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Guidebook for Sustainable Use of Wood Biomass

for Energy Production in Bosnia and Herzegovina

Guidebook for Sustainable Use of Wood Biomass for Energy Production in Bosnia and Herzegovina

This Guidebook was prepared under the project “Biomass Energy for Employment and Energy Security in Bosnia and Herzegovina” funded by the Czech Republic and implemented by the United Nations Development Program (UNDP) in BiH, in cooperation with the Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina, Ministry of Agriculture, Forestry and Water Management of the Government of the Republika Srpska, FBiH Ministry of Agriculture, Water Management and Forestry and the Department for Agriculture, Forestry and Water Management of the Government of the Brcko District. The contents of this Guidebook do not necessarily reflect the views of the donor, partner or UNDP.

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List of abbreviations

BHAS	Agency for Statistics of Bosnia and Herzegovina
BiH	Bosnia and Herzegovina
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Central mechanized storage
EUTR	EU Timber Regulation 995/2010
FAO	Food and Agriculture Organisation of the United Nations
FBiH	Federation of Bosnia and Herzegovina
MoFTER	Ministry of Foreign Trade and Economic Relations BiH
NECP	integrated National Energy and Climate Plan for period 2021-2030
NREAP	National Renewable Energy Action Plan
RES	Renewable Energy Sources
PJ	Petajoule
RS	Republika Srpska
SAA	Stabilisation and Association Agreement
FWA	Forest wood assortments
FMP	Forest Management Plan
FMA	Forest Management Area

Foreword

Sustainable use of natural resources, while meeting the growing society needs for energy, are complex challenges that require synergistic action by international and national institutions, the economy, the non-governmental sector and the scientific community worldwide. Recognized as one of the ways to tackle climate change and the aforementioned challenges, the concept of biomass mobilization for energy production has been an indispensable part of strategic energy planning for a long time. Moreover, the strategic and operational planning process increasingly recognizes the need for achieving cross-sectoral collaboration by aligning production targets and capacities to maximize the use of this renewable energy source.

As an important aspect of the energy mix in Bosnia and Herzegovina, biomass is included in the relevant strategic framework and action plans at all levels, and it is an important renewable energy source for fulfilling Bosnia and Herzegovina's energy transition commitments. The project "Biomass Energy for Employment and Energy Security in Bosnia and Herzegovina", funded by the Czech Republic and implemented by the United Nations Development Program in Bosnia and Herzegovina, through implementation of a set of activities seeks to contribute to improving the cross-sectoral cooperation framework when it comes to use of wood biomass. The project is directly linked to the Sustainable Development Goal 7 (Affordable and clean energy), more specifically, with the target 7.2 (By 2030, increase substantially the share of renewable energy in the global energy mix). Furthermore, the project contributes to the achievement of the Sustainable Development Goal 13 (Climate Action), since responsible and sustainable forest management, including the sustainable use of wood biomass potential, is one of the ways of adapting to climate change. Finally, the project is linked to the Sustainable Development Goal 15 (Life on land) as it is related to sustainable forest management as a dominant terrestrial ecosystems in Bosnia and Herzegovina.

Through implementation of activities aimed at developing policies, improving the availability and quality of wood biomass as an energy carrier and creating business models for investment in infrastructure projects in this field, it has repeatedly been identified that there is a need to create guidelines for sustainable use of wood biomass. That is why this publication has been prepared, which contains information on key aspects that need to be considered and respected when carrying out activities aimed at mobilizing wood biomass in Bosnia and Herzegovina, by drawing on past knowledge and experience in this field, and taking into account similar experiences in this field from the Czech Republic.

While recognizing the need for cross-sectoral cooperation in the sustainable use of wood biomass, through preparation of this publication the idea was to present information relevant for this area in a simple manner. Therefore, this Guidebook can provide a basis for understanding aspects of the sustainable use of wood biomass by actors who are directly and indirectly interested in this field, primarily those involved in forest management processes, and those who base their actions on the use of renewable energy resources in Bosnia and Herzegovina.

About the Guidebook

In order for the environmental, economic and social benefits deriving from the use of wood biomass to be realized in its full potential, it is necessary to ensure the conditions of regulated and controlled use of forest potential. Under such conditions, the sustainable use of wood biomass, as a renewable energy source, contributes to the forests' conditions improvement and the climate change impact mitigation.

With a view to supporting competent institutions at all levels of government in establishing a system for the sustainable use of forest biomass potential, the UNDP project *Biomass Energy for Employment and Energy Security in Bosnia and Herzegovina*, funded by the Czech Republic in cooperation with the project of the Czech Republic and UNDP for Sustainable Development Goals, a *Guidebook for Sustainable Use of Wood Biomass for Energy Production in Bosnia and Herzegovina* was developed.

The focus of the Guidebook is on operational measures and methods of forest management, production technology and the wood biomass market. Therefore, the Guidebook includes information on the current state of the forestry sector in Bosnia and Herzegovina, trends in biomass utilization in the European Union and the Czech Republic, environmental aspects of wood biomass utilization, forestry planning, technologies and practice for wood biomass mobilization, as well as the importance of involving the public in the creation and decision-making process in this field. For the purpose of development of the Guidebook, the term " wood biomass" includes all forest wood mass (tree, treetops, branches and twigs) and wood residue after logging. In other words, the focus of the Guidebook is all wood biomass that originates from forest ecosystems and which can be used for energy generation.

The consortium consisted of NGO Forestry and Environmnental Action (Fea) and consultancy company Enova Ltd. was commissioned to prepare the Guidebook, with the following team of national experts: Ajla Dorfer (Team eader), Adnan Medić (forest management specialist), Dane Marčeta (forest exploitation specialist) and Bruno Marić (forest economics specialist). In addition to engaging this team, thanks to the funding of the Czech Republic-UNDP partnership project for the Sustainable Development Goals, Strahinja Mladenović was engaged as an international expert for the transfer of Czech know-how, experience and best practice in the wood biomass utilization.

In order to ensure that the information in the Guidebook is in line with current circumstances in the forestry sectors in Bosnia and Herzegovina and in order for the competent institutions to have the necessary data to create an environment where wood biomass would be used sustainably, in the course of development of the Guidebook a workshop was organised in June 2019 with the representatives of the relevant institutions. During the workshop, the engaged team of experts presented the key aspects of mobilizing the untapped wood biomass potentials in BiH, their impact on mobilization of the potentials, and the ability of forestry companies to remedy identified obstacles by themselves. In discussions with the present representatives of the institutions, the contents of the Guidebook were interactively and flexibly discussed, and very useful suggestions were provided for better mobilization of untapped

wood biomass potentials, which were later integrated into the Guidebook. Such an approach aimed at encouraging ownership by the institutions' representatives over jointly created Guidebook so as to ensure its widespread application in practice.

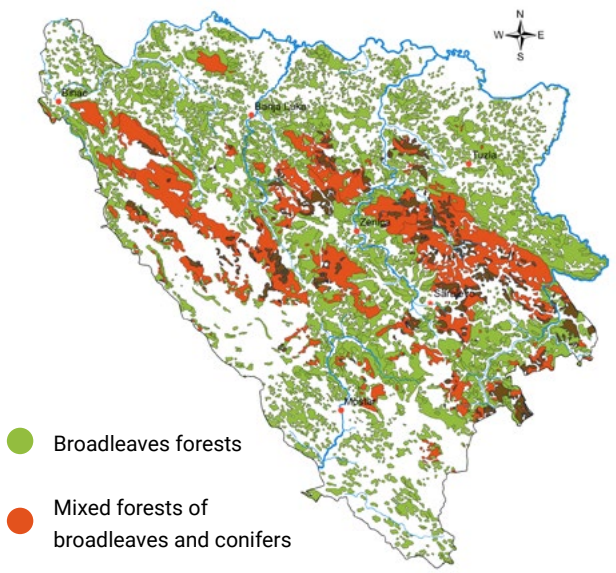
An important segment of the Guidebook is related to the involvement of stakeholders in creation and decision-making processes pertaining to wood biomass. Wood biomass-based energy production in Bosnia and Herzegovina implies the cooperation of different sectors: forestry, wood processing, energy, agriculture, environmental protection and rural development. At the same time, governmental and non-governmental institutions, which are active in these areas, are the target groups of this Guidebook.

1 Forestry in BiH:

"Proponent or opponent of wood biomass mobilization"

As dominant terrestrial ecosystems, forests are of great importance for the general well-being of citizens and the economic growth and development of forest ecosystem products and services-based industries in Bosnia and Herzegovina (hereinafter BiH). Given that BiH is one of the countries with a high percentage of forest cover (over 60% of the land area – FAO, 2015), the forestry sector plays an important role in rural development, while forest wood products are a resource base for the wood processing industry development. In addition, official data indicate a trend of an increasing area under forests in recent decades, mainly as a result of afforestation and natural forest expansion on abandoned agricultural areas (FAO, 2015). On the other hand, the level of production of wood products (i.e. forest wood assortments) in the forestry sector is relatively homogeneous in the period 2003 – 2017 (ASBiH[1], 2018) and in average it amounts to over 3.8 million m^3 of wood products per year (net forest wood assortments), with relatively homogeneous production of coniferous and deciduous wood products (Figure 2). Official

Figure 1:
BiH Forests and Forestry in Figures – basic indicators[2]



Forest area in BiH
3.231.500 ha

Percentage of forest cover
63%

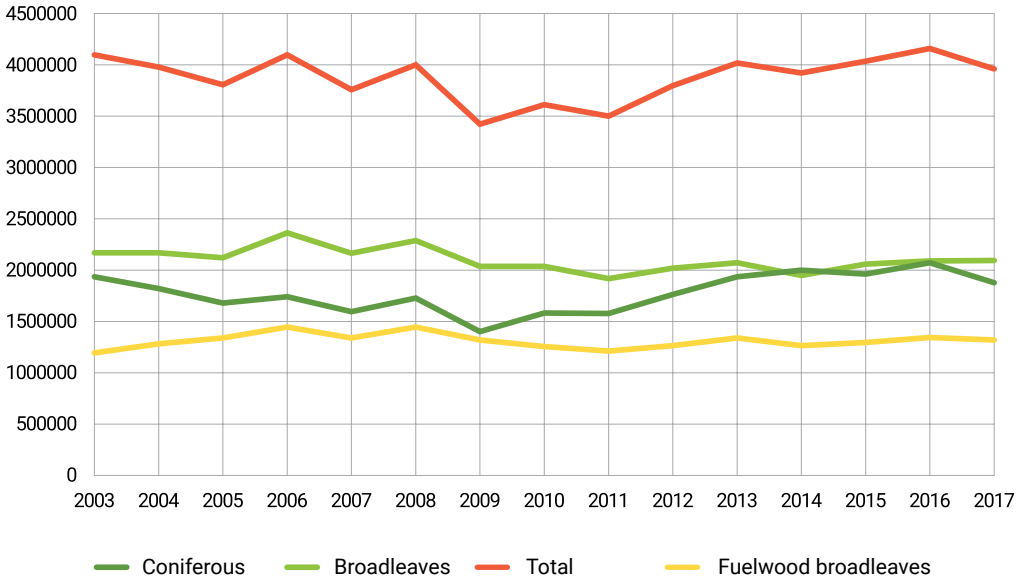
Average timber stock volume per ha
201 m^3/ha

Average production of FWAs (2003 – 2017)
3.883.177 m^3/per year

Average number of workers directly employed in the forestry sector (2017)
9.789 workers

1 BiH Agency for Statistics
2 Sources: FAO, 2015; Publications, RS Forestry Bulletin, 2018 and FBiH Forestry Bulletin, 2017

Figure 2:
Production of forest wood assortments in BiH, 2003 – 2017.



The BiH Agency for Statistics collects and processes data on production, sales and stocks of forest assortments in BiH by assortment (quarterly and annual releases). In the period 2003 – 2017, the highest production level was recorded in 2016 and it amounted to 4.169 million m³, while the lowest production level was recorded in 2009 when it was 3.429 million m³. The average production of broadleaved wood assortments for the observed period was relatively balanced and amounted to over 2.1 million m³, while the average level of production of coniferous wood assortments was over 1.7 million m³, with a pronounced trend of production increase in the period from 2011 to 2016. When it comes to fuelwood production, there has been a steady trend in production, which in average amounts to 1.31 million m³ per year, dominated by broadleaved tree species. The share of fuelwood in the total production of forest wood assortments in average amounts to around 33%.

data indicate that average share of energy production wood in the total production of forest wood assortments is over 33% and with a relatively homogeneous trend over the observed period. This indicates that the provision of wood for heating energy is a very important segment of the production process in BiH forestry, which, in addition to the economic dimension, has a very important social dimension, since it is a dominant source of heat energy for households in BiH.

Economic growth based on the use of environmentally friendly resources and technologies and those supporting the climate change mitigation efforts, represents a global strategic commitment. Consequently, efforts on improving ecosystem services of forest resources, defined as the overall benefit for the society from forests as ecosystems (Daily, 1997), are in synergy with global strategic action and are often linked to the green economy paradigm. On the other hand, local economic development interests, traditions and a lack of proactive ideas and investments are often major showstoppers in adapting

the forestry sector to current global trends. In this context, one of the biggest challenges that the forestry sector in BiH is facing is related to securing a sufficient quantity of products, primarily wood, that could meet the needs of different stakeholders, while preserving and improving the condition of forests as a resource base. An adequate response to the challenge of sustainable mobilization of wood implies existence of effective and efficient organizational and legislative framework, a transparent planning process and the promotion of innovative solutions that ensure the sustainable use of forest resources.

1.1 Organizational and legislative framework that defines public and private sector operations in BiH forestry

The institutional framework of the forestry sector in BiH follows the administrative organization of the country. At the BiH level, in line with the Article 9 of the Law on ministries and other administrative bodies of Bosnia and Herzegovina (Official gazette of BiH, no. 5/03, 42/03, 26/04, 42/04, 45/06, 88/07, 35/09, 59/09 i 103/09), Ministry of foreign trade and economic relations of BiH holds responsibilities for defining policies, basic principles, coordination and harmonization of entities' plans and international institutions in fields of agriculture, energy, tourism, environmental protection, development and management of natural resources. Department for water resources, toruism and environmental protection of this Ministry is responsible for activities related to CITES (*Convention on International Trade in Endangered Species of Wild Fauna and Flora*) while Department for agriculture, food, forestry and rural development is responsible for EU Timber Regulation no. 995/2010 and other international obligations, directly related to forestry. Besides, Department for energy is coordinating harmonization of domestic legislative frameworks with EU requirements in field of renewable energy sources (RES) and fulfilment of obligations from the Energy Community Treaty. These activities implies coordination and implementation of activities as well as reporting on implementation of commitments related to RES. By doing so, these activities have direct implications on forest policy, particulary when it comes to the wood biomass mobilization, which is recognized as an important segment of energy mix needed for accomplishment of defined goals on RES share. Besides, MoFTER, together with entities' ministries of energy, has been coordinating the development of integrated National energy and climate plan for period 2021-2030 (integrated National Energy and Climate Plan – NECP).

The strategic and governance activities of the forestry sector in reality are carried out at the Entity and Brcko District levels through the work of special departments, sectors and administrations. The key forestry institutions in the Federation of Bosnia and Herzegovina (hereinafter: FBiH) are the FBiH Ministry of Agriculture, Water Management and Forestry, under which the Forestry and Hunting Division operates, as well as the FBiH Forestry Administration. The governance function is further decentralized and transferred to the line ministries at the cantonal level, which often in their composition have cantonal forestry administrations, with main responsibilities related to organization of forest conservation and support to private forest owners. When it comes to Republika Srpska (hereinafter: RS), the Ministry of Agriculture, Forestry and Water Management within the Government of Republika Srpska has a Forestry and Hunting Department, which, inter alia, is in charge of normative and legal, analytical, administrative and supervisory tasks. The Public Enterprise "Šume Republike Srpske" a.d. Sokolac is under direct com-

petence of this Ministry, and it has a role of beneficiary of forests and forest land owned by RS. As regards Brcko District, the forestry activities are entrusted to the Department of Agriculture, Forestry and Water Management of the Government of the Brcko District, respectively the Sub-Department for Forestry and Water Management. This institution deals with implementation of legislation in the field of forestry and hunting, adoption of plans and programs, and forests conservation. Due to the prevalence of private forestry, no public forest management enterprise was established in the Brcko District.

Operational activities of forest utilization/ management are carried out by public forest management enterprises or private forest owners for privately owned forests. In the FBiH, the cantonal public forestry enterprises (forest management companies) are established in eight cantons and are in charge of use of public-owned forests within the administrative boundaries of the cantons in which they are established. The exception is the Posavina Canton, in which no cantonal public enterprise is established and all operations are carried out by the Cantonal Forestry Administration, as well as the Herzegovina-Neretva Canton, in which there are several forestry enterprises managing public-owned forests. In the organizational structure of the cantonal forest management enterprises, the operational activities of forest utilization are carried out at the level of forest management enterprises, which mainly cover the territory of a single municipality and are in charge of the operational implementation of the plans. RS-owned forests are managed by PE "Šume Republike Srpske" a.d. Sokolac. Operational activities of forest utilization are carried out through 27 forest holdings, which in their composition have several forestry administrations, territorially distributed by municipalities. In addition, this company includes the company headquarters, Centre for Seed and Nursery Production, Research and Development and Project Centre and Centre for Karst Management.

1.2 Forest management planning

Forest management planning is a complex process that can be divided into two components. The first component referes to the strategic plans adopted for the Entity-level forestry sector, while their adoption and implementation mainly falls under the responsibility of the relevant ministries. The process of adopting the strategic framework of the forestry sector in the FBiH is not yet complete. The general part of the FBiH Forestry Program was adopted by the FBiH Government in 2017 and submitted to the FBiH Parliament for consideration and approval. The general part of the FBiH Forestry Program sets political and strategic goals, which should be further elaborated and implemented through the implementing part of this program, while ensuring the necessary financial resources. Taking into account that it took more than nine years to develop and adopt the General part of FBiH Forestry Program, and that at the FBiH level there is no Law on Forests as the basic regulatory instrument for the implementation of forest policy, it is difficult to speak about further perspective of the FBiH Forestry Program implementation (UNDP, 2017). On the other hand, the RS Forestry Development Strategy 2011 – 2022, adopted by the RS National Assembly in 2012, is in force.

The second component in the process of forest management planning in BiH consists of operational business and production plans. In accordance with the current legal framework and International Accounting Standards, public forestry enterprises plan their operations for a period of three years (medium-term plans) and one year (short-term plans). When it comes to production plans, which are mainly focused on planning of forest wood assortments production, the so-called forest management plans are made for all forest categories, which represent a legally defined obligation. This category of plans is developed for a period of 10 years and is essentially a forest management plan of a specific area, and components of a forest management plan can be used to develop long-term (strategic) business plans (Delić and Bećirović, 2017). It is a common practice, and at the same time a legal obligation, for forestry enterprises to produce annual forest management plans, which envisage the implementation of 1/10 of the activities planned in the forest management plan.

Main characteristics of forest management plans

Drafting and adoption of a forest management plan is a legally binding process defined by the regulatory framework at the Entity or cantonal administrative level. In the RS, the RS Law on Forests regulates this process, and in the FBiH, due to the lack of the Law on Forests, the Decision on development, content and application of forest management plans is in force. The applicable legal regulations for the forestry sector in each of the cantons of the FBiH also incorporate elements that define the content of forest management plans and it can be concluded that they follow the structure of regulations at the FBiH level. The Law on Forests of Brcko District also defines the elements and content of forest management plans.

Generally, it can be concluded that the process of forest management plans development, regardless of the different legislative bases in the Entity and/or cantonal regulations, has a number of common characteristics, such as:

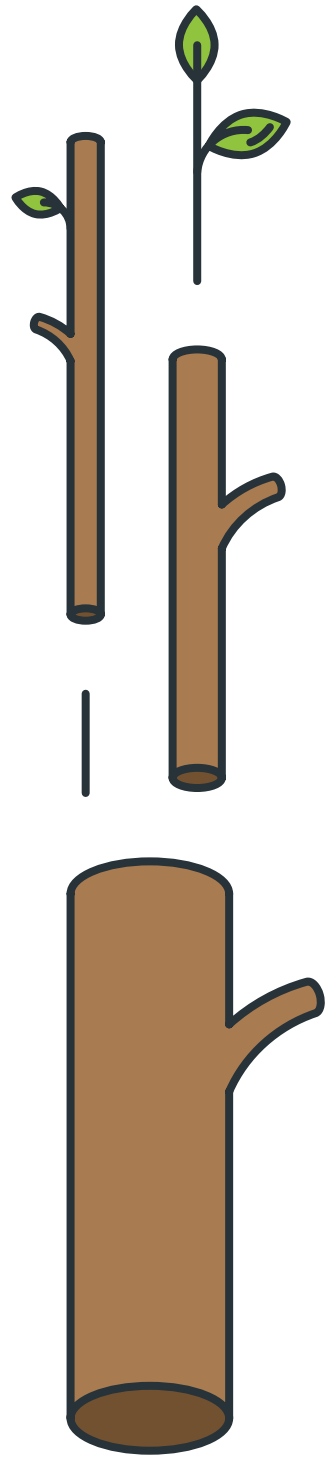
1. A forest management plan may be developed by a company registered for forestry business that employs at least four graduate forestry engineers/masters of forestry, who will work on the preparation of forest management plan, one each for: silviculture and protection of forests, forest management planning and forest infrastructure, utilization of forests and forestry economics, with a minimum of five (5) years of work experience in this specific field after graduation.

2. A forest management plan consists of the following chapters: introduction, state of forests at the time of forest management planning, analysis and evaluation of forest management to date, plans for forest management and development for the next forest management planning period and economic and financial analysis of forest management for the next forest management planning period.

3. Plans for management and development for the next 10-year forest management development period are a key part of the forest management plan. These chapters consist information on quantities and dynamics of felling by tree species and assortment structure, as well as the scope and types of sylvicultural works. In addition, areas for biological forest regeneration are presented, as well as description of measures for maintaining and improving biodiversity and other ecological and social functions of forests. Finally, necessary investments for the construction of forest roads, demining and other necessary investments are described, as well as the possibility of using non-wood forest products, and the economic and financial result of the planned measures of forest management in the next forest management development period is analysed.

4. The plans for implementation of forest management measures, which are presented in the forest management plans, are based on inventory data. In order to enable continuous implementation of field inventories in BiH, a classification of forests and forest lands was made according to their purpose and a forest inventory system (field tree inventory) was adopted, based on the application of a statistical representative sample and typological classification of forests and forest lands.

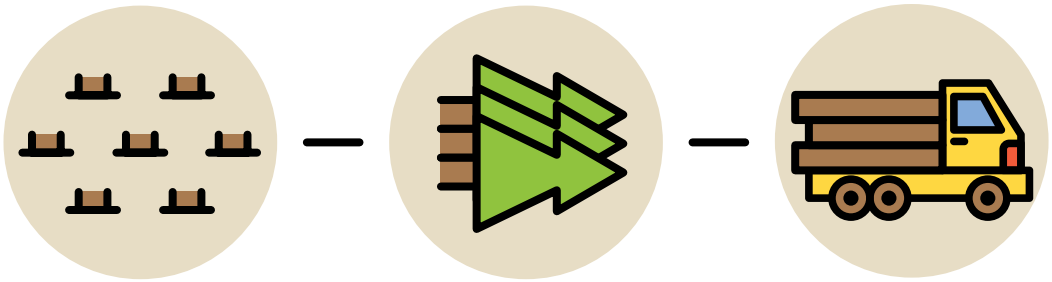
1.3 Traditional and modern practice in the forest utilization process in BiH



The process of organized forests utilization in BiH has a long tradition and can generally be characterized as close-to-nature forest management, because the efforts of forest utilization tend to prevent endangering of the existing state and preserve the stands, with predefined and limited interventions in the available wood stock. This statement is supported by legal restrictions according to which clear cutting on large areas for the purpose of regular forest management measures are prohibited. Taking into account that wood products are currently the main focus of economic activities in the forestry sector, and the aspirations towards an environmentally friendly forest utilization model, it can be concluded that this framework requires a great deal of expertise of the personnel involved in the forest utilization process, an adequate planning basis and efficient technological solutions. Due to the stand conditions and the relatively high share of poor-quality products, the cost-effectiveness of such a traditional framework for implementing forest management measures is increasingly being questioned, where the share of human labour is at a high level and the forest utilization process is not accompanied by investments in modern technological solutions and systems. Therefore, forest users need to think about mobilizing all available resources for which there is market demand and adapt existing internal capacities to new market realities in order to enrich supply chains for new and or hitherto unused forest ecosystem products.

Since the first phase in the supply chains of forest products is actually the process of use (utilization) of forests, a concise overview of practice related to the production of forest wood assortments used in BiH is given further below.

This process starts with:



a) **Logging and processing phase of wood products** - in BiH conditions, this phase is mainly done manually - by the use of chainsaws and the use of the cut-to-length method of production of forest timber products at the site of logging (in the cutting area).

This phase is characterized by: environmental acceptability on the one hand, but also low percentage of mechanization, difficult working conditions and limited possibilities for achieving productivity and economies of scale on the other.

b) The next stage is trees **dragging**, in which the wood is transferred from the logging site, mainly through by the use of tractors, to the long-distance transport point – storage.

Characteristics of this phase: Due to legal restrictions regarding the movement of "heavy" machinery on forest soil outside the network of secondary road infrastructure (the so-called skid trails), during this stage the dragging is carried out by means of animal-powered logging and using a winch mounted on the wood-dragging tractor.

c) **The final phase of wood mobilization from forest is long-distance transport**, which in the forestry conditions in BiH is exclusively done using trucks with or without loaders.

General conclusion: Current practices of forest use, primarily logging and processing, dragging and long-distance transport, have the character of partial mechanization, with the use of classic labour-intensive technologies and with high share of manual labour (Gurda et al, 2010), while increasing the productivity, cost-effectiveness and working conditions will depend on available financial resources for investment and labour market developments.

Types of felling and their characteristics

In order to eliminate limitations for improving ergonomics, productivity, as well as cost-effectiveness, and for the needs of forest biomass mobilization, efforts should be made to transfer a part of the work operations from cutting area to storage sites (i.e. special centralized mechanized storage facility providing close to industrial working conditions). In this context, it is necessary to use processor technologies and techniques, modelled as per international experience, which requires considerable financial investment. When choosing working technologies, it is necessary to take into account the environmental conditions, types of felling and the location and methods of production of wood products. The links between these elements are shown below.

Type of felling	Conditions for application	Place and method of processing	Mechanization to use
Selective cutting	Ecologically sensitive areas; not demanding to medium-demanding terrains; lower cutting-intensity; smaller average tree growing stock, smaller dragging distance	Cutting area, cut-to-length method of technical and stere wood near stump	Chainsaw, anchor of the tractor, animal-powered logging, adapted or specialized forest tractors, cable crane, hydraulic crane, truck, plastic logg lines
Selective cutting	Ecologically lesser sensitive areas; demanding terrains with soil of less bearing capacity; higher cutting-intensity; bigger average tree growing stock; longer dragging distance	Lumber yard in forest, tree-length and semi tree-length method with cutting of wood assortments and processing on storage.	Chainsaw, skidder with anchor, cable crane, tree-splitting machines, chipper, processor for tree-splitting, truck with hydraulic crane
Selective cutting	Final thinning on not demanding to medium demanding terrains	Forest roads applicable for tractors or lumber yard in forest, cut-to length or long-length method, central mechanised storage (CMS)	Chainsaw or harvester, animal-powered logging or forwarder, portable chipper, truck for roundwood transport, trucks with specialised containers for wood chips
Grouped selective cuttings	Coppice forests and stands with poor quality of growing stock (in this case – cuttings are directed toward improvement of quality of growing stock)	Forests roads (for tractors and trucks), plants for wood-processing (in case when wood-processing facilities are close to cutting area)	Chainsaw, biomass-harvester, animal-powered logging, anchor, skidder/forwarder, portable chipper, tree-splitting machines, processors for stere wood, trucks with or without containers
Clear cuttings	Energetic plantations of fast-growing species for wood biomass production as energetic resource	Cutting area, forest roads for trucks, plants for wood-processing	Harvesters, processors, specialised forest tractors (forwarders), trucks with or without specialised containers for transport of wood chips.

Source: Gurda et al, 2010: Final Study Report: Forestry technologies, forest wood assortment standards and forest biomass

1.4 Energy transition in Bosnia and Herzegovina

The process of accession of Bosnia and Herzegovina (BiH) to the EU is one of the main driving forces in the reform of the BiH legal framework. BiH signed the Stabilization and Association Agreement (SAA) with the EU in 2008, which entered into force in June 2015. SAA is the main framework for the relations between the EU and BiH, further preparing the country for future EU membership. It specifies that BiH is required to gradually harmonize its legislation with the EU acquis.

According to SAA the cooperation between BiH and EU shall focus on priority areas related to the EU acquis in the field of energy, including, as appropriate, nuclear safety aspects. It shall be based on the Treaty establishing the Energy Community and shall be developed with a view to the gradual integration of BiH into Europe's energy markets.

BiH is a Contracting Party of Energy Community, established by an international treaty in October 2005 which entered into force in July 2006. By signing the Energy Community Treaty, BiH made legally binding commitments to adopt core EU energy legislation among which also Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. The Ministerial Council adopted Directive 2009/28/EC into Energy Community legal framework through the Decision 2012/04/MC-EnC. By adopting this Decision, the Ministerial Council determined the Contracting Parties' binding national targets to be achieved through the use of renewable energy in the electricity, heating and cooling, and transport sectors by 2020. BiH has a renewable energy target of 40% by 2020.

Following the adoption of Directive 2009/28/EC by the Ministerial Council Decision 2012/04/MC-EnC, the Contracting Parties agreed also to submit their National Renewable Energy Action Plans (NREAP) to the Secretariat of Energy Community by 30 June 2013. In the NREAPs, the Contracting Parties are to lay down the sectoral targets, including the technology mix they expect to use, and determine the trajectory they intend to follow in the years to come. The plans are to comprise detailed descriptions on the measures and reforms the Parties intend to undertake to overcome the barriers in developing renewable energy. As mentioned before, MoFTER, together with entities' ministries responsible for energy, has been coordinating the development of integrated National energy and climate plan for period 2021-2030 (NECP). NECP BiH is consisted of following segments, including the defition of management and coordinating structure for development of NECP: (1) energy security, (2) renewable energy sources and integration of internal energy market, (3) energy efficiency, (4) decarbonization, (5) research, innovation and competitiveness. Adoption and implementation of NECP will enable BiH to integrate goals relevant for climate and energy, as well as policies and measures, thus supporting the harmonization of energy policies with EU requirements.

Based on the proposal of MoFTER, the Council of Ministers of BiH adopted the Renewable Energy Action Plan of BiH (NREAP BiH) in 2016. NREAP BiH is based on previously adopted Entity action plans for the use of renewable energy sources, which are prescribed by FBiH and RS Laws on the Use of Renewable Energy Sources and Efficient Cogeneration. NREAP BiH overall target for BiH

implies a targeted share of energy from RES in gross final energy consumption (hereinafter: GFEC) in 2020 in the amount of 40%. According to the comparative overview of RES technologies shares in incentive schemes to produce electricity in the period until 2020 in BiH, the share of biomass technologies is only 8.33%. In NREAP BiH the use of biomass is mostly planned in cogeneration biomass power plants with an installed capacity of 35.7 MW, which would ensure annual production of electricity in amount of 117.4 GWh. In addition, biomass is planned to be used in heat energy production, and the goal is to reach 1082.4 ktoe in 2020. The foreseen biomass for production of heat energy in BiH includes solid biomass and biogas.

Currently, BiH does not have any incentive programmes for the use of energy generated from biomass, except feed-in tariffs on Entity level for stimulating use of biomass in production of electric power. In 2016, Bosnia and Herzegovina achieved a 25,3% share of renewable energy in gross final energy consumption, below the 36,7% median trajectory for 2015-2016. This is due to the downwards revision of biomass consumption and limited investments in newly added renewable energy capacities. Still, activities on reforms of subsidies for RES have been initiated in Republika Srpska and Federation of Bosnia and Herzegovina. At the end of 2019 a Final report on reform of system for subsidies for RES in BiH was prepared as well as drafts of law and bylaw documents that define the reforms of these systems in BiH. Furthermore, MoFTER, in cooperation with the BiH Agency of statistics, has been working on improvement of energy statistics, especially the data related to biomass. In forthcoming period, the revision of energy balances for 2014-2017 will be conducted and it will include data on biomass consumption that are mentioned in the Progress report in implementation of RES Directive that was submitted by MoFTER to the Energy Community (available on the web page of the Secretariat).

2 Forests and Forestry in EU

"Sustainable utilization of wood biomass as a tool for climate change mitigation"

In EU the biomass and biowaste account for about two-thirds of all renewable energy consumption. In 2014, the European Commission published a Report on the sustainability of solid and gaseous biomass for heat and electricity generation. This Report contains non-binding recommendations on sustainability criteria for biomass. These recommendations are meant to apply to energy installations of at least 1MW thermal heat or electrical power. Among these recommendations, two are essential for solid biomass:

→ forbid the use of biomass from land converted from forest, and other high carbon stock areas, as well as areas with high biodiversity, and

→ encourage the monitoring of the origin of all biomass consumed in the EU to ensure their sustainability.

In November 2016 the Commission proposed a revised Renewable Energy Directive containing updated sustainability criteria for biofuels used in transport, and solid and gaseous biomass fuels used for heat and power. In the case of the adoption of this revised Directive in EU, there is a great possibility that it will become mandatory for BiH through a future decision of the Energy Community. This means that in the future, BiH will need to transpose the sustainability criteria related to the use of biomass in its legislation.

The EU-28 has approx. 182 million hectares of forests and other wooded land, corresponding to 43 % of its land area (excluding lakes and large rivers). According to Eurostat, EU-28 forest coverage gained 322.800 hectares every year. On average, about 63% of the annual forest increment in Europe is felled, meaning that 38% of this annual increment remains in forests[3].

3 This may vary from country to country.

2.1 Czech know-how and experience on biomass utilization

According to the Act No. 180/2005 on the Promotion of Electricity Production from Renewable Energy Sources and on Amendments to this Act, biomass is defined as a plant material which can be used as a fuel for the purpose of utilizing its energy content if it comes from the food, forestry or agricultural industries, pulp grout and papermaking, cork processing, woodworking (with the exception of wood waste containing halogen compounds or heavy metals as a result of treatment with wood preservatives or paints, and wood waste from the building industry).

In Czech Republic, terms "biomass" and "forest dendromass" are defined by legislative documents that regulate electricity production from renewable energy sources.

Forest dendromass, according to Decree No. 482/2005 on the determination of types, uses and parameters of biomass in support of electricity production from biomass, consists of:

— fuelwood

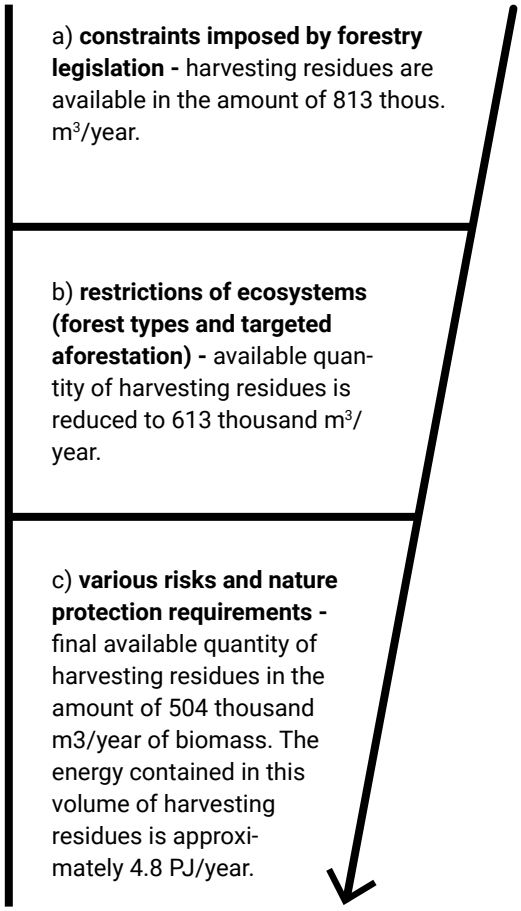
— logging/harvesting residues

— bark of forest trees

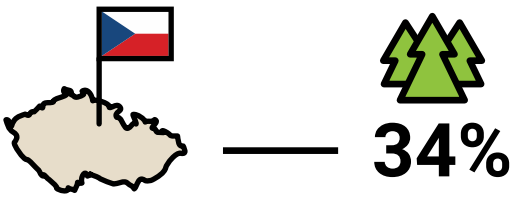
— residues from wood processing industry.

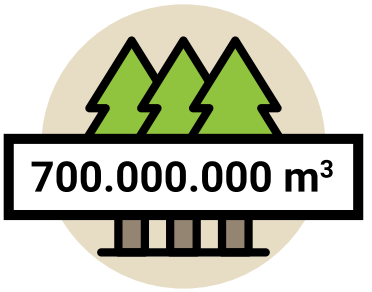
Timber residues from tending, logging and harvesting, which remain in the forest stand for further processing are mainly branches and treetops with a share of 10–15%, and assimilation parts of the trees of 2-3%. The use of the other 5-25% of the harvested tree (i.e. roots and stumps) is not recommended from an ecological point of view of forest ecosystems stability and it is not economically viable.

Different factors and their influences on available quantity of biomass on annual basis in Czech Republic are displayed below:



2.1.1 Overview on Czech Republic forestry sector

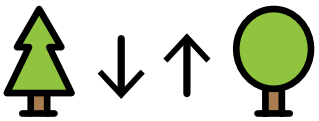




Forest land currently covers almost 2.7 million ha, representing 34% of the total land area of the country. The forest land has been steadily increasing since the second half of the 20th century. Introduction of new models of sustainable forestry, in line with principles of equilibrium and permanency in forest production, is main reason for increasing of the forest cover. For example, in 2016, the forest land area in the Czech Republic has increased by 1800 ha.

According to the data of the forest management plans, total timber supply reach almost 700 million m^3, while the average stock volume is 270 m^3.

There is continuing increase of total timber supply in the Czech Republic. This state is the result of the long-term application of the principle of sustainability and economic equilibrium. However, compared to 1930s, the figure for total stock volume in Czech forests has increased to more than double. The Czech Republic's stock volume of timber per hectare and the annual increment of wood mass per hectare classify the Czech Republic to the top positions in Europe's forestry.

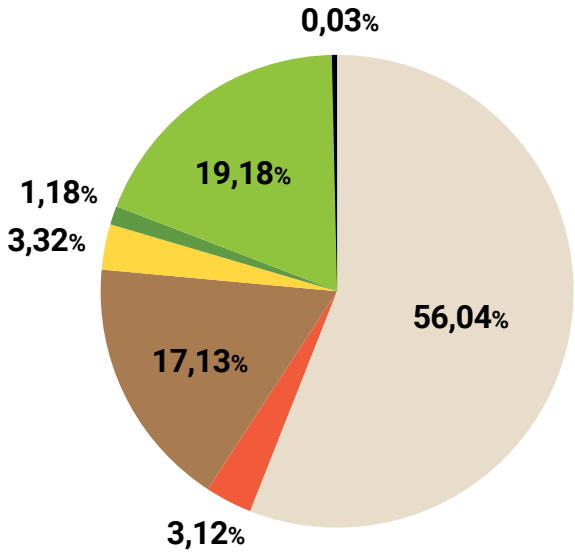


Regarding species composition of the Czech forests, conifer tree species have higher surface area than deciduous. However, the total area of main coniferous species, particularly spruce, has further declined. On the other side, the share of broadleaves, particularly beech, has been increasing.

Tree species composition on the Czech Republic in 2000 and 2017 in percentage

Tree species	2000.	2017.
Norway spruce	54,1	50,3
Fir	0,9	1,1
Pine	17,6	16,3
Larch	3,8	3,8
Oak	6,3	7,2
Beech	6	8,4
Birch	2,9	2,8
Other conifers	0,2	0,3
Other broadleaves	7,1	8,6

Source: Information on Forests and Forestry in the Czech Republic by 2017



Forest ownership structure in the Czech Republic (2017)

Source:
Information on Forests and Forestry in the Czech Republic by 2017

Total forest land owned by the state is cca 1.460 thousand hectares and approx. 83% or 1.218 thousand hectares is under direct administration and management of the state forest enterprise "Lesy České republiky[4]", 122 thousand hectares under administration and management of the state enterprise "Vojenské lesy a statky ČR[5]" and 95 thousand hectares are managed by the National Parks Administration.

At the state enterprise "Lesy České republiky", the preparation of forest management plans is awarded through a public tender. Currently, only two types of owners are required to prepare a forest management plan:

— legal persons entrusted with the management of state forests, irrespective of size (forests of the Czech Republic, military forests and estates, etc.)

— all other owners, whose forest has an area of over 50 hectares

For non-state forests and forest land, which do not exceed 50 hectares within the region, the forest management guideline should be prepared.

There are two main sources of biomass available in the Czech Republic:

— Biomass purposely cultivated (fast-growing trees, adequate agricultural cultures such as rapeseed, etc.)

— By-products (plant residues, forest and wood-processing residues, organic residues, animal residues, municipal bio-waste).

Tables below outline the most important figures regarding import and export of timber in the Czech Republic for 2017.

4 Forests of the Czech Republic, state enterprise.

5 Military Forests and Farms of the Czech Republic. The Military Forest Office is responsible for management of forests and other woodlands which are in areas possessed by or entrusted to the Ministry of Defence of the Czech Republic.

Table 1: Import/export trend of timber in the Czech Republic in 2017

	Exports	Imports	Balance	Exports	Imports	Balance	Exports	Imports
	CZK million			1 000 m³			Average price CZK/m³	
Total	13.736	4.494	9.242	7.890	3.271	4.619	1.741	1.374
of which								
EU – 27	13.548	4.031	9.517	7.826	3.077	4.749	1.731	1.310
Germany	4.921	596	4.325	2.956	660	2.296	1.665	903
Austria	7.124	183	6.941	4.199	320	3.879	1.697	572
Slovakia	497	1.555	-1.058	305	975	-670	1.630	1.595
Poland	97	1.424	-1.327	56	1.077	-1.021	1.732	1.322

Source: 1) Czech Statistical Office, 2) Ministry of Agriculture

Table 2: Timber exports and imports (1,000 m³)

Assortment		Export	Import
Softwood roundwood and pulp		6,380	1,623
of which	Spruce	5,999	1,128
	Pine	310	277
	Other	71	218
Hardwood roundwood and pulp		203	193
of which	Oak	24	64
	Beech	112	68
	Poplar	4	5
	Birch	35	19
	Other	28	37
Charcoal		0	13
Fuelwood		123	20
Chips, particles		246	600
Sawdust, Wood Waste, Residues		445	711
Wood pellets and other agglomerates		493	111
Total		7,890	3,271

Source: Czech Statistical Office, Ministry of Agriculture

The total length of forest roads in the Czech Republic is comparable to a public road network; it reaches about 80% of its length (55.752 km of public roads to 48.095 km of roads used for forest management). Access to forests in the Czech Republic is generally considered as enviable, but in comparison to Austria, Switzerland or Germany, it can be concluded that the density and length of the forest transport network in the Czech Republic is not sufficient and requires further construction and reconstruction (Source: Lesnicka Práce, 2013).

2.1.2. Czech legislation on forestry and biomass utilization

Most important legislation documents with regards to cultivation and utilization of biomass:

→ *Decree No. 477/2012 on the determination of the types and parameters of supported renewable energy sources to produce electricity, heat or bio-methane and on the establishment and storage of documents.* "Purposely cultivated biomass" is clearly defined by this decree. In Section 7, paragraph 3, it is stated that in the "Declaration of the manufacturer or supplier of biomass fuel" data on the area on which the biomass is cultivated must be in accordance with the data stated in the declaration of the purposely cultivated biomass in the form of identification of all the numbers of soil blocks or parts of soil blocks and area to which the declared biomass is cultivated in the respective year. This declaration shall be submitted at the same time as an application for a grant under a directly applicable European Union rule governing common rules for direct support schemes under the common agricultural policy, on a form issued by the State Agricultural and Intervention Fund for the calendar year concerned and submitted before 15th of May of the calendar year if the producer or supplier of biomass is registered in the land use records.

The Decree defines the following terminology related to forest/wood biomass (dendromass):

— purposefully grown energy trees, i.e. trees grown outside the forest land from which the above-ground part is used for energy purposes, eventually adapted for transport to the final consumer of biomass;

— residual material from logging and harvesting, i.e. wood up to 7 cm in diameter and residual products from its processing including roots (stumps), residues from thinning and tending, dendromass from maintenance of public and private green areas including rails, watercourses, electricity distribution etc. and residual products of its processing, including their processing for transportation to the final consumer of biomass;

— used timber, used products made of wood and wood materials, wood packaging including by-products from their processing and including their further processing for transportation to the final consumer of biomass;

— residual wood mass resulting from the production of cellulose, including bark, by-products from its processing and including its processing for transportation to the final consumer of biomass;

— wood chips for material production, including by-products and residual products of their processing and including its processing for transportation of biomass to the final consumer of biomass;

— wood chips produced in the sawmill while processing barked and debarked wood;

— pellets and briquettes from specifically grown biomass, by-products from agricultural and forest production and residual wood from the processing industry

→ Act No. 201/2012 on air protection. This Law stipulates measures related to air pollution reduction by burning fuels and inappropriate use of outdated boilers in Czech households;

→ Act No. 165/2012 on supported energy sources. In terms of support for biomass for energy use, several fundamental changes have been introduced, including the introduction of RES support for heat production, support for the production of bio-methane from biogas, but also puts more pressure on the higher efficiency of energy use in biomass and limits the maximum amount of support.

→ Act No. 289/1995 on Forests. According to this Act, the forest owner is obliged to undertake measures of restoring and tending in order to improve their condition, increase their resistance and improve the performance of forest ecosystem functions. Under appropriate conditions, natural regeneration is desirable; however, it is not applicable in genetically unsuitable forests. In the case of intentional main felling, the surface area of the clear-cut **must not exceed 1 hectare** and the maximum width, depending on the type of habitat, can be twice of the average height of stands covered under felling. In justified cases, when approving a plan or developing management guidelines or at the request of a forest owner, a forestry authority may allow an exception from the specified size or width of the clear-cut in the following situations:

— natural habitats of pine stands on sandy soils and natural floodplain habitats up to 2 hectares of clear-cut without width restrictions and,

— on mountain slopes that are inaccessible and unsuitable for transport and longer than 250 m, up to 2 hectares of clear-cutting area.

2.1.3. Planning documents and studies relevant for biomass utilization in Czech Republic

Biomass Action Plan for the Czech Republic for the period 2012 – 2020

Biomass Action Plan in the Czech Republic is based on an analysis of the biomass use for energy purposes and proposes appropriate measures for synchronized planning of production in agricultural and energy sectors until 2020. The Action Plan includes information on energy use of biomass, including the use of solid biomass for direct combustion to produce heat and electricity, biogas production and liquid biofuels and proposes appropriate measures to achieve sustainability in biomass utilization by 2020.

The overall estimate of the energy potential of forest dendromass is between 44.3 to 48.4 PJ. After deducting this fuelwood potential for the amount of fuelwood used in households (this information is obtained based on the fuelwood supply report), annual potential is considered to be between 26.3 and 30.4 PJ. Unlike agricultural production, this potential can be considered more or less stable until year 2020.

Potential of energy utilized forest dendromass is represented in the table below.

Table 3: Energy potential of forest dendromass in the Czech Republic

Item	PJ	Average value	%
Fuelwood (exlc. households)	0.5-0.6	0.55	8
Harvesting residues	4.8	4.8	17
Bark	4-6	5	18
Wood processing waste	8-10	9	32
Other waste from wood processing	9	9	31
TOTAL	16.3-30.4	28.4	100
Fuelwood (households)	18	18	-

Source: Expert team of Biomass Action Plan, Ministry of Agriculture, 2011, Available online in Czech language.

Guidelines for biomass utilization in the Czech Republic

There are few publicly available methodological guidelines for effective biomass utilization which are used in the Czech Republic. Most of the guidelines, handbooks and methodologies were developed between 2006 and 2014 with the support of EU programmes and grants. Some of the publications worth to mention are:

Cultivation and utilization of biomass of forest trees for further processing and energy purposes

This is a working methodological handbook for consultants in forestry issued by Forest Management Institute Brandýs nad Labem, 2012 (*Ústav pro hospodářskou úpravu lesů Brandýs nad Labem*).

The goal of this handbook is to identify the potential of forest biomass and fast-growing crops and the use of technically available biomass quantities. It is developed to provide basic information to private advisors/ consultants and forest owners about this topic. Currently, Czech forests are used for economical purposes to large extent with a focus on sustainable development and nature protection. The change in the use of agricultural land result in potential areas for planation of poplar and willow cultures. The methodology also includes information on cultivation of fast-growing trees plantations on agricultural land.

Possibilities of biomass utilization for energy purposes – Practical case studies from the National Biomass Action Plan in the Czech Republic 2012-2020

Publisher: Ministry of agriculture and **BIOM (Czech Biomass Association), 2013.**

The aim of this publication was to create a summary of biomass action plan and introduce biomass energy use opportunities to the general public. This material demonstrates the measures proposed in the biomass action plan in practice from the three most important perspectives: agriculture, municipality and the households.

The publication also seeks to facilitate the orientation of stakeholders in legislative procedures, and summarizes possible energy uses that biomass offers. At the same time, the material contains information about specific projects and other useful information.

Modern utilization of biomass – technological and logistic possibilities

Publisher: Ministry of Industry and Trade, 2006

This publication provides a critical view of the technological and logistical use of biomass regarding the political commitment to biomass utilization in the EU and the Czech Republic. The publication provides a comprehensive overview of modern technological and logistic solutions for the use of biomass regarding their suitability for application in the Czech Republic. This publication may serve as a basis for initiation of discussion about fulfilment of political objectives in the field of RES and in particular biomass under the current conditions of grant support for utilization of RES. In addition, the publication contains information on technological and logistic solutions of biomass utilization, which are beneficial in aspects of energy production (utilization of local RES), economy (investment and operating costs), society (job creation) and environment (reduction of greenhouse gas emissions, minimization of other environmental impacts).

Methodology for determining biomass potential in relevant zones with respect to food safety

Publisher: Silva Tarouca Research Institute for Landscape and Ornamental Gardening, 2013.

The methodology describes the procedure for determining the biomass potentials from agricultural and forest land suitable for energy production in any area of interest in the Czech Republic. It is intended for strategic natural resource planning with regards to sustainable use of land for food security and biomass production for energy use. The main biomass sources considered are harvest residues from agriculture, timber residues and purposefully grown biomass (woodchips of fast-growing trees; residues/straw of non-woody energy crops). Recommendations for adequate collection of forest biomass are based on the principles of sustainable forest management. The methodological approach is based on the available data on forest and agricultural crops productivity, their current use and the latest results of energy crop productivity research. In addition to mapping the current biomass potential in the areas of interest, the methodology also includes modelling the future land-use according to different requirements and strategic plans of the government or other organizations.

Methodology for determining biomass potential for energy production in crisis situations

The methodology describes the procedure for determining the biomass potential of agricultural and forest biomass that can be used in crisis situations to ensure the operation of heating plants and their associated infrastructure. It is intended for strategic planning and for the preparation of energy resources, settlements and, where appropriate, regions for cases of supply disruptions or interruption of fossil fuel logistics chains for duration of 1 to 12 months. The methodology determines the potential of biomass according to its basic types in an area of a heating plant and identifies required area to ensure the amount of biomass needed. Identification of biomass potential with respect to individual types of biomass will allow accounting the amount and structure of available biomass in preparation for potential crisis situations (e.g. installation of technologies that will enable burning of available types of biomass in a given location).

Remeš J., Bílek L., Zahradník D. (2016) Methods for determining the quantity of aboveground biomass of Scots pine (Pinus sylvestris L.) in forest management units 13 and 23.

The proposed methodology aims at determining the potential of the aboveground biomass of one of our major commercial tree species in Czech Republic, Scots pine (*Pinus sylvestris L.*). The first part of this document provides detailed methodological guidance for the empirical determination of the aboveground biomass potential of Scots pine, by utilising destructive analysis. The data were collected in natural pine stands on acidic forest sites in the locality of Municipal forest of Doksy. In total, in the frame of research project of the National Agency for Agricultural Research, 18 selected sample trees were felled aimed at estimating the dry mass of the aboveground part of tree. The second part of the methodology shows best suited local models for the estimations of aboveground biomass potential of Scots pine based on dendrometric characteristics of individual trees. For five types of tested allometric equations parameters were determined and coefficient of determination and error rate was calculated. Two models with best prediction of aboveground biomass potential for Scots pine were selected.

Vejpustková M., Čihák T., Šrámek V. (2017) Quantification of aboveground biomass of Norway Spruce (Picea Abies (L.) Karst.)

To date, several studies concerned with quantifying the aboveground biomass of Norway spruce (*Picea abies; L.*) have been carried out in the Czech Republic. All these studies can be classified as being local and they cannot be utilised for the biomass evaluation on a national scale. The aim of presented methodology is to give detailed guidelines for the empirical assessment of spruce biomass potential and create allometric equations applicable to prediction of spruce biomass at a national level. Derived functions are based on an extensive dataset of 177 spruce trees representing a wide range of tree dimensions and site conditions (25 stands on 15 different sites). The models enable estimation of total aboveground biomass and its basic compartments – stem, crown and foliage. The biomass (in kg of dry matter) was modelled using linear regression equations with one (tree diameter – D), two (D, tree slenderness ratio H/D) or three (D, H/D, site index B, resp. tree age T) predictors.

2.1.4 Support/Grants for use of biomass for energy production

State Budget Funds for the forestry sector

In accordance with the governmental financial obligations, subject to the Forest Act No. 289/1995, the state allocated total CZK[6] 185,9 million (EUR 6,96 million) in 2017 under the obligations determined by the Forest Act. The amount of CZK 7,2 million (EUR 270 thous.) was granted as partial payment to cover the increased costs of planting the soil-improving and stabilising tree species on

6 The CZK / EUR average exchange rate for the 2014-2017 period was 1 EUR = 26.7 CZK.

the total area of 1.312,00 ha of regenerated forest stands. CZK 127,1 million (EUR 4,76 million) covered the activities of licensed forest managers who manage forests of up to 50 ha in case these did not contract their own forest managers[7]. The allocated amount corresponds the work of licensed forest managers on total 389.961,00 ha of forests. The overall amount allocated for such forest owners reached CZK 15,4 million (EUR 580 thous.) and provided for management guidelines for total 52.940 ha of forest land. The data stated above apply to forest management guidelines valid from 1 January 2018 with the funds allocated in 2017. An amount of CZK 36,2 million (EUR 1,36 million) was granted to support measures related to soil improvement and torrent control carried out upon a decision of a state forest administration body. Such measures were adopted to control torrents of 5 km in length, and to build or repair water reservoirs of total water retention capacity of 22 thousand m³.

The government bodies provide free of charge services to assist forest owners to improve the standards of forest management and ensure forest protection against damaging agents (mainly spruce bark beetle - *Ips typographus*). Within those services, the state mainly supplies forest owners with up-to-date information concerning preventive protection of the forests and potential protective measures against damaging agents.

Table 4: The amount of funds allocated from the public budget for supporting forest management in the Czech Republic for the period 2014 – 2017 (EUR million)

Type of service	2014.	2015.	2016.	2017
Aerial liming and fertilisation	0,00	2,50	1,88	1,66
Aerial fire control services	0,04	0,13	0,05	0,30
Large-scale measures in forest protection	0,00	0,00	0,03	0,03
Consultancy	0,28	1,08	1,20	1,09
Other services	0,18	0,03	0,02	0,02
TOTAL	0,51	3,74	3,18	3,11

Source: Ministry of Agriculture, 2018

State budget subsidies

Financial support in form of subsidies granted for forest management activities is provided from the state budget under the Government Decree No. 30/2014 on determining binding rules for granting subsidies to forest management and selected game management activities. Such subsidies are granted to forest owners (or persons having the rights and obligations of a forest owner as established by the Forest Act), and to users of hunting areas, owners of hunting dogs or owners of breeding stations of hunting birds of prey. In the table below, main activities and purposes are represented which are supported by Ministry of Agriculture's subsidies for forest management in the Czech Republic, excluding game management activities.

7 The Government reimburses the costs of forest management guidelines to forest owners who own a total forest area of up to 50 ha and do not have a forest management plan drawn up for their property.

Table 5: Subsidies for forest management provided by the Ministry of Agriculture of the Czech Republic for the period 2014-2017 (EUR million)

Purpose	Forest ownership	2014.	2015.	2016.	2017.
Regeneration of forests affected by air pollution	Municipal	0,37	0,48	0,34	0,36
	State	0,00	0,00	0,00	0,00
	Other	0,30	0,39	0,33	0,37
	Total	0,67	0,87	0,67	0,72
Regeneration, establishment and tending of stands (≤ 40 years)	Municipal	2,21	1,84	1,81	2,54
	State	0,01	0,00	0,00	0,00
	Other	3,49	3,07	3,67	6,81
	Total	5,71	4,91	5,48	9,35
Green and environmentally friendly technologies	Municipal	0,11	0,15	0,17	0,22
	State	0,00	0,00	0,00	0,00
	Other	0,33	0,63	0,79	1,39
	Total	0,43	0,78	0,96	1,61
Elaboration of forest management plans	Municipal	0,37	0,37	0,28	0,39
	State	0,00	0,00	0,01	0,00
	Other	0,32	0,64	0,68	0,70
	Total	0,69	1,01	0,97	1,09
Total subsidies for forest management	Municipal	3,06	2,84	2,60	3,51
	State	0,10	0,02	0,02	0,03
	Other	4,43	4,74	5,47	9,27
		7,51	7,58	8,08	12,78

Source: Ministry of Agriculture, 2018

Rural Development Programme 2014-2020/ Program rozvoje venkova 2014-2020[8]

The European Commission has officially approved the programming document of the Rural Development Programme of the Czech Republic for the period 2014-2020 for improving the competitiveness of the agricultural, food and forestry sectors. Thanks to the Rural Development Programme (RDP), nearly EUR 3.5 billion (more than CZK 96 billion) was channelled to the Czech agriculture and forestry during this period. Of that, EUR 2.3 billion (CZK 62 billion) comes from the Union sources and EUR 1.2 billion (CZK 34 billion) from the Czech budget.

8 More about this Programme can be found on this link: http://eagri.cz/public/web/mze/dotace/program-rozvoje-venkova-na-obdobi-2014/

Activity: 8.1.1 Afforestation and forestry

The aim of this activity is afforestation of agricultural land, including the silviculture measures for established forest stands and compensation for termination of agricultural activities. The financial support is targeted at the defined agricultural land in LPIS[9], which is defined as suitable for afforestation and eligible for direct payment. The applicant must submit an entry notification to the measure before afforestation process. Applicants who are eligible to apply are private and public owners, tenants and land lessee and their associations. The possibility of applying for subsidies for afforestation excludes an entity that is a contributory organization or an organizational unit of the state.

Table 6: Tariffs/rates of the financial support

Establishment of forest cover by trees	fir, pine, beech, oak, linden, Douglas fir, ash	EUR 3.035/ha
	other tree species	EUR 2.100/ha
Care/tending of the established forest cover	fir, pine, beech, oak, linden, Douglas fir, ash	EUR 669/ha/year
	other tree species	EUR 298/ha/year
Termination of agricultural activities on the land-plot which was registered as a plantation in LPIS	arable land, hop field, vineyard, orchard, nursery or other permanent culture	EUR 488/ha/year
	grassland, fallow or other plantations	EUR 161/ha/year

Activity: 15.1.1. Preservation of forest stands

The aim of this activity is to preserve the current species composition of the forests or the current type of forests and the state of the natural habitats of the forests under Natura 2000 and in the special protected areas. Applicants who are eligible to apply are forest owners, forest tenants, forest lessee and their associations. In the case of state land, the support may only be granted if it is managed by a private entity or municipality. The commitment to recognize eligible costs is based on compensating for the additional costs and loss of revenue resulting from the preserving of selected stand types (fir, oak, beech, other deciduous, poplar and coppice forest) rather than converting them to a lower ecological value management set of stands, especially for stand groups that are at least in the beginning of the regeneration period.

The financial support is provided as a fixed rate of EUR 183 per hectare per year.

9 LPIS - National Soil Registry operated by the Ministry of Agriculture – available online - http://eagri.cz/public/app/lpisext/lpis/verejny2/plpis/

Activity: 15.2.1 Conservation and reproduction of genetic resources

The aim of this activity is to provide a support for protection of genetic resources and preserving resources of reproduction material of forest tree species of the higher quality categories. Applicants who are eligible to apply are forest owners, forest tenants, forest lessee and their associations. The commitment to recognize eligible costs is based on compensating for the additional costs and loss of revenue resulting from the collection of seeds tree-friendly technologies, for example, in conifer trees seeds shall be collected only from the standing trees and in deciduous trees by using tarps or hanging nets.

The financial support is provided as a fixed rate of EUR 74 per hectare per year.

Activity: 4.3.2. Forest infrastructure

The aim of this activity is promoting the reconstruction and building of forestry infrastructure to improve the quality or density of forest roads. The impact of the network of trails and drainage conditions and the equipment of roads for forest protection will also be considered. Applicant can be natural or legal persons, associations and associations registered as legal entity, municipalities or their associations managing forests owned by private individuals or their associations, or associations with legal personality, regions, municipalities or their unions.

Total available financial sources for period 2014-2020: EUR 35,2 million

Operational Programme "Environment"/Operační program Životní prostředí[10]

The 2014-2020 Operational Programme Environment (OPE) builds on the 2007-2013 OPE. In the past couple of years nearly EUR 2.506 billion from the Cohesion Fund and the European Regional Development Fund have been earmarked for applicants. The Operational Programme aims to protect and ensure the quality of the living environment, promoting the efficient use of natural resources, eliminating the negative impacts of human activities on the environment and climate change mitigation.

The programme is open to municipalities, organizations, state and local governments, research and scientific institutes, educational institutions, legal and natural entities and non-profit organisations. The Managing Authority is the Ministry of Environment, the intermediary body is the State Environmental Fund of the Czech Republic. Supervision of the programme is performed by the Monitoring Committee, which continuously monitors the programme in order to assess its implementation and progress towards achieving the programme objectives, considering financial data, common indicators and indicators specific to 2014-2020 OPE. The Monitoring Committee consists of representatives of the Ministry, intermediate bodies and representatives of the partners (ministries, regions, municipalities, NGOs, professional organizations, etc.).

10 More about this Programme can be found on this link: https://www.opzp.cz/about/

Operational Programme Enterprise and Innovation for Competitiveness

The aim of the Operational Programme Enterprise and Innovation for Competitiveness (OP EIC) is to achieve a competitive and sustainable economy based on knowledge and innovation. The term "competitive" includes the ability of local firms to promote themselves at global markets and create enough jobs. The term "sustainable" accentuates the long-term competitiveness, which includes, among other things, the environmental dimension of economic development. More about this Programme can be found on this link: www.oppik.cz

New Green Savings Programme/ Nová zelená úsporám

The New Green Savings Programme of the Ministry of the Environment is administered by the State Environmental Fund of the Czech Republic and is one of the most effective programmes in the Czech Republic focused on energy savings in family houses and apartment buildings.

The Programme supports the reduction of the energy intensity of residential buildings (complex or partial thermal insulation), construction of houses with very low energy intensity, environmentally friendly and efficient use of energy sources and renewable sources of energy (RES).

The main objective of the programme is to improve the state of the environment by reducing the production of pollutants and greenhouse gas emissions (in particular CO2 emissions), by achieving energy savings and by stimulating the Czech economy through measures of improving the quality of housing of citizens, improving the image of towns and villages, starting up long-term progressive trends.

The New Green Savings Programme supports:

— Renovation of family houses and apartment buildings (thermal insulation of facade, roof and ceiling, replacement of windows and doors)

— Construction of family houses and residential buildings in so-called passive standard (passive houses)

— Solar thermal and photovoltaic systems

— Green roofs

— Use of heat from wastewater

— Controlled ventilation systems with heat recovery (recuperation)

— Replacement of heat sources for heat pumps, biomass boilers

Owners or builders of family houses and residential buildings, both individuals and legal entities can apply for this support programme. More about this Programme can be found on this link: www.novazelenausporam.cz/o-programu

3 Ecological aspects and sustainability – protection of forest ecosystems and their services

3.1 Environmental aspects of forest planning and management in BiH

The term biological diversity or biodiversity refers to the diversity of nature and all biological systems. Biodiversity is an important indicator of ecosystem status, environmental potential and further trends, and one of the most reliable indicators of global environmental change. Different authors distinguish multiple levels of biodiversity categorization, of which three categories are presented here:

— Ecosystem biodiversity (ecosystem diversity). It implies the diversity of ecosystems which occurred under different ecological, hydrological and geological conditions, spread across different climatic zones of planet Earth.

— Species biodiversity (species diversity). It implies a diversity of plants, animals, fungi, and unicellular organisms.

— Gene biodiversity (genetic diversity). It implies the diversity of the genetic pool contained in various types of plants and animals.

BiH has a very high level of species diversity and is ranked among countries with very rich ecological diversity. As many as 252 ecosystems are registered in this territory (51,129 km^2), building 11 landscapes or biomes (Riter-Studnička, 1956, 1959; Lakušić, 1970; Redžić, 2007a, 2011a; Redžić et al, 2008; 2011;). These are: (i) Mediterranean, (ii) Sub-Mediterranean, (iii) Mediterranean-montane, (iv) mountainous (montane), (v) Pannonian, (vi) Peripanonnial, (vii) highland, (viii) sub-mountainous, (ix) alpine, (x) relict pine forests, (xi) refugial-relict deciduous broad-leaved forests, and (xii) wetlands. With regard to forest ecosystems, out of a total of 70 habitats proposed under Natura 2000, as many as 20 habitats refer to forest plant communities in BiH (Milanović et al, 2015).

BiH still has well-preserved ecosystems and natural resources contained in them – medicinal, edible, vitamin and aromatic plants and fungi, economically important species, natural habitats and communities, as well as a wide range of ecosystems (Redžić, 2007b, 2010, 2011b). The long tradition and connectedness of BiH society with forest resulted in creation of a specific relationship towards this natural resource and relatively high dependence of local communities on the products and services provided by forest resources. This is primarily related to the products that people used for household purposes and later for industrial development, which led to the forestry sector becoming an important economic sector. In this context, a need has occurred to integrate conservation and forest resource utilization principles, and thus specific organizational-legislative and expert criteria were created for planning and implementing forest management measures. These criteria sought to establish production consistent with the environmental characteristics of the forest resources subject to planning and operation. For the classification of forests, from the standpoint of the production of wood mass and other non-wood products, a classification was established based on the ecological and production characteristics of ecosystems.

Recently, there has been a change in legislation regulating the issue of biodiversity protection. Namely, a separate subsection has been introduced into the prescribed content of forest management plans, in the chapter dedicated to plans, which elaborates and treats this issue by economy classes. The Law on Nature Protection (Official Gazette of the Federation of BiH, No. 66/13), Article 40, paragraph 1, stipulates the following: For the purpose of conservation of biological diversity in all forests, a permanent percentage should be ensured of mature, old and dry trees, especially trees with cavities, determined by the requirements of nature protection which are integral part of forest management plans.

3.1.1 Forest utilization process and ecological minimum

According to decades-old BiH forestry practice, twigs, waste and stumps are left in the forest in order to meet the ecological needs of stands. This practice is partly regulated by the regulations defining the measures to be implemented after the cuttings in the stands so as to assure ecological equilibrium in the stand is not disturbed. Based on this practice, it can be concluded that the minimum remaining in the forests is the green assimilation apparatus (leaves) and approximately 30% of unused wood mass that remains after logging. According to the research results, the annual inflow of organic residues reaching the forest soil for moderate climates amounts to 2-6 t/ha (Ćirić, M. 1984). The major mass of organic waste is made of leaves and needles (they make up to 90% of organic residues in beech forests). The research conducted in the pedunculate oak forest and narrow-leafed ash in Croatia established that only 35% of the annual production of wood biomass is utilized through regular management. The necessary amount of wood biomass required for the functioning of this forest ecosystem remains within the forest, and it can be estimated that such forest is properly and sustainably managed (Vukelić, J. and Rauš, Đ. 1998). It should be noted that there are different indicators as well such as the soil humification index and the change in the C:N ratio with respect to the preserved forest ecosystem (Martinović, J., 2003). Based on the analysis of literature sources, it can be concluded that the problems related to the effects of the extraction/use of wood biomass on the stability of ecosystems are still under-explored in our region. In some cases, the removal of twigs can have a positive effect on the stability of forest ecosystems. For example, fir needle moth (*Argyresthia fundella F.R.*), an insect living in fir needles, in over-reproduction, can cause attacks on healthy vital trees, even defoliation of fir forests (Harapin, M., Hrašovec, B. 2001). The extraction of fir twigs from the forest that has been attacked is a great measure to reduce the population and intensity of attack of this insect.

Current aspirations to maximize the wood biomass mobilization, due to new market trends aimed at increasing the production of energy from renewable energy sources, call into question the established practice of leaving wood mass after harvesting and redefinition of the biological minimum. In order to perform redefinition of the biological minimum on an objective basis, it is necessary to carry out detailed scientific research and answer a number of questions such as:

→ What is the importance of dry trees, tips and stumps for biodiversity, and what is their benefit in wood mass mobilization?

→ Is it justified to use stumps as a form of wood biomass for energy production, given the fact that BiH forests are generally spread over steep terrains?

→ Are there objective reasons to move the border between large and small-sized wood from 7 cm to 5 or 3 cm in order to obtain larger quantities of large wood?

→ Is it justified to mobilize wood biomass that remains in the forest after harvesting and thus compromising the stability of ecosystems when existing potentials within high, degraded and coppice forests and crops are not fully utilized?

The scientific and expert community is already trying to give some answers to all these questions, so in one part of the expert public an opinion was formed that

the harvesting residues should range within the interval from 10 to 20%, while the other part insists on additional research. This Guidebook seeks, based on available data, to provide insight into the existing potential for mobilizing wood biomass by applying the current management practices.

Definition of a sustainable forestry concept and ecological minimum in the legislation of the Czech Republic

In accordance with the Czech Forest Act, assumptions of sustainable management in the forests are divided into two categories:

1. Forest management differentiation which includes territorial plans for forest development

2. Forest management tools

   a. Forest management plans
   b. Forest management guideline
   c. Forest inventories

The concept of sustainable forest management has become a strategy and objective of forest policy in the Czech Republic. In this manner, Act No. 289/1995, the Forest Act, declares that its "purpose is to establish the prerequisites for forest conservation, forest management and forest regeneration as a national asset, constituting an irreplaceable part of the environment, for all its functions and to promote sustainable management in it". Act No. 114/1992 on Nature Protection, defines the forest as an important landscape element. The protection of landscape and nature requires the provision of ecologically friendly forest management. It can be assumed that the term "ecologically friendly forestry" is identical to the term "sustainable forest management". The principle of equilibrium of forest management mainly monitors the balance between forest productivity and exploitation intensity. It is an important prerequisite for proper management and economic self-sufficiency, while maintaining all ecological functions of forests.

In order to achieve the aforementioned equilibrium, the issue pertaining to determining the ecological minimum of deadwood represents an indispensable step. Ecological minimum of deadwood/wood residue left in the forests after felling is not defined by Czech legislation as a binding number defined in advance. There are numerous discussions about this topic and its definition directly depends on the specific location of the concrete forest ecosystem and its developmental phase. For example, the volume of wood residue in plantation forests ranges from about 4 to 10% of the stand stock, and in natural reserves without intervention, the volume of deadwood is in the range of about 20% to 40%. From the viewpoint of maintaining the necessary volume of decaying wood mass in a stand, it is preferable to determine the number of trunks per ha, or to another surface unit, which will be left to the natural decomposition processes rather than to determine the required volume of the logs that should be left on the same unit. It is not possible to determine the universal minimum or optimal proportion of the deadwood, especially with respect to the forest dynamics. Also, the high proportion of deadwood is not a sign of stability of a particular stand. Even in mature forests, the deadwood mass does not exceed 60-70% of the stand stock. **Approximately 10 - 20% of the stand stock can be considered as the minimum amount of deadwood for all types of forest stands.** The optimal proportion of deadwood in the nature reserves ranges from 30 to 40% of the stand stock for the stands at the optimum stage of development.

Source: Ministry of Environment, 2006

3.1.2 Regulations defining the measures to be implemented after the cuttings in order to assure ecological equilibrium in the stand is not disturbed

Rulebook on the scope of measures to be implemented after the cuttings in order to assure ecological equilibrium in the stand is not disturbed and the method of their implementation in the FBiH (which is out of force but is applied in practice) sets out implementation and ongoing maintenance of respective measures in all forests. The Rulebook was adopted on the basis of Article 35, paragraph 8 of the Law on Forests (Official Gazette of the Federation of BiH, 20/02). From the point of view of wood biomass left in the stand after logging as an ecological minimum (branches, stumps, bark, tip), this Rulebook clearly prescribes the method of their treatment in the stand. In this regard, it is stated that branches and tips (diameter of the thicker end below 7 cm), as well as conifer bark, must be stacked in piles/bulks so that the thicker ends of the branches are turned within the pile/bulk due to bark beetles. It is forbidden to form piles/ bulks in places with saplings, with live standing trees, in watercourses, above water sources and at a distance of less than 10 m from the roads. The branches and tips (diameter of the thicker end below 7 cm) of the broadleaves must be shortened to one meter in length and spread evenly across the cutting area, taking care of saplings, watercourses and water sources.

Rulebook on measures to be implemented after the cuttings in order to assure ecological equilibrium in the stand is not disturbed in Republika Srpska, adopted pursuant to Article 73 (3) and Article 107 (3) of the Law on Forests (Official Gazette Republika Srpska, 75/08), sets out that in younger stands of conifer species, in addition to usual measures of protection and care in the form of thinning, it is obligatory to prune the ground branches and extract them, take them out of the stand and remove the infectious nuclei. In parallel to felling and processing of forest wood assortments, all branches and tops of conifers and elms that remain unused in the forest must be stacked in piles up to two meters in diameter. Residues of individual trees, from which forest wood assortments cannot be made, are cut in several places and secured against displacement, and in conifers and elms it is obligatory to perform debarking.

For the purpose of maintaining the health of forests, forest users and owners inspect at least once a year those forests that are not subjected to regular felling during the year and, upon preliminary marking of the trees, all dry and semi-dry trees or their parts are removed from the forest, except in cases where leaving them in the stand is provided for by the forest management plan for protection of biodiversity, that is, to preserve ecosystems.

Both Rulebooks stipulate leaving waste and small-sized wood in stands after felling so that the health of the forests is not compromised. The RS Rulebook is in line with current trends and gives an overview of the protection of biodiversity, provided that the health and stability of ecosystems are not threatened. Based on this, it can be concluded that, if this form of wood biomass is to be mobilized, the by-laws defining the measures to be implemented after the cuttings in order to assure ecological equilibrium in the stand is not disturbed must be improved in the part that answers the question about the forms of wood residue that can be taken out from stands.

3.2 Planning process and development of forest management plans

Development of a forest management plan is a process based on data collection through periodic forest inventories and processing of collected data. A prerequisite for conducting a forest inventory is a good classification of forests and forest lands with regard to their use or protection zones in protected areas. In forestry practice in BiH, the planning process is based on the application of a systematic pattern with circular sampling plots, so-called exemplary areas (Matić, V, 1964, 1965, 1977; Stojanović, O, 1964; Stojanović, O, Drinić, P, 1974; Koprivica, M, 1984) and typological classification of forests and forest lands (Ćirić, M. et al, 1971; Stefanović, V. et al, 1977a, 1977b, 1983). Exemplary areas are circular tree-marking plots systematically distributed over a square network of the established distance, depending on the size of forest management area and the broader category of the forest under survey.

Adoption and designing of a forest management plan for a forest management area, in addition to their necessity from a professional and practical point of view, is a legal obligation. The laws and by-laws defining this area are shown below.

Based on the analysis of the above documents, it can be generally concluded that the process of development of forest management plan, regardless of the different legislative basis in the Entity and/or cantonal regulations, has a number of common characteristics.

When the purpose of forest management is taken into account, the practice of development of forest management plans to date has proven particularly well in the case of forests and productive forest land, which can be concluded based on the state of

Table 7: Laws and by-laws defining development and content of forest management plans

	Federation of BiH	Republika Srpska	Brčko District
Law	Decision on development, content and application of forest management plans (Official Gazette of the Federation of BiH, 15/14 and 45/18).	Law on Forests (RS Official Gazette, 75/08 and 30/10).	Law on Forests of the Brcko District of BiH (Official Gazette of the Brcko District of BiH, 14/10 and 26/16).
By-laws	Rulebook on elements for development of forest management plans (Official Gazette of the Federation of BiH, 62/02) – out of force.	Rulebook on elements and content of forest management plans (Official Gazette of Republika Srpska, 52/09).	Rulebook on elements, content and method of preparation of forest management plans (Official Gazette of the Brcko District of BiH, no. 6 of 4 March 2019)
Methodological framework	Lojo, A, Balić, B, Treštić, T. 2003: Methodology of field tree inventory in Sarajevo.	Koprivica M, Maunaga Z. 2000: Forest Inventory and Forest Management Planning in RS.	The methodology from the FBiH or RS is applied.

forests in BiH. The same practice of forest management plans development applies to forests and forest lands with poor economic conditions, protective and special purpose forests that are different in nature from productive forests (i.e. biological and economic components have different priority). It is important to note that this system of forest management plans development is conceived as an open data collection system, based on the experience gained from conducting forest inventories, identification of deficiencies and needs of the society for new information and through expert and scientific analysis of the collected information. The results of such approach led to changes in existing inventory methodologies and the creation of new databases for developing better quality plans. Thus, the Methodology for collection of inventory data on field for the purpose of forest management plans development (Lojo et al, 2017), prepared in the framework of the project supported by the Czech Republic, anticipates conducting the inventory of deadwood mass as part of the inventory process. Based on these data, information on wood biomass remaining in the stands after logging can be directly and indirectly generated, including biomass that may need to be left in the stands to ensure a biological minimum or biomass used for wood-biomass based energy production.

Information collected from field tree inventory and from various expert studies are processed in the relevant GIS environments and specific software solutions for processing inventory elements. After data processing, they are analysed and presented in the form of tables, charts and maps within the forest management plans and in the accompanying studies. Collected data and information within the forest management plans are also calculated by calculation methods based on political-administrative units such as municipalities, cantons, Entities and BiH.

3.2.1 Structure of forest management plans and analysis of elements for planning wood biomass mobilization

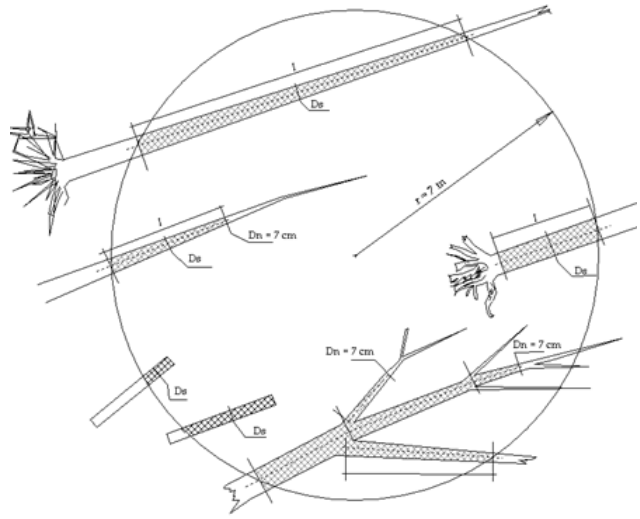
As already mentioned in the introductory part, forest management plan in BiH forestry practice is the basic planning document. Considering the fact that forest management plan is starting point for planning of felling and mobilization of wood and wood assortments, construction of forest road infrastructure as well as establishment of new forest plantations (crops), this chapter gives an analysis of the content of a forest management plan, which either directly or indirectly may have an impact on the wood biomass mobilization for energy production.

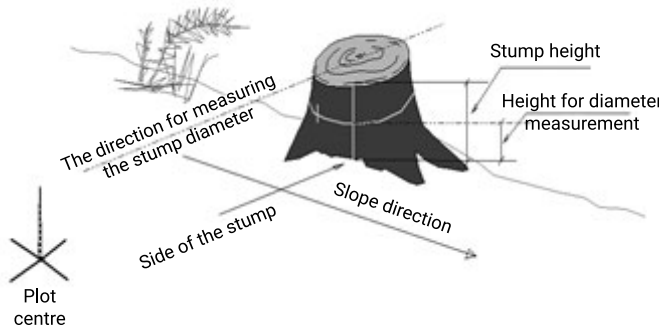
3.2.1.1 State of forests at the forest management planning period

This chapter summarizes the data in the form of table, which represent the starting point for the analyses on the basis of which decisions will be made for the preparation of management plans for the next forest management planning period. Given that according to the current practice, data related to wood biomass are not collected during field inventories, this chapter does not contain information that would indicate its state or availability. In order to change this practice and use the benefits of an open data collection system, future local forest inventories or inventories on a pilot location, data on wood biomass could be collected, such as in the case of the Second forest inventory on large areas in Bosnia and Herzegovina in the period 2006 – 2009.

Method of inventory of lying deadwood mass and stumps used in the Second forest inventory on large areas in BiH

In order to begin collecting quantitative and qualitative indicators related to the state of wood biomass, it is possible to use the method of inventory of lying dead wood biomass used in the Second forest inventory on large areas in BiH. According to the methodology of the Second forest inventory on large areas, deadwood mass is the mass of decaying wood or its parts in lying position, stumps thicker than 7 cm at the thinner end (in lying position) and thicker than 5 cm in the breast height (upright position) up to 2.6 m in height. Dry upright trees, that is, broken dry trees with a breakage height above 2.6 m from the ground, are also part of deadwood mass, but information about them is recorded together with live trees. Procedures of inventory of deadwood mass, stumps and information that are recorded are given below:





In the forms for field inventory survey (inventory of deadwood mass), the following forms of deadwood are recorded: old stumps (older than 1 year), lying dead parts of trees or whole lying trees, produced wood assortments that were not removed from the stand in time and most likely this will not happen, and the stack of such tree. The extent of decomposition is also recorded. Since only pieces – parts for which the diameter at the thinner end is more than 7 cm and the length is more than 1 m for the assortment are measured, and for the processed pieces, parts longer than 0.5 m and with diameter larger than 7 cm, it can be concluded that this is large wood biomass.

Data, information and their meaning are recorded as follows:

Type of data	Code and data description	Explanation
Tree species:	02 – conifers 03 – broadleaves	If we cannot conclude with certainty whether it is a tree/stump of conifers or deciduous trees, we should enter the most likely option.
Form of deadwood:	1 - lying trunks, parts of trunks or branches 2 - lying processed and left assortments 3 - old stumps and breakages up to 2.6 m in height 4 - stere wood stack	**Stack:** The larger quantity of produced assortments (stere wood in the stack) is directly measured on site, the volume in m^3 is calculated and entered as a separate entry in the table (without entering dimensions).
Dimensions:	**Diameter:** measured at half the length of a piece or half the height of a stump and in the centre – stump direction. The diameter is entered in cm. **Length:** It is measured in the part of the lying pieces within the radius of 7 m to the plot centre. The length is written in dm.	
Decomposition:	1 – healthy 2 – semi-rotten 3 – rotten	**Healthy** – recently decayed, bark present on the tree, no live branches, no signs of rotting; **Semi-rotten** – noticeable initial decomposition, bark in decomposition or missing, wood still firm, rotting affects less than 1/3 of diameter; **Rotten** – advanced decomposition, sapwood soft, pulp only partly hard, rotting affects more than 1/3 of diameter.

Source: Faculty of Forestry, University of Sarajevo, 2007: Methodology of second forest inventory on large areas in Bosnia and Herzegovina; Special Issues No. 20, Volume 1

Data collected and processed in this way can provide quantitative and qualitative indicators on the state of wood biomass that remains in the forest after logging and that results from the tree decay, i.e. biological processes in the forest. The information on the shape of the tree (i.e. stack of the stere wood) can provide information on how long that stere wood was left in the forest and not extracted in the forest utilization process. For the purpose of biological minimum analysis, and in connection with further research, decomposition data in terms of the volumes of healthy trees in relation to the volume of semi-rotten and rotten trees may provide indicators for specific stands when it comes to the volume of deadwood (semi-rotten and rotten) to be left in the stand for biodiversity protection and which can be mobilized (healthy). Based on the data on the volume of healthy lying trees, it can be estimated whether it is profitable to mobilize wood biomass from a particular stand. As these are the data on large wood, they can serve as a supplement to other data in order to form an overall picture of the state of biomass in specific stands.

This chapter provides an overview on openness of forests, which is of great importance for planning and the possibility of wood biomass mobilization. GIS technique is used to measure the length of roads that directly open broader forest categories or which affect them, so as to obtain direct openness information relative to the total area openness in m'/ha or in km'/1000 ha. According to the research conducted so far and considering the developed forest management plans, taking into account the lengths of all roads (public and forest) affecting forest openness, forest openness in BiH ranges from 9.0 to 11.0 m'/ha. Considering openness in developed European countries, which ranges between 20.0 – 30.0 m'/ha and more, forest openness in BiH is still far below European standards. Forest openness generally plays an important role in mobilizing wood assortments. Considering the fact that low-value wood assortments should represent the primary resource for energy production, forest openness is one of the dominant factors affecting the cost-effectiveness of mobilizing wood biomass for energy production.

3.2.1.2 Analysis and evaluation of forest management to date

The analysis and assessment of the forest management to date is a method by which the most important inventory elements are compared between the two forest management planning periods for a particular area. According to this, conclusion is drawn on how the forest management was conducted in a given forest management planning period. Although this chapter does not contain information on wood biomass, based on a comparison of data on the permissible logging volume and total logging, conclusions useful for wood biomass mobilization can be drawn.

According to the data on realisation of the felling plan (Table 8), it can be seen that in high forests the extent of felling is implemented on average above 80%, while the implementation in the case of crops and coppice forests is much lower, below 40%. In degraded forests, due to their specificity, the percentage of implementation depends on many factors, often unforeseen (a large number of trees with severely over-cut treetop), therefore the analysis based on the data on realisation of felling plan only is not sufficient.

Table 8: Realization of felling plan (annual allowable cut)

Forest category	Type	Highland (FBiH)			Mountainous (RS)		
		Felling volume - m³ large wood			**Felling volume - m³ large wood**		
		Planned	**Performed**	**%**	**Planned**	**Performed**	**%**
High (1000)	coniferous	4.400,0	4.090,0	**93**	188.211,0	150.105,0	**80**
	broadleaf	263.200,0	249.369,0	**95**	7.975,0	4.943,0	**62**
	Σ	267.600,0	253.454,9	**95**	196.186,0	155.048,0	**79**
	surface (ha)	6.821,50	5.722,81	**84**	-	-	**-**
Crops (3000)	coniferous	17.000,0	778,0	**5**	13.685,0	446,0	**3**
	broadleaf	8.500,0	1.731,0	**20**	270,0	9,0	**3**
	Σ	25.500,0	2.509,0	**10**	13.955,0	455,0	**3**
	surface (ha)	1.920,40	351,46	**18**			
Coppice (4000)	coniferous	0,0	56,0		0	46,0	**0**
	broadleaf	75.000,0	25.435,0	**34**	11.400,0	2.196,0	**19**
	Σ	75.000,0	25.491,0	**34**	11.400,0	2.242,0	**20**
	surface (ha)	6.907,00	2.369,23	**34**	-	-	**-**

3.2.1.3 Forest management and forest development plans for the succeeding forest management planning period

Of all the existing forest management and forest development plans for the succeeding forest management planning period, this chapter addresses only those plans that can be directly or indirectly linked to wood biomass, and these are the volume and dynamics of logging (annual allowable cut) by tree species and assortment structures, including the scope and type of silvicultural works and forest protection works.

Quantity and dynamics of felling – felling plan

The quantity and dynamics of felling, i.e. felling plan (annual allowable cut) for forest management area is determined by: quantity and dynamics, economic classes and categories of forests, types of trees, for management units and areas of municipalities and by structure of forest wood assortments for the same classification units. When the quantity of annual allowable cut is determined by species of trees and forest categories and the diameter structure is defined, the assortment structure is calculated based on the quality of the timber stock of the test tree marking, and exceptionally on the basis of the timber stock.

Indirectly, data can be obtained from the assortment structure relevant for determining the potential of wood biomass for energy production.

From the aspect of possible logging volume (annual allowable cut), distributed by assortment structure, the difference between the gross and net mass in large wood is residue. Thus, the gross mass is the mass of the possible logging volume (annual allowable cut), while the net mass is the sum of all assortments made from the possible logging volume without waste. Additionally, forest residues and waste data obtained through the assortment structure presented in the forest management plan can serve for definition of additional potential wood biomass that can be mobilized if it is proven that the mobilization of such material has no adverse impact on the stability of forest ecosystems. When comparing the current market demand for certain assortments and those assortments in the tables, it can be concluded that certain assortments are no longer in demand at all (e.g. rods and poles for hop, poles for vineyards, vineyards and orchard poles – often grouped into category of small-sized technical wood). Therefore, it can be concluded that small-sized technical wood can also be a source of biomass for energy production.

In addition, it can be concluded that it is necessary to review the current assortments and to consider the introduction of wood biomass as a new assortment. It is important to emphasize that the forest laws in BiH impose the obligation of recording-keeping and timber marking before shipment of logs and other wood assortments and long-distance transport. On the waybills, as well as the logging reports, the volume of wood by assortments and species of trees is entered for each individual unit in order to monitor the realization and to analyse the felling plan. In this sense, in order to keep records of the amount and origin of wood biomass, it is necessary to develop a new assortment/product that will have its own system of measurement and record-keeping, because,

otherwise, the long-distance transport of wood biomass, from the point of view of inspection, will not be possible.

Taking into account the data for coppice forests from the analysis of the current management and the assortment structure, it can be concluded that the large wood potential remains untapped in the coppice forests, which occupy large areas of forests in BiH. The beech coppice forests are of particular interest, since, according to the assortment structure, fuelwood is mainly represented.

The active use of wood biomass in coppice forests could ultimately solve the problem of neglect of these forests in BiH, so that the better coppice forests would be managed systematically like poor quality forests (also known as "low forests"), while for those with poorer timber stock volume and quality structure one of the conversion systems to a higher sylvicultural form would be applied. In order to show the potential of coppice forests from the aspect of wood biomass, the structure of forest wood assortments on an example of coppice forests in forest management area located in a highlands is shown in Table 9 as an example for analysis.

Based on the assortment structure of the coppice forests of a highland forest management area, in which the coppice forests are represented with 37% of the total area, it can be seen that from a total of 82,600 m^3 of ten-year allowable cut (beech 39,408 m^3 or 47.71%, oak 19,345 m^3 or 23.42% and other broadleaved trees 23.847 or 28,87%) 62,600 m^3 consists of pulp and fuelwood, i.e. 75.79% of the total annual allowable cut. More active use and intensification of economic measures in the category of coppice forests can increase the supply of timber on the market and respond to changing market demands.

Table 9: Production of wood assortments in coppice forests in forest management area located in a highlands

Assortment type	Broadleaves			Total		
	For 10 years	Annually	%	For 10 years	Annually	%
	m^3			m^3		
F and L logs	136	14	0,16	136	14	0,16
PT of I class	636	64	0,77	636	64	0,77
PT of II class	4.194	419	5,08	4.194	419	5,08
PT of III class	6.676	668	8,08	6.676	668	8,08
Logs	**11.642**	**1.164**	**14,09**	**11.642**	**1.164**	**14,09**
Total roundwood	**11.642**	**1.164**	**14,09**	**11.642**	**1.164**	**14,09**
Pulp wood	23.557	2.356	28,52	23.557	2.356	28,52
Fuelwood	39.043	3.904	47,27	39.043	3.904	47,27
Stere wood	**62.600**	**6.260**	**75,79**	**62.600**	**6.260**	**75,79**
Net assortment	**74.242**	**7.424**	**89,88**	**74.242**	**7.424**	**89,88**
Waste	8.358	836	10,12	8.358	836	10,12
Large wood	**82.600**	**8.260**	**100**	**82.600**	**8.260**	**100**

Sylvicultural and forest protection works

In addition to the aforementioned forests, the habitats under shrubs and barren land also have a potential for sustainable utilization of wood biomass, which occupy 317,800 ha in BiH. For the afforestation of such areas, it is necessary to analyse and create the conditions for raising new plantations (crops) with indigenous tree species, where the primary goal of management would be to produce as much wood biomass as possible per unit area and at short intervals. Most forestry professionals believe that tree species that are also melliferous should be planted in order to support other ecosystem services of forest ecosystems. According to the practice so far, the crops were raised systematically, and their technical management objective, with the use of appropriate thinning, was the production of forest wood assortments. For the purpose of supplying the society with wood biomass, it is necessary to create new models and systems of management, with specific technical management goals, aimed at producing as much biomass as possible in the shortest possible time. In order to keep up with these trends, the Cantonal Public Enterprise for the Management of Public Forests "Sarajevo-šume" d.o.o. Sarajevo implemented a project: *The first establishing of Paulownia elongata plantations* in the area managed by this company. In three different management units, under different environmental conditions, in 2016 this allochthonous species was planted experimentally on an area of 1 ha each. Results related to the adaptation of this species have not yet been evaluated or available.

4 Technologies and experience in the process of wood biomass mobilization

High costs are inevitably related to the utilization of forest residues. Therefore, in practice, there is a number of technologies and logistical supply chains for wood biomass to further optimize the utilization process in order to reduce costs. The decision on the method and technology of utilization of wood residues depends on ecosystem conditions, available technologies, forest transport infrastructure, the traditional approach to forest management and the planned level of integration of regular forest utilization systems with the utilization of forest residues. In practice, the following four methods of supplying wood biomass are differentiated (Kuiper and Oldenburger, 2006):

1. The terrain chipping method in the stand: residues chipped inside the forest stand – transported by truck to the energy plant

2. The chipping at roadside method: forest residues piled up at the roadside – chipping at roadside – transported by truck to the energy plant

3. The bundling method: bundling the forest residues inside the forest stand– bundles pilled along the forest road – bundles transported to the energy plant – chipping at the energy plant

4. Extract forest residues from the forest stand – forest residues piled up along the forest road – transport the forest residues to the power plant - chipping at the energy plant

Figure 3: Wood biomass production (www.eri.nau.edu)

4.1 Current state of forest utilization in BiH

All relevant research shows that by selecting optimal technological solutions the amount of raw material that can be used from forests can be significantly increased, and production costs per unit of product significantly reduced, thus ensuring lower cost of raw material on the market. Sustainable use of forests implies the application of modern technical solutions, where in addition to economic, other aspects should be taken into account (silvicultural, ecological, ergonomic and economic). The current state of forest utilization technologies in BiH is such that the technological system of chainsaw and forest tractor (skidder) is mainly applied. Under specific conditions, animals and cable rope devices are used to a lesser extent. The so-called assortment exploitation method is being applied, which involves cutting of wood assortments, processing and classifying assortments in the forest near stump. Roundwood is dragged to the forest road (storage area), and stere wood (classic fuelwood) is dragged by animal-powered logging. Other parts of the wood remain unused at cutting area. The forest complexes are open with primary and secondary road network. Neither the primary nor the secondary forest road network is at a satisfactory level, that is, they are below the European average when it comes to both density and quality. The secondary forest road infrastructure is mainly composed of skid trails and roads that can be used for traffic of machinery, i.e. exclusively forest tractors. In most cases, laws and by-laws prohibit the machinery to pass outside the skid trails, therefore this is a limiting factor for many other machineries, such as harvesters and forwarders. The cadastre of the secondary road network, which is the most important in terms of the use of wood biomass from stands, is not being maintained, and hence there are no precise data.

Such state of forest exploitation technologies results in a low percentage of utilization of total tree biomass. In other words, a large percentage of wood biomass remains unused in the cutting area. Practice has shown that on average about 25-30% of the total mass of harvested broadleaved trees and 15-20% of conifers remain unused. The use of forest residues from forests in the highland conditions of BiH requires an analysis at level of forest management unit. This conclusion comes from the experience to date in countries that made great progress in the use of wood biomass for energy, and those are the countries with developed forestry (Austria, Germany, Canada, etc.). These countries could not count on increased use of wood biomass until they made significant progress in the development of techniques and technologies. In addition, the use of wood biomass is part of the overall production process of forest utilization. It is a complex process, which requires the inclusion of a number of factors to be considered when optimizing the technological process of forest utilization.

4.2 Types of wood biomass-based energy products

In the current forest management in BiH, fuelwood and forest residues are mainly used as a raw material for energy, which are the by-products in the production of wood assortments. By origin, residues can be primary, secondary and tertiary.

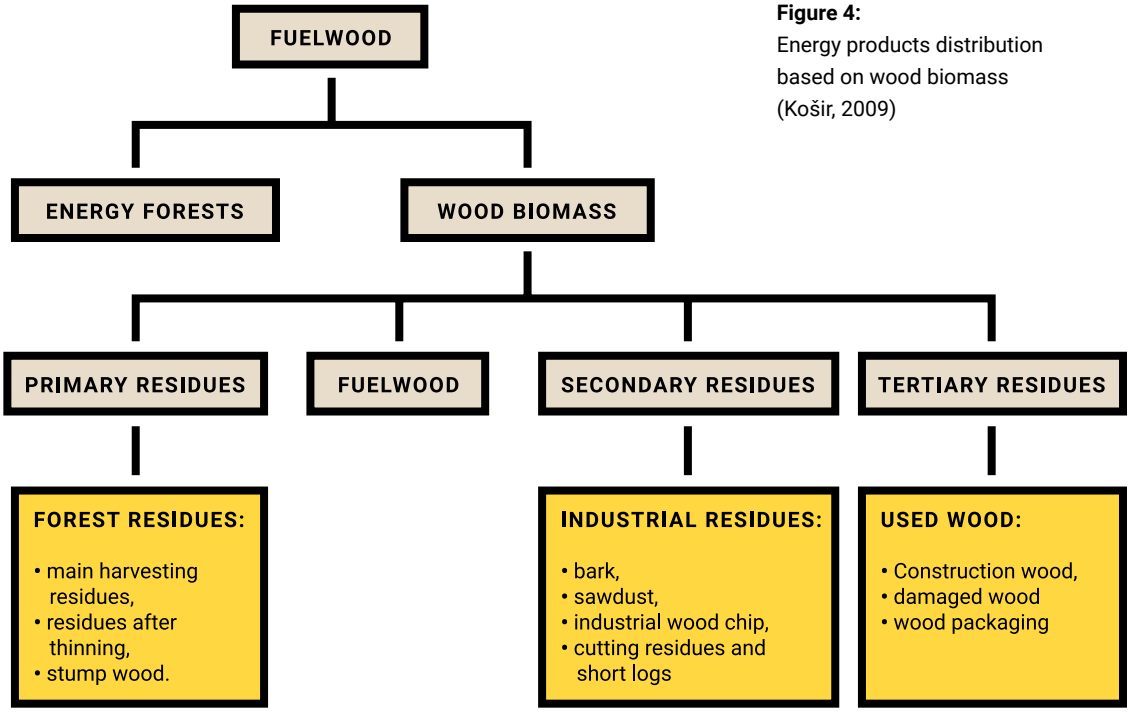


Figure 4:
Energy products distribution based on wood biomass (Košir, 2009)

Potential sources of biomass include:

- Forest: regular felling, thinning and final felling.
- Forest: emergency felling, wind breaks, snow breaks, snow damages, fires.
- Agricultural land: energy crops established outside of forests and forest land.
- Agricultural land: land improvement, conversion, deforested area.
- Deforested areas resulting from construction or infrastructural works.
- Industrial wood residues.
- Municipal waste, used wood.

In forestry, in parallel to implementation of forest tending and restoration measures, forest utilization is also realised. In such production process of forest cultivation and utilization, considerable amounts of wood biomass are obtained that can be used for energy production. For energy purposes, wood from sanitary felling can also be used (windbreaks, snow damages, sick trees, wood from burnt areas, etc.). In the classic utilization of forests in BiH, tree trunks, forks and branches are used with the diameter with bark at the thinner end that exceeds 7 cm. In this way, 60 to 70% of the wood mass of mature stands is utilized, and only 50% of the younger ones. The residue from logging and processing make the part of the large wood unusable, but also a part of the volume is lost due to the prescribed method of measuring forest wood assortments. Damage to logs mainly occur due to inadequate means for work on cutting areas and storages, and this is also due to the work methods, environmental impacts and human errors. The proportion

of residue and waste depends on a number of factors, and on average, all the stands and species of trees at felling and processing, as well as dragging account for just over 20% of the residue.

In addition, a significant part of waste is generated in the wood processing industry. Apart from direct use of this type of waste for production of heat and electricity (it can be used in the fresh and wet state), by further processing (pressing) of dry log end-cutting and sawdust, briquettes and pellets are produced, which have high energy potential. Although certain types of wood biomass, such as wood residues, have long been used as fuelwood, there are also a number of new forms of biomass, the use of which requires new know-how regarding production, and felling (forestry) or harvesting (agriculture), storage and processing.

4.3 Types of raw wood materials per part of the tree they originate from

All parts of tree can be used for energy, however, there are differences between types of trees as well as differences in the availability and quality of tree parts. When it comes to classifying tree biomass according to the part of the tree from which the biomass originates, there are multiple classifications which are quite similar. Below are two examples of biomass classification depending on the part of the tree from which it originates.

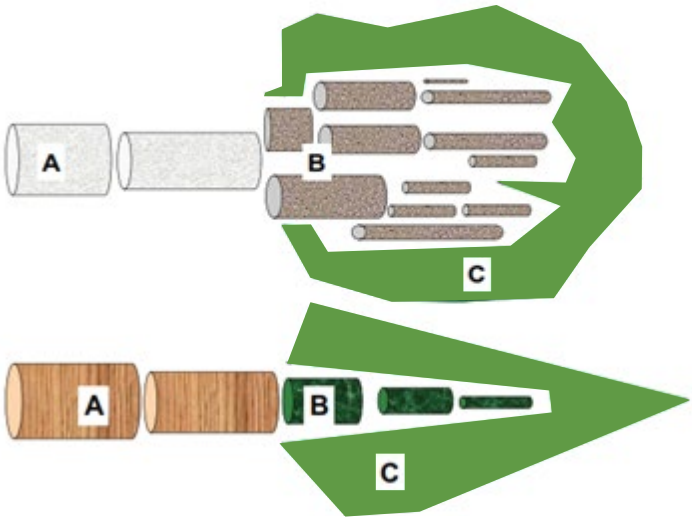
Simplified structure of wood biomass (Figure 5)

A - Good quality roundwood for veneer and log cutting

B - Poorer quality roundwood for the production of pulp wood, roundwood for technical purposes, fuelwood, etc.

C - Residues after felling, all under 7 cm, twigs and tips

Figure 5:
Wood mass structure
(Košir, 2009)



The main tree components according to Roser et al (2008) are presented in Figure 6.

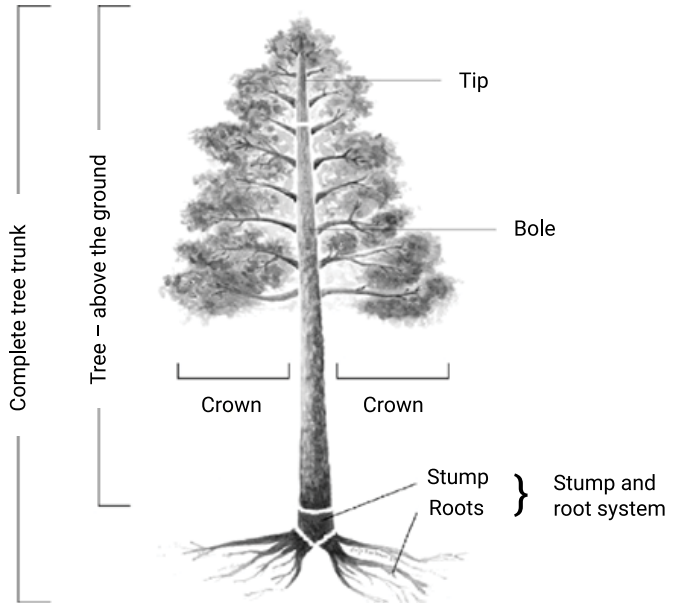


Figure 6:
Wood biomass categories (Roser at al, 2008)

4.4 Overview of forest biomass utilization technologies

Work technology in broader sense means the production method which is determined by the technological work process, operating means and technique, organization of work and control of production. Current methods of production of forest wood assortments in BiH forestry are mainly oriented to production of technical wood and fuelwood in the forms defined by the relevant standards. Many parts of tree outside of these categories (leaves, branches, twigs and unusable wood residues, etc.) remain unused in the cutting area. The basic criterion of technological division of labour in forest exploitation is the place where forest wood assortments are made. According to this criterion, we distinguish two basic systems of forest utilization:

1. Tree felling system and definitive processing of wood assortments in the cutting area at stump.

2. System of tree felling in the cutting area at stump with assortments processing on the storage.

In the first case we are talking about the cut-to-length method of forest exploitation, while the second case has two variants: tree-length and whole tree method of forest exploitation. In the trunk method, after felling of trees, the branches are cut and they remain in the cutting area, and the whole trunk is transported to the storage site. In the tree method, after felling, the whole tree with branches and leaves is transported to the storage site where further processing is carried out. With regard to the use of wood biomass, the whole tree method is the most suitable method, then the trunk method, and the least suitable is the cut-to-length method.

Various technological solutions for felling allow greater or lesser use of machinery, that is, systems that allow the use of whole-tree biomass. Trees that are cut during crops thinning have a relatively small volume. Compared to logging in high economic forests, the value of manufactured wood assortments is lower, the achieved effects are lower and the production costs are much higher.

There is a range of technologies aimed at making the use of tree biomass rational. They can be classified into two basic groups, given the degree of utilization of available tree biomass:

System	Phases	
One-component system	tree trunk – chipping – chips	
Two-component system	tree trunk – cutting of wood assortments	classic assortments
		residue chipping – chip

One-component system of tree biomass utilization

This system implies chipping the whole tree in the form of a wood chip. It is mainly carried out in clear cutting at the end of the production period. Depending on the place where the chipping is carried out, at least three varieties of this system are possible:

Application of one-component system of wood biomass utilization presupposes fulfilment of several very important assumptions. First of all, there must be a market for chips, that is, consumers interested in buying this product. Machines that convert wood biomass into wood chips are also needed, as well as significant forest areas suitable for wood chips production so that the purchase of expensive chipper machines would be economically viable.

Variants	Technological flow
1	Tree trunk – chipping in cutting area – wood chip transport – use
2	Tree trunk – transport of whole trees – chipping at storage – wood chip transport – use
3	Tree trunk – transport of whole trees – chipping at the place of final use – use

Two-component system of tree biomass utilization

The two-component system provides two groups of tree biomass products: standard forest wood assortments and waste biomass as potential raw material for future use. At least three varieties are possible with this system, given the place where the wood peeling and the assortments are made, as shown below.

Variants	Technological flow
1	trunk – cutting – assortments – assortments dragging - transport ↓ biomass - biomass packing/pressing – extraction and transport ↓ biomass - biomass chipping – extraction and transport
2	trunk – whole trees dragging – cutting – assortment – transport ↓ biomass – chipping at storage – transport
3	trunk – dragging and transport to CMS – cutting – assortments – transport ↓ biomass – chipping

Forest timber harvesting, transport and logistics are important factors in the process of producing sufficient quantities of wood-based energy products, and efforts are being made to make all these phases more efficient. The examples are harvesters that have been developed specifically for the use of wood biomass, which combine harvesting, chipping and transport of wood biomass for energy.

4.5 Wood chip technologies

In BiH, the production of wood chips in the forest is almost inexistent. Therefore, there is a need to study in detail the modern technological processes for the production of wood chip from a technological, economic and logistical point of view. Production of wood chip cannot be viewed separately from the production of roundwood, so the study and introduction of new technological solutions must be observed in an integrated manner. Some typical links between roundwood and wood chip processing technologies are presented in Table 10.

Table 10: Typical links between roundwood and wood chip processing technologies (Košir, 2009)

Technology		Wood chip		
		Processing in forest	Processing on forest road	Processing at central storage
Roundwood	Processing in forest	Chipping of tips and branches is performed in the forest	Wood chip is made from less valuable parts of the roundwood, the harvesting residues that remain in the cutting area	Bales are made from the harvesting residues, which are transported
	Processing on the forest road	Not possible	Trunk method, separation of technical wood from wood for chipping is made on the road	Bales are made from the harvesting residues, which are transported
	Processing at central storage	Not possible	Not possible	There are experiments, quite demanding technology

According to experience from abroad, competent institutions are expected to get activated in terms of encouraging the production of wood biomass as a renewable energy source. The main factors that influence the technological process of wood chip production are presented in Table 11.

Table 11: Main factors affecting wood chip production (Košir, 2009)

Raw material	Wood	Wood	
	Harvesting residues	Harvesting residues	Harvesting residues
		Roundwood of poor quality	Roundwood of poor quality
			Industrial wood residues
			Used wood
			Other wood biomass
Raw material composition	Available green biomass	Available green biomass	Very versatile raw material
	High share of bark	High share of bark	Dirt (mud, sand)
			Contaminated raw material
			Admixtures (plastic, metal)
Concentration	Very small, at best 10-40 t/ha god.	Higher concentration possible (100 and more t/ha p.a.)	Very high
Process - machines	Classic technologies are possible in some stands	Classic technologies are possible in some stands	Highly mechanised process, good organisation, long-term contracts with raw material suppliers and consumers
	Collection and chipping of residues with a chipper with container, usually in final felling or deforesting	Chipping of residues resulting from roundwood processing when applying tree-length method	
	Cutting and chipping by combined machine: mainly in thinning of up to D1,3 = 30 cm	Whole tree chipping by whole-tree method	
Product	High humidity risk, green wood chip	High humidity risk, green wood chip	If the storage is covered, the quality is good, otherwise, it depends on the material received
	Harvesting residues must be dried (6 months), winter logging is mandatory when whole tree is used	Harvesting residues must be dried (6 months), winter logging is mandatory when whole tree is used	
Value	Risk of reduced heat value	Risk of reduced heat value	Higher possibility for control of heat value
Logging costs	None, since these are the costs of obtaining roundwood, with combined machines the costs are less	None, since these are the costs of obtaining roundwood	None
Collection costs	High	None, since these are the costs of obtaining roundwood	None
Chipping costs	High	Medium	Small
Transport costs	High	Medium	Small
Manipulation costs	Small	Medium	High
Time of activity performing	Winter season, after drying of raw material	Winter season, after drying of raw material	Any time
Chipping effects	Small	Medium	High

Chipping machines used for making wood chip are differentiated according to the following characteristics:

a) Wood chipping methods (disk, drum, coil, mill, hammer mill)

b) Type of drive (propeller, own engine)

c) The principal machine on which the chipper machine is mounted (added tractor unit, self-propelled, freestanding, truck mounted, etc.)

d) Raw material feeding method (horizontal conveyor, vertical inlet tube, etc.)

e) Method of filling (manually, by crane on chipper, tractor crane, etc.)

f) Maximum dimension of wood

g) Wood chip size

h) Portable or stationary

i) Engine power, fuel consumption, etc.

The above characteristics show that there are chippers intended for use in the forest, on a forest road or in a central storage site. Figure 7 shows the types of chippers currently in use in the world.

Figure 7:
Some types of chippers (www.forestry.com; www.pezzolato.it;)

When it comes to the sale of energy wood, it should be noted that the selling price should essentially not depend on the moisture content, but the wood should be sold to the buyer at “atro weight”, i.e. at the weight in absolutely dry condition. The cost of transportation is an important factor since the moisture content increases these costs. Figure 8 shows an illustration of the transport of wood mass (wood chips) with different moisture content. The line represents the water level in the total load.

For this reason, it is recommended to dry the wood before chipping and transporting. It is recommended to chip the wood before drying. Some of the solutions are shown in Figure 9.

Figure 8:
Overview of moisture content in the transport of wood biomass (line – moisture level) (Košir, 2009)

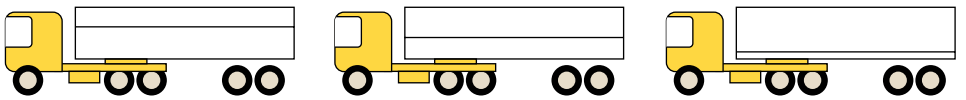


Figure 9:
Mechanization for chipping (www.westtech.at)

4.5.1 Technologies for roundwood processing and use of harvesting residues with the use of cable crane

This system is suitable for activities on the steep terrain with whole tree exploitation method. Felling is done by a chainsaw or other mechanized means, and the cable crane is used to drag the whole trees to the storage site, where the pruning and assortment is made with a processor integrated with the cable crane or separately. The remainder remains concentrated at the storage site, which is suitable either for chipping or making rolled wood dust (bundling) and for further transport (Figure 10). There are also some downsides to this method. First of all, the wood residue is raw and as such is not suitable for transportation. Then, the amount of wood residue is not constant, so it is very difficult to achieve that the chipper is always fully operational. Forest roads often do not leave enough space for material storage and machine operation.

Figure 10:
Cable crane with processor (www.mm-forsttechnik.at)

4.5.2 Highly mechanized combined technology for roundwood processing and use of harvesting residues

This combination is based on the use of harvesters and forwarders. Thanks to technological advancements reflected in the ability of harvesters to work with larger cutting diameters and to overcome rough terrain conditions, as well with the development of forwarders in terms of varying load and passability, this system is applicable to many stands where it has not been previously. The system is suitable for all conifers, as well as deciduous tree stands up to 30 cm in diameter. The larger diameter of the deciduous trees, due to its specific structure, hinders the operation of harvesters and creates major setbacks.

The system has two methods:

1. Cut-to-length method - is based on harvesters cutting down trees and processing assortments, leaving cutting residues on skid trails (cutting lines) in piles. Forwarder takes out assortments in one pass, and collects and takes out the residues after logging in the second pass.

2. Whole tree method - is based on the harvester cutting down the trees and stacking them along the skid trail, and forwarder collects them and takes them out together with the branches

Some of the major technological problems encountered by the first option is that the residues have a relatively small density in the cutting area, 10 times less than the roundwood, so it is very difficult to make the forwarders work effectively. Usually, forwarders are not designed to transport twigs, so they hardly reach the optimum load. Because of this, there are special variants of the load space upgrade. Tractor forest trailers with the mounted crane are also often used to collect residues (Figure 11).

The second option is used for thinning in young stands and involves the use of whole tree biomass, which means that roundwood is also chipped and used for energy. Trees can be harvested with a harvester, feller buncher, even a chainsaw. The forwarder collects them into the storage area and takes them out to the forest road, where it arranges them so that the crane truck with the chipper can reach them (Figure 12). Forwarder-carrying load is quite large because part of the trees can also be dragged on the ground

Figure 11:
Collection of residues after logging (www.directindustry.com; www.ecopedia.be)

behind the forwarder. Most of the time is lost on loading, so it is of great importance that the harvester places the cut trees in an optimal position for collection.

Figure 12:
Forwarder carrying the wood out of forest (www.hsm-forest.net)

4.5.3 Technology of processing roundwood and use of wood biomass on forest road with harvester-saddle tractor

This technology is applicable on rough terrains. It is based on the use of a machine that combines a saddle tractor with a harvester head (Konrad GmBh: Highlander Clam-bunk with Woody 60 harvester head) (Figure 13). The same machine cuts down trees and transports them to storage site. This type of harvester is characterized by exceptional mobility, it has the ability to switch off the drive on one roar axle on suitable roads and it reaches the speed of up to 40 km/h, making it suitable for the first phase of transport. It has the 360° rotation cabin and a system for constant maintenance of the horizontal position regardless of the slope of the terrain.

When it comes to economic efficiency of its operation, due to the high purchasing price of the tractor, which amounts to around EUR 200,000, it has the best efficiency in rows with a mean diameter of over 20 cm.

Figure 13:
Highlander harvester saddle tractor (www.colettoholz.it)

4.5.4 Technology of roundwood processing and use of wood biomass at stump area with combined machine

In modern forestry, combined machines appear at all stages of operation. This technology is based on a machine that is able to cut a tree, make wood chip out of it and store it in the loading area (e.g.: Komatsu: Valmet 801 Bioenergy) (Figure 14). When the loading area is filled, the wood chip is brought out. Other combinations are also considered, such as processing roundwood left in the cutting area and the wood chips, then combinations with a chainsaw if larger tree diameters are involved and similar.

Aggravating factors for using such mechanization in our conditions are poor terrain passability and dense stands. Optimal effects are achieved up to a diameter of 25 cm, and larger diameters require combination with a chainsaw or other mechanized means.

Another highly mechanized technology, which is practically state of the art technology which combines felling and transport of wood, is called the harwarder. Harwarder was created by combination of forwarders and harvesters. It can be used for processing and transportation of roundwood (cut-to-length method) or transporting whole trees (whole-tree method). Of course, the choice of a method is conditioned by field and stand conditions, as well as by end purpose of the tree. If it is a cut-to-length method, it is usually done in combination with a portable chipper that chips the residues in the forest on skid trails, or in combination with a forwarder that is adapted to collect residues after logging. If roundwood is processed, the best effects are achieved at diameters of about 25 cm. For smaller diameters, the whole-tree method is advised. In Figure 14 there is a harwarder Valmet 801 Bioenergy. The maximum cutting diameter is 50 cm, the hydraulic arm has a reach of 11 m and its load capacity is about 13 t. It is characterized by high mobility.

4.5.5 Combined technology for processing of roundwood and rolled wood dust (bundling) from harvesting residues

This is an example of logging and roundwood processing on a stump and chipping on a central storage. This technology is widely used in Scandinavia and America, and there are examples of its application in Germany and Austria. The transport of the raw material for chipping is done with special machines, usually mounted on a forwarder or truck, which compress the cutting residues into bundles (rolled wood dust), thus thickening the material and making transport more economical. The main advantages of this technology are the use of whole wood and higher transport effects, while the disadvantages are high baling costs and high-water content in baled harvesting residues. This technology is not suitable for classic thinning because of the low density of residues. It is mainly used in final felling as well as in sanitary felling, such as rehabilitation of areas that were affected by fires, wind breaks, etc.

Figure 14:
Valmet 801 Bioenergy
(www.pottupellossa.fi)

4.5.6 Technology for processing roundwood and harvesting residues at stump

This technology is based on the use of harvesters for cutting and production and forwarders with mounted chipper and loading area for collecting debris, making wood chip and transport. The harvesting residues resulting from processing of the assortments are left in piles next to the skid trails by harvester so that the forwarder can collect them as easily as possible without interrupting the the roundwood extraction. This system, as opposed to the combined Valmet 801 Bioenergy system, can be used in larger diameter stands up to 65 cm (depends on harvester type). It is advisable to leave the wood residue for some time after felling to dry before chipping.

Harvester and forwarder are on Figures 15 and 16, which are equipped with a chipper and loading area for the transport of wood chip.

Figures 15 and 16:
Harvester HSM 405H and John Deere with BRUKS chipper (www.hsm-forest.net; www.bruks-siwertell.com)

5 Socio-economic and market aspects of wood biomass mobilization "from waste to product"

5.1 Wood product market and description of how to sell forest wood assortments

The timber market in BiH can rightly be categorized as an "incomplete market" because supply and demand are not balanced, and there is no real competition between providers, i.e. public forest management companies (Delić, et al, 2011). This is supported by the fact that the capacities of the wood processing industry are higher than the actual supply, and the price of the products is determined solely by the providers (public forestry enterprises) in the annual price lists. The process of selling products in the forestry sector is determined by the regulatory framework established by the competent ministries in cooperation with public enterprises. The role of this regulatory framework is to ensure equal access to raw material for timber-processing operators, as well as for vulnerable categories of population (e.g. marginalized population), when it comes to the sale of fuelwood, by defining a transparent way of selling forestry products.

In the case of the FBiH, the *Decision on sale of forest wood assortments from public forests on the territory of the Federation of BiH* (FBiH Official Gazette, 52/09 and 25/10) is in force. One of the goals of this Decision is to develop the timber market, to establish market prices and to enable all interested buyers to obtain forest wood assortments (hereinafter referred to as the FWAs) under the same conditions. In addition, this Decision seeks to develop FWAs sales system that eliminates illegal actions and influence by individuals in customer selection and pricing, as well as the distribution of FWA quantities by customers. In addition to this Decision, when setting prices for forestry products, companies refer to the applicable statutes and regulations at the cantonal level governing this area. The price list is made for each forest user (forestry company) individually on the basis of the average price achieved by selling forest wood assortments by the market method of sale. The price list is used to determine the initial price of forest wood assortments for public offering in the coming year and the fees for conducting professional activities in private forests.

In the case of RS, the sale of the FWAs is regulated by internal decisions on the manner and terms of sale of the FWAs for the current year of the public forestry enterprise "Šume Republike Srpske" a.d. Sokolac, which are adopted (updated) every year. In this way, the methods, terms and elements of sale are defined, and in the Instruction on application of this decision the necessary conditions that buyers must fulfil are elaborated in more details, depending on the way of purchasing the FWAs.

The sale of forest timber products in BiH is made based on the following three methods:

→ **Sales through successive product supply contracts**

This method of sale is applied when the logs are being sold primarily to wood processing companies and in the event of sale of less valuable forest wood assortments. In order for a company to qualify for the purchase of FWAs, it is necessary to have a decision on registration in the court register, identification and VAT number, transaction account held with the bank, as well as proof of eligibility for performing the activity of wood cutting, wood chipping, semi-final, final and chemical processing of wood[11]. Less valuable forest wood assortments can also be sold through successive supply contracts, however the companies that are interested in purchasing them must be registered for processing and/or trade in timber when it comes to fuelwood for energy production, mining and pulp wood and other less valuable forest wood assortments. When it comes to pulp wood, companies that are registered for pulp wood processing are given the preference in the purchase process.

→ **Sale through bidding/auction**

Provided that FWA auction information must be made publicly available through official media and websites, businesses can use this method of sale for all wood products for which there is interest in the market. Official regulations stipulate that businesses operating in the FBiH may, through bidding/auction, use mechanisms of pre-sale (sale of their wood from one unit), after-sale (sale of at least 20% of the FWAs with subsequent sale at forest and/or central storage site) and sale of high-value assortments (sale by piece through international tender). When it comes to public forestry enterprise „Šume Republike Srpske" a.d. Sokolac, it is foreseen that logs in the amount of up to 25% of the planned realization may be sold by means of auction, and in the case of the sale of less valuable FWAs, and depending on market trends, the mechanism of bidding/auction may be applied.

→ **Sale for the needs of the local population – retail sale**

In this way, the FWAs are sold primarily with the aim of meeting the needs of the local population for timber if they do not exceed the quantities foreseen by the forest management plan or the annual management plan. In general, it can be stated that fuelwood and small-sized wood can be sold in this way, with limiting the quantities of wood that can be bought by a single household. According to the currently applicable regulations in Republika Srpska, it is envisaged that local residents may be allowed to purchase coniferous logs of 5 m3 annually for the construction and repair of family homes and auxiliary facilities in the countryside (Forests RS, 2019).

5.2 Overview of the quantity and range of forestry products in BiH

There are different categories of wood products[12] on the market, which are further used in industrial processing or directly sold to end consumers (most commonly this is the case with fuelwood). All wood products are classified into two basic categories based on the types of trees they are made of (i.e. coniferous and broadleaved tree products). For the production and share of individual products

11 Rulebook on minimum technical, technological and other conditions for sawmilling (FBiH Official Gazette, 14/02); Decree on minimum technical and technological conditions for the operation of primary wood processing facilities (RS Official Gazette, 46/10)

12 This terminology is similar to the wood assortments.

in total production, it can be stated that it has a relatively homogeneous character in terms of quantities and ratios of individual product categories. In this context, it is evident in Table 12 that in the observed period (2007 – 2017), the production of FWAs ranged from 3,429 million m3 in 2009 (lowest production) to 4,169 million m3 (highest production) in 2016. In this observed ten-year period, the average production of all FWAs was 3,840 million m3. The trend of production and structure of wood products in the BiH forestry sector for the period 2007 – 2017 has a relatively homogeneous and stable character both in terms of volume and the share of individual products by percentage.

Based on the data of the Agency for Statistics of BiH for the period 2007 – 2017, it can be concluded that the highest production was achieved in the category of fuelwood, the share of which in the total production averaged 33.96% (Figure 17). The share of conifer logs averaged 31.28%, while the share of broadleaf logs in total production averaged 16.64%. As for the other products, the highest share was recorded in the category of coniferous cordwood (10.33%), followed by coniferous mining wood (2.93%), and broadleaf cordwood (2.71%).

Table 12: Production of forest wood assortments in BiH in the period 2007 – 2017 (in thousands of m^3)

FWA	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Logs, coniferous	1.195,8	1.308,1	1.028,7	1.060,4	1.047,8	1.176,5	1.256,2	1.254,5	1.275,7	1.335,8	1.275,9
Mining wood, coniferous	102,5	105,6	83,8	102,3	118,8	122,9	136,5	115,9	119,6	122,5	106,4
Other long wood, coniferous	113,5	116,0	76,7	83,0	92,9	74,8	14,4	17,2	12,8	18,6	15,3
Coniferous cordwood	168,6	181,5	204,3	330,4	318,8	388,1	536,3	596,7	564,1	599,9	475,2
Coniferous fuelwood	11,4	7,8	2,2	1,7	1,9	1,6	1,1	1,8	2,4	1,8	1,3
Logs, broadleaf	727,7	733,2	568,6	597,6	567,7	613,4	643,3	596,8	654,9	655,7	669,2
Mining wood, broadleaf	8,8	6,4	7,0	7,1	5,9	4,9	3,7	3,8	3,4	2,8	3,5
Other long wood, broadleaf	14,6	13,2	13,1	16,4	13,6	17,3	15,9	18,0	17,2	18,9	19,9
Cordwood, broadleaf	81,2	103,5	117,6	157,6	127,1	130,7	82,0	79,9	86,1	87,1	91,4
Broadleaf fuelwood	1.328,3	1.432,4	1.326,7	1.257,8	1.205,1	1.266,3	1.334,4	1.255,9	1.303,6	1.325,6	1.309,3
Other rough wood	0,6	0,3	0,6	0,7	0,7	0,1	0,4	0,4	0,2	0,2	0,2
TOTAL	**3.753,2**	**4.007,9**	**3.429,3**	**3.614,9**	**3.500,4**	**3.796,4**	**4.024,2**	**3.941,0**	**4.040,0**	**4.169,1**	**3.967,6**

Source: Agency for Statistics of Bosnia and Herzegovina: Press release – Production, sales and stocks of forest wood assortments in Bosnia and Herzegovina for the period 2007 – 2017

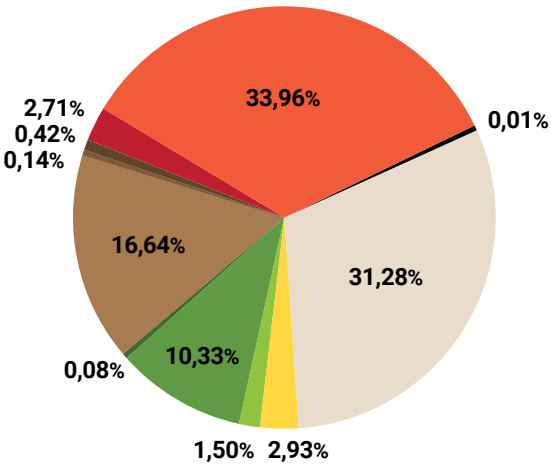
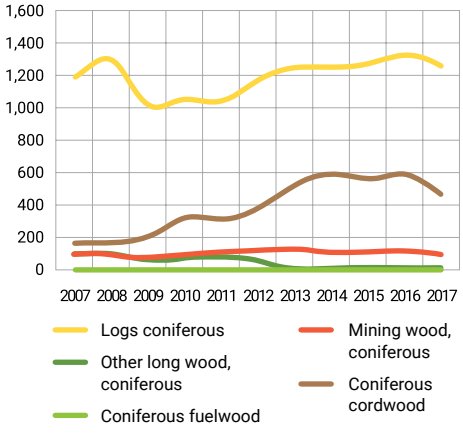
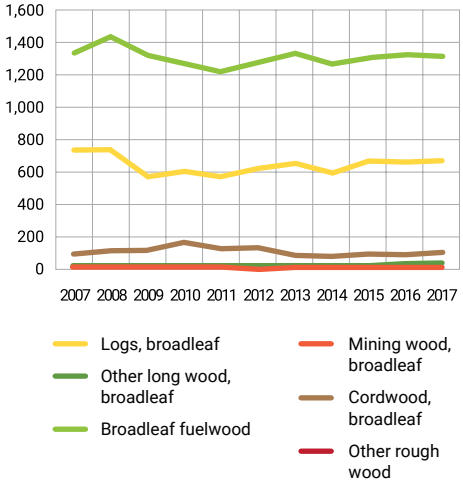


Figure 17:
Average relative structure of wood products in BiH for the period 2007 – 2017

Overview of the structure of wood products in BiH for the period 2007 – 2017





In the structure of products of wood of coniferous origin, logs have the largest share, the production of which in the observed period ranged from 1,028 to 1,336 million m^3.

The next product in terms of representation is the coniferous cordwood, the average production of which was over 369 thousand m^3, with a recorded trend of increased share in total production, especially in the period from 2009 to 2014. The coniferous mining wood accounted for over 112.4 thousand m^3 on average, and the production interval ranged from 83 to 116 thousand m^3. Other coniferous wood products had a steady and declining trend in production, with an average production of about 60 thousand m^3 during the year.

The structure of broadleaf wood products is dominated by fuelwood, the average production of which was 1.3 million m^3 in the observed period, and the production trend was quite homogeneous and ranged from 1.205 to 1.432 million m^3. When it comes to broadleaf logs, a homogeneous trend of production can be noted for this product category as well, with oscillations in the range from 567 to 733 thousand m^3. Other broadleaf wood products had an average production level of over 125 thousand m^3 annually.

Knowledge and continuous monitoring of the structure of production of wood products is of great importance for planning measures for the wood biomass mobilization, given that the obtained data can be used to estimate the available residues from the forest utilization process, as well as from the wood processing. This approach is necessary because currently there are no clear data on the amount of wood left in forest stands after logging or the data on the amount of residue and its use in the wood processing. Knowledge of the quantity of available and usable residues is necessary for planning the process of wood biomass mobilization and generally for improving the supply of wood for energy in the BiH market.

5.3 Analysis of price trends of forestry products

Another important market aspect in wood biomass mobilization is the movement of wood prices. Price changes can be seen as a mechanism for balancing supply and demand in the market. According to the official data, average timber prices in BiH are increasing (ASBiH, 2018). For all product categories, the percentage increase in realized prices has a growing character and averages 4.14% annually, observed from 2010 to 2017 (Figures 18 and 19). In the mentioned period, a higher percentage growth of broadleaved wood products was observed (4.67% annually) compared to coniferous wood products (2.75% annually). It can be concluded that the prices of assortments in the observed period increased by over 28% compared to the 2010 as baseline year.

Regarding the absolute magnitude of the realized prices of wood products, there was a change in the interval from the average of 74.7 BAM/m^3 in 2010 to 96.33 BAM/m^3, which was achieved in 2017. Higher average prices of coniferous wood products were achieved compared to broadleaf wood products, because in the structure of coniferous wood products, logs have the highest share. The achieved prices of coniferous assortments ranged from 90.88 BAM/m^3 in 2010 to 108.35 BAM/m^3 in 2017, with a noticeable drop in achieved prices in the period from

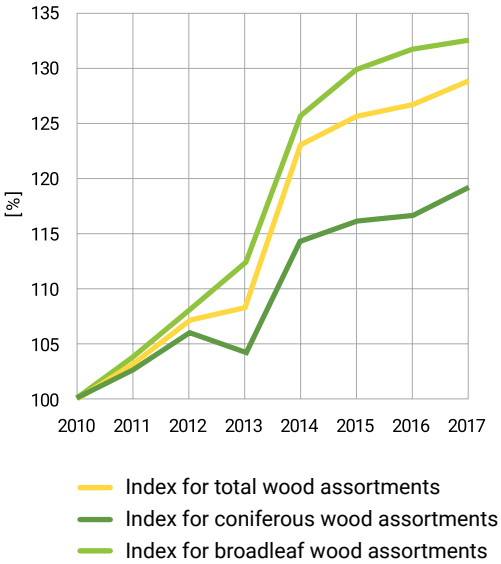


Figure 18:
Price growth indices for wood assortments in total, wood assortment of conifers and broadleaf

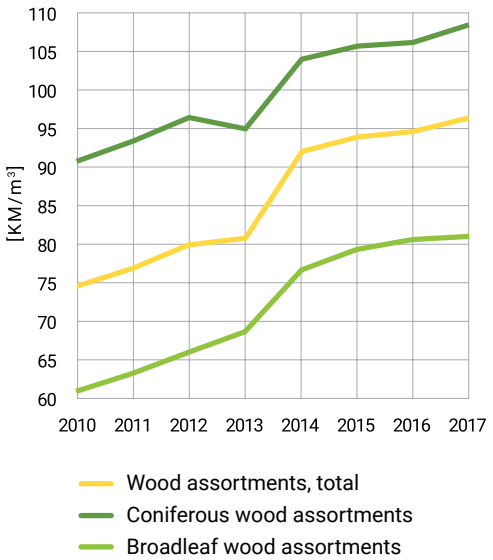


Figure 19:
Trends in prices of wood assortments in total, wood assortment of conifers and broadleaf

2012 to 2013. When it comes to coniferous wood products, the achieved prices ranged from 61.12 BAM/m^3 in 2010 to 81.13 BAM/m^3 in 2017, with a steady upward trend in the observed period.

As can be seen from Table 13, the average achieved prices for broadleaf fuelwood have a growing trend and ranged from 45.47 to 52.12 BAM/m^3. Based on the price index for fuelwood, it can be concluded that in the observed period the price increase for this wood assortment was 12%.

In addition to fuelwood, forestry companies also offer other products in their portfolio that can be used as wood for energy production, such as "small round billet", "unusable wood residues", "stump wood" and "forest waste". The term "yarding" is also often used in the official price lists of public forestry enterprises, which can be defined as the procedure carried out after regular felling in high forests and handover of the unit – the site where the felling took place. Yarding and extraction of wood (wood residues) is carried out to the intermediate storage, where the measuring and control is carried out by the seller, and the wood can be put on the market upon payment and presentation of the payment slip by the buyer. This form of sale of wood biomass is pertinent to the retail mechanism, applied by forestry enterprises and it is used to meet the needs of the local population.

Table 13: Overview of average prices of FWAs in the period 2010 – 2017

	2010	2011	2012	2013	2014	2015	2016	2017
				[KM/m^3]				
Logs, coniferous	114,74	117,61	120,71	118,53	117,64	118,95	119,51	120,13
Cordwood, coniferous	42,43	44,25	45,7	46,72	46,85	47,51	48,57	49,7
Industrial wood, coniferous	103,65	106,45	109,35	107,9	105,72	107,5	107,97	110,25
Mining wood, coniferous	63,92	66,03	70,18	70,95	70,92	70,24	69,84	69,52
Other long wood, coniferous	75,42	71,2	96,39	71,72	66,97	80,91	78,7	79,57
Technical wood, coniferous	65,76	66,81	74,44	71,02	70,47	71,42	71,08	70,95
Fuelwood, coniferous	19,35	21,81	9,64	25,49	24,85	22,65	22,6	22,12
Forest assortments, coniferous	**90,88**	**93,24**	**96,24**	**94,79**	**103,82**	**105,51**	**105,99**	**108,35**
Logs, broadleaf	99,57	100,96	102,86	104,55	104,06	106,94	109,46	110,24
Cordwood, broadleaf	41,4	54,03	57,59	62,23	62	62,57	61,31	61,36
Industrial wood, broadleaf	88,98	95,48	98,32	101,61	101,05	103,65	105,98	106,77
Mining wood, broadleaf	59,77	62,34	67,78	66,94	62,87	71,16	65,89	68,31
Other long wood, broadleaf	46,95	52,3	58,59	64,84	62,16	60,7	62,4	66,71
Technical wood, broadleaf	48,39	53,47	59,71	65,28	62,31	62,41	62,87	66,98
Fuelwood, broadleaf	46,54	45,47	48,36	50,64	51,52	51,72	52,11	52,12
Forest assortments, broadleaf	**61,12**	**63,44**	**66,13**	**68,7**	**76,79**	**79,43**	**80,61**	**81,13**
Forest assortments, total	**74,68**	**77,07**	**79,98**	**80,88**	**91,93**	**93,83**	**94,66**	**96,33**

Prices of wood for energy production

Valid price lists of public forestry enterprises in BiH contain prices for various types of products that can be classified as energy wood. In addition to fuelwood offered in various forms (logs and staves, i.e. long fuelwood), some price lists include products such as "unusable wood residues", "small round billets – forest waste", "wood residues collecting after felling" and "stump wood". The table below is an excerpt from the price list for several forestry companies in BiH, which shows the prices of energy wood in different positions – at the stump, near the stump area, on the truck roadside and on the central storage site.

Valid prices for energy wood in PE Šume Republike Srpske (KM/m^3)

Type of assortment			Central storage site	Ex works truck roadside	In forest at stump
Energy wood	Round-wood	I Quality class	77	63	35
		II Quality class	66	52	23
	Split wood	I Quality class	67	55	30
		II Quality class	57	45	20
	Small round billet		0	35	10
	Stump wood		0	32	7
	Forest waste		0	32	7

Valid prices for energy wood at public forestry enterprise "Unsko-sanske šume" (BAM/m^3)

Assortment	Price at stump	Price near stump area	Price at storage (truck roadside)
Hardwood broadleaf staves	40,2	53	70
Softwood broadleaf staves	30	43	60
Hardwood broadleaves class I and II	36	45	59
Softwood broadleaves class I and II	20	30	44
Small roundwood billet, forest residue	17	25	36
Coniferous fuelwood	17	25	36
Wood shavings	17	25	36

Valid prices for energy wood at public forestry enterprise "Bosansko-podrinjske šume" (BAM/m^3)

Assortment	Price at stump	Price near stump area	Price at storage (truck roadside)
Hardwood broadleaves I class	30,00	38,00	60,00
Hardwood broadleaves II class[13]	20,00	28,00	50,00
Softwood broadleaves I class	24,00	32,00	54,00
Softwood broadleaves II class[14]	16,00	24,00	46,00
Small roundwood billet – all types of wood	24,00	32,00	54,00
Declared wood (wood shavings, residues on storage)	0,00	0,00	39,00
Retail sale			
Hardwood broadleaves	30,00		
Softwood broadleaves	24,00		
Wood residues collecting		24,00	
Small roundwood billet	24,00		

In 2019, PE "Bosansko-podrinjske šume" d.o.o. Goražde initiated the procedure for amending the Basic Price List of the FWAs for 2019. The amendment refers to inclusion of "wood chips" as a new marketable product.

13 1 m long logs

14 1 m long logs

5.4 Overview of methods of heat generation for household heating in BiH

When it comes to the ways of households heating in BiH, based on data from the BiH Agency for Statistics (Survey on Household Energy Consumption of 2015), rooms heating is dominant, which involves heating by individual furnaces and the so-called split systems, with a share of almost 73% (Table 14). Own central heating of households accounts for 19% of dwellings, and central heating from a district heating plant accounts for 7.9%. The share of households which are not heated dwellings or business premises amounts to 0.2%. As far as own central heating system is concerned, there is a slight difference between the share of this type of heating in urban and other/rural areas, both at the level of BiH and at the level of Entities and Brcko District (Figure 20). On the other hand, the form of room heating of dwellings is more prevalent in rural areas, with the exception of the Brcko District where this ratio is almost equal.

Table 14: Heating types in BiH dwellings

	Not heated	Room heating	Own central heating	District heating from heating plant
		[%]		
Federation of BiH	0,1	69,8	20,4	9,6
Republika Srpska	0,4	78,2	16,3	5,2
Brčko District BiH	0,7	78,2	21,1	
Bosnia and Herzegovina	**0,2**	**72,9**	**19,0**	**7,9**

Source: Agency for Statistics of Bosnia and Herzegovina (2015): Survey on Household Energy Consumption in BiH

Figure 20:
Overview of heating types representation in urban and rural areas

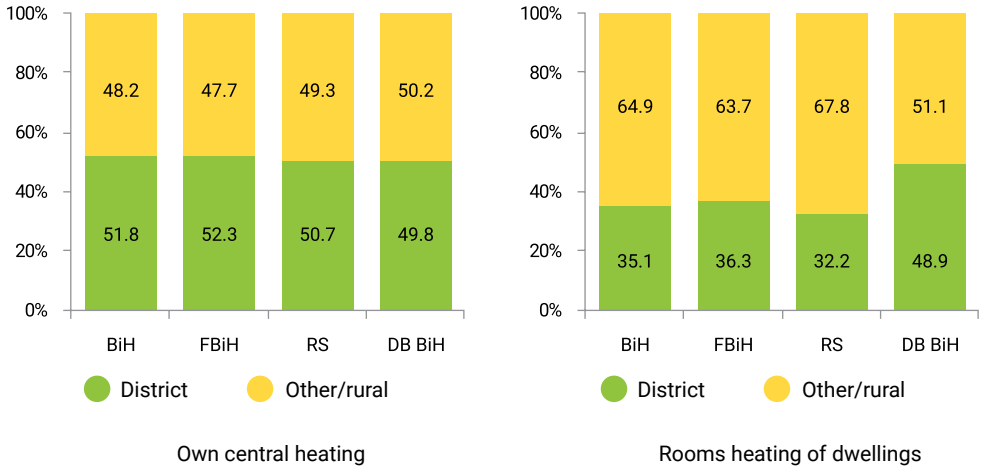


Table 15: Energy products predominantly used for heat generation

	Own central heating					Rooms heating				
	Electricity	Natural gas	Fuel oil	Coal	Wood	Electricity	Natural gas	Fuel oil	Coal	Wood
Federation of BiH	1,2	13,4	1,4	38,8	54,5	5,9	1,4	0,1	8,6	84,0
Republika Srpska	8,1	-	1,9	13,3	45,1	4,0	-	0,1	0,7	95,2
Brčko District BiH	7,0	-	1,9	45,7	76,7	7,6	-	-	1,6	90,7
Bosnia and Hercegovina	**3,4**	**9,1**	**1,6**	**31,4**	**45,5**	**5,2**	**0,8**	**1,1**	**5,5**	**88,3**

Source: Agency for Statistics of Bosnia and Herzegovina (2015): Survey on Household Energy Consumption in BiH

Electricity appears as an energy product for thermal energy production in BiH with 3.4% share in own central heating, or 0.8% in room heating, respectively (Table 15).

9.1% of dwellings with own central heating and 0.8% of dwellings with room heating, are heated with natural gas. Energy product in the form of fuel oil is represented in 1.6% of dwellings with own central heating, as opposed to 1.1% of dwellings with room heating. The use of coal is far more pronounced in own central heating and has a share of 31.4% of dwellings, unlike dwellings with room heating, where coal accounts for a modest 5.5%. Both room and own central heating in BiH are dominated by the use of wood on the basis of which 88.3% of dwellings with room heating and 45.5% of dwellings with own central heating are heated.

When it comes to the consumption of wood for heat generation in dwellings in BiH, it was established that, on average, each household that uses wood for heat generation consumes about 10.8 stere meters of fuelwood or 7.7 m^3 per year. The consumption of fuelwood for the FBiH is on average 9.5 stere meters, while this parameter is significantly higher in RS (12.9 stere meters) and Brcko District (11.9 stere meters). Regarding the ratio of urban and semi-urban/rural areas, there is a 15% increase in consumption of fuelwood in rural areas compared to urban centres.

6 Participation in the sustainable use of wood biomass in BiH

"The forest is no longer just ours"

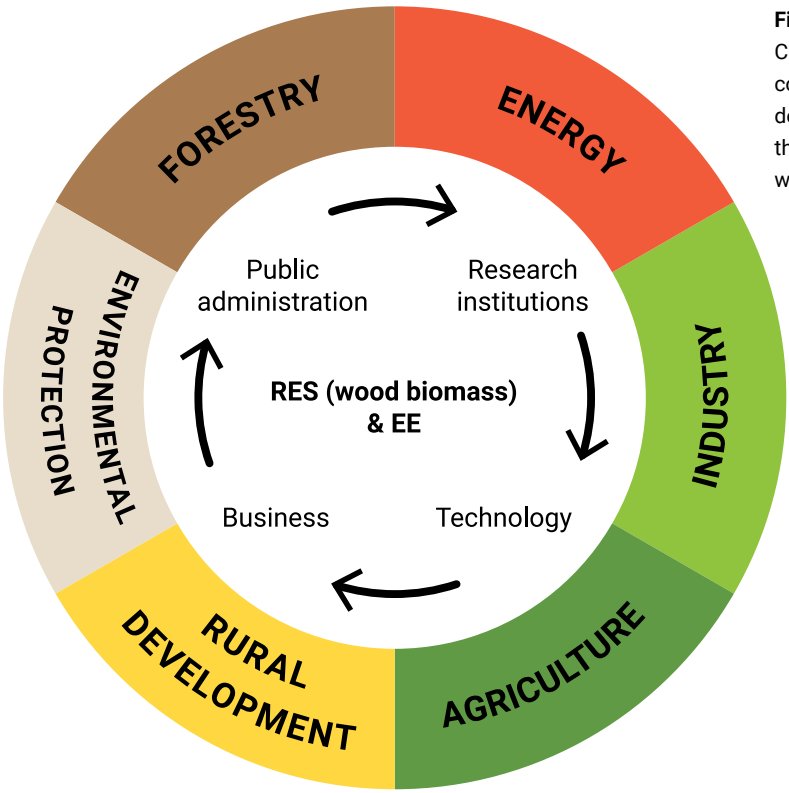


Figure 21: Cross-sectoral collaboration and decision-making in the sustainable use of wood biomass

In the face of pluralistic, and often conflicting, social needs to use ecosystem services of forest resources, a participatory approach to planning and decision-making becomes part of everyday forestry practice in BiH.

The need for participatory decision-making comes to the fore in efforts to create a system of sustainable use of wood biomass, given that it is an issue of *cross-sectoral* interest (forestry, energy, industry, agriculture, rural development and environmental protection; Figure 21) and *inter-institutional interest* (*public administration, research institutions, technologies and business*; Figure 21).

As part of the workshop with representatives of relevant institutions, organized in June 2019, a plenary discussion was held on the topic of participation in the decision-making process related to the sustainable use of wood biomass in BiH. One important conclusion was that the forestry enterprises, through the forest management certification process, have become accustomed to involving and successfully cooperating with the relevant sectors and local communities in the decision-making process. In discussing this topic, a scheme was used to identify stakeholders relevant to the issue of wood biomass. Stakeholders are classified according to the sector they come from (public, private and non-governmental sector) and depending on their influence and role (Figure 22).

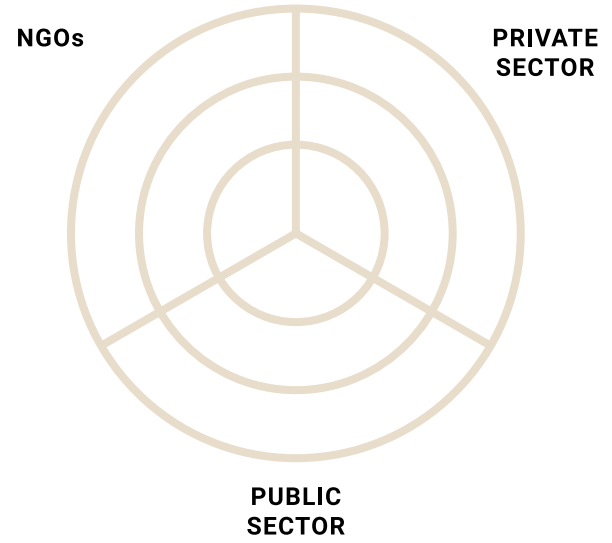


Figure 22:
Scheme for stakeholder identification

Public institutions have the highest interest in wood biomass: ministries in charge of forestry, energy, environment at all levels, forestry enterprises, forestry administrations at all levels, Entity environmental protection funds, chambers of commerce at all levels, local communities and secondary and higher education institutions in the field of forestry. *Educational institutions* play a key role in training professional staff to be able to adequately respond to the challenges associated with the use of wood biomass. As for the *non-governmental sector,* environmental associations have a primary interest and should work closely with the competent public institutions. On the other hand, *private entrepreneurs from the wood processing sector* and *private forest owners* also have a strong interest related to the use of wood biomass. When it comes to the private sector, the degree of finalization is an important factor in prioritizing wood biomass buyers.

Sustainable use of wood biomass requires joint creation of solutions, while respecting the positions and roles of each stakeholder. As highlighted in the plenary discussion, so far, interaction with other sectors was rare, and the forest certification process is full of successful examples of establishing cooperation between different stakeholders. The forest sector representatives emphasized that the forest certification process helped them to understand the necessity of cooperation with the relevant parties, while respecting the positions and roles of each stakeholder. In addition, the poor image of the forestry sector in the public was highlighted, and therefore, it is necessary to work on relations with the media and strengthen their interest in the positive results of forest management. With regard to NGOs, cooperation with hunting associations needs to be strengthened, given the very frequent problems arising from the mismatch between forest and game management plans. Moreover, private forest owners' associations represent organizations that may have an interest in wood biomass. In addition, the role of non-governmental organizations is especially recognized in the segment of raising public awareness and organizing appropriate training programs on the topic of wood biomass.

Associations in the Czech Republic active in the field of biomass

Poplar Commission of the Czech Republic/Topolářská komise České republiky

Poplar Commission of the Czech Republic is a voluntary, non-governmental and non-profit association of citizens of the Czech Republic, established so that research and educational staff and cultivators of fast-growing trees could exchange experience, research results and participate in the development of legislative standards regulating the conditions of their cultivation. The Association is the basis for international cooperation and for the participation of the Czech Republic in the International Poplar Commission (FAO).

Forestry and Wood Chamber of the Czech Republic/Lesnicko-dřevařská komora ČR

Forestry and Wood Chamber of the Czech Republic is an association of legal entities from forestry sector and the primary timber production. It was established in 2013 with the ambition to create a unifying platform for the forestry and wood processing sector and to bring together professional organizations of the particular interests under one entity, which will become the umbrella representative of these organizations and it will be a relevant partner for public administration, entrepreneurs, political representation and media. Main reasons for establishing this Chamber were:

- fragmentation of the professional organizations in forestry and related industries,
- current economic situation in the forestry industry and its position within the complex agrarian sector,
- long-term absence of an umbrella organization representing the interests of the forestry and wood processing community within the competence of the Agrarian Chamber's bodies and building a solid background in the sector.

CZ BIOM – Czech Biomass Association/ CZ BIOM - České sdružení pro biomasu

CZ Biom is a non-governmental organization and professional association supporting the development of bioenergy in the Czech Republic. The Czech Biomass Association (CZ Biom) is the Czech Republic's largest professional organisation engaged in the issue of using solid biomass, biogas or biofuels as an energy source and utilization of biodegradable waste. Established in 1994, the association currently represents approximately 200 companies and members. CZ Biom is working with other key players within the renewable energy sector and is a full member of Bioenergy Europe and European Compost Network. **Topics which are covered by CZ Biom are biomass combustion, biofuels quality standards**, compact biofuels, biomass production and utilisation, liquid biofuels, composting, biogas and biomethane, energy efficiency and savings and biowaste.

7 The way forward: steps for the sustainable wood biomass mobilization

Sustainable use of wood biomass for energy production can be understood as an attempt to balance relationships and interests within a complex set of resource, environmental, economic, political, social, technological and institutional factors, at different administrative levels (from global to local). It has been repeatedly pointed out that the use of this resource is an important political and economic issue, which underpins global policies on participation of renewable energy sources in total energy production and consumption and the prevention of the climate change impacts. Taking into account ecological, economic and socio-political realities of BiH, the country can and should base its development and strategic energy path on utilizing existing potentials and increasing the production of wood biomass. Such an approach will enable sustainable economic development based on the principles of bioeconomy, but also help achieve the set goals on the road towards EU integration.

A strategic approach to achieving sustainable use of wood biomass is an important element in the process of reconciling the interests of different sectors in terms of this resource. Therefore, in order to mobilize the existing potential of wood biomass in BiH, it is necessary to ensure continuous cooperation between all political stakeholders and institutions in relevant sectors such as energy, agriculture, forestry, nature protection, etc. Understanding the concept of sustainable use of wood biomass, as an integrative factor for harmonization of cross-sectoral policies, and its incorporation into strategic and development documents at the local level (local environmental action plans, local action plans for the use of sustainable energy sources, etc.), would improve forest management as one of BiH's most important natural resources, and, thus, create the preconditions for achieving the strategic development goals of the entire state more easily.

The traditional approach to forest resource management in BiH and activities implemented at all levels do not ensure maximization of the benefits from forest from environmental, economic and social aspects. Insufficient commitment to sustainable wood biomass mobilization leads to market disruption and increased uncertainty in the supply of wood for energy production. Considering the complexity of the process of wood biomass mobilization and the need to reconcile different interests in this resource, the necessary steps to create preconditions for the intensification and further development of activities on the wood biomass mobilization will be presented further below. The steps are classified into three groups and represent the most important results obtained in the development of this Guidebook.

Achieving environmentally friendly wood biomass mobilization

Mobilization and active use of wood biomass should not impair the stability of forest ecosystems or lead to their further degradation. In this sense, it is necessary to improve the current planning and utilization system, which will ensure the maintenance of a stable state in the most economically valuable forest categories and create preconditions for the improvement of all functions of degraded and endangered forest complexes, as well as those where potentials are underutilized. The planning process requires collection, processing and analysis of a range of different information, on the basis of which the quality of plans can be improved and the activities related to forest utilization made more efficient and effective. This is how the preconditions for meeting the environmental aspects of the wood biomass mobilization are created. It is very important to approach this issue systematically and responsibly, while respecting the cross-sectoral approach as a guiding principle, through creating an environment for the exchange of experience and knowledge between various stakeholders involved in the wood boimass value chain. Recognizing the need to preserve the ecological stability of forest ecosystems, the following prerequisites need to be met in order to mobilize wood biomass:

→ Improve existing methods of local forest inventories by collecting information relevant to wood biomass and biodiversity,

→ Perform additional research to determine the biological minimum in all forest categories that have the potential for wood biomass production,

→ Develop a special Rulebook for determining the biological minimum at the level of forest management unit (similar to the scoring system in the Rulebook on protection of forests from fire) and harmonise it with the Rulebook on measures to be implemented after the cuttings in order to assure ecological equilibrium in the stand is not disturbed,

→ Create a separate system for recording, measuring, reporting and marking wood biomass for the purpose of mobilization and legal long-distance transport,

→ Improve the contents of planning documents by introducing chapters that address issues of wood biomass and its mobilization, taking into account the specificities of forest production,

→ Analyse the possibilities of mobilization and utilization of wood biomass in crops, degraded and coppice forests as a primary product from these forest categories,

→ Analyse opportunities for raising energy plantations on suitable forest land with management goals primarily focused on the production of wood biomass in shorter production cycles,

→ Improve planning modalities at the level of detailed design and address the issues related to wood biomass mobilization through all activities on their design.

Innovation and improvement of technological process of wood biomass production

Taking into account that the process of forest utilization in BiH is somewhat hard due to the large share of diverse, mostly highland and mountainous terrains, as well as the dominance of the selective forest management system, it can be stated that it is difficult to apply modern, highly efficient technologies that enable the use of wood biomass. However, this does not mean that there are no possibilities for its mobilization, but that a systematic approach is needed to create the conditions for efficient and sustainable wood biomass mobilization. The following prerequisites need to be fulfilled for the successful application of modern forestry technologies that would facilitate wood biomass mobilization:

→ With the use of modern tools (GIS, LIDAR, etc.), taking into account a wide range of criteria, create technical and technological standardisation of forest terrains in order to obtain and further analyse areas and locations suitable for application of new technologies.

→ Through a participatory process and by involving all stakeholders, based on previously adopted justifiability indicators, improve the legislative framework in the field of forest utilization in order to remove obstacles to the use of new technologies (harvesters, forwarders, harwarders, portable chippers, etc.).

→ Within the existing public forest utilization systems, create specific norms of work and overview of costs of applying new technologies, which will enable development of operational plans and the contracting process through public procurement (tendering).

→ Improve and review Forest Product Standards by introducing wood biomass products.

→ Conduct a set of training activities and demonstration presentations for employees of public forestry enterprises and representatives of forestry contractors on the ways and benefits of applying new technologies for each of the forest categories.

→ For the purpose of indicating possibilities of investment and development of entrepreneurial ideas, present the opportunities and need for wood biomass mobilization to the current contractors, potential investors and other stakeholders.

Although the technologies currently used in BiH forestry are at a low level of development, and there is a strong need for the introduction of new technologies, it is necessary to emphasize that this process cannot be put exclusively at the expense of enterprises using public-owned forests. This process must be supported through: subsidies, involvement of funds from international funding, funds for improvement of ecological stability of forests, as well as participation of other sectors having an interest in renewable energy (ministries in charge of energy and environment).

Steps to create encouraging market environment for developing wood biomass-based business models

An important factor for mobilizing wood biomass for energy production is increase of the demand for energy products such as wood chips, briquettes and pellets, especially for users who traditionally use fuelwood as energy source. It is crucial that end-users are informed about the benefits of investing in technological solutions that enable the use of energy from wood biomass. In order to improve the market environment and create the preconditions for the development of business models based on the use of wood biomass, it is necessary to meet the following requirements:

→ By using a mix of information instruments, through promotional and educational activities, initiate a change in the pattern of use of wood for energy production and point out the advantages and disadvantages of using different energy products for heating.

→ Create a set of environmental policy information instruments at the appropriate administrative level, combined with economic (e.g. incentives and taxes) and regulatory instruments (relevant legislation), with the aim of more efficient development of the domestic energy market based on wood biomass.

→ Encourage public forestry enterprises and financially support initiatives for sustainable wood biomass mobilization, with the active involvement of the local population throughout the raw material supply chain.

→ Improve the transparency of the production process by developing and implementing systems for digitalisation of production data, including wood biomass.

→ Improve existing contracting models for timber supply and ensure long-term supply to potential investors.

→ Create an encouraging environment for establishing all forms of public-private partnerships throughout the forest biomass supply chain.

→ Although forest biomass-based energy products are an attractive market for both forest management companies and the private sector, its future mobilization planning must continue to address the needs of the rural population, especially the marginalized population groups in terms of fuelwood.

References

1. United Nations Food and Agriculture Agency – FAO (2015): Analysis of the Forest Sector in Bosnia and Herzegovina – Preparation of IPARD Forest and Fisheries Sector Reviews in Bosnia and Herzegovina, available at: www.fao.org/3/a-au015o.pdf.

2. Agency for Statistics of Bosnia and Herzegovina (2015): Survey on Household Energy Consumption Survey in BiH, available at: www.bhas.gov.ba.

3. Agency for Statistics of Bosnia and Herzegovina (2018): First Release – Production, sales and stocks of forest wood assortments in Bosnia and Herzegovina from 2003 to 2017, available at: www.bhas.gov.ba

4. Agency for Statistics of Bosnia and Herzegovina (2019): First Release – Prices and indices of forest assortments in BiH for the period 2010 – 2017, available at: www.bhas.gov.ba.

5. Alakangas, E, T. Sauranen, T. Vesisenaho, 1999, Production techniques of harvesting residue chips in Finland, VTT Energy, Jyväskylä.

6. Daily, C, G. (1997): Nature's Service – Societal Dependence on Natural Ecosystems, Island Press Washington DC, p. 3.

7. Final report of the Study – Planning, economics and marketing of forestry business, Final report of the Study, available at: www.fmpvs.gov.ba.

8. Federal Office of Statistics of the Federation of BiH (2018): Statistical Bulletin – Forestry, available at: www.fzs.ba.

9. Gurda, S, Jovanović, B, Musić, J. i Halilović, V. (2010): Završni izvještaj studije: Tehnologije u šumarstvu, standardi šumskih drvnih sortimenata i šumska biomasa, CEPOS – Centar za podršku održivom gospodarenju šumskim resursima, dostupno na: www.fmpvs.gov.ba /Final report of the Study: Forestry technologies, forest wood assortment standards and forest biomass, CEPOS – Centre for Supporting Sustainable Forest Resource Management, available at: www.fmpvs.gov.ba.

10. Koprivica M., Maunaga Z. (2000). Inventura šuma i planiranje gazdovanja šumama u Republici Srpskoj, Banja Luka/Forest inventory and forest management planning in Republika Srpska, Banja Luka.

11. Košir B. (2009): Uvajanje tehnologij strojne sečnje in izkoriščanje sečnih ostankov: -končno poročilo projekta. Ljubljana, Oddelek za gozdarstvo in obnovljive gozdne vire: 177. pg.

12. Kuiper, L, & Oldenburger, J. (2006). The harvest of forest residues in Europe. Biomassa-upstream Stuurgreop Report, (D15a).

13. Lojo, A, Balić, B, Pikula T. (2017): Snimanje taksacionih podataka na terenu za potrebe izrade šumskogospodarske osnove, Sarajevo & Brandýs nad Labem/ Methodology for collection of inventory data on field for the purpose of forest management plans development, Sarajevo & Brandýs nad Labem.

14. Lojo, A, Balić, B, Treštić, T. (2003): Metodika terenskih radova u prikupljanju podataka potrebnih za izradu šumskogospodarske osnove, Sarajevo/Methodology of fieldwork in collecting data necessary for the development of forest management plan, Sarajevo.

15. Matić, V. (1977): Metodika izrade šumskoprivrednih osnova za šume u društvenoj svojini na teritoriji SRBiH, Sarajevo/ Methodology of development of forest management plans for publicly owned forests in the territory of SRBiH, Sarajevo.

16. Matić, V,Drinić, P, Stefanović, V, Ćirić, M. (1971): Stanje šuma u SR Bosni i Hercegovini prema inventuri šuma na velikim površinama u 1964 - 1968. godine. Posebno izdanje Šumarskog fakulteta i Instituta za šumarstvo, br. 7, Sarajevo/State of forests in the SR Bosnia and Herzegovina according to the inventory of forests on large areas in 1964 – 1968. Special edition of the Faculty of Forestry and the Institute of Forestry, no. 7, Sarajevo.

17. Milanović, Đ, Brujić, J, Đug, S, Muratović, E, Lukić Bilela, L. (2015): Vodič kroz tipove staništa BiH prema Direktivi o staništima EU, Brussels/Guide to BiH Habitat Types under the EU Habitats Directive, Brussels.

18. Institute of Statistics of Republika Srpska (2018): Statistical Bulletin – Forestry, available at: www.rzs.rs.ba.

19. Official Gazette of the Brcko District of BiH, 14/10 and 26/16: Law on Forests of the Brcko District of BiH.

20. Official Gazette of Brcko District of BiH, 6/19: Rulebook on elements, content and method of preparation of forest management plans.

21. RS Official Gazette, 52/09: Rulebook on elements and content of forest management plans.

22. RS Official Gazette, 52/09: Rulebook on measures to be implemented after the cuttings in order to assure ecological equilibrium in the stand is not disturbed in Republika Srpska.

23. FBiH Official Gazette, 62/02: Rulebook on elements for development of forest management plans.

24. FBiH Official Gazette, 62/02: Rulebook on the scope of measures on establishment and maintenance of measures to be implemented after the cuttings in order to assure ecological equilibrium in the stand is not disturbed and the method of their implementation in the FBiH.

25. FBiH Official Gazette, 20/02: Law on Forests of the Federation of BiH.

26. FBiH Official Gazette, 15/14 and 45/18: Decision on development, content and application of forest management plans.

27. RS Official Gazette, 75/08 and 30/10: Law on Forests of Republika Srpska.

28. Stefanović, V, Beus, V, Burlica, Č, Dizdarević, H, Vukorep, I. (1983): Ekološko-vegetacijska rejonizacija Bosne i Hercegovine. Šumarski fakultet u Sarajevu, Posebno izdanje, br. 17, Sarajevo/Ecologic-vegetative reionization of Bosnia and Herzegovina. Faculty of Forestry in Sarajevo, Special edition no. 17, Sarajevo.

29. Forest Management Plan for forest management area “Bosnian Podrinje region”, with the validity from 01/01/2017 to 31/12/2026.

30. Forest Management Plan for forest management area “Romanija”, with the vallidty from 01/01/2015 to 31/12/2024.

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