have to import chipboard from Croatia and Slovenia, while Kosovo never had chipboard production for furniture producers in Kosovo.

Chipboard production companies are very good places for wood waste utilization in non-energy purposes, but here this production doesn't exist, and all wood wastes will be utilized for pellet production.

New enterprises are emerging dealing with pellet production in the whole region. The general motivation for new enterprises or for existing wood processing companies in the region to produce pellets is to sell them in developed countries only. Practically speaking, there is no market or demand for pellets in the region. There are single examples of using pellets, but the majority of pellet production in the region is intended for export.

Until 2007, there were no pellet producers in region countries such as Croatia and Serbia, but now according to the available data, there are several, including three big producers. The total capacity of all pellet production in Croatia does not exceed 80.000 tons per year. An important step in the development of pellet production there was the creation of a cluster of existing and prospective small pellet.

Reliable information about present pellet production in Serbia, Bosnia & Herzegovina and Montenegro could not be found. The assumption is that Montenegro has only a few small producers, while Bosnia & Herzegovina has bigger producers. The assumed production in these two countries is about 100.000 ton/year.

Comparing the values of pellet production in Croatia, Montenegro, Bosnia & Herzegovina and Serbia (together app.450.000 ton/year) with the announced capacity for 2010/2011 in Kosovo (app.60.000 ton/year), together with annual wood cutting in these countries, it can be concluded that there is significant potential for pellet production in the region.

5.4 European Union Market

In March 2007 the European Union Member States agreed to a 20% binding target by 2020 for renewable energy sources as a response to the European Commission package proposed. Biomass will be the main contributor to achieving that target. According to the European Commission, biomass technology could achieve at that time up to 215-239 Mtoe (only using the indigenous resources). As wood fuels (including wood pellets) are the most available biomass form in most

European countries, they will play a crucial role in achieving the 2020 objective. In addition, bio-energy trade (imports) represents a great opportunity to achieve even higher shares.

The main objective of the European Union Biomass Action Plan, put forward in December 2005, is to double the 4% share of biomass energy by 2010.

The availability of raw material, competitive prices, and diversified energy policies favors development of a wood pellet industry in the EU. Sweden, Denmark, Germany, and Austria have the most highly developed pellet markets, others such as Italy, Belgium, France, and the UK recently have been following that trend. In 2008, the production of pellets in the EU was about 2.8 million tons, while in 2008 was 3.3 million tons, with Sweden, Austria, and Germany the main producers. Almost 300 pellet plants are located in the EU ranging from small scale producers with an annual capacity from 2000 to 150 000 tons of pellets.

The figure 5.1 indicates that EU pellet production in 2008 was 3.3 million m^3, while the EU pellet consumption was 8 million m^3. Between EU consumption and producing is a change of 4.7 million m^3, and this is a great chance for Kosovo Pellet Producers to export all their pellet production in EU countries.

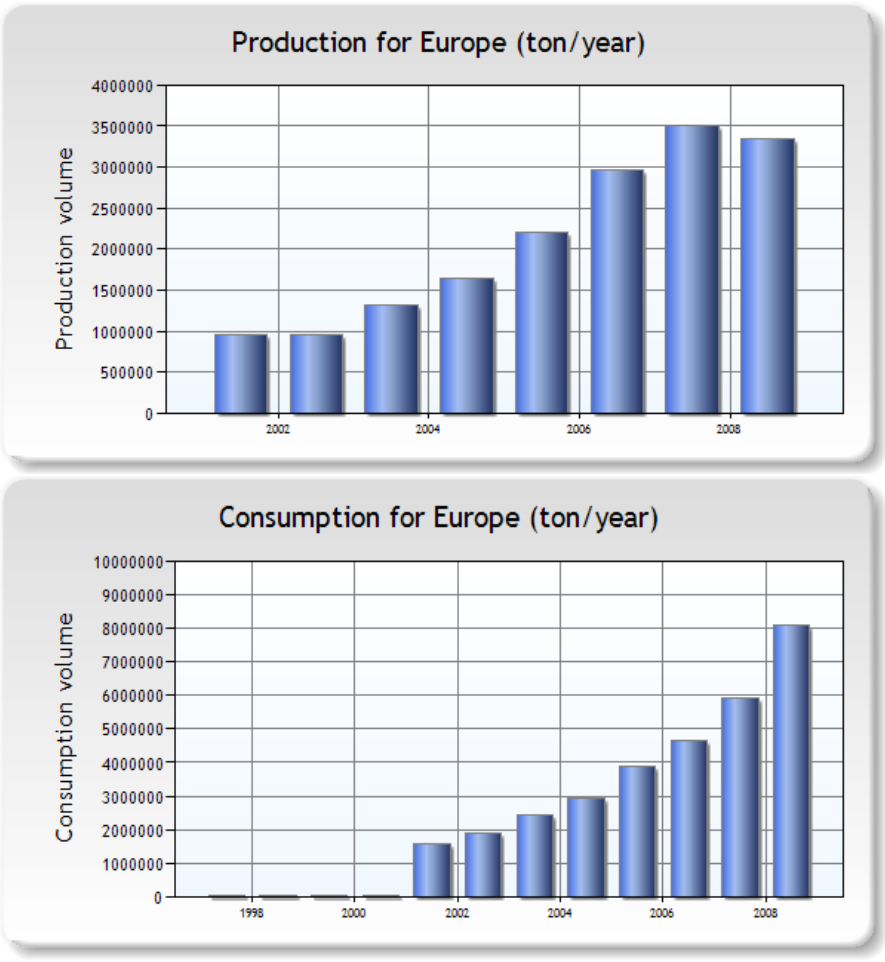


Figure 5.1

In 2008, wood pellet consumption in the EU only in residential sector was 4.4 million m^3, while total consumption was more than 8 million m^3, which indicates a significant amount of import. Wood pellets are used both in electricity and heat production (in large, medium, and small scale).

EU markets for residential pellet heating since 2008:

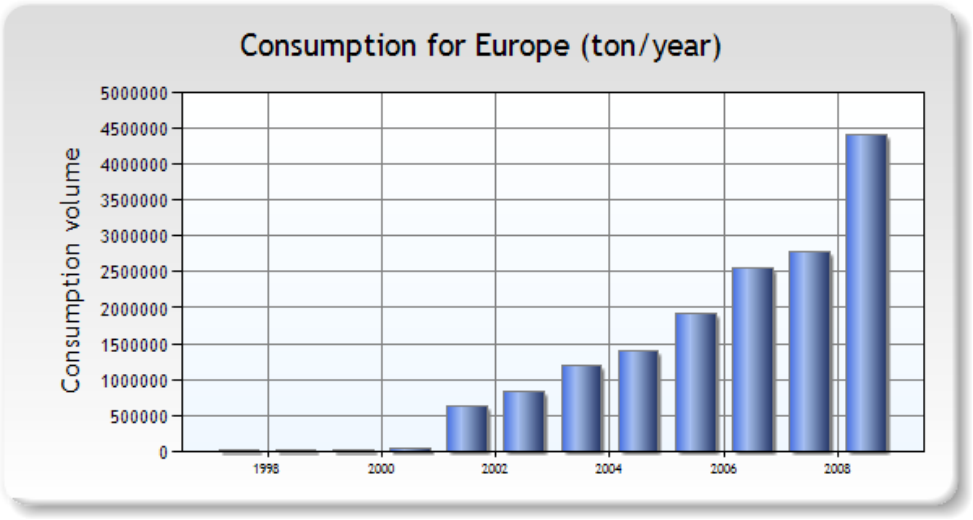


Figure 5.2

Pellet use in power plants in the EU since 2008:

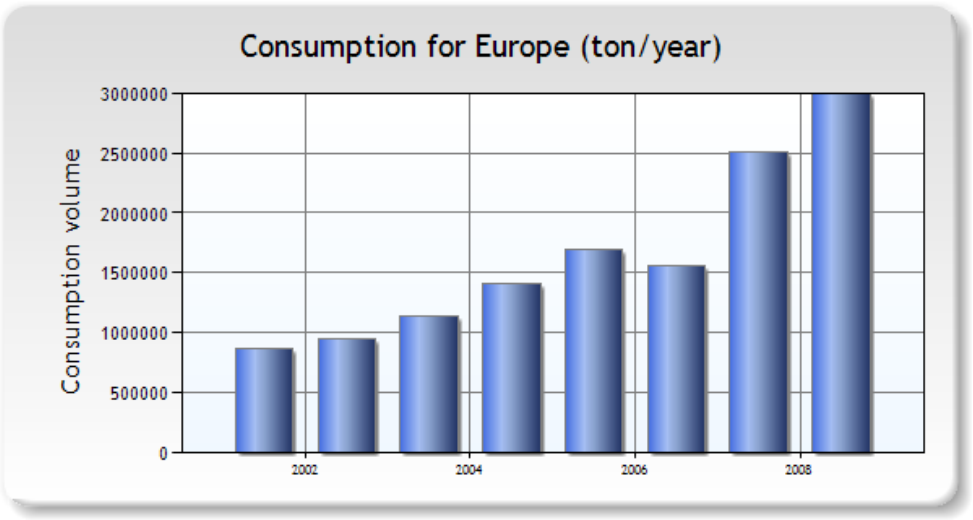


Figure 5.3

Consumption of wood pellets in Germany:

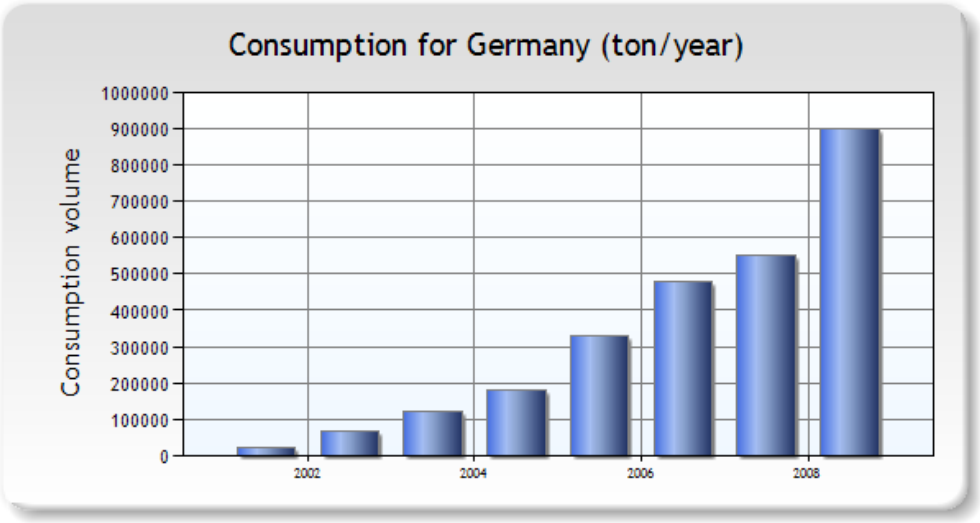


Figure 5.4

Only in Germany, which is a potential pellet export country, consumption in 2008 was 900.000 ton.

In January 2007, the price of wood pellets in Germany was extremely high (265 €/ton) and reached the price of fuel oil. Very soon after that, in March 2007 the price of wood pellets decreased to the level before of the winter of 2006/2007 (200 €/ton). The probable reason for that increase in price was an increased demand for pellets, and the increased demand could be caused by colder weather or by higher incentives for bio-fuel use. From January 2009 price is about 260 €/ton.

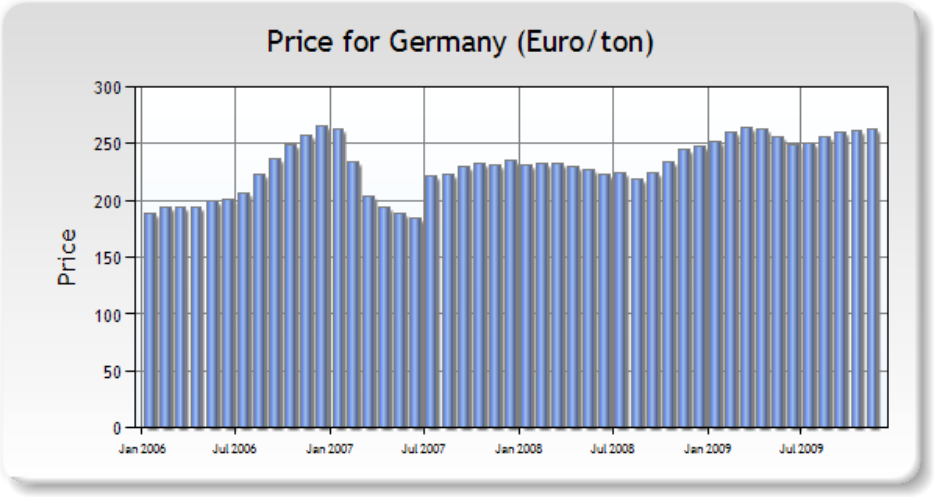


Figure 5.5

Comparing the prices of natural gas, fuel oil, and wood pellets in Germany, it can be concluded that using wood pellets is the cheapest solution for heating.

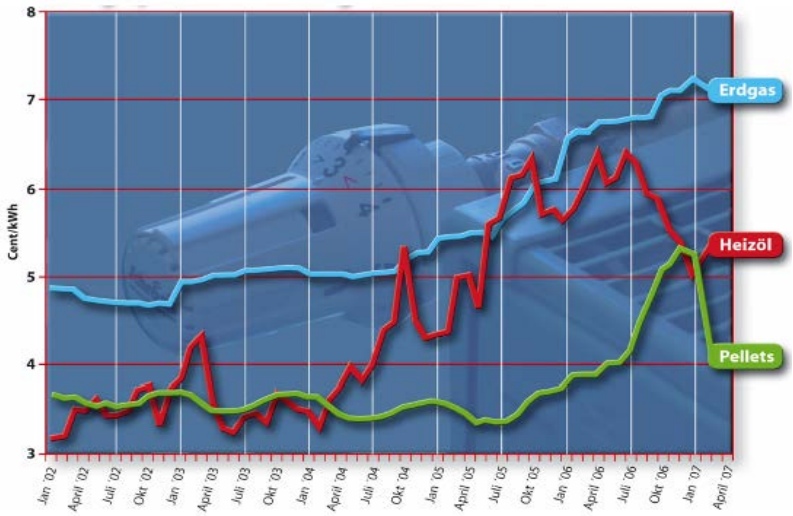


Figure 5.6 Pellet prices (c€/kWh) in Germany January 2002 - April 2007, with comparison to natural gas (Erdgas) and fuel oil (Heizol)

Austria exports more than half of its pellet production (780.000 tons in 2007) to other countries. It could be reasoned that this means that the Austrian market has a surplus of wood pellets, and consequently the price of wood pellets would be low. But the price of wood pellets in Austria is high.

In the EU, the price of wood pellets varies from country to country, which intensifies the trade in wood pellets. Wood pellets are the most expensive in Germany, with Austria and Sweden following. Prices are lower in Finland and Spain.

Austria and Sweden have very high prices despite the fact that they have immense wood resources. Their market of biomass use for energy is developed, and the demand for wood pellets is high, which leads to an increase in price.

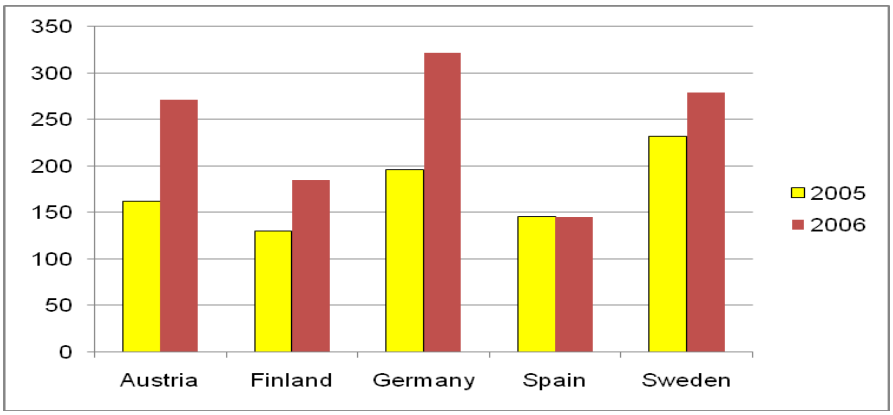


Figure 5.7 Pellet prices (€/ton) in Austria, Finland, Germany, Spain, and Sweden in 2005/2006.

Pellets price in EU since 2009, which is about 230 - 250 Euro/ton:

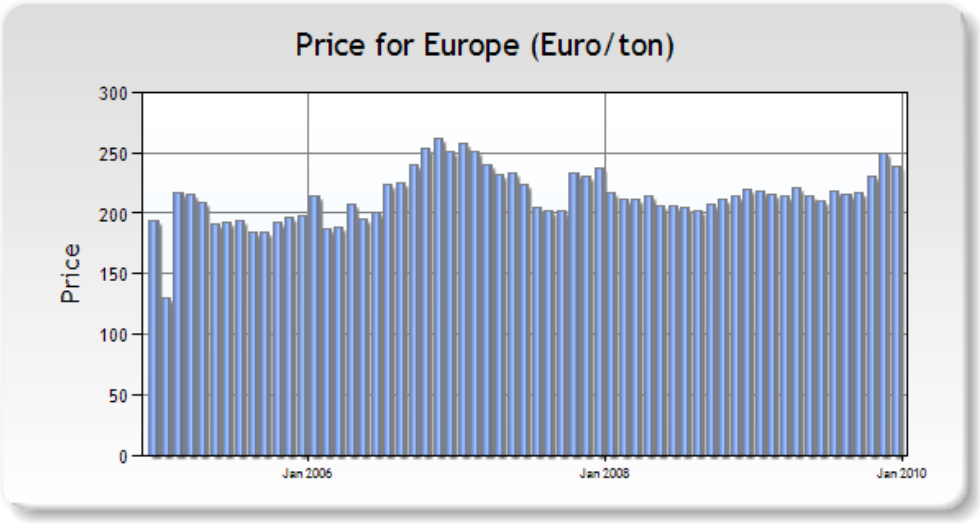


Figure 5.8

The price of wood pellets in Austria significantly increased during the winter of 2006/2007. Just after winter the price decreased to the level of the previous year. It can be seen that during the winters of 2005/2006 and from 2007 to 2010 the price of pellets was very stable. After the winter of 2007/2008, the price decreased slightly in comparison with the same period the year before. Since Austria exports more than half of its production to other countries, and a great part to Germany, the jump in pellet price during the winter of 2006/2007 was likely the consequence of the jump of pellet price in Germany in the same period. More and more wood pellet producers are emerging in Europe in the European Union (Ukraine, Belarus, Bosnia, Serbia, and Croatia as well) and the offer of wood pellets is larger, and which probably drives the price decrease.

The price of pellets in Austria is about 230 Euro/ton.

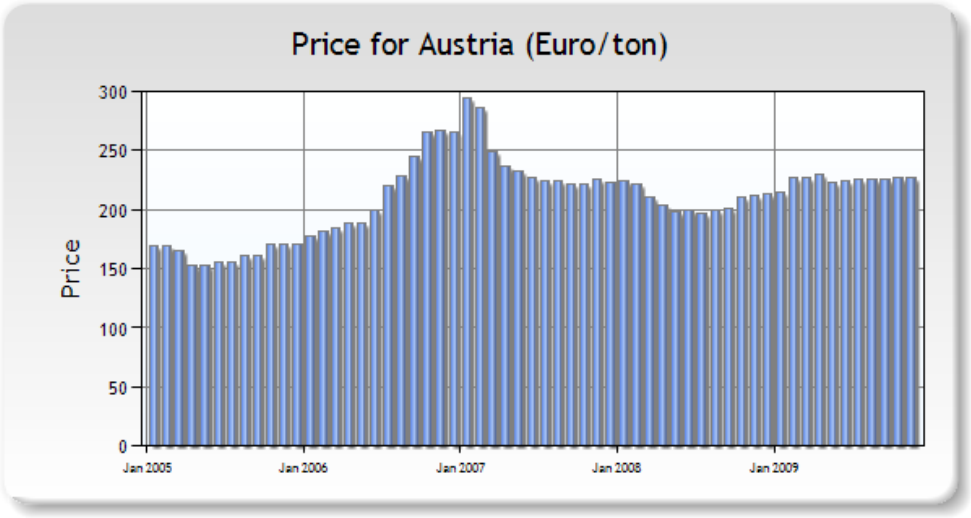


Figure 5.9 Price (€/ton) of wood pellets in Austria (2005-2009)

A comparison of prices in Austria and Kosovo shows that electricity in Kosovo is much cheaper, almost three times cheaper than Austria, while fuel oil is somewhat more expensive. It is clear that the price of wood pellets in Austria is absolutely the cheapest fuel in comparison with those listed in table, while in Kosovo, with the assumed price of about 100 €/t, wood pellets is the cheapest fuel in comparison with the listed ones in table, but this is not the case in comparison with fuel wood.

Prices of energy carriers in first quarter of 2008:

	Austria	Kosovo
	c€/kWh	c€/kWh
Wood pellets	3.4	1.9
Natural gas	6.24	4.1
Fuel oil	8.87	9.1
LPG	10.35	8.2
Electricity	17.27	5.5

Table 5.2 Price of wood pellets in Kosovo is assumed

The Netherlands has very limited domestic resources of wood wastes. But the Netherlands has great consumption of wood pellets. The annual demand for pellets in the Netherlands is more than 900.000 ton/annually. Pellets are imported from South Africa, North America (mainly Canada) and South America (Chile and Brazil).

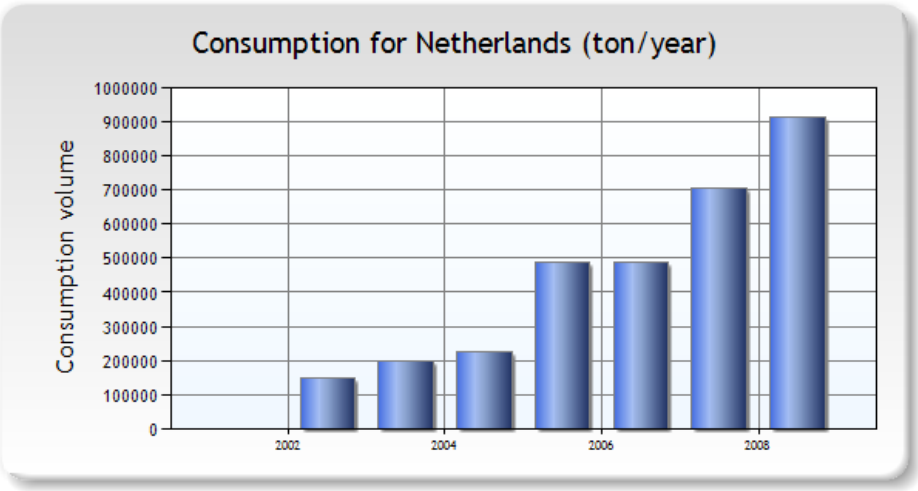


Figure 5.10

Market pellets in Italy, the main barriers and perspectives

Technology for production of equipment for pelleting is rich in Italy.

Manufacturer's pellets were enlarged twice in the last two years and many of them want to enter in the market of pellets. National production of pellets has increased in recent years from about 100.000 tons to 160.000 tons annually, while national demand of pellets was increased to 210.000 tons per year. Because a large part of the request is covered by the import of pellets from foreign countries.

Potential biomass from sawmills and timber processing industry has reached their limit. Consumption of wood pellets in 2008 was 850.000ton, which is a great chance for Kosovo pellet producers. Exports of pellets in Italy will be through Albania by ship.

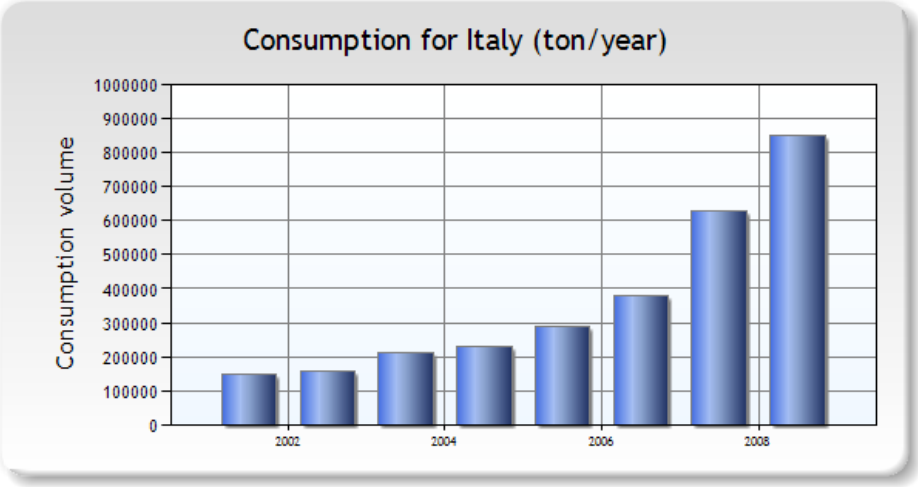


Figure 5.11

Pellet market in Italy is slowly but progressive developed, where significant growth occurred in the last 4 years. In this period the market increased from 20 to 40 producers. In previous research studies (CTI, broke through the program) retail price in the market is quantified within the limit of 0:18 to 0:40 Euro/kg. For wholesale market, the price is within the limits of 0.15 to 0:25 Euro/kg.

Price of wood pellets in Italy are very stable and it is 220 Euro per ton.

Price of wood pellets in Italy since 2008:

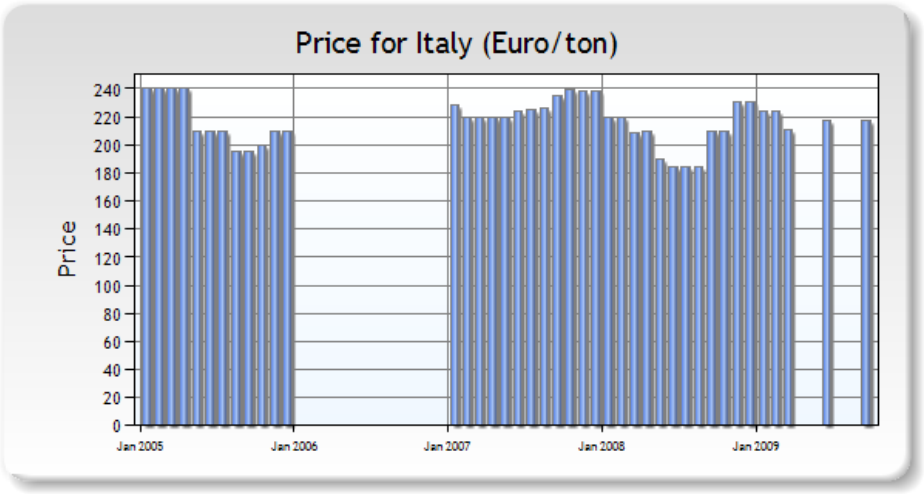


Figure 5.12

The table 5.3 presents the dates of production costs and prices of pellets in Italy in 2006:

Number	Pellet price	Euro/kg
1	Production costs (including raw materials)	0.07 – 0.10
2	Wholesale price	0.15 – 0.25
3	Retail price	0.25 – 0.40

Table 5.3

Since bio-fuel, pellets are used for three different purposes: heating the citizens, in large plants for the production of energy for heating and settlements. Use of pellets for heating citizens is tested and significantly increased in the last few years, as well as increase the number of certificates sold stoves and pellet boilers. About 60 producers were monitored to achieve those dates.

Market pellets in Denmark

Statistical dates show that consumption of pellets was greater than 400.000 ton/year in 2002. Annual energy consumption of pellets in Denmark in 2008 was more than 1 million ton/year. Denmark creating the largest market of pellets in Europe.

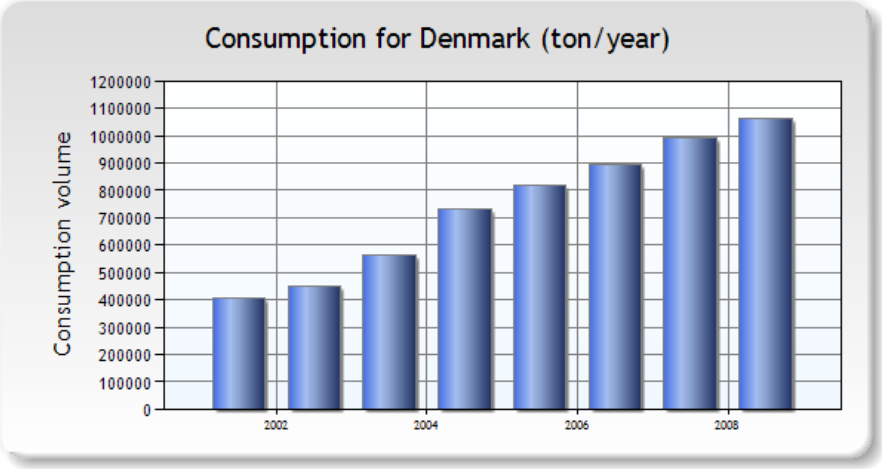


Figure 5.13

Denmark can produce up to 200.000 tons annually, the rest must be imported. Denmark has 15.000 household boilers and furnaces to pellet. Price of wood pellets in 2006/2007 was 240 Euro/ton. In 2010 this price is 280 Euro/ton.

Due to an increase of pellets in the thermal plants in 2006/2007, increased the total potential expenditure of 1 million tons per year. Many with oil heating move to the use of biomass pellets. Supply of bio-fuels over the Internet increases the consumption of fuel. This is now a trend.

Price of wood pellets in Denmark is presented in table 5.14:

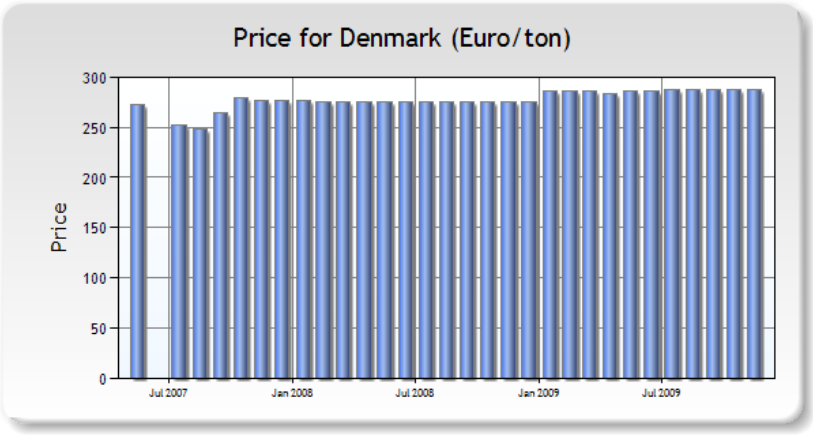


Figure 5.14

Market pellets in Greece

Total consumption of wood pellets in Greece in 2008 was 112.000 ton. Greece is no more 300 km from Kosovo and this pellet market is a desirable for our producers.

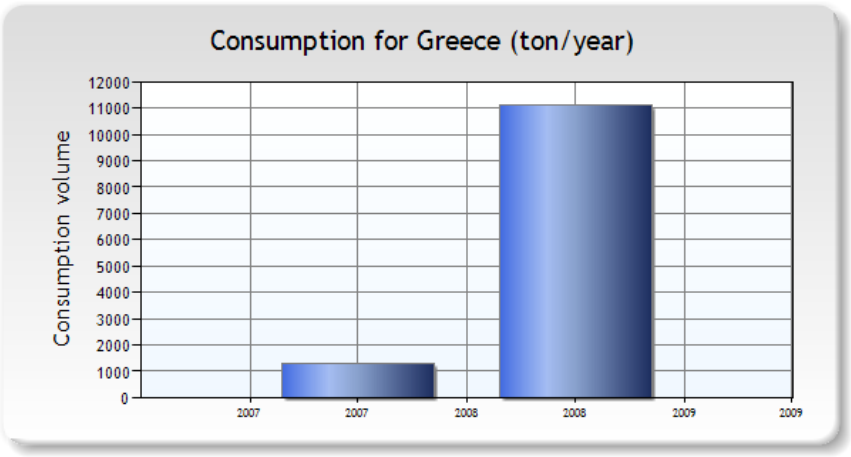


Figure 5.15

Price of wood pellets in Greece is about 210 Euro/ton, transport costs are very low because Greece is near Kosova, and transport will be by train from railway station in Xerxe which is 10 km from Gjakova or from station in Fushe-Kosove. Therefore is a good market for our producers:

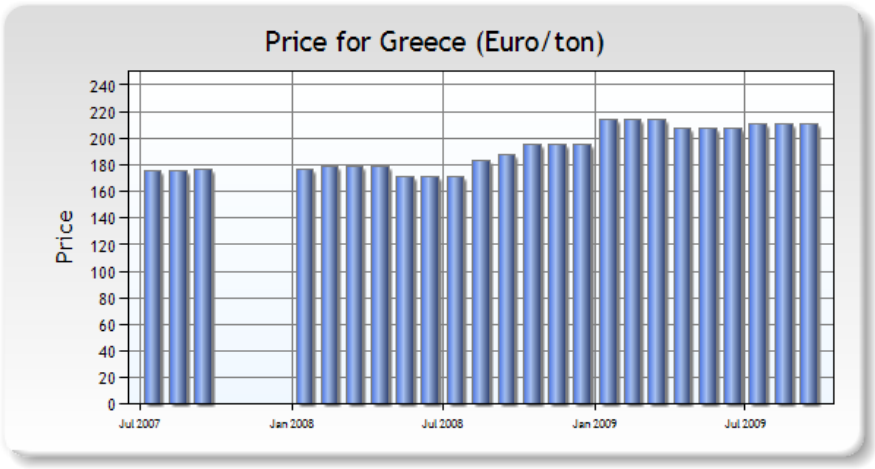


Figure 5.16

The greatest chance for our pellet producers is their export in European Countries, especially in Italy, Greece, Denmark and Germany.

5.5 Regulatory environment for wood waste fuel products in Kosovo

Biomass pellet and briquette production for the Kosovo market is practically non-existent. National standards for their production have not been officially adopted yet. But because pellet production in Kosovo will be mainly directed to EU countries, producers in Kosovo can make wood pellets according to standards of these countries.

The Law of Wastes doesn't exist in Kosovo jet, but when they approved will define different kind of wastes according to their harmful potential, and will define measures for waste handling and disposal, as well as penalties for disobeying the rules.

The Law on Forests 2003/3 deals with forest management for the optimum utilization of forests, but it does not prescribe treatment or disposal of residues from timber cutting. The general approach is to leave stumps of beech, oak and conifers, because the cost of removal is high. Sometimes conifer biomass wastes in public forests are collected and removed in pyramid form, which is created the so-called 'forest order', which is provided by forest legislation during the tree cuttings in conifer forests.

Broadleaves forest biomass sometimes is allowed for sale to local community, with so-called 'free sale', and depending on market value, biomass wastes are sold or are given to local inhabitants. But if a type of biomass wastes does not have any market value, such are conifer wastes; it can be left in forests. Since logs above 7cm in diameter have market value, it can be expected that some quantity of smaller diameter branches will be left in forests.

It can be expected that in the near future, some norms similar to the ones in the European Union would be adopted in Kosovo. Such norms consider the balance of different elements in the soil, such as nitrogen and mineral matters. Since the balance of nitrogen in the soil, is very important for the regular growth of trees and the development of forests, it is necessary to prevent an overload or shortage of nitrogen in soil. These measures are conducted by removing or leaving some quantities of wood wastes, especially stumps.

Emission limits for biomass combustion boilers and furnaces:

	Capacity MWth		
	>1 -50	>50 -300	>300
	mg/m^3	mg/m^3	mg/m^3
dust	50	50	50
CO	250	250	250
NO_2	500	400	200
Organic compound expressed as total C	50	50	50

Table 5.4

As it can be seen in table 5.4, the Rulebook defines emission limits for boilers on biomass above 50 MW, which doesn't exist in Kosovo, while it does not prescribe emission limits for medium and small boilers below 1 MW, which constitute the greatest share of installed biomass boilers.

In the event Kosovo develops a market for pellets, it would be necessary to develop standards regarding the quality of pellets and briquettes, declarations on products, and standards on the quality of boilers and furnaces.

Specification	**Austria** ÖNORM M7135		**Sweden** SS 18 71 20			**Germany** DIN 51731 / DIN plus			**CEN** CEN/TS 14961
	Wood pellets	Bark pellets	Group 1	Group 2	Group 3	5 size classes [cm]			
Origin									Chemically unt
Size	- Pellets : 4 - 20 mm Ø max.100 mm lg.	-Briketts: 20 -120 mm Ø max. 400 mm lg.	max. 4 Ø**)	max. 5 Ø	max. 6 Ø		Length	Ø	D06 ≤ 6 mm ± D08 ≤ 8 mm ±
						HP1	>30	>10	
						HP2	15-30	6-10	
						HP3	10-15	3-7	
						HP4	<10	1-4	
						HP5	<5	0,4-1	
Bulk density			≥ 600 kg/m³**)	≥ 500 kg/m³	≥ 500 kg/m³				Recommended basis
Fines in % <3mm			≤ 0,8	≤ 1,5	≤ 1,5				F1.0 ≤ 1,0 % F2.0 ≤ 2,0 %
Unit density	≥ 1,0 kg/dm³	≥ 1,0 kg/dm³				1-1,4 g/cm³			
Moisture content	≤ 12 %	≤ 18 %	≤ 10 %	≤ 10 %	≤ 12 %	<12 %			M10 ≤ 10 %
Ash content	≤ 0,5 % *)	≤ 6,0%*)	≤ 0,7 %	≤ 1,5 %	>1,5 %	< 1,5 %			A0.7 ≤ 0,7 %
Calorific value	≥ 18,0 MJ/kg*)	≥ 18,0 MJ/kg*)	≥ 16,9MJ/kg ≥ 4,7 kWh/kg	≥ 16,9MJ/kg 4,7 kWh/kg	≥ 16,9MJ/kg 4,7 kWh/kg	17,5 - 19,5 MJ/kg ***)			16,9 MJ/kg 4,7 kWh/kg
Sulphur	≤ 0,04 %*)	≤ 0,08 %*)	≤ 0,08 %	≤ 0,08 %	anges	< 0,08			S0.05 ≤ 0,05 %
Nitrogen	≤ 0,3 %*)	≤ 0,6%*)				< 0,3			N0.3 ≤ 0,3 % N0.5 ≤ 0,5 % N1.0 ≤ 1,0 % N3.0 ≤ 3,0 % N3.0+ > 3,0 %
Chlorine	≤ 0,02%*)	≤ 0,04%*)	≤ 0,03%	≤ 0,03%	anges	< 0,03			Recommended CL 0.03 CL 0.07 CL 0.10 CL 0.10+ (if CL stated)
Arsenic						<0,8 mg/kg			
Cadmium						<0,5 mg/kg			
Chromium						<8 mg/kg			
Copper						<5 mg/kg			
Mercury						<0,05 mg/kg			
Lead						<10 mg/kg			
Zinc						<100 mg/kg			
EOX, extractabl.org. halogens						<3 mg/kg			
Fines. bevor delivery to costumer	max. 1 %					max. 1 %			
Additives	max. 2 % only natural		to be stated						< 2w-% of dry primarily agricu not chemically added as a pre additive has to
Ash melting point			temperatur to be stated						
Durability									DU97.5 ≥ 97,5

*) of dry basis **) at factory ***) witout ash and water

Table 5.5 National pellets standards for Austria, Sweden, and Germany and European standards for pellets.

5.6 Environmental and other impact of wood waste utilization

The utilization of forest and wood waste should be conducted in such a way that does not have an environmental impact on life in forests. Pursuant to the Law on Forests 2003/3, Kosovo Forest Agency is responsible for forest management in Kosovo.

Productive forestry should contribute to bio-diversity, which means saving different species of plants and animals. Therefore typical measures in EU silviculture include leaving a number of old trees and dead wood (trunks) on the clear-cut, and preferably some young deciduous trees also. Regarding the branches, whether to remove them or not, the opinion is that once trees have been felled the natural environment is not disturbed further if the branches are also harvested.

Consequently, consideration to nature does not imply a barrier to comprehensive use of forest fuel. But it is recommended not to remove all felling residues. Stumps are left in the soil in significant numbers, for both soil-beneficial and technical reasons (erosion prevention), and they favor wood-living organisms.

At the UN Conference on Climate Change in Kyoto in 1997, international obligations were drawn up to limit the emission of greenhouse gases. The greenhouse gases related to forestry and the energy sector are carbon dioxide CO_2, methane CH_4, and nitrogen-oxide N_2O. The EU has resolved to reduce its emission by 8% from the level of 1990 by the period 2008-2012.

The utilization of biomass for energy production is treated as CO_2 neutral, based on the fact that plants capture CO_2 during growth through the process of photosynthesis. Combustion of biomass releases CO_2 but the same quantity that is already captured in the plant. If the use of forests is carried out in a sustainable way then all the CO_2 released during combustion of biomass would be captured during the growth of the next generation plant. Therefore the EU Directives impose the increase of biomass and other renewable energy sources utilization for energy purpose.

Beside CO_2, the use of biomass as an energy source has other positive effects. Comparing contents of ash in biomass and coal, it is obvious that the replacement of coal with biomass would decrease by several times the quantity of ash generated during combustion. Taking into account that ash contains toxic metals, and that ash from one plant is usually deposited in a selected site, means that the soil at these sites is very much polluted. Decreasing the volume of ash will help these sites be less endangered.

Comparing the sulfur content of biomass on one hand and coal and liquid fuel on the other demonstrates that utilization of biomass instead of these two types of fossil fuels would lead to a decrease of SO_2 emission. SO_2 is not a greenhouse gas, but its negative effect is the formation of so-called acid rains, which is harmful to forests, causing leaves and needles to drop off, and other forest damage.

In spite of the fact that it is useful for the sake of biodiversity to leave some residues after clear-cutting a forest, leaving all these residues in the forest would cause more damage than benefit. Areas under the residues would be degraded. The degradation would occur because of nitrogen and metals leaching from the residues. Nitrogen is very important for the growth of trees. Neither the lack nor an excess of nitrogen in soil is good for forests. It is of great importance to maintain the balance of nitrogen in forest soil, as well the balance of minerals. The balance of nitrogen can be controlled by leaving or removing some quantity of forest residues, while the balance of minerals, in the case of intensive use of forests for wood production, can be partly maintained by leaving part of residues, but also with wood ash recycling. It means that the ash generated after combustion of wood residues should be prepared in granules and returned to the forest soil.

In addition to the environmental impact, the utilization of wood residues would have positive effects on forest regions. If wood wastes utilization was developed and financially attractive, including residues of forest cutting, forest owners and managers would try to increase the forest area that would be used as a resource. Therefore, it is necessary to improve the existing forest infrastructure and develop new forest infrastructure. This will enable forest managers and staff to reach all forest areas and to act if necessary for the protection of forests against disease and fires.

The regions with the largest area of forests in Kosovo are some of its poorest ones. The municipalities of Decan, Kamenica and Leposavic are examples. Sustainable and intensive utilization of forests and wood residues in these areas would lead to an increase in employment of local people. Since the bulk density of forest and wood residues are rather low, it is not economically viable to transport residues long distances, and therefore industry of wood processing and wood fuel production would operate more intensively and new enterprises would be established.

It is hoped that the intensive exploitation of forests will lead to a greater concern and understanding for sustainability and environmental protection. Activities directly connected to wood processing and fuel wood production, as well as activities related to maintenance of sustainable use of forests, environmental protection would ask for a new engagement of the local population. This new engagement could lead to the improvement of the population's social status. It must not be forgotten, the potential damage, which could occur if the utilization of forests is not sustainable and if wood fuel is not used in an efficient way.

As it was previously mentioned, forests must be used in a sustainable way with protection of the biodiversity. A sustainable way means that the forest area and the volume of trees must not be decreased in the long term and the forest soil must not undergo degradation by the depletion of minerals and nitrogen. Trees and animal species must be preserved, and animals be provided with secure new settlements prior to new clear-cutting of forests.

The biomass combustion process is generally treated as CO_2 neutral, which contributes to the decrease of greenhouse gas emission. But if boilers and furnaces are inefficient then gaseous combustion products can contain a high concentration of methane, as a result of incomplete combustion. Methane is a gas with potential for greenhouse effects 21 times higher than CO_2. Therefore, incomplete combustion with methane emission decreases the positive effects of biomass use as an energy source on the greenhouse gases balance in the atmosphere.

5.7 Possible utilization of wood waste for non-energy purposes

Different kinds of wood waste appear in forest, after wood cutting and wood processing. Typical wood wastes in forest after cutting are: stumps with large roots, thin branches up to 7cm in diameter, and bark of round wood. Some residues from wood cutting result from milling appropriate dimensions and shapes of commercial assortments. These residues have limited potential to be used for production of wood products, or to be used for any other commercial purposes other than fuel. That means an estimated volume of 330.000 m^3 forest wood wastes would be used mainly as fuel.

Wood residues in wood processing companies such are sawmills or factories which producing furniture, joinery (doors and windows) and other wood processing works, are of a different kinds.

In sawmills, wood residues consist of a bark, woodchips and sawdust. Biomass wastes containing toxic components after the chemical treatment of wood in finally wood processing, such as in joinery or furniture production, after processes of coating.

Woodchips have many different uses, especially for board or panel production (which doesn't exist in Kosovo now). Sawdust can also be used for board production, while bark is mostly used for energy purposes. Biomass wastes containing toxic components can be used as fuel only.

Residues used in the production of windows/doors and furniture, can be pure wood, contaminated wood, and parts of boards or panels. If the residue is contaminated wood, previously protected with some resins or paint, or parts of board containing resin in glue, then its utilization is limited. If it is not possible to find uses for large pieces of residue in the production of furniture, windows and doors, this residue should be used as a fuel, in an environmentally safe way, in the combustion process. An environmentally acceptable way means the combustion gases should satisfy the defined concentration limits regarding toxic gasses containing chlorine and mercury, while ash with higher concentrations of some metals, such as cadmium, zinc, and lead, should be specially treated.

This means contaminated residues are not suitable for pellet production or for use in households with open fire stoves. Standards for pellets (Austrian, Danish, German, and EU) define the maximum content of dangerous metals in pellets. The solution for production of pellets could include mixing low contaminated wood residues with pure wood to keep the level of hazardous metals down, so as not to exceed the maximum levels allowable.

5.8 Attitude of main stakeholders towards the production and utilization of wood waste for energy purposes

The stakeholders related to wood waste production and utilization can be divided into two main groups: entities in the chain of production and entities in the chain of utilization.

Stakeholders in the chain of production are: forest owners, entities doing harvesting, wood processing companies, and enterprises which producing pellets.

Stakeholders in the chain of utilization are: householders, municipalities with heating systems for schools, hospitals and other public buildings and wood processing companies.

Forest owners, both public and private, are generally very interested in as much utilization of their resources as possible. Of course, they must keep in mind the sustainable use of forests. The sustainability guidelines are defined by the Kosovo Forest Agency, which mark the trees and define the quantity of trees that can be felled every year in all the forests of Kosova.

Entities dealing with the harvesting the forests also have interests in widening the forest assortments that can be commercial.

In Kosovo don't have any company which produces a wood based panel, which will be used a wood waste for its production. All wood wastes can be used in pellet production.

Others, which produce wood products, but cannot use all the wood wastes they make, they would try to make their wastes valuable. There are two possibilities for this: the first one is to sell or give the wood wastes to other entities which can produce bio-fuel or to use them for heat production, and the second possibility is to produce bio-fuel/pellets themselves.

Presently, the first option, to give the wood wastes free of charge to another entity, is not as probable. This is because there is no obligation for producers of wood wastes to solve the wastes problem. A more probable option is to sell the wood wastes.

The second option, to produce the bio-fuel itself, is a feasible option only if the enterprises have enough volume, have a suitable quality of non-toxic wastes, and have the financial capabilities for new investments. It should be taken into account that many companies are new or have been recently privatized, which means that many of them have already spent a lot of money on investments in the main production line.

Households are potentially great consumers of wood pellets. In addition, municipalities in forest regions with public buildings (schools, hospitals) are potentially great consumers as well.

Public buildings under the management of municipalities have their heating provided by the municipalities. As a result, these entities are not as motivated to introduce technology using cheaper fuel that requires an operator's skill and responsiveness. Lessons were learned in the past, during the economic crisis, when responsiveness was low and many facilities stopped operations, which forced many entities to replace biomass or coal boilers with another type where the need for a skilled operator was lower. Now it is not easy to return to technologies that require skilled operators.

A more serious consideration of the municipality budget would show that the utilization of wood wastes from that municipality would improve the economy. These municipalities would not have to pay for imported liquid or gaseous fuel, people of the area would be employed to collect and transport the wastes, and local enterprises of wood processing would have the potential for additional revenue. It should also be noted that the forest regions are mostly regions of low development and a boost to their economy is greatly needed.

6. WOOD WASTE MANAGEMENT

6.1 Main stakeholders for supply of Wood Wastes

From 464.800ha of Kosovo forest, 60% are public, while 40% are private forest. With forests manage Kosovo Forest Agency, which conduct actions on afforestation, cutting, development and maintenance of infrastructure, and all other activities related to improvement of forests.

Kosovo Forest Agency, by the Annual Managing Plan, every year contract with firms for forest exploitation. The tree-price is definite based on type of wood: it is technical (round) wood or fuel wood, and from places in forest.

Kosovo Forest Agency did the sale of standing trees in forest. Their calculated value starting from the market price, by subtracting from this price: forest track construction, cutting and processing expenses, withdrawal costs, uploads-downloads costs, transport, road maintenance costs and others.

In practice these costs are presented in table 6.1:

Assortments	Costs €/m^3							***total costs**
	track construction	cutting	withdrawal	upload-download	transport	road maintenance	other	
Technician wood	3	4.5	5	3	8	1.5	7.5	**32.5**

Table 6.1 Kosovo Forest Agency by actually legislation sold as standing trees.

In the table 6.2 are presented prices of some categories of standing woods in forest:

assortments	Costs €/m^3			
	specie	price	*total costs	Timber value in forest
Technician wood	spruce/pine	80	32.5 – 55.0	47.5 – 25.0
Technician wood	beech	60	32.5 – 40.0	27.5 – 20.0
Fuel wood	beech/oak	30	19 - 24	11.0 – 6.0
thin branches	beech/oak	-	-	6.0
thin branches	spruce/pine	-	-	free

Table 6.2 Kosovo Forest Agency by actually legislation sold as standing trees.

As is seen, technical wood in forest have a price from 25 to 47.5 euro for spruce, depending of the place in forest, conditions, and so far is that parcel. In the same way is done and with another wood assortments.

Branches and another wood waste in broadleaves have a price of 6 €/m^3 or 10.50 €/ton, which price is the lowest in the region, while in conifer wood wastes are for free.

Private forests are used based on permits issue by Kosovo Forest Agency, divided into relatively small parcels with an average area of 1 ha. Therefore, if an entity has demands for a considerable volume of forest wood then that entity has to contact and make agreements with several private forest owners.

Private forest owners are united in one association: 'Association of Private Forest Owners to Kosova'.

Private owners do not have the appropriate equipment for professional wood cutting. In addition, they do not have the heavy machines for transportation of stems and logs. Therefore, the purchasing of wood, both commercial round wood or wood waste, from forests in private ownership, is much more complicated than it is with state owned forests.

The managements of municipalities, in the territories that the forests grow, now do not have responsibilities regarding the forests, but with decentralization by Ahtisari Plan, municipalities will benefit competences in forests, and that in managing and forest protection.

6.2 Securing a regular supply of wood waste

According to the actual state, the prospective producer of pellets has to make agreements with many entities. The best solution is for the producer to make two agreements: one with Kosovo Forest Agency for long-time wood waste purchasing, including wood cutting and another agreement with a company for wood waste collection, processing and transport.

However, for pellets producers with the remarkable production rate of over 10.000 t/year, this is easy to realize. After legal and illegal cuttings, wood waste has in large in our forests or more than 330.000m^3 annually, and should only make their collection.

For a prospective pellet producer, it would be more realistic to have several agreements for wood waste purchasing, including public forests, owners of private forests, wood processing companies, with one agreement for cutting, collection, processing and probably one agreement for transportation. This organizational scheme however, seems very complicated.

It should be noted again that Kosovo has about 500 wood processing companies. This means that a significant number of them have a small capacity. Most of these companies have wood residues suitable for pellet producers. Therefore, for full utilization of wood wastes for pellet production, a great number of agreements should be made.

Within the ‘Kosovo’s Chamber of Commerce’, there is the ‘Association of Forestry Engineers and Technicians of Kosova’, ‘Association of Wood Processors of Kosova’ and ‘Association of Kosovo’s Private Forest Owners’.

Here are to help and foreign organizations which operating in Kosovo such are:
Netherlands SNV, Sweden’s SIDA, German’s GTZ, the USA’s - USAID-KPEP with forestry and wood processing sector, etc.

Presently, since private forests owners are organized through ‘Association of Kosovo’s Private Forest Owners’, prospective producers of pellets can make contacts with this association for wood waste exploitation in private forests. Prospective producers of pellets can find forest owners and through municipal entities. The municipalities are interested in the improvement of its local economy, and will surely helps investors and forest owners to make agreements on providing forest wood wastes.

7. STATE OF WOOD WASTE TECHNOLOGIES APLIED IN KOSOVO

7.1 Producing technologies for solid bio-fuels

There are two main types of solid bio-fuels. One type includes fuel wood, wood chips and other wood wastes without any preparation. The other types are pellets and briquettes, the bio-fuel, which is produced by increasing the bulk density of wood wastes under pressure and high temperature.

Collection, Processing and Transport of Biomass Material

Pellet production factories require wood-based material to produce a pellets. In particular, factories need the material to be within a specified size range, below a maximum moisture content value, and exclude contaminated material. With this in consideration, wood-based materials suitable for pellet production are the following: manufacturing waste (sawdust, chips, and bark), harvesting residue (branches, tops, and stumps) and whole-trees (tree parts or logs in areas under illegal logging).

The challenge, from an operations perspective, is to find the most economic approach to convert trees and harvesting residue (branches, tops, and stumps) located in the forest, into a suitable product and delivers it to the pellet production factory (figure 7.1). The conversion includes tree harvesting or logs/residue collecting, comminuting and transportation.

Is to provide insight into various approaches to convert wood biomass into suitable raw material for pellet plant and to recommend specific approaches for operations located in the Kosovo.

Overview of the wood biomass supply chain:

Figure 7.1

7.2 Wood Biomass Conversion

The process to convert trees and harvesting residue into suitable material for pellet plant requires tree harvesting or tree parts collection in illegal cuttings areas, accumulation and processing of residues and tree parts, and transportation to the facility. There are a variety of approaches to each one of these steps, but not all are compatible with subsequent steps.

The order of the steps is also influenced by the approach of each step, however, harvesting residue requires comminuting or compaction prior to being transported, because the material has a low bulk density. The driving force behind wood processing is the low-bulk density nature of harvesting residue (especially small branches and bundles) This section will explain options for each step and compile them into biomass conversion systems.

7.2.1 Harvesting/wood parts collection in areas under illegal cutting.

Harvesting trees includes processes required to deliver a collected and topped product to roadside. This includes felling, collection, transporting from the stump to the roadside landing (skidding or forwarding), but in Kosovo this mean and accumulation of whole-tree parts: round wood and logs, in forest areas under illegal cutting, where more than 90% of tree left in forest (photo 7.1).

Photo 7.1 Tree parts after illegal logging.

7.2.2 Accumulation of Harvesting Residues

Wood waste stoves in forest are different in type and size, and they are in slash, wood parts, and bundles and like round wood. Their bulk density is different from one to another. Terminals along forest roads are presented in photo 7.2:

Photo 7.2

Accumulation and transport of wood waste will be in different way, depending of wood waste type, bulk density and their size (photo 7.3).

Photo 7.3

Accumulation includes all activities associated with collecting and piling harvesting residue. Accumulation of harvesting residue is only necessary if the material is not located at roadside, and this is not required for all harvesting systems. General accumulation processes will be realized by:

- Tractor - Bundler
- Tractor – Forwarder
- Tractor with trailer
- Track with grapple loader
- Tractor/track with container

The tractor – bundler (photo 7.4/a) travels throughout the harvest job site and collects compacts, and bales harvesting residue into biomass bundles.

The tractor - forwarder (photo 7.4/b) loads the bundles onto the forwarder with a grapple loader and transports them to roadside.

The tractor - forwarder approach uses a forwarder to collect harvesting residue throughout the job site. It loads tree tops and large branches into the back of the forwarder and transports them to the roadside landing. Occasionally a removable brush pan is added to the forwarder to minimize the amount of brush that falls out of the forwarder bunk or drags on the ground.

Photo 7.4 Tractor – bundler (a) Tractor – forwarder (b)

Tractor with trailer (photo 7.4/c) – uses for wood parts and branches transport in short distance (up to 10km), where his loading becomes with forestry workers manually or with grapple loader. Transport capacity is around 6m^3.

The track with forwarder (photo 7.4/d) serves better for log and log parts transport. Track loads logs onto the forwarder with a grapple loader and transport them to the pellet production facility. The transport capacity of track is 17 m^3 of wood biomass in log and a log parts, while with trailer is around 30m^3 (in forest tracks).

Photo 7.4 Tractor with trailer (c) Track with grapple loader and forwarder (d)

Harvesting wood residues will be transported with container (photo 7.4/e), while biomass bundles with a tractor or truck/bundler with grapple loader (photo 7.4/f).

It is important to note, however, that the bundles must be comminuted before the energy facility can utilize them.

Photo 7.14:

Loading Harvesting Residue into a Container (e) Transporting Biomass Bundles (f)

7.3 Processing of Biomass Material

Wood chips

Wood chips are usually wood wastes in sawmills and wood processing industry, with density from 200 to 400 kg/m^3, but can be manufactured specifically for use as fuel for electricity or for heating.

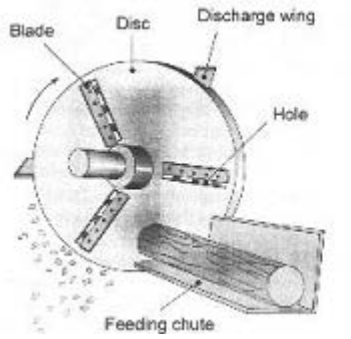
Intentional production of woodchips is usually for household demand. The typical technologies for woodchips production are presented in photos 7.5. There are machines of different capacities and capabilities. Some equipment is for the cutting of tiny branches for domestic purposes with a capacity of about 6-10 m^3/h, while others are for cutting thin stems with a capacity of 100 m^3/h. As will later described, in European Countries, in USA, in Canada and in other developed countries are in use a whole-tree chippers, but who can not be used here, because of their very high capacity and for economic reason, they are very expensive for our conditions.

Photo 7.5

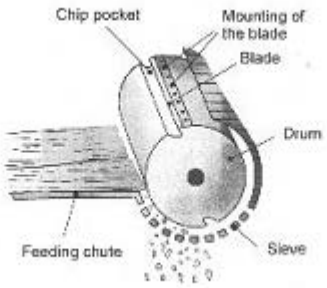
In spite of the forest residues availability, the existence of biomass boilers and the relatively low price of machines for wood chip production, these technologies for wood chip production, have not been applied in Kosovo and regional countries yet. The lack of information and promotion of bio-fuel use, especially of forest wood wastes, is most likely the main reason this technology has not yet been applied.

The choice of chipper used is important, if the wood chips have to be used with many types of feed mechanisms, especially auger feeds as found on many wood chip heating systems. Also some wood chip boilers have constraints on the parameters of the wood chips to be used.

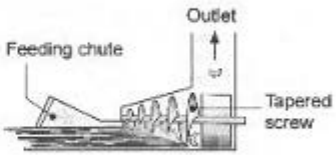
Chippers generally works in these principles:



Disc chipper



Drum chipper



Tapered screw chipper

General purpose chippers designed primarily for volume reduction, and do not usually produce chips suitable for use with many auger feeds which require chips of closely defined dimensions, with low levels of fines or slivers. Slivers in particular can cause difficulties as they can bridge or jam the auger.

Types of Wood Chippers

Processing includes all activities associated with converting harvesting residues, or trees, into smaller pieces (wood chips). There are three general types of processing equipment:

- Tub Grinder
- Horizontal Grinder
- Whole-Tree Chipper

Tub Grinder

A tub grinder processes harvesting residue into smaller pieces by means of a hammer mill (photo 7.6) located at the bottom of the tub. Harvesting residues is placed in the top of the tub which rotates to feed the material into the hammer mill. A screen around the hammer mill limits oversize material from passing through to the conveyor system which either feeds directly into a transport container, or is piled onto the ground to be loaded later.

Photo 7.6:

Hammer mill with screen

Tub grinder

Horizontal Grinder

A horizontal grinder processes whole-tree parts or harvesting residue into smaller pieces by means of a hammer mill located at the end of the feed table (photo 7.7). Harvesting residue or whole-trees are placed on the feed table and brought to the hammer mill via a rugged conveyor. A screen around the hammer mill limits oversize material from passing through to the conveyor system which either feeds directly into a transport container, or is piled onto the ground to be loaded later.

Photo 7.7:

Horizontal grinder

Whole-Tree Chipper

Whole-Tree Chippers

A whole-tree chippers process whole-tree parts or harvesting residue into chips by either a drum or disc type chipper. Harvesting residue or whole-tree parts are placed on the feed table and brought to the chipper by a rugged conveyor. The chips are blown out of a chute directly into a transport container. Piling chips on the ground is difficult, and this less common, because it is not easy to contain the chips in a manageable pile. Loading chips from a pile on the ground also adds dirt and rocks to the chip load, which is not desirable by the energy facility.

Each of the grinding equipment can be fed material by the following equipment types/categories:

- Track-Type/Off-Road Loading Equipment
- On-Board or Road-Based Loading Equipment

It is theoretically possible to feed a whole-tree chipper with track-type/off-road loading equipment, however, this equipment is typically used to accumulate and transport harvesting residue short distance on the landing. Accumulating harvesting residue that is distributed throughout the landing increases the percentage of rocks and dirt that goes into the chipper, which in turn increases damage to chipper knives and replacement or sharpening frequency, thus increasing maintenance and repair costs and decreasing machine utilization. This for all practical purposes, chippers are typically loaded with on-board loaders or road-based loaders. Again, this is nothing inherent about the loading equipment but rather purely a relationship between the loading equipment used and how the harvesting residue was collected during the harvesting step.

Track-Type/Off-Road Equipment

Track-type/off-road loading equipment refers to any device that is capable of traveling short-distances on off-road conditions, and accumulating and loading harvesting residue and/or whole-trees into a grinder.

In the forest location, this generally refers to excavators with thumb attachments and track-type loaders. However, it is also possible on level terrain to use a front-end loader or skid-steer equipped with brush handling attachments or a forwarder. The important distinction is that these types of equipment are capable of moving and accumulating harvesting residue short distances, thus offering more flexibility in the harvesting step for utilization of harvesting residue because material does not need to be piled within the reach of an on-board or road-based loader.

Photo 7.8
Excavator Track-type loader

On-board or Road-Based Loading Equipment

On-board loading equipment refers to loaders located on chipper or grinder carriers (photo 7.9). Road-based loading equipment refers to loaders located on crane carriers.

These loading approaches are limited by the loader reach, which for all practical purposes is a fixed distance from the road. Grinders and chippers are occasionally located on the landing when processing material, however, the machine must be moved and set-up again once all of the material within an on-board loader's reaches has been processed. Grinders or chippers on self-propelled track carriers ease this process, but loading material into a chip-van or transport container from hog fuel or chip piles that are scattered throughout the landing decreases utilization and can be an inefficient process. Further, track-type/off-road loading equipment can access more difficult terrain than a grinder or chipper on a self-propelled track carrier.

The distinction is that for these loading methods, the harvesting residue must be piled within reach of the loading equipment during the harvesting step. Otherwise, the chipper or grinder would not be able to fully utilize the material when it arrives on the job site.

Photo 7.9 Loader on a Crane Carrier On-board loader

In addition, there is an off-road/mobile chipping approach where a drum chipper and chip-bin equipped with a dumping mechanism are mounted on a tractor-forwarder (photo 7.10).

The tractor-forwarder travels throughout the harvest job site and feeds harvesting residue into the on-board chipper which blows the chips into the on-board chip-bin. When the on-board chip-bin is full, the tractor-forwarder travels back to the road and dumps the chip-bin into a chip-van or transport container.

Photo 7.10:

Off-road/Mobile Chipping Equipment

Off-Road/Mobile Chipper Dumping Chips

7.4 Transportation

Transportation of wood wastes or chips from the forest location to an pellet production facility can be accomplished by tractors or trucks with the following configurations:

- Tractor-Truck & Open Top Chip-Van
- Tractor-Truck & Enclosed Chip-Van
- Transport with Containers

Tractor-Truck & Open Top Chip-Van

The tractor-truck and open top chip-van configuration consists of a tractor-truck and a two or three axle open top chip-vans (photo 7.11). The open-top van configuration allows for top or rear loading of chips or hog fuel. Some vans are equipped with live or walking floors which allow for self-unloading at the pellet production facility. Otherwise, chip-vans are unloaded by chip-van dumpers.

Photo 7.11:

Open Top Chip-Van

Chip-Van Dumper

The tractor-truck and enclosed chip-van configuration consist of a tractor-truck and a two or three axle enclosed chip-vans. The enclosed chip-van can only be loaded with wood wastes or chips from the rear. Some vans are equipped with live or walking floors which allow for self-unloading at the pellet production facility. Otherwise, chip-vans are unloaded by chip-van dumpers.

Photo 7.12 Transport with Containers

Transport with containers configuration consists of modular containers and a straight-frame tractor equipped with an on-board hydraulic grapple. The configuration can be operated with or without a pup-trailer, which is another trailer with a modular container that is pulled by the hook truck.

The containers can be left at the forest location and loaded while the truck is in route with another load or it can be loaded when the truck arrives on the job site (photo 7.13).

The hook truck unloads the containers at the pellet plant with the on-board hydraulic grapple. It should be noted that there is a modification to this configuration, where harvesting residue is loaded into the transport containers by a loader and then transported a short distance to a centralized area where a grinder or chipper is located. The idea behind this modification, which is discussed in more detail in the reference link below, is to increase utilization of the grinder or chipper.

The hook truck configuration can also be used to haul logs with log-bunk containers (photo 7.13):

Hook Track Loading Container

Hook Track Unloading Container

7.5 Pellets and briquettes

Briquettes have a greater dimension than pellets. The typical dimensions of wood briquettes are diameter 60 -100 mm, and length 20 -200mm. Because of their relatively large dimensions, briquettes, unlike pellets, are not suitable for small and medium boilers with automatic feeding. They are more suitable for boilers and furnaces with manual feeding. There are producers of briquettes in Kosovo, but their production is very low.

Because of their weights and dimensions briquettes are much more inclined to attrition and breaking than pellets. Therefore, wood pellets are a better material for fuel. Pellets can be used in small boilers with automatic regulation, since the feeding rate can be regulated.

Scheme and photo of pellet production and matrix:

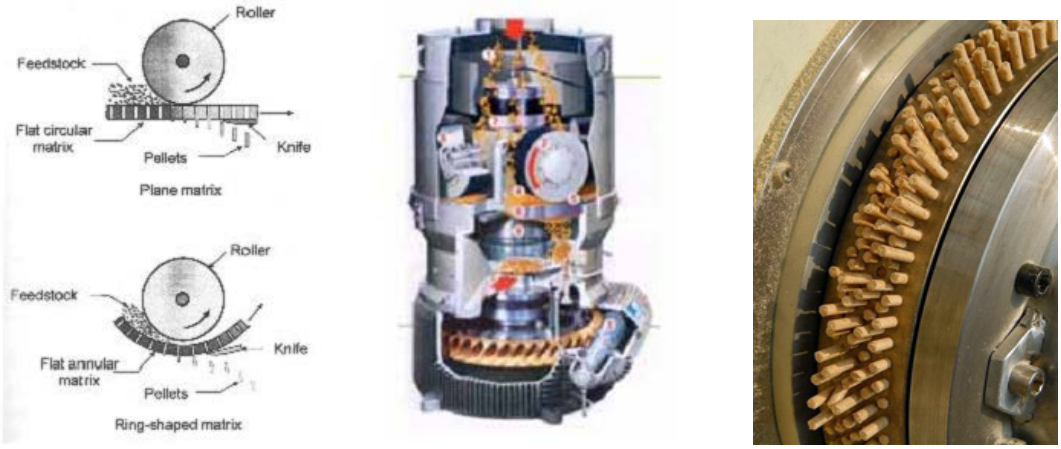


Figure 7.2

The production of wood pellets is becoming more frequent in region countries such as Serbia, Bosnia and Croatia.

There are producers of wood pellet production technology in different countries. And several web addresses of technology producers in China can be found on the Internet, these include: Xushou Orient Industry Co., Henan Double Elephant Machinery, and Anyang GEMCO Energy Machinery.

European technology producers can be found in different countries, like Andritz in Austria, Larus Impianti and Palazzetti in Italy, Salmatec and Calimax in Germany, SG Strojina in Czech Republic, Power Chippers Ab in Sweden, etc.

The principle of pellet production is the same. Pellets should be produced from pure wood, but it is not obligatory. The usual pellet production practice is to make them without adding glue or resin. The technology of pellet production has to meet the request for resistance of mechanical wear, which include the attrition and breaking of pellets caused by their storage and transport. Some European countries, where pellets are in use in great volumes, have adopted very detailed standards regarding the quality of pellets.

Pellets can be produced from non-pure wood wastes and additives. But, if this is done, the pellets must not exceed the acceptable level of maximum value of harmful matters. Since the pellets should have a list of specifications, if the raw material is pure wood, the price of pellets is higher on the market.

The ownership structure of the pellet plants that will become in Kosovo, which provided that to built in the near future, is mixed. Plants can be owned by either a foreign or a domestic company, or they can be owned by a combination of both. The technology used for the production of pellets is from European manufacturers. But, the smaller domestic pellet producers usually will have second hand technology from European manufacturers or Chinese technology, which is much cheaper.

Quality of wood pellets: in left side is a qualitative pellet, produced with modern technology, and where the moisture of raw material in production is under 20%, while in right side are pellets with lower quality (figure 7.3).

Figure 7.3

7.6 Technologies of wood waste use for energy production

The most common way to utilize wood biomass for the purposes of energy production is to burn it in boilers or furnaces. Other technologies, like gasification, are rarely used, and they are experimental.

For combustion of wood biomass in medium scale boilers the typical technology used is grate firing boilers. This means that wood biomass is burning on a static or moving inclined grate or slope. There are several manufacturers of medium scale boilers (0.5 - 20 MW) in Region Countries such as Serbia, Bosnia and Croatia.

One of the typical solutions for woodchip combustion in a boiler with a temperature-isolated furnace which enables full combustion of biomass fuel is given in figure 7.4:

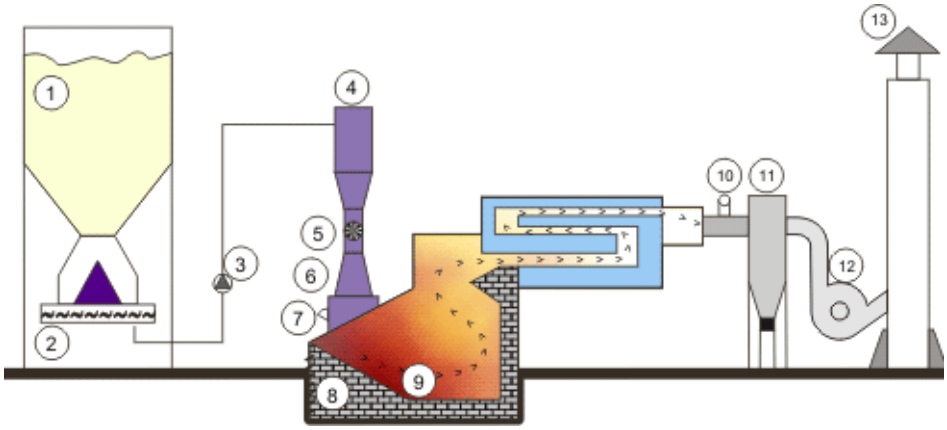


Figure 7.4 Schematic of a woodchips boiler with auxiliary equipment
1–bunker of wood wastes; 2–screw feeder; 3–fan; 4-cyclon; 5,6,7-feeding system; 8–furnace wall; 9-combustione zone; 10–regulator; 11–cyclone; 12–fan; 13–chimney

In regards to small boilers for biomass combustion, which are typically up to 300 kW, there are several manufacturers in Region and EU Countries, like Palazetti in Italy or Calimax in Germany. The cheaper solution is the pellet stove from China, but with doubtfulness quality.

Some of them offer the small boiler, including the auxiliary equipment explicitly for wood pellet combustion. Another producer offers auxiliary automatic fuel feeding equipment but mainly just for wood chips. Others usually produce boilers for biomass combustion but mainly for logs, briquettes or coarse pieces of wood waste.

Now in region and EU countries produces a modern pellet stoves, with great technical performance and design. There are and producers from China, with cheaper solution of pellet stoves.

Modern pellet stoves (figure 7.5):

Pellet stove from Calimax – Germany

Palazzetti from Italy

Made in China pellet stove

A short review of boiler manufacturers in region and EU countries shows that they already produce boilers for wood and wood wastes combustion.

Typical design of a boiler for biomass:

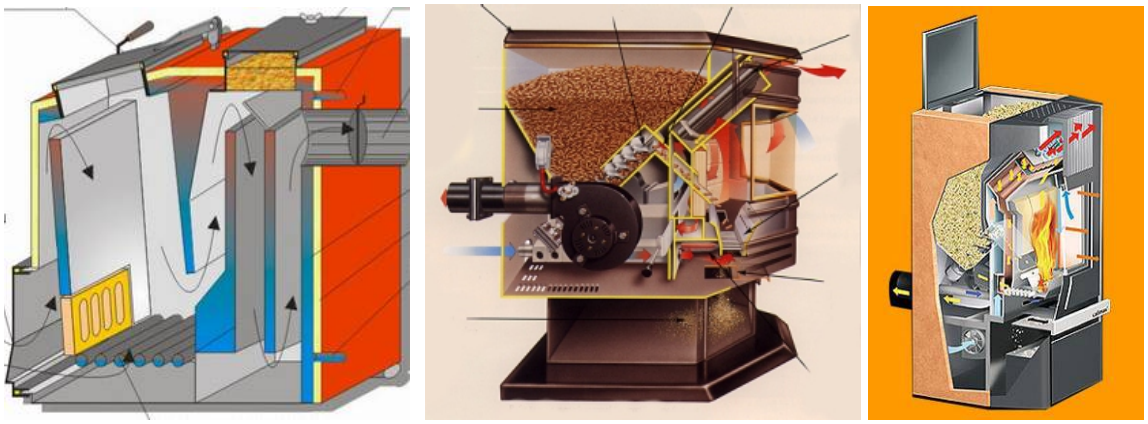


Figure 7.6

All boilers produced in region countries, like Termomont and Alfaplam from Serbia, and very qualitative and expensive stoves from EU countries, meet the standards regarding safety and efficiency. Unfortunately, the standards and regulations regarding combustion in small and medium scale boilers, were defined twenty years ago, and they do not prescribe contemporary maximum levels of gas emissions, combustion and boiler efficiency. Taking into account that boilers, in addition to similar equipment in many wood processing firms, are old, the standards do not impose high requirements regarding the level of gas emissions and boiler efficiency. The result is that many boilers operate with an average efficiency of up to only 70%.

Therefore, the necessary action is an introduction of updated standards and regulations for emissions from small and medium boilers. This measure will force domestic manufacturers to pay more attention to boiler efficiency.

Some wood processing enterprises, except simple sawmills, have chambers for drying wood. Since they use electricity for the operation of all machines, this means that the wood processing industry has a demand for both the heat and electricity. Therefore, from the technical point of view, wood processing firms are the ideal places for installation of combined heat and electricity power plants – CHP.

The advantage of CHP plants is their overall high efficiency of about 80%, when compared to an efficiency of 85% for separate plants for heat, and 35% for electricity generation plants. Higher efficiency means lower fuel consumption, and the lower fuel consumption for the given available volume of wood wastes means higher production of heat and electricity. The electricity produced in the enterprise can be used for meeting its own demand or it can be sold to the grid. For that reason the enterprise is, in principle, interested in high electricity production, after meeting its own heat demand.
A typical, but at the same time modern, solution for a CHP plant based on wood wastes fuel is a steam boiler with a steam turbine. Capacities of CHP plants, which are offered by manufacturers, vary from a few hundred kilowatts up to a few hundred megawatts.

Typical parameters of CHP plant with steam turbine:

Advantages	Weaknesses	Ratio Heat/El.	Efficiency	Power
High overall efficiency; Satisfying need for different parameters of steam; Possible variation of ratio electricity and heat production; Long working life	Slow start up; Low ratio electricity generation over heat production	3:1 up to 8:1	El: 10 - 20 % Total: up to 80 %	200 kWe – 500 MWe.

Table 7.1

Plants with relatively low installed power of electricity generation can be purchased on the market. This means, from technical point of view, those even small wood processing companies can install this kind of plant. However, the final answer about the viability of this technical solution will be given after economic evaluation, which takes into account a very important parameter, the electricity price.

Wood wastes can be burnt simultaneously with other fossil fuels within one boiler. This way of biomass combustion is called co-combustion. If the other fuel is coal of a similar size to wood wastes, the existing feeding system can be used for both fuels, and consequently very small investments are needed. This technical solution of using biomass for energy production is the cheapest one, but it implies that the existing boiler already uses technology, which is suitable for combustion of biomass wastes. In other cases it is necessary to carry out some construction changes on the boiler, as it could also burn biomass wastes. For example, if a boiler burns pulverized coal, and a firm has coarse wood wastes, then the structure of the existing boiler has to be adapted so it can efficiently burn coarse particles of wood wastes.

Co-combustion is a good option for wood processing companies with a relatively small volume of wood wastes compared to their needs of fuel and to the already installed boilers, especially if some of them use coal. Some types of co-combustion can be done with biomass and liquid or gaseous fuel, but in this case it is usually necessary to carry out several significant modifications on the boiler structure. However, these modifications are usually cheaper than having two boilers - one for biomass and one for fossil fuel combustion.

8. PRE-PRODUCTION LOGISTICS

Pre-production logistics depend on whether the prospective pellet plant is located within a wood processing company with available wood wastes for pellet production.

A simple solution would be locating the pellet plant within a wood processing company and meeting the demand of the pellet plant with available wastes from the company. In that case, wood wastes would move within the company from one site to another close to the pellet plant. For that, transportation could be conducted through pipes, or by conveyor belt with protection from rain and snow.

If the pellet plant is not close to a wood processing company, and the source is raw material which would be collected in the forest, or brought from a remote wood processing company, management of the pellet plant would need a solution to the problem of a reliable supply of raw material. Reliable supply is not a matter of transportation costs and vehicles, but the long- term availability of wood wastes. It is likely investors would install only small pellet plants if they do not have their own wood wastes, at least at some limited volume. In any case, if someone decided to install a pellet plant in agreement with forest owners and wood processing companies, it would be necessary for him to rent or buy a truck for transport. Wood wastes in forests are collected in volume, and stored near roads, while some wastes are left in the forest. Usually this consists of branches smaller than 7cm. All these wastes should be collected manually.

Kosovo has 464.800 ha covered with forests, where wood demand is about 1.3 million m^3 annually, which is covered by legal and illegal cutting. Theoretically, wood waste in this provided annually cut is about 500.000m^3, if all wood waste can be collected.

With our measurements, forest wood waste is about **333.000m^3**(192.000 t) and about **100.000m^3** (58.000 t) wood residues annually from primary wood processing.

Three locations are suggested for potential locations of new pellet factories, and they are: Gjakova, Ferizaj and Mitrovica. These three locations comprise wood waste collection of all 29 municipalities.

The selected locations would allow for production greater than 28.000 ton per year for each. This assumes that the most of raw material for the pellet factory, forest wastes and wood processing residues, would be collected from the area of the listed municipalities, where transport distances would not be longer than 80 km.

In column ‘on all wood wastes’, we can calculate wood residues from sawmills and other finally wood processing producing lines in those municipalities.

Selected places for potential pellet production (table 8.1):

Municipality		Forest area (ha)	Possible production of pellets (ton/year)		
			On Forest Wood Waste		On sawmills residues
			1/3 of wood waste total volume	Total volume of wood waste	
1	Gjakova	26.753	1.965	5.895	
2	Decan	19.023	7.392	22.176	
3	Peja	25.708	6.312	18.936	
4	Kline	11.568	626	1.878	
5	Istog	20.694	4.961	14.883	
6	Prizren	24.865	1.827	5.481	
7	Suhareke	15.070	1.589	4.767	
8	Rahovec	7.601	265	795	
9	Malisheve	13.840	535	1.605	
10	Dragash	6.338	772	2.316	
Pellet factory in Gjakova:			26.244	78.732	20.000
			46.244		**98.732**
11	Ferizaj	12.871	1.871	5.613	
12	Kacanik	17.369	3.526	10.578	
13	Shterpce	10.331	559	1.677	
14	Shtime	6.376	431	1.293	
15	Gjilan	24.235	2.296	6.888	
16	Kamenica	20.394	3.036	9.108	
17	Viti	9.936	1.095	3.285	
18	N. Berd	2.779	230	690	
Pellet factory in Ferizaj:			13.044	39.132	15.000
			28.044		**54.132**
19	Mitrovica	20.324	3.929	11.787	
20	Vushtri	10.430	1.774	5.322	
21	Skenderaj	15.226	1.089	3.267	
22	Leposavic	27.508	5.318	15.954	
23	Zubin Potok	20.773	4.016	12.048	
24	Prishtine	28.357	2.577	7.731	
25	Podujeve	25.966	4.367	13.101	
26	Lipjan	12.954	1.102	3.306	
27	Drenas	10.474	547	1.641	
28	Fushe Kosove	1.390	54	162	
29	Obilic	1.153	62	186	
Pellet factory in Mitrovica:			24.835	74.505	15.000
			39.835		**89.505**
Total (t):			**64.123**	**192.369**	**50.000**
Total production in Kosovo(t/annually):			**(64.123 + 50.000) 114.123**		**(192.369 + 50.000) 242.236**

As is seen from table, annually pellet production in Kosovo, distributed in three pellet factories, based on forest wood waste and sawmills residues, expected to be:

a. the least 110.000 ton/annually pellets, with third part collection of forestry wood waste and all sawmills/finally processing residues.

b. mostly 240.000 ton/annually pellets, with collection of all wood wastes from forest and all sawmills/finally processing residues.

With third part collection of forestry wood wastes and all wood residues from sawmills, guaranty production of pellets is about 110.000ton/annually, while with better forestry infrastructure and forestry equipment for collection, processing and wood biomass transport, production capacity in Kosovo will be around 240.000 ton/annually.

Based on forest infrastructure, wood waste collection machinery, transport etc, annual capacity will be between110.000 ton/annually and 240.000 ton/annually.

The total number of sawmills in Kosovo is 172 with annual production of 272.500m^3. Assumed wood residue from this production is 100.500m^3 annually, which weights around 58.000 t (0.58t/m^3). In the table 8.1 this is presented as 50.000 ton/annually.

1. Pellet plant in Gjakova

Installation of first pellet factory is provided to be in Gjakova, because is between Peja and Prizren Forestry Regions, which will make the forest wood wastes and wood processing residues from municipalities of those forestry regions.

Installation of pellet production factory expected to be in 'Interwood-Modeli', which before privatization has produced joinery (doors and windows), parquet, briquettes and log houses.

This company has great prerequisites to invest in program of pellet production, because there was the highest concentration of sawmills (Decan, Peja, Istog) and its rich in forest, is localized between Prizren Forestry Region with 25.800m^3 forest wood waste annually and Peja Forestry Region with 109.951m^3 forest wood waste annually.

If this factory starts with pellet production during 2010, with realistic expected forest wood waste collection in these two regions of 26.000 ton/annually (third part of forestry wood waste) and sawmills residues about 20.000m^3 annually, guaranty capacity will be 46.000 ton/year with the intention of expanding production, while with collection of all forest wood wastes, than annually production in this pellet factory is estimated to be around 98.000 ton/annually, this with better forest tracks, modern machinery for collection, transport and processing.

2. Pellet plant in Ferizaj

Another will be in Ferizaj, in wood processing factory 'Tefik Canga'. This factory has a great infrastructure for all wood processing works, especially for pellet and briquettes production. Ferizaj is rich with broadleaves forests. From here will become a collection of forestry wood wastes from Kacanik, Shtrpce, Gjilan, Kamenice, etc.

With third part of wood waste collection in Ferizaj and Gjilan Forestry Region, and collection of all wood residues from sawmills of those regions, guaranty capacity in this plant will be from 28.000 ton to 54.000 ton/annually (with all forestry wood waste collection).

3. Pellet plant in Mitrovica

The third wood pellet production factory will be in Mitrovica. Wood wastes from Mitrovica, Vushtri, Leposavic, Zubin Potok and Zvecan will be collected and transported in factory in Mitrovica. In wood waste collection in three municipalities with majority Serb population, also will help the community through employment in collection, transport and pellet production.

With third part of forestry wood waste collection in Mitrovica and Prishtina Forestry Regions, and with all sawmills residues collection from those areas, guaranty capacity will be the least 40.000 ton to maximum 90.000 ton/annually, with all collection of all wood wastes in those two regions.

Wood waste collection and transport costs from forest to plant:

From those dates, a possible pellet production in each of those pellet factories is from 28.044 ton to 98.723 ton/annually, but we can calculate for excepted annual pellet production of 20.000 tons annually for each factory, in two shifts, with 12 workers for plant.

Radius from each pellet facility to place where they get collection of raw material is 20 to 70 km, or in average about 50 km.

The cost of raw materials depends mainly on the factory location. If the pellet production facility is located within a wood processing factory, the raw material is cheaper. This is the optimal solution, not only because the price of raw material is cheaper, but more importantly because its supply is ensured.

If the pellet factory has to provide resources for production, then transportation of wood wastes (sawdust, woodchips, and bark) would be by trucks or tractors, depending on the distance and the type of wood wastes.

If the raw material is more compact, such as bark or wood parts, the transportation cost per ton would be lower. If the transportation distance is short, for example up to 10 km, then transport can be by tractor, and would be cheaper than by truck. But if the transportation distance is longer, then the capacity of the vehicle is an important factor, and should be done by truck.

For planning 20.000 ton/annually production, a day production will be around 74 ton/day in two shifts, which need for transport 2 tracks, one from them must stay in the forest during the wood wastes collection and loading, and another transport a raw material for facility.

A track with trailer can carry up to 40 spatial meter of wood waste, which in thin branches is real 30m^3 or 17 ton of wood wastes.

For factory supplying with raw material, for daily production needed 4 track laps, or around 2 laps per track in one day. In this conditions (forest tracks) price of wood waste transport will be 4.7 €/ton (maximum price).

Transportation of wood waste depends on bulk density of different wood fuels, which is presented in picture, where 1m^3 of stacked wood is 0.67 m^3 which weights about 390kg, or in bulk is real 0.4m^3 ore only 230kg:

Figure 8.1

580 kg/m^3 = 390 kg/m^3 = 230 kg/m^3

Based on these calculations, for different bulk density of wood waste parts, should perform a real way for transport.

Density of wood chips is between 0.20 and 0.40 ton/m^3. A track will carry 25m^3 of wood chips which weighs 5-10 ton, however this depends on track size.

Transport with containers, is more favorable, which for our forest infrastructure transport capacity will be up to 40m^3 (8-16ton).

Chipping can be performed on small round wood (diameter 7-14cm), tree crown or mixed brash (photo 8.2). The resultant bulk density will be around 200-400 kg/loose m^3, which is less than that of the solid wood and even packed, logs, but more than loose brash.


Photo 8.2

Transporting of different kinds of wood waste, based on their bulk density:

Figure 8.2 Wood waste transports depending on the type of waste

With suitable equipment, chips may be more easily handled, transported and stored than branches and brash, however small round wood and logs should usually be transported before chipping owing to the higher bulk density if stacked properly.

The value of wood chips transport is more favorable then transport of slash, mixed brash and tree crown.

Processing costs in chippers are much smaller per unit, as the largest is the processing capacity.

Chipping costs in small chippers with capacity from 8 to 15 m^3/hour are between 3.8 and 7.2 €/m^3, so with stronger chippers with capacity from 30 to 50 m^3/hour, costs are much lower or from 2.5 to 3.3 €/m^3.

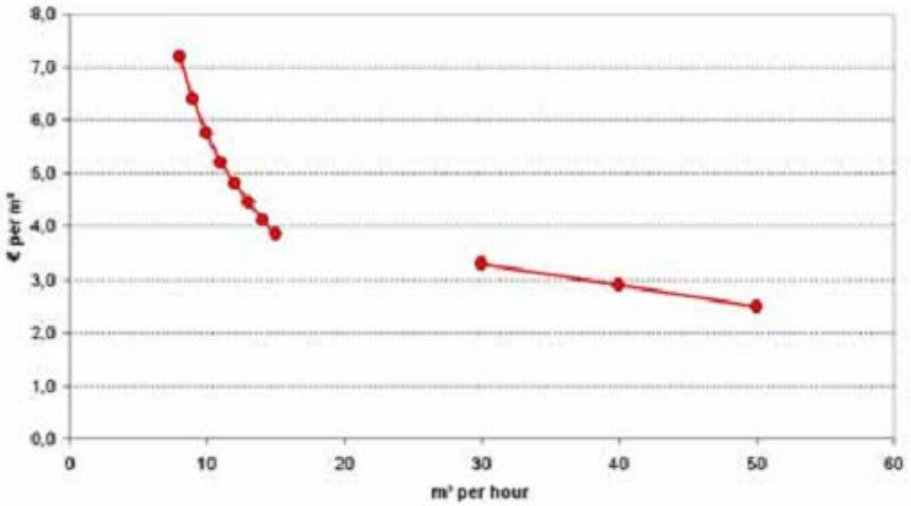


Figure 8.3 Influence of chippers capacity in chipping costs.

The resource for wood pellet production will come directly from the forest or from sawmills. If the pellet producer has to provide some wood wastes directly from the forest, price of wood waste would be maximum 25 €/t with collection and transport costs.

Wood residues from sawmills generally costs about 20€ per tractor of sawdust (about 2.5m^3), converted this is 8 €/m^3 or 36 €/ton.

The prices of forest residues in Kosovo are very cheep or are for free. One cubic meter of beech or oak residues costs 6 €/m^3, this mean about 10.50 €/ton for hardwood waste and 19 €/ton for firewood. This is the value from the price list of the Kosovo Forest Agency.

Forest residues of conifers are for free, because their removal from forest eliminated the causes of forest diseases and those residues have very good heating value.

Assuming that the transport of wood wastes by truck would be similar to the transport of firewood, the price would be within the range of 0.6 and 1.5 €/km (bad forest tracks) for distances up to 50km for trucks with a capacity of 15-25 tons.

Converting this to the cost per ton of pellets, the price is between 1.2 and 4.7 €/t.

The price greatly depends on the density of the wood wastes when transported. If the wood wastes are wood chips and sawdust, with a low bulk density, then the transport price would be higher than for thin branches and stumps.

9. PRODUCTION PROCESS

9.1 Producing technologies for wood pellets

The simplest pellet factory is one installed within a sawmill enterprise, where sawdust and cutter shavings are biomass wastes. In that case, the raw material is dry, the plant does not need a dryer and grinder, and the greatest attention has to be paid to protect biomass wastes from impurities (metal). In addition, if the capacity of the pellet plant is small, for example up to 300 t per year (1 t per day), then the only equipment is a pelletizing machine. All other tasks can be executed more or less manually, such as packing, internal transport, and storage.

If the raw material is wood wastes consisting of bark or other coarse pieces of wood, wet sawdust and wood chips, and the capacity is relatively large, over 10.000 ton per year (30 ton per day), then the pellet plant should consist of more machines with considerable level of automation.

The main processes in a pellet factory are:

- Reception of raw material - unloading of road or rail vehicle
- Storage system – enabling optimal conditions for further steps in manipulation
- Cleaning - before grinding, sieving machines and magnetic separators remove various impurities such as stones or metal particles
- Conveying – an internal transport system for horizontal and vertical conveying of the raw material
- Grinding – necessary if the raw material is not sawdust or wood material with dimensions under the upper limit, usually up to 3mm, but at least less than the diameter of pellets
- Conditioning – prepared in appropriate size, sawdust and wood chips are heated, usually by steam, releasing the lignin contained in the wood, which is then available as a binding material during the pelletizing process, also, the raw material should be dried up to a maximum 20% of moisture, and then can be pressed in order to produce pellets
- Grinding or milling and drying of raw material can be combined, if drying is necessary. In a miller-dryer the crusher changes the particle size of sawdust, which is dried. Crushing makes the process of drying considerably easier, and dried wood particles are easily crushed. The particles should be of equal size and equal moisture content. As the moisture content of all particles is homogeneous, the pellets are more durable.
- Hot gas generators are used for drying. Usually they use sawdust and other biomass wastes as fuel.
- Pelletizing – pellets are produced under very high pressure in pellet mills. After the particles of wood wastes are prepared for pellet production, they are put into the press. The process of pressing is carried out in a drum with small holes, through which the crushed wood wastes are pressed, producing pellets. A typical

drum with holes for pellets is presented in figure 9.3, there is a rolling cylinder for executing the press.

- Cooling under appropriate conditions for obtaining qualitative pellets
- Bagging – bagging lines prepare the pellets for onward transportation
- Loading of road and rail vehicles

If a pellet plant uses round wood (timber) as a raw material, the first step in the process is making wood chips from timber, then grinding the chips to a size appropriate for pellet production. Mobile machines for making wood chips from timber are presented in photo 7.5, while stationary machines applying the same technology can process even larger timber.

Typical plant for wood pellet production:

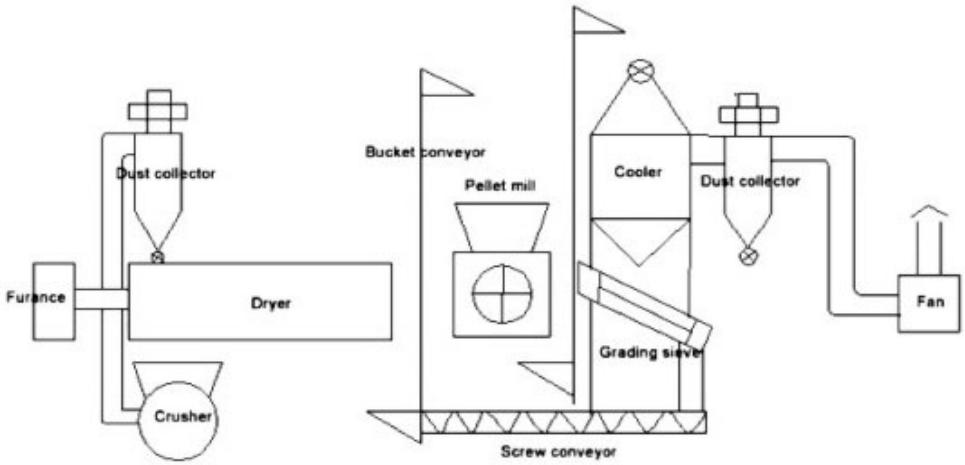


Figure 9.1

Pellet machine:

Figure 9.2. Example of small pellet machine (300kg/hour)

Figure 9.3. Key parts of pellet machine (roller and die)

9.2 Costs of Production Process:

The price of pellets is based on investment costs, operational costs, and cost of transport to consumers, tax, and business profit.

Operating costs consist of: the cost of providing wood waste, the costs of energy (electricity and heat), salaries, maintenance, and insurance. The different operating costs are presented in figure 9.4. If, for example, a pellet factory gets wood waste from the Kosovo Forest Agency for the average price of 14 €/ton (between10 €/ton for forest wastes and 18 €/ton for firewood), then the greatest share in operating costs is the cost of wood waste (48%). This price is for beech and oak forest wood wastes, while the conifers wastes are for free. Broadleaves and conifers residues in wood processing companies have a similar price.

Operations costs:

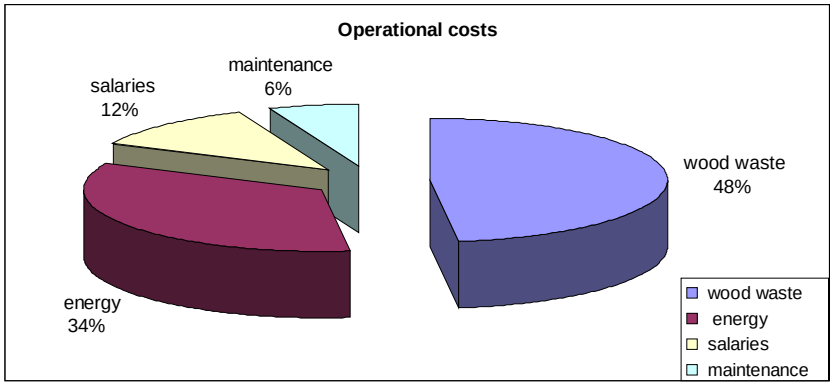


Figure 9.4

Energy consumption costs are of second level importance of operating costs. The process of drying and milling wood wastes as a preparatory phase for production requires electricity for milling and manipulation and the heat for drying. The press, as the main facility for pellet production, also requires electricity. If the price of wood waste is low, then the energy cost can rise to above 50% of the total production cost. This is under the conditions in Kosovo.

A plant for wood pellet production with a maximum 30.000 tons per year is taken as an example for the economic analysis. This maximum production can be reached only if the plant operates in three shifts.

Investment costs are estimated at 1 million €. It assumes a green-field investment and comprises the following main items: cost of equipment (dryer, press, boiler for heat production), cost of purchasing the land, cost for construction of buildings for storage and operation, connection to the electricity grid, and vehicles for internal transport.

A brief analysis of investment and annual operating costs shows that operating costs are very high, and can be higher than the investment cost. Even when costs of raw material are low, the annual operating costs are very close to the total investment cost. Also, an important fact is that the domestic price of electricity is low. It means that investment cost does not play an important role in the assessment of the viability of the project of wood pellet production.

The two main operating parameters for attaining the financial viability of wood pellets production are the costs of raw materials and electricity. Two additional important parameters are the number of shifts for the plant operation and the cost of transport, especially for long distances.

In the case of pellet plants located in Kosovo, salaries do not make up a significant share of the total operating cost. Even in developed countries, salaries would not present a significant share of the total operating cost.

The following parameters for techno-economic analysis are adopted:

Investment cost:	1 million €
Annual production:	20 000 tons (2 shifts, 5 working days per week)
Price of wood waste:	25 €/ton (including collection and transport costs from forest to plant)
Price of electricity per 1 ton of wood pellet:	7.69 €/ton
Annual salary:	6 000 € per worker
Working staff:	6 workers for 1 shift
Transport costs of pellets within Kosovo:	5 €/ton
Transport costs of pellets to Europe:	36 €/ton (truck + ship)
Price of pellets in Kosovo:	100 €/t (without VAT, transport included)
Price of pellets in the EU:	120 €/t (without VAT, transport included)
Discount rate:	10%
Operating life:	15 years

The annual income under the above conditions of the pellet plant is 2 million € for the Kosovo market and 2.4 million € if pellets are exported to the EU countries. The annual income exceeds the total investment.

Since the investment cost is relatively low compared to the operating costs, a simple payback period and internal rate of return (IRR) are not relevant to the financial assessment. A simple payback period for a typical pellet plant is not longer than two years, and under some other assumptions it is less than one year. Internal rate of return relates to the value of the total investment and it cannot give a right answer on the financial viability of wood pellet plant.

The relevant financial parameters for assessment of the viability of the project are: the ratio of the total benefit versus total cost (B/C) and profit (B-C). Benefit (B) and cost (C) are the present values of total discounted income and costs for the total period of the working life of the plant.

If wood pellets are sold in Kosovo the use of wood wastes with a price of 25 €/ton leads to a total profit during the whole working life (B-C) of 3.64 million € present value, and the ratio B/C is 1.49.

With the price of wood waste from 15 €/ton, then profit (B-C) is 5.0 million €, and the ratio B/C is 1.8.

If the wood pellet producer purchases get wood wastes for a lower price, for example only 8 €/t, then the pellet production would achieve better financial parameters: the total profit during the working life of the plant is 6.1 million € and the ratio B/C is 2.12.

In any cases, the internal rate of return is very high, between 39%, 45% and 50% respectively.

Influence of wood wastes cost on financial parameters when wood pellets are sold to domestic consumers:

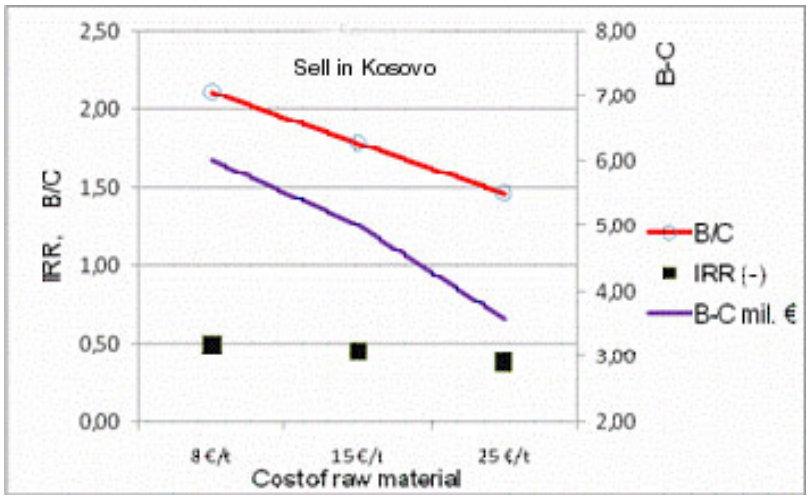


Figure 9.5

Similar analysis can done assuming the pellets are exported to Europe with the price of 120 €/ton including transport cost. Since the transport cost to the international market is a significant share in the total costs, the wood waste price has less influence on B/C ratio and profit.

The decrease of the raw materials price from 25 €/ton to 8 €/ton, which is possible if the supply is only with conifer residues (which are for free, and 8 €/ton is collection, processing and transport cost) leads to an increase of profit from 5.1 to 7.51 million €. The ratio B/C is increased from 1.44 to 1.79, while the internal rate of return (IRR) is again very high, 46% and 55% respectively.

Influence of wood wastes cost on financial parameters when wood pellets are exported:

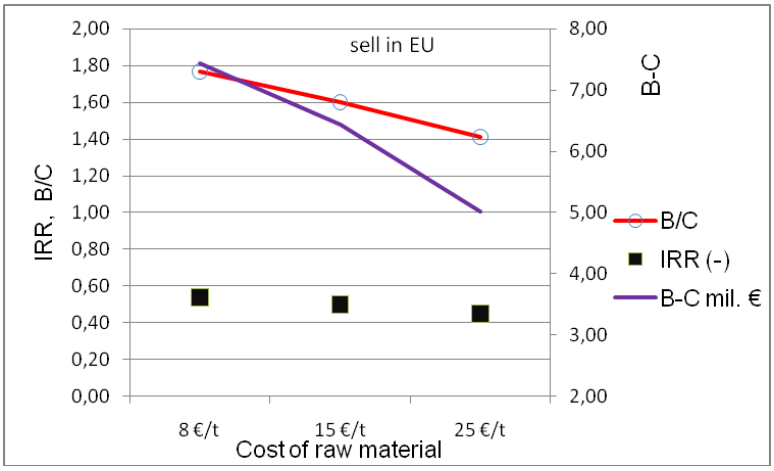


Figure 9.6

The previous analysis was conducted based on the wood pellet price in EU of 120 €/ton. This price includes transportation by truck (within Kosovo and region countries) and ship (from Kosovo to the EU). According to information from the Kosovo's transporters companies dealing with transportation over the seas, the ship transport to 1000 km distance is 30 €/ton including loading and unloading. Then the total transport cost, including transport by truck in Kosovo, is 35 €/ton.

The increase of transport costs from 35 €/ton to 50 €/ton leads to the decrease of profit (B-C) from 5 million € to 3 million €.

If the transport costs increase to 60 €/ton, then the profit for the whole working life of the pellet factory is only 1.60 million € present value. The ratio B/C is going down from 1.43 (for the price of 36 €/ton) to 1.12 (for 60 €/ton). The internal rate of return (IRR) is very high (46%) for relatively low transport cost of 36 €/ton, but for higher price of 60 €/ton, IRR is decreased 27%.

It can be concluded that increase of transport costs dramatically influences the viability of wood pellet production. Therefore, it is necessary to carefully investigate different transportation methods and carefully select the destinations for selling the pellets.

Influence of exporting transport costs on financial parameters:

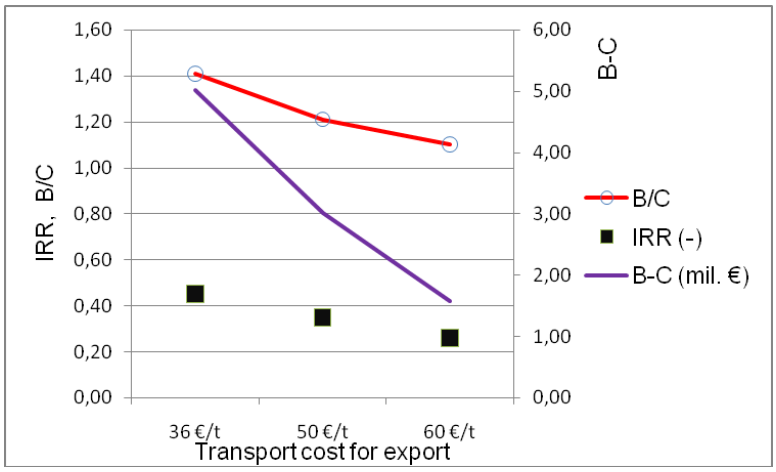


Figure 9.7

Since the operating costs are dominant for assessment of the viability of the project, it is necessary to investigate every possibility of reducing any operating costs elements.

The factory can operate in one, two or three shifts. The change in number of shifts does not change the consumption of any resource such as, raw material and energy, nor the transport costs expressed per volume of products such as, tons of pellets, but the investment is better utilized. If the operation is in three shifts, the plant is more intensively engaged and should have a higher profit. But, the investment cost has very limited influence on the profit of wood pellet production.

Therefore, the increase of operation of three shifts instead of two shifts leads to a decrease of costs of electricity and probably salaries. And vice verse, if number of shifts is decreased from two to one, then the electricity costs increase. With increased shifts the production rate is increased. The overall financial parameters change with a variation of working shifts. With the change from one to three shifts the profit of the plant increases from 1.77 million € to 8.6 million €. The ratio B/C is slightly increased from 1.28 to 1.51, while internal rate of return increases from 29% to 58%.

The minimum price, with tax excluded of wood pellets, including transport costs by truck within Kosovo and by ship to the EU, is 64 €/ton for the Kosovo market and 94 €/ton for the EU market. These prices are for one shift plant operation.

For three-shift operation, the minimum prices are: 49 €/ton for the Kosovo market and 79 €/ton for the EU market. Under the term minimum price is considered that the profit (B-C) is zero.

Financial parameters, simple payback period and the internal rate of return cannot be real measures of financial viability for wood pellet production. Investment costs are relatively low when compared to operating costs. For the operation of three shifts with a production of 30.000 tons per year the annual operating costs can be higher than total investment costs.

Influence of number of shifts on financial viability of the pellet production:

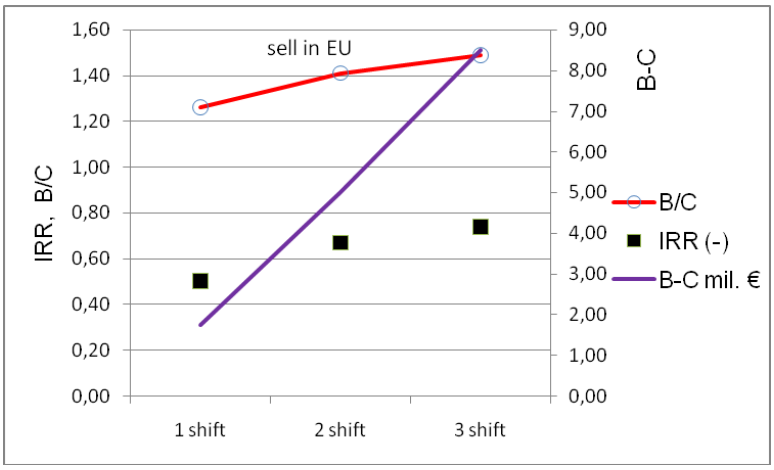


Figure 9.8

As a final result of the economic analysis it can be concluded that an investment in wood pellet production in Kosovo would be an attractive option. The conditions for success are as low as possible operating costs, especially costs of wood wastes and transport.

Therefore, all enterprises dealing with wood processing have a remarkable advantage, since they have wood wastes as a by-product, and for them the price of raw material is zero.

For others who plan to build plants for pellet production without ensuring at least a part of the raw material from their own wood processing plant, there is a risk of providing raw material at unacceptable price. With an increase in demand, the price of wood wastes will be higher. On the other hand, a large demand for wood pellets in the EU, and a further increase in demand would increase the price of wood pellets on the market, which would eliminate the negative effects of the increased price of the raw material.

10. POST-PRODUCTION LOGISTICS TO MARKET

In general, pellet producers in Kosovo will have two possibilities: to export pellets to European countries, which is better solution, or to sell them on the domestic market.

Wood pellets produced in region countries, are mainly exported.

Presently wood pellets don't use in Kosovo, but in the future, after adoption of measures for promotion of renewable energy sources and support measures for their use, it can be expected that wood pellets will be used however in Kosovo.

The main destinations for pellet export are expected to be: Italy, Greece, Germany, Netherlands, Denmark and other northern European countries.

There are two main routes for exports to Italy: one is through Albania, to Durres by road, which is only 250 km from Kosova, and then by ships from Durres to Italy. The second option is by road, through Serbia and Croatia, which is expensive solution.

For transport of pellets in Greece, transport could be through Macedonia or Albania. Thessalonica is no more 300 km from Kosovo.

If the export destination is for example Germany, there is a possibility to transport wood pellets through Serbia, Hungary and Austria or through Durres in Albania, then by ships in Italy. From Italy transport in Germany and in other EU countries will be by roads.

A cheaper solution is to transport wood pellets in bulk, without packing them in bags. However, in that case, ports and railway stations must have installed facilities for pneumatic transport of wood pellets, from one vehicle to another.

Pneumatic transport for wood pellets manipulation in ports and railway stations could be avoided if wood pellets are packed in big bags, for example of 1/2 ton. In that case, typical machines for loading can be used. However, the producer of wood pellets would have to be equipped with the appropriate facilities for packing pellets and for the manipulation of them.

The only way to transport wood pellets within Kosovo is by trucks. Transportation by truck is more expensive when compared with trains and ships.

The current price of wood pellet transportation by a truck with a capacity of 25 ton capacity at a distance of 200 km would be about 0,7 €/km, or about 6 €/ton including insurance.

Main transportation routes in Kosovo:

Map.10.1

11. CERTIFICATION OF FORESTS IN KOSOVO

Kosovo Forest Agency manages with Kosovo forests and is responsible for forests in the rest of the territory.

There are however, is one national park PN'Malet e Sharrit'. With park manage Ministry of Ambience.

Almost 40% of the forests in Kosovo are located on private property. But private owners do not have the freedom to cut trees of their own accord. The Law on Forests, states that, in private forests, Kosovo Forest Agency is entitled to mark trees for cutting. Every year, the personnel of Kosovo Forest Agency mark the trees to be cut in forests, which are both private and public owned.

This means that despite the fact that the forest is under private ownership, wood cutting is defined by Kosovo Forest Agency. Every year this institution defines the volume of wood cutting in forests. This is how the sustainable use of forests in Kosovo is sustained.

In regards to the international certification of forests Kosovo Forest Agency intends to certify all their forests.

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