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REPORT ON BIOMASS POTENTIAL MONITORING IN BOSNIA AND HERZEGOVINA

Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina

RS Ministry of Agriculture, Forestry and Water Management

Federal Ministry of Agriculture, Water Management and Forestry

Government of Brcko District Department for Agriculture, Forestry and Water Management

REPORT ON BIOMASS POTENTIAL MONITORING IN BOSNIA AND HERZEGOVINA

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Disclaimer

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LIST OF ABBREVIATIONS AND UNITS

ABBREVIATIONS	EXPLANATION
AIC	Annual increment of coniferous forest
AID	Annual increment of deciduous forest
BHAS	Agency for Statistics of Bosnia and Herzegovina
BiH	Bosnia and Herzegovina
BLL	Black liquor
BMZ	German Ministry for Economic Cooperation and Development
BSD	Berkeley Software Distribution
BWP	Byproducts of the wood processing industries
CAM	Cattle manure
CAS	Cattle slurry
CF	Calculation flowchart
COC	Corncobs
CORINE	Coordination of Information on the Environment
CPU	Central processing unit
CST	Cereal straw
CRES	Centre for Renewable Energy Sources and Saving
DB	Brčko District of Bosnia and Herzegovina
DBFZ	Deutsches Biomasseforschungszentrum gGmbH
DBMS	Database management system
DHS	District heating systems
EC	European Community
EnCT	Energy Community Treaty
ETL	Extract, transform, load
FAO	Food and Agriculture Organization of the United Nations
FBiH	Federation of Bosnia and Herzegovina
FMERI	Federal Ministry of Energy, Mining and Industry
FMPVŠ	Federal Ministry of Agriculture, Water-Management and Forestry
FWC	Fuel wood coniferious
FWD	Fuel wood deciduous
FZS	Federal Office of Statistics for the Entity of the Federation of Bosnia Herzegovina
GDP	Gross domestic product
GIS	Geographic information system
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH

GIZ ProRE	GIZ project 'Promotion of Renewable Energy in Bosnia and Herzegovina'
GOM	Goat manure
HDD	Hard disk drive
IE	International expert
IEA	International Energy Agency
IT	Information technology
IWC	Industrial wood coniferous
IWD	Industrial wood deciduous
J2EE	Java 2 Platform, Enterprise Edition
LE	Local expert
max	maximum
MIER RS	Ministry of Industry, Energy and Mining of Republika Srpska
min	minimum
MIT	Massachusetts Institute of Technology
MoFTER (en) MVTEO	Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina
MPŠVRS	Ministry of Agriculture, Forestry and Water of Republika Srpska
MSc	Master of Science
MST	Maize straw
NREAP	National Renewable Energy Action Plan
OSS	Open source software
PIM	Pig manure
PIS	Pig slurry
POM	Poultry manure
PRO	Pruning residues from orchards
PRR	Pruning residues from raspberries
PRV	Pruning residues from vineyards
RAM	Random-access memory
RE	Renewable energy/Renewable energies
REAP	Renewable Energy Action Plan
RES	Renewable energy source
RS	Republika Srpska
RZSRS	Republika Srpska Institute of Statistics
SDGs	Sustainable Development Goals
SHM	Sheep manure
SRC	Short rotation coppice
TPES	Total primary energy supply

UN	United Nations
UNDP	United Nations Development Programme (Project: 'Biomass Energy for Employment and Energy Security in Bosnia and Herzegovina', financed by the Czech Republic)
USAID	United States Agency for International Development
USAID EIA	USAID Project 'Energy Investment Activity'
Vlada BD	Government of Brčko District of Bosnia and Herzegovina
WWC	Waste wood coniferous
WWD	Waste wood deciduous

UNIT	EXPLANATION
%	percentage
a	year
GJ	gigajoule (unit of energy)
ha	hectare
ktoe	kiloton of oil equivalent (unit of energy)
kWh	kilowatt hours (unit of energy)
m^2	square metre
m^3	cubic metre
MW	megawatt (unit of power)
MW_{el}	megawatt electrical (unit of electrical power)
PJ	petajoule (unit of energy)
RWE	roundwood equivalent
t	tonne
t DM or t_{DM}	tonne dry matter
t FM or t_{FM}	tonne fresh matter

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Summary

By becoming a signatory to the Energy Community, Bosnia and Herzegovina committed itself to achieving the target share of 40 per cent of renewable energy sources within its gross final energy consumption by 2020. The Biomass Potential Monitoring activity for Bosnia and Herzegovina can help decision makers, politicians and public and private investors facilitate positive development toward achieving this goal by providing transparent information on the availability of biomass in the country. With regard to the partial lack of data, it was of great importance to identify, establish, collect and present the relevant data in order to assess the potential for biomass at the state, entity and municipal level with sufficient accuracy. In this context, biomasses were clustered in terms of agricultural biomass (byproducts only) and forestry biomass (main and byproducts of the forestry and wood processing industries).

The main outcomes of the Biomass Potential Monitoring were as follows:

(1) application and adoption of a transparent methodological approach for biomass potential monitoring tailored to the needs of Bosnia and Herzegovina;
(2) availability of data on the potential of biomass for the years 2012 to 2017 in an online database;
(3) visualisation in an interactive online atlas (http://atlasbm.bhas.gov.ba/) containing data on different spatial levels;
(4) structured display of information on the means of calculation, data collection and updating of the monitoring (calculation flowcharts, the excel calculation tool and a report).

In addition, an example analysis was conducted for 2015 (see Chapter 2, 2.2.3). This analysis shows that the biomass potential in Bosnia and Herzegovina in 2015, based on the 23 biomasses examined, was between 10.3 (minimum value) and 10.4 (maximum value) million tonnes of dry matter, which in theory, without considering calorific values and conversion related factors and depending on the mobilisation, could cover up to an additional 12 to 15 per cent of the total primary energy supply of the country. Considering the current share of total primary energy supply by renewable energy sources is 9.1 per cent, a total share of 21 to 24 per cent is therefore possible. However, careful consideration should be applied when considering these percentages because unofficial non-registered wood consumption (see Chapter 4) is currently not captured in this monitoring system. This is especially true considering the significant potential of wood biomass. Furthermore, the largest share of that potential stems from annual increment of coniferous and deciduous forests. However, geographic and technical restrictions such as accessibility have not been addressed fully and a complete assessment of the potential would require a larger investment in terms of additional forest infrastructure accompanied by implementation of the respective policy and forest management measures.

The application of transparent Biomass Potential Monitoring successfully obtained and visualised the first overview of the scale of the existing biomass potential in Bosnia and Herzegovina. Yet recording the status quo is just the starting point. Over the next few years, the responsible institutions must provide the monitoring system with new data and the existing data gaps must be closed in order to increase the validity of the data and ensure a complete representation of the different biomass potential at all spatial levels. This report provides guidance on how to continue Biomass Potential Monitoring and fill the remaining data gaps, which is a key task for the future. Extending or adapting the monitoring system through the incorporation of new biomasses or the removal of existing biomasses is also very easy to achieve and it can therefore be updated at any time in order to present the current needs of the country in this respect.

This report provides a comprehensive overview of the approach to the systematic collection, processing and presentation of data aimed at the evaluation of biomass potential in Bosnia and Herzegovina.

1 INTRODUCTION

Biomass plays a significant role within the economy of Bosnia and Herzegovina as a feedstock for industrial processes and as a renewable energy source. Forests cover around 43 per cent of the country and around the same amount of land is reserved for agricultural purposes.[1] The wood processing industry contributed roughly 3 per cent of GDP and 11 per cent of the country's exports in 2010[2] through furniture and construction wood production and the increasing market for high quality wood fuels (pellets, briquettes and chips) with a growing tendency.

Firewood heating is a common traditional form of heating in households in Bosnia and Herzegovina, especially in rural areas. The utilisation of biomass as an efficient wood fuel for district heating systems and larger buildings has grown in importance over the past decade. This was done under the premise of increasing the share of renewable energy in the country's final energy consumption and of switching from fossil and partly imported to sustainable and locally produced fuels. Yet the contribution made by the agriculture sector to GDP continues to decrease annually, the share in 2017 was just 5.6 per cent.[1] Agricultural residues such as straw or animal waste remain unused despite the fact that they could make a significant contribution to satisfying the demand for biomass for energy purposes.

The present document is one of the outcomes of the Biomass Potential Monitoring activity for Bosnia and Herzegovina established by the involved public institutions and donor organisations. It is aimed at assessing the reliability of the existing data on the current potential and utilisation of different types of biomass in the country. It describes the background, the applied methodology, data sources and the main results whilst providing recommendations for a long-term monitoring process for the biomass potential. The findings can serve evidence based decision-making with regard to the implementation of policy measures in the energy, forestry and agriculture sectors and can aid investment decisions in the private sector in general.

1.1 The big picture

As part for the 2030 Agenda for Sustainable Development, the United Nations established 17 Sustainable Development Goals (SDGs) in 2015.[3] While the 17 goals are not legally binding, governments do have the responsibility to follow-up on the implementation of the goals. The 17 SDGs encompass 169 targets that address issues such as poverty, food security, gender equality, water, energy, climate change and industrial development. Global partnerships underpinned by indicators measure progress toward achieving the SDGs.[4] Their achievement depends heavily on their integration into national policies, strategies and plans.[5] All SDGs apply to all countries, developed as well as developing. They address the three dimensions of sustainable development (economic, social and environmental) whilst considering their inter-linkage and accounting for national circumstances.[6,7]

Many countries are currently pursuing an energy transition from nuclear and fossil fuels toward renewable and sustainable energy supply. This energy transition addresses several SDGs, namely SDG 7 (affordable and clean energy), SDG 11 (sustainable cities and communities), SDG 12 (responsible consumption and production), SDG 13 (climate action) and SDG 15 (life on land). Currently, bioenergy is the most important and versatile renewable energy and is expected to maintain its leading role in energy transition and renewable energy provision over the next decades.[8] Many of the SDGs rely on biomass but do not reflect the sustainable aspects of their production and consumption.[9] Biomass and its production, consumption and conversion are implicit in several SDGs including SDG 2 (zero hunger), SDG 7 (affordable and clean energy), SDG 9 (industry, infrastructure and innovation), SDG 12 (responsible consumption and production), SDG 13 (climate action) and SDG 15 (life on land).

[1] Gross Domestic Product of Bosnia and Herzegovina 2017, production approach and the first results.
[2] Foreign Investment Promotion Agency of Bosnia and Herzegovina, 2011.
[3] United Nations, The Sustainable Development Agenda.
[4] Hák, T., Janoušková, S. and Moldan, B., 'Sustainable Development Goals: A need for relevant indicators', Ecological Indicators 60 (2016), 565–73.
[5] Stafford-Smith, and others, 'Integration: The key to implementing the Sustainable Development Goals', Sustainability Science 12 (2017), 911–9.
[6] Osborn D., Cutter A. and Ullah F., Understanding the Transformational Challenge for Developed Countries: Report of a study by stakeholder forum.
[7] United Nations, Report of the United Nations Conference on Sustainable Development, (A/CONF.216/16).
[8] Rose, S. K., and others, 'Bioenergy in energy transformation and climate management', Climatic Change 123 (2014), 477–93.
[9] Müller A., and others, The Role of Biomass in the Sustainable Development Goals: A Reality Check and Governance Implications.

1.2 The role of biomass as a renewable energy source in Bosnia and Herzegovina

By signing the Energy Community, Bosnia and Herzegovina committed itself to achieve a target share of 40 per cent of renewable energy sources in its gross final energy consumption by 2020. In 2015, Bosnia and Herzegovina had a total primary energy supply of 336 petajoule, 25 per cent of which was supplied by renewable resources. Renewable electricity in the country is supplied almost exclusively by hydropower whereas renewable heat is supplied solely by solid biofuels.[10] In total, 33 per cent of the country's final energy consumption is provided by renewable energy sources. There is an additional sector specific goal for transportation of reaching a 10 per cent share of renewable energy sources in terms of the sector's final energy consumption. The set targets and the respective energy values for the baseline year 2009 and the target year 2020 are provided in the following table.

Table 1. Baseline and target values for renewable energy sources for final energy consumption according to the NREAP for Bosnia and Herzegovina for 2020 [11]

Energy from renewable sources share of gross final consumption of energy in 2009	34.0 %
Energy from renewable sources target share of gross final energy consumption in 2020	40,0 %
Expected total adjusted energy consumption in 2020	4.851,3 ktoe
Expected amount of energy from renewable sources corresponding to the 2020 target	1.940,5 ktoe

Table 2 shows the trajectory of the targeted share (final energy consumption) per each renewable energy source in Bosnia and Herzegovina for heating and cooling including biomass during the period 2010–2020 according to the NREAP.

Table 2. Trajectory for RES target achievement for heating and cooling according to NREAP for Bosnia and Herzegovina 2020

ktoe	B. year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal energy (excluding low temperature geothermal energy in case of heat pumps)	0,00	0,00	0,12	0,53	0,66	0,83	0,97	1,24	1,54	1,78	2,41	2,84
Solar energy	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Biomass	792	835,36	867,10	909,58	941,16	1.004,19	1.022,22	1.031,47	1.046,09	1.039,69	1.079,28	1.082,35
Solid	792	799,65	796,17	877,04	901,70	947,45	979,80	1.001,09	1.028,00	1.033,36	1.082,23	1.081,13
Biogas	0,00	0,00	0,05	0,23	0,28	0,36	0,42	0,53	0,66	0,76	1,05	1,22
Liquid biofuels	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Renewable energy sources from heat pumps	0	0	0	0	0	0	0	0	0	0	0	0

[10] International Energy Agency, Bosnia and Herzegovina: Balances for 2015 (2018). Available from www.iea.org/statistics/statisticssearch/report/?year=2015&country=BOSNIAHERZ&product=Balances.
[11] National Renewable Energy Action Plan (NREAP) for Bosnia and Herzegovina for 2010–2020.

TOTAL	792	835,4	867,2	910,1	941,8	1.005,0	1.023,2	1.032,7	1.047,6	1.041,5	1.081,7	1.085,2
Out of which remote heating	7,8	7,9	8,1	9,1	9,4	9,8	10,2	10,6	11,1	11,4	12,7	13,3
Out of which household biomass	784,2	827,5	859,1	901,0	932,5	995,2	1.013,0	1.022,1	1.036,5	1.030,0	1.069,0	1.071,8

The Western Balkans and especially Bosnia and Herzegovina have a high share of wood biomass consumption in the household sector, which is reflected strongly in the gross renewable energy sources share of the total final energy consumption (see tables 3 and 4).

Table 3. Sectorial shares of renewable energy sources in final energy consumption (Bosnia and Herzegovina First Progress Report)[12]

	2014 Year n-1	2015 Year n-2
RES heating and cooling (%)	54,8%	56,2%
RES electricity (%)	44,5%	41,1%
RES transport (%)	0,4%	0,5%
Overall RES share (%)	41,1%	41,5%

Table 4. Renewable energy sources contribution per sector in ktoe (Bosnia and Herzegovina First Progress Report)[15]

	2014 Year n-1	2015 Year n-2
(A) Gross final consumption of renewable energy sources for heating and cooling	1.393,5	1.587
(B) Gross final consumption of electricity from renewable energy sources	510,3	477,3
(C) Gross final consumption of energy from renewable energy sources in transport	4	5
(D) Gross total renewable energy sources consumption	1.905,4	2.066,3

However, the application of different assessment methodologies, especially when compared to the baseline value of the NREAP for 2009, show a high level of variation in the results within a range of 50 to 200 per cent of that baseline value. The reference year 2015, for example, shows assessed results for wood consumption in households that differ between 491 ktoe[13] (resulting in a 25.1 % total renewable energy sources share of gross final energy consumption) and 1,587 ktoe[14] (resulting in a 41.5% total renewable energy sources share of gross final energy consumption). The largest contributor to biomass consumption for energy purposes is consumption for heating and cooking in the household sector. The Energy Balance for Bosnia and Herzegovina for 2015 indicates consumption of 437 ktoe of biomass in the household sector (89% of total biomass final energy consumption in the country), while the respective household surveys show consumption ranging from 1,232[15] to 1,439[16] ktoe per year in 2014/15 (78–91% of total reported biomass consumption for 2015, according to the first Progress Report for Bosnia and Herzegovina). Both surveys point out that around 75 per cent of households already partly or fully use biomass for heating or cooking purposes. Yet these deviations do not correspond to reality, because the necessary changes in biomass utilisation for energy purposes that this would have entailed were not visible in the market development.

[12] The first Progress Report for Bosnia and Herzegovina under Renewable Energy Directive 2009/28/EC, December 2017.
[13] Agency for Statistics of Bosnia and Herzegovina, Energy Balance for Bosnia and Herzegovina 2015, (2018).
[14] First Progress Report for Bosnia and Herzegovina under the Renewable Energy Directive 2009/28/EC, December 2017.
[15] United Nations, Food and Agriculture Organization, Wood fuels consumption in 2015 in Bosnia and Herzegovina (2017).
[16] Agency for Statistics of Bosnia and Herzegovina, Survey on household energy consumption in Bosnia and Herzegovina, Energy Community Treaty (2015).

The differences in the final results and the values given in the Energy Balance for Bosnia and Herzegovina can be attributed largely to the high use of non-registered biomass and the fact that household owners provide their own estimation of consumption. Chapter 3 (3.4) provides a more detailed comparison of the applied methodologies and recommendations for simplified evaluation in the future. Considering the high relevance of biomass for heating purposes in households as well as the difficulty of collecting reliable data on this subject, there is a need for evidence based policy and decision-making aimed at monitoring the existing potential of biomass and the application of a reliable and transparent assessment methodology.

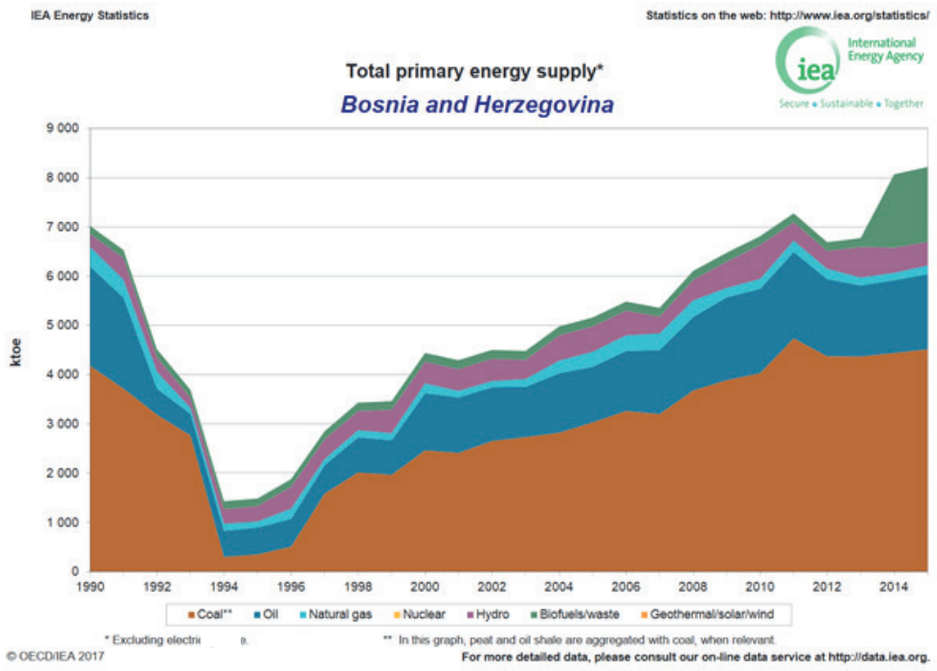
Regarding the contribution to electricity generation, biomass as a renewable energy source remains comparatively insignificant. In Republika Srpska, two biogas plants with a total installed capacity of 1,036 MWel are in operation on local farms and one (solid) biomass co-generation plant of 0.25 MWel has been installed as part of the district heating plant of the City of Prijedor. The electricity generation from these plants results in a final energy consumption of under 1 ktoe per year. Several other biogas and biomass co-generation plants are currently under development mostly within the husbandry sector, the meat and dairy industry and the wood processing industry.[17] At this time, no biogas or biomass project is in operation in the Federation of Bosnia and Herzegovina; however, several projects are in the development phase. In both entities, biogas and biomass projects are subject to an incentives system. The incentives systems were established through the respective legislation in each entity (laws on renewable energy sources and efficient co-generation plus bylaws and rulebooks). Both systems foresee, amongst others, incentivised remuneration on electricity generation based on biomass and biogas through so-called defined guaranteed prices per technology (feed-in-tariffs).[18] A reform of the support scheme system in both entities is currently under development. An inter-entity and inter-institutional working group supported by GIZ ProRE has been working on the reform since October 2017. However, in order to plan adequately for the potential contribution from biomass to the future energy supply for electricity generation without competing with the existing utilisation of biomass in households, a reliable and transparent monitoring system for biomass potential is of utmost importance here as well.

The contribution of biomass and biofuels to the final energy consumption in the transport sector is not yet visible in the energy statistics. The total renewable energy share of the final energy consumption of the transport sector for 2015 was 0.4 per cent and was based solely on the share of renewable electricity for non-road transport.[19] The current share of biofuel is not registered statistically[20] and there is no support mechanism in place to promote or require an increased share of biofuels for transport. However, an increased share of biofuels in the total energy mix of the country is needed if the targets set for transport under the Energy Community Treaty are to be met. Thus, respective policy measures need to be established based on reliable information on the existing potential of biomass in Bosnia and Herzegovina for this and other sectors.

The graph below shows the development of the composition of the energy supply of Bosnia and Herzegovina over the last two decades. Biomass as a renewable energy source has become more important during the past few years. However, the recent increase in the share of biomass could also be due partly to the different assessment methodologies applied (see Chapter 3, 3.4).

[17] Among others, the projects GIZ ProRE and USAID EIA prepared several project proposals and feasibility studies for interested Bosnia and Herzegovina investors and stakeholders in these sectors. Licensing and permits in both entities for Biomass CHP and biogas projects are published under www.reers.ba/lat/node/5833 and http://operatoroieiek.ba/wp-content/uploads/2018/11/Lista-postrojenja-koja-su-stekla-status-PPP.pdf.
[18] Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH, Gap Analysis of the Bioenergy Sector in Bosnia and Herzegovina (2016).
[19] First Progress Report for Bosnia and Herzegovina under the Renewable Energy Directive 2009/28/EC, December 2017.
[20] Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH, Recommendations for Biofuels in Transport in Bosnia and Herzegovina (2017).

Figure 1. Total primary energy supply (excluding electricity trade) for Bosnia and Herzegovina[21]



1.3 The Bioenergy Coordination Body in Bosnia and Herzegovina

The bioenergy sector is considered one of the most complex yet insufficiently developed sectors in Bosnia and Herzegovina. For the purpose of identifying and planning sustainable improvement opportunities in the country, UNDP (Biomass Energy for Employment and Energy Security project, financed by the Czech Republic), GIZ (ProRE) and USAID (EIA) offices in Bosnia and Herzegovina, supported by the Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina, established an inter-institutional and inter-entity **Bioenergy Coordination Body for Bosnia and Herzegovina**, which includes the main public stakeholders in the sectors.

The aim of the Bioenergy Coordination Body is to contribute effectively to the development of a sustainable bioenergy market. During regular meetings, the institutions involved exchange knowledge and experiences on existing and new policies, strategies and support activities related to bioenergy and when required and possible agree on respective improvement measures.

The coordination body comprises representatives from the institutions listed in the table below.:

Table 5. Members of the Bioenergy Coordination Body in Bosnia and Herzegovina

MOFTER/MVTEO	Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina
FMERI	Federal Ministry of Energy, Mining and Industry of the Federation of Bosnia and Herzegovina
MIER RS	Ministry of Industry, Energy and Mining of Republika Srpska
FMPVŠ	Federal Ministry of Agriculture, Water-Management and Forestry of the Federation of Bosnia and Herzegovina

[21] International Energy Agency, Bosnia and Herzegovina: Balances for 2015 (2018). Available from www.iea.org/statistics/statisticssearch/report/?year=2015&country=BOSNIAHERZ&product=Balances.

MPŠVRS	Ministry of Agriculture, Forestry and Waters of Republika Srpska
Vlada BD	Government of Brčko District
GIZ ProRE	'Promotion of Renewable Energies' project
UNDP	'Biomass Energy for Employment and Energy Security' project
USAID EIA	'Energy Investment Activity' project
Czech Embassy	Embassy of the Czech Republic

Biomass Potential Monitoring is part of the improvement measures that the Bioenergy Coordination Body decided to implement and monitor. Several members of the Bioenergy Coordination Body are also members of the institutional Working Group on Biomass Potential Monitoring (see Chapter 1, 1.7).

1.4 GIZ ProRE

Bosnia and Herzegovina and the Federal Republic of Germany have cooperated on sustainable energy since 2010. Over the last four years, the Energy Efficiency Technical Assistance project consisted of joint activities of the Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina (MOFTER) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). The German Ministry for Economic Cooperation and Development (BMZ) has approved a further renewable energy technical assistance project aimed at assisting Bosnia and Herzegovina in establishing a sustainable energy supply and meeting its obligations under the Energy Community Treaty. The project 'Promotion of Renewable Energy in Bosnia and Herzegovina' (GIZ ProRE) consists of four areas of intervention targeted at the creation and strengthening of a framework for increased use of renewable energy sources in the country.

The four areas of intervention comprise the following:

- general framework and conditions for the renewable energy sector (framework for licensing and permits),
- support schemes and community based approaches to finance renewable energy projects,
- small hydropower sector development,
- development of the bioenergy market and promotion of innovative bioenergy technologies.

1.5 UNDP energy and environment portfolio

Since 2009, the UNDP Energy and Environment portfolio in Bosnia and Herzegovina has included several projects that contribute to environmentally sustainable development and the use of natural resources. The 'Biomass Energy for Employment and Energy Security in Bosnia and Herzegovina' project, financed by the Czech Republic, aims to further strengthen and enhance the energy safety of rural communities throughout the country. It also aims to foster the development of enterprises for processing locally available wood biomass and the setting up of sustainable partnerships that will contribute to the economic development of micro-regions.

The project activities can be grouped into three inter-linked components::

(1) policy development to ensure sustainable wood biomass utilisation in Bosnia and Herzegovina;

(2) increased quality and availability of the wood biomass energy carriers for heating purposes through the adoption and use of updated wood biomass processing methods;

(3) business models and financing schemes developed and enabled for investment in wood biomass

infrastructure projects/implementation of demonstration fuel-switch projects.

This project is linked directly to SDG 7 (affordable and clean energy) and more specifically to target 7.2 (to increase substantially the share of renewable energy in the global energy mix by the year 2030). The project contributes to the achievement of SDG 13 (climate action) through responsible and sustainable forest management. This includes the sustainable utilisation of the wood biomass potential, which represents one of the pathways toward adaptation to climate change. Finally, the initiative relates to SDG 15 (life on land) as it refers to the sustainable management of forests as the predominant terrestrial ecosystem in Bosnia and Herzegovina.

1.6 Objective and timeline of Biomass Potential Monitoring

As previously mentioned, there is a general lack of reliable data on the biomass potential in the Bosnia and Herzegovina. This lack of data hinders strategic decision making at the policy level and private investment in innovative bioenergy technologies. In order to quantify the existing biomass potential and make this information accessible to decision makers, GIZ and UNDP decided jointly to support the development of **Biomass Potential Monitoring** under the umbrella of the Bioenergy Coordination Body in Bosnia and Herzegovina.[22]

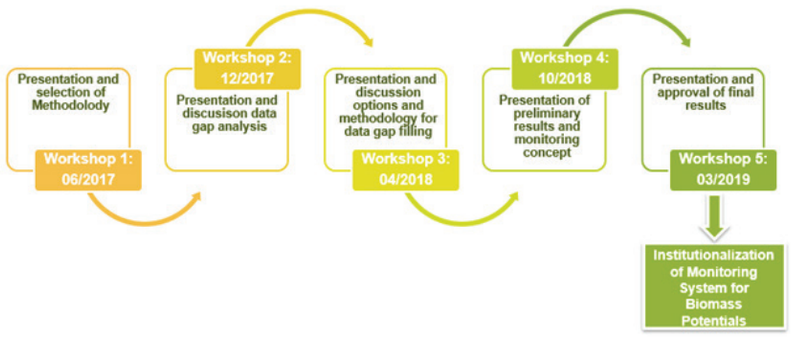
The objective of **Biomass Potential Monitoring** is to identify, establish, collect and display the relevant data and maps required for an assessment of the biomass potential of the forestry and agriculture sectors at the state, entity, Brčko District, cantonal (in the Federation of Bosnia and Herzegovina) and municipal level. It should be mentioned that the main as well as byproducts of the forestry and wood processing industries but only the byproducts of agriculture were investigated. The results of the assessment are publicly available via an online-platform. In order to facilitate the continuous utilisation and future monitoring of changes in the biomass potential, the platform transparently outlines the sources and calculation methodologies. The transparent manner of presentation of the results, sources and methodologies will support discussion among experts and market stakeholders and therefore provide the basis for continuous improvement of the gathering/analysis/quality of data as well as the applied methodology. The findings of such a monitoring approach will contribute to further market development and the more widespread use of biomass as a sustainable energy source.

The final outcomes of the activity were as follows:

(a) a report that includes a detailed description of the applied methodology, assessment approaches, results, conclusions, guidelines and recommendations for future updating and monitoring;

(b) a database and a bioenergy potential online atlas at the state, entity, Brčko District, cantonal (in the Federation of Bosnia and Herzegovina) and municipal level together with the relevant data, sources and data conversion parameters that will form the basis for the long-term monitoring process.

Figure 2. Timeline of biomass monitoring activities



[22] Supported by the donor organisations UNDP, USAID EIA and GIZ ProRE, the institutions involved established the Bioenergy Coordination Body in December 2016 at the state and entity level in order to discuss and monitor the implementation of the relevant improvement measures and adaptation of the legislation.

1.7 Partnership constellation

The expert team assigned to this project consisted of a team of international and local experts in the fields of biomass monitoring, forestry and agricultural biomass, database development and programming. The international experts at Deutsches Biomasseforschungszentrum gGmbH (DBFZ, financed by GIZ ProRE) developed the assessment methodology including the biomass calculation flowcharts, the database and the platform concept. Local experts in the fields of agriculture and forestry (financed by UNDP, with funding provided by the Czech Republic) performed the data gap and gap filling assessment in their respective fields. They provided the results to the experts at DBFZ who then converted the received data into a consistent database for Biomass Potential Monitoring. The local IT service provider GAUSS d.o.o. from Tuzla performed the task of converting the database into a virtual atlas for Biomass Potential Monitoring. The entire team discussed the relevant steps and decisions within the development of the platform for biomass potential during regular meetings.

In order to ensure the active participation of public institutions and experts and to establish their ownership over the aforementioned activities and their results, the Working Group for Biomass Potential Monitoring was established. The Working Group consists of representatives of the relevant ministries, the state and entity statistical institutions, the chambers of commerce, forest management companies, individual experts and UNDP, USAID and GIZ.

The Working Group for Biomass Potential Monitoring consists of the following institutions:

- Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina,
- Agency for Statistics of Bosnia and Herzegovina,
- Federal Office of Statistics for the Entity of the Federation of Bosnia Herzegovina (FZS),
- Republika Srpska Institute of Statistics (RZSRS),
- Federal Ministry of Agriculture, Water Management and Forestry of the Federation of Bosnia and Herzegovina,
- Ministry of Agriculture, Forestry and Water Management of Republika Srpska,
- Chamber of Economy of the Federation of Bosnia and Herzegovin,
- Chamber of Commerce and Industry of Republika Srpska,
- Banja Luka University (Faculty of Forestry),
- Sarajevo University (Faculty of Forestry),
- public forest enterprise 'Šume Republike Srpske' a.d. Sokolac and the enterprise 'Bosanskohercegovačke šume'.

Within the assessment of the biomass potential and the development of the Biomass Data Platform, the Working Group performed the following tasks:

- it approved the methodology and the concept,
- commented on the results and recommendations provided by the experts,
- reached a decision on the future monitoring approach,
- exchanged information related to data availability.

1.7.1 Cooperation with Deutsches Biomasseforschungszentrum gGmbH (DBFZ)

Deutsches Biomasseforschungszentrum gGmbH (DBFZ)[23] works as a central and independent thinker in the field of energy and the material use of biomass and the question of how limited available biomass resources can contribute to the existing and future energy system in a sustainable and highly efficient manner. As part of its research, DBFZ identifies, develops, accompanies, evaluates and demonstrates the most promising fields

[23] www.dbfz.de.

for the application of bioenergy and especially positive outstanding examples together with partners from research, industry and the public. The scientific work of DBFZ offers knowledge on the possibilities and limitations of energy and the integrated material utilisation of renewable raw materials in a bio-based economy. This should be expanded as a whole and the outstanding position of the industrial location Germany in this sector permanently secured.

As part of the Department of Bioenergy Systems, the Working Group on Resource Mobilisation has the following key areas of expertise 1) development and implementation of resource monitoring systems, 2) provision of a consistent database and a transparent approach (e.g. flowcharts), 3) stakeholder analysis on different levels and contexts (e.g. regional, national or international) and 4) development of resource mobilisation strategies for unused or inefficiently used biogenic resources.

Table 6. DBFZ experts [24]

Name and role	Summary of expertise
André Brosowski (Project Leader)	**André Brosowski** holds a Dipl.-Geogr. degree in Geography and joined DBFZ in 2011. Since early 2018, he has held the position of Group Leader of the Working Group on Resource Mobilisation. His research focus is on determining biomass potential and the current utilisation of these biogenic resources. The methodology applied in the Bosnia and Herzegovina project was developed as part of a German research project, which provides the basis for his ongoing PhD research.
Alexandra Pfeiffer (Scientific implementation)	**Alexandra Pfeiffer** holds a MSc degree in Industrial Enterprise Management and joined DBFZ in spring 2018. With over six years of experience in supply chain management research her research focus is on resource mobilisation strategies and stakeholder analysis.
Tim Krause (Scientific implementation)	**Tim Krause** holds an MSc degree in Natural Resource Management and joined DBFZ in January 2018. He is part of the Working Group on Resource Mobilisation and works on the development and application of methods for the assessment of resource availability in various non-European countries. These include quick scans and the establishment of monitoring systems.
Thomas Horschig (Support)	**Thomas Horschig** holds a MSc degree in Natural Resource Management and joined DBFZ in January 2014. He has been part of the Working Group on Resource Mobilisation since January 2018. Prior to this, he was part of the Working Group on Markets and Utilisation. His research focuses mainly on strategies for biomass mobilisation using GIS analysis and economic assessment.

1.7.2 Cooperation with local experts

Data collection at the state, entity (including Brčko District), cantonal (in the case of forestry biomass in the Federation of Bosnia and Herzegovina) and municipal level for the purpose of calculating the biomass potential was carried out or strongly supported by local experts. The main tasks of the local experts (two with responsibilities related to information on wood biomasses in the Federation of Bosnia and Herzegovina and Republika Srpska and two with responsibilities related to agricultural biomasses in these two entities) were as follows: 1) provide expert input and local expertise with regard to the applied methodology, 2) collect all available data required to calculate the theoretical biomass potential (such as livestock numbers, felled trees or crops grown), 3) provide entity or state level data on calculation elements (such as the dry matter content, the technical recovery rate or current usage), 4) provide expert input for data gap filling and other data based on expert assessment and 5) support the establishment of a protocol for long-term assessment of biomass potential in Bosnia and Herzegovina. If no national data was available then they also revised European or international data suggested by DBFZ for its applicability. This process led to close collaboration between DBFZ, the local experts and representatives of the responsible institutions in order to collect a data set that was then used by DBFZ in the calculation of the biomass potential. A brief profile of all local experts is provided below in Table 7.

[24] The DBFZ team changed during the project duration: Kay Schaubach, Mattes Scheftelowitz and Christian Weiser were initially part of the expert team.

Table 7. Local experts

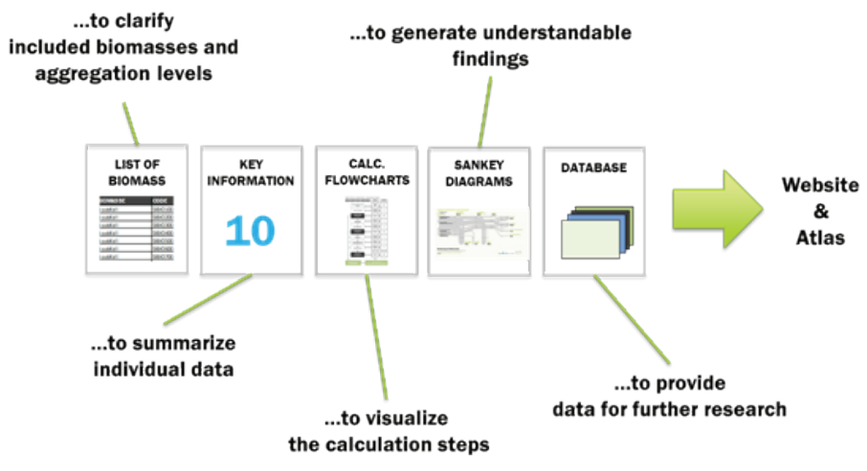
Name and role	Summary of expertise
Mersudin Avdibegović (Forestry, Federation of Bosnia and Herzegovina)	**Prof Avdibegović** is a full professor in forest economics, policy and organisation at the Sarajevo University. He has 23 years of teaching and research experience in forest policy and governance, conflict resolution in natural resource management and wood biomass energy as well as in forest and environmental legislation.
Aleksandar Mrkobrada (Forestry, Republika Srpska and Brčko District)	**Mr Mrkobrada** has 21 years diversified experience in the field of forestry in Bosnia and Herzegovina. He mainly undertook consultancy engagements in different forest related fields (such as the wood processing industry, climate change, disaster risk reduction and private forests).
Hamid Čustović and Melisa Ljuša (Agriculture, Federation of Bosnia and Herzegovina)	**Prof Čustović is a** full professor in agricultural sciences at Sarajevo University. His career spans 37 years and his expertise relates to the following fields: soil science, agro-ecological research, land use, agriculture and climate change.
	Dr Ljuša is an assistant professor at Sarajevo University and works closely with Prof Čustović. Her expertise relates to the following fields: soil science, agro-ecological research, land use, agriculture and climate change.
Dragan Čomić (Agriculture, Republika Srpska and Brčko District)	**Prof Čomić** is an associate professor at the Faculty of Forestry of Banja Luka University. He has 12 years of experience in environmental protection and forestry. His expertise in the field of biomass potential assessment covers both wood and agricultural biomass.

2 STATUS QUO – BIOMASS MONITORING IN BOSNIA AND HERZEGOVINA

2.1 Methodology – biomass monitoring

The biomass monitoring system is based on a methodology developed by DBFZ in the German context[25] that was then adapted to the background and needs of Bosnia and Herzegovina. A detailed description of the applied methodology can be found in Brosowski et al.[26] Project relevant parts of the methodology are visualised in Figure 3.

Figure 3. Visualisation of the methodological approach[27]



Source: Brosowski et al. 2019 (in publication)

[25] The Working Group on 'Biomass potential of By-Products, Residues and Wastes', FKZ 22019215, is funded by the German Federal Ministry of Food and Agriculture.
[26] Brosowski, A., and others (in publication), The Impact of Biogenic Residues, Wastes and By-Products: Development of a National Resource Monitoring based on the example of Germany.
[27] Ibid.

A categorisation of the biomasses was established together with local experts in order to clarify the biomasses and aggregation levels to be included in order to match the needs of Bosnia and Herzegovina. This categorisation is presented in Chapter 2 of this report in a list (see Chapter 2, 2.2.1) that shows all biomasses investigated as part of this study.

So-called key information was calculated for each investigated biomass by using biomass specific calculation elements of different origin and dynamics in order to summarise the individual data and to calculate the biomass potential.

1. Theoretical biomass potential
2. Technical biomass potential
3. Not mobilisable
4. Data situation unclear
5. Material use
6. Energetic use
7. Material or energetic use
8. Use not differentiablet
9. Technical biomass potential used
10. Mobilisable technical biomass potential

These ten key information elements are interdependent in different ways and are given in tonnes of dry matter (tDM) in order to ensure the comparability of the individual biomasses. In this way, it is possible to describe the supply and use of raw materials across sectors. However, this does not take energy properties, such as calorific value, into account.[28] A calculation flowchart (see Annex A1) was created for each biomass in order to visualise the individual calculation steps. Thus, the calculation path of each biomass potential is visualised and comprehensible. Another possibility of visualisation is to generate understandable findings with the help of Sankey diagrams. Lastly, all biomass specific calculation elements and key information were stored in a database.[29] This database feeds into the online atlas that provides a visualisation of the results for different spatial resolutions (municipal, cantonal, Brčko District, the entities and state level). The inclusive timeframe from 2012 to 2017 was selected in order to show how resource availability has developed over time. Throughout the development of the methodology for biomass monitoring as well as the development of the database and online atlas open source data (e.g. official and publicly available statistical data or open access publications) and software were utilised as much as possible in order to ensure easier platform updating and data collection as well as monitoring and verification practices.[30]

2.1.1 Data sources and quality

A wide range of sources was considered in order to obtain all of the necessary data needed to calculate the biomass potential. Official statistics play a key role in calculating the theoretical potential, e.g. the number of animals and land area used for farming, and hence their credibility was a key consideration. The latter is addressed later in this chapter.

The competent authorities for organising, producing and disseminating statistics in Bosnia and Herzegovina are the Agency for Statistics of Bosnia and Herzegovina, the Federal Office of Statistics for the Entity of the Federation of Bosnia Herzegovina and the Republika Srpska Institute of Statistics. In addition to state, municipal and entity level statistics, this study uses data from national and international literature as well as expert assessments of these values. Detailed information on each biomass can be found in Annex 3. With this approach in mind, the presence of missing data is an important result as it clearly demonstrates the presence of loopholes within the current system of data collection and analysis in the country. Comments on these minor inconsistencies can be found in Annex 6.

Hence, **data sources** are divided into 1) statistics, 2) literature, 3) expert assessments and 4) expert assumptions (see the right hand side of the calculation flowchart column 'source of data').[31] Statistics in the country typically refer to statistical data at the municipal, cantonal (in the case of the Federation of Bosnia and Herzegovina), entity or state level. When referring to the literature, the project team decided to consult national or

[28] Ibid.
[29] Ibid.
[30] Ibid.
[31] Ibid.

international literature in order to determine values applicable to the Bosnia and Herzegovina context. If no data was available in the form of statistics or in the literature then an expert assessment was utilised. Expert assessments were not based solely on the experience of the experts but also on comprehensive research, conversations with representatives of key institutions and stakeholders as well as consultation of comparable values from European or international literature and their adaptation to the Bosnia and Herzegovina context. Assumptions were in some cases required to further adjust international or European values (e.g. for dry matter content) to the local circumstances; these assumptions refer to bandwidths that allow for discrepancies that may occur in expert assessments. Detailed information on the expert assessments required for the individual biomasses can be found in Annex 3 and Annex A1.

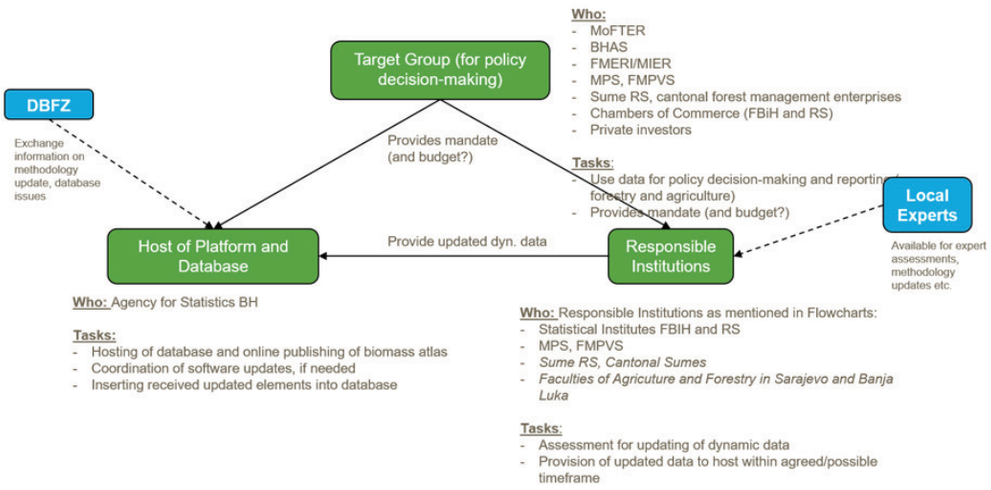
The quality of the above data sources is indicated through use of a traffic light system (see the right hand side of the calculation flowchart column 'data quality'). It is differentiated between 'very good' (green), 'good' (yellow) and 'poor' (red).[32] Statistical data as well as the literature applicable to the Bosnia and Herzegovina context without adjustment is marked as 'very good'. Expert assessments, depending on how well grounded or how much additional information was accessible in order to establish this expert assessment, were either marked as 'very good' or 'good'. Estimations are by nature of poor quality.

2.1.2 Updating and adaptation

Figure 4 visualises the proposed updating process, which is required in order to ensure that the monitoring system and consequently the database and online atlas will continue over the next few years in line with the methodology used for the data collection and analysis. It is proposed that the Agency for statistics of Bosnia and Herzegovina be responsible for hosting the database and the online atlas as well as for updating the dynamic calculation elements based on input from the responsible institutions in Brčko District and the entities. DBFZ will provide the host with an excel file that contains input cells for all of the dynamic calculation elements that automatically generate the required IT transfer for updating the database and online atlas.

How to operate the file and how to input data is described in the first sheet of the excel file under 'Code, Definitions and Instructions' and in Chapter 2.2.4.3) of this report. The proposal is for the so-called 'responsible institutions', indicated in the calculation flowcharts (see Annex A1) and the list of dynamic calculation elements (see Annex A5), to supply the host with an annual update of the dynamic data in order to generate a new annual dataset to feed into the database and online atlas. Local experts and DBFZ can be contacted if any queries arise. Over the forthcoming period, the plan is to organise meetings with relevant institutions at the entity level and at the state level in order to reach decisions on the modalities of the institutional cooperation required for updating the database and concerning the appropriate form of the bylaws that will define the updating process and the obligations and responsibilities of each institution.

Figure 4. Proposed updating process for database and online atlas



[32] Ibid.

2.2 Results

The main outcomes of this project are 1) the methodology for biomass potential calculation and 2) a database and online atlas (see Chapter 2, 2.2.4). The latter can be used manifold: 1) by policy makers in order to further renewable energy policies including the development of integral cross-sector approaches aimed at the sustainable management of natural resources, 2) by investors to decide where it may be feasible to develop a bioenergy project based on the available resources, 3) by researchers and statistical institutions to further research in relevant areas and to improve data collection and 4) by ministries for planning purposes and policy development such as land use improvement or subsidies for certain production.

This chapter offers certain options on how the data could be used and analysed. It is apparent that the establishment of a proper monitoring system and its results is an important tool for the quantification of the impact of biomass and energy from biomass.

2.2.1 List of biomasses

The list of biomasses (see Table 8) is based on Brosowski et al.[33] It was adapted through close collaboration with the national experts in order to fit the Bosnia and Herzegovina context. Over the project duration, some adaptation was made based on the available data and the recommendations of the international and local experts. Whether the biomass is a main or byproduct of the respective sector can be seen by the designation of Level 4 in Table 8. As previously mentioned, only byproducts were investigated for agricultural biomasses.

The biomasses 'annual increment coniferous/deciduous' (AIC and AID) differ from the other biomasses. Based on the available data and the current reporting on forestry data in the categories of fuel wood, industrial wood and waste wood, 100 per cent of the available technical potential is used. In order to establish what unused forestry biomass potential is available in Bosnia and Herzegovina, the biomasses AIC and AID were developed. These record the annual allowed felling and then subtract the used biomass potential (from the categories fuel wood, industrial wood and waste wood) in order to establish the unused potential that can then be considered through further analysis and during the development of strategies for the better utilisation/accessing of forest resources. The current theoretical potential equals the technical one, based on both annual increment and annual allowed felling. This means that the technical recovery rate and inaccessible area are not considered to the fullest. The paragraph below further explains these restrictions and provides suggestions on how to work carefully with the data.

There are several restrictions regarding the mobilisation of the unused potential as per AIC and AID. The highest values of growing stock and annual increment in Bosnia and Herzegovina stem mainly from forests within the central part of the country following the axis of the inner Dinaric Mountains, which are characterised by specific terrain and geological conditions. These conditions (slope and mountain topography) often complicate forest management and can even make it impossible; hence, the area of forest available for wood supply is restricted. Additionally, forests (particularly coppice) are poorly served by infrastructure (the average density of forest roads is below that of other European countries with similar topography). Therefore, harvesting is only possible in forests that are geographically (topography) and economically (infrastructure) accessible without harming the stability of the forest ecosystem. Furthermore, parts of the country remain contaminated by explosive remnants of war (ERW) dating from the war (1992–1995) and this prevents all forest management activities. The following may improve these conditions and hence increase the use of wood biomass: 1) The introduction and application of economic instruments, supported by an appropriate forest policies such as investment in the construction, and/or reconstruction and maintenance of forest roads, 2) subventions for coppice management activities (particularly in private forests), 3) the application of technically advanced solutions (e.g. forest cable systems) and (4) ERW clearance programmes.

[33] Brosowski, A., and others, 'A review of biomass potential and current utilization - Status quo for 93 biogenic wastes and residues in Germany'. Biomass and Bioenergy 95, (2016) pp. 257-272.

Table 8. List of biomasses, based on Brosowski et al. (2016) [34]

D	CODE	Level 1	Level 2	Level 3	Level 4	Level 5
1	IWC	Industrial wood coniferous	Stem wood coniferous	Stem wood	Main products from forestry and wood industries	Forestry biomass
2	FWC	Fuel wood coniferous	Stem wood coniferous	Stem wood	Main products from forestry and wood industries	Forestry biomass
3	IWD	Industrial wood deciduous	Stem wood deciduous	Stem wood	Main products from forestry and wood industries	Forestry biomass
4	FWD	Fuel wood deciduous	Stem wood deciduous	Stem wood	Main products from forestry and wood industries	Forestry biomass
5	AIC	Annual increment of coniferous forest	Stem wood coniferous	Stem wood	Main products from forestry and wood industries	Forestry biomass
6	AID	Annual increment of deciduous forest	Stem wood deciduous	Stem wood	Main products from forestry and wood industries	Forestry biomass
7	WWC	Waste wood coniferous	Logging residues coniferous	Logging residues	Byproducts from forestry and wood industries	Forestry biomass
8	WWD	Waste wood deciduous	Logging residues deciduous	Logging residues	Byproducts from forestry and wood industries	Forestry biomass
9	BWP	Byproducts of the wood processing industry	-	Industrial waste wood	Byproducts from forestry and wood industries	Forestry biomass
10	BLL	Black liquor	-	Industrial waste wood	Byproducts from forestry and wood industries	Forestry biomass
11	CST	Cereal straw	Straw	Byproducts from annual crops	Agricultural byproducts	Agricultural biomass
12	MST	Maize straw	Straw	Byproducts from annual crops	Agricultural byproducts	Agricultural biomass
13	COC	Corncobs	-	Byproducts from annual crops	Agricultural byproducts	Agricultural biomass
14	PRR	Pruning residues from raspberries	Byproducts from perennial crops	Pruning	Agricultural byproducts	Agricultural biomass
15	PRO	Pruning residues from orchards	Byproducts from perennial crops	Pruning	Agricultural byproducts	Agricultural biomass
16	PRV	Pruning residues from vineyards	Byproducts from perennial crops	Pruning	Agricultural byproducts	Agricultural biomass
17	CAS	Cattle slurry	Animal slurry	Byproducts from livestock production	Agricultural byproducts	Agricultural biomass

[34] Ibid., pp. 257-272.

18	PIS	Pig slurry	Animal slurry	Byproducts from livestock production	Agricultural byproducts	Agricultural biomass
19	CAM	Cattle manure	Solid manure	Byproducts from livestock production	Agricultural byproducts	Agricultural biomass
20	PIM	Pig manure	Solid manure	Byproducts from livestock production	Agricultural byproducts	Agricultural biomass
21	POM	Poultry manure	Solid manure	Byproducts from livestock production	Agricultural byproducts	Agricultural biomass
22	SHM	Sheep manure	Solid manure	Byproducts from livestock production	Agricultural byproducts	Agricultural biomass
23	GOM	Goat manure	Solid manure	Byproducts from livestock production	Agricultural byproducts	Agricultural biomass

2.2.2 Open data gaps

Based on the current status quo, complete data sets for the calculation of key information are available for all biomasses at the state and entity level. As shown in Figure 5, the data input at the municipal level that is generated for eight biomasses in the Federation of Bosnia and Herzegovina (IWC, FWC, IWD, FWD, WWC, WWD, BWF and BLL) and four biomasses in Republika Srpska (WWC, WWD, BWF and BLL) remains incomplete.

Furthermore, because data was only supplied for some of the municipalities based on the available data there are some data gaps regarding the biomasses annual increment coniferous/deciduous (AIC and AID) in the Federation of Bosnia and Herzegovina. In addition, the distribution of farms with the minimum requirement in terms of the number of animals (heads) at the municipal level appears questionable in the case of CAS, PIS, CAM, PIM and POM in the Federation of Bosnia and Herzegovina. The number of animals registered in farms, for example, partly exceeds the statistically reported animal numbers for the same region and this in turn leads to negative potential (see Annex A 3.3.1). In Republika Srpska, the information on farms with the minimum heads' requirement is not yet available and is therefore a technical restriction, because only the theoretical potential can be calculated. As a result, only one of the ten key information elements can be provided.

In the case of forest biomasses without data at the municipal level in the Federation of Bosnia and Herzegovina, except for BWP and BLL, the spatial level of the cantons was used as an additional means to achieve the maximum spatial resolution. With additional effort, this information could be made available for all other biomasses.

In the annexes, especially annexes 3 and 6, further information is provided on the data collection process and the existing data gaps.

Figure 5. Current status quo of the open data gaps

ID	Code	Biomass	DATA COLLECTION							MAPPING									
			KEY INFORMATION							FEASIBILITY						IT-TRANSFER			
				ENTITY			MUNICIPALITY						MUNICIPALITY			DATA AVAILABLE			
			NATIONAL	FBIH	RS	DISTRICT BRCKO	FBIH	RS	DISTRICT BRCKO	NATIONAL	ENTITY	CANTON (FBIH)	FBIH	RS	DISTRICT BRCKO	NATIONAL	ENTITY	CANTONS	MUNICIPALITIES
1	IWC	Industrial wood coniferous	10	10	10	10		10	10										
2	FWC	Fuel wood coniferious	10	10	10	10		10	10										
3	IWD	Industrial wood deciduous	10	10	10	10		10	10										
4	FWD	Fuel wood deciduous	10	10	10	10		10	10										
5	WWC	Waste wood coniferous	10	10	10	10			10										
6	WWD	Waste wood deciduous	10	10	10	10			10										
7	AIC	Annual increment coniferous	10	10	10	10	10	10	10			n/a						n/a	
8	AID	Annual increment deciduous	10	10	10	10	10	10	10										
9	BWP	By products of wood processing industries	10	10	10	10			10										
10	BLL	Black liquor	10	10	10	10			10										
11	CST	Cereal straw	10	10	10	10	10	10	10										
12	MST	Maize straw	10	10	10	10	10	10	10										
13	COC	Corn Cobs	10	10	10	10	10	10	10										
14	PRR	Pruning residues from raspberries	10	10	10	10	10	10	10										
15	PRO	Pruning residues from orchards	10	10	10	10	10	10	10										
16	PRV	Pruning residues from vineyards	10	10	10	10	10	10	10										
17	CAS	Cattle slurry	10	10	10	10	10	1/10	10			n/a						n/a	
18	PIS	Pig slurry	10	10	10	10	10	1/10	10										
19	CAM	Cattle manure	10	10	10	10	10	1/10	10										
20	PIM	Pig manure	10	10	10	10	10	1/10	10										
21	POM	Poultry manure	10	10	10	10	10	1/10	10										
22	SHM	Sheep manure	10	10	10	10	10	10	10										
23	GOM	Goat manure	10	10	10	10	10	10	10										

available | open questions | not (yet) available | * extra effort

2.2.3 Biomass potential and recommendations for analysis

This chapter describes the ways in which the data can be placed on the website and the benefits of the online atlas for analysis. All data is provided in tonnes of dry matter (tdm); no conversion to an energy unit (e.g. PJ) was undertaken because the lower heating value/net calorific value varies for each biomass. The user may have to undertake this biomass specific conversion when utilising the data from the database and online atlas for certain analyses.

The reference year used in this chapter is 2015; however, the same and further analyses can be conducted for the years 2012 to 2017 inclusive.

As illustrated in figures 6 and 7, the biomass potential in Bosnia and Herzegovina in 2015 was between 10.3 (minimum value) and 10.4 million (maximum value) tonnes of dry matter and could in theory, not considering the lower heating values/net calorific values and conversion related factors and depending on the mobilisation, cover up to 24 per cent of the total primary energy supply of the country. The 2.0 million tonnes of dry matter currently 'not used'[35] translates to a potential share of 716 to 907 ktoe of the total primary energy supply, when assuming a lower heating value from 15 to 19 GJ/t_{DM} [36], which equals a share of 12 to 15 per cent of the total primary energy supply. Considering the current share of the total primary energy supply for renewable energy sources is 9.1 per cent,[37] a total share of 21 to 24 per cent is possible.

[35] The terms 'unused' and 'not used' are used interchangeably in this report when considering the biomass potential.
[36] Kaltschmitt, M., Hartmann, H. and Hofbauer, H. (eds.), Energie aus Biomasse: Grundlagen, Techniken und Verfahren, 3rd edn. (Berlin: Springer, 2016).
[37] International Energy Agency, Bosnia and Herzegovina: Balances for 2015 (2018). Available from www.iea.org/statistics/statisticssearch/report/?year=2015&country=BOSNIAHERZ&product=Balances.

Figure 6. Sankey diagram, biogenic resources in Bosnia and Herzegovina 2015 (minimum scenario)

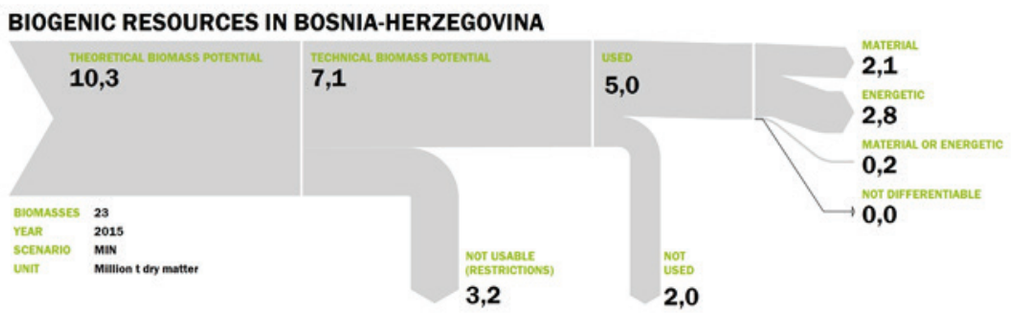
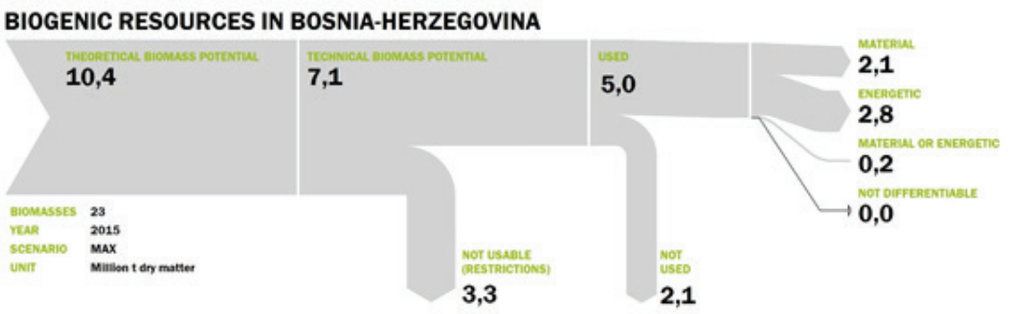


Figure 7. Sankey diagram, biogenic resources in Bosnia and Herzegovina 2015 (maximum scenario)



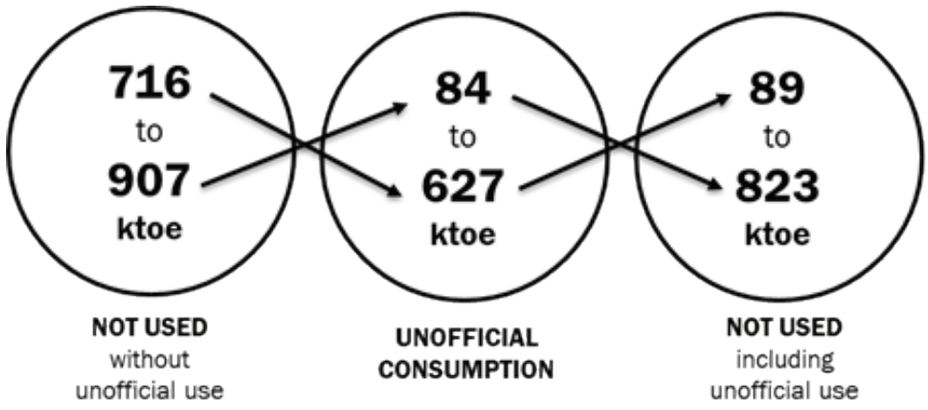
These percentages need to be considered carefully because unofficial non-registered wood consumption is currently not captured in this monitoring system, especially when referring to the potential for annual forest increment and waste wood. Table 9 and Figure 8, below, attempt to visualise unofficial non-registered wood; however, this is a rough estimate meant to show the limitations of the current monitoring and the need to improve reporting on wood consumption in order to draw comprehensive conclusions.

Table 9. Consideration of unofficial non-registered wood consumption

Monitoring	Back-checking calculation (see Chapter 4, 4.3)
620 – 700 ktoe fuel wood consumption of that 80 – 95 % in households → 496 – 665 ktoe	936 ktoe heat demand in households +/- 20 % → 749 – 1.123 ktoe
Result: unofficial non-registered wood consumption currently not included in the biomass mapping: **84 – 627 ktoe** (1,123 ktoe – 496 ktoe = 627 ktoe; 749 ktoe – 665 ktoe = 84 ktoe)	

This results in 'not used' biomass potential of between 89 and 823 ktoe, as shown in Figure 8. Chapter 3 (3.4) provides more information on the back-checking calculation mentioned in Table 9 as well as fuel wood consumption and its recording in general.

Figure 8. 'Not used' biomass potential in Bosnia and Herzegovina



Because forests cover 43 per cent of Bosnia and Herzegovina, it is unsurprisingly that the majority of unused biomass potential consists of wood biomass (see Figure 9 below) amounting to 1.56 million tonnes of dry matter. However, as described above, all of the results need to be considered carefully because as with the unofficial non-registered fuel wood consumption the potential may already be exceeded. Furthermore, the comments on annual increment coniferous/deciduous in Chapter 2 (2.2.1) need to be considered when drawing conclusions on the unused potential of wood biomass.

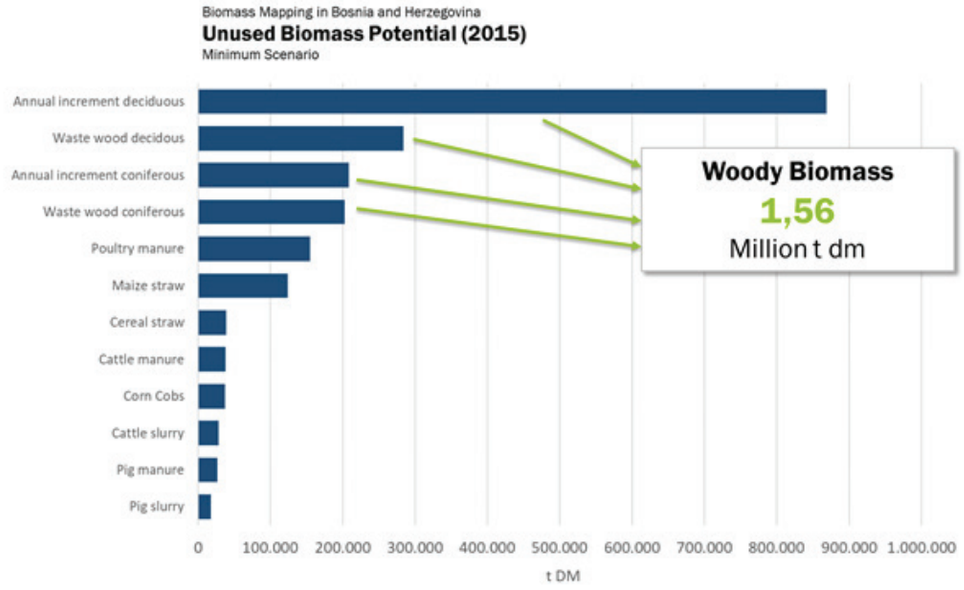


Figure 9. Unused biomass potential 2015 (minimum scenario)

Apart from the state level analyses presented above, further analysis can be undertaken by looking at the theoretical (see figures 10 and 11) or 'unused' (see figures 12 and 13) potential at the entity level.

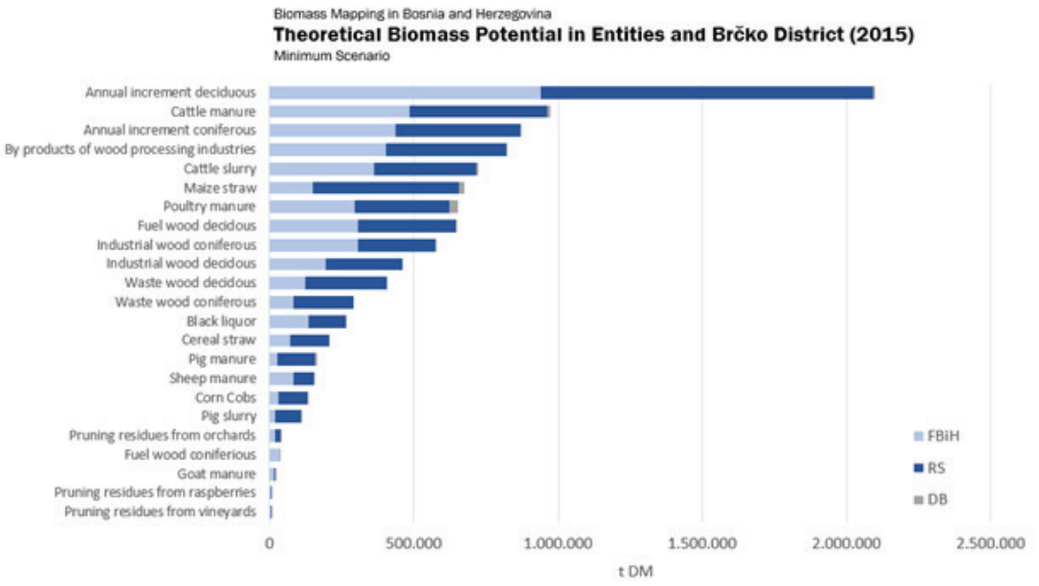


Figure 10. Theoretical biomass potential by entity and Brčko District 2015 (minimum scenario), diagram based on the data exported to excel

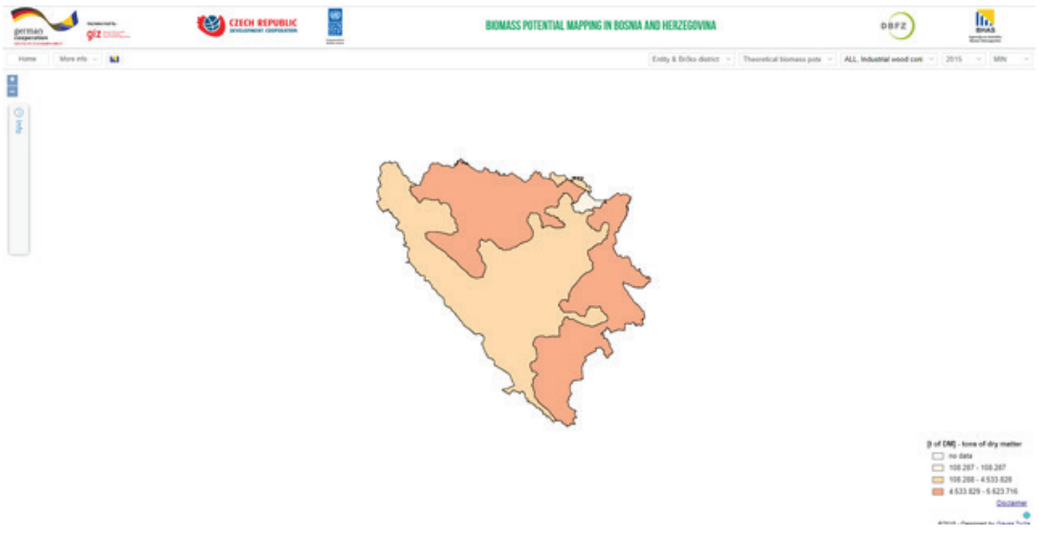


Figure 11. Theoretical biomass potential by entity and Brčko District 2015 (minimum scenario), screenshot online atlas

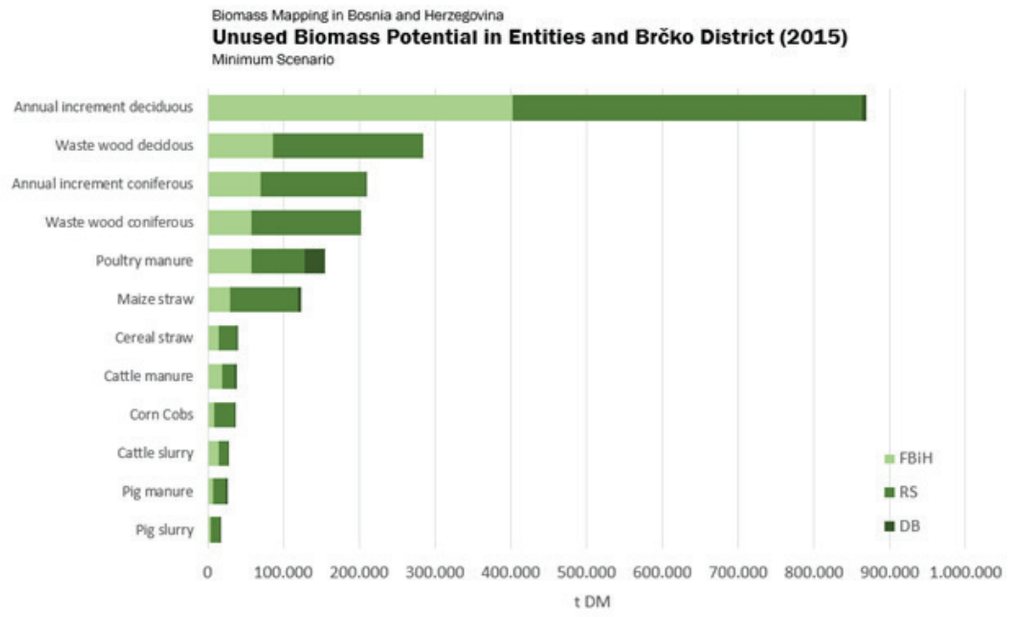


Figure 12. Unused biomass potential by entity and Brčko District 2015 (minimum scenario), diagram based on the data exported to excel

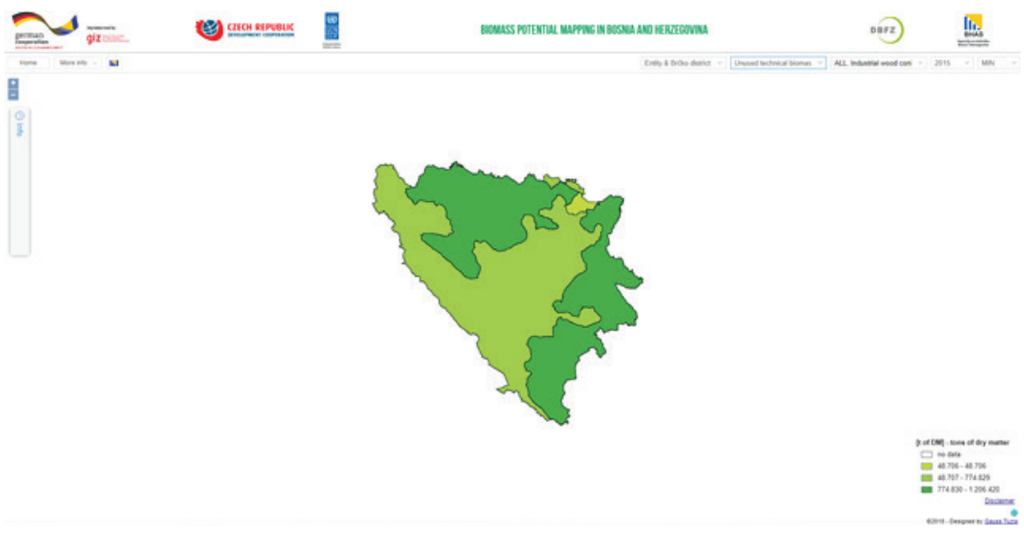


Figure 13. Unused biomass potential by entity and Brčko District 2015 (minimum scenario), screenshot online atlas

A screenshot of the municipal data (see Figure 14) is included to show the visualisation on that spatial level. Generally, depending on the underlying question of the party using the data, conclusions can be drawn from the database and online atlas concerning which biomasses should be supported by legal incentives and in which regions investment would make sense as well as where it is possible to mobilise unused resources.

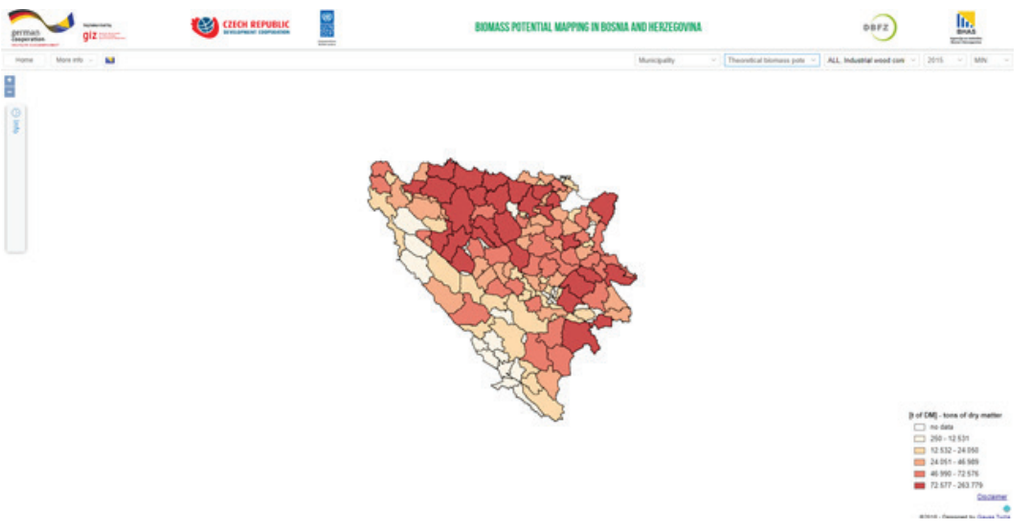


Figure 14. Screenshot from the online atlas showing distribution by municipality

2.2.4 The database and the online atlas

2.2.4.1 IT requirements and the software configuration

The biomass potential mapping included the identification, collection and establishment of the relevant data related to the assessment of the biomass potential in the forestry and agriculture sectors in Bosnia and Herzegovina. One of the results is the **publicly available and updatable data via an online platform/atlas**. The platform helps to provide data that policy decision-makers can use and therefore contributes to the further market development and sustainable use of biomass for energy purposes.

The final outcome is a database that is linked to an online available bioenergy potential atlas (platform) with information on the relevant data and respective sources at the state, entity, Brčko District, cantonal (in the Federation of Bosnia and Herzegovina) and municipal level in Bosnia and Herzegovina.

The development of the database and online platform/atlas is described below.

- Technical Concept

  The concept for the implementation of the web-based solution for biomass potential mapping in Bosnia and Herzegovina was developed.

  The concept was then presented to the relevant stakeholders.

- Installation

  The platform, database and maps were programmed (including the transfer of the provided data into the database).

  The platform, database and maps were then integrated into the existing website of the host institution.

- Training

  In order to ensure regular updating of the database, a maintenance concept and schedule were development and these will be handed over to the host and other stakeholders.

  Two training units for handling the platform were conducted for the host institution.

- Maintenance

Maintenance and on demand support is available for 12 months.

The IT team that works on this project is described in tables 10 and 11.

Table 10. IT experts

Name and role	Summary of expertise
Mirza Ponjavić (GAUSS d.o.o.)	**Prof Mirza Ponjavić** is a director at GAUSS (IT company) and a professor at Tuzla University and the International Burch University in Sarajevo. He has 20 years of experience in the development of databases and online tools as well as in programming GIS-based online maps.
Almir Karabegović (GAUSS d.o.o.)	**Prof Almir Karabegović** is the Technical Director at GAUSS and a professor at the Faculty of Electrical Engineering of Sarajevo University. He has 18 years of experience in data modelling, GIS architecture design, development of databases and online tools as well as in programming GIS-based online maps.

Table 11. Technical support team

Name and role	Summary of expertise
Elvir Ferhatbegović (GAUSS d.o.o.)	**Dr Elvir Ferhatbegović** is a business development manager at GAUSS and an assistant at Tuzla University. He has 15 years of experience in the development of databases and online tools, ETL spatial data processing as well as in programming GIS-based online maps.
Midhat Alić (GAUSS d.o.o.)	**Midhat Alić** is a software engineer at GAUSS with 10 years of experience in the development of WebGIS apps and programming of GIS-based online maps.
Merima Kamberović (GAUSS d.o.o.)	**Merima Kamberović** is a software engineer at GAUSS with 10 years of experience in the development of databases, WebGIS application development and the programming of GIS-based online maps.

The system is implemented using open source software (OSS) and related components. The code of all components is licensed under the BSD open source license. This means that any organisation can use, modify and even integrate the code into their commercial application without paying any licensing fees. DBMS PostgreSQL, which is released under the PostgreSQL license and is a liberal open source license similar to the BSD or MIT licenses, was used.

Figure 15 shows the architecture for the realisation of the interactive map. It is a fully open geospatial software stack for publishing data on the web. The system leverages a full separation of concerns between the **back-end** and the **front-end**. The **front-end** is a JavaScript web application that communicates with web services using AJAX and external ones through an internal configurable proxy. The **back-end** is a suite of web services developed in Java and deployed into a J2EE container (e.g. Apache Tomcat). It includes the software listed below.

- **PostGIS** - This is a robust spatial database system.GeoServer - server za mape i geoprostorne podatke.
- **GeoServer** - This is a map and geospatial data server.
- **GeoExplorer** - A browser based tool commonly used to view, navigate and manage data, either local or remote. It is built upon **OpenLayers** and **GeoExt**, which are two JavaScript libraries for building geospatial applications.
- **GeoWebCache** - A server that accelerates the delivery of map images by pre-drawing and caching.
- **QGIS** - A desktop based tool for viewing and interacting with geospatial data and maps.

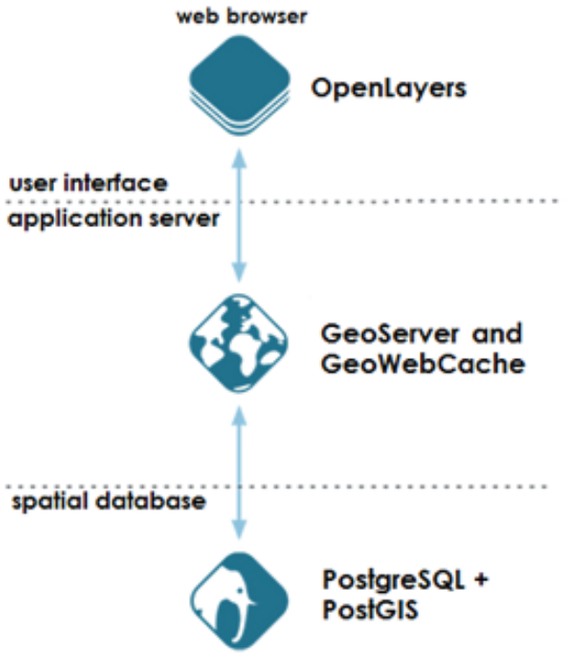


Figure 15. The system architecture based on recommendation of the OSS community

The following minimum IT infrastructure is required for the optimal running of the platform :

- **hardware** - RAM 16 GB, HDD 100 GB, CPU 2 processors
- **operating system** - Windows (recommended 2012 or newer) or Linux (recommended CentOS)
- **platform** - physical or virtual machine.

Maintenance and on demand support are included for the first 12 months after the system installation. Upon the expiration of this 12-month maintenance period, the user will have the opportunity to extend the system maintenance contract.

The maintenance includes a help desk service (IT administration by users at the internal level network and server operation:

- The first level of support is a telephone call during regular working hours (8.00 - 16.30 Monday to Friday) with ensured connection to appropriately experienced and qualified staff (within 30 minutes of the call).
- The first level of support via e-mail during regular working hours ensures a response within 24 hours..
- Uninterrupted and quality system operation is ensured.

2.2.4.2 The user interface

The user interface (shown in Figure 15) is simple and self-explanatory. The online atlas is available in English and in local language. The logos of all involved organisations are shown in the top section of the website. At the top left, under 'more information', the user can access this report and the calculation flowcharts as well as further information on the database and online atlas. Right next to that is the language selector. At the top right, the user can find the input section. Here the user can select the desired spatial level, key information, biomass and year and whether the user wants to see the minimum, maximum or average values. Based on this,

a map will be generated. When clicking on the map a small window will pop up providing detailed information on the selected region. In the pop-up window, which is located in the top right hand corner, the selected data can be exported as an excel file. The map itself can be reset to the default scale by pressing the 'home' button on the top right, while just below this the user can zoom in and out using the + and - commands. The map legend is provided in the bottom right hand corner and changes automatically in accordance with the user selection. Copyright and system information is given in the bottom right hand corner.

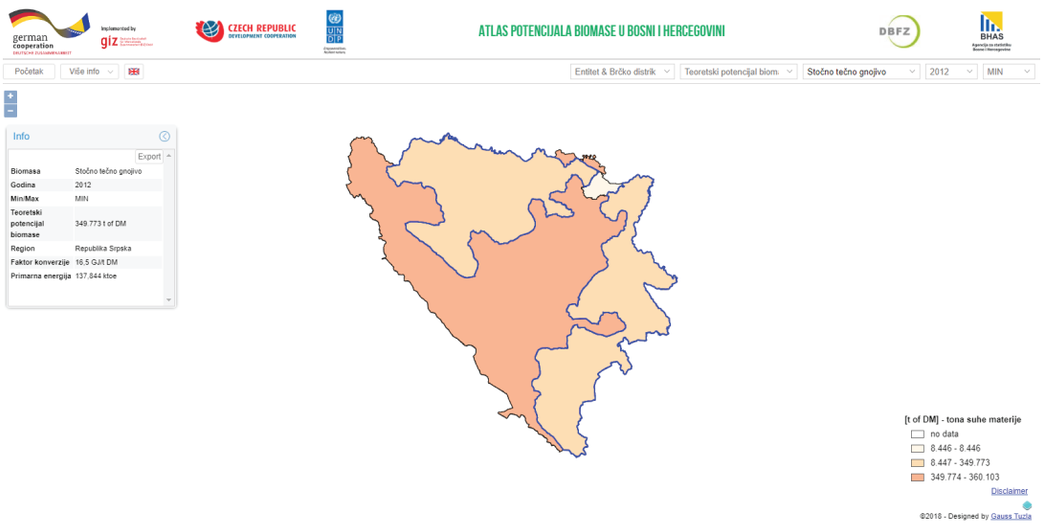


Figure 16. The user interface of the online atlas

2.2.4.3 Operator interface

The operator, who can edit data or add new data, has three options for maintenance according to the IT administrator's preference (see Table 12 below).

Table 12. Data maintenance tools

Tool for data maintenance	Explanation	Most suitable for
Microsoft Excel	Use MS excel, because the data comes from this source. It is possible to connect it to DBMS using ODBC protocol.	Data expert
QGIS	Use QGIS as an editing tool.	GIS Expert
pgAdmin	Use pgAdmin, one of the PostgreSQL tools, which is probably the most popular and feature rich open source administration and development platform for PostgreSQL.	IT administrator

The most useful tool for data maintenance and updating for IT and data administrators is pgAdmin. The administrator can login directly to the database and when changing data it will be dynamically changed on the web application of the atlas. The excel spreadsheet referred to in Chapter 2 (2.1.2) includes IT transfer tables to feed the IT infrastructure designed by GAUSS. All dynamic data can be updated by the host institution and is linked via an IT transfer to the database. However, it is currently possible to change dynamic data but non-dynamic elements. If non-dynamic elements are changed then the methodology will no longer be consistent. If non-dynamic elements need to be adjusted or biomasses added then consultation with the working group is necessary. After which, the initiated updating process will be supported by DBFZ.

3 FUTURE BIOMASS OPPORTUNITIES UTILISING ABANDONED AND UNUSED LAND

Abandoned land can be differentiated as land with the potential to be utilised for agricultural purposes or land that over the past years and decades has turned into forest. The latter can be a source of fuel wood for household heating through unofficial non-registered felling (see Chapter 3, 3.4 on fuel wood consumption). However, abandoned agricultural land should not to be confused with fallow land, which is arable land set aside for between one and five years for the purpose natural renewal and afterwards reclaimed as agricultural land, pasture or meadow. Abandoned land is the result of numerous factors. In addition to the economic situation, the war in Bosnia and Herzegovina caused a major displacement of the population from rural to urban areas; estimates place the level of displacement at around two million people. The most common consequences of this in rural areas include the abandonment of land (now often covered with young trees, coppice and herbaceous crops), land degradation, loss of biodiversity and the destruction of natural and cultural heritage. Consequently, abandoned agricultural land is suitable for the reintroduction of managed agricultural activity.

Because the monitoring system is based on statistical data, the kind of biomass described in the following sub-chapters is currently not or only partially included in the database and atlas. The input data is based on statistical reporting in Bosnia and Herzegovina, which is closely linked to official land use classification. Such 'new forests' are actually growing on abandoned agricultural land and therefore the land use category needs to be adjusted in order for them to be recorded as private forests. This would also allow the statistical institutes to collect and present data more accurately. Once done, the potential of such 'new forests' can be quantified using the monitoring approach. Comments from the local experts on data collection for abandoned land are included in Annex 6.

3.1 Potential of abandoned land and short rotation coppice

The latest data from the second National Forest Inventory in Bosnia and Herzegovina (2006–2009) shows a total figure of 3,231 million ha of forest and other woodland out of which 1,652 million ha are high forests and 1,252 million ha are coppice forest.[38] The rest is characterised as other wooded land that comprises of shrub, barren forestland and other forest areas. In total, these new figures imply that around 63 per cent of the total territory of Bosnia and Herzegovina is covered with forest and other woodland, which is one of the highest values in Europe.

Compared to the first National Forest Inventory that dates back to the 1960s, which reported a total forest and other wooded land area at a magnitude of 2,734 million ha, it is clear that a significant increase in the forest area has occurred in all categories. The main reason for this is the factual increase in forest area resulting from natural reforestation mainly on abandoned private agriculture land, particularly in rural areas. These changes have resulted into a significant increase in the share of private forests. According the Cadastre of Republika Srpska for 2015, for example, private forests cover 300,328.63 ha and yet according to data from the second National Forest Inventory private forests in Republika Srpska cover 501,600 ha and therefore 201,271.37 ha more than the documented area of private forests

The war and post-war developments have strongly affected the land use pattern in Bosnia and Herzegovina. The large-scale migration of the population within the country resulted in intensified urbanisation and transformed the traditional and cultural land use. More importantly for forests, the trend of abandoning land followed the trend of urbanisation and this has had a combined effect on the amount and management of forestland. The trend of land abandonment began in the 1960s and found its peak during the war (1992–1995). The war caused the displacement of more than half of the pre-war population of Bosnia and Herzegovina from their homes and in many cases rural populations did not return to their pre-war settlements and many villages remain abandoned.

Consequently, land previously used for agriculture (pastures, orchards, ploughed fields etc.) has now naturally reforested and turned into unmanaged forests of pioneer species and/or shrubs and former managed coppice forests (mainly small-scale and largely fragmented) are no longer cared for. This has resulted in an increase in wood biomass but a decline in active forest management and the production of quality timber. This shift toward lower value forest types of primary successions has severe implications for the economic potential and

[38] USAID, SIDA, Utilisation of low grade Forest assortments and the transformation of Coppice Forests in Bosnia and Herzegovina (2013).

value creation of forestland. Yet these 'new forests', either unmanaged coppice or associations of pioneer species on what was formerly agriculture land, have significant potential as a source of wood biomass.

However, the current legislative framework is more restrictive when it comes to the management of private forests than of forests on (abandoned) agricultural land. Irrespective of the amount of wood that the owners of private forests plan to cut on their property they are still obliged to obtain a harvesting permit, which is a procedure that requires time and resources from the applicant. In contrast, harvesting on abandoned agricultural land for the purpose of household heating require less administrative efforts since felling in the 'new forests' can be categorised as 'repurposing the land for its original use for agricultural production'.

As this is one of the legal ways to obtain firewood for personal needs, a possible error arises in statistical calculations and reports in terms of the quantification of firewood and the approved amount. In the case of Republika Srpska, the latter is approved by the public enterprise 'JP Šume Republika Srpska'. These reports commonly declare such felling/cutting as unofficial usage of wood. Currently there are no incentives to convert agricultural land to forestland and thus landowners that grow forest for firewood production for their own consumption prefer to register such land as an agricultural area.

Therefore, a mix of forest policy instruments (regulatory, economic and informative) as well as innovative institutional/management arrangements (e.g. interest associations, machinery rings, forest leasing, public-private partnership etc.) are necessary to organise the currently unorganised private forest owners (the main holders of these forests) in order to ensure the sustainable use of these forests for wood biomass production.

Because private forest owners are limited as individuals in terms of their means (financial, institutional power/influence) the founding of cooperation or interest associations would help enable private forest owners to develop their forest properties and make them more economically viable. This would support positive developments within forest management in Bosnia and Herzegovina. The quality and distribution of forest ecosystems in Bosnia and Herzegovina shows that privately owned forests are of lower quality but are still well suited to the production of wood biomass for the needs of energy production. However, there are certain obstacles to the formation of associations of private forest owners. The main obstacle is the large number of individual private forest owners and their different interests, which prevent them from becoming organised. The root causes of this lack of organisation among private forest owners in Bosnia and Herzegovina stems mainly from the negative experiences related to similar associations (agricultural cooperatives) during the previous socialist period and the subsequent lack of tradition and motivation among private forest owners in forming such associations.

3.2 Information on abandoned/unused land in the Federation of Bosnia and Herzegovina

There is no official or exact data on abandoned or unused agricultural land areas in the Federation of Bosnia and Herzegovina, which is also the case at the state level. One of the most relevant data sources is the Coordination of Information on the Environment (CORINE)[39] land cover database. Yet it should be noted that CORINE data, which is prepared on a scale of 1:100,000 with a minimum polygon size of 25 hectares, is indicative from the viewpoint of detecting such changes in agricultural areas due to their character and dynamics at the local level. This is seen mostly as the gradual transition of agricultural areas, pastures and abandoned land into forest vegetation and ultimately into forests. The most common cause for this relates to the displacement of the population during and after the war and the consequent abandonment of rural areas.

According to data from the CLC2012 database, it is evident that the category of forest and semi-natural vegetation has the predominant share in the Federation of Bosnia and Herzegovina at 66.6 per cent (1,738,849 ha). The second most represented category is agricultural land at 30.6 per cent (798,019 ha), while the remaining area of 2.7 per cent belongs to the categories of artificial surfaces (1.9%), water bodies (0.1%) and wetlands (0.7%). The group category representing intensive agricultural production (non-irrigated arable land, permanently irrigated land, vineyards and orchards) accounts for just 8.4 per cent (67,041 ha) of agricultural land, while the remaining 91.6 per cent (730,977 ha) is divided into the following classifications: pasture, complex cultivation patterns and land principally occupied by agriculture with significant areas of natural vegetation.

The largest share of agricultural land (36.8%) belongs to the classification 'complex cultivation patterns', which represents fragmented agricultural areas under different crops. The second largest (30.0%) is the classification

[39] Coordination of Information on the Environment (CORINE) is a European programme initiated in 1985 by the European Commission. Its purpose is to gather information on certain priority topics related to the environment (air, water, soil, land cover, coastal erosion, biotopes, etc.) for the European Union.

'agricultural land with a significant share of natural vegetation cover'. This covers fragmented agricultural areas with different crops scattered among areas of natural vegetation. Pastures are also a very significant classification that accounts for 24.8 per cent of the overall structure of agricultural land.

The definition of abandoned agricultural land in the Law on Agricultural Land of the Federation of Bosnia and Herzegovina reads as follows, "The abandoned agricultural land is an uncultivated land covered by weeds and indigenous and forest vegetation where the vegetative production residue is present longer than two years." The definition of 'succession' according to CORINE is more detailed: "shrubby or herbaceous vegetation with scattered individual trees."

Considering that the cessation of agricultural activities gives way to afforestation and urbanisation, Ljuša[40] states that in the case of Bosnia and Herzegovina it is necessary to distinguish the broader concept of "abandonment of agricultural activities" from the narrow concept of "land abandonment", which refers to cases where there are no economic activities at all (division according to Corbelle and Crecente).[41]

There are two main causes of this situation: migration of the population caused by war activities and the abandonment of rural areas as a trend that has lasted from the Second World War to up to the present. It is evident that the area of abandoned agricultural land or land no longer used for agricultural purposes is continuously increasing. CORINE data and the official statistics support this supposition. The change matrix (CORINE data, change in agricultural areas > 5 ha) indicates a trend of transition of agricultural land to succession, which is particularly visible in the classifications 'pasture' and 'agricultural areas with natural vegetation'. When it comes to the trends presented in Table 13, it is noteworthy that the biggest changes in agricultural land usage occurred over the period 1990 to 2000. This period is linked directly to the war and its consequences, such as the major population displacement and subsequent migration. However, data for that period is not available. The monitoring of land use changes only began in 2000 by which time most of the changes had already taken place. The period from 2000 to 2018 shows trends that are far less intensive yet still significant at the state level, which is the actual target level of CORINE.

Table 13. Transition to succession of forest vegetation (ha) (2000–2018)

2000-2006.	2006-2012.	2012-2018.
542 ha	564 ha	692 ha

These changes are very dynamic at the local level (scale 1:10,000, IV level of CORINE). According to analyses of the Faculty of Agriculture and Food Sciences of Sarajevo University (2018), for example, in the Municipality of Srebrenik around 375 hectares of agricultural land transitioned to forest land over the period 2008 to 2012. According to statistical data, the total agricultural land area in the Federation of Bosnia and Herzegovina was 1,148,979 hectares in 2016. Within this category, arable land accounted for 401,555 hectares. Within the arable land area, 187,350 hectares was cultivated and 50.1 per cent or 201,309 hectares uncultivated. If one follows the definition of transition to succession (CORINE) and unused land (statistics) these two categories are different and cannot be compared.

There is no doubt that abandoned and unused land areas represent a significant potential that can be utilised for biomass production. Yet in the case of the Federation of Bosnia and Herzegovina, attention should also be paid to those areas under waste material caused by overburdening of disposal sites. The area of Tuzla Canton has the most severely degraded land area in Bosnia and Herzegovina. Surface mining, disposal of the overburden of material and ash from the thermal power plant, the disposal of municipal and industrial waste as well as erosion and landslide are causes of land degradation in Tuzla Canton. The largest areas of land affected by surface mining are found in the municipalities of Lukavac (1,459.82 hectares), Banovići (1,329.79 hectares), Živinice (596.70 hectares) and Tuzla (317.54 hectares). There are approximately 5,500 hectares of technogenic landfill sites as well as 613 identified wild landfills that occupy an area of 7,720 hectares in the Canton

Given the above, it is fair to conclude that the potentially uncultivated land area is statistically significant and exceeds 200,000 ha with many specific locations that are suitable for biomass cultivation for energy production. In addition to these areas, the landfills that receive the overburden from mines in the area of Central Bosnia and the industrial waste landfills for the thermal power plants and other process industries are also very suitable for

[40] Ljuša, M., Trends and characteristics of the change of use of agricultural land in Bosnia and Herzegovina (2015).
[41] Corbelle, E. and Crecente, R., 'Land abandonment: Concept and consequences', Revista Galega de Economia 17(2) (2008).

the cultivation of biomass for energy production. The data provided for the area of Tuzla is the best indication of this. Yet in order to identify additional areas for the development of biomass production it is necessary to investigate these potential areas in more detail at the local level and to identify not only the areas but also the land potential for growing specific crops that could be used for energy production purposes. Using the existing technologies, satellite and orthophoto images and GIS as well as by enlisting the support of the local communities interested in this type of projects, these studies could be carried out with relative precision and success.

3.3 Opportunities for catch crops

With the emergence of new trends in agricultural production, particularly sustainable agriculture and organic production, catch crops are beginning to assume a significant place in the sowing structure. The main objective of planting catch crops is not limited merely to increased yield but also to the protection of the agro-ecological system. It involves primarily the reduction or total elimination of the use of mineral fertilisers and pesticides and the use of biomass for the production of energy from renewable resources. With the raised level of environmental awareness among consumers, the criteria for the production of good quality food is becoming stricter and the efforts to protect natural resources and the environment more pronounced.

Catch crops are single crops or their mixtures that are sown between two main crops. However, in some circumstances, these crops can be the main crop. In terms of the sowing time, catch crops are usually sown in winter and then as second and subsequent crops. They are usually grown out of the vegetation season as winter crops because they include a large number of species from different legume, grass and cabbage families.

In addition to pure crops and their mixtures, catch crops can also be sown as joint crops, when sown between the rows of the main crop.

The significance of catch crops

Incorporating catch crops into the system of plant production can be beneficial both in terms of the environmental and economic aspects of production.

Summing up the results of several authors in the area of crop production, the significance of catch crop cultivation can be reduced to the follow:

- a reduction in the cost of fertiliser,
- preservation of the soil moisture and prevention of nutrient leaching,
- improved physical, chemical and biological properties of the soil,
- prevention of erosion,
- reduction in the use of pesticides (especially herbicides),
- preservation of the water quality,
- preservation of the environment and an improvement of health in general.

Despite the fact that the above listed benefits of catch crop production are largely dependent on the agro-ecological conditions for production, at least two or three of these benefits are always achievable.u.

The choice and properties of the most significant catch crops

In order to make a proper choice of catch crop or a mixture that is suitable for the specific pedo-climatic conditions, it is necessary to carefully analyse the situation and determine which of the aforementioned primary benefits of the catch crops is to be achieved. The benefits of the application of catch crops are largely dependent on an appropriate choice of plant species

It is necessary to determine the right time and place for sowing catch crops within a given management system and to consider several options depending on the conditions. By so doing, the catch crops should fit properly into the existing crop rotation system. The following text provides an overview of the most significant and most represented forage catch crops that can be grown in the Federation of Bosnia and Herzegovina.

Areas suitable for the cultivation of catch crops as biomass for the production of energy can be established throughout the territory of the Federation of Bosnia and Herzegovina wherever there is sufficient soil for this type of production, namely that it is deep enough and has good water retention capacity or irrigation is provided. It is difficult to achieve satisfactory yields of biomass if there is not enough moisture in the soil. It is for

this reason that the availability of land in terms of its water and physical properties can be a limiting factor for the production of biomass in many locations. Potential areas for growing biomass, as recommended in the following table, could include disposal sites for surface waste material emanating from the exploitation of coal or other mineral resources. This also applies to the sites used for the disposal of ash and slag as byproducts of thermal power plants in the areas of Tuzla, Kakanj, Ugljevik and Gacko. It applies to areas of agricultural land abandoned because of displacement in regions affected by the war as well as migration for economic reasons. Generally, there are many abandoned and marginalised areas across the entire Federation of Bosnia and Herzegovina in which invasive plants, weeds and shrubs are increasingly suppressing crops grown for the needs of humans and animals. An inventory of these potential areas can be made based partly on data from the CORINE database and/or by developing the fourth level of CORINE for the specific areas, which would provide a complete picture of the potential and the conditions for catch crop production.

Tabela 14. Catch crops in Bosnia and Herzegovina

	Elephant Grass	Elephant Grass Sorghum Millet and Sudan Grass	Grain winter crops (Rye)	Grain crops in association with seasonal leguminoses (pease and common vetch)	Field pea
Latin name	*Miscanthus sp.*	*Sorghum vulgare and sorghum vulgare sudanensis*	*Secale cereale*	*Pisum sativum or Vicia sativa*	*Pisum arvence*
Yield in t DM/ha	15-30	8-12	4-10	4-10	4-5

3.4 Potential of short rotation coppice plantations in Republika Srpska

Most projections on global energy usage indicate that biomass will be an important component of primary energy sources in the coming decades. Short rotation plantations have the potential to become an important source of renewable energy in Europe because of their high biomass yield, good combustion quality as a solid fuel, ecological advantages and comparatively low biomass production costs.[42] This is especially the case with woody crops, including short rotation coppice.[43] Of the various cropping modules, short rotation coppice seems to reflect best the expectations of farmers, because these farmers are used to short return times and generally show little enthusiasm for traditional wood plantations harvested at ten to thirty year intervals.[44] The main characteristics and benefits of establishing short rotation coppice plantations are that they are 1) establishment once every 20 to 30 years, 2) offer optimal exploitation every 2 to 5 years, 3) provide optimal usage in 6 to 8 rotations and 4) have a planting density of 1,000 to 30,000 seedlings per hectare. The dry matter production per year depends on the short rotation coppice: poplar yields range from 9 to 16 t DM/ha, while willow yields are 8 to 15 t DM/ha.

Additional benefits relate to CO2-sequestration (with potential financial valorisation), phytoremediation (wastewater purification) and flood protection. The fact that short rotation coppice, like other fast growing plantations, is formed along river streams can be considered as a benefit in Republika Srpska because there are several large river streams in the entity. The most important and suitable river streams for the establishment of short rotation coppice emanate along the Una, Sava, Vrbas, Bosna and Drina rivers. It is also very important to emphasise that there is a lot of abandoned agricultural and other land in those areas.

However, these preconditions alone are insufficient for the establishment of short rotation coppice. The following open questions require answering in order for investment in these areas to be successful and cost-effective.

[42] Klašnja, S., Kopitovic, S. and Orlovic, S.,'Variability of some wood properties of eastern cottonwood (Populus deltoides Bartr.) clones', Wood Science Technology 37, (2003) pp. 331–337.
[43] Heller, M.C., Keoleian, G.A. and Volk, T.A., Life cycle assessment of a willow bioenergy cropping system. Biomass and Bioenergy, 25(2), (2003) pp.147-165.
[44] Spinelli, R., Nati, C. and Magagnotti, N., 'Harvesting short-rotation poplar plantations for biomass production', Croatian Journal of Forest Engineering: Journal for Theory and Application of Forestry Engineering, 29(2), (2008) pp.129-139.

(1) What is the size of the area available (exact data, including information on ownership)?

(2) Which species and clone are appropriate (poplar, willow or other, such as paulownia)?)

(3) Which establishment technology is most adequate (planting space) and which planting material is required?

(4) What is the CO2-sequestration (quantify)?

(5) What is the economic feasibility of the investment (calculate)?

The Faculty of Forestry of Banja Luka University, as the leading higher education institution in Republika Srpska, and the public forest enterprise 'Šume Republika Srpska' have already started several activities in order to provide the preconditions for the establishment of the first short rotation coppice plantations in Republika Srpska. The most important of which are listed below.

- Intensive cooperation has been established with the Institute of Lowland Forestry and Environmental Protection from Novi Sad;
- Testing of the planting material quality has begun in Doboj with seven Italian and five German clones;
- Trail plots have been established:
    - o 10 ha in Podgradci in the Municipality of Gradiska,
    - o the separation of suitable land areas is planned in the Municipality of Laktaši,
    - o cooperation has been established with several private owners.

In conclusion, it is necessary for the State to provide adequate support and an appropriately formulated national strategy, particularly in regard to the issue of using biomass as a renewable energy source, in order to further the development of short rotation coppice.

4 FUEL WOOD CONSUMPTION

As per the officially available information,[45] 43 per cent of Bosnia and Herzegovina is covered by private and public forests. Hence, wood is one of the major natural resources in the country that can significantly contribute to the utilisation of renewable resources. Over recent decades, the forestry sector in Bosnia and Herzegovina has faced significant structural changes. During the socialist period private forests experienced neglect from both the responsible policy makers and the private forest owners themselves, the latter resulting in even less policy attention. However, only 20 per cent of forests in Bosnia and Herzegovina are privately owned, either by individuals or in a few cases by (religious) institutions. The remaining 80 per cent of forests in the country are publicly owned and are hence called 'state forests'. With the exception of Brčko District, whose few thousand hectares of public forest is managed by the public forest administration,[46] ownership and forest management now rests with the entities.

Wood biomass, especially in forest rich regions, is traditionally one of the most common biomasses used in private households for energy (mainly heat) generation and therefore the term 'fuel wood' is used in the Bosnia and Herzegovina context for this application of wood biomass. According to the 2013 census, Bosnia and Herzegovina has a population of 3.4 million organised in 1.12 million households. An average of 75 per cent of these private households (approximately 0.9 million households) use wood biomass for heating.[47,48,49] According to the Agency for Statistics of Bosnia and Herzegovina, biomass covered 15.3 per cent of total energy consumption of which 94.5 per cent was used in households in 2015. [50]

[45] Foreign Investment Promotion Agency of Bosnia and Herzegovina, Forestry and Wood Industry (2011).
[46] Food and Agriculture Organization, Wood Fuels Consumption in 2015 in Bosnia and Herzegovina (2016).
[47] Ibid.
[48] Robina, V.K.G. and Lončarević, A.K., Implementation of the new statistics approach on final energy consumption of biomass in household sector in three countries: Croatia, Bosnia and Herzegovina and Macedonia, Energy Conversion and Management, 149, (2017) pp.1010-1018.
[49] Agency for Statistics of Bosnia and Herzegovina, Survey on Household Energy Consumption in Bosnia and Herzegovina 2015, Energy Community Treaty (2015).
[50] Agency for Statistics of Bosnia and Herzegovina, Energy Balance for Bosnia and Herzegovina 2014–2016.

Fuel wood consumption therefore contributes significantly to the achievement of the set renewable energy goal of 40 per cent of total final energy consumption through renewable energy sources (see Chapter 1). However, the values reported for fuel wood consumption in households and therefore the total biomass consumption differ significantly depending on the underlying source and methodology of the study in question. The baseline value for 2009 is 792[51] ktoe with an increase to 1,578 ktoe in 2015; however, the 2015[52] value was corrected downwards to 491 ktoe based on Agency for Statistics of Bosnia and Herzegovina Indicator 9.[53] This broad range of values for fuel wood consumption in 2015 implies a broad range of renewable energy sources achieving between 25.1 and 41.5 per cent of the target. Considering that fuel wood consumption in households contributes to over 90 per cent of total biomass consumption, the recorded values need to be evaluated carefully in order to decide on the most appropriate methodological approach for establishing the most accurate value.

4.1 Studies on fuel wood consumption

Over the years, several studies were conducted with the aim of determining biomass utilisation in households and collecting precise data. This precise data is required for accurate renewable energy reporting. As a result, data on fuel wood consumption in all sectors and in households in particular is available in official reports as well as in third party studies that used different methodologies. Figures 17 and 18 illustrate the different studies and their results.

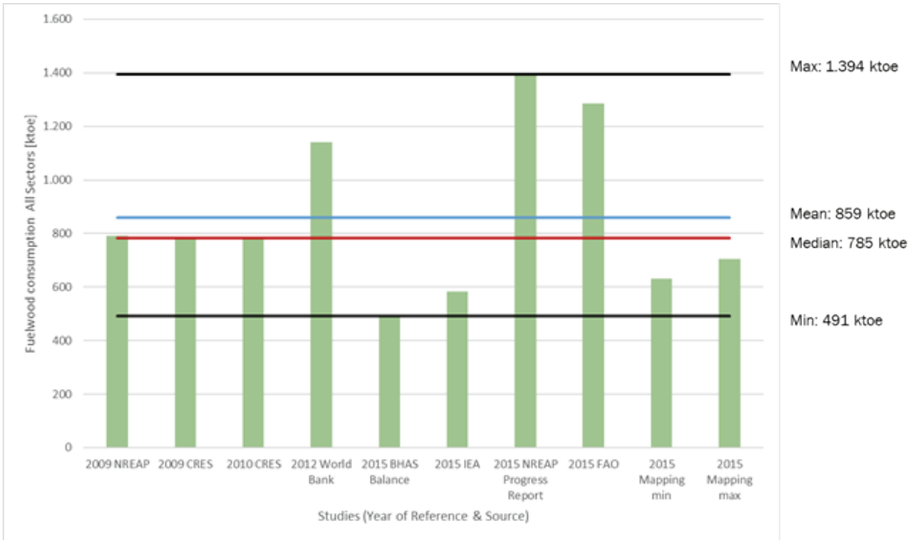


Figure 17. Fuel wood consumption (all sectors)[54,55,56,57,58,59,60,61]

[51] National Renewable Energy Action Plan (NREAP) Bosnia and Herzegovina for 2010–2020.
[52] Agency for Statistics of Bosnia and Herzegovina, Survey on Household Energy Consumption in Bosnia and Herzegovina 2015. Energy Community Treaty (2015).
[53] Agency for Statistics of Bosnia and Herzegovina, SEE 2020 Indicator 9 'Share of Renewable Energy in Gross Final Consumption (2017).
[54] National Renewable Energy Action Plan (NREAP) Bosnia and Herzegovina for 2010–2020.
[55] Centre for Renewable Energy Sources and Saving, Study on the Biomass Consumption for Energy Purposes in the Energy Community (2012).
[56] World Bank, Biomass-based Heating in the Western Balkans – A Roadmap for Sustainable Development (2017).
[57] Agency for Statistics of Bosnia and Herzegovina, Energy Balance for Bosnia and Herzegovina 2014–2016.
[58] International Energy Agency, Bosnia and Herzegovina: Balances for 2015 (2018). Available from www.iea.org/statistics/statisticssearch/report/?year=2015&country=BOSNIAHERZ&product=Balances.
[59] National Renewable Energy Action Plan (NREAP) Progress Report 2015.
[60] Food and Agriculture Organization, Wood Fuels Consumption in 2015 in Bosnia and Herzegovina (2016).
[61] The mapping values are based on the monitoring results in Chapter 2 (2.2.2) of this report.

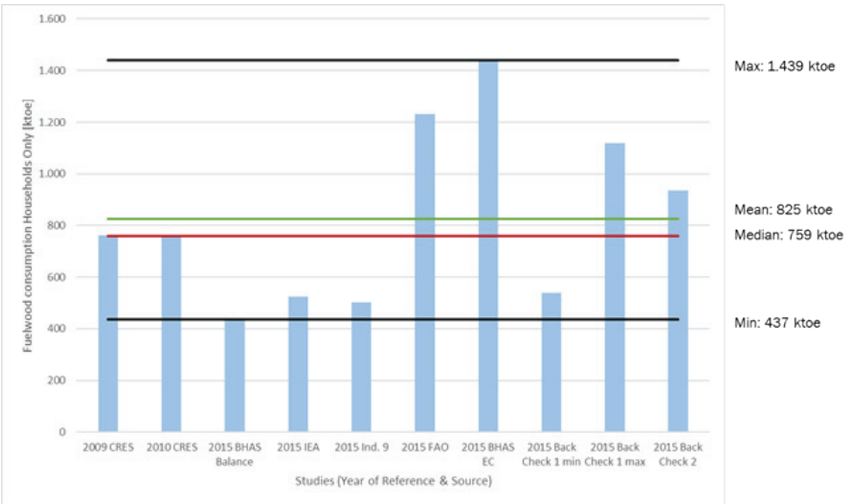


Figure 18. Fuel wood consumption (households only[62,63,64,65,66,67,68]

The figures show that the discrepancies in the studies for all sectors as well as those for households are very significant. Minimum, maximum as well as statistical mean and median were indicated in order to better illustrate the bandwidth of the values. Considering only the household studies and the reference year of 2015, the values range from 437 ktoe[69] to 1,439 ktoe.[70] This large bandwidth of fuel wood consumption is the result of different methodologies (e.g. top-down, bottom-up, calculation), data collection methods (e.g. survey and interview) and different assumptions and estimates as well as extrapolation errors. Many elements influenced fuel wood consumption yet it can be difficult to collect reliable data in this respect. Figure 19 illustrates the different elements that influence the overall amount of fuel wood consumption and highlight the availability of data.

The individual studies are commented on in more detail in the following section and recommendations provided on establishing accurate values.

As explained in Chapter 1 (1.2), the Western Balkans and especially Bosnia and Herzegovina has a high share of wood biomass consumption in the household sector. This fact is reflected strongly in the gross renewable energy source share of total final energy consumption (see tables 3 and 4). This significantly affects the achievement of the 2020 targets in terms of the share of renewable energy sources in the final consumption (see Table 1). The baseline value for biomass consumption in Bosnia and Herzegovina for the year 2009 is indicated in the National Renewable Energy Action Plan (NREAP)[71] at 792 (see Figure 17). The methodology for setting this value was based on expert assessment and therefore it is not comparable with the surveys and evaluations conducted to monitor biomass consumption in subsequent years. This is why the different target achievements published for biomass consumption for the period 2014–2016 do not directly reflect the actual trend compared to the 2009 value.

In order to monitor the changes in the contribution made by biomass to the renewable energy sources target up until 2020 Bosnia and Herzegovina must ensure that the assessment of interim results and targets remains as close as possible to the baseline assessment. Considering the extent of market development in the past

[62] Centre for Renewable Energy Sources and Saving, Study on the Biomass Consumption for Energy Purposes in the Energy Community (2012).
[63] Agency for Statistics of Bosnia and Herzegovina, Energy Balance for Bosnia and Herzegovina 2014–2016.
[64] International Energy Agency, Bosnia and Herzegovina: Balances for 2015 (2018). Available from www.iea.org/statistics/statisticssearch/report/?year=2015&country=BOSNIAHERZ&product=Balances.
[65] Agency for Statistics of Bosnia and Herzegovin, SEE 2020 Indicator 9 'Share of Renewable Energy in Gross Final Consumption' (2017).
[66] Food and Agriculture Organization, Wood Fuels Consumption in 2015 in Bosnia and Herzegovina, 2016.
[67] Agency for Statistics of Bosnia and Herzegovin, Energy Community Treaty, Survey on Household Energy Consumption in Bosnia and Herzegovina 2015 (2015).
[68] The back-checking calculations are explained in Chapter 4 (4.3) of this report.
[69] Agency for Statistics of Bosnia and Herzegovin, Energy Balance for Bosnia and Herzegovina 2014-2016.
[70] Agency for Statistics of Bosnia and Herzegovin, Survey on Household Energy Consumption in Bosnia and Herzegovina 2015, Energy Community Treaty (2015).
[71] National Renewable Energy Action Plan (NREAP) Bosnia and Herzegovina for 2010–2020.

decade, it is apparent that fuel wood utilisation has increased slightly through the utilisation of woodchips in district heating systems and public buildings and wood pellets in larger buildings and households whereas modern households in the larger urban areas have switched to gas, heat pumps and electricity. Separate assessments are made of the biomass consumption of district heating systems and public buildings. Therefore, it can be assumed that the anticipated strong market changes in biomass consumption in households that were implied through the different data between 2009 and 2016 (50 to 200% of the 2009 value) have not occurred in Bosnia and Herzegovina.

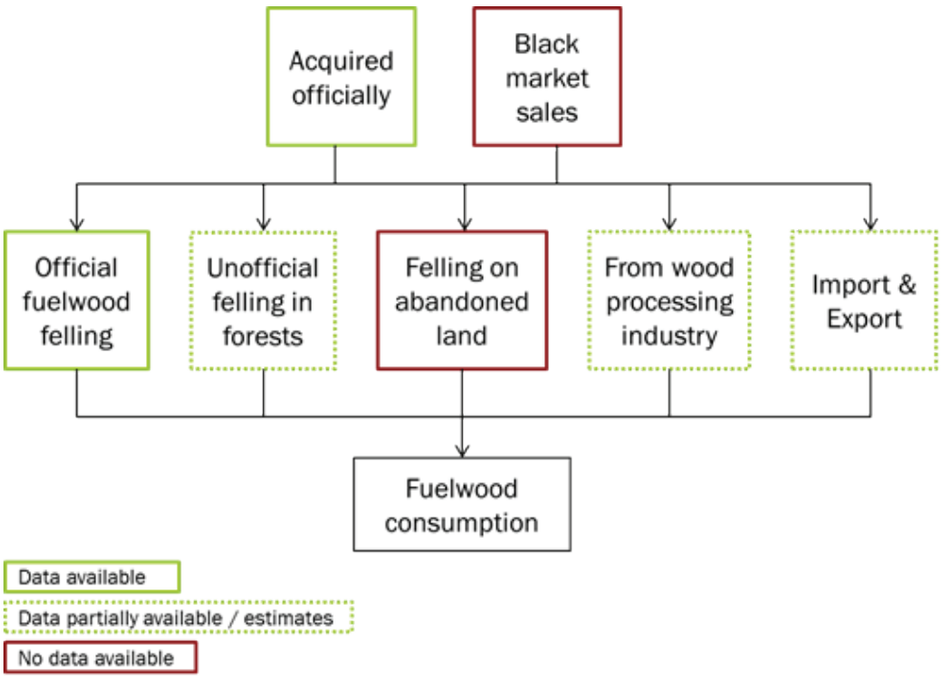


Figure 19. Elements that influence fuel wood consumption

Figure 19 is self-explanatory and shows that many elements can influence fuel wood consumption; however, not all elements can be captured statistically or otherwise.

4.2 Examination of the methodological approaches

The methodology of choice, e.g. bottom-up, top-down and calculation, also influences the quality of the result. Without referring to specific studies, Table 15 briefly highlights the differences, advantages and disadvantages of the three methodological approaches prior to making an in-depth analysis of the studies.

Table 15. Overview of the methodologies used for establishing fuel wood consumption

	Top-down Approach	*Bottom-up Approach*	Calculation
Description of the methodology	A top-down approach considers official data and follows the official channels through which fuel wood is sourced and traded.	The bottom-up approach considers the current usage of fuel wood in households, regardless of the source.	Calculation of fuel wood consumption based on household numbers, average heat consumption per m^2 and assumptions on the space heated.
Advantages	Available data is reliable (official statistics) and partially considers unofficial non-registered pathways, e.g. unofficial, non-registered felling in forests.	Because the data on fuel wood consumption is collected independent of the source (collection of 'real data' from residents), all sources are considered.	All sources are considered, because the calculation is based on consumption and not supply.
Disadvantages	It does not consider all unofficial non-registered pathways.	Depending on the sample size, there is a high probability of extrapolation error; the data quality is reliant on the truthfulness and reliability of the respondents.	Large bandwidths and error are possible, based on the accuracy of the assumptions.
Expected values of fuel wood consumption	Low (as not all sources are considered).	High (Taking into consideration the probability of extrapolation error and the data quality).	It covers the entire bandwidth (depending on the assumptions).

4.2.1 Bottom-up studies

This chapter takes a closer look at the three studies considering fuel wood consumption in households using the bottom-up approach. Table 16 provides an overview of several studies on fuel wood consumption that are currently available in Bosnia and Herzegovina.

Table 16. Bottom-up studies on fuel wood consumption in households

Basic Information			Methodology	
Study	Year	All sectors / households (ktoe)	Advantages	Shortcomings
CRES, EC (2012)[72]	2009/10. 2010/11.	789/763 780/754	• Sample based on strata sampling • Sound methodological framework • 82% of households use biomass	• Not based on the latest census • Different reference year
FAO (2016),[73] Glavonjić i ostali (2017)[74]	2015.	1.286/1.232	• Based on latest census • 75% of households use biomass	• Insufficient description of the methodology • Poor sampling strategy
BHAS, EC (2015)[75] , Robina and Loncarevic (2017)[76]	2014.	-/1.439	• Based on latest census • 75% of households use biomass	• Sampling strategy not clearly described • Household responses prone to credibility error • Very high conversion factor (energy to mass) • Different reference year

[72] Centre for Renewable Energy Sources and Saving, Study on the Biomass Consumption for Energy Purposes in the Energy Community (2012).
[73] Food and Agriculture Organization, Wood Fuels Consumption in 2015 in Bosnia and Herzegovina (2016).
[74] Glavonjić, B., Oblak, L., Čomić, D., Lazerević, A. and Kalem, M., 'Wood fuels consumption in households in Bosnia and Herzegovina'. Thermal Science Journal (2017).
[75] Agency for Statistics of Bosnia and Herzegovina, Survey on Household Energy Consumption in Bosnia and Herzegovina 2015, Energy Community Treaty (2015).
[76] Robina, V.K.G. and Lončarević, A.K., 'Implementation of the new statistics approach on final energy consumption of biomass in household sector in three countries: Croatia, Bosnia and Herzegovina and Macedonia', Energy Conversion and Management 149, (2017) pp.1010-1018.

The Centre for Renewable Energy Sources and Saving (CRES) published EC (2012) in 2012 and provided values for the 2009/10 and 2010/11 heating periods. Overall, the study is methodologically sound. It utilises a survey methodology with a sample selection based on strata sampling. However, the underlying values in relation to the number of households, which is highly influential on the sample selection, were not based on the latest census carried out in 2013. This means that even though the methodological approach can be considered correct one significant element is defective.

The other two studies conducted by the Food and Agriculture Organization (2016) and Glavonjic et al. (2017) and the one conducted by the Statistics Agency for Bosnia and Herzegovina (Energy Community Treaty, 2015) and Robina and Loncarevic (2017) using the bottom-up approach do not describe their methodological approaches in detail. The sampling strategy does not correspond to the type typically used in strategies applied to quantity and survey based studies. Both surveys took a 1 per cent sample of the total number of households based on the 2013 census. However, it is not explained why 1 per cent was deemed an adequate sample size. Furthermore, the selection of interviewees was not in accordance with the strata sampling. Therefore, although the study may be replicable it is unclear whether the selected sample correctly represents the population. Furthermore, because respondents might not always be truthful surveys are by nature prone to credibility error. The assumed conversion factor of 9,000 MJ/m^3 is also high compared to other studies (Robina and Loncarevic, 2017).

All three studies also collected information such as 'm^3 wood biomass used in one year', which is a value that interviewees would have found difficult to provide because fuel wood is typically bought in small quantities over the course of the year or heating period rather than at one time or large amounts for the entire period. The value that can be assumed most accurate is the number of households using fuel wood, because this is a simple yes/no question and therefore subject to the least amount of error. Considering that the Food and Agriculture Organization (2016) and Glavonjic et al. (2017) and the Statistics Agency for Bosnia and Herzegovina (Energy Community Treaty, 2015) and Robina and Loncarevic (2017) all came to the conclusion that 75 per cent of households use fuel wood this value will be used for the following back-checking calculations until a better value becomes available.

4.2.2 Top-down studies

In October 2017, the Statistics Agency for Bosnia and Herzegovina published the SEE 2020 Indicator 9 study on the 'Share of Renewable Energy in Gross Final Consumption'.[77] Unlike the studies described in the previous chapter, this study adopted a top-down methodological approach to determining the share of fuel wood consumption. Based on official reporting and statistics on the sale of wood assortments and firewood, a biomass consumption of 494 ktoe was calculated. Yet this value is also prone to error as it was based on an assessment of the share of unofficial non-registered felling and there was no further validation of this assessment. Furthermore, the analysis validated itself against International Energy Agency (IEA) values based on statistics provided by the Statistics Agency for Bosnia and Herzegovina and hence the analysis goes in circles.

4.3 Back-checking calculations

The following presents two options for back-checking calculations, using 2015 and 2016 as the reference years. According to the 2013 census, Bosnia and Herzegovina has 1,155,736 households. The back-checking calculations used the most accurate results from surveys and information from other studies or statistical data in order to establish a value for fuel wood consumption in households to use from 2015 onwards. The energy consumption for household heating from other sources (see Table 17) was taken from the Energy Balance for Bosnia and Herzegovina and can be considered correct because the reporting for other fuels is much less defective than for fuel wood consumption.

Table 17. Other sources for household heating (all values in ktoe) energy balance (2014, 2015 and 2016)

Bosnia and Herzegovina	2014.	2015.	2016.
District Heating Systems	84 ktoe	97 ktoe	95 ktoe
Coal	57 ktoe	55 ktoe	73 ktoe

[77] The Agency for Statistics of Bosnia and Herzegovina, SEE 2020 Indicator 9 'Share of Renewable Energy in Gross Final Consumption (2017).

Fuel oil	85 ktoe	77 ktoe	85 ktoe
Natural gas	27 ktoe	33 ktoe	35 ktoe
Electricity [78]	50 ktoe	50 ktoe	50 ktoe
Total	303 ktoe	312 ktoe	338 ktoe

4.3.1 Option 1

Back-checking calculation Option 1, using 2015 as the reference year, is presented below in Table 18. It used values on average heat consumption, the heated area and the efficiency of the heating systems taken from Arnautovic-Aksic et al. (2016)[79] and expert assessments.

Table 18. Back-checking calculation Option 1, reference year 2015.

	Minimum	Maximum
Annual average heat consumption (excluding cooking) [80]	130 kWh/m^2	160 kWh/m^2
Average heated area [81]	50 m^2	70 m^2
Average efficiency	70 %	75 %
Total energy consumption for heating in households (annual)	923 ktoe	1.484 ktoe
Other fuel sources (annual)	- 312 ktoe	- 312 ktoe
Biomass consumption in households	**611 ktoe**	**1.172 ktoe**

Even though Option 1 provides a bandwidth and does not narrow fuel wood consumption in households down to one value, it shows that the survey-based values can be considered too high. It can be concluded, based on the methodological approach utilised by Arnautovic-Aksic et al. (2016), that the values given in Table 18 are much more reliable than the values from the other surveys.

4.3.2 Option 2

Option 2 was developed in order to establish one value for fuel wood consumption that can be used for official recording. This option is based on the two assumptions:

(1)The values for other sources of household heating are accurate and taken from the energy balance.[82] The total of other sources used for household heating is 312 ktoe (2015) (see Table 17).

(2)If 75 per cent of all households use fuel wood[83,84,85,86] then the 312 ktoe from other sources makes up 25 per cent of total energy consumption in households

Using these two assumptions and the simple 'rule of three' leads to the fuel wood consumption shown in Table 19.

[78] Total electricity consumption in households = 396 ktoe (2014), 406 ktoe (2015) and 407 ktoe (2016), electricity for heating based on expert assessment.
[79] Arnautovic-Aksic, D., and others, Typology of Residential Buildings in Bosnia and Herzegovina (2016).
[80] According to the Food and Agriculture Organization (2016) it is 160.7 kWh/m^{2}a, while the Agency for Statistics of Bosnia and Herzegovina and the Energy Community Treaty (2015) combined with Robina and Loncarevic (2017) place it at 263.2 kWh/m^{2}a.
[81] According to the Food and Agriculture Organization (2016) it is 71 m^2, whereas the Agency for Statistics of Bosnia and Herzegovina and the Energy Community Treaty (2015) place it at 51 m^2.
[82] Agency for Statistics of Bosnia and Herzegovina, Energy Balance for Bosnia and Herzegovina 2014–2016.
[83] Food and Agriculture Organization, Wood Fuels Consumption in 2015 in Bosnia and Herzegovina (2016).
[84] Glavonjić, B., Oblak, L., Čomić, D., Lazerević, A. and Kalem, M., 'Wood fuels consumption in households in Bosnia and Herzegovina', Thermal Science Journal (2017).
[85] Agency for Statistics of Bosnia and Herzegov, Survey on Household Energy Consumption in Bosnia and Herzegovina 2015, Energy Community Treaty (2015).
[86] Robina, V.K.G. and Lončarević, A.K., 'Implementation of the new statistics approach on final energy consumption of biomass in household sector in three countries: Croatia, Bosnia and Herzegovina and Macedonia', Energy Conversion and Management, 149, (2017) pp. 1010-1018.

Table 19. Back-checking calculation Option 2 for Bosnia and Herzegovina 2014, 2015 and 2016.

Bosnia and Herzegovina	2014.	2015.	2016.
Households using non-biomass (≙ 25%)	303 ktoe	312 ktoe	338 ktoe
All households (≙ 100 %)	1.212 ktoe	1.248 ktoe	1.352 ktoe
Households using biomass (≙ 75 %)	**909 ktoe**	**936 ktoe**	**1.014 ktoe**

The different efficiencies of heating appliances per technology and fuel can be neglected because as opposed to natural gas and fuel oils the advantages and disadvantages of biomass systems balance each other. Wood based heating systems generally have lower working hours (less comfort demand) and are heated partly through other materials (coal based fuels, lignite or waste materials). The utilisation for biomass as a fuel for cooking appliances is neglected here as well, considering that a share of natural gas and coal, as given in the energy balance for household utilisation, is also used for cooking purposes.

As long as other sources for household heating are listed explicitly in the energy balance then this approach can also be applied. Currently, energy balances for Bosnia and Herzegovina at the state level and for Republika Srpska[87] allow for the implementation of the presented approach of Option 2. It is therefore recommended that entity reporting on the energy balance of the Federation of Bosnia and Herzegovina be aligned with that of the national energy balance in order to utilise this approach at the entity level.

4.4 Recommendations

The following conclusions can be drawn considering that the figure of 75 per cent of households using wood biomass was taken from surveys applying an uncertain methodological approach.

(1) Existing top-down and bottom-up approaches are subject to error and cannot be taken as is.

(2) Most reliable values from existing studies are utilised to develop back-checking calculations.

(3) Back-checking calculation Option 2 is currently the most accurate value available and hence should be used for official recording.

(4) As both surveys reach the same percentage of households using biomass, the percentage of 75 per cent can be used until it can be verified through a new survey.

(5) Any new survey should follow the CRES (2012)[88] methodology or a similar strata sampling approach and based on the 2013 census in order to collect the most accurate data possible.

(6) Any new survey should be simplified and used predominantly to establish the percentage of households using wood biomass, because data collected on m^3 of wood consumed is subject to error.

(7) The reporting of wood biomass in other sectors should continue as is.

(8) Reporting on the energy balances of the Federation of Bosnia and Herzegovina should be adapted to provide information on other sources of household heating (similar to the national energy balances and those for Republika Srpska) in order to enable the application of the back-checking calculation Option 2.

[87] Republika Srpska Institute of Statistics, Energy Balances in 2018 (2019). Available from www2.rzs.rs.ba/static/uploads/bilteni/energetika/Bilten_Energetski_bilansi_2018_WEB.pdf.
[88] Centre for Renewable Energy Sources and Saving, Study on the Biomass Consumption for Energy Purposes in the Energy Community (2012).

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Bibliography

Arnautovic-Aksic, D., and others. Typology of Residential Buildings in Bosnia and Herzegovina. 2016.

Bayerische Landesanstalt für Landwirtschaft (2013), Basisdaten

Agency for Statistics of Bosnia and Herzegovina. SEE 2020 Indicator 9 'Share of Renewable Energy in Gross Final Consumption'. 2017.

Agency for Statistics of Bosnia and Herzegovina. Survey on Household Energy Consumption in Bosnia and Herzegovina 2015. Energy Community Treaty. 2015.

Agency for Statistics of Bosnia and Herzegovina. Energy Balance for Bosnia and Herzegovina 2014-2016.
Brosowski, A., and others. The Impact of Biogenic Residues, Wastes and By-Products: Development of a National Resource Monitoring Based on the Example of Germany.

Brosowski, A., and others. A review of biomass potential and current utilization - Status quo for 93 biogenic wastes and residues in Germany. Biomass and Bioenergy 95, pp. 257-272 (2016).

Corbelle, E. and Crecente, R. Land abandonment: Concept and consequences. Revista Galega de Economia 17(2), (2008).

Centre for Renewable Energy Sources and Saving. Study on the Biomass Consumption for Energy Purposes in the Energy Community. 2012.

United Nations, Food and Agriculture Organization. Wood Fuels Consumption in 2015 in Bosnia and Herzegovina. 2016 and 2017.

First Progress Report for Bosnia and Herzegovina under Renewable Energy Directive 2009/28/EC. (December 2017).

Foreign Investment Promotion Agency of Bosnia and Herzegovina. Forestry and Wood Industry, 2011.
Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH. Gap Analysis of the Bioenergy Sector in Bosnia and Herzegovina. 2016.

Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH. Recommendations for Biofuels in Transport in Bosnia and Herzegovina. 2017.

Glavonjić, B., and others. Wood fuels consumption in households in Bosnia and Herzegovina. Thermal Science Journal (2017).

Hák, T., Janoušková, S. and Moldan, B. Sustainable Development Goals: A need for relevant indicators. Ecological Indicators 60, pp. 565–73 (2016).

Heller, M.C., Keoleian, G. A. and Volk, T. A. Life cycle assessment of a willow bioenergy cropping system. Biomass and Bioenergy, 25(2), pp.147-165 (2003).

International Energy Agency. Bosnia and Herzegovina: Balances for 2015. 2018. Available from www.iea.org/statistics/statisticssearch/report/?year=2015&country=BOSNIAHERZ&product=Balances.

Kaltschmitt, M., Hartmann, H. and Hofbauer, H., eds. Energie aus Biomasse: Grundlagen, Techniken und Verfahren, 3rd ed. Berlin: Springer, 2016.

Klašnja, S., Kopitovic, S. and Orlovic S. Variability of some wood properties of eastern cottonwood (Populus deltoides Bartr.) clones. Wood Science Technology 37, pp. 331–337 (2003).

Knezevic, D., Kondic, D., Srdic, S. and Paunovic, A., eds. Harvest index and components of yield in winter wheat cultivars (Triticum aestivum L.). 2015.

Kranjc, N. Wood fuels handbook. Pristina: Food and Agriculture Organization of the United Nations, 2015.

Ljuša, M. Trends and characteristics of the change of use of agricultural land in Bosnia and Herzegovina. 2015.

Müller A., and others. The Role of Biomass in the Sustainable Development Goals: A Reality Check and Governance Implications.

Bosnia and Herzegovina. National Renewable Energy Action Plan (NREAP) Bosnia and Herzegovina for 2010–2020.

National Renewable Energy Action Plan (NREAP) Progress Report 2015.

Osborn D., Cutter A. and Ullah F. Understanding the Transformational Challenge for Developed Countries: Report of a study by stakeholder forum.

Research Centre for Energy Resources and Consumption. EuroPruning Deliverable Reporting: D3.1 Mapping and analysis of the pruning biomass potential in Europe. 2014.

Robina, V.K.G. and Lončarević, A.K. Implementation of the new statistics approach on final energy consumption of biomass in household sector in three countries: Croatia, Bosnia and Herzegovina and Macedonia. Energy Conversion and Management, 149, pp.1010-1018 (2017).

Rose, S., and others. Bioenergy in energy transformation and climate management, Climatic Change 123, 477–93 (2014).

Republika Srpska Institute of Statistics. Energy balances in 2018. 2019. Available from www2.rzs.rs.ba/static/uploads/bilteni/energetika/Bilten_Energetski_bilansi_2018_WEB.pdf.

Scarlat, N., Blujdea, V. and Dallemand, J.F. Assessment of the availability of agricultural and forest residues for bioenergy production in Romania. Biomass and Bioenergy 35, 1995–2005 (2011).

Scheftelowitz, M., Schaubach, K. Methodology for biomass potentials in Bosnia and Herzegovina. 2017.

Simic, M., Dragicevic, V., Momirovic, N., Brankov, M. and Spasojevic, I., eds. The effect of organic and mineral fertilization in different cropping systems of maize. 2016.

Spinelli, R., Nati, C. and Magagnotti, N. Harvesting short-rotation poplar plantations for biomass production. Croatian Journal of Forest Engineering: Journal for Theory and Application of Forestry Engineering, 29(2), pp. 129-139 (2008).

Stafford-Smith, and others. Integration: The key to implementing the Sustainable Development Goals. Sustainability Science 12 911–9 (2017).

United Nations, Report of the United Nations Conference on Sustainable Development. A/CONF.216/16.

USAID, SIDA Utilization of low grade forest assortments and transformation of coppice forests in Bosnia and Herzegovina. 2013.

Weiser, C., and others. Integrated assessment of sustainable cereal straw potential and different straw-based energy applications in Germany. Applied Energy, 114, 749–62 (2014).

World Bank. Biomass-based Heating in the Western Balkans – A Roadmap for Sustainable Development. 2017.

ANNEX A1 CALCULATION FLOWCHARTS

		National consistent	International consistent			
ID	CODE	Level-1	Level-2	Level-3	Level-4	Level-5
1	IWC	Industrial wood coniferous	Stemwood coniferous	Stemwood	Main products from forestry and wood industries	Forestry biomass
2	FWC	Fuel wood coniferious	Stemwood coniferous	Stemwood	Main products from forestry and wood industries	Forestry biomass
3	IWD	Industrial wood deciduous	Stemwood deciduous	Stemwood	Main products from forestry and wood industries	Forestry biomass
4	FWD	Fuel wood deciduous	Stemwood deciduous	Stemwood	Main products from forestry and wood industries	Forestry biomass
5	AIC	Annual increment of coniferous forest	Stemwood coniferous	Stemwood	Main products from forestry and wood industries	Forestry biomass
6	AID	Annual increment of deciduous forest	Stemwood deciduous	Stemwood	Main products from forestry and wood industries	Forestry biomass
7	WWC	Waste wood coniferous	Logging residues coniferous	Logging residues	By-products from forestry and wood industries	Forestry biomass
8	WWD	Waste wood deciduous	Logging residues deciduous	Logging residues	By-products from forestry and wood industries	Forestry biomass
9	BWP	By products of wood processing industries	-	Industrial waste wood	By-products from forestry and wood industries	Forestry biomass
10	BLL	Black liquor	-	Industrial waste wood	By-products from forestry and wood industries	Forestry biomass
11	CST	Cereal straw	Straw	By-products from annual crops	Agricultural by-products	Agricultural biomass
12	MST	Maize straw	Straw	By-products from annual crops	Agricultural by-products	Agricultural biomass
13	COC	Corn Cobs	-	By-products from annual crops	Agricultural by-products	Agricultural biomass
14	PRR	Pruning residues from raspberries	By-products from perennial crops	Prunings	Agricultural by-products	Agricultural biomass
15	PRO	Pruning residues from orchards	By-products from perennial crops	Prunings	Agricultural by-products	Agricultural biomass
16	PRV	Pruning residues from vineyards	By-products from perennial crops	Prunings	Agricultural by-products	Agricultural biomass
17	CAS	Cattle slurry	Animal slurry	By-products from livestock production	Agricultural by-products	Agricultural biomass
18	PIS	Pig slurry	Animal slurry	By-products from livestock production	Agricultural by-products	Agricultural biomass
19	CAM	Cattle manure	Solid manure	By-products from livestock production	Agricultural by-products	Agricultural biomass
20	PIM	Pig manure	Solid manure	By-products from livestock production	Agricultural by-products	Agricultural biomass
21	POM	Poultry manure	Solid manure	By-products from livestock production	Agricultural by-products	Agricultural biomass
22	SHM	Sheep manure	Solid manure	By-products from livestock production	Agricultural by-products	Agricultural biomass
23	GOM	Goat manure	Solid manure	By-products from livestock production	Agricultural by-products	Agricultural biomass

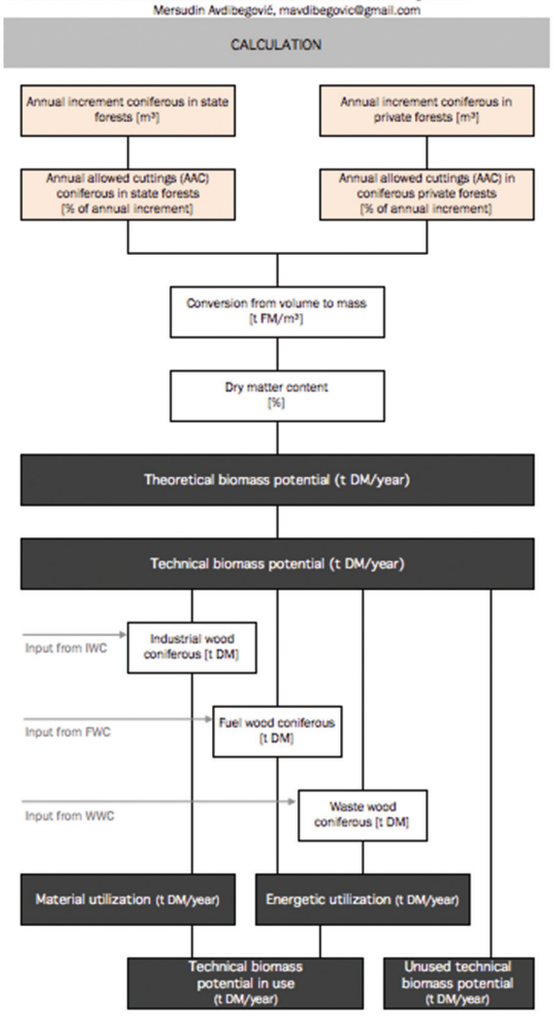
Advisory for biomass potential map development

Main, by-products and residues

26/09/18

ID..... AIC
Biomass..... Annual increment of coniferous forest
Raw material..... Wood
Production process..... Production of wood
Definition..... Part of tree from the felling cut to the tree top, with the branches removed, including bark
Contact..... Aleksandar Mrkobrada aleksandar.mrkobrada@gmail.com
Mersudin Avdibegović, mavdibegovic@gmail.com

Categorization
Level-5..... Forestry biomass
Level-4..... Main products from forestry and wood industries
Level-3..... Sternwood
Level-2..... Sternwood coniferous



CALCULATION	Responsible	Source of data	Update	Data quality	Spatial level
Annual increment coniferous in state forests [m³]	[1-4]	Statistics [1-4]	Annual		M
Annual increment coniferous in private forests [m³]	[1-4]	Statistics [1-4]	Annual		M
Annual allowed cuttings (AAC) coniferous in state forests [% of annual increment]	Research Institutes (Universities)	Literature [5]	One-time		N
Annual allowed cuttings (AAC) in coniferous private forests [% of annual increment]	Research Institutes (Universities)	Literature [5]	One-time		N

dynamic calculation element

Explanation & Sources:

M = Municipality; E = Entity; N = National; I = International

Due to detailed statistical database it is not needed to consider further calculation elements.

[1] BiH Agency of Statistics (2017)
[2] Federal Office of Statistics (2012); Federal Office of Statistics (2017)
[3] FBiH: Cantonal Forest Enterprises, Cantonal Forest Offices
[4] JP Sume RS
[5] Krajnc (2015)

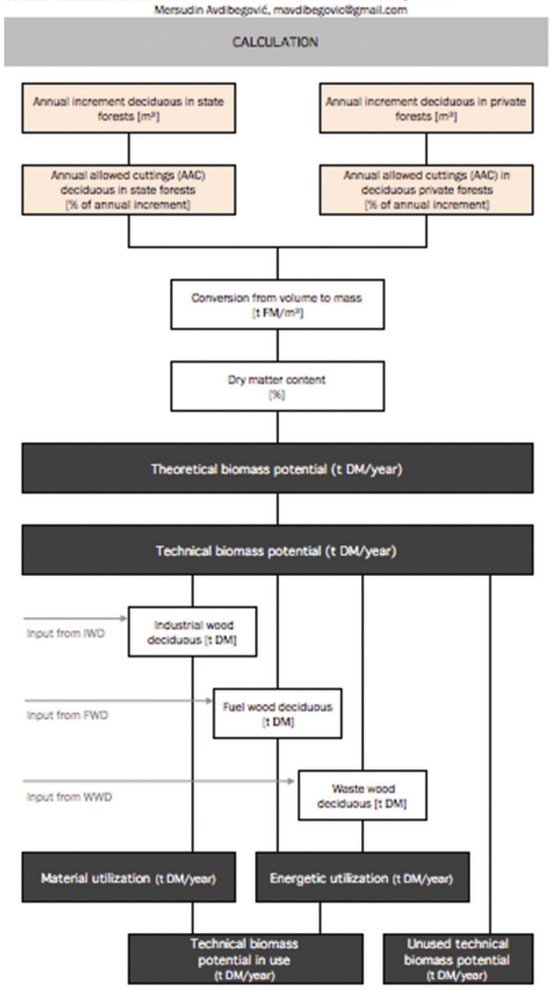
Advisory for biomass potential map development

Main, by-products and residues

26/09/18

ID..... AID
Biomass..... Annual increment of deciduous forest
Raw material..... Wood
Production process..... Production of wood
Definition..... Part of tree from the felling cut to the tree top, with the branches removed, including bark
Contact..... Aleksandar Mrkobrada aleksandar.mrkobrada@gmail.com
Mersudin Avdibegović, mavdibegovic@gmail.com

Categorization
Level-5..... Forestry biomass
Level-4..... Main products from forestry and wood industries
Level-3..... Stemwood
Level-2..... Stemwood deciduous



CALCULATION	Responsible	Source of data	Update	Data quality	Spatial level
Annual increment deciduous in state forests [m³] / Annual increment deciduous in private forests [m³]	[1-4]	Statistics [1-4]	Annual		M
Annual allowed cuttings (AAC) deciduous in state forests [% of annual increment] / Annual allowed cuttings (AAC) in deciduous private forests [% of annual increment]	[1-4]	Statistics [1-4]	Annual		M
Conversion from volume to mass [t FM/m³]	Research Institutes (Universities)	Literature [5]	One-time		N
Dry matter content [%]	Research Institutes (Universities)	Literature [5]	One-time		N

Explanation & Sources:

M = Municipality; E = Entity; N = National; I = International

Due to detailed statistical database it is not needed to consider further calculation elements.

[1] BiH Agency of Statistics (2017)
[2] Federal Office of Statistics (2012); Federal Office of Statistics (2017)
[3] FBiH: Cantonal Forest Enterprises, Cantonal Forest Offices
[4] JP Sume RS
[5] Krajnc (2015)

dynamic calculation element

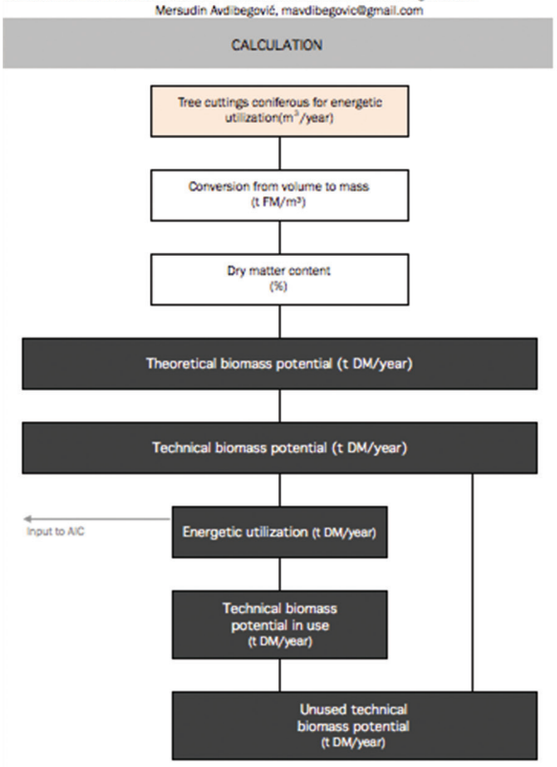
Advisory for biomass potential map development

Main, by-products and residues

26/09/18

ID..... FWC
Biomass..... Fuel wood coniferious
Raw material..... Wood
Production process..... Production of wood
Definition..... Part of tree from the felling cut to the tree top, with the branches removed, including bark
Contact..... Aleksandar Mrkobrada aleksandar.mrkobrada@gmail.com
Mersudin Avdibegović, mavdibegovic@gmail.com

Categorization
Level-5..... Forestry biomass
Level-4..... Main products from forestry and wood industries
Level-3..... Stemwood
Level-2..... Stemwood coniferous



Responsible	Source of data	Update	Data quality	Spatial level
[1,2,4]	Statistics [1,2,4]	Annual		C, E
Research Institutions (Universities)	Literature [3]	One-time		I
Research Institutions (Universities)	Literature [3]	One-time		I

dynamic calculation element

Explanation & Sources:

C = Canton; E = Entity; N = National; I = International

Due to detailed statistical database it is not needed to consider further calculation elements.

[1] BiH Agency of Statistics (2017)
[2] Federal Office of Statistics (2012); Federal Office of Statistics
[3] Krajnc (2015)
[4] JP Sume RS

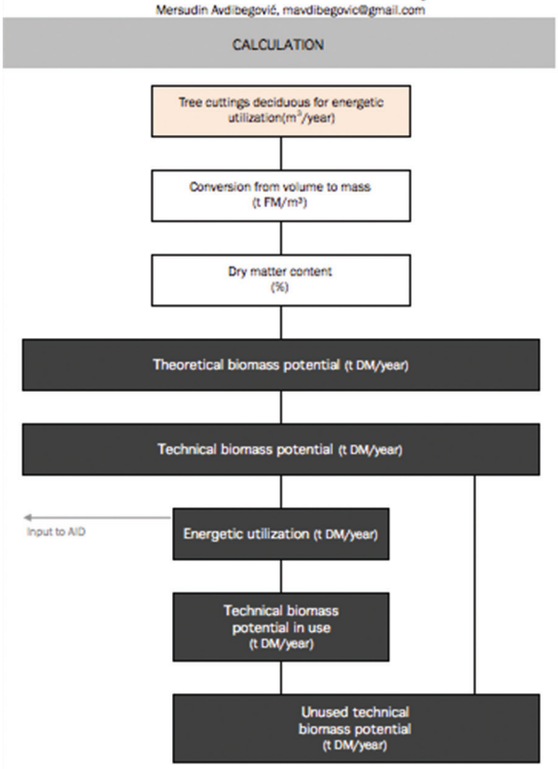
Advisory for biomass potential map development

Main, by-products and residues

26/09/18

ID..... FWD
Biomass..... Fuel wood deciduous
Raw material..... Wood
Production process..... Production of wood
Definition..... Part of tree from the felling cut to the tree top, with the branches removed, including bark
Contact..... Aleksandar Mrkobrada aleksandar.mrkobrada@gmail.com
Mersudin Avdibegović, mavdibegovic@gmail.com

Categorization
Level-5..... Forestry biomass
Level-4..... Main products from forestry and wood industries
Level-3..... Stemwood
Level-2..... Stemwood deciduous



Responsible	Source of data	Update	Data quality	Spatial level
[1,2,4]	Statistics [1,2,4]	Annual		C, E
Research Institutions (Universities)	Literature [3]	One-time		I
Research institutions (Universities)	Literature [3]	One-time		I

dynamic calculation element

Explanation & Sources:

C = Canton; E = Entity; N = National; I = International

Due to detailed statistical database it is not needed to consider further calculation elements.

[1] BiH Agency of Statistics (2017)
[2] Federal Office of Statistics (2012); Federal Office of Statistics
[3] Krajnc (2015)
[4] JP Sume RS

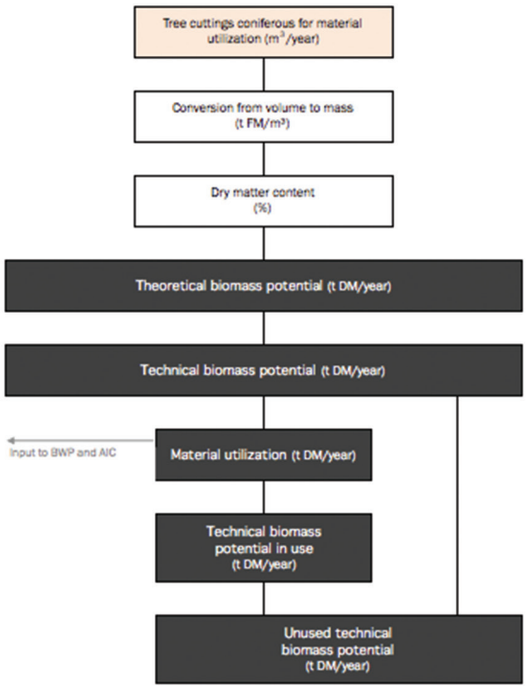
Advisory for biomass potential map development

Main, by-products and residues

26/09/18

ID..... IWC
Biomass..... Industrial wood coniferous
Raw material..... Wood
Production process..... Production of wood
Definition..... Part of tree from the felling cut to the tree top, with the branches removed, including bark
Contact..... Aleksandar Mrkobrada aleksandar.mrkobrada@gmail.com
Mersudin Avdibegović, mavdibegovic@gmail.com

Categorization
Level-5..... Forestry biomass
Level-4..... Main products from forestry and wood industries
Level-3..... Stemwood
Level-2..... Stemwood coniferous



CALCULATION	Responsible	Source of data	Update	Data quality	Spatial level
Tree cuttings coniferous for material utilization (m³/year)	[1,2,4]	Statistics [1,2,4]	Annual		C, E
Conversion from volume to mass (t FM/m³)	Research Institutions (Universities)	Literature [3]	One-time		I
Dry matter content (%)	Research institutions (Universities)	Literature [3]	One-time		I

Explanation & Sources:

C = Canton; E = Entity; N = National; I = International

Due to detailed statistical database it is not needed to consider further calculation elements.

[1] BiH Agency of Statistics (2017)
[2] Federal Office of Statistics (2012), Federal Office of Statistics (2017)
[3] Krajnc (2015)
[4] JP Sume RS

dynamic calculation element

Advisory for biomass potential map development

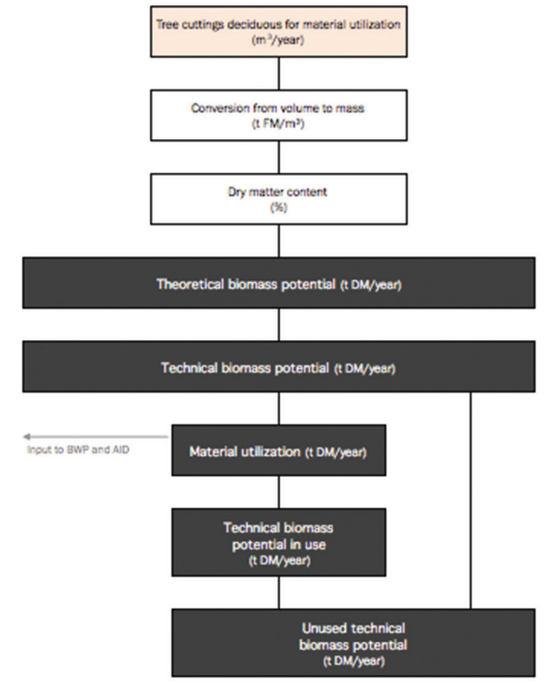
Main, by-products and residues

26/09/18

ID	IWD
Biomass	Industrial wood deciduous
Raw material	Wood
Production process	Production of wood
Definition	Part of tree from the felling cut to the tree top, with the branches removed, including bark
Contact	Aleksandar Mrkobrada aleksandar.mrkobrada@gmail.com Mersudin Avdibegović, mavdibegovic@gmail.com

Categorization

Level-5	Forestry biomass
Level-4	Main products from forestry and wood industries
Level-3	Stemwood
Level-2	Stemwood deciduous



Responsible	Source of data	Update	Data quality	Spatial level
[1,2,4]	Statistics [1,2,4]	Annual		C, E
Research Institutions (Universities)	Literature [3]	One-time		I
Research institutions (Universities)	Literature [3]	One-time		I

Number Format

dynamic calculation element

Explanation & Sources:

C = Canton; E = Entity; N = National; I = International

Due to detailed statistical database it is not needed to consider further calculation elements.

[1] BiH Agency of Statistics (2017)
[2] Federal Office of Statistics (2012), Federal Office of Statistics (2017)
[3] Krajnc (2015)
[4] JP Sume RS

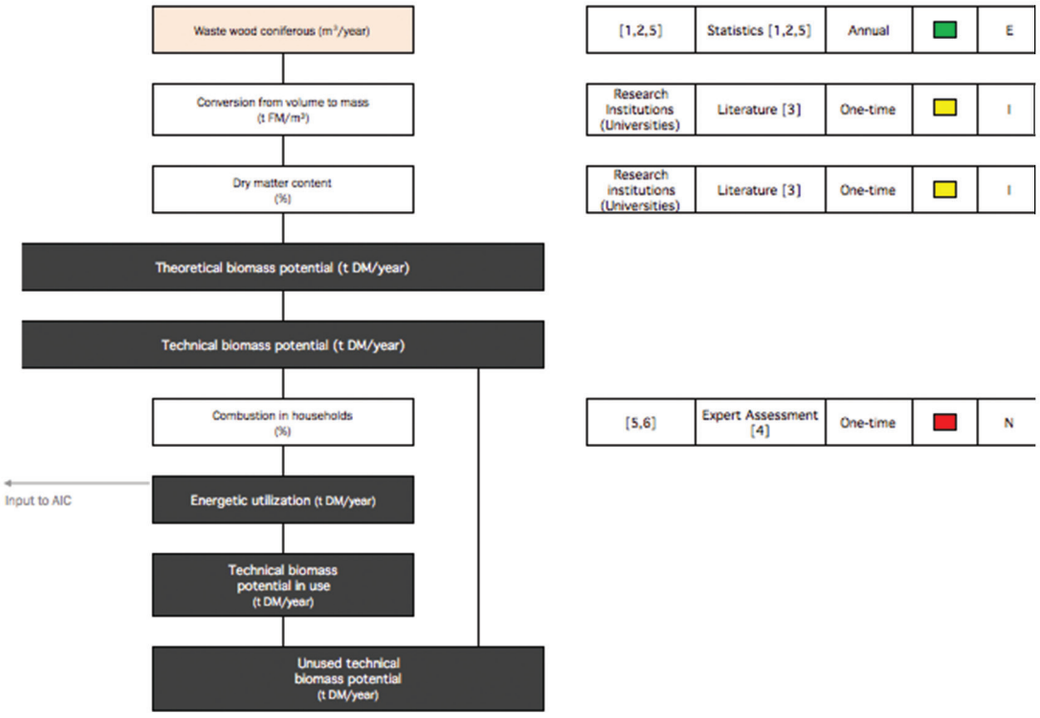
Advisory for biomass potential map development

Main, by-products and residues

26/09/18

ID..... WWC
Biomass..... Waste wood coniferous
Raw material..... Coniferous wood
Production process..... Production of wood assortiments
Definition..... Logging residues includes all parts of wood wich remain nonutilised in forest, during tree cutting (branches, rut, peel, stumps).[1]
Contact..... Aleksandar Mrkobrada aleksandar.mrkobrada@gmail.com
Mersudin Avdibegović, mavdibegovic@gmail.com

Categorization
Level-5..... Forestry biomass
Level-4..... By-products from forestry and wood industries
Level-3..... Logging residues
Level-2..... Logging residues coniferous



dynamic calculation element

Explanation & Sources:

M = Municipality; E = Entity; N = National; I = International

Due to detailed statistical database it is not needed to consider further calculation elements.

[1] BiH Agency of Statistics (2017)
[2] Federal Office of Statistics (2012), Federal Office of Statistics (2017)
[3] Krajnc (2015)
[4] refer to Appendix 3
[5] JP Sume RS
[6] FBiH: Cantonal Forest Enterprises, Cantonal Forest Offices

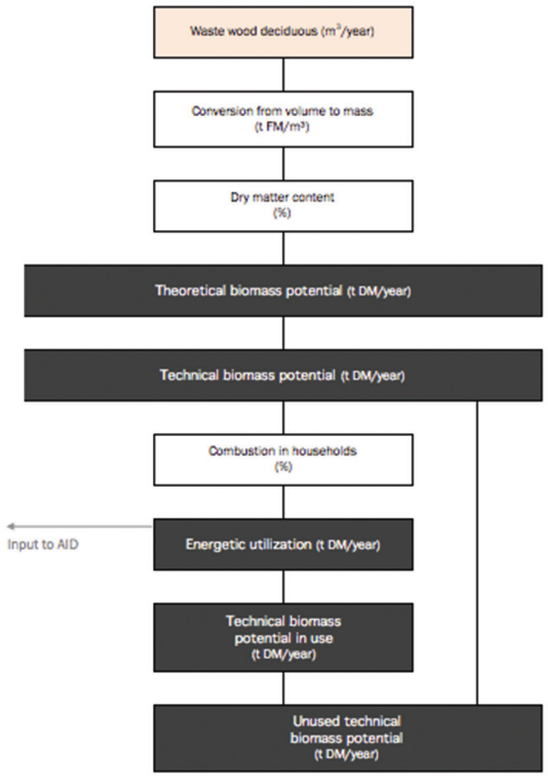
Advisory for biomass potential map development

Main, by-products and residues

26/09/18

ID..... WWD
Biomass..... Waste wood deciduous
Raw material..... Deciduous wood
Production process..... Production of wood assortiments
Definition..... Logging residues includes all parts of wood wich remain nonutilised in forest, during tree cutting (branches, rut, peel, stumps).[1]
Contact..... Aleksandar Mrkobrada aleksandar.mrkobrada@gmail.com
Mersudin Avdibegović, mavdibegovic@gmail.com

Categorization
Level-5..... Forestry biomass
Level-4..... By-products from forestry and wood industries
Level-3..... Logging residues
Level-2..... Logging residues deciduous



Responsible	Source of data	Update	Data quality	Spatial level
[1,2,5]	Statistics [1,2,5]	Annual		E
Research Institutions (Universities)	Literature [3]	One-time		I
Research institutions (Universities)	Literature [3]	One-time		I
[5,6]	Expert Assessment [4]	One-time		N

dynamic calculation element

Explanation & Sources:

M = Municipality; E = Entity; N = National; I = International

Due to detailed statistical database it is not needed to consider further calculation elements.

[1]BiH Agency of Statistics (2017)
[2] Federal Office of Statistics (2012), Federal Office of Statistics (2017)
[3] Krajnc (2015)
[4] refer to Appendix 3
[5] JP Sume RS
[6] FBiH: Cantonal Forest Enterprises, Cantonal Forest Offices

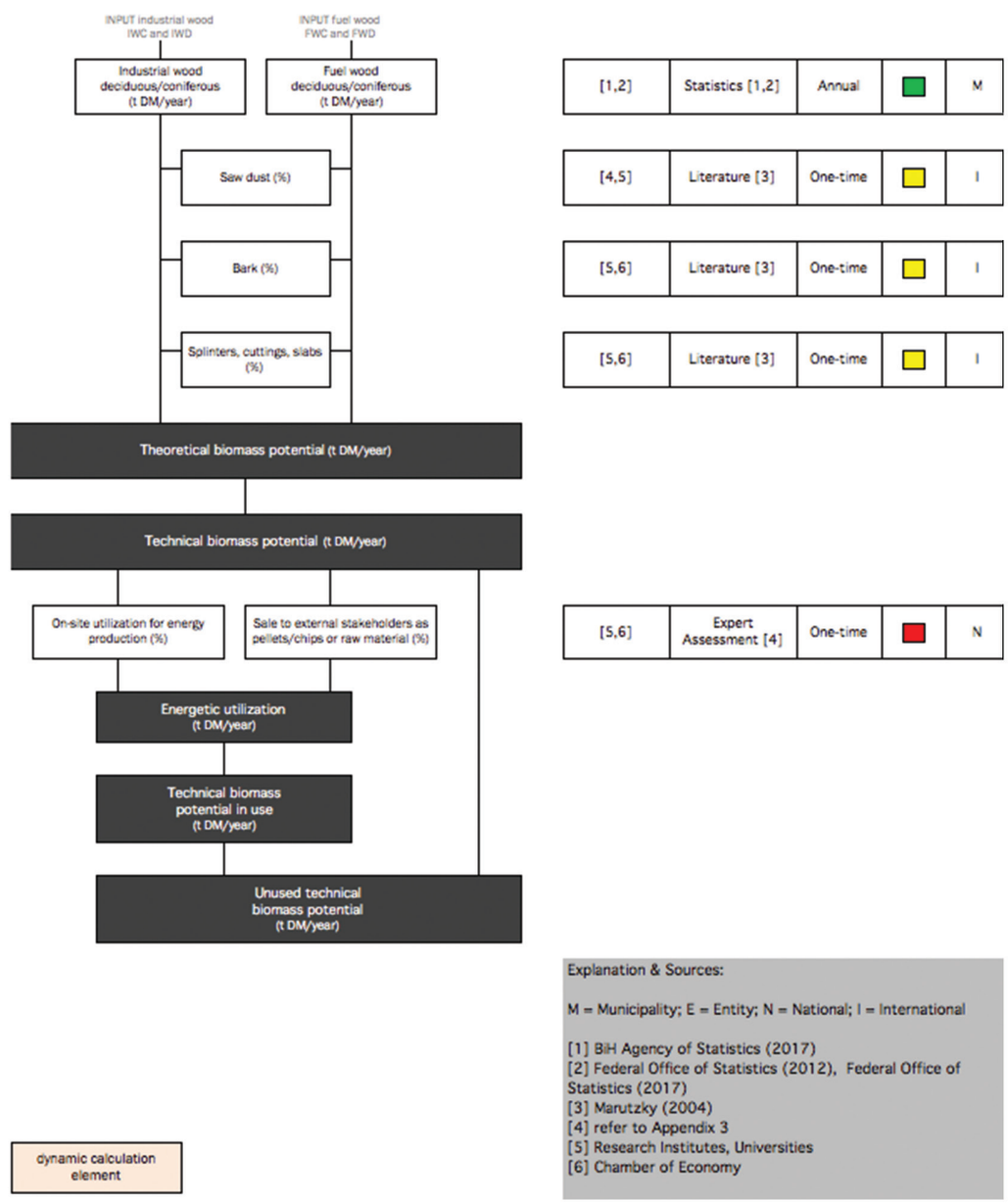
Advisory for biomass potential map development

Main, by-products, residues

26/09/18

ID..... BWP
Biomass..... By products of wood processing industries
Raw material..... Wood
Production process..... Production of wood assortiments
Definition..... Sawdust: Co-product of wood cutting, flat cuboid and pin-like shape. Chips: by-product of the chopping process in lumber production. Solid wood parts cut diagonal to the fiber direction. Slabs & splinters: co-products of the trimming of logwood (slabs) and board (splinters)
Contact..... Aleksandar Mrkobrada aleksandar.mrkobrada@gmail.com
Mersudin Avdibegović, mavdibegovic@gmail.com

Categorization
Level-5..... Forestry biomass
Level-4..... By-products from forestry and wood industries
Level-3..... Industrial waste wood
Level-2..... -



Explanation & Sources:

M = Municipality; E = Entity; N = National; I = International

[1] BiH Agency of Statistics (2017)
[2] Federal Office of Statistics (2012), Federal Office of Statistics (2017)
[3] Marutzky (2004)
[4] refer to Appendix 3
[5] Research Institutes, Universities
[6] Chamber of Economy

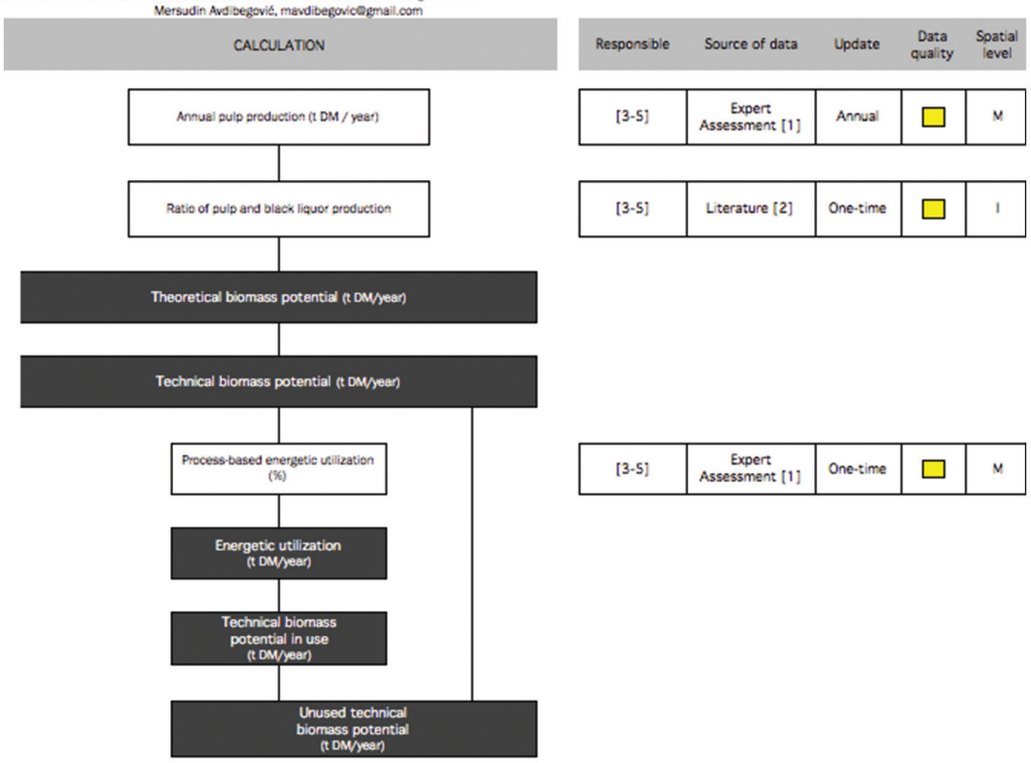
Advisory for biomass potential map development

Main, by-products, residues

26/09/18

ID..... BLL
Biomass..... Black liquor
Raw material..... Wood
Production process..... Pulp production
Definition..... Black liquor is a byproduct of pulp production. It results in the separation of lignin and cellulose, and is a mixture of lignin, water and the chemicals that are used for the extraction.
Contact..... Aleksandar Mrkobrada aleksandar.mrkobrada@gmail.com
Mersudin Avdibegović, mavdibegovic@gmail.com

Categorization
Level-5..... Forestry biomass
Level-4..... By-products from forestry and wood industries
Level-3..... Industrial waste wood
Level-2..... -



Responsible	Source of data	Update	Data quality	Spatial level
[3-5]	Expert Assessment [1]	Annual		M
[3-5]	Literature [2]	One-time		I
[3-5]	Expert Assessment [1]	One-time		M

dynamic calculation element

Explanation & Sources:

M = Municipality; E = Entitiy; N = National; I = International

[1] refer to Appendix 3
[2] Thrän et al. (2016)
[3] Ministry of Industry
[4] BiH Agency of Statistics (2017)
[5] Federal Office of Statistics (2012), Federal Office of Statistics (2017)

Advisory for biomass potential map development

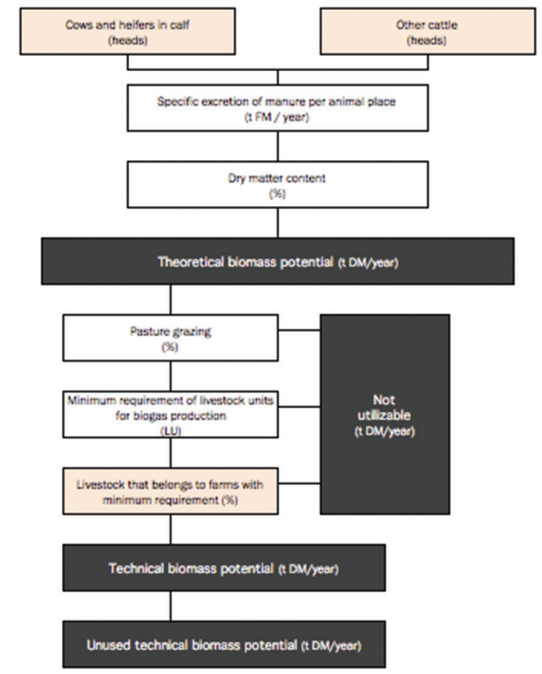
Main, by-products and residues

26/09/18

ID..... CAM
Biomass..... Cattle manure
Raw material..... Cattle
Production process..... Production of dairy products and beef
Definition..... Solid manure with straw litter,from dairy and beef cattle

Contact..... Dragan Comic, dcomic.sfbl@gmail.com
Hamid Custovic, custovic.hamid@gmail.com

Categorization
Level-5..... Agricultural biomass
Level-4..... Agricultural by-products
Level-3..... By-products from livestock production
Level-2..... Solid manure



Responsible	Source of data	Update	Data quality	Spatial level
Statistical Institutes	Statistics [1,2]	Annual		M
[5,7]	Expert Assessment [3]	One-time		N
[5,7]	Literature [4]	One-time		I
[5,7]	Expert Assessment [3]	One-time		N
[5,7]	Expert Assessment [3]	One-time		I
[2,6]	Statistics [1,2]	Annual		M

dynamic calculation element

Explanation & Sources:

M = Municipality; E = Entity; N = National; I = International

[1] BiH Agency of Statistics (2017)
[2] Federal Office of Statistics (2012), Federal Office of Statistics (2017)
[3] refer to Appendix 3
[4] Bayrische Landesanstalt für Landwirtschaft (2013)
[5] Faculty of Agriculture, University of Banja Luka; Faculty of Agriculture, University of East Sarajevo; Agriculture Institute of Republic Srpska
[6] Minstry of Agriculture, Forestry and Water Management (RS); Department of Agriculture, Veterinary Section (RS)
[7] Federal Institute for Agriculture (FBiH), Faculty of Agricultural and Food Sciences, University of Sarajevo

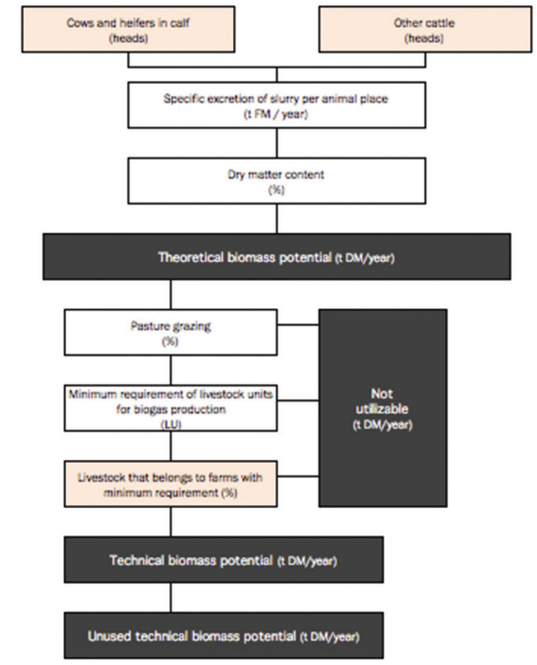
Advisory for biomass potential map development

Main, by-products and residues

26/09/18

ID..... CAS
Biomass..... Cattle slurry
Raw material..... Cattle
Production process..... Production of dairy products and beef
Definition..... Solid manure, liquid manure from dairy and beef cattle and rain and wastewater from milking systems and cattle housing
Contact..... Dragan Comic, dcomic.sfbl@gmail.com
Hamid Custovic, custovic.hamid@gmail.com

Categorization
Level-5..... Agricultural biomass
Level-4..... Agricultural by-products
Level-3..... By-products from livestock production
Level-2..... Animal slurry



Responsible	Source of data	Update	Data quality	Spatial level
Statistical Institutes	Statistics [1,2]	Annual		M
[5,7]	Expert Assessment [3]	One-time		N
[5,7]	Literature [4]	One-time		I
[5,7]	Expert Assessment [3]	One-time		N
[5,7]	Expert Assessment [3]	One-time		I
[2,6]	Statistics [1,2]	Annual		M

dynamic calculation element

Explanation & Sources:

M = Municipality; E = Entity; N = National; I = International

[1] BiH Agency of Statistics (2017)
[2] Federal Office of Statistics (2012), Federal Office of Statistics (2017)
[3] refer to Appendix 3
[4] Bayrische Landesanstalt für Landwirtschaft (2013)
[5] Faculty of Agriculture, University of Banja Luka; Faculty of Agriculture, University of East Sarajevo; Agriculture Institute of Republic Srpska
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[7] Federal Institute for Agriculture (FBiH), Faculty of Agricultural and Food Sciences, University of Sarajevo

Advisory for biomass potential map development

Main, by-products and residues

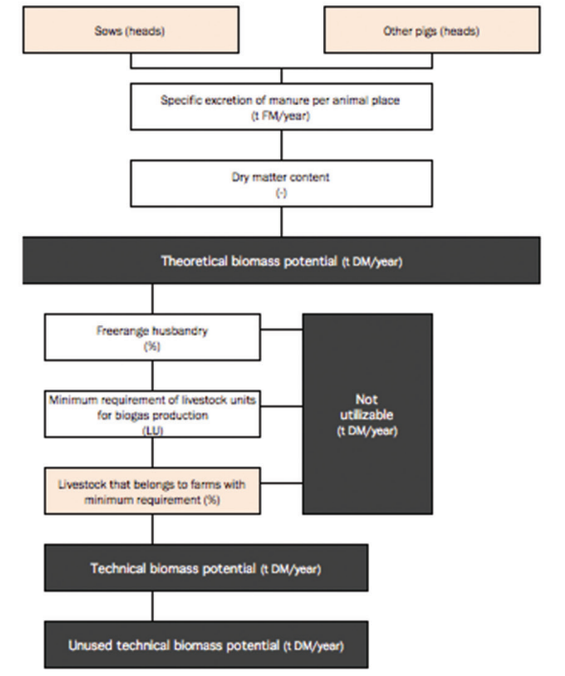
26/09/18

DBFZ

ID..... PIM
Biomass..... Pig manure
Raw material..... Pig
Production process..... Production of pork
Definition..... Solid manure from pigs and straw for litter purposes in pig housing

Contact..... Dragan Comic, dcomic.sfbl@gmail.com
Hamid Custovic, custovic.hamid@gmail.com

Categorization
Level-5..... Agricultural biomass
Level-4..... Agricultural by-products
Level-3..... By-products from livestock production
Level-2..... Solid manure



Responsible	Source of data	Update	Data quality	Spatial level
Statistical Institutes	Statistics [1,2]	Annual		M
[5,7]	Expert Assessment [3]	One-time		N
[5,7]	Literature [4]	One-time		I
[5,7]	Expert Assessment [3]	One-time		N
[5,7]	Expert Assessment [3]	One-time		I
[2,6]	Statistics [1,2]	Annual		M

dynamic calculation element

Explanation & Sources:

M = Municipality; E = Entity; N = National; I = International

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[7] Federal Institute for Agriculture (FBiH), Faculty of Agricultural and Food Sciences, University of Sarajevo

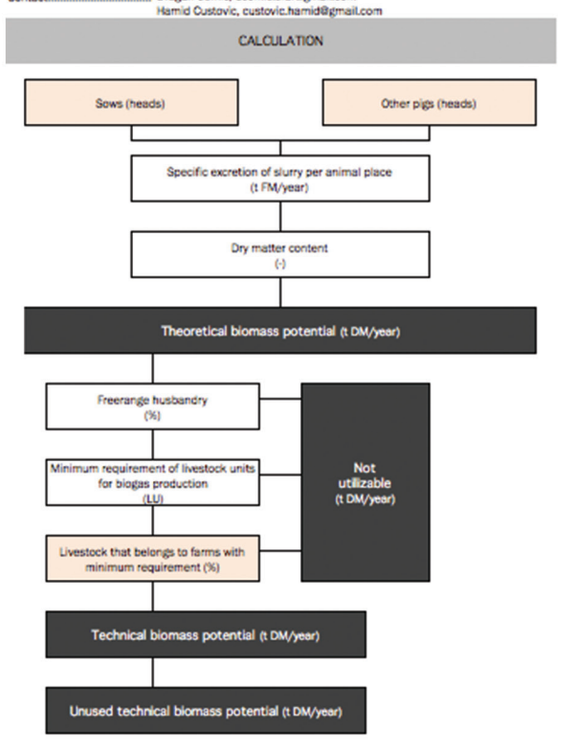
Advisory for biomass potential map development

Main, by-products and residues

26/09/18

ID..... PIS
Biomass..... Pig slurry
Raw material..... Pig
Production process..... Production of pork
Definition..... Solid manure, liquid manure from pigs and cleaning and wastewater from pig housing
Contact..... Dragan Comic, dcomic.sfbl@gmail.com
Hamid Custovic, custovic.hamid@gmail.com

Categorization
Level-5..... Agricultural biomass
Level-4..... Agricultural by-products
Level-3..... By-products from livestock production
Level-2..... Animal slurry



Responsible	Source of data	Update	Data quality	Spatial level
Statistical Institutes	Statistics [1,2]	Annual		M
[5,7]	Expert Assessment [3]	One-time		N
[5,7]	Literature [4]	One-time		I
[5,7]	Expert Assessment [3]	One-time		N
[5,7]	Expert Assessment [3]	One-time		I
[2,6]	Statistics [1,2]	Annual		M

dynamic calculation element

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Advisory for biomass potential map development

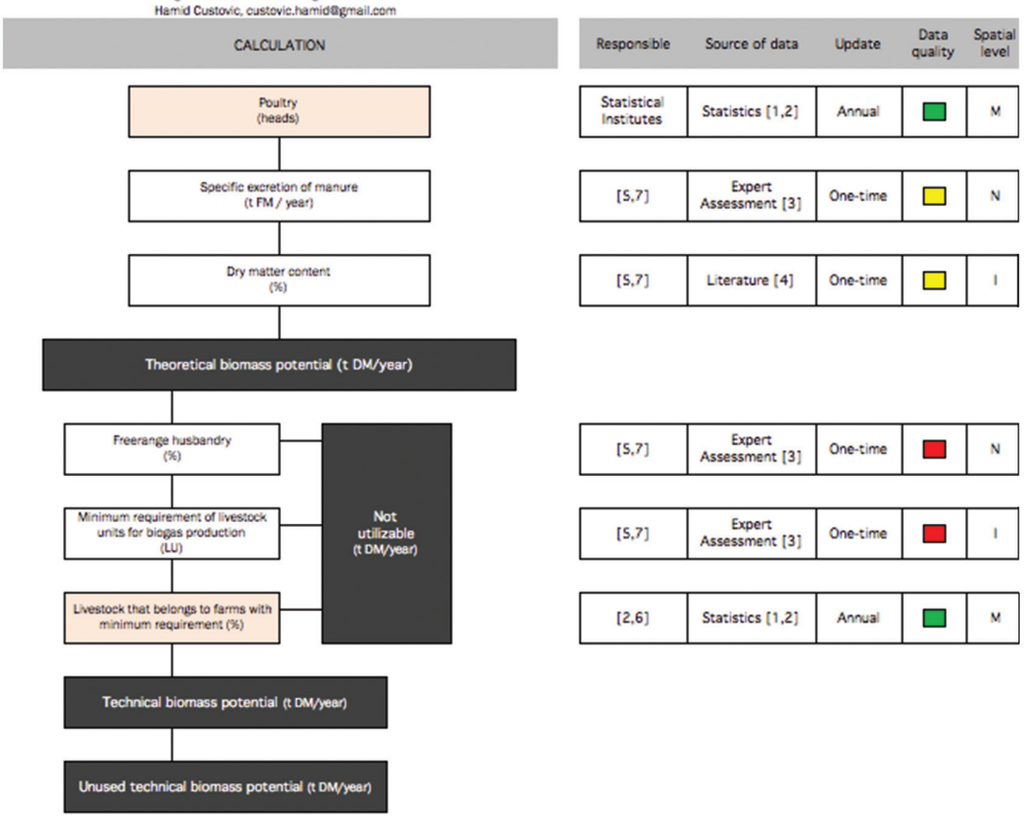
Main, by-products and residues

26/09/18

ID..... POM
Biomass..... Poultry manure
Raw material..... Poultry
Production process..... Production of poultry products and eggs
Definition..... Solid manure from poultry

Contact..... Dragan Comic, dcomic.sfbl@gmail.com
Hamid Custovic, custovic.hamid@gmail.com

Categorization
Level-5..... Agricultural biomass
Level-4..... Agricultural by-products
Level-3..... By-products from livestock production
Level-2..... Solid manure



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dynamic calculation element

Advisory for biomass potential map development

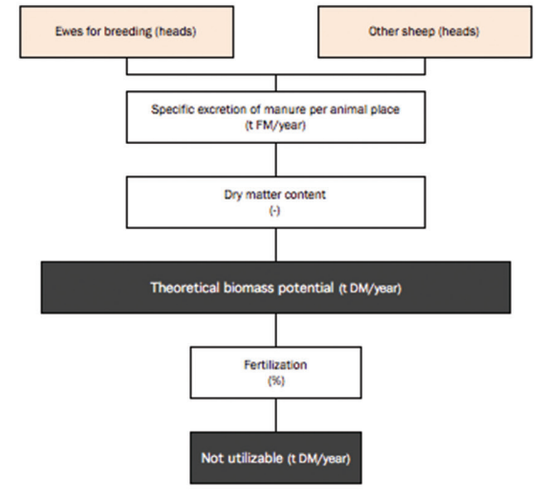
Main, by-products and residues

26/09/18

ID..... SHM
Biomass..... Sheep manure
Raw material..... Sheep
Production process..... Production of sheep products and beef
Definition..... Solid manure with straw litter

Contact..... Dragan Comic, dcomic.sfbl@gmail.com
Hamid Custovic, custovic.hamid@gmail.com

Categorization
Level-5..... Agricultural biomass
Level-4..... Agricultural by-products
Level-3..... By-products from livestock production
Level-2..... Solid manure



CALCULATION	Responsible	Source of data	Update	Data quality	Spatial level
Ewes for breeding (heads) / Other sheep (heads)	Statistical Institutes	Statistics [1,2]	Annual		M
Specific excretion of manure per animal place (t FM/year)	[5,6]	Expert Assessment [3]	One-time		N
Dry matter content (-)	[5,6]	Literature [4]	One-time		I
Theoretical biomass potential (t DM/year)					
Fertilization (%)	[5,6]	Expert Assessment [3]	One-time		N
Not utilizable (t DM/year)					

dynamic calculation element

Explanation & Sources:

M = Municipality; E = Entity; N = National; I = International

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[3] refer to Appendix 3
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[6] Federal Institute for Agriculture (FBiH), Faculty of Agricultural and Food Sciences, University of Sarajevo

Advisory for biomass potential map development

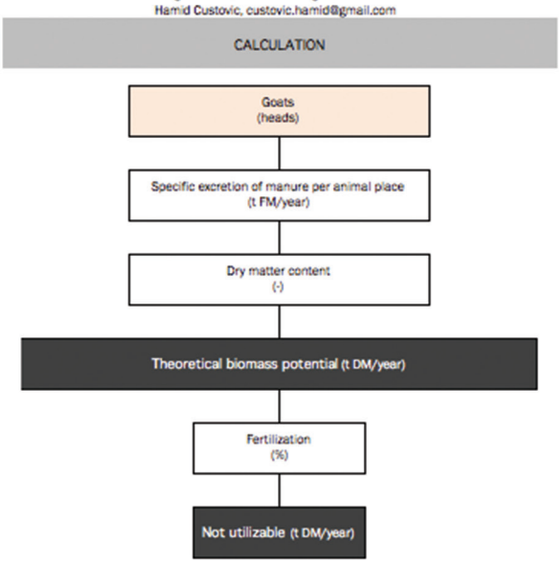
Main, by-products and residues

26/09/18

ID..... GOM
Biomass..... Goat manure
Raw material..... Goat
Production process..... Production of goat products and beef
Definition..... Solid manure with straw litter

Contact..... Dragan Comic, dcomic.sfbl@gmail.com
Hamid Custovic, custovic.hamid@gmail.com

Categorization
Level-5..... Agricultural biomass
Level-4..... Agricultural by-products
Level-3..... By-products from livestock production
Level-2..... Solid manure



Responsible	Source of data	Update	Data quality	Spatial level
Statistical Institutes	Statistics [1,2]	Annual		M
[5,6]	Expert assessment [3]	One-time		N
[5,6]	Literature [4]	One-time		I
[5,6]	Expert assessment [3]	One-time		N

dynamic calculation element

Explanation & Sources:

M = Municipality; E = Entity; N = National; I = International

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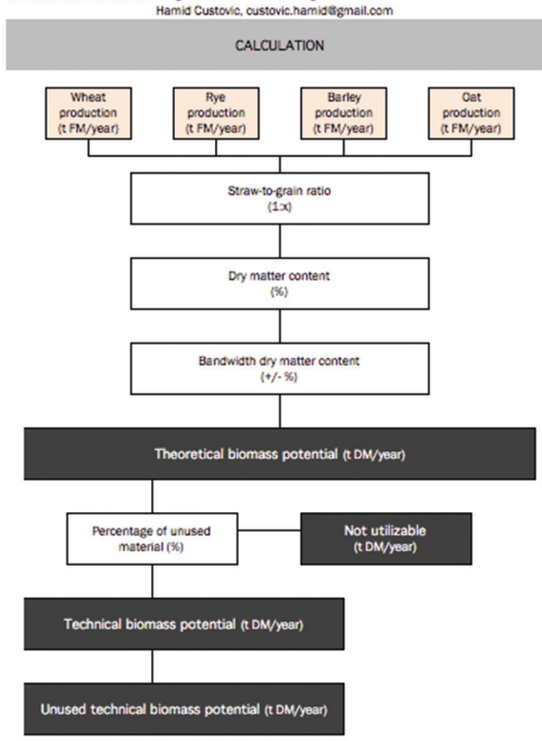
Advisory for biomass potential map development

Main, by-products and residues

26/09/18

ID..... CST
Biomass..... Cereal straw
Raw material..... Small grain cereals
Production process..... Production of small grain cereals
Definition..... Aboveground material other than grain from the cultivation of cereals (wheat, rye, barley, oats)
Contact..... Dragan Comic, dcomic.sfbl@gmail.com
Hamid Custovic, custovic.hamid@gmail.com

Categorization
Level-5..... Agricultural biomass
Level-4..... Agricultural by-products
Level-3..... By-products from annual crops
Level-2..... Straw



Responsible	Source of data	Update	Data quality	Spatial quality
Statistical Institutes	Statistics [1,2]	Annual		M
[5,6]	Expert Assessment [3]	One-time		N
[5,6]	Literature [4]	One-time		I
[5,6]	Assumption [3]	One-time		I
[5,6]	Expert Assessment [3]	One-time		N

dynamic calculation element

Explanation & Sources:

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[1] BiH Agency of Statistics (2017)
[2] Federal Office of Statistics (2012), Federal Office of Statistics (2017)
[3] refer to Appendix 3
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[5] Faculty of Agriculture, University of Banja Luka; Faculty of Agriculture, University of East Sarajevo; Agriculture Institute of Republic Srpska
[6] Federal Institute for Agriculture (FBiH), Faculty of Agricultural and Food Sciences, University of Sarajevo

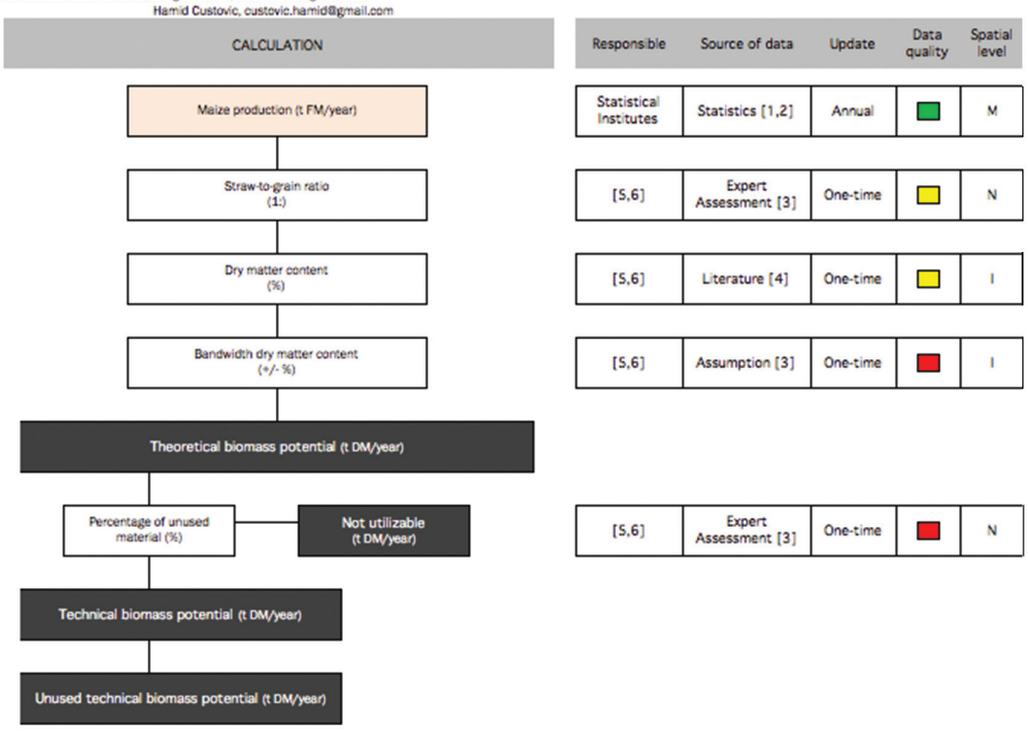
Advisory for biomass potential map development

Main, by-products and residues

26/09/18

ID..... MST
Biomass..... Maize straw
Raw material..... Maize for grain production
Production process..... Production of maize grain
Definition..... Aboveground material other than grain from the cultivation of maize for grain
Contact..... Dragan Comic, dcomic.sfbl@gmail.com
Hamid Custovic, custovic.hamid@gmail.com

Categorization
Level-5..... Agricultural biomass
Level-4..... Agricultural by-products
Level-3..... By-products from annual crops
Level-2..... Straw



dynamic calculation element

Explanation & Sources:

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[1] BiH Agency of Statistics (2017)
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Advisory for biomass potential map development

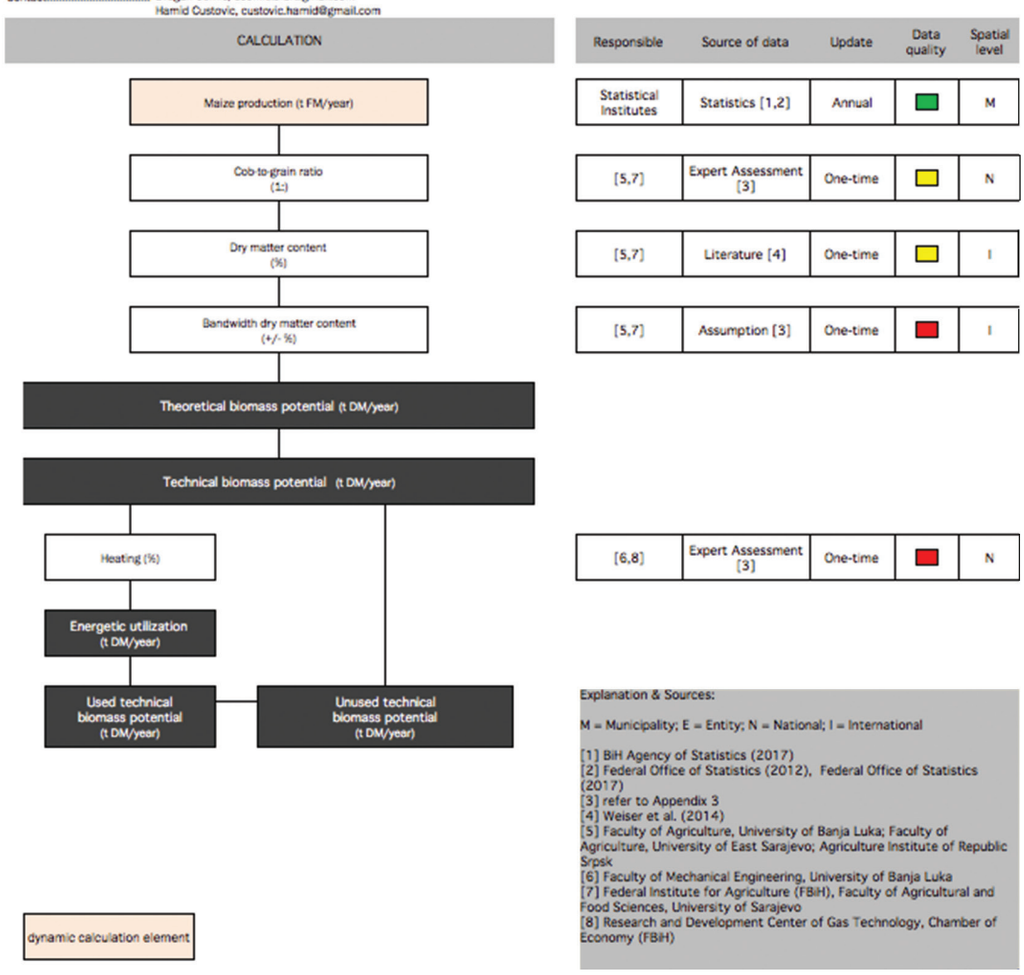
Main, by-products and residues

26/09/18

ID..... C0C
Biomass..... Corn Cobs
Raw material..... Maize for grain production
Production process..... Production of maize grain
Definition..... Aboveground material other than grain from the cultivation of maize for grain

Contact..... Dragan Comic, dcomic.sfbl@gmail.com
Hamid Custovic, custovic.hamid@gmail.com

Categorization
Level-5..... Agricultural biomass
Level-4..... Agricultural by-products
Level-3..... By-products from annual crops
Level-2..... -



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[3] refer to Appendix 3
[4] Weiser et al. (2014)
[5] Faculty of Agriculture, University of Banja Luka; Faculty of Agriculture, University of East Sarajevo; Agriculture Institute of Republic Srpsk
[6] Faculty of Mechanical Engineering, University of Banja Luka
[7] Federal Institute for Agriculture (FBiH), Faculty of Agricultural and Food Sciences, University of Sarajevo
[8] Research and Development Center of Gas Technology, Chamber of Economy (FBiH)

Advisory for biomass potential map development

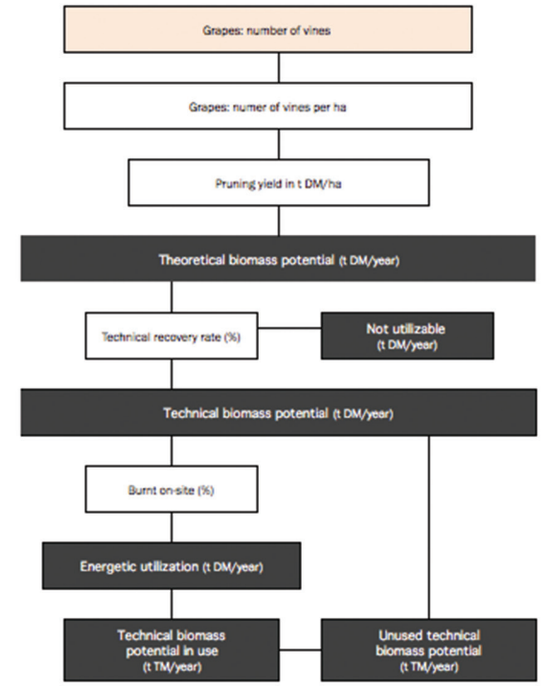
Main, by-products and residues

26/09/18

ID..... PRV
Biomass..... Pruning residues from vineyards
Raw material..... Pruning residues
Production process..... Production of grapes
Definition..... Additional biomass from vineyards pruning and by-products form vineyards

Contact..... Dragan Comic, dcomic.sfbl@gmail.com
Hamid Custovic, custovic.hamid@gmail.com

Categorization
Level-5..... Agricultural biomass
Level-4..... Agricultural by-products
Level-3..... Prunings
Level-2..... By-products from perennial crops



CALCULATION	Responsible	Source of data	Update	Data quality	Spatial level
Grapes: number of vines	Statistical Institutes	Statistics [1,2]	Annual		M
Grapes: numer of vines per ha	[2,5]	Expert Assessment [3]	One-time		N
Pruning yield in t DM/ha	[5,6]	Expert Assessment [3]	One-time		N
Theoretical biomass potential (t DM/year)					
Technical recovery rate (%) / Not utilizable (t DM/year)	[5,6]	Literature [4]	One-time		I
Technical biomass potential (t DM/year)					
Burnt on-site (%)	[5,6]	Expert Assessment [3]	One-time		N
Energetic utilization (t DM/year)					
Technical biomass potential in use (t TM/year) / Unused technical biomass potential (t TM/year)					

dynamic calculation element

Explanation & Sources:

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[1] BiH Agency of Statistics (2017)
[2] Federal Office of Statistics (2012), Federal Office of Statistics (2017)
[3] refer to Appendix 3
[4] Scarlat et al. (2011)
[5] Faculty of Agriculture, University of Banja Luka; Faculty of Agriculture, University of East Sarajevo; Agriculture Institute of Republic Srpska
[6] Federal Agro-Mediterranean Institute (FBiH); Faculty of Agricultural and Food Sciences, University of Sarajevo

Advisory for biomass potential map development

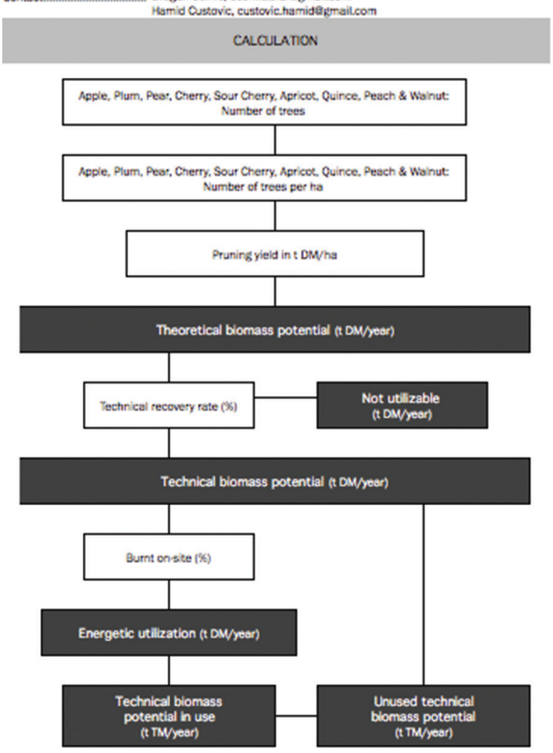
Main, by-products and residues

26/09/18

ID..... PRO
Biomass..... Pruning residues from orchards
Raw material..... Pruning residues
Production process..... Production of fruit and fruit products from orchards
Definition..... Additional biomass from orchards pruning and by-products form orchards

Contact..... Dragan Comic, dcomic.sfbl@gmail.com
Hamid Custovic, custovic.hamid@gmail.com

Categorization
Level-5..... Agricultural biomass
Level-4..... Agricultural by-products
Level-3..... Prunings
Level-2..... By-products from perennial crops



Responsible	Source of data	Update	Data quality	Spatial level
Statistical Institutes	Statistics [1,2]	Annual		M
[2,5]	Expert Assessment [3]	One-time		N
[5,6]	Expert Assessment [3]	One-time		N
[5,6]	Literature [4]	One-time		I
[5,6]	Expert Assessment [3]	One-time		N

dynamic calculation element

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[6] Federal Agro-Mediterranean Institute (FBiH); Faculty of Agricultural and Food Sciences, University of Sarajevo

Advisory for biomass potential map development

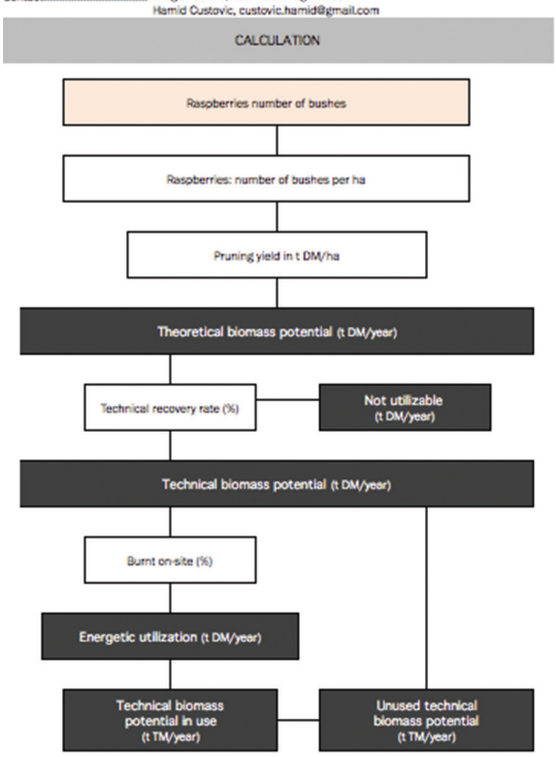
Main, by-products and residues

26/09/18

ID..... PRR
Biomass..... Pruning residues from raspberries
Raw material..... Pruning residues
Production process..... Production of raspberries
Definition..... Additional biomass from raspberries pruning

Contact..... Dragan Comic, dcomic.sfbl@gmail.com
Hamid Custovic, custovic.hamid@gmail.com

Categorization
Level-5..... Agricultural biomass
Level-4..... Agricultural by-products
Level-3..... Prunings
Level-2..... By-products from perennial crops



Responsible	Source of data	Update	Data quality	Spatial level
Statistical Institutes	Statistics [1,2]	Annual		M
[2,4]	Expert Assessment [3]	One-time		N
[4,5]	Expert Assessment [3]	One-time		N
[4,5]	Expert Assessment [3]	One-time		N
[4,5]	Expert Assessment [3]	One-time		N

dynamic calculation element

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ANNEX A2 KEY DATA FOR THE REFERENCE YEAR 2015

BIOMASS		01	02	03	04	05	06	07	08	09	10
		Theoretical biomass potential	Technical biomass potential	Not mobil-isable	Data situation unclear	Material use	Energetic use	Material or energetic use	Use not differen-tiable	Technical biomass potential used	Mobil-isable technical biomass potential
Cereal Straw	MIN	194,695	38,939	155,756	0	0	0	0	0	0	38,939
Cereal Straw	MIN	219,033	43,807	175,226	0	0	0	0	0	0	43,807
Maize Straw	MIN	619,752	123,950	495,801	0	0	0	0	0	0	123,950
Maize Straw	MIN	697,221	139,444	557,777	0	0	0	0	0	0	139,444
Cattle manure	MIN	973,801	38,102	935,699	0	0	0	0	0	0	38,102
Cattle manure	MAX	973,801	39,089	934,712	0	0	0	0	0	0	39,089
Cattle slurry	MIN	724,585	28,350	696,234	0	0	0	0	0	0	28,350
Cattle slurry	MAX	724,585	29,085	695,500	0	0	0	0	0	0	29,085
Goat manure	MIN	21,052	0	21,052	0	0	0	0	0	0	0
Goat manure	MAX	21,052	0	21,052	0	0	0	0	0	0	0
Pig manure	MIN	163,169	26,581	136,588	0	0	0	0	0	0	26,581
Pig manure	MAX	163,169	26,581	136,588	0	0	0	0	0	0	26,581
Pig slurry	MIN	111,194	18,114	93,079	0	0	0	0	0	0	18,114
Pig slurry	MAX	111,194	18,114	93,079	0	0	0	0	0	0	18,114
Poultry manure	MIN	653,316	154,600	498,717	0	0	0	0	0	0	154,600
Poultry manure	MAX	653,316	154,600	498,717	0	0	0	0	0	0	154,600
Sheep manure	MIN	157,035	0	157,035	0	0	0	0	0	0	0
Sheep manure	MAX	157,035	0	157,035	0	0	0	0	0	0	0
Pruning residues from orchards	MIN	38,786	31,029	7,757	0	0	31,029	0	0	31,029	0

Pruning residues from orchards	MAX	38,786	31,029	7,757	0	0	31,029	0	0	31,029	0
Pruning residues from vineyards	MIN	5,067	4,053	1,013	0	0	4,053	0	0	4,053	0
Pruning residues from vineyards	MAX	5,067	4,053	1,013	0	0	4,053	0	0	4,053	0
Pruning residues from raspberries	MIN	5,818	4,654	1,164	0	0	4,654	0	0	4,654	0
Pruning residues from raspberries	MAX	5,818	4,654	1,164	0	0	4,654	0	0	4,654	0
Black liquor	MIN	264,366	264,366	0	0	0	264,366	0	0	264,366	0
Black liquor	MAX	264,366	264,366	0	0	0	264,366	0	0	264,366	0
Industrial wood coniferous	MIN	576,582	576,582	0	0	576,582	0	0	0	576,582	0
Industrial wood coniferous	MAX	576,582	576,582	0	0	576,582	0	0	0	576,582	0
Fuel wood coniferous	MIN	35,124	35,124	0	0	0	35,124	0	0	35,124	0
Fuel wood coniferous	MAX	35,124	35,124	0	0	0	35,124	0	0	35,124	0
Industrial wood deciduous	MIN	460,636	460,636	0	0	460,636	0	0	0	460,636	0
Industrial wood deciduous	MAX	460,636	460,636	0	0	460,636	0	0	0	460,636	0
Fuel wood deciduous	MIN	647,965	647,965	0	0	0	647,965	0	0	647,965	0
Fuel wood deciduous	MAX	647,965	647,965	0	0	0	647,965	0	0	647,965	0
Waste wood coniferous	MIN	290,046	290,046	0	0	0	87,014	0	0	87,014	203,032
Waste wood coniferous	MAX	290,046	290,046	0	0	0	87,014	0	0	87,014	203,032
Waste wood deciduous	MIN	405,985	405,985	0	0	0	121,796	0	0	121,796	284,190

Waste wood deciduous	MAX	405,985	405,985	0	0	0	121,796	0	0	121,796	284,190
By products of wood processing industries	MIN	823,710	823,710	0	0	0	657,674	166,036	0	823,710	0
By products of wood processing industries	MAX	823,710	823,710	0	0	0	657,674	166,036	0	823,710	0
Corn Cobs	MIN	123,950	123,950	0	0	0	86,765	0	0	86,765	37,185
Corn Cobs	MAX	139,444	139,444	0	0	0	97,611	0	0	97,611	41,833
Annual increment of coniferous forest	MIN	869,859	869,859	0	0	576,582	85,307	0	0	661,889	207,969
Annual increment of coniferous forest	MAX	869,859	869,859	0	0	576,582	85,307	0	0	661,889	207,969
Annual increment of deciduous forest	MIN	2,099,339	2,099,339	0	0	460,636	769,760	0	0	1,230,396	868,943
Annual increment of deciduous forest	MAX	2,099,339	2,099,339	0	0	460,636	769,760	0	0	1,230,396	868,943

A 3 BACKGROUND INFORMATION

In this section, background information on the individual biomasses and the calculation of their potential is given. The calculation flowchart for each biomass (see Annex 1) should be considered alongside the explanations below. Information regarding the sources and quality of the data is only included in the following if previously commented on in Chapter 2 (2.1.1).

A 3.1. Formulae for calculating the potential

In preparation for this project in 2017, DBFZ prepared the handbook 'Methodology for biomass potentials in Bosnia and Herzegovina'.[89] Based on the handbook and in collaboration with the local experts, DBFZ built on this and developed a customised methodological approach for this project.

Table 20. Formulae for calculating the potential

Biomass	Conversion factor from volume to mass, industrial and fuel wood
AIC, AID	theoretical potential [tDM] = technical potential [tDM] = annual allowed felling [m^3] * conversion factor [tDM/m^3]
FWC, FWD	theoretical potential [tDM] = technical potential [tDM] = tree felling for energetic utilisation [m^3] * conversion factor [tDM/m^3]
IWC, IWD	theoretical potential [tDM] = technical potential [tDM] = tree felling for material utilisation [m^3] * conversion factor [tDM/m^3]
WWC, WWD	theoretical potential [tDM] = technical potential [tDM] = waste wood [m^3] * conversion factor for waste wood [tDM/m^3]
BWP	theoretical potential [tDM] = technical potential [tDM] = input from IWC, IWD, FWC, FWD [tDM] * (sawdust [%] + bark [%] + splinters, cuttings, slabs [%]) / 100
BLL	theoretical potential [tDM] = technical potential [tDM] = annual pulp production [tDM] * ratio pulp to black liquor [%] / 100
CAM, CAS	theoretical potential [tDM] = (number of cows and heifers [-] * specific excretion rate [tFM] + number of other cattle [-] * specific excretion rate [tFM]) * dry matter content [%] / 100 technical potential [tDM] = theoretical potential [tFM] * animals in farms with the minimum requirement [%] / 100 * (1 - pasture grazing [%] / 100)
PIM, PIS	theoretical potential [tDM] = (number of sows [-] * specific excretion rate [tFM] + number of other pigs [-] * specific excretion rate [tFM]) * dry matter content [%] / 100 technical potential [tDM] = theoretical potential [tFM] * animals in farms with the minimum requirement [%] / 100 * (1 - free range husbandry [%] / 100)
POM	theoretical potential [tDM] = number of poultry [-] * specific excretion rate [tFM] * dry matter content [%] / 100 technical potential [tDM] = theoretical potential [tFM] * animals in farms with the minimum requirement [%] / 100 * (1 - free range husbandry [%] / 100)
SHM	theoretical potential [tDM] = (number of ewes for breeding [-] * specific excretion rate [tFM] + number of other sheep [-] * specific excretion rate [tFM]) * dry matter content [%] / 100 technical potential [tDM] = theoretical potential [tFM] * (1 - fertilisation [%] / 100)
GOM	theoretical potential [tDM] = number of goats [-] * specific excretion rate [tFM] * dry matter content [%] / 100 technical potential [tDM] = theoretical potential [tFM] * (1 - fertilisation [%] / 100
CST	theoretical potential [tDM] = (wheat production [tFM] * straw-to-grain ratio [-] + rye production [tFM] * straw-to-grain ratio [-] + barley production [tFM] * straw-to-grain ratio [-] + oat production [tFM] * straw-to-grain ratio [-]) * dry matter content [%] / 100 * bandwidth [%] / 100 technical potential [tDM] = theoretical potential [tDM] * unused material [%] / 100
MST	theoretical potential [tDM] = maize production [tFM] * straw-to-grain ratio [-] * dry matter content [%] / 100 * bandwidth [%] / 100 technical potential [tDM] = theoretical potential [tDM] * unused material [%] / 100
COC	theoretical potential [tDM] = technical potential [tDM] = maize production [tFM] * corn-to-cob ratio [-] * dry matter content [%] / 100 * bandwidth [%] / 100
PRV	theoretical potential [tDM] = vineyard area [ha] * pruning yield [tDM/ha] technical potential [tDM] = theoretical potential [tDM] * technical recovery rate [%] / 100

[89] Scheftelowitz, M., Schaubach, K., Methodology for biomass potential in Bosnia and Herzegovina (2017).

PRO	theoretical potential [tDM] = (orchard area apple [ha] + orchard area plum [ha] + orchard area pear [ha] + orchard area cherry [ha] + orchard area sour cherry [ha] + orchard area apricot [ha] + orchard area quince [ha] + orchard area peach [ha] + orchard area walnut [ha]) * pruning yield for all fruits [tDM/ha] technical potential [tDM] = theoretical potential [tDM] * technical recovery rate [%] / 100
PRR	theoretical potential [tDM] = raspberry plantation area [ha] * pruning yield [tDM/ha] technical potential [tDM] = theoretical potential [tDM] * technical recovery rate [%] / 100

A 3.2 Forestry biomass

Forestry biomass in this study consists of six categories: 1) annual increment, 2) fuel wood, 3) industrial wood, 4), waste wood, 5) byproducts from the wood processing industry and 6) black liquor. Categories 1, 2, 3 and 4 distinguish between coniferous and deciduous wood. Several calculation elements apply to all categories of forestry biomass and these are summarised in Table 21. The input data for the calculation of biomasses 1 to 4 is the amount of trees felled in m^3. This already considers the technical recovery rate and hence the only calculation element necessary is the m^3 to tonnes of dry matter conversation ratio. If the conversion factor is from m^3 to tonnes of fresh matter then only the dry matter content needs to be considered. However, this is not the case here and the conversion factors are listed in Table 21. Therefore, the theoretical potential equals the technical potential for these three biomasses.

Table 21. General calculation elements for wood biomass [90]

	Conversion factor from volume to mass, industrial and fuel wood	Conversion factor from volume to mass, waste wood
Coniferous	1 RWE m^3 = 0,31 t DM	1 RWE m^3 = 0,43 t DM
Deciduous	1 RWE m^3 = 0,46 t DM	1 RWE m^3 = 0,68 t DM

Statistics in Bosnia and Herzegovina do not distinguish between different volume units, e.g. stere/stacked cubic metre and solid cubic metre, which typically are used in the forestry industry. Instead, the unit m^3 is used for all wood volumes without any additional specification. This could lead to calculation errors when applying volume-to-mass conversion rates. In order to improve the monitoring process in the long term, it would make sense to specify the volume units in the statistical data collection.

Expert assessment was necessary for several calculation elements related to waste wood, byproducts of the wood processing industry and black liquor. These expert assessments were based on the extensive knowledge of the experts in the forestry industry as well as on interviews with stakeholders in the relevant industries, e.g. the paper industry or sawmills. However, it is recommended that these values be validated through the use of qualitative or quantitative methods such as interviews or surveys with the operators of sawmills and paper factories.

The theoretical and technical potential can be calculated twofold for the annual increment coniferous/deciduous (AIC and AID). If the annual allowed felling is available in m^3 then the calculation in Annex A 3.1 can be applied. If the annual allowed felling is only available as a percentage of the annual increment, then in order to obtain a value for the annual allowed felling in m^3 the annual increment in m^3 is multiplied by this percentage. After that, the above stated approach can be used.

A 3.3. Agricultural biomass

Agricultural biomass can be placed in two sub-categories: livestock based and plant based biomass. The following livestock based biomasses were considered for the purposes of this study 1) cattle slurry, 2) pig slurry, 3) cattle manure, 4) pig manure, 5) poultry manure, 6) sheep manure and 7) goat manure. The sub-category plant based biomass consists of 1) cereal straw, 2) maize straw, 3) corncob and pruning residues, which are subdivided into 4) orchard, 5) vineyard and 6) raspberry.

[90] Kranjc, N., Wood fuels handbook (Pristina: Food and Agriculture Organization of the United Nations, 2015).

A 3.3.1. Livestock based biomass

The same approach was used to calculate the theoretical potential of all livestock based biomass. The theoretical potential was the mathematical product of the livestock numbers, specific excretion rate per animal and the dry matter content. Livestock numbers were listed in the official statistical yearbooks in both entities. The dry matter content was taken from data in Germany[91] and the specific excretion rate per animal was based on the expert assessments listed below in Table 22. The calculation flowcharts for sheep and goat manure were simplified in accordance with the current usage structure for these manures. All sheep and goat manure was either left on the pasture as fertiliser or (in winter) collected in the stables and then spread as fertiliser. Yet the theoretical potential for manure from both animals was so insignificant that it did not warrant further investigation, given its set use as fertiliser.

The values for pasture grazing and free-range husbandry were based on expert assessment. These values were developed on the basis of the literature, conversations with farmers and representatives of the ministries of agriculture and the extensive experience of the experts in the field of agriculture.

Table 22. Dry matter content and specific excretion rate per animal for all manures and slurries

Livestock based biomass	Animal category	Dry matter content[92] [%]	Specific excretion rate per animal (expert assessment) [tFM /a]
Cattle slurry	Dairy cows and heifers in calf	10	18.6 [a]
	Other cattle	10	11.1 [b]
Pig slurry	Sows	5	6.1 [a]
	Other pigs	5	3.7 [b]
Cattle manure	Dairy cows and heifers in calf	25	10.0 [a]
	Other cattle	25	6.0 [a]
Pig manure	Sows	25	1.8 [a]
	Other pigs	25	1.1 [a]
Poultry manure	Poultry	50	0.06 [a]
Sheep manure	Ewes for breeding	30	0.58 [a]
	Other sheep	30	0.36 [a]
Goat manure	Goats	30	0.69 [a]

[a] Expert assessment by Hamid Čustović (national expert, Federation of Bosnia and Herzegovina)

[b] Expert assessment by Christian Weiser (DBFZ): The slurry amount is only given for cattle and pigs in general; it was assumed suitable for dairy cows and sows, while the slurry amount for other cattle and pigs was obtained through the ratio manure other cattle/pigs versus manure dairy cows/sows.

[91] Bayerische Landesanstalt für Landwirtschaft (2013), Basisdaten
[92] Ibid.

Manure refers to solid manure with straw litter from livestock in straw-based housing systems. **Slurry** refers to solid manure, liquid manure from livestock, rain and wastewater from milking systems in slurry based cattle housing. Straw based and slurry based housing were considered exclusive to one another for the purposes of this study. **Poultry manure** refers to residues from bedding material from poultry production. Poultry includes broilers, hens, turkeys, geese, ducks and other poultry. For all manures, regardless of the type of livestock, time spent on pasture was not considered. Of the listed species, the most important was chicken manure. This is because chickens are grown in large numbers on large farms, while the manure from other poultry was considered to be of no importance.

Based on the feedstock requirements for small-scale biogas plants, criteria were determined in terms of the minimum number of animals required by a farm in order to warrant the logistical effort related to the transportation of the manure and/or slurry. International and local experts decided that this minimum number of heads is 200 cattle, 350 pigs or 25,000 poultry respectively.

However, the decision to include these minimum requirements led to discrepancies in the data supply. In Republika Srpska, data on animals in farms over the required number of heads was only available at the entity level and therefore it was only possible to calculate the theoretical potential at the municipal level. In the Federation of Bosnia and Herzegovina, data on animals in farms over the required number of heads was only available at the municipal level. However, the Federal Ministry of Agriculture, Water Management and Forestry as opposed to just the Federal Office of Statistics for the Entity of Federation of Bosnia Herzegovina (FZS) does provide this information in the Farm and Client Register. Yet the data collection methods of these two institutions differ: in some cases, the number of animals in farms over the required number of heads is higher than the total number of animals. This need to be investigated and therefore it is recommended that the data collection methods of the Ministry and the FZS be aligned in order to avoid the current discrepancies in the future.

Overall, an increase in animal numbers was noted over the monitoring period. Beginning in 2018, Bosnia and Herzegovina can now export meat to the European Union and this increase in the number of livestock and poultry can be attributed largely to this fact.

A 3.3.2. Plant based biomass

Plant based biomass can be differentiated through crop based residues such as straw and corncob and residues emanating from fruit growing. Although the individual calculation elements for each subgroup are explained in the following sub-chapters, because no official data is available the current energetic or material utilisation of all these biomasses is based on expert assessment. Because of the high potential of these biomasses, it is recommended that the expert assessments relating to cereal and maize straw be investigated further. The impact of the other biomasses is currently so insignificant that further investigation might make sense for specific municipalities but not for the country as a whole.

A 3.3.2.1. Cereal, maize straw and corncob

The national experts provided the straw-to-grain ratios and the corn-to-cob ratio based on farming practices. The values of these ratios are lower than those found in the literature[93,94] and are based on more traditional and less effective harvesting techniques. The dry matter content for all crops was taken from German literature[95], while a bandwidth of -6/+4 per cent was added to the dry matter content in order to allow for country specific discrepancies and different storage methods. The theoretical potential is the mathematical product of the grain production, straw-to-grain/corn-to-cob ratio, the dry matter content and the bandwidth.

[93] Knezevic, D., Kondic, D., Srdic, S. and Paunovic, A. (eds.), Harvest index and components of yield in winter wheat cultivars (Triticum aestivum L.) (2015).
[94] Simic, M., Dragicevic, V., Momirovic, N., Brankov, M. and Spasojevic, I. (eds.), The effect of organic and mineral fertilization in different cropping systems of maize (2016).
[95] Weiser, C., and others, 'Integrated assessment of sustainable cereal straw potential and different straw-based energy applications in Germany', Applied Energy 114, (2014) 749–62.

Table 23. Straw-to-grain ratio and the dry matter content for maize and cereal straw and corncob

Plant based biomas straw and corncob	Straw-to-grain ratio	Dry matter content[96] [%]	Bandwidth dry matter content [%]
Maize	1 : 1	86	-6 / +4
Wheat	1 : 1	86	-6 / +4
Rye	6 : 5 (1.19)	86	-6 / +4
Barley	1 : 1	86	-6 / +4
Oats	1 : 1	86	-6 / +4
Corncob	1 : 5 (0.2)[97]	86	-6 / +4

A 3.3.2.2 Pruning residues for orchards, vineyards and raspberries

European values for pruning yields and the average spacing of fruit trees and vines from the EuroPruning project[98] were adjusted by the national experts to the Bosnia and Herzegovina context because cultivation in Bosnia and Herzegovina is more traditional compared to intensive and industrialised fruit, grape and raspberry cultivation in other parts of European. Data on the technical recovery for pruning residues from orchards is utilised as described in Scarlat et al. (2011).

The theoretical potential for pruning residues for orchards, vineyards and raspberries is the mathematical product of the orchard/vineyard/raspberry plantation area and pruning yield per hectare. If the orchard/vineyard/raspberry plantation area is not readily available (which it should be in the case of Bosnia and Herzegovina) then it can be calculated using information on the total number of plants per plantation and plants per hectare. Hence, this is indicated in the calculation flowcharts.

Table 24. Pruning yield and technical recovery rate

Plant based biomass Pruning residues	Pruning yield (t dm/ha)	Technical recovery rate[99] [%]
Orchard	1,05	80
Vineyard	0,95	80
Raspberry	3,50	80[100]

[96] Ibid.
[97] Corn-to-cob ratio
[98] Research Centre for Energy Resources and Consumption, EuroPruning Deliverable Reporting: D3.1 Mapping and analysis of the pruning biomass potential in Europe (2014).
[99] Scarlat, N., Blujdea, V. and Dallemand, J. F., 'Assessment of the availability of agricultural and forest residues for bioenergy production in Romania', Biomass and Bioenergy 35, (2011) pp. 1995–2005.
[100] NE assessment, based on Scarlat et al. (2011).

ANNEX A4 CALCULATION ELEMENTS BASED ON EXPERT ASSESSMENT

BIOMASS		KEY DATA	UPDATE	UNIT	FBiH	RS			Brčko Distrikt
						MIN	MAX	CALC	
Cereal Straw	CST	Straw-to-grain ratio wheat straw	ONE-TIME	%	0,80	0,80			0,80
		Straw-to-grain ratio rye straw	ONE-TIME	%	0,90	0,90			0,90
		Straw-to-grain ratio barley straw	ONE-TIME	%	0,70	0,70			0,70
		Straw-to-grain ratio oat straw	ONE-TIME	%	1,10	1,10			1,10
		Percentage of unused material	ONE-TIME	%	20	20			20
Maize Straw	MST	Straw-to-grain ratio maize straw	ONE-TIME	%	1,0	1,0			1,0
		Percentage of unused material	ONE-TIME	%	20	20			20
Corncobs	COC	Cob-to-grain ratio	ONE-TIME	%	0,2	0,2			0,2
		Heating	ONE-TIME	%	70	70			70
Cattle manure	CAM	Specific excretion rate of manure per animal place (cows and heifers in calf)	ONE-TIME	t fm / year	10,001	10,001			10,001
		Specific excretion rate of manure per animal place (other cattle)	ONE-TIME	t fm / year	5,986	5,986			5,986
		Pasture grazing	ONE-TIME	%	0	20	15	17,5	0
Cattle slurry	CAS	Specific excretion rate of slurry per animal place (cows and heifers in calf)	ONE-TIME	t dm	18,615	18,615			18,615
		Specific excretion rate of slurry per animal place (other cattle)	ONE-TIME	t dm	11,114	11,114			11,114
		Pasture grazing	ONE-TIME	%	0	20	15	17,5	0
Goat manure	GOM	Specific excretion rate of manure per animal place	ONE-TIME	t dm	0,694	0,694			0,694
		Fertiliser	ONE-TIME	%	100	100			100

Pig manure	PIM	Specific excretion rate of manure per animal place (sows)	ONE-TIME	t dm	1,789	1,789	1,789
		Specific excretion rate of manure per animal place (other pig)	ONE-TIME	t dm	1,095	1,095	1,095
		Free-range husbandry	ANNUAL*	%	0	5	0
Pig slurry	PIS	Specific excretion rate of slurry per animal place (sows)	ONE-TIME	t dm	6,096	6,096	6,096
		Specific excretion rate of slurry per animal place (other pig)	ONE-TIME	t dm	3,731	3,731	3,731
		Free-range husbandry	ANNUAL*	%	0	5	0
Poultry manure	POM	Specific excretion rate of manure	ONE-TIME	t dm	0,060	0,060	0,060
		Free-range husbandry	ANNUAL*	%	0	10	0
Sheep manure	SHM	Specific excretion rate of manure per animal place (ewes for breeding)	ONE-TIME	t dm	0,584	0,584	0,584
		Specific excretion rate of manure per animal place (other sheep)	ONE-TIME	t dm	0,361	0,361	0,361
		Fertiliser	ANNUAL*	%	100	100	100
Pruning residues from orchards	PRO	All fruits pruning yield	ONE-TIME	t dm	1,05	1,05	1,05
		Burnt on-site	ONE-TIME	%	100	100	100
Pruning residues from vineyards	PRV	Pruning yield	ONE-TIME	t dm/ha	0,95	0,95	0,95
		Burnt on-site	ONE-TIME	%	100	100	100
Pruning residues from raspberries	PRR	Pruning yield	ONE-TIME	t dm /ha	3,5	3,5	3,5
		Technical recovery rate	ONE-TIME	%	80	80	80
		Burnt on-site	ONE-TIME	%	100	100	100
Black Liquor	BLL	Pulp production	ANNUAL	t dm	annual value	annual value	not applicable
		Process based energetic utilisation	ONE-TIME	%	100	100	
Waste wood coniferous	WWC	Combustion in households	ONE-TIME	%	30	30	30
Waste wood deciduous	WWD	Combustion in households	ONE-TIME	%	30	30	30
Byproducts of the wood processing industry	BWP	On-site utilisation for energy production	ONE-TIME	%	80	80	30
		Sale to external stakeholders as pellets/chips or raw material	ONE-TIME	%	20	20	70
* same value for all years of the study							

ANNEX A5 DYNAMIC CALCULATION ELEMENTS

BIOMASS [101]			KEY DATA [102]	Source: FBiH	Source: RS	Source: Brčko District	SPATIAL QUALITY	UNIT
1	Cereal Straw	CST	Wheat production	FZS	RZSRS	BHAS	MUNICIPALITY	t fm/year
2	Cereal Straw	CST	Rye production	FZS	RZSRS	BHAS	MUNICIPALITY	t fm/year
3	Cereal Straw	CST	Barley production	FZS	RZSRS	BHAS	MUNICIPALITY	t fm/year
4	Cereal Straw	CST	Oat production	FZS	RZSRS	BHAS	MUNICIPALITY	t fm/year
5	Maize straw and corncobs	MST & COC	Maize production	FZS	RZSRS	BHAS	MUNICIPALITY	t fm/year
6	Cattle manure and slurry	CAM & CAS	Cows and heifers in calf	FZS	RZSRS	BHAS	MUNICIPALITY	-
7	Cattle manure and slurry	CAM & CAS	Other cattle	FZS	RZSRS	BHAS	MUNICIPALITY	-
8	Cattle manure and slurry	CAM & CAS	Cattle that belong to farms with the minimum requirement (> 200 heads)	FZS	Ministry of Agriculture, Forestry and Water Management (RS); Department of Agriculture, Veterinary Section (RS)	BHAS	MUNICIPALITY (RS: ENTITY)	-
9	Goat manure	GOM	Goats	FZS	RZSRS	BHAS	MUNICIPALITY	-
10	Pig manure and slurry	PIM & PIS	sows	FZS	RZSRS	BHAS	MUNICIPALITY	-
11	Pig manure and slurry	PIM & PIS	Poultry manure	FZS	RZSRS	BHAS	MUNICIPALITY	-
12	Pig manure and slurry	PIM & PIS	Pigs that belong to farms with the minimum requirement (> 350 heads)	FZS	Ministry of Agriculture, Forestry and Water Management (RS); Department of Agriculture, Veterinary Section (RS)	BHAS	MUNICIPALITY (RS: ENTITY)	-
13	Poultry manure	POM	perad	FZS	RZSRS	BHAS	MUNICIPALITY	-
14	Poultry manure	POM	Poultry that belong to farms with the minimum requirement (> 25,000 heads)	FZS	Ministry of Agriculture, Forestry and Water Management (RS); Department of Agriculture, Veterinary Section (RS)	BHAS	MUNICIPALITY (RS: ENTITY)	-

[101] BWP does not have any dynamic calculation elements as the input values were taken automatically from FWC/FWD and IWC/IWD.
[102] All animals refer to the 'number of animals' and therefore do not have a unit.

15	Sheep manure	SHM	Ewes for breeding	FZS	RZSRS	BHAS	MUNICIPALITY	-
16	Sheep manure	SHM	Other sheep	FZS	RZSRS	BHAS	MUNICIPALITY	-
17	Pruning residues from orchards	PRO	PLUM total area orchard	FZS	RZSRS	BHAS	MUNICIPALITY	ha
18	Pruning residues from orchards	PRO	APPLE total area orchard	FZS	RZSRS	BHAS	MUNICIPALITY	ha
19	Pruning residues from orchards	PRO	PEAR total area orchard	FZS	RZSRS	BHAS	MUNICIPALITY	ha
20	Pruning residues from orchards	PRO	CHERRY total area orchard	FZS	RZSRS	BHAS	MUNICIPALITY	ha
21	Pruning residues from orchards	PRO	SOUR CHERRY total area orchard	FZS	RZSRS	BHAS	MUNICIPALITY	ha
22	Pruning residues from orchards	PRO	APRICOT total area orchard	FZS	RZSRS	BHAS	MUNICIPALITY	ha
23	Pruning residues from orchards	PRO	QUINCE total area orchard	FZS	RZSRS	BHAS	MUNICIPALITY	ha
24	Pruning residues from orchards	PRO	PEACH total area orchard	FZS	RZSRS	BHAS	MUNICIPALITY	ha
25	Pruning residues from orchards	PRO	WALNUT total area orchard	FZS	RZSRS	BHAS	MUNICIPALITY	ha
26	Pruning residues from vineyards	PRV	Total area vineyard	FZS	RZSRS	BHAS	MUNICIPALITY	ha
27	Pruning residues from raspberries	PRR	Total area raspberry plantation	FZS	RZSRS	BHAS	MUNICIPALITY	ha
28	Industrial wood coniferous	IWC	Tree felling coniferous for material utilisation	FZS	JP Sume RS, RZSRS	BHAS	ENTITY (FBiH + CANTON)	m^3/year
29	Fuel wood coniferous	FWC	Tree felling coniferous for energetic utilisation	FZS	JP Sume RS, RZSRS	BHAS	ENTITY (FBiH + CANTON)	m^3/year
30	Industrial wood deciduous	IWD	Tree felling deciduous for material utilisation	FZS	JP Sume RS, RZSRS	BHAS	ENTITY (FBiH + CANTON)	m^3/year
31	Fuel wood deciduous	FWD	Tree felling deciduous for energetic utilisation	FZS	JP Sume RS, RZSRS	BHAS	ENTITY (FBiH + CANTON)	m^3/year
32	Waste wood coniferous	WWC	Waste wood coniferous	FZS	JP Sume RS, RZSRS	BHAS	ENTITY (FBiH + CANTON)	m^3/year
33	Waste wood deciduous	WWD	Waste wood deciduous	FZS	JP Sume RS, RZSRS	BHAS	ENTITY (FBiH + CANTON)	m^3/year
34	Annual increment of coniferous forest	AIC	Annual increment state forests	FZS, cantonal forest enterprises	JP Sume RS, RZSRS	BHAS	MUNICIPALITY (FBiH + CANTON)	m^3/year
35	Annual increment of coniferous forest	AIC	Annual allowed felling (ACC) state forests	FZS, cantonal forest enterprises	JP Sume RS, RZSRS	BHAS	MUNICIPALITY (FBiH + CANTON)	m^3/year

36	Annual increment of coniferous forest	AIC	annual increment private forests	Cantonal forest offices	JP Sume RS, RZSRS	BHAS	MUNICIPALITY	m^3/year
37	Annual increment of coniferous forest	AIC	annual allowed felling (ACC) private forests	Cantonal forest offices	JP Sume RS, RZSRS	BHAS	MUNICIPALITY	m^3/year
38	Annual increment of deciduous forest	AID	annual increment state forests	FZS, cantonal forest enterprises	JP Sume RS, RZSRS	BHAS	MUNICIPALITY (FBiH + CANTON)	m^3/year
39	Annual increment of deciduous forest	AID	annual allowed felling (ACC) state forests	FZS, cantonal forest enterprises	JP Sume RS, RZSRS	BHAS	MUNICIPALITY (FBiH + CANTON)	m^3/year
40	Annual increment of deciduous forest	AID	annual increment private forests	Cantonal forest offices	JP Sume RS, RZSRS	BHAS	MUNICIPALITY	m^3/year
41	Annual increment of deciduous forest	AID	annual allowed felling (ACC) private forests	Cantonal forest offices	JP Sume RS, RZSRS	BHAS	MUNICIPALITY	m^3/year
42	Black liquor	BLL	Pulp production	FZS	RZSRS	N/A	Entity	m^3/year

ANNEX A6 INSIGHTS ON DATA COLLECTION BY THE LOCAL EXPERTS

The information contained in the following annexes offers an insight into data collection by the local experts. It describes the current data collection process as well as how to improve updating. This annex provides a guide for future data collection and defines an institutional approach for a long-term integrated reporting and monitoring system for the assessment of the biomass potential in Bosnia and Herzegovina.

A 6.1. Collection of Forestry Data

A 6.1.1. Forestry sector in the Federation of Bosnia and Herzegovina

In order to collect, monitor and update dynamic data on wood biomass potential, it is necessary to apply a participatory, cross-sectorial and cross-institutional approach. This implies both close cooperation between the potential data users (ministries responsible for forestry and energy at all administrative levels), the primary institutions for data collection and processing (the state and entity statistics institutions) and secondary institutions for data collection and processing (Federal Forest Office, cantonal forest offices, cantonal forest companies and the wood processing industry) as well as defining a clear protocol for the institutional updating of data and maps concerning the wood biomass potential.

As data users, the responsible ministries should secure political support (in terms of providing the mandate) and provide a sustainable financial framework to ensure the continued long-term collection, monitoring and updating of dynamic data on the wood biomass potential. By so doing, the obtained data will provide the fundament for strategic and political decisions in the sectors of forestry and bioenergy. Stable relations between the primary and secondary institutions for the collection and processing of the data, in terms of its continual long-term delivery to the statistics institutions by the forest companies/public forest administration/wood processing industry should be achieved through the creation and subsequent completion and delivery of the appropriate statistical forms. This includes all data related to the different types of wood biomass as proposed by the methodology as well as the annual volume increment, available annual felling and actual felling for conifers and broadleaves in both state and private forests and at the entity, cantonal and municipal level, data

on the production of industrial/technical wood, fuel wood and waste for conifers and broadleaves in state and private forests at the entity, canton and municipal level and byproducts from the wood processing industry and black liquor. This can be realised through the already existing institutional arrangements that deal with regular statistical reporting and data collection. Local experts at universities and research institutions in Bosnia and Herzegovina should be involved in the necessary expert assessments, definition of specific parameters and factors for the assessment of the types of wood biomass and in improving the methodological approach to data collection.

In order to provide data from the lower administrative levels (municipal and cantonal) and its processing at the entity level, it is important to define the relations, procedures and responsibilities between the primary and secondary institutions for data collection and processing. The main difficulties in obtaining data were identified at the municipal level. Having this in mind as well as the highly decentralised administrative set up in the Federation of Bosnia and Herzegovina (this entity is divided into 10 cantons), it seems appropriate to use the cantonal level as opposed to the municipal level as the lowest level for data gathering and presentation. The lack of a law on forests at the level of the Federation of Bosnia and Herzegovina[103] effectively means that forest management and governance in the entity has been practically 'usurped' by the cantonal forest companies and cantonal forest offices.

The following list provides an overview of main available data and data gaps per forestry biomass at the level of the Federation of Bosnia and Herzegovina:

- Data on the annual volume increment: Available annual felling and actual felling data for conifers and broadleaves in state forests at the entity and cantonal level can be provided by the Federal Office of Statistics for the Entity of the Federation of Bosnia Herzegovina (Statistical Bulletin: Forestry in the Federation of Bosnia and Herzegovina).
- Data on the annual volume increment: Available annual felling and actual felling data for conifers and broadleaves in state forests at the municipal level can be provided by the cantonal forestry companies (except for the Posavski Canton where a cantonal forest company has yet to be established because of a lack of state forests). Recommendation: The Federal Office of Statistics for the Entity of the Federation of Bosnia Herzegovina (FZS) should create an appropriate form and request that the cantonal forest companies or Federal Forest Office complete the form and deliver the data within the regular process of statistical reporting.
- Concerning the data on the annual volume increment: Available annual felling and actual felling data for conifers and broadleaves in private forests is provided at the entity, cantonal and municipal level. Data at the cantonal and municipal level can be provided by the cantonal forest offices (except in those cantons where forest management plans for private forests do not yet exist). Recommendation: The FZS should create an appropriate form and requests that the cantonal forest offices or the Federal Forest Office complete and deliver the data within the regular process of statistical reporting. Simple summarised data from all cantons is accumulated at the entity level.
- Data on the production of industrial/technical wood, fuel wood and waste for conifers and broadleaves: The FZS (Statistical Bulletin: Forestry in the Federation of Bosnia and Herzegovina) provides this data for state and private forests at the entity and cantonal level.
- Data on the production of industrial/technical wood, fuel wood and waste for conifers and broadleaves: This is provided for state and private forests at the municipal level by the cantonal forestry companies and the cantonal forest offices (except in those cantons where forest management plans for private forests do not yet exist). Recommendation: The FZS should create an appropriate form and request that the cantonal forestry companies and the cantonal forest offices (or the Federal Forest Office) complete and deliver the data within the regular process of statistical reporting.

[103] The Mayor of the Municipality of Konjic and the Association of Municipalities and Cities of the Federation of Bosnia and Herzegovina both, but separately, addressed the Constitutional Court of the Federation of Bosnia and Herzegovina concerning the 2002 entity Law on Forests. They referred to the protection of the right to local self-government, which is guaranteed under the Constitution of the Federation of Bosnia and Herzegovina. The Constitutional Court issued a judgment in November 2009. The judgment stated that the Law on Forests violated the right of the municipalities to local self-government. As a transitional measure, the Court allowed the Parliament of the Federation of Bosnia and Herzegovina up to six months to bring the Law on Forests into compliance with the provisions of the European Charter on Local Self-Government and the Law on Local Self-Government of the Federation of Bosnia and Herzegovina. However, the Parliament failed to make the required adjustments within the foreseen deadline and consequently the application of this Law terminated upon the expiration of the set deadline. Numerous attempts by scientific institutions, professional associations, the Association of Municipalities and Cities of the Federation of Bosnia and Herzegovina, representatives of the legislative authority and the responsible federal Ministry to adopt the new Law on Forests have been unsuccessful. In practice, the management and organisation of the forestry sector in the entity is implemented on the basis of the cantonal forest laws, which were adopted in the meantime and have largely taken over the provisions of the 2002 Law on Forests as well as its bylaw documents in regard to professional issues.

- Data on the byproducts from the wood processing industry (quantities, local usage, selling and processing as wood based energy generating products): This is not available at one place. Recommendation: The FZS should create an appropriate form and requests that the wood processing enterprises (if legally prescribed) complete and deliver the data within the regular process of statistical reporting. Otherwise, it would be necessary to conduct an expert assessment on a representative sample of wood processing enterprises, bearing in mind at least the parameters size (capacities for processing), the type of processing (primary, secondary or tertiary) and the geographical distribution of the enterprises in the sample design.
- Data on the production of black liquor: This exists within individual companies producing this type of wood biomass in the Federation of Bosnia and Herzegovina (such as Natron-Hayat d.o.o. in Maglaj). Recommendation: The FZS should create an appropriate form and request that the company (if legally prescribed) complete and deliver the data within the regular process of statistical reporting.

Over the last few decades, natural reforestation of abandoned agriculture land, particularly in rural areas, has increased the forest area in the Federation of Bosnia and Herzegovina. Land that was previously agricultural has turned into unmanaged forest of pioneer tree species or shrubs now through natural reforestation. The process of identifying and officially registering changes in land use is the key precondition for any institutional approach to an assessment of the wood biomass potential of abandoned agricultural land. Once land that was formerly agriculture has been officially recognised as forestland in the land books and cadastres it will be possible to conduct a forest inventory of this land. The basic data (forest taxation elements) would be collected through regular (every 10 years) forest taxation and forest management plans (created regardless of the type of ownership). Up until such a time, it is only possible to estimate the wood biomass potential of such land through expert assessment. Concerning the assessment of illegal or unofficial logging of fuel wood from public and private forests in the entity, official data is available at the cantonal forest offices and forest inspections within the departments for inspection affairs at the entity and cantonal level. The Federal Office of Statistics for the Entity of the Federation of Bosnia Herzegovina should create an appropriate form and request that these institutions (or the Federal Forest Office) complete and deliver data on illegal/unofficial logging within the regular process of statistical reporting.

A 6.1.2. Forestry sector in Republika Srpska

The centralised administrative structure in Republika Srpska, compared to the Federation of Bosnia and Herzegovina, means that determining official sources is more regulated.

The public company 'Šume Republika Srpska' a.d. from Sokolac (hereinafter referred to as 'JP Šume') along with its organisational units is the first and only authorised and qualified institution to collect and process all data related to the types of wood biomass as proposed by the methodology. As a forest company under public ownership and a provider of professional technical services for privately owned forests, JP Šume is legally obliged to submit data to the Republika Srpska Institute of Statistics and this data is then forwarded to the Agency for Statistics of Bosnia and Herzegovina.

Concerning lower geographic and administrative level data (i.e. municipal), only JP Šume is responsible for collecting and processing this data and only in accordance with the applicable law.

The following list provides an overview of the main data available and the data gaps per forestry biomass at the entity level in Republika Srpska.

- Data on annual volume increment: Available annual felling and actual felling for conifers and broadleaves in state forests is provided at the entity level in Republika Srpska by the Republika Srpska Institute of Statistics (Statistical Bulletin: Forestry).
- Data on the annual volume increment: The Republika Srpska Institute of Statistics (Statistical Bulletin: Forestry) provides available annual felling and actual felling data for conifers and broadleaves in private forests at the entity level.
-Data on the production of industrial/technical wood, fuel wood and waste for conifers and broadleaves: The

Republika Srpska Institute of Statistics (Statistical Bulletin: Forestry) provides this data at the state level for private forests in Republika Srpska.

-Data on the annual volume increment: Available annual felling and actual felling data for conifers and broadleaves in state forests is provided at the municipal level by JP Šume (cadastre, annual reports and forest management plans).

-Data on the annual volume increment: Available annual felling and actual felling data for conifers and broadleaves in private forests is provided at the municipal level by JP Šume (cadastre, annual reports, forest management plans).

-Data on the production of industrial/technical wood, fuel wood and waste (only for state forest after 2015) for conifers and broadleaves: This data is provided for state and private forests at the municipal level by JP Šume (forest management plans).

-Data on the production of waste from conifers and broadleaves for private forests: This data does not exist for private forests at the municipal level.

-Data on byproducts from the wood processing industry (quantities, local usage, selling and processing for wood based energy-generation products): This data is not available at one place, as in the Federation of Bosnia and Herzegovina. Recommendation: The Republika Srpska Institute of Statistics should create an appropriate form and request that the wood processing enterprises (if legally prescribed) complete and deliver the data within the regular process of statistical reporting. Otherwise, it would be necessary to conduct an expert assessment on a representative sample of the wood processing enterprises bearing in mind at least the parameters of size (processing capacities), type of processing (primary, secondary or tertiary) and the geographical distribution of enterprises in the sample design.

-Data on the production of black liquor: Attempts to obtain this data from the only officially contracted company that deals with the processing of wood in the Republika Srpska ('Destilacija' a.d. in Teslić) proved unsuccessful. Recommendation: The Republika Srpska Institute of Statistics should create an appropriate form and request that the company (if legally prescribed) complete and deliver the data within the regular process of statistical reporting.

Former agricultural land has naturally reforested over the last few decades and has turned into unmanaged forest of pioneer tree species or shrubs. Data from the second National Forest Inventory (at present not legally available) shows that the Republika Srpska has 501,600 ha covered by forest. That is 212,692.62 ha more than the data contained in the Republika Srpska cadastre, which states 288,907.31 ha. Because of the absence of a clearly defined methodology for estimation, the wood biomass potential for such land is currently based solely on expert assessment. The complex and cost-intensive procedure that private forest owners have to fulfil when felling or cutting private forests is the reason why a large number of them have no interested in registering their forests as forestland. This is attributable to the fact that the current legislation allows for a very simple way of using this forestland if registered as agricultural land. The poor quality coppice forest in these areas is used mostly for household heating.

Concerning the assessment of unofficial non-registered logging of fuel wood from public forests in Republika Srpska, official data is available at the entity level through the Republika Srpska Institute of Statistics (Statistical Bulletin: Forestry). Data concerning the assessment of unofficial non-registered logging of fuel wood from private forests in Republika Srpska does not exist at the entity level. Data concerning the assessment of unofficial non-registered logging of wood conducted in state forests in Republika Srpska exists at the municipal level in JP Šume (annual reports), but only in the form of spent resources in terms of funds planned to protect against illegal logging activities. Data related to unofficial non-registered logging of state and private forests in Republika Srpska at both the entity and municipal level is insufficient, scarce and incomplete compared to the extent of damage it inflicts. In order to follow the damage caused by these unofficial activities it is necessary to adopt a far more serious and transparent approach to this problem.

Recommendation: The Republika Srpska Institute of Statistics should create an appropriate form and request that JP Šume complete and deliver the data on unofficial non-registered logging within the regular process of statistical reporting.

Annex A 6.2. Collection of agricultural data

A 6.2.1. Agriculture sector in the Federation of Bosnia and Herzegovina

Two sources were used when it came to data collection for the purpose of calculating biomass. The Federal Office of Statistics for the Entity of the Federation of Bosnia Herzegovina (FZS) was the first and the principal source of data at the entity and the municipal level. Data from this source was obtained very quickly and its quality was satisfactory. When it came to statistical data, it was found that plant production statistics are published regularly at the entity, cantonal and municipal level. The exception was data on the number of livestock and poultry, which was not available in statistical publications but was duly obtained from the FZS. There was also no available data relating to energy crops. More detailed data, such as the number of farms in accordance with the defined thresholds for the number of animals as well as their number per municipality, was obtained from the Register of Farms and Clients. The latter is actually a database managed by the Ministry of Agriculture, Water Management and Forestry of the Federation of Bosnia and Herzegovina. This data represents the producers and farms that are profit-oriented and registered for receiving incentives.

Given that the purpose as well as the methodology for collecting information from these two data sources is different, the comparison of the data from these two sources contained significant deviations. There can be numerous reasons for this and therefore it is recommended that the gaps between the data be analysed and the causes for the discrepancies identified. This would allow for a decision on which data source is more relevant and more acceptable for future computations. Since surveys are used to collected statistics on farms, it would be useful to add data on the number of livestock and poultry next to the number of farms as well as the number of batches (rounds) produced in a calendar year. In this way, it would be easier to filter the data in terms of setting the criterion required for computing the biomass and capacity. This implies that additional discussions need to be organised with representatives of the FZS and then, as required, regular reporting on this issue established. Additional efforts to process the data should not create a financial burden as it could be defined within the regular statistical activities.

However, any additional data collection, processing and provision would require certain decisions at the entity statistical institution level, which would be coordinated by the state level statistical agency. The data required for the computation of biomass should be made an integral part of the regular annual plans of the statistical institutions and should be regularly collected and processed in accordance with the calculation methodology. This is the only way to ensure the viability of the collection and processing of the required data.

With regard to the identification of abandoned land, the CORINE land cover database is currently the only relevant source of information on land coverage/usage and spatial change dynamics in Bosnia and Herzegovina. It should be emphasised that land coverage/usage identification is done at a scale of 1:100,000 with a minimum polygon size of 25 hectares, a minimum change mapping unit of 5 hectares and that projects of this type are implemented once every six years. The Sarajevo Faculty of Agriculture and Food Sciences of Sarajevo University has developed a very detailed nomenclature (IV level of CORINE) for the municipal level and it is currently working on developing land coverage/usage maps at a scale of 1:10,000, where the minimum polygon size is 1 hectare. Such detailed maps would provide a precise and clear insight into the condition of the land coverage, including the size and spatial distribution of abandoned land areas as well as the dynamics of change in terms of time and space. These maps could be prepared as a basis for planning biomass production on agricultural land.

A 6.2.2. Agriculture sector in Republika Srpska

The two institutions most important for the collection of data related to biomass in the agriculture sector in Republika Srpska are the Republika Srpska Institute of Statistics (which is the primary institution for data collection and processing) and the Ministry of Agriculture, Forestry and Water Management of Republika Srpska. The Republika Srpska Institute of Statistics regularly publishes up-to-date official data on plant and animal production at both the municipal and entity level through statistical publications/bulletins. This data can be considered sufficient for the underlying methodology. The lack of data that is evident pertains to the part re-

ferring to the number of heads per individual farm in the Republika Srpska. This data is only available through the Department of Veterinary Affairs within the Ministry of Agriculture, Forestry and Water Management of Republika Srpska. One recommendation is that the Institute of Statistics of Republika Srpska initiates an official procedure on the collection of data related to the number of farms, the number of heads and the number of rotations on individual farms. This would enable the Institute to provide all of the necessary data at the municipal and entity level and at the same time avoid additional financial expenditure.

The Institute is the official administrative organisation of Republika Srpska tasked with generating official statistics for all categories of users ranging from the Government and other official bodies to the business systems, scientific institutions, the media, the general public and individuals. The Institute has already defined official procedures for the collection of data on lower geographical and administrative levels (i.e. municipalities) as well as for their unification at the entity level. In this sense, it is not necessary to undertake any initiatives other than the collection of data on the number of farms, the number of heads and the number of rotations/turns on individual farms. This would consolidate all of the data needed for an assessment of biomass within the agriculture sector in accordance with the methodology defined by this project.

CORINE land coverage data should certainly be used to identify abandoned agricultural land; however, all of the constraints and imprecision that this implies should be taken into account and particular attention paid to the level of precision at 25 hectares. A more suitable option could be to use LANDSAT satellite images that offer greater accuracy. The disadvantage is that when using LANDSAT remote sensing of a satellite images is required before the spatial data can be analysed, which requires far more human and material resources.

ANNEX A 7 STATISTICAL DATA SOURCES

A 7.1. Data sources in Brčko District

Statistical data in Brčko District is contained in the Brčko District bulletins on the Agency for Statistics of Bosnia and Herzegovina website. However, no statistical forestry data was submitted and therefore all data for our project was obtained through the subsection Forestry and Water Management Brčko District

A 7.2. Statistical data sources in the Federation of Bosnia and Herzegovina

The Federal Office of Statistics for the Entity of the Federation of Bosnia Herzegovina Statistical Yearbook 2012 and the Yearbook for 2017

The annually published statistical yearbooks include data on forestry biomass as well as livestock and agriculture. The 2012 yearbook covers the period 2007 to 2011 and provides agriculture, hunting and forestry data on pages 180 to 203. The 2017 yearbook covers the years from 2012 to 2016 and provides information on agriculture, forestry and fishing on pages 200–223. The same data collection procedure was used for both yearbooks.

Agriculture: "The data on agricultural land, agricultural production and number of trees/vines […] have been gathered through the regular statistical surveys. Report submitted by legal entities and the parts of legal entities, and for family farms data are obtained by evaluation made by experts for agriculture in local authorities of municipalities." (2017, p. 201)

Livestock (stockbreeding): "Data are the result of statistical surveys […]. Statistics on stockbreeding records data on legal entities and their parts and data on private family farms separately. Data on livestock number in legal entities and parts of legal entities are gathered by the regular annual reports. Data on livestock number, on livestock production in private family farms have been estimated from the agricultural experts in the municipalities." (2017, p. 202)

Forestry: "The data on fallen timber, afforestation, damages to forests refer to forests in state and private ownership […]. The data on forestry statistics are collected through monthly and annually reports. Data on forests in state ownership are collected in the companies which are occupied in the field of forestry, and data on forests in private ownership are collected from competent apparatus of administration. The data on forest areas and general data on public forests are taken from Federal Ministry of Agriculture, Forests and Water Management." (2017, p. 202)

A 7.3. Statistical data source in Republika Srpska

Statistical Yearbook No. 9 - 2017 issued by the Republika Srpska Institute of Statistics

The annually published statistical yearbook includes data on forestry biomass as well as livestock and agriculture. The yearbook covers the period 2007 to 2016 and provides data on agriculture, hunting and forestry on pages 253–302.

Agriculture and Livestock: "Data on crop production and [on number of livestock] were collected through regular annual surveys, separately for business entities (business companies, cooperatives, etc.) and their organisational parts, and separately for family agricultural holdings. Sources of data for business entities and their organisational parts are accounting and other records of agricultural enterprises and agricultural cooperatives. Data on land areas and crop production [and livestock] at family agricultural holdings are the result of the estimates by local self-government estimators for corresponding estimation areas (municipality/city). For estimations, local self-government estimators rely on the newest cadastral data [and on the newest data from the register of cattle], estimates from previous years, data from the register of family agricultural holdings, information collected from agricultural producers and experts, as well as on their own observations and other sources." (pp. 256-258)

Forestry: "For data collection in the field of forestry statistics, depending on the nature and complexity of a statistical activity, [reporting and estimation] methods are used. […] Reporting method is based on technical and other documentation, i.e. on the data from accounting register, cadastral land survey, forestry and economic management studies, and other technical documentation. […] Forestry and economic management studies are used as a source of data on areas, felled timber and increase of forests classified into types of stands and types of trees, as well as data on silviculture, forest roads, non-covered forest land, and other data. […] Estimate method is used when identifying forest area, afforestation or non-covered forest land, when establishing damage in forests, […]. Estimate method is usually applied for unmanaged forests. […] Also, reporting units are municipalities, i.e. their expert services for reports which refer to private forests. Data on production, sale and stocks of forest assortments in state forests are taken over from monthly reports of forestry enterprises and other enterprises […]. Data on forest area are taken over from the regular annual survey on changes of forest area. Other forestry data are collected through annual reports for regular statistical surveys in the forestry field. […] For data on changes of forest area, timber felling, forest growing and silviculture, as well as for data on hunting association, coverage is full. Data on production, sale and stocks of forest assortments cover production and sale of forest assortments in enterprises engaged in regular production of forest assortments." (p. 288)