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CELEBio

D.2.1

Country report: Bulgaria

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Publishable executive summary in English	This report is organized in 9 chapters. In chapter 1 a first description is given of the key characteristics of the country of Bulgaria. In the chapters 2, 3, and 4 the biomass production including their current uses and opportunities for what biomass can be additionally mobilised, is summarized for respectively the agricultural, forest, and waste sectors. In Chapter 5 a description is given of the current biobased industries and markets, in Chapter 6 the infrastructure, logistics, and energy sector are described. Chapter 7 focusses on the innovation potential. Chapter 8 focusses on the policy framework, in chapter 9 potential financing options related to the development of biobased production chains are discussed. The chapters are closed by swot analysis.
Publishable executive summary in national language	Този доклад е организиран в 9 глави. В глава 1 е направено описание на основните характеристики на България като страна. В глави 2, 3 и 4 е обобщено производството на биомаса, включително тяхното настоящо използване и възможности за допълнителна мобилизация на биомаса, съответно за селскостопанския, горския и сектор отпадъци. В глава 5 е дадено описание на настоящите био-базирани индустрии и пазари, в глава 6 са описани инфраструктурата, логистиката и енергийният сектор. Глава 7 се фокусира върху иновационния потенциал. Глава 8 се фокусира върху политиките, в глава 9 са разгледани потенциалните възможности за финансиране, свързани с развитието на биобазирани производствени вериги. Главите завършват чрез със swot анализи.

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Summary

The development of a bio-based industry in Bulgaria is in its initial stage. Bulgaria belongs to the group of "modest innovators" in the Innovation ScoreBoard, meaning that is well below that of the EU average. A bioeconomy is assumed to be a relatively new paradigm to the major share of Bulgarian businesses. With regard to the current policy framework, a bioeconomy is not the central topic of any specific Bulgarian strategy. There are, however, several national and EU frameworks that touch on the topic of a bioeconomy.

The agricultural sector is growing again and the food processing sector is also in a good position to grow again towards pre-market economy levels providing good opportunities for further exploitation of residual biomass sources in the near future.,

Bulgaria is one of the top countries covered by forests - around 38 % of its territory. They are mainly beech, fir-beech and beech-oak forests, all of which have a relatively high production capacity.

Competitive Bulgarian bio-based products for the market are: herbal phyto-pharmaceutical products; rose, lavender and other oil products: plant cosmetics, pharmaceuticals; timber houses, furniture, bio oils; pellets production, and textiles. The companies are still lagging in bio-based R&D; the connection between them and the research institutes and universities is not well established. They are part of different industries and sectors (agriculture, wood processing, pharma, energy, pulp and paper, plastics, textile, etc.), focused on traditional manufacturing and processing. There is a need to increase the focus on bioeconomy opportunities for creating new value chains.

Bulgaria has a wide range of universities and research institutes of applied sciences. Building upon their know-how, these institutions can make a significant contribution to the bio-based industry and related value chains through interdisciplinary cooperation and associated initiatives.

For example, the bioeconomy is a leading topic and a research focus in the Plovdiv region. It combines agricultural sciences, natural sciences and economic and social sciences in an interdisciplinary way. The aim of bioeconomy proponents is to secure global nutrition, to

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make agricultural production sustainable, to produce healthy and safe food, to use sustainable raw materials industrially, and to expand the productive use of available biomass.

Although the bio-sector is fairly new to Bulgaria, biotechnology is one of the most important and most widespread key technologies in public research organisations as well as in the business sector. Further examples of successfully translated R&D into manufactured goods and products in biochemical and bioplastic production and in development of environmentally friendly new materials and substances can be found in the relatively large pharmaceutical companies.

An analysis of strengths and opportunities of the bioeconomy of Bulgaria shows that the country has good preconditions for converting to a bio-based economy in terms of their natural geographic conditions and resources, their traditional industry, an R&D infrastructure and quality human resources. This capacity also provides new opportunities to complement traditional products with new projects, products and services to maintain and improve the competitiveness of the country. In addition to the potential within the industrial sector that has long been based on agriculture and forestry, the development of a bioeconomy also offers inherent opportunities for the increased use of biomass raw materials within other commercial sectors.

This applies, for example, to phyto-pharmaceuticals and packaging, plastics and biopolymers. The construction of environmentally friendly new materials and substances can be found in relatively large pharmaceutical companies in Bulgaria. Several SMEs are also emerging In the biopharmaceutical sector through the technology transfer process from universities and R&D institutes. Investments in RDI are being made in order to address and support the next phases of technological readiness. This is particularly the case in the field of biotechnology.

Recently, new R&D infrastructures have been established in the field of bio-based products. The most relevant research infrastructure equipment related to bio-based industrial development may be found at High Tech Park in Sofia, the Institute of Organic Chemistry, the Faculty of Chemistry and Chemical technology at the University of Sofia, and the Pulp

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and Paper Institute. Research is oriented towards the development of new technologies and products, which will help to ensure the long-term development of Bulgaria and are contemporaneously internationally relevant.

Bulgaria has an excellent potential for fostering a bioeconomy, but there is a need for a bold, ambitious vision for bioeconomy development as well as for investment incentives and the facilitation of collaboration in sectors and between public and private entities. A lack of awareness and practical knowledge among regional/local authorities and stakeholders, a low degree of cooperation and networking at all levels, insufficient involvement of local/regional stakeholders in drawing up bioeconomy strategies, or inadequate technology transfer and exploitation of innovation should be overcome in order to achieve sustainable and efficient conversion of renewable biological resources into vital products and bioenergy. More specifically, development of a specific action plan will address the need in investment in research, innovation and human resource skills; reinforcement of policy interactions and stakeholder engagement, as well as enhancement of market competitiveness by the development of bio-based industrial activities.

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1. Introduction

This chapter gives an overview of the objectives and approach of the CELEBIO Project and will directly pinpoint to the key and most typical characteristics of the country.

1.1 Objectives and approach

This report aims to provide the necessary background information needed to evaluate the possibilities for setting up bio-based production chains in Bulgaria.

The information structure and analysis presented in this report was developed by building on the method designed and applied by Van Dam et al. (2014) and was further refined through the execution of interviews with bio-based business developers and other experts. In these interviews further information was obtained on key factors that guide the choice of setting up bio-based activities in countries. Most of the experts stressed that all the identified factors are important and that a system approach is key in developing bio-based initiatives. If one link in the chain is missing, the bio-based initiative will not succeed. The identified factors are mapped in this report and will be the basis for performing a SWOT analysis for development of bio-based production chains.

In Annex 1 a further explanation is given of the approach used to set-up this country report and the main interview outcomes with experts interviewed to refine the approach.

1.2 Reading guide

This report is organized in 9 chapters. In chapter 1 (section 1.3) a first description of the key characteristics of Bulgaria is given.

In the chapters 2, 3, and 4 the biomass production including their current uses and opportunities for what biomass can be additionally mobilised, are summarized for

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respectively the agricultural, forest, and waste sectors. First the main traditional production and availability of biomass for food, feed, forest biomass and wood products are discussed and how this is handled in further processing industries and/or used for domestic markets and exports. Subsequently an overview is given of additional biomass potentials that are likely to still be unused or only partly used and that are a good basis for development of new bio-based activities.

In Chapter 5 a description is given of the current bio-based industries and markets, advanced bio-based initiatives, and future biomass valorisation options.

In Chapter 6 the infrastructure, logistics, and energy sector are described.

Chapter 7 focusses on the innovation potential, particularly in the context of bio-based research and development options. The research and educational infrastructure is described and the potential for developing bio-based start-ups and Public-Private-partnerships will be discussed.

Chapter 8 focusses on the policy framework and describes extensively what regulations, legislation, taxes and tariffs exist of relevance for the development of bio-based production chains. Attention will also be paid to situations where regulation and support measures are actually missing and to which extend the rule of law situation influences the establishment of new bio-based activities.

In Chapter 9 potential financing options related to the development of bio-based production chains are discussed.

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1.3 SHORT CHARACTERISATION OF COUNTRY

Bulgaria is a medium sized country in the EU according to land surface with 7 million inhabitants resulting in a relatively low population density (See Table 1.1.1).

Table 1.3-1 Main population, land surface, GDP and trade characteristics of Bulgaria benchmarked against EU average

Category	Bulgaria	EU	Unit
Population	7.1	512.4	million (2018)
Area (total)	11	447	million ha (2018)
% population in urban areas	71,2	44.9	% of total population (2018)
% territory predominantly rural	22.1	43.8	% of total territory (2018)
% territory predominantly urban	1.2	10.7	% of total territory (2018)
Agricultural area	4.5	173.3	million ha (2016)
Forest area	4.6	164.8	million ha (2016)
Population density	64	115	n°/km² (2018)
Agricultural area per capita	0.63	0.34	ha/capita(2016)
Forest area per capita	0.65	0.32	ha/capita(2016)
GDP/capita	7 789	30 956	at current prices in 2018
	15 934	30 956	GDP at purchasing power in 2018
GVA by Agriculture, forestry and fishing	4.2	1.6	% of total GVA (2018)

GDP = Gross Domestic Product; PPS = Purchasing Power Standard; GVA = Gross Value Added; UAA = Utilised Agricultural Area

Source: Eurostat most recent statistical data sources (Accessed August/September 2019) (https://ec.europa.eu/eurostat/data/database) and statistical factsheets (https://ec.europa.eu/agriculture/statistics/factsheets_en)

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Bulgaria has relatively large resources of agricultural and woodland areas (see Table 1.1.1) as these land resources expressed per capita are twice the per capita availability for the EU average. Gross value added by agriculture, forestry and fishing is more than twice that of the European average. 38% of the total area in Bulgaria is forest, and about 47,1% of the total area is agricultural. The majority of the population lives in urban areas, while only 28% of the population is spread out in rural areas. The population density however is pretty similar to the European average. The GDP and purchasing power in Bulgaria are far below the European average. The average income level in Bulgaria is the lowest in Europe.

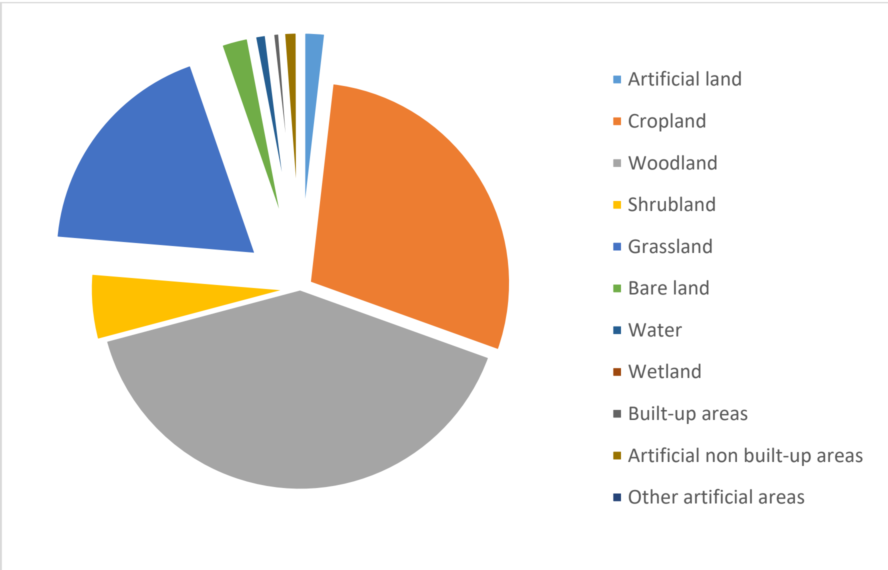

Figure 1.3-1 Main land cover distribution over Bulgaria

Bulgaria has a relatively high urbanisation level as 71,2 % of the population lives in a predominantly urban area while this is at 45% for the whole EU. Land cover distribution (see Figure 1.3.1) shows that the artificial and build up area make up only 4% of the land surface while the most dominant land cover classes by far are woodland (40%), cropland (29%) and grassland (18%) areas.

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The North of Bulgaria is dominated by cropland. The forested areas are in the central parts and in the south of the country and mostly coincide with where the mountainous parts of the country are located. The bigger cities of Bulgaria are mostly found in the central and southeast of the country, which are surrounded mostly by agricultural lands. The regions of the north where most of the cropping lands are concentrated are separated from these central regions by significant mountain ranges.

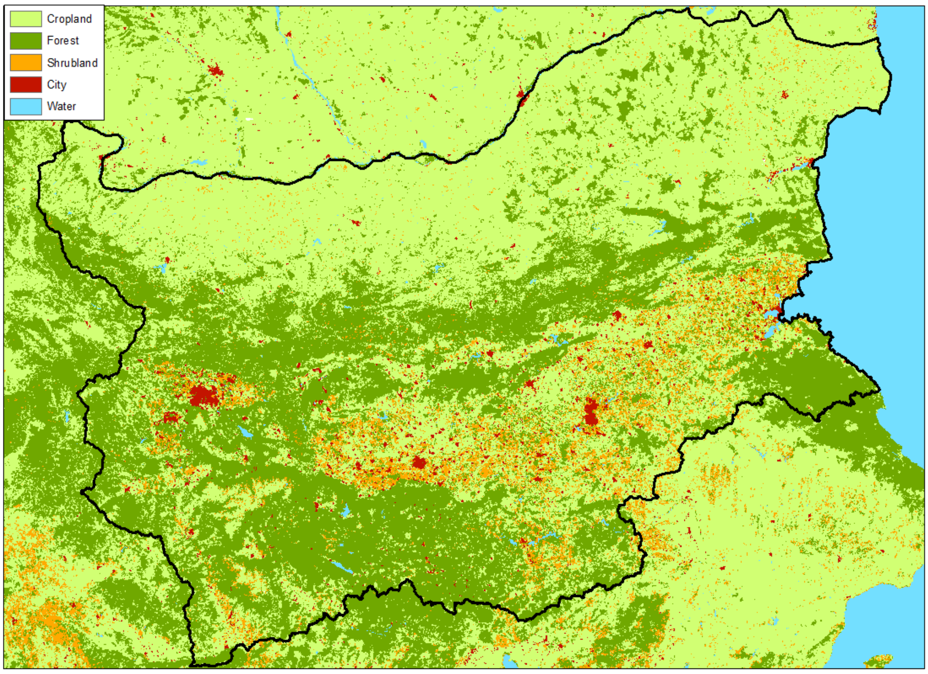

Figure 1.3-2 Bulgaria and its bordering countries

Bulgaria is located in the southeast part of the EU and borders on the east side with the black sea. It is bordered by Romania in the North, Serbia and North Macedonia in the east and Greece and Turkey in the South.

In the case of traffic, Bulgaria is a transit-heavy country. Due to its favourable crossroads, Bulgaria is one of the countries through which half of the European

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corridors pass these are corridors IV, VII, VIII, IX and X with a total length of roads of more than two thousand kilometres, the entirely Bulgarian section on the Danube River is within the corridor VII. One of the busiest in its territory is Corridor X to Sofia and from there Corridor IV to Greece and Turkey and further to the Middle East.

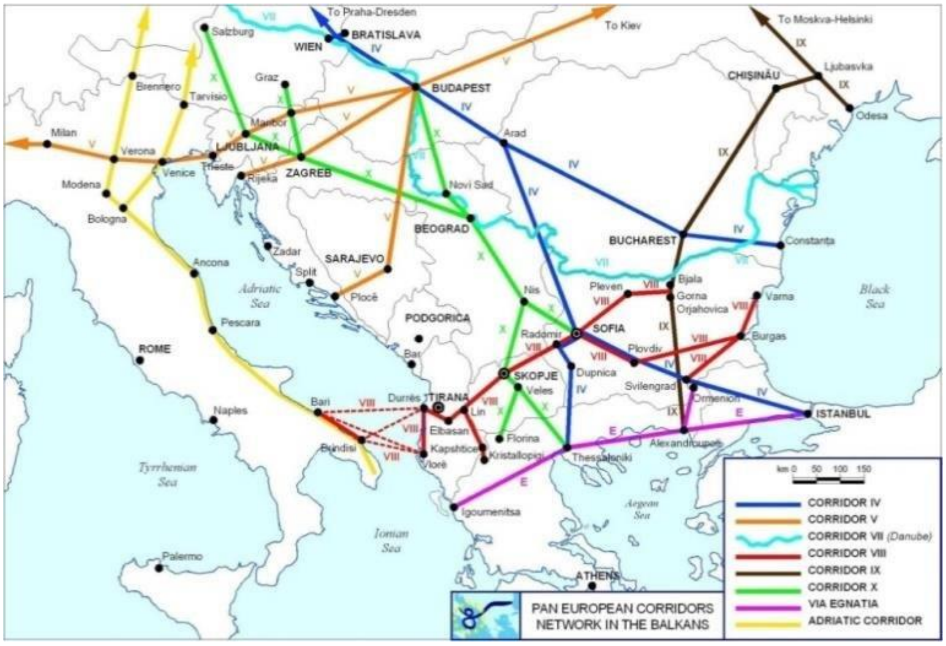


Figure 1.3-3 Position in European corridors in Bulgaria

(Source: https://www.researchgate.net/figure/Position-of-Sarajevo-at-the-Pan-European-corridor-network-in-the-Balkans-Corridor-V_fig1_336374842)

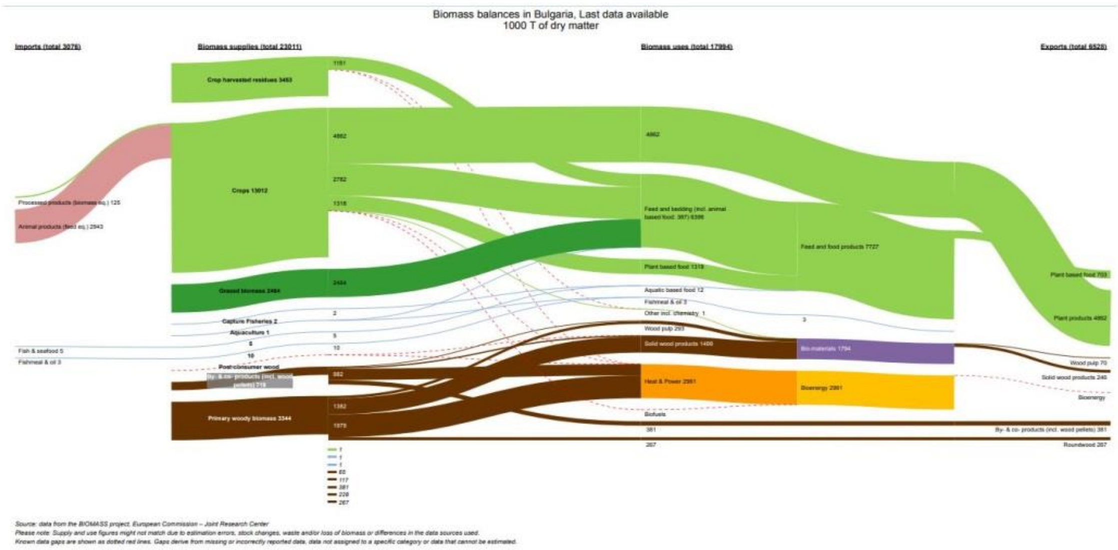
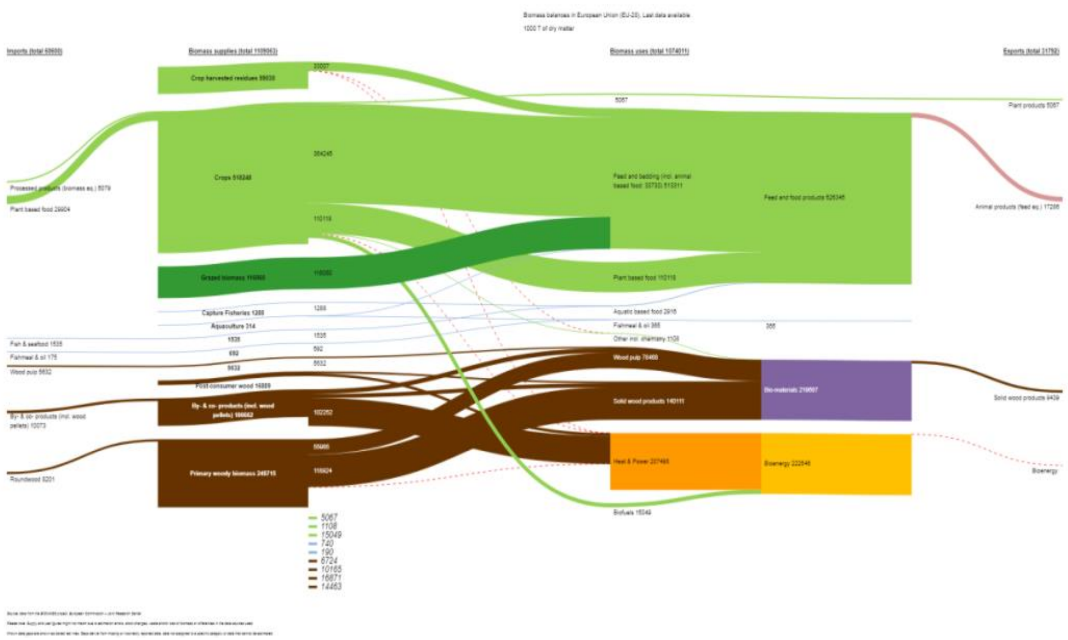


Figure 1.3-4 Biomass flows in Bulgaria (top) and EU-28 (bottom)

JRC Sankey diagrams of biomass flows[1]
(https://datam.jrc.ec.europa.eu/datam/public/pages/index.xhtml)



[1] Gurría Albusac, Patricia; Ronzon, Tévécia; Tamošiūnas, Saulius; López Lozano, Raul; García Condado, Sara; Guillén Garcia, Jordi; Cazzaniga, Noemi; Jonsson, Klas Henrik Ragnar; Banja, Manjola; Fiore, Gianluca; Camia, Andrea; M'barek, Robert (2017): Biomass uses and flows. European Commission, Joint Research Centre (JRC) [Dataset] PID: http://data.europa.eu/89h/34178536-7fd1-4d5e-b0d4-116be8e4b124

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Explanation of Sankey diagram (Figure 1.3.5):

The Sankey biomass diagram is split into biomass supply (shown on the left of the diagram) and biomass uses (right portion of the diagram). Each of these areas shows different categories: agriculture, forestry and fishery (supply), as well as feed and food, biomaterials, bioenergy, and direct exports for each sector (uses). All supply and uses of biomass have been converted to Ktons dry mass before integrating in the diagram. It is important to know that some of the components of the diagram will be missing for a certain country and/or year if the corresponding data has been reported as zero. This implies that the flow data should be interpreted with care as not all diagrams cover all biomass supply and/or use categories present.

Further information on the method and source data in: https://publications.europa.eu/en/publication-detail/-/publication/a19750d4-5498-11e7-a5ca-01aa75ed71a1/language-en

From the Sankey diagram for Bulgaria (Fig 1.3-5) the following main observations can be made (quantities below are all expressed in million tons of dry matter). The main biomass supply produced in Bulgaria is from crops (13.0), grazed biomass (2.46) and primary woody biomass from forests (3.34). Most of the produced crop harvested residues (3.45) and grazed biomass (2.46) are used for food and feed production. It is striking that almost half of the cropped supply is directly exported (4.86) as plant products without being processed into food or feed products first. The most sizable export from Bulgaria consists of plant products. Imports consist mostly in of animal products (2.94).

The production of biomaterials (1.79) and bioenergy of which is all heat and power (2.96) is much smaller then food, feed and plant products and practically all based on woody biomass supply. Biofuels are not included in the Sankey, which is likely a data problem as it will be explained in Chapter 2 that some biodiesel and bioethanol is produced based on sunflower and cereal feedstock.

In general, proportionally the biomass supplies in Bulgaria are similar to the European Sankey diagram. The biomass uses differ slightly in proportions in the amount of biomaterials produced from solid wood products and pulp. The Sankey's also differ in that Bulgaria exports a lot of unprocessed plant products.

2. Biomass supply: agriculture

2.1 Introduction

In this chapter the agricultural biomass production and main uses is described. A distinction will be made between the main economic products produced and their main process chains and residual biomass potentials from primary production and available as by-products of food processing industries. The residual biomass sources, certainly the ones from primary sources are largely not used as already became clear from Section 1.3. In addition to presenting the main biomass production attention will also be paid to the importance and the structure of the agricultural sector and to the main environmental challenges associated with agriculture in Bulgaria.

2.2 Characterisation of current agricultural sector

The agriculture sector in Bulgaria (including economic activities agriculture, forestry and fisheries) is the third most important sector in the national economy. Its contribution to gross value added created is steadily declining - from 12.1% in 2001 to 4.4% in 2016 (the EU average is ar. 2%).

Bulgaria has a relatively high agricultural land area ratio (Table 1.1.1), and the agricultural land area per capita and the % of agricultural employment are both close to double the European average (Table 2.2.1). The crop output is high (73%) compared to the livestock output (27%), while the European average is 56% and 44% respectively. Livestock density is about 1/5 of the European average.

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Bulgarian's population is concentrated in urban areas; the percentage of people living in rural area is 18.8 %, which is about the EU average of 18.9 %. Despite this fact, Bulgarian agriculture is still behind the EU average in terms of structural changes.

The soil erosion (2.03 tonnes/ha/yr) is comparable to the European average, and the farm holdings are very small (7 ha UAA, compared to 16.9 ha). The nutrient balance for nitrogen is twice lower than the European average while the phosphorous is 6kg of nutrient per ha (compared to 1 in Europe).

The average size of the utilised arable are (UAA) of a farm is 22 ha (EU average 16.9 ha), the number of livestock animals is 9.1 (EU average 22.9). Bulgarian farms are on average still very small, dispersed and not specialized – that is why the structural change in Bulgarian agriculture has a long way to go to catch up with the goals and frankly current state of the EU agriculture. There is also relatively more low input farms (52%) compared to Europe (39%).

The key characteristics of the Bulgarian agricultural sector are shown in table 2.2.1.

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Table 2.2-2 Key characteristics for the agricultural sector in Bulgaria

Category	Bulgaria	EU average	Unit
Agriculture in % of total employment	6.8%	3.9%	% of total employment 2017
Agricultural area per capita	0.63	0.34	ha/capita
Cereal yield	4.6	5.2	t/ha
Crop output in total output	73%	56%	% of total agricultural output value (2018)
Livestock output in total output	27%	44%	% of total agricultural output value (2018)
Agricultural income (2010=100)	202	121	Index 2010=100 (2018)
Livestock density	0.205	1.02	LSU/ha UAA
High input farms	6%	29%	%/ total farms 2016
Low input farms	52%	39%	%/ total farms 2016
Gross nutrient balance nitrogen	28	51	kg of nutrient per ha (average 2011- 2015)
Gross nutrient balance phosphorus	-6	1	kg of nutrient per ha (average 2011- 2015)
Irrigated utilised agricultural area	2.1%	n.a.	% of UAA 2016
HNV farmland			% of agricultural land
Soil erosion	2.03	2.4	tonnes/ha/yr 2012
Average farm size	22.0	16.6	ha UAA/holding (2016)
% of agr. holdings < 5 ha	82.6%	62.6%	%/total no. of holdings

HNV= High Nature Value

Source: S2BIOM, Benchmarking factsheets (https://s2biom.wenr.wur.nl/web/guest/data-downloads) updated with https://ec.europa.eu/agriculture/statistics/factsheets_en) and additional Eurostat data (https://ec.europa.eu/eurostat/web/agriculture/data/database)

The agricultural income index is also almost double the European average. Only 2.1% of the utilized agricultural lands are irrigated and the levels of nutrients are quite low compared to the average in Europe. The majority of the agricultural holdings in Bulgaria are smaller than 10 ha in size (1 859 316 farmers or 99.88% of all owners although the average farm size is higher than the EU average, but this is related to the extreme land distribution over farms with many very small farms and a few very large farms.

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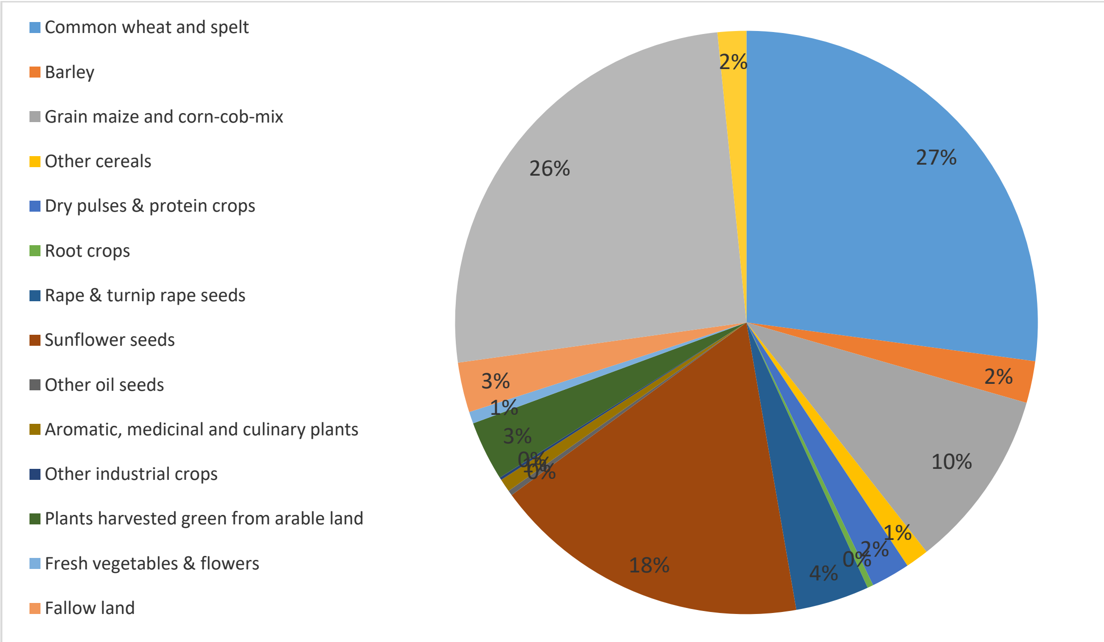

Figure 2.2-5 Main crops and land uses in Bulgaria

Source: Eurostat, data 2016 (accessed July 2019)

2.2.1 CROP PRODUCTION

When looking at the production of crops for existing food and feed uses the Bulgarian production is in the average position at EU level with 8.2 mln ton d.m. production (see Figure 2.2-2). The most important crops in Bulgaria are cereals and oil crops, e.g. sunflower and rape. Permanent crops cover a relatively small percentage of the cropping area, particularly in comparison to the majority of EU countries.

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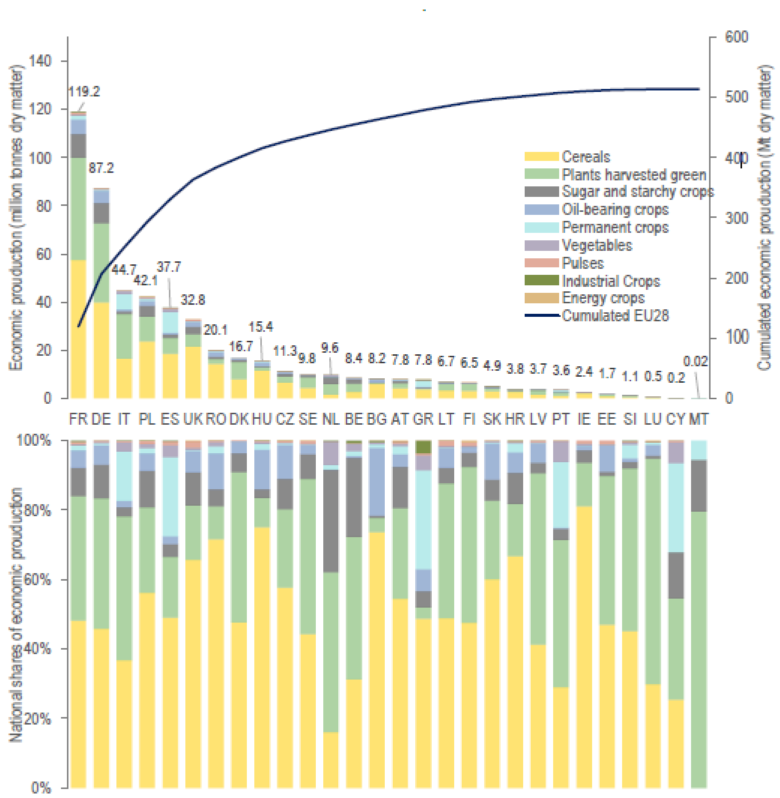

Figure 2.2-6 Economic production (top pane) from the main crop groups per member state, expressed in Mt of dry matter per year; and the shares at national level (bottom pane). Average values over the reference period 2006-2015.

Source: Camia et al. (2018). https://publications.europa.eu/en/publication-detail/-/publication/358c6d4b-1783-11e8-9253-01aa75ed71a1/language-en/format-PDF/source-search

Cereals

All major cereals have higher average yields in 2017 compared to 2016, with the result that most of them have increased production. Only the production of barley and rice declines on an annual basis, as a result of less sown and, consequently, harvested areas.

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Table 2.2-3 Cereals production 2017

Crops	Harvested area (ha)	Average yield (t/ha)	Production (t)
Wheat	1 144 519	5,36	6 132 671
Rye	8 237	2,10	17 304
Triticale	18 660	3,17	59 140
Barley	128 365	4,64	595 237
Oats	13 266	2,40	31 849
Corn for grain	398 152	6,44	2 562 569
Rice	10 434	5,61	58 523
Total	**1 795 031**		**9 826 359**

Source: Ministry of agriculture, food and forest, Agrostatistics Department, Crop Production Survey

Wheat

Wheat production in 2017 is 6,132.7 thousand tons. This is 8.3% above the level in 2016, with a slight decrease in harvested areas, offset by an increase in average yield of 12.8%, under the influence of favourable climatic conditions.

The area sown with wheat in 2017 is 1,147,208 ha, of which 1,144,519 ha were harvested. The relative share of wheat in the total harvested cereals in 2017 is 64%. The North-East region - 24%, followed by the North-West -21.4% and the South-East - 21.2% occupy the largest share of the harvested areas with wheat.

Rye and triticale

The rye grain produced in 2017 increased by 14% on an annual basis to 17.3 thousand tons, and from triticale - by 20% to 59.1 thousand tons. In both crops, there is a significant increase in harvested areas (by 10.3% and 15.9% respectively), combined with a slight increase in average yields.

The highest harvested areas with rye and triticale are observed in the South Central region - 3 305 ha and 10 529 ha respectively.

Barley

Barley production in 2017 amounted to 595.2 thousand tonnes - 13.7% less than in 2016, as a result of a 19.7% decrease in harvested areas, partially offset by an increase of the average yield by 7.4%.

The areas with barley, both sown and harvested, decreased by almost 20% compared to the previous year, which is related to the redirection of farmers to other crops, mainly to sunflower.

The largest area of barley in 2017 is in the South-East region – 35,794 ha or 27.9% of the total amount of harvested area in the country. The second largest area is the North-western region with 28,373 ha or 22.1%.

Oats

In 2017, 31.8 thousand tonnes of oats were produced in the country - 1.5% more than in 2016, as a result of the higher yields of 17.3% per unit area, while the harvested areas with oats decreased by 13.4%.

Most areas with oats were harvested in the Northwest Region - 4,059 ha or 30.9% of the total area harvested in the country.

Corn for the grain

The maize grain obtained in 2017 increased by 15.1% compared to 2016, to 2 226.1 thousand tons, which is due to an increase of the average yield by 17.7%.

The area sown with maize for grain in 2017 is 400 886 ha, of which 398 152 ha were harvested - by 2.2% less than in 2016.

The largest share of cultivated maize areas in the Northwest Region is 39.3% (156 512 ha). This is followed by the North-East Region with 120 310 ha or 30.2% and the North Central Region with 94 730 ha or 23.8%.

Rice

In 2017, rice production shrunk from 9.6%/ y to 58.8 thousand tonnes. The average yield for the 2017 harvest increased by 3.8% compared to 2016, to 5.61 tonnes / ha, while the harvested rice area decreased by 13% to 10 434 ha.

Cereals distribution by NUTS2 are shown in the following figure.

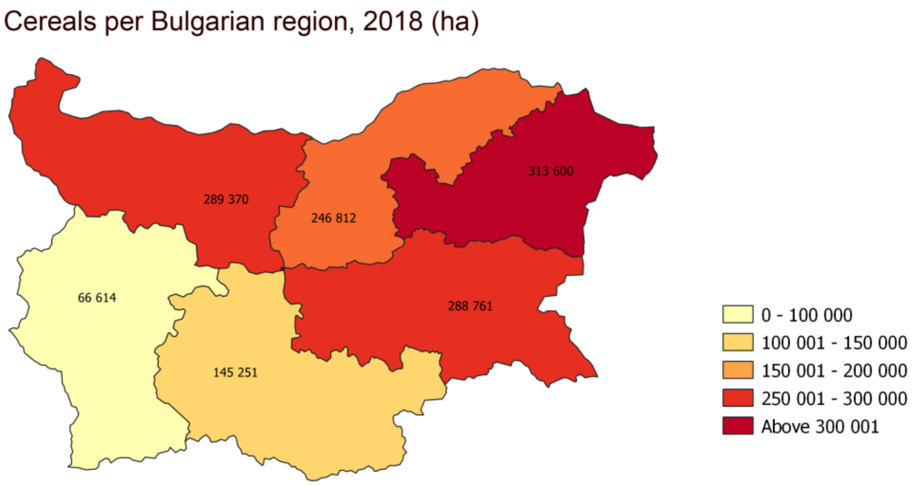

Figure 2.2-7 Cereal crop area by regions

Oil crops

The main oil crops grown in the country are sunflower and winter oilseed rape.

Table 2.2-4 Production of oil crops 2017

Crops	Harvested area (ha)	Average yield (t/ha)	Production (t)
Sunflower	898 844	2,29	2 056 987
Oilseed rape	160 650	2,98	478 987

Source: Ministry of agriculture, food and forest, Agrostatistics Department, Crop Production Survey

Sunflower

Sunflower production in 2017 increased by 11.9% compared to 2016, reaching 2,057 thousand tons. Both the harvested area is 9.9% up to 898,844 ha and the average yield is 1.8% up to 2.29 tons / ha.

Sunflower sown areas in 2017 amount to 910,918 ha, up 11.1% from 2016.

Most sunflower areas in 2017 are in the North-western region – 226,445 ha or 25.2% of the harvested areas in the country. The Northeast region is followed by 204,450 ha (22.7%). The third is the North Central Region with 179,880 ha (20.0%).

For the next year, the largest is the share of sunflower areas, located on a wheat precursor - 65.1%.

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Rapeseed

The production of rapeseed from the 2017 harvest is 479 thousand tons, 5.9% less than in 2016. The areas sown with rapeseed in 2017 are 165,216 ha, of which 160,650 ha have been harvested - 6.3% less than in 2016. The average yield is maintained around the level of the previous year - 2.98 tonnes / ha (+ 0.4%).

The highest number of harvested rapeseed areas in 2017 was reported in the North-East region - 39 696 ha or 24.7% of the harvested areas in the country, followed by the South-East - 38 909 (24.2%) and North-West region with 38 814 ha (24.2%).

Oil-bearing crops distribution by NUTS2 are shown in the following figure.

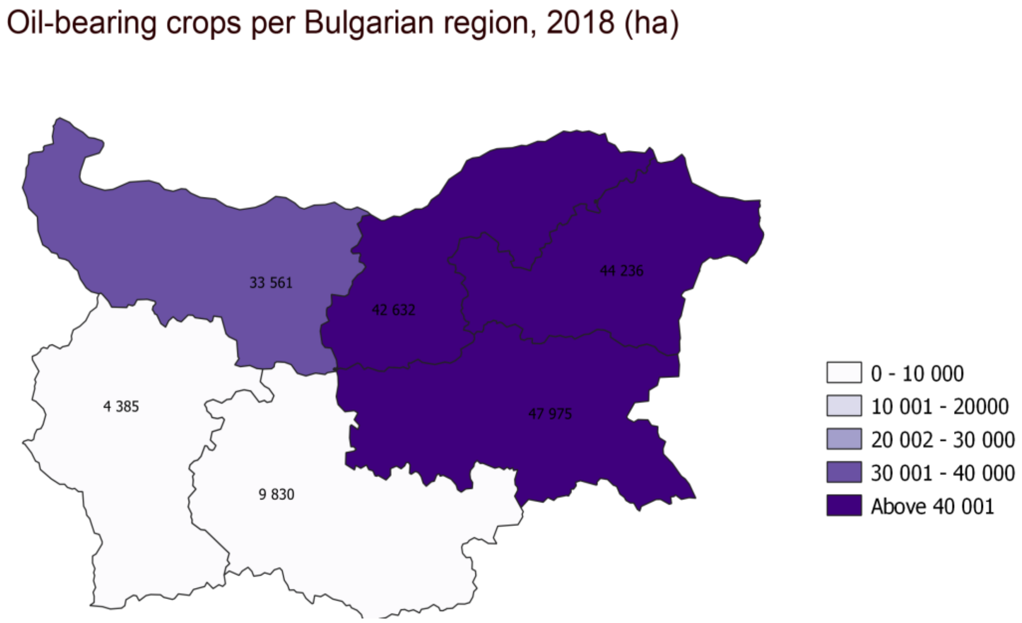

Figure 2.2-8 Oil-bearing crops by regions

2.2.2 PERMANENT CROP PRODUCTION

The permanent crops by regions are presented in the tables bellow.

Table 2.2-5 Fruit production - 2018 by NUTS and statistical zones, ha

NUTS2	Apples	Pears	Peaches and Nectarines	Apricots and Prunes	Plums and Junks	Cherries	Sour Cherries
Bulgaria total	**3 981**	**571**	**3 521**	**2 550**	**7 357**	**10 049**	**1 184**
North and South-East BG	1 685	269	2 566	2 392	4 734	5 277	704
North-West	**437**	**13**	**44**	**13**	**1 028**	**128**	**84**
North-Central	**292**	**96**	**375**	**2 078**	**1 405**	**910**	**237**
North-East	**421**	**71**	**103**	**157**	**1 083**	**611**	**314**
South-East	**535**	**89**	**2 044**	**144**	**1 218**	**3 628**	**69**
South West and South-Central	2 296	302	955	158	2 623	4 772	480
South-West	**883**	**87**	**704**	**10**	**761**	**2 490**	**165**
South Central	**1 413**	**215**	**251**	**148**	**1 862**	**2 282**	**315**

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Table 2.2-6 Fruit production - 2018 by NUTS and statistical zones, ha

	Nuts	Raspberrie s	Other Fruits	TOTAL
Bulgaria total	**6 181**	**2 102**	**2 358**	**39 854**
North and South-East	4 786	1 463	1 561	25 437
North-West	**528**	**174**	**223**	**2 672**
North-Central	**1 218**	**317**	**193**	**7 121**
North-East	**1 034**	**751**	**407**	**4 952**
South-East	**2 006**	**221**	**738**	**10 692**
South-West and South-Central	1 395	639	797	14 417
South-West	**111**	**340**	**150**	**5 701**
South-Central	**1 284**	**299**	**647**	**8 716**

Source: Ministry of agriculture, food and forest, Agrostatistics Department, Fruit Production Survey

In 2018, 228,501 tonnes of fruit were produced. The leading position in fruit production is occupied by the Southeast Region - 27% and the South Central Region - by 26%. Pea (57%) and cherry (37%) production are concentrated in the South-East. The South Central region accounts for 43% of apple production in the country, pears - 37%, plums - 30%, and cherries - 29%. In the North Central region, 85% of apricots are produced in the country. In the production of raspberries, the Northeast region has the highest share.

The areas under fruit, nuts and berries on the agricultural holdings in 2018 occupy 68.3 thousand hectares. 39.85 thousand hectares were harvested. The production of fruit is 228.5 thousand tons. In 2018, 88% of the area under fruit, nuts and berries was harvested. For climatic and other reasons, about 12% of the fruit areas with fruit trees have not been harvested. The total harvested area in 2018 is 7.8% more than in 2017. Cherries occupy the largest share - 25.2%, followed by plums and junks - 18.5%.

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Of the harvested areas, 36% and 58% of cherries and peaches and nectarines are in the South-East region. In the South Central region, 35% of the harvested areas are with apples and in the North Central Region - 81% of the areas are apricots.

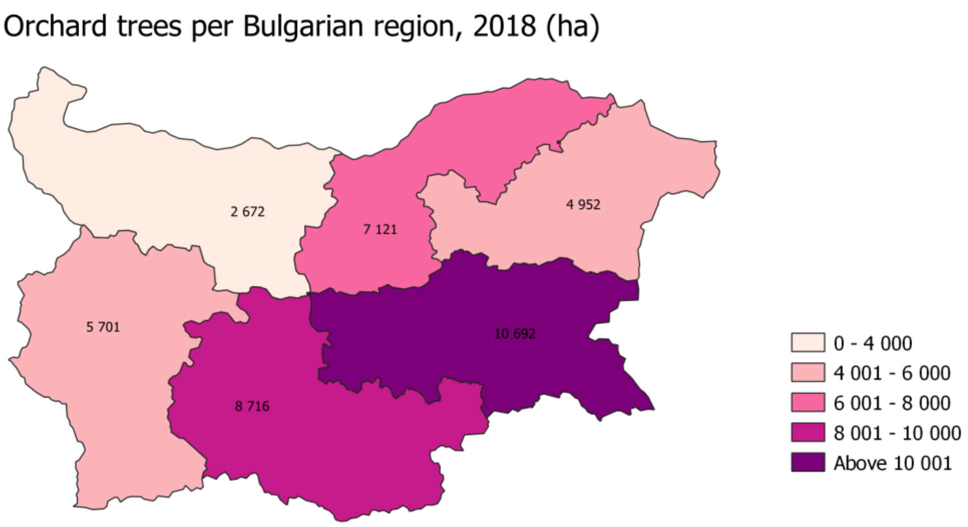

Figure 2.2-9 Orchard tree area by regions

Table 2.2-7 Fruits production -average yield –2018 (kg/ha)

Statistical zones Statistical regions	Apples	Pears	Peaches	Apricots
Bulgaria	**12 635**	**5 881**	**8 202**	**5 330**
North and South-east BG	*12 770*	*5 677*	*7 899*	*5 344*
North-West	**9 430**	**4 769**	**6 841**	**5 462**
North-Central	**9 829**	**4 083**	**7 467**	**5 566**
North-East	**14 252**	**6 521**	**6 738**	**2 764**
South-East	**15 938**	**6 854**	**8 060**	**4 951**
South-West and South- Central	*12 535*	*6 063*	*9 015*	*5 114*
South-West	**8 313**	**6 805**	**9 705**	**4 500**
South-Central	**15 173**	**5 763**	**7 080**	**5 155**

Table 2.2-7 continues

Statistical zones Statistical regions	Plumes and Juncks	Cherries	Sour Cherries	Nuts	Raspberries
Bulgaria	**7 671**	**5 504**	**4 046**	**828**	**3 544**
North and South-east BG	*7 225*	*5 359*	*4 077*	*835*	**3** *697*
North-West	**4 684**	**5 141**	**4 869**	**875**	**3 310**
North-Central	**7 211**	**4 897**	**4 899**	**847**	**3 098**
North-East	**8 303**	**4 224**	**3 105**	**769**	**3 850**
South-East	**8 426**	**5 673**	**4 710**	**850**	**4 339**
South-West and South- Central	*8 475*	*5 665*	*4 002*	*804*	*3 196*
West and South-Central	**6 640**	**6 002**	**3 364**	**1 423**	**2 974**
South-West	**9 226**	**5 297**	**4 337**	**751**	**3 448**

Source: Ministry of agriculture, food and forest, Agrostatistics Department, Fruit Production Survey

95% of the produced 228 501 tonnes of fruit were realized - 37% are targeted for the commercial network, 37.8% - for the fruit industry and 2.2% for own consumption.

Grapes

In 2018, the area under vineyards is 50,727 ha.

In the South-eastern region 44% of the grapes are produced and in the South Central region - 31%. The relative share of the cultivated areas with red wine varieties is 61% of the cultivated areas with wine grape varieties, and of the whites - 39%.

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The unsupported vineyards, as well as those of small and fragmented plots outside the agricultural holdings, are 13,673 ha. The total area under vineyards in Bulgaria in 2018 is 64,400 ha.

The area under varieties suitable for wines with a protected designation of origin (PDO) registered in the Vineyard register maintained by the Executive Agency for Vine and Wine (EAPW) is 16 676 ha, for wines with a protected geographical indication (PGI) - 21 636 ha, and for other wines - 22 935 ha. According to EALW data, 1 421 ha of vineyards were created in 2018.

The processed grapes from the 2018 vintage for the production of wine and grape must declared by registered wine producers in the EAVW are 151 938 tonnes. The total quantity of wine produced under industrial conditions is 1,040,648 hectoliters, the produced wines with PDO are 5,740 hectoliters, the wines with PGI - 412,107 hectoliters and other wines - 622,801 hectoliters. The production of grape must is 43,385 hectoliters.

Table 2.2-8 Grape production by NUTS and statistical regions and zones–2018, t

	Grape from vineyards			Grape from acme	Total grape produced
Statistical zones Statistical regions	Wine grapes	Dessert grapes	Total		
Bulgaria total	**182 569**	**11 828**	**194 397**	**1 073**	**195 470**
North and South-East BG	**115 218**	**4 176**	**119 394**		
North-West	11 827	95	11 922		
North-Central	7 793	284	8 077		
North-East	14 235	209	14 444		
South-East	81 363	3 588	84 951		
South-West and South-Central	**67 351**	**7 652**	**75 003**		
West and South-Central	12 702	1 539	14 241		
South-West	54 649	6 113	60 762		

Source: Ministry of agriculture, food and forest, Agrostatistics Department, Grape and Wines Production

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Vineyards per Bulgarian region, 2018 (ha)

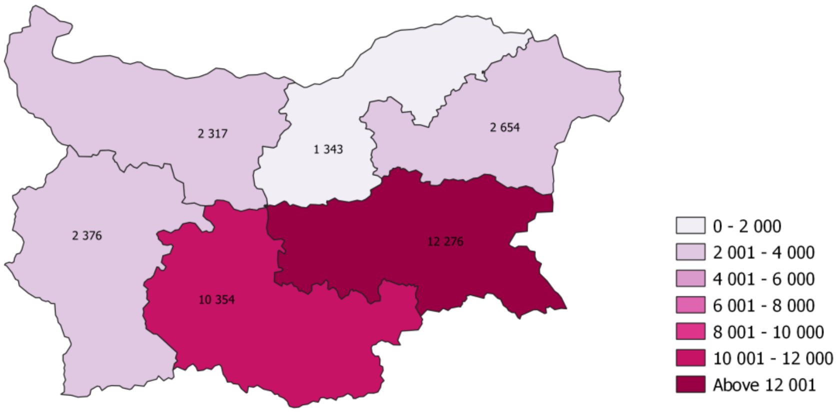

Figure 2.2-10 Vineyards by regions

In 2018, the area under vines on agricultural holdings is 50 727 ha, of which 31 320 ha have been harvested. The production of grapes decreased by 3% compared to the previous year.

In the South-eastern region 44% of the grapes are produced and in the South Central region - 31%. The relative share of the cultivated areas with red wine varieties is 61% of the cultivated areas with wine grape varieties, and of the whites - 39%. About 5% of the area on the farms is young, unmanaged vines. Due to bad climatic conditions, 2 180 ha of fruit vineyards have not been harvested and about 15 000 ha of the vineyards in the farms have not been taken care of for economic and social reasons.

The unsupported vineyards, as well as those of small and fragmented plots outside the agricultural holdings, are 13 673 ha. The total area under vines in Bulgaria in 2018 is 64 400 ha.

The area under varieties suitable for wines with a protected designation of origin (PDO) registered in the Vineyard register maintained by the Executive Agency for Vine and Wine (EAPW) is 16 676 ha, for wines with a protected geographical indication (PGI) - 21 636 ha, and for other wines - 22 935 ha. According to EALW data, 1 421 ha of vineyards were created in 2018.

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In 2017, there is a continuing downward trend in the number of farms, mainly at the expense of part of the small farms. The enlargement of the sector contributes to greater farm sustainability, more efficient and cost-effective production.

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2.2.3 LIVESTOCK PRODUCTION

Compared to 2016, cattle ranches decreased by 15.1% and those in buffaloes by 6.1%. In the sheep and goat holdings, the decline was by 14.6% and 22.3% respectively, and in pigs by 26.4%.

In 2017, the total number of cattle and sheep decreased by 3.2% annually and that of pigs by 3.8%. At the same time, the number of goats raised is 8.2% and that of buffaloes is 4.4%.

The total number of animal species is shown in the table below.

Table 2.2-9 The total number of animal species in 2017

Type of livestock	2017
cattle total, including :	**540 115**
Cows	348 691
Meat cows	96 635
Buffalo total, including:	**12 809**
buffaloes	8 720
Sheep total, including:	**1 316 784**
Mother sheep total	1 096 393
Meat sheep	104 324
Goats, including:	**256 967**
Mother goats	220 866
Pigs total including:	**593 154**
Total breeding female pigs over 50 kg	62 156
Poultry total - thousands including:	**14 756**
Chickens	6 898
Chicken for meat	5 966
Waterfowl	1 712
Other birds	
Bee families	

Source: Ministry of agriculture, food and forest, Agrostatistics Department

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Livestock by regions is shown in the following table.

Table 2.2-10 The total number of animals by regions

	Broilers	Cattle	Swine in farms	Hens/Chicken
North and South-East BG	2 877 361	15 125	8 787	352 815
North-West	6 598 611	23 164	177 386	1 554 336
North-Central	1 812 645	28 878	190 591	1 216 786
North-East	2 171 279	27 258	124 586	45 200
West and South Central	286 060	13 116	4 052	176 174
South-West	513 243	38 352	33 631	849 454
Total	**14 259 199**	**145 893**	**539 033**	**4 194 765**

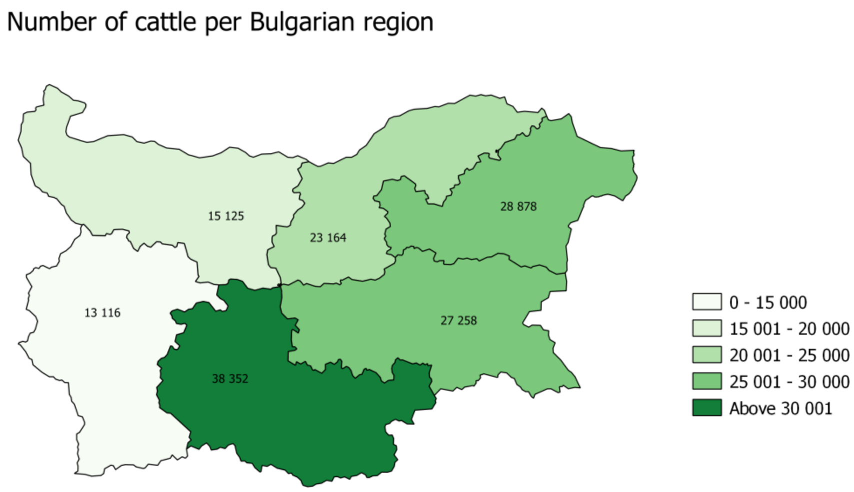

Figure 2.2-11 Number of cattle by regions

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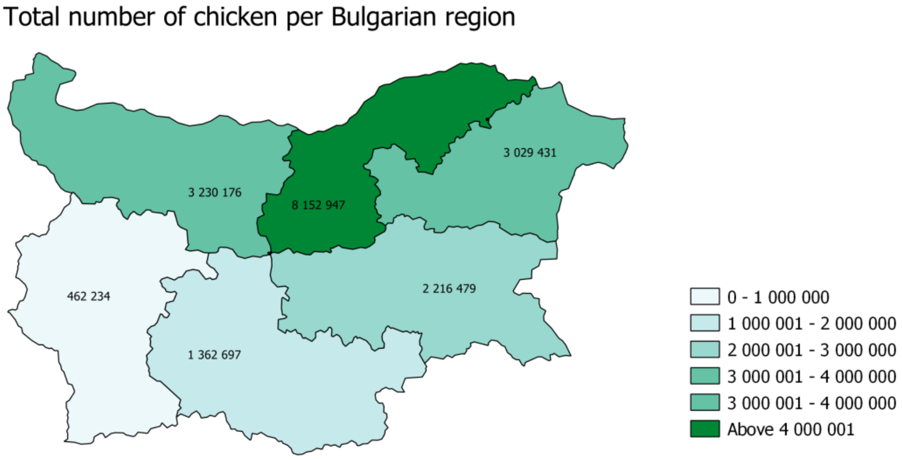

Figure 2.2-12 Number of chicken by regions

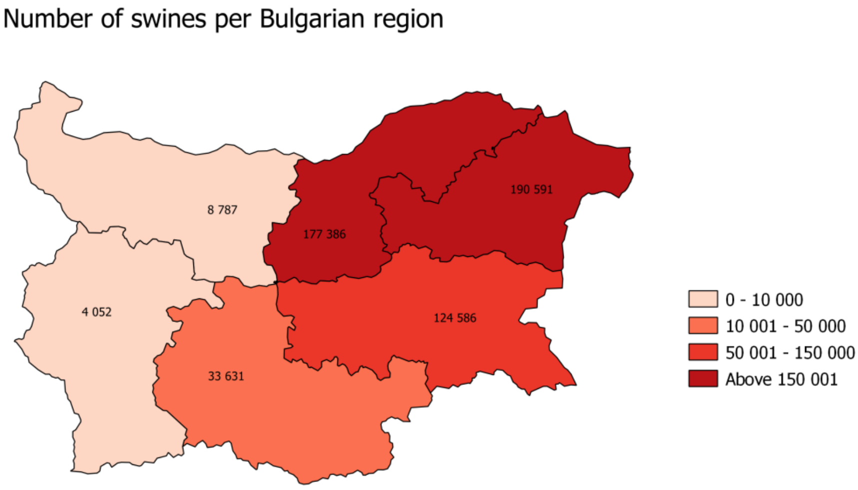

Figure 2.2-13 Number of pigs by regions

2.3 BIOMASS POTENTIALS FROM RESIDUES AND UNUSED LANDS

In terms of residual biomass production Bulgaria scores quite well as compared to other EU countries of this size (Hungary, Czech Republic, Denmark) , as Figure 2.3-1 shows. 13.7 million tonnes per year of residues are produced of which the main sources are cereals and oil crops. Only 8.2 million tonnes is known to be harvested within the period of 2006-2015

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(according to the Sankey diagram in Figure 2.2-1) that is behind the same countries. In year 2018 the harvested crop was increased to 9,8 million tonnes. How much can be mobilised of these residual resources taking account of sustainability consideration of which the main is the conservation of organic carbon in the soil, will be discussed in next Section 2.3.1 in greater detail.

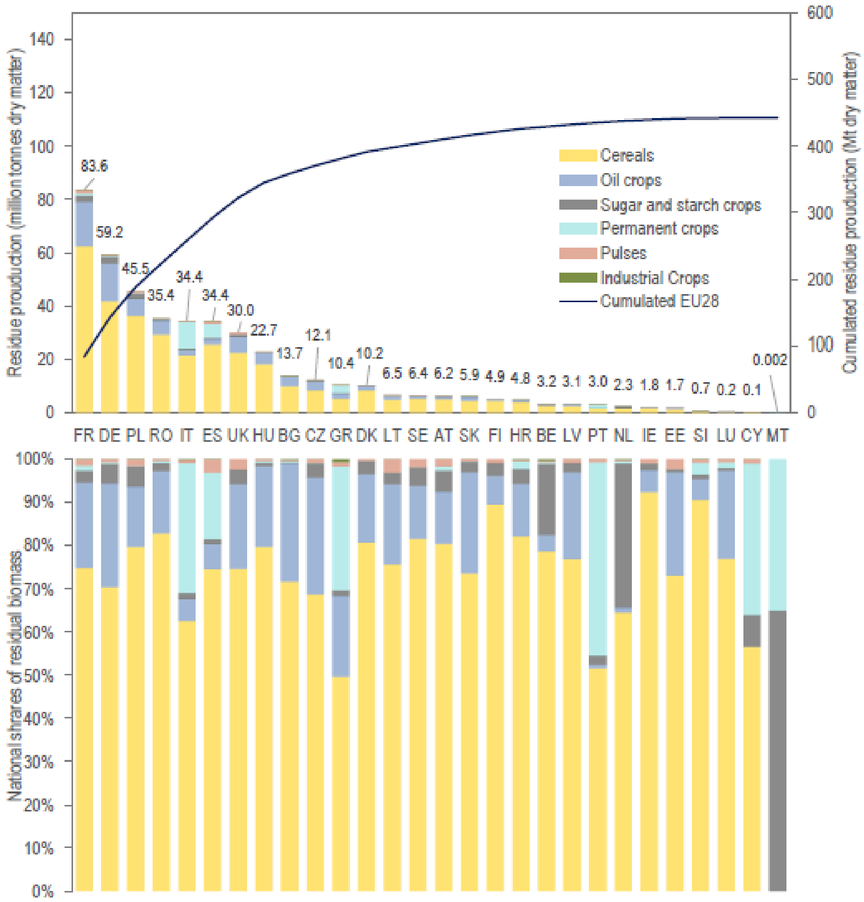

Figure 2.3-1 Residue production (top pane) from the main crop groups per member state, expressed in million tonnes of dry matter per year; and the shares at national level (bottom pane). Average values over the reference period 2006-2015

Source: Camia et al. (2018). https://publications.europa.eu/en/publication-detail/-/publication/358c6d4b-1783-11e8-9253-01aa75ed71a1/language-en/format-PDF/source-search

2.3.1 LIGNOCELLULOSIC RESIDUAL BIOMASS FROM CROPS

As already became clear Bulgaria has a large cropping sector and therefore the residual biomass potential from arable crops is certainly of interest. However, how many crop residues (e.g. straw) can be removed sustainably depends on several factors. Especially the maintenance of soil organic matter is a relevant function of straw-removal. Also the nutrient balance should be maintained, but nutrients are often replenished, by mineral fertilizer application practices. The input of soil organic matter however is often only dependent on crop residues left behind. The amount of straw to be kept in the field is complicated to estimate as it depends strongly on the soil and climate characteristics and the long term management practices. To give a good estimate of residual biomass potentials that can be sustainable removed we use data generated in the S2BIOM project (Dees et al., 2017ab). In S2BIOM a 'base potential' was assessed for residual biomass. It identified the part of the residues that can be removed from the field without adversely affecting the SOC content in the soil. The soil organic carbon balance is the difference between the inputs of carbon to the soil and the carbon outputs. A negative balance, i.e. outputs are larger than the inputs, will reduce the SOC stock and might lead to crop production losses on the long term. To calculate the soil carbon balance at regional level S2BIOM used the MITERRA-Europe model (Lesschen et al., 2011) to provide the input data and the "RothC-26.3" model (Coleman & Jenkins, 1999) to calculate the soil carbon dynamics. Further details on the whole assessment of biomass potentials in S2BOM are presented in Annex 2 of this report. In the following tables and text the S2BIOM biomass potentials are presented for Bulgaria.

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Table 2.3-11 Residual biomass potentials from arable crops 2020 in ton d.m. (=S2BIOM base potential) (see also Annex 2)*

Region	Rice straw	Cereals straw	Oil seed rape straw	Maize stover	Sugar beet leaves	Sunflower straw	Total
Видин (Vidin)	-	104,295	-	49,107	3,356	96,623	253,381
Монтана (Montana)	-	125,030	-	58,800	4,013	115,613	303,456
Враца (Vratsa)	-	124,436	-	58,527	3,981	114,937	301,881
Плевен (Pleven)	-	185,643	-	107,498	437	146,648	440,226
Ловеч (Lovech)	143	163,682	-	95,038	40	126,844	385,746
Велико Търново (Veliko Tarnovo)	24	188,351	205	110,393	34	146,621	445,627
Габрово (Gabrovo)	94	81,208	-	47,237	-	62,986	191,524
Русе (Ruse)	-	117,771	-	68,636	1,410	90,790	278,607
Разград (Razgrad)	-	123,213	-	66,066	15,793	85,083	290,156
Силистра (Silistra)	-	146,789	-	78,373	19,651	100,786	345,599
Варна (Var)	-	190,726	890	101,252	25,398	130,865	449,131
Добрич (Dobrich)	-	239,107	-	127,658	32,022	164,163	562,950
Шумен (Shumen)	-	174,751	157	93,197	23,377	119,964	411,446
Търговище (Targovishte)	-	138,547	168	74,017	18,137	95,377	326,246
Бургас (Burgas)	-	98,448	79,467	1,157	290	60,278	239,641
Сливен (Sliven)	177	46,833	35,856	1,024	152	28,517	112,559
Ямбол (Yambol)	159	43,124	34,326	87	-	26,100	103,796
Стара Загора (Stara Zagora)	11,072	108,684	97	7,046	-	50,505	177,403
София (столица) (Sofia (stolitsa))	-	12,844	-	3,134	-	2,770	18,748
София (Sofia)	57	68,897	-	17,068	42	16,023	102,087
Благоевград (Blagoevgrad)	4	61,627	-	15,030	-	13,300	89,962
Перник (Pernik)	-	22,881	-	5,583	-	4,935	33,398
Кюстендил (Kyustendil)	-	29,039	-	7,086	-	6,263	42,387
Пловдив (Plovdiv)	12,884	124,860	-	7,265	-	57,429	202,438
Хасково (Haskovo)	11,971	115,718	81	6,582	-	53,215	187,567
Пазарджик (Pazardzhik)	9,204	90,961	-	5,565	-	41,315	147,044
Смолян (Smolyan)	6,899	66,828	-	3,841	-	30,677	108,245
Кърджали (Kardzhali)	6,967	67,287	-	3,831	-	30,935	109,020
Bulgaria	59,653	3,061,580	151,247	1,220,099	148,133	2,019,559	6,660,271

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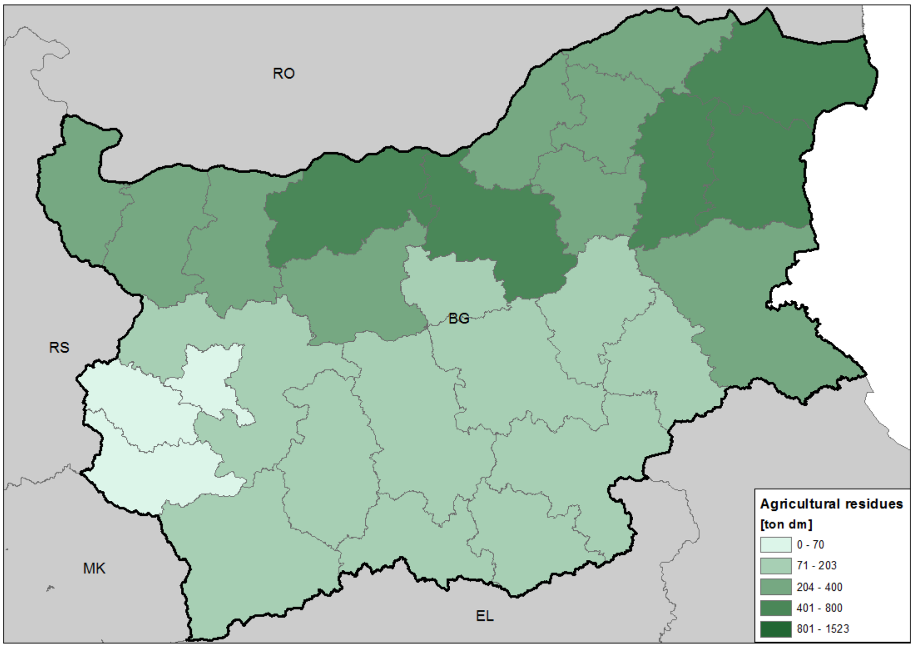
Table 2.3-12 Residual biomass potentials from permanent crops 2020 in ton d.m. (=S2BIOM base potential) (see for assessment approach Annex 2)*

Region	Residues from vineyards	Residues from fruit tree plantations (apples, pears and soft fruit)	Total
Видин (Vidin)	0	25	25
Монтана (Monta)	0	34	34
Враца (Vratsa)	0	36	36
Плевен (Pleven)	0	400	401
Ловеч (Lovech)	0	383	383
Велико Търново (Veliko Tarnovo)	0	434	434
Габрово (Gabrovo)	0	187	187
Русе (Ruse)	0	261	261
Разград (Razgrad)	0	165	165
Силистра (Silistra)	0	191	191
Варна (Varna)	0	247	247
Добрич (Dobrich)	0	310	311
Шумен (Shumen)	0	227	227
Търговище (Targovishte)	0	183	183
Бургас (Burgas)	0	65	65
Сливен (Sliven)	0	34	34
Ямбол (Yambol)	0	30	30
Стара Загора (Stara Zagora)	0	221	221
София (столица) (Sofia (stolitsa))	1	167	168
София (Sofia)	6	872	878
Благоевград (Blagoevgrad)	5	801	807
Перник (Pernik)	2	298	300
Кюстендил (Kyustendil)	3	378	380
Пловдив (Plovdiv)	0	255	256
Хасково (Haskovo)	0	234	235
Пазарджик (Pazardzhik)	0	207	208
Смолян (Smolyan)	0	138	138
Кърджали (Kardzhali)	0	136	137
Bulgaria	23	6,919	6,942



Map 2.3.1-1 Total primary residual biomass potential from agriculture (S2BIOM Base potential)

Another assessment of agro-biomass potential by NUTS2 is made based on the quantities of residues from each stream were estimated using the agro-energy chain models, developed by the RADAR IEE project. It represents the maximum level of theoretical biomass present. The evaluation is also based on the biomass(agricultural residues) production in t/ha for different groups of crops - 1,4t/ha, 1,55t/ha, 2t/ha, 3t/ha, 4t/ha, 5t/ha, 0,69t/ha corresponding to straw from cereals, pruning from orchards, vineyard, stalks from fodder, grass from pastures and residues of oleaginous cultivations.

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Table 2.3-13 Estimated primary biomass potential by NUTS2, t/y

NUTS	Cereals (Straw)	Orchard (pruning)	Vinery (pruning)	Fodder corn stalks and cobs	Permanent Pastures (grass)	Oleaginous cultivations residues
Bulgaria	**1 890 571**	**61 774**	**62 640**	**2 253 828**	**772 455**	**126 007**
North and South Bulgaria	**1 593 960**	**39 427**	**37 180**	**2 014 380**	**445 875**	**116 199**
North-West	405 118	4 142	4 634	707 964	125 085	23 157
North-Central	345 537	11 038	2 686	597 576	175 435	29 416
North – East	439 040	7 676	5 308	567 140	24 315	30 523
South-East	404 265	16 573	24 552	141 700	121 040	33 103
South-West and South-Central Bulgaria	**296 611**	**22 346**	**25 460**	**239 448**	**326 580**	**9 808**
South-West	93 260	8 837	4 752	80 196	203 390	3 026
South – Central	203 351	13 510	20 708	159 252	123 190	6 783
Total	**1 890 571**	**61 774**	**62 640**	**2 253 828**	**772 455**	**126 007**

Source: Assessments based on the data from the Ministry of agriculture, food and forest, Agrostatistics Department, Crop Production Survey

The total residual biomass is estimated to 5,2 Mt/y that differs from S2BIOM estimation of 6,7 Mt/y as a 'base potential' (residual biomass). The difference might be because of higher yields taking into account in S2BIOM calculations.

The biomass potential from different type of agricultural residues is shown the following figures.

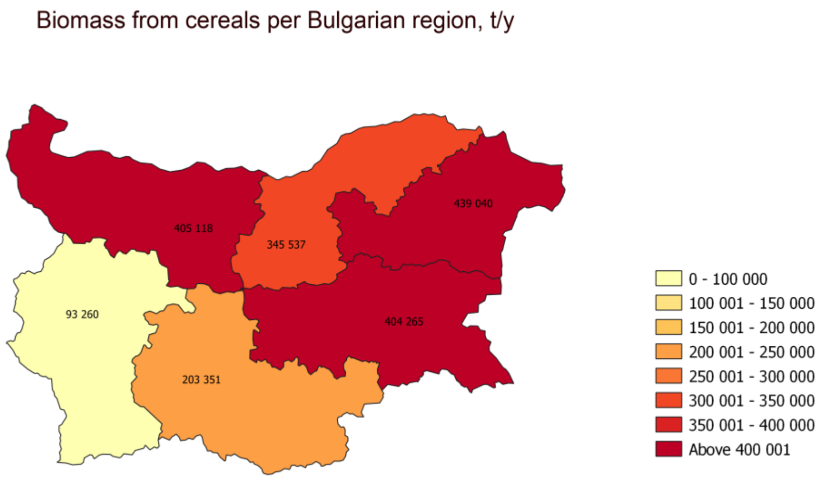

Figure 2.3-14 Biomass from cereals per Bulgarian region, t/y

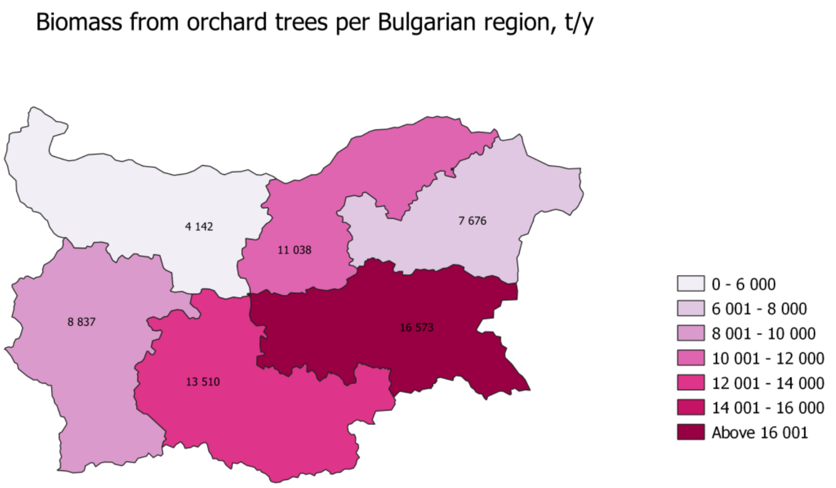

Figure 2.3-15 Biomass from orchard trees by regions

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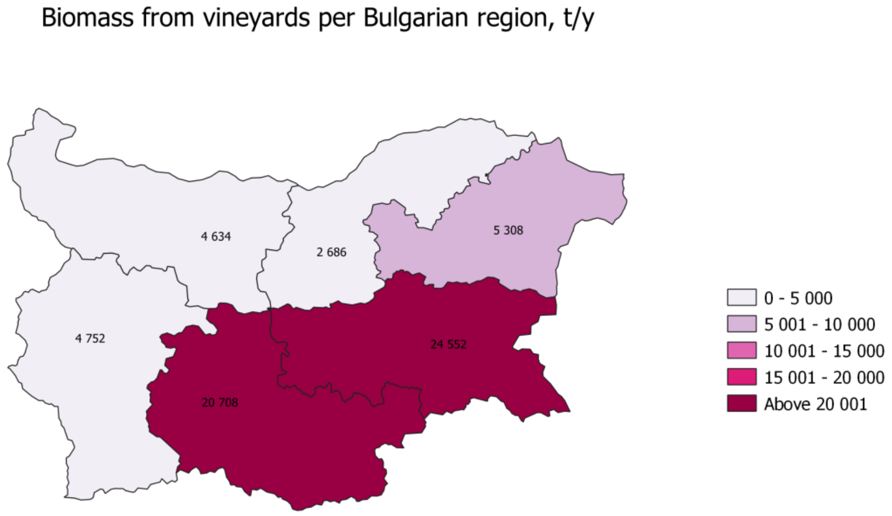

Figure 2.3-16 Biomass from vineyard by regions

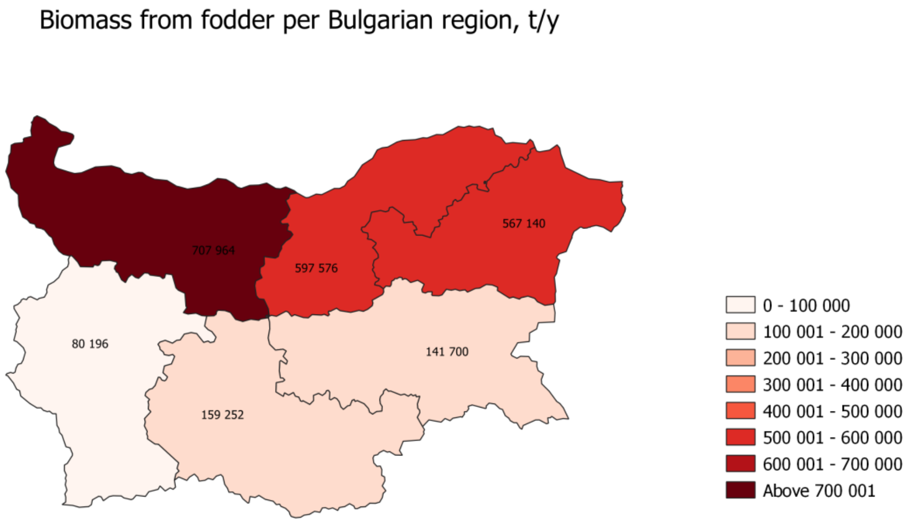

Figure 2.3-17 Biomass from fodder by regions

This project received funding from the BBI JU under the EU Horizon 2020 research and innovation programme under grant agreement No.838087

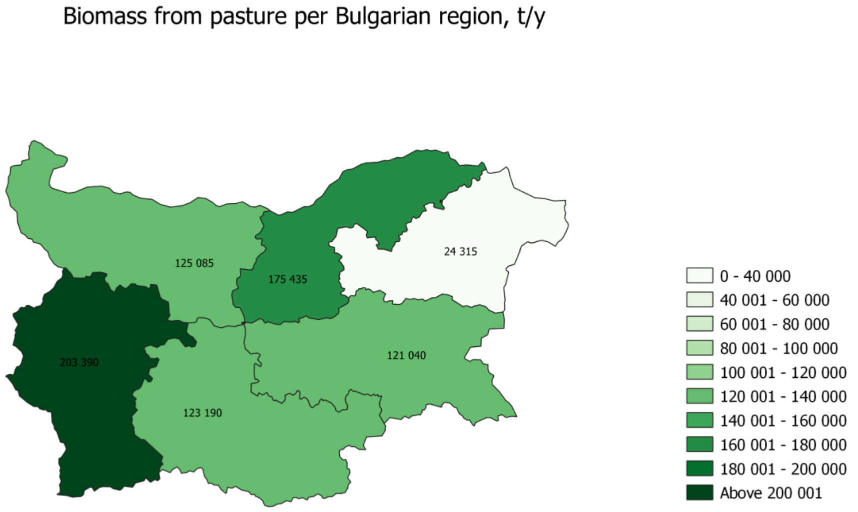

Figure 2.3-18 Biomass from pasture by regions

There is a well-developed practice to utilise a considerable portion of the straw from harvested crops and use it in horticulture and livestock breeding. Vine and fruit tree pruning were used as fuel in the past. This practice could be facilitated by the shredding of the wood close to the areas for pruning, similar to the shredding of branches and twigs from forestry. Solid agricultural residues are generated in the process of growing crops, and their quantity is in direct dependence from the annual yield and harvested areas. About 20 % of straw can be utilised for energy purposes and bio-based materials. The remaining types of solid agricultural by-products have no other application and the share of quantities used for the purposes of bio-energy and bio-based materials is set according to the maximum capacity for collection.

2.3.2 DEDICATED CROP POTENTIALS FROM UNUSED LANDS

In terms of indicator, the area under cultivation in the first place (according to Ministry of agriculture, food and forest, Agrostatistics Department) is the North-West region - BG31, where energy crops may be recommended.

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The total biomass potential from unused lands is estimated at 3,906,809 ton d.m in total. The corresponding distribution of estimated biomass potential by regions is presented in the following table.

Table 2.3-14 Biomass potentials from unused lands 2020 in ton d.m. (=S2BIOM base potential) (see for assessment approach Annex 2)*

Region	Total
Видин (Vidin)	261,059
Монтана (Monta)	293,488
Враца (Vratsa)	311,048
Плевен (Pleven)	158,977
Ловеч (Lovech)	82,181
Велико Търново (Veliko Tarnovo)	145,247
Габрово (Gabrovo)	38,509
Русе (Ruse)	94,586
Разград (Razgrad)	100,322
Силистра (Silistra)	99,147
Варна (Var)	93,291
Добрич (Dobrich)	143,380
Шумен (Shumen)	126,873
Търговище (Targovishte)	90,141
Бургас (Burgas)	327,627
Сливен (Sliven)	161,233
Ямбол (Yambol)	158,554
Стара Загора (Stara Zagora)	276,397
София (столица) (Sofia (stolitsa))	12,736
София (Sofia)	47,088
Благоевград (Blagoevgrad)	32,515
Перник (Pernik)	18,588
Кюстендил (Kyustendil)	23,273
Пловдив (Plovdiv)	317,899
Хасково (Haskovo)	191,171
Пазарджик (Pazardzhik)	154,844
Смолян (Smolyan)	49,558
Кърджали (Kardzhali)	97,078
Bulgaria	3,906,809

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2.3.3 RESIDUAL BIOMASS POTENTIALS FROM LIVESTOCK

Livestock manure

Based on the availability the most promising manure type for biogas production is from cattle, pigs and poultry. Their numbers have remained almost unchanged over the last ten years. Biogas obtained from anaerobic fermentation can be used for cogeneration of electricity and heat, and the dry process residue containing carbon, phosphorus and nitrogen can be composted and used for fertilization (biofertilisers). Under certain conditions, biogas can also be used as a transport fuel.

According to MAFG, the Agrostatistics Department has the best conditions for the construction of biogas plants in the South Central Region (BG42), where the cattle population is highest, followed by Southeast (BG34) and Northeast (BG33). In terms of pig production, the North Central Region (BG31) comes first, followed by Northeast (BG33) and Southeast (BG34). In the poultry sector, the North Central Region (BG31) again comes first, followed by the North East (BG33) and the South Central Region (BG42).

The energy potential of livestock is assessed by regions based on the type livestock and farms location in the country. The calculations was based on assessment of Energy Agency of Plovdiv.

Table 2.3-15 Animal manure energy potential

	Biogas, м3	CH4, м3	Electricity MWh/y	Heat MWh/y	Total installed capacity, MW	Residual fertilizer, t
Cattle	900 777	673 476	973 528	1 189 868	247	16 388
Pigs	413 235	330 061	446 610	545 857	113	5 263
Poultry	1 134 504	912 857	1 138 551	1 391 563	289	7 388
Total	**2 448 516**	**1 916 395**	**2 558 690**	**3 127 287**	**649**	**29 039**

Source: Assessment of Energy Agency of Plovdiv

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The energy potential of biogas shown above can be used to generate around 313 GWh/yr. of electricity.

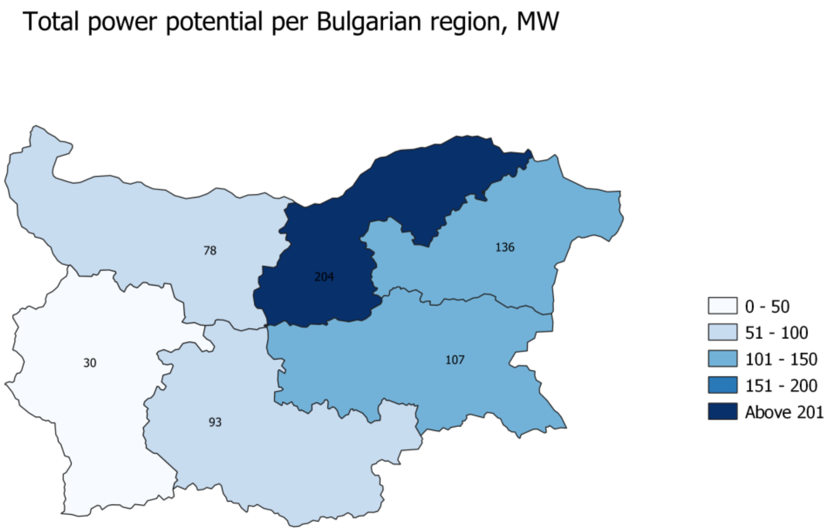

Figure 2.3-19 Total potential for CHP biogas plants by regions

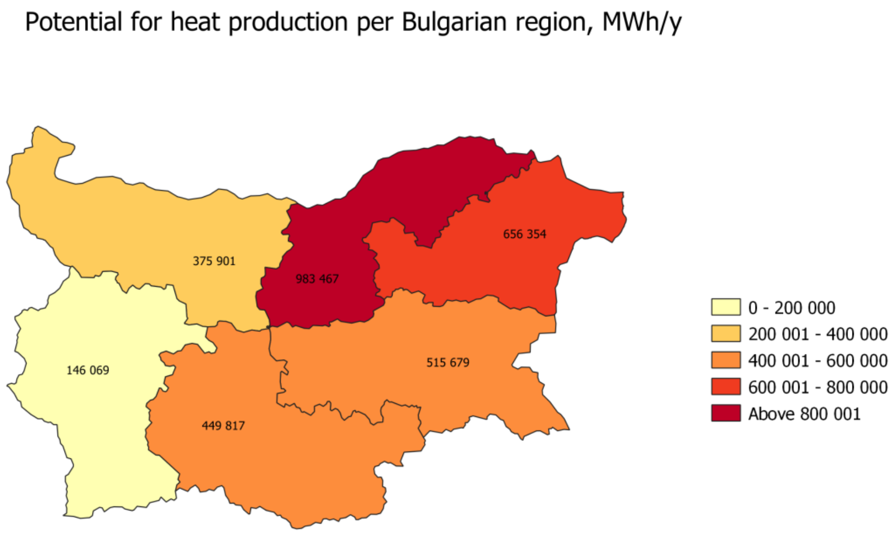

Figure 2.3-20 Heat production potential by regions based on manure

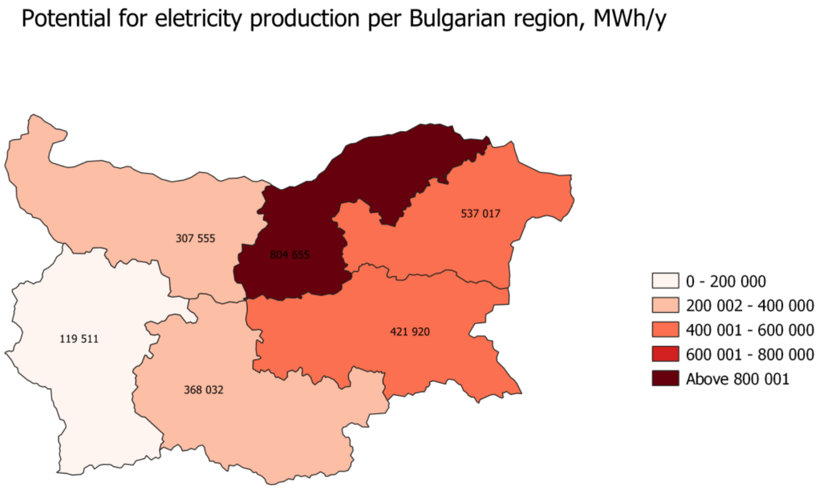

Figure 2.3-21 Electricity production potential by regions based on manure

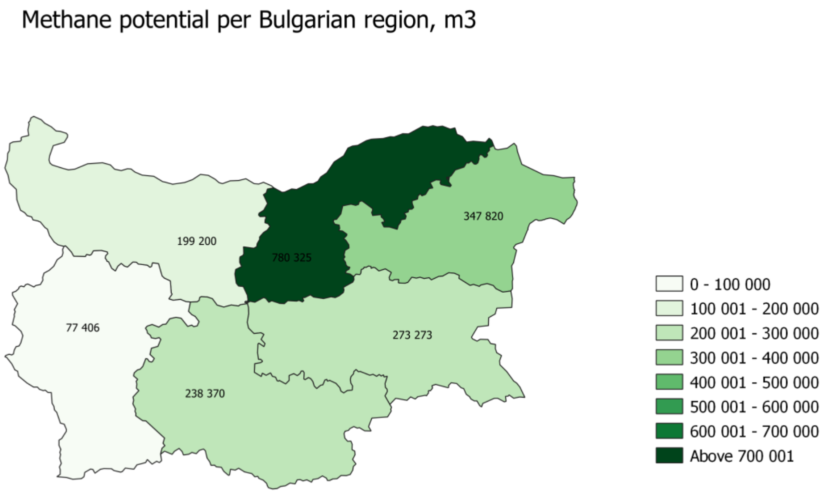

Figure 2.3-22 Methane production potential by regions based on manure

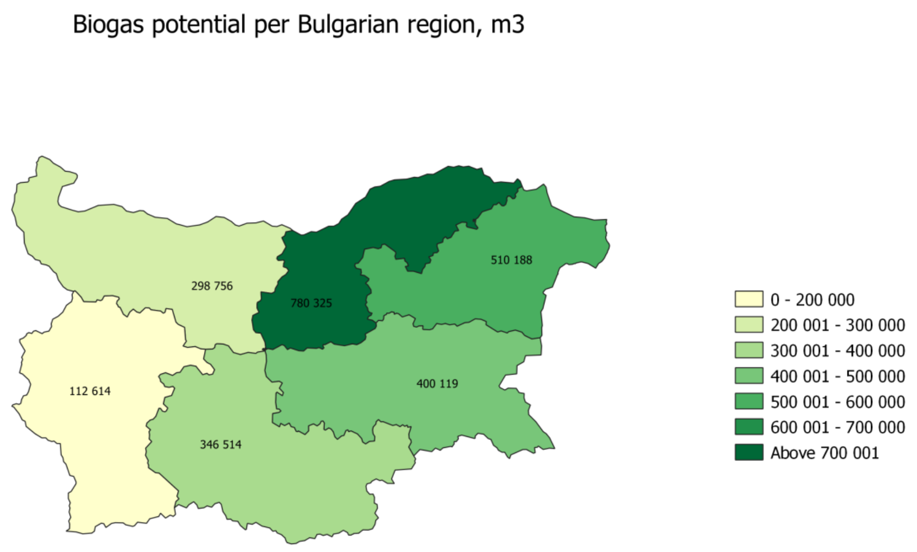

Figure 2.3-23 Biogas production potential by regions based on manure

2.4 AGRICULTURAL PROCESSING INDUSTRIES

2.4.1 MAIN AGRIFOOD PROCESSING INDUSTRIES

Food processing is a traditional industry of the Bulgarian economy with a very high importance determined by its share in the production value, foreign trade and employment, as well as its interdependence with other key sectors in the country – agriculture, machine building, tourism, transport and logistics. The high quality of farmland, preserved nature, in combination with the favourable climatic conditions in the country, allows for the cultivation of a wide variety of crops that is considered as an excellent base for healthy and safe food and beverage production with great potential for raising productivity.

Food processing sector In Bulgaria accounts for about 1/5 of the manufacturing production. The turnover of food producing enterprises in 2018 increased by 3.9% and represents 7.1%

of the total export of the country. Ten percent of the gross domestic product of the country is formed by the food industry. Food production is carried out by about 6220 companies, with about half of them located in the South-Central and South-Western regions.

The most important activities in this sector are canning industry, milk processing, including chees and yoghurt production, vines production, honey production, cigarette production and tobacco processing, mineral water bottling, beer production, and soft drink production. There are about 30 larger agricultural processing industries in Bulgaria. The largest ones are in the meat and dairy sectors. These are also the industries that have attracted most foreign investment and operate highly successful companies.

2.4.2 SIDE-PRODUCTS FROM AGRI-FOOD PROCESSING

Residues from food and fruit processing represent an excellent opportunity to improve cost efficiency of agro-food processing companies. Generating yield from waste streams just started to be considered as a good opportunity to improve competitiveness. It is likely that hesitation lies in the necessity to step out from the current market place and food processing as core business.

In Table 2.4-1, an overview is given of secondary residual biomass sources from the wine and cereal processing industries, (how these potential estimates were assessed is explained in Box 2.3).

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Table 2.4-16 Biomass potentials from agrofood processing industries 2020 in Ton d.m. (=S2BIOM base potential) (see also Annex 2)

Region	Cotton gin residues	Rice husk	Pressed grapes dregs	Cereal bran	Total
Видин (Vidin)	-	-	114	9,208	9,322
Монтана (Monta)	-	-	136	11,065	11,201
Враца (Vratsa)	-	-	136	11,016	11,151
Плевен (Pleven)	-	-	117	12,316	12,434
Ловеч (Lovech)	24	31	102	10,717	10,874
Велико Търново (Veliko Tarnovo)	4	5	114	12,204	12,327
Габрово (Gabrovo)	16	20	50	5,265	5,352
Русе (Ruse)	-	-	78	7,547	7,625
Разград (Razgrad)	-	-	155	7,262	7,417
Силистра (Silistra)	-	-	189	8,614	8,803
Варна (Var)	-	-	248	11,333	11,581
Добрич (Dobrich)	-	-	308	14,032	14,340
Шумен (Shumen)	-	-	226	10,280	10,505
Търговище (Targovishte)	-	-	177	8,174	8,351
Бургас (Burgas)	-	-	335	18,343	18,679
Сливен (Sliven)	30	38	157	8,466	8,691
Ямбол (Yambol)	27	34	148	7,998	8,208
Стара Загора (Stara Zagora)	1,890	2,399	293	9,180	13,763
София (столица) (Sofia (stolitsa))	-	-	15	34,721	34,737
София (Sofia)	10	12	83	11,763	11,869
Благоевград (Blagoevgrad)	1	1	74	10,679	10,755
Перник (Pernik)	-	-	28	3,966	3,994
Кюстендил (Kyustendil)	-	-	35	5,034	5,069
Пловдив (Plovdiv)	2,199	2,792	340	10,583	15,914
Хасково (Haskovo)	2,044	2,594	316	9,807	14,760
Пазарджик (Pazardzhik)	1,571	1,994	245	7,883	11,694
Смолян (Smolyan)	1,178	1,495	182	5,675	8,529
Кърджали (Kardzhali)	1,189	1,510	184	5,696	8,579
Bulgaria	10,184	12,926	4,585	288,830	316,524

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Box 2.3: Methodology of S2BIOM to calculate the secondary residue potentials from food processing in Table 2.4 -1

All the secondary agricultural residues presented refer to residues of crops that are mostly grown and processed in the same country. Their assessment can therefore be based on production information (area and/or yield information) derived from national agricultural statistics.

For further details on the whole assessment of biomass potentials in S2BOM consult Dees et al (2017) and a summary is given in Annex 2.

The largest potential from secondary residues is from cereal bran with a total amount of 229 kton d.m. per year. Another 4.6 Kton d.m. of pressed grape dregs should be available from the wine industry.

The milk processing into cheese and yellow cheese generates a whey. For 2018, the total production of fresh milk is 1,059,376 liters. Given that an average of 6 liters of milk produces 1 kg of cheese, the amount of residual quantity whey is estimated about 882 813 liters. This calculation does not include 17.8 thousand tonnes of raw milk (mainly cow's milk - 17.4 thousand tonnes and sheep - 0.4 thousand tonnes), received from EU Member States and from third countries.

The declared amounts of milk production in 2016, 2017, 2018, it is presented in the Table 2.4 -2.

Table 2.4-17 Declared produced amounts of milk in Bulgaria - 2016, 2017 2018

Type of milk	2016		2017		2018	
	Amounts	% processed milk	Amounts	% processed	Amounts	% processed
	(thousands l)	(%)	(thousands l)	(%)	(thousands l)	(%)
Cow milk	508 772	93.6%	561 932	93.5%	624 178	94.4%
Sheep milk	21 745	4.0%	26 857	4.5%	24 660	3.7%
Goat milk	10 354	1.9%	9 360	1.5%	8 827	1.3%
Buffalo and milk mixture	2 973	0.5%	2 765	0.5%	3 690	0.6%
Total:	543 844	100%	600 914	100%	661 354	100%

Source: Ministry of agriculture, food and forest, Agrostatistics Department, survey "Activity of dairy enterprises in Bulgaria in 2017"

Side animal wastes

Large quantities of slaughterhouse waste are released and their disposal poses a major logistical challenge for meat processing companies. This is clearly evident from the data in Table 1, which presents the ratio of edible to non-edible parts in the carcasses of different types of slaughtered animals (as a percentage of live weight) (Jedrejek, et al., 2016).

Table 2.4-18 Ratio of edible and non-edible parts in carcasses of slaughtered animals

Slaughtered animals	Edible parts, % live weight	Non-edible parts, % live weight
Cattle	54	46
Pigs	62	38
Sheep	52	48
Chicken	68	32

According to the Ministry of agriculture, food and forest, Department of Agrostatistics, at the end of 2016 the number of bred animals in the country was 557 866, the number of pigs raised was 616 426 and the number of sheep was 1 360 087. The total beef production in the same period was 17 463 t slaughtered weight. The production of pork is 73 242 t slaughter weight and the sheep meat produced is 9834 t slaughter weight (Annual Report on the State and Development of Agriculture (Agrarian Report, 2017)). Using the data in Table 1, it can be established that **non-edible portions of processed slaughtered animals amount to approximately 70 000 tonnes per year, including: from bovine animals - 14 875,891; from pigs - 44 890,261; from sheep - 9077,541.**

According to Franke-Whittle and Insam, melting is another method of treating animal by-products. It involves the conversion of animal waste into three end products: bone meal (protein rich), melted fat and wastewater. The resulting fat can be used as a cheap raw material for the production of lubricants, feed, biodiesel; and protein flour can be fed into feed.

According to Jayathilakan et al., The waste from the meat industry can be used as a secondary fuel by thermal recycling at the meat processing plant itself. Solid organic waste from the meat processing industry can also be used as a fuel. Biodegradable residues can be used as a source of energy for various processes in processing plants (Jayathilakan, et al., 2012). Rahman and staff share the same view (Rahman, et al., 2014).

Wine production residues

There is a possibility for converting wine production waste into biofuel. This solution also does not require the planting of new crops.

According to a study by the School of Agriculture, Food and Wine at the University of Adelaide, Australia, on the composition of grape marc (solid residues from wine making, such as hides, seeds and handles). In dry weight, between 31-54 percent of the grape marc consist of carbohydrates. Of this amount, between 47 and 80% are soluble in water. The use of acids and enzymes allows one ton of grape marc to be converted to up to 400 litres of bioethanol. Without these additives, most of the carbohydrates available in grape marc can also be converted directly to ethanol by fermentation, but in yields of up to 270 litres per tonne. The rest can be used as fertilizer or feed.

2.5 Cost of main biomass sources

Since for most agricultural residues no commodity market has developed yet it is very difficult to provide figures on prices. Instead cost estimates can be presented building on the S2BOM methodology and assessment. The cost refers to *Road side cost* and these cover all biomass production collection and pre-treatment cost up to the road where the biomass is located. The road side cost is a fraction of the total 'at-gate-cost.'

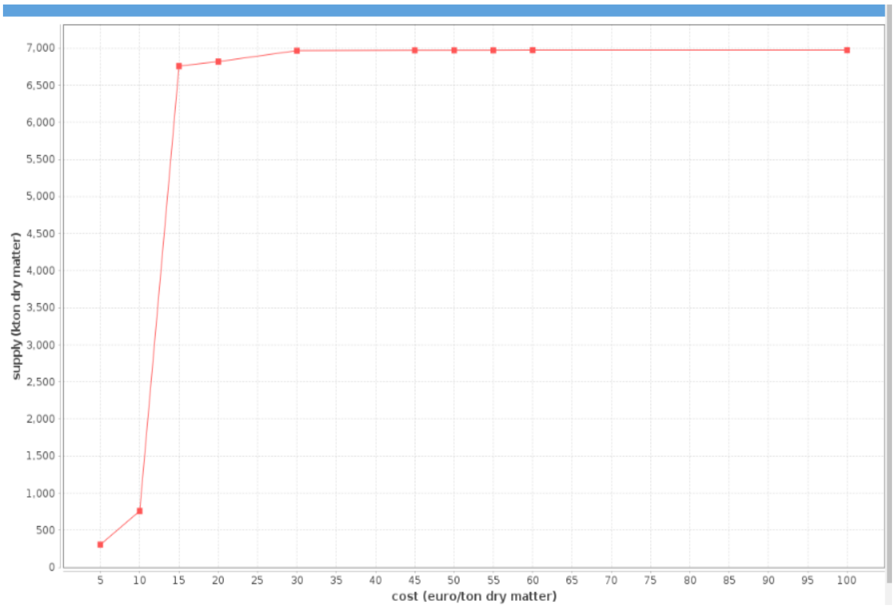

Figure 2.5-24 Cost (Euro/ton d.m) supply (Kton d.m) of all primary and secondary residues from agriculture in Bulgaria

Source: S2BOM: https://s2biom.wenr.wur.nl/web/guest/biomass-cost#_48_INSTANCE_bNEOGMUfuY37_%3Dhttps%253A%252F%252Fs2biom.wenr.wur.nl%252Fbiomasscostsupplyviewer%252Findex.html%253Fmode%253Dcost%2526

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Table 2.5-19 Road side cost levels (€/ton d.m.) for agricultural biomass sources based on S2BIOM cost calculations [16]

Road side cost for agricultural biomass	Average (€ ton dm)
	(2020 cost level)
Maize stover	21
Residues from vineyards	290
Residues from fruit tree plantations (apples, pears and soft fruit)	131
SRC unused lands	64
Dedicated crops on unused lands	64

2.6 SUMMARY AND CONCLUSIONS IN RELATION TO SWOT ELEMENTS

Harvesting and collection of biomass production in Bulgaria is a challenge for different reasons. One of these is that biomass is produced dispersed (a low density per area) and is almost by definition bulky, low in energy density and generally contains considerable amounts of water. The idea of bio-hubs as regional facilities to collect, transport and pre-treat biomass in the areas with the highest biomass concentration did not come to life.

Biomass from the agricultural sector in Bulgaria has a large potential for future development, but there are also several threats to this development. A SWOT analysis is presented in the following Figure 2 4 to show the Strengths, Weaknesses, Opportunities and Threats of this sector in Bulgaria.

The development of new bio-based value chains from primary production to consumer markets needs to be done by connecting enterprises from different regions and industries. But due to a missing holistic transnational approach, Bulgarian actors in bio-based industry still operate disconnected and cannot properly benefit from the potential.

Strengths	Weaknesses
• Bulgaria has enough land to provide raw materials for food and biofuels production • Long tradition in agriculture and food processing • Regions with preserved biodiversity • Unused potential available from primary residues, secondary residues and unused lands. • Cost of biomass resources are relatively low in comparison to many regions in the EU • Still many underutilised biomass resources • A long agricultural tradition in planned economy • Non-utilised arable land • Established Rural Development Program to support agro-food projects	• Abandon of the spatial concentration of biomass is low, makes collection cost relatively high • Absolute amounts of agricultural biomass are not very large per hectare as the average agricultural land is small, and yields are relatively low • Ownership of land is very dispersed and still unclear, so it presents a challenge to mobilise unused land resources • Support needed to make investments • Market demand for unused biomass not developed • High share of small and medium size agricultural land • Small agricultural field plot size • Lack of logistics centres to establish a stable and cost efficient biomass supply • Rural Development program is not supporting biobased projects and innovations.
Opportunities	**Threats**
• Still many biomass resources that can be mobilised • Turning bio-waste, residues and discards into valuable resources and creation the innovations and incentives • Opportunities to produce low-ILUC biomass on abandoned lands • Production of healthy and functional food and drinks for a healthy Europe is a trend the Bulgarian market can connect to. • Production of medical aromatic plans for medicines, food additives and cosmetic products	• Depopulation of rural areas • Lack of labor in agriculture because of non-attractive remuneration in agriculture sector • Lack of rural population to produce and collect the biomass in the long term • No market for high added value biomass, uses only low-quality chains for heat/electricity • Pollution through inefficient use of biomass, firewood burned in low-efficient hearing devices in local heat production • Import of value-added products

Figure 2.6-25 SWOT analysis for agriculture sector

This project received funding from the BBI JU under the EU Horizon 2020 research and innovation programme under grant agreement No.838087

3. Biomass supply: Forestry

3.1 Introduction

Bulgaria has considerable forest resources - forest territories occupy more than one third of the country's territory. According to the Executive Forest Agency, the area of the forest territories in 2018 amounts to 4,257,200 hectares. The state forest territories cover an area of 3,090,010 ha (72.58%). Non-state forest territories cover an area of 1,050,424 ha (24.67%), of which 558,116 ha (13.11%) - municipal forest territories, 425,246 ha (9.99%) - forest territories owned by individuals amount to 47,167 ha.

The dynamics of the main quantitative characteristics of forests in Bulgaria for the period 1995 -2020 are shown in Table 3.1-2. It shows the afforested forest area in hectares (ha) in Bulgaria over the last 25 years. It grows, along with it grows the total and average stock of timber in thousands of cubic meters (m^3).

Table 3.1-20 Bulgarian forests in numbers

№	Parameter	Unit	1995	2000	2005	2010	2015	2016	2020
1	Forest area in hectares	ha	3 334 256	3 375 117	3 615 243	3 737 542	3 833 640	3 833 640	3 925 000
2	Total stock	1000 m^3	467 315	526 063	590 780	644 840	680 522	680 522	743 547
3	Average stock /ha	m^3	140	156	162	172	178	178	201,73
4	Total increment	1000 m^3	12 003	13 563	14 120	14 364	13 974	13 974	16 734
5	Average age	Year	44	49	51	53	57	57	59
6	Average density		0,73	0,73	0,72	0,72	0.70	0,70	0,70
7	Planned usage per year (10-years plans)	1000 m^3	6 519	6 812	8 184	8 176	8 459	8 117	8 500
8	Actual usage per year	1000 m^3	4 852	4 630	7 056	6 726	8 389	8 448	7 188

Source: National action plan forest biomass 2018-2027

Note: Data for 2020 for parameter №: 2,3,4,7 and 8 are deterred by EFISCEN simulation model – basic scenario

The table shows that both the total and the average stock increased continuously, and for the period from 2010 to 2016, the total stock increased from 644 840 thousand m^3 to 680 522 thousand m^3, i.e. with about 35 682 thousand m^3 of wood. This increase of over 35 million m^3 is due both to the natural growth of the forests and to the relatively low volume of timber used during the period.

3.2 PRIMARY BIOMASS RESOURCES FROM FORESTRY

The assessment of the roundwood and primary residue potentials in S2BIOM is done by using the EFISCEN model and using national forestry inventory data as an input. The secondary forestry residues from sawmills and wood processing industries build on the potentials assessed in EUWood and S2BIOM in combination with some up-dated data from national sources. In addition to this overall potential assessment, a pilot studies for the Bulgarian forest sector was performed by the Energy Agency of Plovdiv as part of the study providing information on wood wastes and residues in Bulgaria.

Bulgarian Forest Executive Agency reported that for the period 2012-2016 the average harvested roundwood was totally 6 782 660 m3 (5 086 995 t).

Table 3.2-1 describes the primary biomass potential from Bulgarian forests in 2020. Data was obtained during the S2Biom project. It should be noted that biomass potential is expressed in thousands of tons (Kton) of dry matter (d.m.).

Primary forest biomass resources include forest residues (tops) from final logging and thinning, untreated wood (small size wood-fuelwood, non-waste timber).

This project received funding from the BBI JU under the EU Horizon 2020 research and innovation programme under grant agreement No.838087

Table 3.2-21 Primary biomass potential from forests Kton d.m. (S2BIOM Base potential 2020)

Region	Final fellings	Thinnings	Logging residues from final fellings	Logging residues from thinnings	Total
Видин (Vidin)	35	17	6	1	59
Монтана (Monta)	47	22	7	2	78
Враца (Vratsa)	36	14	11	2	63
Плевен (Pleven)	29	12	10	2	54
Ловеч (Lovech)	103	52	26	7	188
Велико Търново (Veliko Tarnovo)	51	26	20	6	102
Габрово (Gabrovo)	41	23	10	3	77
Русе (Ruse)	27	9	12	2	50
Разград (Razgrad)	24	8	10	2	44
Силистра (Silistra)	30	11	14	3	57
Варна (Var)	53	21	10	2	86
Добрич (Dobrich)	41	16	16	3	76
Шумен (Shumen)	48	21	13	3	84
Търговище (Targovishte)	34	15	16	4	68
Бургас (Burgas)	154	189	29	30	402
Сливен (Sliven)	84	84	17	12	196
Ямбол (Yambol)	37	30	9	6	82
Стара Загора (Stara Zagora)	72	47	29	13	161
София (столица) (Sofia (stolitsa))	23	11	8	2	44
София (Sofia)	164	78	49	12	301
Благоевград (Blagoevgrad)	149	154	46	32	381
Перник (Pernik)	42	18	11	3	74
Кюстендил (Kyustendil)	49	22	11	3	85
Пловдив (Plovdiv)	95	65	39	18	217
Хасково (Haskovo)	73	46	33	15	168
Пазарджик (Pazardzhik)	136	125	24	14	299
Смолян (Smolyan)	134	154	34	26	348
Кърджали (Kardzhali)	57	51	29	18	154
Bulgaria	**1,870**	**1,341**	**546**	**243**	**4,000**

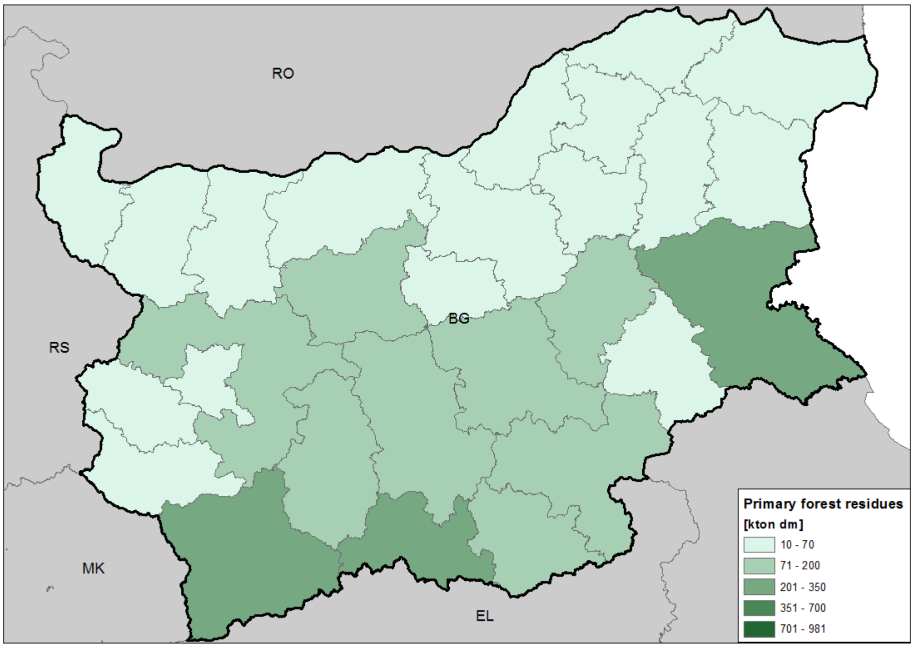

Figure 3.2-26 Distribution of primary residues potential from forests Kton d.m. (S2BIOM base potential 2020)

The export of roundwood for the period 2012-2016 was approximately 748,071 cubic meters (561,053 t) compared to 0.6 million cubic meters of imported roundwood 32,633 m^3 (24 475t). The most important exporting countries for Bulgaria are Greece and Turkey.

Table 3.2.2 summarises how the harvest levels and the total additionally harvestable stem wood and residue resource relate to the total yearly forest biomass increment. It becomes clear from this table that in almost all countries, the common harvest levels are considerably below the yearly increment level, this also applies to Bulgaria. Part of this low level can be explained by a skewed age structure in the forest population but may also refer to a large unused potential.

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Table 3.2-22 2010, 2020 and 2030 EFI-GTM harvest levels expressed as % of yearly average biomass increment level in forests. (Source: Biomass Policies, Elbersen et al., 2016)

		% Harvest & residues potential/Increment			% Harvest & residues potential maximum additional harvestable potentials/increment		
	Country	2010	2020	2030	2010	2020	2030
AT	Austria	60%	53%	59%	110%	91%	86%
BE	Belgium	55%	55%	53%	87%	87%	85%
BG	**Bulgaria**	**22%**	**18%**	**18%**	**55%**	**44%**	**43%**
HR	Croatia	72%	67%	64%	181%	169%	162%
CZ	Czech republic	69%	75%	72%	110%	99%	100%
DK	Denmark	24%	17%	17%	68%	46%	41%
EE	Estonia	56%	68%	68%	103%	98%	93%
FI	Finland	59%	57%	53%	64%	58%	53%
FR	France	29%	26%	35%	83%	68%	71%
DE	Germany	43%	47%	50%	76%	76%	74%
EL	Greece	35%	46%	48%	80%	80%	80%
HU	Hungary	23%	33%	30%	79%	75%	66%
IE	Ireland	36%	40%	47%	67%	60%	68%
IT	Italy	8%	10%	13%	88%	84%	80%
LV	Latvia	44%	42%	55%	94%	95%	115%
LT	Lithuania	49%	49%	53%	84%	74%	76%
LU	Luxembourg	44%	48%	63%	109%	98%	108%
NL	Netherlands	36%	31%	33%	60%	53%	53%
PL	Poland	47%	56%	53%	79%	78%	73%
PT	Portugal	58%	56%	63%	88%	85%	97%
RO	Romania	26%	36%	35%	65%	56%	53%
SK	Slovakia	95%	81%	82%	120%	105%	104%
SI	Slovenia	21%	31%	45%	161%	167%	156%
ES	Spain	41%	39%	35%	73%	65%	60%
SE	Sweden	69%	62%	62%	93%	81%	77%
UK	United Kingdom	45%	47%	49%	80%	78%	84%

Data from the National Forest Biomass Energy Action Plan 2018-2027 for so-called falling wood (= primary residues in the S2BIOM data), such as the difference between standing and lying timber, consisting of branches, tops, etc., much of which remain unused, show a large reserve of unused scrap wood. The quantity varies for the period from about 1,091,000 m^3 in 2014 to 1,402,000 m^3 in 2016. The actual quantities used for the peak period are more than symbolic and decrease from 25,581 m^3 in 2012 to 10,803 m^3 in 2016. How much of this crap wood can be removed depends on local circumstances regarding technical limitations, biodiversity uses and needs for maintaining soil nutrients and carbon. The potentials of residual biomass from S2BIOM (logging residues) in table 3.2-1 take account of these limitations and show sustainable removal rates of around 800,000 ton (600,000 m^3) for whole Bulgaria, which is clearly lower than the quantities estimated in the National Forest Action Plan mentioned above.

Forest biomass according to the National Forest Biomass Energy Action Plan 2018-2027 (NAPEGB) includes forest-wood biomass from the categories of medium, small wood and firewood, minus the quantities consumed by large enterprises, as well as the exported and of timber harvested, recalculated as energy equivalent as gigajoules and tonnes of oil equivalent (toe). 35% for coniferous and 45% for deciduous wood is forest biomass for energy production. These percentages vary and include volumes of firewood (up to 15%) as well as bark and stumps (18%), branches and apex of about 17-22%. Calculated in this ways, for the period 2012-2015 the harvested utilised in the country biomass is 1 578 233 t DM that has an average annual energy equivalent of 731,000 toe, of which 19.5% or 142,400 toe has coniferous firewood and 80.5% or 588 600 toe have deciduous firewood. Only planned branches and tops have an average annual energy equivalent of 59,800 toe, of which 21 100 toe or 35.3% have coniferous branches and apex and 38 700 toe or 64.7% have deciduous branches and tops.

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3.3 Secondary biomass resources from forestry: wood processing industries

In the forest sector stem wood, primary residues and secondary residues from forest industries are available. For bioenergy and bio-material potential assessment we particularly focus on availability of primary and secondary residues as stem wood conversion to energy is not the most resource efficient and therefore preferable use. The assessment of the stem wood and primary residue potentials is done by using the EFISCEN model and using national forestry inventory data as input. The secondary forestry residues from sawmills and wood processing industries build on the potentials assessed in EUWood and S2BIOM in combination with some up-dated data from national sources. http://www.fao.org/forest-resources-assessment/current-assessment/country-reports/en/

The transformation of the wood raw material into a semi-finished product is known as first machining, and it is carried out in a typical woodworking enterprise. The transformation of semi-finished products into finished products takes place in furniture enterprises, where a second machining is carried out, which is also related to residues of wood.

By type of wood waste can be classified into three groups:

- Solid - covers, cuts, cuts, slats, veneer pieces, in some cases cross;
- Soft - sawdust, sawdust and sandpaper;
- Tree bark.

Soft wood residues and crushed solid residues are channelled as energy source - for direct combustion at the plant where they are produced or for the production of briquettes and pellets. The percentage share of wood for energy purposes in the balance of wood-processing raw material is as follows:

- In the production of wooden shaped materials (WSM) from coniferous logs: 14-18% wood residues and 10% bark;
- In the production of WSM from deciduous logs: 27-33% wood residues;
- In the second machining (furniture enterprises): wood residues 27-33%;

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- For the production of veneer and plywood: wood residues 33-40% and bark 6-8%. The real values for the percentage of energy input in commodity production should be greatly reduced - wood by 60% and bark by 90%. This is due to the fact that our woodworking industry is fragmented into thousands of small producers and is in poor technological condition. The average production load of the companies producing profiled materials is 40-50%, and of the production boards is 70-80%.

Solid bark-containing residues are usually shredded and transformed as energy raw material in the form of cod. Indicators of energy wood chips and wood processing industry are not significantly different from wood chips. The fractional composition of sawdust varies from 3 wt (coarse) to 0.5 wt (small). It depends on the type of saw machine and the saws used.

Solid bark-containing residues are usually shredded and transformed as energy raw material in the form of chips. Quality parameters of wood chips from wood processing industry do not differ substantially from wood chips from logging. The fractional composition of sawdust varies from 3 mm (coarse) to 0.5 mm (small). It depends on the type of saw machine and the saws used.

Wood dust from grinders is a polydispersed material with an admixture of abrasive dust separated from the sanding sandpaper. With a moisture content of 2%, the bulk weight of the grinding dust is 180 to 230 kg/m^3. It is very effectively used in woodworking companies as an energy raw material for combustion systems for boilers and dryers in conjunction with fuel oil using the torch burning method.

In Table 3.3.1 wood potentials from forest industry are presented. How these were assessed is explained in Annex 2.

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Table 3.3-23 Secondary biomass potential from forests in Kton d.m. (S2BIOM Base potential 2020)

Region	Sawdust	Other residues	Residues from industries producing semi-finished wood based panels	Residues from further wood processing	Total
Видин (Vidin)	3	6	1	4	13
Монтана (Monta)	3	5	1	5	14
Враца (Vratsa)	2	4	1	5	12
Плевен (Pleven)	1	2	0	28	32
Ловеч (Lovech)	6	11	2	3	23
Велико Търново (Veliko Tarnovo)	4	8	1	27	40
Габрово (Gabrovo)	3	6	1	3	14
Русе (Ruse)	1	2	0	27	31
Разград (Razgrad)	2	3	0	3	8
Силистра (Silistra)	2	3	0	3	8
Варна (Var)	2	4	1	10	17
Добрич (Dobrich)	1	2	0	4	7
Шумен (Shumen)	2	4	1	3	10
Търговище (Targovishte)	2	3	0	2	7
Бургас (Burgas)	6	11	2	7	26
Сливен (Sliven)	3	5	1	3	11
Ямбол (Yambol)	1	2	0	2	5
Стара Загора (Stara Zagora)	3	5	1	5	15
София (столица) (Sofia (stolitsa))	1	2	0	21	25
София (Sofia)	9	16	2	26	53
Благоевград (Blagoevgrad)	8	15	2	5	31
Перник (Pernik)	2	4	1	2	10
Кюстендил (Kyustendil)	3	6	1	2	13
Пловдив (Plovdiv)	6	12	2	33	52
Хасково (Haskovo)	5	9	1	4	20
Пазарджик (Pazardzhik)	8	15	2	47	72
Смолян (Smolyan)	8	15	2	2	28
Кърджали (Kardzhali)	5	9	1	3	18
Bulgaria	**103**	**190**	**28**	**291**	**612**

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Respectively, according to data of National Action Plan for Energy from Biomass 2018-2027 the secondary residues/wastes are:

Table 3.3-24 Assessment of secondary wood residues in tonnes

t, DM	from roundwood	from technological	Total
2012	167 079	282 940	450 019
2013	175 397	333 030	508 427
2014	161 151	265 078	426 229
2015	181 259	330 016	511 275
2016	164 442	344 518	508 960
average	**169 865**	**311 116**	**480 982**

The expert assessment is based on the assumption that roundwood residues are 26% for the coniferous and 30% for deciduous wood and 26% for both type of technological residues. . So considering both S2BIOM and National Action Plan for energy the secondary residues available are in the range from 480 to 600 Kton d.m..

Secondary biomass resources are considered as wood waste, generated as part of the production process or when the wood product is discarded at the end of its life.

3.4 FOREST BIOMASS MOBILISATION OPTIONS

The balance of roundwood (2018) by category shows that the remaining timber produced in the categories average, small, firewood and top with an average annual size of 5,400,374 m3 (80% of the average annual production of wood) is perfectly suitable for production and consumption as forest biomass. With regard to available forestry resources, especially those in the categories of medium, small and firewood, ie. so called technological wood and firewood, it can definitely be concluded that in Bulgaria there is sufficient resource for utilization in the form of forest-wood biomass, including for energy production.

The structure of the harvested wood in the country shows that the main share is wood from the categories of medium and small size wood - about 80%, which makes them extremely suitable for energy production, but also for the production of boards, pulp, paper, hardboard and other technological processing.

In fact, the wood biomass is a sum of the forest residues, unprocessed (small non-waste wood) and secondary residues from wood processing industries. In wider context, biomass covers products, materials including wood and agro-ligneous residues, waste and related industries that can be used as fuel to harness their energy potential.

According to the Second National Progress Report on Bulgaria in the Promotion and Use of Energy from Renewable Energy Sources in 2011 totally 221,428 GJ (5.3 ktoe) of wood biomass was consumed for energy purposes, of which 208,771 GJ (5 ktoe) in the Industry sector. The wood residues used in the manufacture of timber and articles of wood and cork, amount to 975 GJ or 230 toe. In 2012, 854 873 tonnes of wood resources (209.65 ktoe) were required for energy purposes, of which 688 964 t (169 ktoe) was consumed in the Industry sector and 165 909 t (40.7 ktoe) in the "Households, trade and public services". Most of the wood residues originates from the production of timber and articles of wood and cork, without furniture; manufacture of articles of straw and knitting materials; manufacture of paper, paperboard and articles of paper and paperboard and manufacture of furniture.

A large part of the technological secondary residues is used as a raw material for energy purposes (mainly thermal energy) and are incinerated in woodworking heat plants for own use (over 50%). Another part is used as a raw material for the production of briquettes and pellets. For Bulgaria, woody biomass is a resource whose wider use will allow reducing dependence on imports of energy resources and will contribute to security of energy supply. Modernization of heating - the transition from primitive biomass (use of wet wood for firewood in stoves with low efficiency - 30-40%) to modern biomass (biofuels burned in heating installations with efficiency above 90%). By supplying households with heat for example, biomass will reduce the use of firewood in the household, which is one of the main reasons for higher concentration of particulate matter in the air.

According to the study potential of forest-wood biomass in Bulgaria, market and opportunities for its utilization, the technical potential of forest biomass for energy recovery is estimated at about 44.4 PJ / y.

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3.5 SUMMARY AND CONCLUSIONS IN RELATION TO SWOT ELEMENTS

Bulgaria possesses good potential for biomass production due to the large available area of forests and land. Woodland and forests have traditionally been very important in Bulgaria – ecologically, economically and socio-culturally. They contain a great diversity of species, ranging from broad-leaved trees (with oak and beech the most widespread species) to conifers (mostly spruce and pine).

More than one third (38%) of the country's territory consists of forest land. The proportion of forest land is around the EU-27 average (43% of the total land area in 2014).

Present it in a table like presented underneath:

Strengths • Dominating publicly owned pattern - large share of state ownership of the forest is a good prerequisite for sustainable management • A long tradition in forest management, uniform forest management system • Availability of 10-years local/regional forest plans, good planning of biomass flow balance, • Possibilities for additional mobilisation of primary forest resources • Forest processing industry is growing and leads to more secondary forestry residues • Well-developed industry for glued boards and chipboard, pulp, paper… • High percentage of firewood in energy balance	**Weaknesses** • Short and vertical value chain • Presence of illegal logging and harvesting • Inefficient utilisation of firewood for heating • Attitudes and ambitions of investors towards the utilisation of wood for electricity production instead of production of efficient solid fuels and heat • High percentage of firewood in energy balance due to the energy poverty (in rural areas and even in the larger cities) • Inefficient burning of wet firewood in primitive stoves and high emissions of PM • Difficult access to the forest, sloping terrains • Unused harvesting residues - tops, branches and stumps of the trees • Insufficient human resources
Opportunities • Mobilisation of unused biomass for future bio-based materials production • Development of new bio-based products on lignocellulosic base • Biomass production for low ILUC biofuels	**Threats** • Climate changes - erosion of forest terrains, probability for fire occurrences, risk agents as insects) • Concerns for overharvesting • Primary (unprocessed) wood export to Turkey and Greece

Figure 3.5-27 SWOT analysis for forestry sector

4. Biomass supply: waste

Bulgaria is among the countries with the lowest number of separately collected waste and management or recycling. In 2018, 39 facilities for waste recycling (paper – 8; plastic – 25; glass – 4; metals – 2), 55 regional waste management facilities, 6 factories for waste treatment/ for backfilling , 50 waste water treatment plants (landfills) and 9 facilities for waste energy recovery operated in Bulgaria (6 incinerating facilities, 3 biogas plants based on sewage sludge).

- 3080 thousand tons of municipal waste was generated in 2017, 1789 thousand tones (58%) of which were sent for preliminary treatment and 1142 thousand tons (37%) of which were deposited in landfill.
- 149 thousand tons or 4,8 % of total municipal waste generated in Bulgaria was collected separately.
- 108 304 thousand tons industrial non-hazardous wastes and 14,011 thousand tons industrial hazardous wastes were generated in 2017, about 4,515 thousand tons of waste recovered and 11,637 thousand tons of waste was landfilled.

4.1 Introduction

In order to calculate the potential of biowaste the following approach was implemented:

1) First the total waste generation per category of waste was taken
2) Then the waste treatment categories were identified per type of waste.
3) Waste treatment factors were applied to the total waste generated to identify which part is already going to alternative useful uses (e.g. compost, backfilling etc.) and which part of the waste is available for further conversion into energy or other future bioeconomy uses. So the part already going to energy is also perceived to be available as part of the potential.

The total waste generation reported by Eurostat in Table 4.1-1 (last column) is only the basis for assessing the biomass potential in this study. The waste assessment was done for 2010, but for several countries the waste generation data from Eurostat were fully (for all categories of waste) or partly (for some categories of waste) replaced by national figures of waste generation. A distinction is made between data used to determine the total waste generation and data to determine the current waste treatments. The latter figures determine the final potential.

It is clear that the potential for biowaste is large (almost 600 kton d.m. per year). However, at this moment it is very challenging to further process this waste in energy, compost and other biomaterials because it is mostly collected in a mixed form together with other inorganic waste types. In order to improve this many investments need to be made in waste separation at the source and/or after collection.

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Table 4.1-25 Bio-waste collectively and separately collected Kton d.m. (S2BIOM Base potential 2020)

Region	Biowaste collectively collected	Biowaste separately collected	Total
Видин (Vidin)	12	2	15
Монтана (Monta)	16	3	19
Враца (Vratsa)	18	3	22
Плевен (Pleven)	23	4	28
Ловеч (Lovech)	12	2	14
Велико Търново (Veliko Tarnovo)	21	4	25
Габрово (Gabrovo)	10	2	12
Русе (Ruse)	18	3	21
Разград (Razgrad)	9	2	11
Силистра (Silistra)	9	2	10
Варна (Var)	33	6	40
Добрич (Dobrich)	13	3	16
Шумен (Shumen)	12	2	14
Търговище (Targovishte)	8	1	9
Бургас (Burgas)	25	5	30
Сливен (Sliven)	11	2	14
Ямбол (Yambol)	7	1	9
Стара Загора (Stara Zagora)	18	3	22
София (столица) (Sofia (stolitsa))	71	14	85
София (Sofia)	14	3	17
Благоевград (Blagoevgrad)	19	4	22
Перник (Pernik)	8	1	9
Кюстендил (Kyustendil)	8	1	9
Пловдив (Plovdiv)	38	7	46
Хасково (Haskovo)	14	3	17
Пазарджик (Pazardzhik)	16	3	19
Смолян (Smolyan)	7	1	9
Кърджали (Kardzhali)	9	2	11
Bulgaria	481	92	573

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Table 4.1-26 Hazardous and non-hazardous post-consumer wood Kton (S2BIOM Base potential 2020)

Region	Hazardous post-consumer wood	Non-hazardous post-consumer wood	Total
Видин (Vidin)	0.2	0.6	0.7
Монтана (Monta)	0.2	0.7	1.0
Враца (Vratsa)	0.2	0.8	1.1
Плевен (Pleven)	0.3	1.1	1.4
Ловеч (Lovech)	0.2	0.5	0.7
Велико Търново (Veliko Tarnovo)	0.3	0.9	1.2
Габрово (Gabrovo)	0.1	0.4	0.6
Русе (Ruse)	0.2	0.8	1.0
Разград (Razgrad)	0.1	0.4	0.5
Силистра (Silistra)	0.1	0.4	0.5
Варна (Var)	0.4	1.5	1.9
Добрич (Dobrich)	0.2	0.6	0.8
Шумен (Shumen)	0.2	0.5	0.7
Търговище (Targovishte)	0.1	0.3	0.4
Бургас (Burgas)	0.3	1.2	1.5
Сливен (Sliven)	0.1	0.5	0.7
Ямбол (Yambol)	0.1	0.3	0.4
Стара Загора (Stara Zagora)	0.2	0.8	1.1
София (столица) (Sofia (stolitsa))	0.9	3.2	4.2
София (Sofia)	0.2	0.7	0.8
Благоевград (Blagoevgrad)	0.2	0.8	1.1
Перник (Pernik)	0.1	0.3	0.4
Кюстендил (Kyustendil)	0.1	0.4	0.5
Пловдив (Plovdiv)	0.5	1.7	2.2
Хасково (Haskovo)	0.2	0.7	0.8
Пазарджик (Pazardzhik)	0.2	0.7	0.9
Смолян (Smolyan)	0.1	0.3	0.4
Кърджали (Kardzhali)	0.1	0.4	0.5
Bulgaria	**6.2**	**21.9**	**28.1**

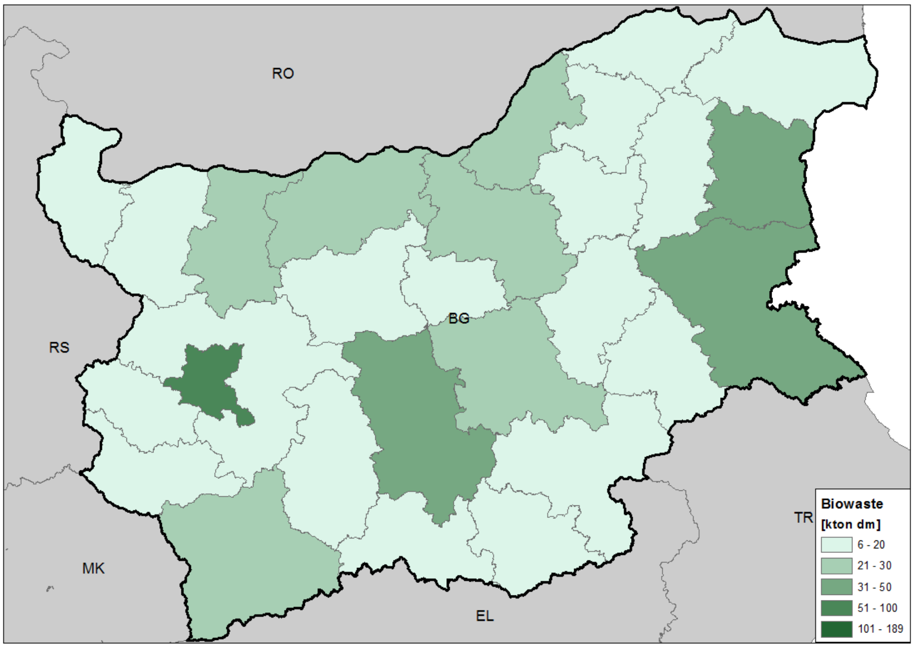

Figure 4.1-28 Distribution of total bio waste potential over country

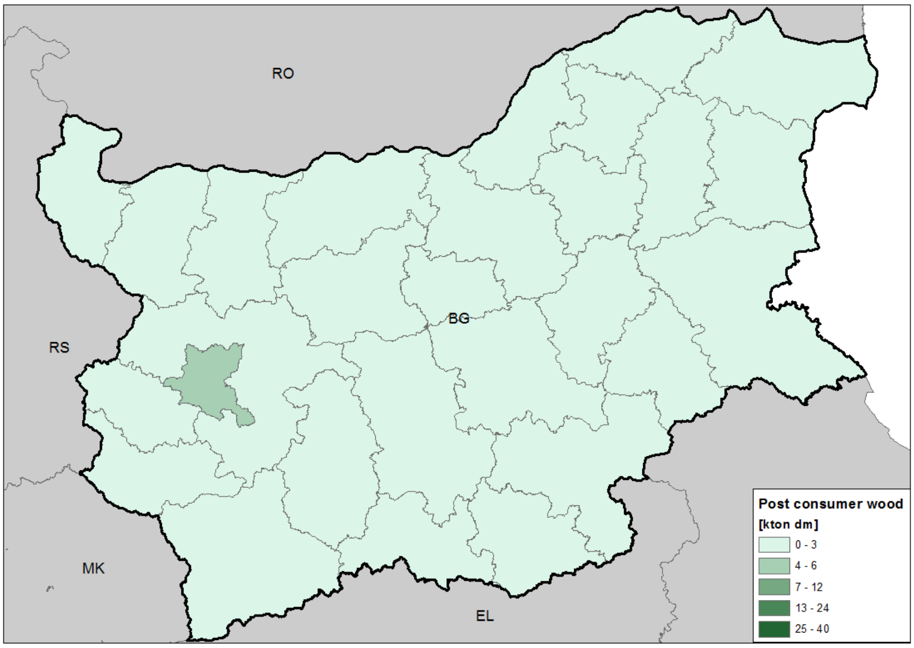

Figure 4.1-29 Distribution of total post-consumer wood potential over country

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4.2 Waste from waste water treatment

Sewage sludge is an organic product that results from the treatment of wastewater after residual precipitation. They are generated by the separation of these residues during the various stages of the wastewater treatment process. Sludge contains valuable agricultural ingredients (including organic matter, nitrogen, phosphorus, potassium, and to a lesser extent, calcium, sulphur and magnesium), but they may also contain contaminants, which typically include heavy metals, organic contaminants and pathogens. The qualities of sludge are determined by their source, by the initial concentration of pollutants in the treated water, as well as by the technical characteristics of the processes carried out in connection with the treatment of waste water and sludge.

Table 4.2-27 Sewage sludge from water treatment plants by district

Water treatment plants	2016 - Sewage sludge, t/dry matter	2017 Sewage sludge, t/dry matter
Blagoevgrad	749.75	795.24
Burgas	2 653.75	3 098.56
Varna	9 227.20	9 817.80
Veliko Tarnovo	2 123.00	1 891.23
Vratsa	433.91	438.80
Montana	1 250.70	343.82
Pazardzhik	548.00	801.04
Pleven	1 684.00	1 648.10
Plovdiv	3 206.40	4 835.00
ruse	6 555.00	6 529.03
Smolyan	537.82	486.56
Sofia	32 959.00	31 458.00
Stara Zagora	1 924.40	1 878.60
Haskovo	586.93	1 622.47
Shumen	966.33	1 317.44
Pernik	336.46	294.87
Total	65 742.65	67 256.56

Source: Executive Agency Environmental Protection

The most common disposal of sewage sludge is landfill. The use of sludge in agriculture and forestry, for the purpose of restoration of damaged terrains, as well as for fuel in various processes, is conditioned by the content of nutrients in them and the possibility of extraction of useful ingredients - nitrogen, phosphorus and others. The use of sludge in agriculture and forestry is a good way to recycle it under the requirements of National and European legislation.

For the year 2017 there are no data on sludge with code 19 08 05, which have been submitted for co-incineration in cement plants and power plants in connection with the fulfilment of the energy recovery targets.

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Table 4.3-28 Sewage sludge from water treatment plants by district

Sewage sludge management activities	2016 - Sewage sludge, t/dry matter	2017 - Sewage sludge, t/dry matter
deposited	6180,02	6 908,20
temporarily stored	18679,01	23 241,89
used in agriculture	26229,46	22 521,19
used for restoration of damaged terrains	11439,70	12 234,84
submitted for fertilizer and biogas production	3263,99	3 810,90

Source: Executive Agency Environmental Protection

Fifty six %(56%) of sewage sludge is utilised, 34% -temporarily stored, 10%-deposited

4.3 CURRENT WASTE TREATMENT AND UNUSED POTENTIAL ESTIMATES

The following facilities operated in Bulgaria in 2018:

- 72 operating landfill sites in Bulgaria
- 39 facilities for waste recycling (paper – 8; plastic – 25; glass – 4; metals – 2) , 55 regional waste management facilities, 6 factories for waste treatment/ for backfilling , 50 waste water treatment plants
- 72 facilities for waste recovery with backfilling, where 1813 thousand tones of waste was recovered (58% of all waste generated in Bulgaria)
- 9 facilities for waste energy recovery operated in Bulgaria (6 incinerating facilities, 3 biogas plants based on sewage sludge)
- 6 facilities for waste incineration for the purpose of energy recovery

Table 4.3 - 1 summarises data on waste treatment facilities and amount of waste treated in years of 2018.

Table 4.3-29 Waste treatment facilities and amount of waste treated, Bulgaria

Households wastes	Unit	2018
Generated households wastes		
Total generated households waste	thousand t	2862
Directly deposited wastes	thousand t	834
Households waste submitted for pre-treatment	thousand t	1813
Household waste submitted for recycling	thousand t	215
Generated waste per capita	kg/capita/y	407
MUNICIPAL WASTE FACILITIES		
Landfills and installations for treatment of household waste	number	72
Occupied area of landfills and installations for treatment of household waste	dka	2614
Residual capacity of landfills and installations for treatment of household waste	thousand м³	16429
SETTLEMENTS AND POPULATION WITH ORGANIZED GARBAGE COLLECTION AND TRANSPORTATION		
Settlements	units	4698
Share of the population covered by organized waste collection systems	%	99,8

4.4 SUMMARY AND CONCLUSIONS IN RELATION TO SWOT ELEMENTS

Bulgaria shows continuing progress in waste management sector improving wastes inventory, as well as reuse and recovery of waste. Still the largest share is still going to landfill. Generated waste per year amounts to 120.5 million tonnes, 2.922 million tonnes of which are municipal wastes (442kg per capita in 2018). The largest share of municipal waste (1.828 thousands) tonnes are still disposed (mainly landfilled) (61%).

Due to the fact that the biodegradable fraction of municipal solid waste has a low calorific value, the incineration technology is complex and expensive, and the public acceptance of incineration is low, biological treatment of the biodegradable organic fraction of MSW is an attractive alternative. Moreover, digestion also produces energy in the form of methane gas (CH4).The composting type of treatment (material recovery) of biodegradable waste is increasing. Some municipalities are able to use the created compost for their own purposes, but many others are simply left with the surplus. Still significant amount of waste that could be energy/materially recovered ends up in landfills and unused. Existing biogas facilities for energy recovery are not covering the generated agricultural wastes. Education of households to separate their waste at the source is required as well as fair wastes taxes system should be established – based on real amounts generated instead of value and location of the building.

The product of biological treatment, compost, can be recycled due to its fertilizing properties - mainly N, P and K and its capacity to maintain and restore the soil quality.

There is a lack of both knowledge on bioeconomy perspective, applicable technologies and citizens' awareness at National, regional and local level. Some bad practices for wastes utilisation, including agro-wastes, sewage sludge generate negative public perceptions. Still the taxation for households waste is based on property value instead of the amount of waste generated.

Biodegradable waste amounts, currently landfilled, could be utilised for energy and/or material recovery. The concept of "waste market" should be implemented to support waste

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for energy and material recovery. Although some steps have been taken for preparation of specific legislation *on by-products and end-of-waste status of wooden and sunflower husks waste* proper regulation is not developed enough.

Although there is a slowly increase of knowledge on waste management, it is system is still in early phases.

Strengths	**Weaknesses**
• Development of waste management infrastructure that can be used for energy and/or material recovery • High existing potential for utilization which is currently still going to landfill • Development of separate waste collection on household level • Utilisation of manure in agriculture • Utilisation of sewage sludge	• Still small share of recycled waste • Bad practices for implementation of separation of wastes collection • Landfilling practices - significant amount of waste that could be energy/materially recovered ends up in landfills and unused • Relatively slow implementation of legislation framework • Bad examples of waste management and utilisation of wastes • High collection and operational costs for waste management • Lack of knowledge on bioeconomy principles and its possibilities • Poor public awareness of waste separation/ management • Lack of proper regulation on by-products and end-of-waste status
Opportunities	**Threats**
• Opportunities for improvement of performance of waste management under the guidance of the EU directives. • Turning bio-waste, residues and discards into valuable resources and creation the innovations and incentives • Knowledge-based production and utilisation of biological resources, biological processes and principles • Knowledge transfer from more advanced countries in EU • Introduction of innovative technologies for biodegradable waste utilization • EU support/funding for improvement of waste management infrastructure and waste management system • Utilization of currently landfilled biodegradable waste • Implementation of "Waste Market"	• Lack of public willingness for waste separation, utilization for energy/recovery purposes • Lack of recognition for the opportunities in waste utilization within bioeconomy principles • Backwardness and lack of change within legislation and strategic framework • Indifference of sector stakeholders

Figure 4.4-30 SWOT analysis of waste sector

5. Bio-based products industries and markets

5.1 Current bio-based industries

The stage of development of bio-based industry in Bulgaria is in its initial stage. Bulgaria belongs to the group of "modest innovators" in the Innovation ScoreBoard, meaning that is well below that of the EU average. Bioeconomy is assumed to be a relatively new paradigm to the major share of the Bulgarian business. At the same time leading innovative Bulgarian companies, although limited in number, might be excellent showcases at EU level or globally, demonstrating how adopting bioeconomy principles impact their performance.

The bio-based value chain transforms the biomass or extracts components from it to make them usable for the bio-based product industries. The industries transforming the biomass can also be the direct manufacturers of a final product. This means that the boundary between the transformer industry and the bio-based product industry can be somewhat blurry. Using the NACE classification, the main industries that may eventually transform the biomass and manufacture or may potentially manufacture bio-based products encompass industries that are grouped in Section C Manufacturing and Divisions. Data on that level of categorization presents a very rough classification of the activities,

The absorption of the biomass potential in Bulgaria depends on the availability of the following main factors:

- Usage of efficient technologies for direct biomass combustion;
- Implementation of energy production technologies;
- Availability of infrastructure allowing the usage of different types of biomass;
- Development of the biomass market in the country.

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The companies are still lagging in the bio-based R&D; the connection between them and the research institutes and universities is not well established. They are part of different industries and sectors (energy, pulp and paper, agriculture, plastics, textile, pharma, etc.), focused on the traditional manufacturing and processing. There is a little or no focus on bioeconomy or the opportunities for creating new value chains.

Competitive bio-based products for the market in Bulgaria:

- Herbal phyto-pharmaceutical products
- Pellets
- Rose, lavender and other oil products: cosmetics, pharmaceuticals
- Timber houses
- Furniture
- Renewable energy
- Textiles
- Bio oils

Energy sector - renewable energy

Biogas

Biogas is produced mainly from organic residues as energy crops and animal by-products. Biogas production from anaerobic fermentation of biomass and from sewage sludge is still negligible. There are 11 biogas plants in Bulgaria that is 2 plans per 1 Mio capita in the country in 2017. The average biogas plant size is 1.2 MW/plant. No any biomethane production plant established.

Biogas is used for electricity and heat generation, in the agriculture sector and in the other services activities sector.

Heat production

Heat production in Bulgaria is mainly based on individual heating systems as pallets heaters and boilers. Two wood chips based biomass plans for district heating are operating – total installed power of 13 MW. Several wood processing companies produce heat based on

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wood wastes for their own needs. Two district heating plants co-fire wood chips in the cities of Sliven and Gabrovo.

Electricity production

According to the National Agency for Sustainable Energy, the electricity produced from solid biomass in 2017 are:

- TPP Mondi Stamboliiski (17.2 MW) - 92,804,371 MWh
- BEP Eco Energy and Sarnitsa (1.3 MW) - 2,729,195 MWh
- Khan Bogrov Biopower Plant (0.855 MW) - 2,108,659 MWh
- BEP Rodopi Belovo (1.75 MW) - 213.852 MWh

Pellets

There are 59 operating enterprises in Bulgaria for 2018, and in recent years the production of pellets is growing. The production capacity for 2018 is 302,000 tons, and the actual production is 162,000 tons.

The raw materials used by Bulgarian producers are mainly soft wood or coniferous wood, namely white fir, black pine, white pine, spruce, etc., and the rest of the producers use hardwood or deciduous wood, such as horse chestnut, beech, acacia, white birch, common and milk maple, mountain elm, oak, walnut, willow, etc.

The quality of the pellets is determined mainly by the type of wood used. Also important are the moisture content of the pellets, the ash content, their calorific value or heat of combustion, the content of carbon, hydrogen and nitrogen in the pellets, sulfur and chlorine content, as well as mechanical stability and bulk density. The moisture in the wood pellets is on average about 6%. The ash for class A1 must be less than 0.7% and for class A2 less than 1.2%. The heat of combustion of working fuel is 17.19 MJ/kg or it is 4.80 kWh /kg about 5 kWh/kg. The average carbon content of the pellets is 50.90%, hydrogen is about 6%, and nitrogen for class A1 should be below 0.3%, for class A2 below 0.5%. The bulk density of the pellets is 651 kg/m3 and the mechanical stability is 98%.

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Biofuels

Bulgaria has sufficient areas to provide raw materials needed for the production of biofuels without causing negative impact on the food and beverage industry. Table below shows estimates for the production of biofuels for growing energy crops. The areas were defined based on the crops currently grown in the country for the production of biodiesel that have low concentrations of fatty acids, leading to a high iodine index (140) of the biodiesel produced. The areas necessary to reach the binding target of 10 % of biofuels by 2020 is 509 001 ha.

Almagest – a joint-stock company is with current annual production capacity of the plant is 30 million liters of ethanol and 24 000 tonnes of DDGS (high-protein animal feed). The plant processes 80 000 tonnes of grains per year (mainly wheat and corn).

Astra Bioplant LtD is a modern plant for production of vegetable oils and biodiesel. The production installation affords reaching annual capacity of 60 000 tons biodiesel.

Oberosterreichische Biodiesel Bulgaria LTD located at the shore of the river Danube is a producer of biodiesel and pharmaceutical glycerin. The production capacity of the plant is 100 000 tons of biodiesel annually and 10 000 tons of glycerin annually.

Buffalo and sheep milk production

Bulgaria is among the 15 largest producers of buffalo and sheep milk in the world. Our country is known for its regions with a very specific microclimate, suitable for symbiotic development of authentic strains of Lactobacillus Bulgaricus and Streptococcus Thermophilus, thanks to which the famous Bulgarian yoghurt is produced.

Goose, donkey and rabbit meat production

Bulgaria is among the top 10 producers of goose, donkey and rabbit meat.

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Herbal phyto-pharmaceutical products

There is huge opportunity in this field as Bulgaria is a leader in herb export, but lags in production of Phyto-pharmaceuticals. The Bulgarian flora includes over 4100 species of higher plants (twice the number included in the English flora), 770 of them are medicinal. The 250 of them are used in traditional and conventional medicine.

Around 17 000 tons of dried or frozen herbs are exported from Bulgaria annually. They are sold on the international market for over 25 million euro. We are a leader in herb export volumes in Europe and are among the top 3 exporters in the world. Medicinal plants provide livelihood to local communities living in close proximity to their habitats. Even today, over 300 000 people rely on the income generated through the collection, cultivation, processing and trade of herbs in Bulgaria.

Rose, lavender and other oil products: cosmetics, pharmaceuticals

Oilseed rose areas in Bulgaria have been increasing over the last 10 years. Downturns are observed in years when a larger area of old plantations is renewed. The total area in 2017 is close to 4070 ha - 14% more on an annual basis and 20% compared to 2009. The harvest in 2017 reaches about 13 t plants flowers.

Most suitable for the oilseed rose is the relatively small area between Stara Planina and Sredna Gora - from Strelcha in the west to Zimnitsa in the east. The main production centres are the municipalities of Karlovo, Pavel Banya and Kazanlak. Accordingly, the districts of Plovdiv and Stara Zagora concentrate 90% of the total area and 80% of the number of holdings. The rest are mainly in Pazardzhik and Sofia-region.

More than 30 are companies and more than 50 are distilleries that produce and market rose oil. We expect total production in 2017 to exceed 3 tonnes (2.53 tonnes according to official 2016 figures).

Lavender areas have tripled in nine years, reaching 9600 ha in 2017. This year alone, they have increased by over 40%. The significant growth is mainly due to the expansion of the area for cultivation of culture in North-eastern Bulgaria. The districts of Dobrich and Varna report double-digit average annual growth after 2010 (in Dobrich, the area doubles in 2017). Dobrudja gradually became the largest manufacturing region in the country, overtaking

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the traditional southern central regions. High yield prospects have attracted many grain growers to include growing lavender in their operations. The number of holdings in the branch reaches 1600 - four times more than in 2009. In the year alone - between 2016 and 2017, the number of producers in the Dobrich district doubles, exceeding 640.

Furniture

Today in Bulgaria, according to official statistics, there are about 2,300 furniture companies and about 22,270 people employed in the sector. Most have high-tech equipment, with good opportunities to win in new markets. Production of furniture in Bulgaria is worth $ 390 million, export of furniture from Bulgaria - worth 316 million Euro. According to this indicator, the Bulgarian furniture industry shows a lasting and significant development. In terms of exports, Bulgaria is among the 40 largest exporters of furniture in the world and ranks 38th.

Pulp & Paper

Bulgaria is a major exporter of paper and paper products in Eastern Europe. The production of wood, paper, cardboard and products and the SMEs involved are of great importance for the country's economy, as these products are related to households and their availability, market demand and the guarantee of their specificity of use. The country has a rich resource base for the production of wood, paper, cardboard and products. The paper, cardboard, paper, and card- board manufacturing sector accounts for about 1.4% of industrial production in the country and accounts for about 1.4% of value added in the industry.

Textile & Clothing

There is a significant opportunity to create a good value chain connected to the production of textiles and clothing as it is one of the most traditional sectors in Bulgaria. It has become one of the Bulgaria's most competitive industries in recent years with considerable investment, and export and employment opportunities.

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Export of textiles and clothing is now going through another boom and is close to the strongest years before the crisis. European countries remain our traditional markets. A great number of major companies have been returning to Bulgaria because of its geographical location, traditionally good relations and technological capabilities of Bulgarian enterprises. Bulgaria's biggest export market remains Germany, followed by Italy, France, Greece and Spain. Domestic consumption is relatively small.

Bio Chemicals

Unfortunately, they are no data just about the bio chemicals industry on the national level. Generally, the chemical industry plays an important role. The chemical sector is highly interconnected with other sections of the manufacturing industry, such as plastics and rubber, textiles, electronics, automotive and others, and represents for them an important sub-sector. There is also an Institute of Organic Chemistry and Biochemistry of the Bulgarian Academy of Sciences. The Institute carries out fundamental research in organic chemistry, biochemistry and related disciplines, focusing in particular on medical and environmental applications.

Bio Polymers

In Bulgaria, the Institute of Polymers within the Bulgarian Academy of Sciences is the leading centre in the field of polymer science in Bulgaria. Its activities include fundamental and applied research in the field of polymers and polymer materials.

The research is focused into three main topics:

New polymers and innovative polymeric (nano) materials and technologies

1. Polymers of different macromolecular architecture, topology, and functionality by controlled polymerization processes and/or modification reactions;
2. Colloid aqueous systems based on amphiphilic copolymers - formation and stabilization of polymeric aggregates of different structure;

3. Polymer-organic and polymer-inorganic hybrid nanomaterials (nanoparticles, nanofibers);
4. Advanced methods and apparatus development for fabricating nanostructured fibrous materials (electrospinning, electrospraying).

Polymeric materials for medicine, pharmacy and biotechnology

1. Smart systems based on temperature- and pH sensitive polymers for sustained/controlled drug delivery;
2. Electroactive composite materials for actuators, sensors and switches;
3. Nanocarriers (nanoparticles, nanocapsules and nanofibers) of bioactive (macro)molecules;
4. Hydrogeles and cryogels for immobilization of drugs, enzymes and cells;
5. Phosphorus-containing biologically active materials - poly(aminophosphonate) and supramolecular polyphosphoesters;
6. New polymeric materials with improved biocompatibility or targeted biological activity.

Polymeric materials for alternative energy sources and polymers from renewable and unconventional resources

1. Polymeric membranes for power converters
2. Active polymer layers for organic solar elements
3. "Green" synthesis of biodegradable polymers
4. Biodegradable polymer mixtures and nanocomposites
5. Recycling and recovery of polymer waste

Institute of Polymers is a co-founder of the Central and East European Polymer Network (CEEPN) which is an informal association of polymer institutes and polymer groups affiliated to national academies of sciences in eight Central- and East- European countries. For ten years the Scientific Council has been granting the Best Young Polymer Scientist Award of the Bulgarian Chemical Society that is a great stimulus for the younger generation of polymer researchers.

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Institute as an important national research centre will support national plastics and rubber industry from the personnel, technology and knowledge viewpoints, and at the same time it will work internationally on all activity levels. The scientific part is framed into two mutually linked programmes connected with polymer processes, bioactive polymers and polymer composites. The research programmes create a sufficient space for the cooperation with the commercial sector with an accent on innovations.

The Polymers Laboratory at the Faculty of Chemistry and Pharmacy at the University of Sofia is another example of the developed biopolymer research. It is conducting research on polymers in the field of property and structure of polymers and watersolible polymers, polyelectrolytes and biopolymers.

Phytopharmaceuticals:

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Actavis is the largest local manufacturer. Other big ones are **Sopharma** and **Chaikapharma**. The only state-owned pharmaceutical manufacturer remains **BB-NCIPB Ltd**, which specializes in products such as vaccines and immunostimulants.BB-NCIPD Ltd. is a commercial company, 100% state-owned, with over 130 years of history.

Ecopharm, BB-NCIPD Ltd., Himax Pharma, Adifarm GE Pharmaceuticals, Borola, "Unipharm"AD are among leading pharmaceutical companies in Bulgaria.

Cluster initiatives related to bio-based industry

- Green Synergy Cluster
- Bulgarian Furniture Cluster
- Black Sea Energy Cluster
- Cluster Bio
- Cleantech BULGARIA
- Cluster Renewable Energy and Sources
- Cluster Mechatronics and Automation
- Textile Cluster and institute Dunav
- Electric Vehicles Industrial Cluster
- Green Energy Cluster
- Automotive Cluster Bulgaria
- TKK Bulclust - Textile Cluster
- Bulgarian Association Polymers

5.2 ADVANCED BIO-BASED INITIATIVES: DEMO AND PILOT PLANTS AND MAJOR INNOVATION ACTIVITIES

The accredited analytical laboratory at the Energy Agency of Plovdiv tests and investigates the chemical composition of solid biofuels, biogas substrates, by-products and residual products, sewage sludge ashes, filtration dusts and biowaste in order to assess the possibilities for use of the various biomasses. The Laboratory for testing biofuels, compost and biowaste (LBCBW) is equipped with modern equipment for testing of solid biomass according to the international standards and based on a problem-oriented methodology. The LBCBW is accredited according to the requirements of EN ISO/IEC 17025 with certificate

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of accreditation No. 192 LI / 10.09.2016. LBCBW is the first Bulgarian specialised laboratory for testing of solid biofuels, biowaste and compost. In March 2017, LBCBW was officially recognised as a testing body by the European Pellet Council (www.enplus-Pellets.eu/about-enplus/testing-bodies) within the ENPlus Certification Scheme. In 2018 it was approved as a testing body under GoodChips Certification Scheme. LBCBW is under preparation to cover the bio-based content testing.

Laboratory complex at the Sofia Tech Park

The laboratory complex is one of the key elements of the Sofia Tech park, consisting of 11 laboratories and managed by an independent consortium, established specifically for that purpose – Research and Development and Innovation Consortium consisting of some academic institutions such as Sofia University, Technical University of Sofia, Medical University of Sofia and the Bulgarian Academy of Science. Laboratories within the complex carry out independent and collaborative research and development activities. **The BioPharm Lab Complex** includes three well integrated laboratories and a supporting analytical center: Laboratory for extraction of natural products and synthesis of bioactive compounds; "In vitro" laboratory for evaluation of biological activity and toxicity; Pharmaceutical development and characterization and "In Silico" design. The lab complex is designed to perform problem-driven and industry oriented R&D directed to efficient, value-added and environmentally-friendly utilization of the national bio-resources and valorization of industry byproducts and bio-wastes to obtain products with high added value.

Out of the total of 14 approved initiatives for the creation of centres of excellence and centres of competence under the Operational program "Science and intelligent grow", 5 of them are in the field of bioeconomy (four competency centres and one centre of excellence)

Competency Center "Clean technologies for a sustainable environment - water, waste, energy for a circular economy"

Coordinator

University of Sofia – Department of Biology

Partners:

- University of Architecture, Construction and Geodesy
- University of Forestry
- University "Prof. Asen Zlatanov" – Burgas
- Institute of Physical Chemistry
- Institute of Organic Chemistry with Center for phytochemistry
- Institute of Microbiology
- Cleantech Bulgaria Foundation

The Clean§Circle Competence Center is focused on building an effectively functioning infrastructure on a modular basis in the areas of 1) Control, Purification, Water Management; 2) Treatment, recycling, recovery and disposal of solid waste; 3) Realization of energy and resource efficient economy by obtaining renewable and alternative sources of energy, materials and resources; 4) Stimulate innovation in sustainable environmental technologies and the circular economy

Main activities

Recovery of natural resources - chemical elements (phosphorus), gypsum, bio-raw materials and microbiological preparations from water, sludge and solid waste; to change and reduce the phosphorus content of wastewater with its extraction through a single technology. Research activities will be focused on the use of algae and wetland technologies that combine a variety of eco, bio and energy benefits and enrichment of bio resources (microorganisms and microbiological agents).

Obtaining compost and bio-fertilizers enriched with micro- and macronutrients

Development of fuel and electrolysis cells for the production of hydrogen from wastewater: Production of energy, electrical or alternative in the form of H_2, in the course of wastewater treatment and recovery.

Competency Center for the Sustainable Use of Bio-Resources and Waste from Medicinal and Aromatic Plants for Innovative Bioactive Products.

Coordinator

Institute of Organic Chemistry with a Phyto-chemistry Center

Partners:

- Agrobioinstitute
- University of Sofia– Department of Chemistry and Pharmacy
- University of Sofia- Department of Chemistry
- Institute of polymers at Bulgarian Academy of Sciences

The following laboratories will be established:

1.1 Laboratory „Agrbiotechnologies“

1.2 Laboratory „Comparative metabolic analysis“

1.3 Laboratory „In vitro reproduction“

2 Department „Bioactive natural and synthetic compounds“

2.1 Laboratory „Preparation of bioactive extracts, natural compounds and synthetic analogues“

2.2 Laboratory „Complex analyses of natural and synthetic compounds and related bioactive materials“

3 Department „Bioactivity of products“

3.1 Laboratory „Virological tests“

3.2 Laboratory „Microbiological research“

3.3 Laboratory „Cellular and molecular biology“

3.4 Vivarium with a physiology laboratory

4. Department „Polymeric nutraceutical and cosmetic formulations” (partner IP-BAS) –

4.1 Design and production of polymer-enhanced nutraceutical and cosmetic formulations „Design and production of polymer-enhanced nutraceutical and cosmetic formulations”

4.2 Laboratory „Quality control of polymer-enhanced nutraceutical and cosmetic formulations” –

5. Department „Development, quality control of plant-based products“(partner FSF-SU) –

5.1 Laboratory „Products and technologies development“

5.2 Laboratory „Quality control of products“

5.3 Laboratory „Assessment of food safety“

Objectives

- Increasing investment in R&D and innovation for the efficient use of national medicinal and aromatic plant (MAP) resources and utilization of agrobio-waste;
- Market orientation of research and enhancement of innovation capacity;
- Investments in modern research infrastructure and equipment.

Expected results

- Concentration of scientific and financial potential and modern scientific infrastructure at the Center for Competence for the Strategic Objective: "Intelligent utilization of Bulgarian biodiversity for economic development and sustainable growth"
- Development of green technologies to create innovative phyto products for medical, cosmetic and nutritional purposes
- Encouraging and supporting farmers from different regions to cultivate MAPs as sustainable livelihoods
- Conservation of plant biodiversity in the country by developing smart and gentle approaches and technologies for its utilization
- Increasing the capacity of Bulgarian companies to develop and implement innovative competitive products, with market demand in the country and abroad

Competency Center "Personalized Innovative Medicine (PERIMED)"

Coordinator

Medical University – Plovdiv

Partners

- Plovdiv University
- Institute of mineralogy and crystallography "Acad Ivan Kostov"

The project envisages:

1. Accreditation of the Biocatalysis Laboratory and Bioactive Substances for the preparation of experimental batches of bioactive components that could be registered as food additives, and

2. Certification of the Laboratory of Molecular Enzymology and Biotechnology for the creation and operation of recombinant (genetically modified) micro-organisms for technological purposes.

There is a strong interest in research products from companies, hospitals and universities in Bulgaria, the Balkans and Eastern Europe. Pharmaceutical companies that are the main users of the data obtained - Novartis Bulgaria, NATSTIM EOOD, SEVEX PHARMA, AMGEN, ROSH Bulgaria and others are interested in the studies related to oncology and onco-hematology. Companies such as NEOFARM, Sofia, PROGEN Ltd. (Biosystems) and others have expressed interest in the scientific products and results of the project

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Center of excellence "Mechatronics and Clean technologies"

Coordinator

Institute of General and inorganic Chemistry

Partners

- Institute of Electrochemistry and Energy Systems Acad. E. Budevski-BAS
- Institute of Catalysis - BAS
- Institute of Metal Science, Equipment and Technology with Center for Hydro and Aerodynamics "Acad. A. Balevsky - BAS
- Institute of Mechanics - BAS
- Institute of Mineralogy and Crystallography, Acad. Eve. Kostov-BAS
- Institute of Optical Materials and Technologies Acad. J. Malinowski - BAS
- Institute of Organic Chemistry with Center for Phytochemistry - BAS
- Institute of Polymers - BAS
- Institute of Solid State Physics - BAS
- Institute of Physicochemistry, Acad. R. Kaishev - BAS000670680 University of Sofia
- Technical University – Sofia
- Technical University - Varna
- Technical University - Gabrovo
- University of Chemical Technology and Metallurgy
- Central Laboratory of Applied Physics, BAS – Plovdiv

Three specific complexes: TU Complex - specialized in the field of mechanical engineering, Lozenets Complex - focused mainly in the field of clean technologies, Complex G. Milev "- covering the fields of mechatronics and clean technologies will support research activities in four work packeges:

WP1. Computer modeling and technology development and new engineering and materials reengineering;

WP2. Electronic, optical, sensory and bio-mechatronic systems and technologies;

WP3. Mechatronic systems and technologies;

WP4. Clean energy and green technologies.

Competency Center Technologies' and systems for generation, storage and consumption of clean energy

Coordinator

Institute of Electrochemistry and Energy Systems Acad. E. Budevski-BAS

Partners:

- Joint Innovation Centre
- Institute of Engineering Chemistry - BAS
- Catalyst Institute - BAS
- Institute of General and inorganic Chemistry - BAS
- Institute of Polymers - BAS
- Central Laboratory of Solar Energy and New Energy Sources
- BG H2 Society Association
- South-Western University "Neofit Rilski"
- Scientific Institute for Clean Technologies Association

The scientific program is grouped into five main thematic areas (batteries, photovoltaic modules and generators, hydrogen and fuel cells, bioenergy, integrated energy systems) that represent the main approaches to the production, storage and conversion of renewable energy.

As a result of the project implementation, the research and innovation infrastructure will be established within two technological modules and one module for transfer and dissemination of knowledge:

Module 1 "Industrial Research" (4 laboratories): L1: "Batteries"; L2: "Photovoltaic modules and generators"; L3: "Hydrogen and fuel cells"; L4: "Bioenergy

Module 2 "Experimental development" (2 laboratories): L5 "HIT for energy storage and electromobility"; L6: Integrated energy systems;

Module 3 "Communication and Knowledge Transfer": Knowledge Management and Technology Transfer;

L4: „Bioenergy" will carry out research focused on generation of hydrogen from biomass and reforming of wastes through innovative processes and technologies.

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Active clusters have been established bringing together businesses (mainly SMEs), research institutes, universities, local and regional authorities. Cluster initiatives related to bio-based industry - Green Energy Cluster, Bulgarian Furniture Cluster, Cluster Bio, Black Sea Energy Cluster, Cluster Renewable Energy and Sources TKK Bulclust - Textile Cluster, Textile Cluster and institute Dunav, Bulgarian Association Polymers

Several clusters within the Association of Business clusters are part of **DanuBioValNet** project aiming at establishing bio-based industry networks across the Danube Region. The expectations are the emerging transnational cooperation of clusters to foster bio-economy and eco-innovations and lead to a strengthening of the regional economies.

Consequently, the partners pursue a strong strategic orientation beyond the immediate and medium-term economic objective of strengthening the regional economiesy. It is the strategic goal to establish crossborder strategic partnerships, particularly in developing regions, with the help of powerful cluster organisations in addition to the creation of strategic investments, especially in emerging industries such as the bio-industry, will be enabled and facilitated. This is envisaged to be achieved mainly by newly emerging or transforming value-added chains, which are increasingly being transnationally established and further developed as a result of the increasing internationalisation of value-added processes. Common Action Plan covered 28 actions in 6 Focus Areas of the Joint Bio-based Industry Cluster Policy Strategy, including the findings and outcomes of the Policy stress testing reports and PLAs on the regional/country level of the project partners.

Bulgaria joined as a member **BIOEAST Initiative** – Central and Eastern European initiative for knowledge-based agriculture, aquaculture and forestry in the bioeconomy. The initiative offers a shared strategic research and innovation framework for working towards sustainable bioeconomies in the Central and Eastern European (CEE) countries initiating cooperation through a multi-stakeholder network and cluster at European level to facilitate joint actions, including the development of a national circular and bioeconomy strategy.

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5.3 Future Biomass valorization options

The following future challenges are identified:

- Need of establishment of durable and sustainable relations among science-education-business;
- Incentives to retain the available and attracting new "fresh blood" human resources with innovative ideas and valuable knowledge;
- Additional reforms in the areas of high and higher education for strengthening the practical focus and covering needs of the labour market;
- Support for adoption of good EU practices, especially management capacity;
- Creation and development of a data base or a network of scientific elaborations, waiting for market realization, as well as dissemination of results of science projects;
- Internationalization and advertisement with focus on guarantee and durable quality.

5.4 Summary and conclusions in relation to SWOT elements

Having long traditions in agriculture as well as regions with preserved biodiversity Bulgaria possesses enough land to secure row materials for bioeconomy development. Bulgaria is a leader in exporting medicinal and aromatic plants. Still the country is lagging in phyto-pharmaceutical products. There are more than 50 distilleries for essential oils production, including famous rose oil. Phyto-cosmetic industry is well developed. Bulgaria has great potential to foster bioeconomy development. With a strong foothold in pharmaceutical, wood processing, pulp and paper, food and beverage industry, there is room for significant R&D and innovation activities and new business models. However, there is still a lack of communication between important stakeholders and leaders of the bioeconomy sector in

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Bulgaria, which could be a potential for improvement and closing the circle of material and energy management in each company.

Challenges for the development of the bio-based industry clusters:

- Build new interconnections between different sectors
- Build new bio-based value chains (from feed- stock to products)
- Small core of existing members and early stage of their business development
- Lack of funding availability / accessibility
- Lack of clear understanding by community of ˝bio-industries˝

Relevant strengths and opportunities in bio-based industry in Bulgaria:

Although bio-sector is fairly new to Bulgaria, biotechnology is one of the most important and most widespread key technologies in public research organisations as well as in business sector.

Biomass and bio-based products are related to the applications of life sciences and biotechnology in a broad variety of sectors as the main innovation drivers of the knowledge-based bioeconomy (KBBE), leading to new growth and competitiveness.

The potential of biomass comprising plant (mainly wood but also several other fast growing plants) and single cell biomass, originating from agriculture, industrial wastes, or cultivation, is in Bulgaria explored both for the conversion to energy, bio-based products and biofuels, as well as for the production of chemicals (mainly pharmaceuticals).

There is an increasing interest for biomass production present among Bulgarian entrepreneurs who require significant RDI contribution to the optimal use of resources that may provide competitive advantages for Bulgaria.

Examples of successfully translated R&D into manufactured goods and products in biochemical and bio plastic production and in development of environmentally friendly new materials and substances can be found in Bulgarian relatively large pharmaceutical and in smaller producers

In the recent years also small knowledge-based companies providing biotechnology services have emerged. Larger companies are all exporters with already established position in the market. Several SMEs are emerging in the biopharmaceutical sector through the technology transfer process. Recent investments in RDI were made in order to address and support next technological readiness level phases, especially when it comes to biotechnology.

The Center of Plant Systems Biology and Biotechnology (CPSBB) with the help of the H2020 Teaming project PlantaSYST will develop new products for the Bulgarian and the global market (breeders, farmers, end-users), in particular new diagnostic tools and technologies for plant breeding, new vegetable varieties resistant to biotic and abiotic stresses, cultivars of vegetable crops with improved yield stability and nutritional, harvesting or processing qualities, and plant-derived products with new pharmaceutical properties for innovative applications in medicine.

CPSBB will play an important role in transfer of knowledge and technology, and will be an important tool to support the biotechnology sector and to increase the deployment of industrial biotechnology.

There are several globally competitive industry segments in Bulgaria, which coincide with also a strong research capacity in pharmaceutical, agriculture, chemistry, healthcare, etc. There is an opportunity for Bulgarian science and research sector to turn to developing innovative solutions with strong commercial potential in this field and transform some sectors in bio-based. For example, traditional and declining automotive and maritime industry can develop advanced structures and materials.

Among the identified barriers for the development of the bio-based industry clusters are:

- Very limited awareness about the bio-based industry;
- No enough information about the opportunities to participate or create new value chains and the benefits for the participants;
- Absence of specific bio-based industry strategy with responsible authorities and adequate financing programs/incentives

Funding needed:

- Grant schemes/vouchers for cooperation science-business
- Support for marketing and export activities;
- Support for governance/management capacity;
- Certification, quality control.

Indicative activities and measures

- Incentives to restructure the product portfolio
- Help clusters internationalization and others forms of cooperation
- Funding of specialized equipment for laboratories
- Support for quality assurance
- Support for learning and training
- Support for information networks, websites, and European forms of cooperation

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Strengths	**Weaknesses**
• Long traditions in agriculture • Long tradition in collection of medical and aromatic plants • Good skills and traditions in production of essential oils • Availability of distilleries for essential oils production • Tradition in phyto-pharma industry – medicines, natural cosmetic • Establishment and development of Competency Center for the Sustainable Use of Bio-Resources and Waste from Medicinal Aromatic Plants (MAPs) for Innovative Bioactive Products • Establishment and development of the BioPharm Lab Complex at the Sofia Tech Park • Availability of accredited laboratory for testing of biofues, compost and bio-wastes • Well established pharmaceutical, wood processing, furniture, pulp and paper industries • Innovative companies with potential for contribution at EU level • On-topic ongoing research projects • Strong academic community • Interest in start-up entrepreneurship in the field of bioeconomy	• Loss of hemp processing tradition (hundreds factories in the past) • Lack of projects related to rural development for bioeconomy • Lack of BBI related projects and partnerships • Lack of R&D and innovations infrastructure outside universities and outside of the capital • Lack of HiTech center for innovations in some of the largest cities • Insulated scientific community, lack of cooperation between academia, public and the private sector • Low interest in science among young people • Low level of internationalisation of SMEs
Opportunities	**Threats**
• The underexploited potential of agricultural residues • Pilot R&D and innovations projects with participation of different stakeholders • Pilot projects to connect the academy community and private investors • EU funding for innovative bio-based initiatives • EC vision to mandatory inclusion of bioeconomy development in the National Strategic Plans for Agricultural Development - the basis of the reformed Common Agricultural Policy (CAP)	• Loss of essential oils markets due to the unethical competition with Chinses companies • The loss of scientists and engineers due to better conditions offered in other countries • The loss of start-up processing companies due to immature legislation (hemp case)

Figure 5.4-31 SWOT analysis of bio-based products, industries and markets

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6. INFRASTRUCTURE, LOGISTICS AND ENERGY SECTOR

6.1 EXISTING INDUSTRIAL HUBS AND HARBOURS

There are six free customs zones in Bulgaria - in Plovdiv Ruse, Burgas, Vidin, Dragoman and Svilengrad. The free duty zone "Varna - Devnya" is in the process of being created. Three of them are owned by the Ministry of Finance, in the city of Plovdiv and city of Burgas the Ministry is a minority owner. 49% of the Dragoman Free Zone, are run by the municipality, the other part is shared by small proportions between multiple owners. Most of the areas have hundreds of thousands of square meters of warehouses and production areas, while in Burgas, Rousse and Vidin they also have access to a port.

Currently, in Bulgaria there are about 14 functioning zones, with active local and foreign investors. Also, there are about 21 zones, either with fully or mostly developed infrastructure and ready to be invested in, and about 27 zones under development.

Six operating zones

Sofia Bozhurishte Economic Zone

Industrial Logistics Park Bourgas

Free Zone Rousse

Free Zone Svilengrad

Industrial Zone Vidin

Transit Trade Zone Varna

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Five zones under development

Industrial Zone Karlovo

Industrial Zone Telish

Industrial Zone Varna West

Industrial Zone Kardzhali

Industrial Zone Stara Zagora

Sofia Bozhurishte Economic Zone **Total area:** 3 038 527m² **Location** • Sofia City Center 15 km away • Sofia Airport 23 km away • 5 km from a highway to Greece • 2 km from a highway to Serbia • 30 km from a highway to the Black Sea • Next to the international road connecting Europe with Turkey and Asia • Direct connection to the railway network	
Industrial Logistics Park Bourgas **Phase 1 of the zone: 238 240 m²** • **Free area: 7 plots for sale** **New industrial land of 600 000 m² is currently under development.** **Location:** • In the second biggest Black Sea city and the biggest cargo harbour in Bulgaria • 10 km to Burgas airport • 4 km to Burgas harbour • 2 km to Trakia highway	

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Free Zone Rousse **Total area: 370 235 m²** • Built-up area: 30 000 m², 29 warehouses • Open-air warehouses: 20 000 m² **Location:** • 800 m to the East of Danube Bridge connecting Bulgaria and Romania • Right next to the port of Ruse – the biggest river port in Bulgaria • Junction of Pan-European Transport Corridors №VII and №IX	
Industrial zone Vidin **Total area: 308 627 m²** • Warehouses: 9 278 m² • Offices: 193 m² • Greenfield area: 159 641 m² **Location:** • On the bank of the Danube river next to Danube Bridge - 2, a freight port, and a ship terminal • Located on two borders – land with Serbia and river with Romania • Junction of Pan-European Transport Corridors №IV and №VII	
Free Zone Svilengrad **Total area: 70 000 m²** • Warehouses for rent: 864 m² • Offices for rent: 187 m² **Location:** • 2 km to the border with Greece • 50 m to railway connections with Turkey and Greece • Access to transport corridor №IV, connecting Europe with Turkey	

Tranzit Free Trade Zone Varna **Total area:** 104 000 m² of industrial urban area with fully developed infrastructure • Warehouses: 5 x 500 m² • Greenfield area: over 40 000 m² **Location** • 1.5 km away from Varna city center, located on the island part in the Southern Industrial Zone • Only 500m from the main entrance out of Port Varna	
Industrial Zone Varna-West **Total Area:** 399 000 m² Infrastructure • In proximity: gas, electricity, telecommunications, national road and railway network **Location** • Near the largest Black Sea city in Bulgaria • 35 km to Varna • 28 km to Varna airport • 18 km to Varna – West port • 11 km to highway to Sofia	

Trakia Economic Zone

6 industrial zones/10 industrial parks

180+companies

75+ thousand employed in industry

30+thousand employed in TEZ

7,5 million m2 million m2

3,2 free area occupied area

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Industrial Zone Maritsa **Location:** 6 km from Plovdiv City Center and 3 km from Trakia Highway **Surface Area:** 5 000 000 m² area **Industries:** Engineering, Electronics, Foor, Logistics	
Industrial Zone Rakovski **Location:** 14 km from Plovdiv City Center and 4 km from Trakia Highway • **Surface Area:** 1 000 000 m2 • **Industries:** Automotive, Chemistry, Textile, Logistics, Food, Energy equipment	
Industrial Zone Kuklen **Location:** 12 km from Plovdiv and 8 km from Asenovgrad, second largest/most populated in Plovdiv Region **Surface Area: 1 000 000 m2** **Industries:** Machinery, Chemistry, Automotive, Metals, Logistics	

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Industrial Zone Plovdiv **Location:** in Plovdiv City • **Surface Area:** 300 000 m2	
High-tech park "Innovations" **Location:** 15 km from Plovdiv City Center **Surface Area:** 2 600 000 m2 **Industries:** Suitable for logistics, agriculture, manufacturing	
Agro Center Karlovo • **Location: 25 km from Plovdiv city center** • **Surface Area:** 800 000 m^2 • **Industries:** Food, Packaging, Food Equipment	

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The main Black sea ports are:

Port Varna

Anchorage depth: 15.5m - 16m

Cargo pier depth: 4.9m - 6.1m

Port Burgas

Anchorage depth: 11m - 12.2m

Cargo pier depth: 6.4m - 7.6m

Oil terminal depth: 6.4m - 7.6m

The inland waterways are the waters of the Republic of Bulgaria comprising the water area of the Danube, in the stretch between its right bank and the demarcation border line between the Republic of Bulgaria and the Republic of Rumania from kilometre 845,650 to kilometre 374,100.

As an EU member-state Bulgaria has the obligation to develop a river information services (RIS) system, which is a part of the Trans-European network, in compliance with the technical guidelines for the planning, implementation and operational use of the RIS in order to ensure efficient and safe navigation on the inner waterways.

Region of operation of **Branch-Territorial Directorate Lom** is from kilometre 645 to kilometre 845,650 of the Bulgarian section of the Danube River with Head office in Lom. Branch-Territorial Directorate Lom serves the infrastructure of: Port Terminal Lom, Port

Port Terminal Vidin-Center, Port Terminal Vidin-South, Port Terminal Ferry Complex Vidin

Region of operation of Branch-Territorial Directorate Ruse is from kilometre 374,100 to kilometre 645 of the Bulgarian section of the Danube River with Head office Ruse.

Branch-Territorial Directorate Ruse serves the infrastructure of: Port Terminal Ruse-West, Port Terminal Ruse - East – 1, Port Terminal Ruse - East – 2, Port Terminal Ruse-Center, Port Terminal Svistov, Port Terminal Silistra, Port Terminal Somovit, Ferry Terminal Nikopol, Port Terminal Tutrakan, Ferry Terminal Silistra

Detail information about Bulgarian ports is provided in Annex 3.

6.2 Existing railway

Bulgaria has a high density of constructed railway lines in comparison with many of the other East European countries. The greater part of the lines has geometric parameters, track substructure and structures for speeds of up to 100km/h. The total track length is 6,938km, including a gauge of 1,435mm. Connections with neighbouring countries' networks are not very satisfactory. Currently there is one border crossing with Turkey, two with Greece, and one with Serbia, with Romania through the only bridge over the River Danube along the Bulgarian – Romanian section in Russe – Giurgiu and one land crossing. The Varna ferry complex ensures the transportation of railway wagons through the Black Sea. There is no railway connection with the FYRO Macedonia.

Along the railway network there are 148 tunnels with a total length of 44,500m along railway lines with a normal gauge, and 41 tunnels along narrow-gauge railway lines. There are also 1,018 bridges with a total length of 26,400m. The railway switches are approximately 7,800 pcs.

During recent years and due to a shortage of funds, the track and structure maintenance has suffered. From the mid-90s, the only investments made to the railway infrastructure have been with international programme funds and with a World Bank loan. This led the quality of passenger and freight transportation to decrease and capacity and speed restrictions were enforced along significant railway sections.

As a result of a completed electrification extension, Bulgaria is a leading country in comparison with East European countries. Currently, 67% of all tracks in Bulgaria are now electrified. 373 traffic points are in operation and a system has been constructed to measure the energy consumed by the locomotives. We are currently testing the system and it is installed on four locomotives.

Railway lines along the Main European Transport Corridors are included in the European Agreement of International Combined Traffic and connected sites (AGTC). This Agreement also contains the terminals at the territory of Republic of Bulgaria that are of great importance for the International Combined Traffic, as well as for the important border points of Republic of Bulgaria, railway-ferry points and harbours.

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The geographical situation is the reason for the passing of five Common European Transport Corridors through the territory of Bulgaria: IV, VII, VIII, IX, X. Two priority axes for the European Union through Bulgaria are determined: Vidin – Sofia – Kulata (Corridor IV) and Danube River (Corridor VII).

The South-Eastern main axis (part of High Level Group II for continuation of the main Trans European axis to the European Union neighbouring countries and regions) passes through the Bulgarian territory, connecting the European Union through the Balkans and Turkey with Kavkaz and the Caspian Sea as well as with Egypt and the Red Sea. There are foreseen connections with Albania, FYRO Macedonia, Iran, Iraq and the Persian Gulf. The main multimodal connections that pass through Bulgari are the Common European Transport Corridor X – C branch, connecting Belgrade – Nis – Sofia and then along the Common European Transport Corridor IV path – Istanbul – TRASEKA, as well as Common European transport Corridor VIII – starting from the Italian harbours Bari /Brindisi and passing through Dures / Vliora – Tirana – Skopje – Sofia – Bourgas – Varna.

Intermodal transport is the logistics solution for the future. At least two different modes of transport should be combined to create a fast, efficient and environmentally sound transportation chain - without changing the transport container. It is planned that Bulgaria will acquire at least 10 intermodal terminals - in Sofia, Varna, Plovdiv, Rousse, Burgas, Dragoman, Gorna Oryahovitsa, Lom, Vidin, Svilengrad. According to experts, future intermodal terminals along the Serbian-Turkish border, and especially between Sofia and Svilengrad and Burgas, have the greatest chances for rapid development. The intermodal terminal near Todor Kableshkov Station in Plovdiv is being built. An intermodal terminal with a motorway, a highway or a fast railway is also planned in Vidin. Technicl design is being carried out for the Varna terminal.

Inter Modal Terminal (BMI) Plovdiv, is the first in Bulgaria intermodal terminal designed to handle Intermodal Freight Units. The Plovdiv Intermodal Terminal loads and unloads containers and trailers from and to trains. The terminal is fully fenced and has a waiting parking space of 6500 m² for approximately 14 trucks.

Free Zone - Rousse EAD has an investment project and is looking for a partnership for the construction of an intermodal terminal with a total area of about 40 thousand square meters for trans-shipment of various types of general cargo. The investment proposal aims at the

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construction of a combined terminal along the lower Danube River for the reloading of various types of indoors cargo, container and truck reloading (ro-ro). The capacity of the port will allow simultaneous servicing of two cargo ships, as well as direct transhipment from river to river-sea vessels. Overloading will be done through bridge cranes with a capacity of 25 tons. The possibility of adding additional cranes is also envisaged in case of increased working volumes.

3 types of congestion activities:

- Ship - Truck
- Ship - Railway composition
- Ship - Ship

There is also the possibility of adding additional cranes in case of increased working volumes. The implementation of the project for construction of the intermodal terminal will close the full cycle of services offered from Free Zone - Rousse EAD.

The EU has also established a rail network giving priority to freight, through the realisation of a number of international freight-oriented "corridors".

The Trans-European Corridors that run through Bulgaria are:

- The Orient – East Med Corridor, from the Romanian border to the Greek border, via Sofia. An eastbound branch goes towards the port of Burgas and the Turkish border.
- The Rhine-Danube Corridor, going along the Romanian border (the River Danube).

6.3 EXISTING ROAD INFRASTRUCTURE

Bulgarian roads with a pavement make up 98.4% of all the country's roads, while 92.5% of them have an asphalt surface and 82.8% of them are able to carry 10tonnes/axle.

The length of the roads with no pavement is 272.1km (1.41% of the total length of the road system) and only 12 villages are not connected to the road network (61.2km). The local/municipal and private roads have a total length of over 24,000km. In addition, the length of the street network in the urban areas is over 60,000km.

The road network with highways and roads of Grades I, II, and III totalled 19,276km, and these are highways (331km), Grade I roads (2,961km), Grade II roads (4,012km), Grade III roads (11,730km) and road connections and nodes (242km).

The coverage of the national territory with highways of three and four lanes has been uneven. The east-west directions are more developed than the north-south ones because the services of the peripheral areas along the southern border, the River Danube bank and those located between the Pan-European Transport Corridors 4 [Dresden/Nuremberg, Prague, Vienna, Bratislava, Gyor, Budapest, Arad, Bucharest, Constanta/Craiova, Sofia, Thessaloniki/Plovdiv, Istanbul] and 9 [Helsinki, Vyborg, St Petersburg, Pskov, Gomel, Kiev, Ljubashevka, Chisinau, Bucharest, Dimitrovgrad, Alexandroupolis] is bad.

The road infrastructure development policy objectives are to finish the construction of the Bulgarian highway system; reconstruct and rehabilitate road sections along the Trans-European Transport Corridors, and improve and standardise the transport operational parameters of the road network.

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6.4 ENERGY SECTOR

Table 6.4-30 Summary on Bulgarian energy sector, S2BIOM project, Eurostat's base in 2013

Category	Bulgaria	EU average	Unit	Assessment	Similar countries
3. Energy					
Primary energy consumption	2.24	3.22	toe/capita (2012)	Medium	ES, FR, PL, SI, SK, ME
Energy dependence	37.8	55.4	%	Medium	
Renewable energy share	19	17.9	%	Medium	
GHG emissions	8.33	9.47	ton CO_2-eq/capita	Medium	
8. Renewable energy (RE)					
Bioenergy in RE	65%	69%	%	Medium	FR, SI
Bioenergy in total energy	7.3%	10.6%	%	Medium	
9. Energy infrastructure					
Biofuels prod. Capacity	0.012	0.051	ton/capita	Low	
CHP	8.5%	17.3%	% gross electricity generation	Low	
District heating	1,566	7,404	km		
	0.2	0.3	m/capita	medium	
CHP = Combined Heat and Power, GDP = Gross Domestic Product; GHG = Greenhouse Gas; LSU = Livestock units; MSW = Municipal Solid Waste, PPS = Purchasing Power Standard, RE = Renewable energy; UAA = Utilised agricultural area					

Bulgarian's priority is to increase the supply of energy from renewable sources with the objective to reach a share of at least 25% of the final energy consumption till 2030. Wood and its by-products are considered as the most important renewable energy source in Bulgaria.

In 2016, the gross final consumption of energy from renewable sources reached 1 999.5 ktoe and registered a growth of 21 % compared to 2012. From 2012 to 2016, energy consumption in the heating and cooling sector and the electricity sector rose by 7.2% and 19.5 %

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respectively. The use of energy from renewable sources increased considerably in the transport sector, up from 5.1 ktoe in 2012 to 171.6 ktoe in 2016.

The breakdown of energy from renewable sources by sector is as follows:

- heating and cooling sector

The heating and cooling sector is the greatest contributor to the achievement of the binding national target. In 2016 consumption of energy from renewable sources in this sector was 1 174 ktoe, registering an increase by 6.6 % (1 101 ktoe) compared to 2012.

Overall actual contribution (final energy consumption) of biomass used for production of renewable energy in Bulgaria to the binding targets for 2020 and to the indicative trajectory for the shares of energy from renewable sources in heating and cooling (ktoe) is:

Table 6.4-31 Final energy consumption of biomass for RE production

	2012	2013	2014	2015	2016
Biomass	1 005	1 010	963	1 009	1 036
solid biomass	1 005	1 010	961	1 005	1 010
Biogas	0	1	2	4	26
TOTAL	1 101	1 127	1 081	1 139	1 174
of which energy from biomass used in households	759	750	733	716	758

The share of biomass was 91 % in 2012 and despite its decrease to 88 % in 2016, it remained the renewable source with the greatest application in this sector. In 2016, as compared to 2012, a positive trend was that the use of renewable energy from heat pumps increased by 73 %, followed by solar energy with a 45 % increase and geothermal energy with a 4 % increase. Solid biomass continues to be the renewable source of highest importance to this sector and with the greatest application in the residential sector. In recent years the use of wood wastes, other plant wastes and biomass from agriculture and sewage sludge increased, although not at the expected rate.

Electricity sector

In 2016, the renewable electricity generated was 7 365 GWh, registering a 20 % increase compared to 2012. This resulted from the commissioning of new wind and photovoltaic power plants and biomass power plants, whereby the installed capacity for the indicated years increased from 4 885 MW to 5 007 MW.

Table 6.4-32 Installed capacity and gross electricity generation of biomass-related technology for renewable electricity

	2012		2013		2014		2015		2016	
	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh
Biomass	14	66	34	112	40	201	54	270	57	354
Solid biomass	14	65	30	95	30	139	34	151	19	163
Biogas	0	1	4	17	10	62	20	119	38	191

Estimated trajectory for the share of renewable energy in gross final energy consumption in the electricity sector for the period 2021—2030 is envisaged to reach 17%, in the heating and cooling sector - is planning to achieve 44 %, in the transport sector - 14 %

Table 6.4-33 Estimated trajectory by renewable energy technology (gross renewable electricity generation), GWh

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Biomass-powered power plants	290	350	364	378	384	391	398	405	412	419	426
Gross renewable electricity generation	7 244	7 508	7 522	7 596	7 663	7 759	7 772	7 874	7 849	7 948	8 046

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Table 6.4-34 Estimated trajectory by renewable energy technology (installed capacity of power plants using renewable energy), MW

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Biomass-powered power plants	70	100	100	100	100	100	100	100	100	100	100
Installed capacity	5 052	5 232	5 232	5 262	5 292	5 322	5 382	5 442	5 502	5 562	5 622

Solid biomass is the renewable energy source most widely used in the country. It is mainly used in the heating and cooling sector. Consumption of other types of biomass, including waste, is still insignificant.

Firewood is the main type of biomass used in the country and the use of wood waste and plant waste is growing. The positive trend towards improving the waste management practices continues and the national targets for household waste recycling, reuse and recycling of packaging waste and, last but not least, recycling of ordinary waste have been achieved.

Bulgaria is one of the countries with the lowest biogas production in the EU. The total number of biogas plants in Bulgaria in 2013 and in 2014 amounted to 11: 8 biogas plants produced biogas from agricultural waste, 2 from biodegradable waste and 1 from sewage. The total installed capacity of all these plants in 2014 amounted to 13.6 MW and in 2015 to 20 MW, which is equivalent to 160 GWh/a electricity and approx.180 GWh/a heat.

Biogas production from anaerobic fermentation of biomass and from sewage sludge is still negligible. As of January 2015, the number of working plants reached 21, including 18 agriculture, 2 co-fermentation and 1 sewage biogas plants. Currently, there is no bio methane production in Bulgaria. Biogas is used in electricity and heat generation, in the agriculture sector and in the other services activities sector.

The use of biomass for energy purposes has wide potential for development. The efforts are focused on the wider use of waste (municipal solid waste, sludge from waste water treatment plants, etc.) and industrial by-products, without affecting the health and quality of life of the population in the regions where the biomass fuelled energy installations are located.

The National Programme for Improving the Ambient Air Quality 2018—2020 includes a measure relating to household heating: mandatory phasing out of solid fuel stoves and boilers burning solid fuel (coal and briquettes) and their replacement with biomass stoves and boilers between 2020 and 2024.

Reducing the share of heating oil and electricity in the heating mix, through maximum use of the available biomass resources based on innovative and efficient technologies, is the key factor in optimising the energy balance of the country. Heating using "modern biomass" offers one of the lowest prices for households, municipalities and businesses. Technologies have been developed and are currently available on the market. Bulgaria is rich in biomass, which it must use wisely and efficiently. Over 3 million tons of firewood (about 600,000 t.o.e.) are being burned yearly for heating at an efficiency coefficient below 40%. The forecast of the Executive Forest Agency for the energy potential of wood biomass by 2020 is about 5.5 million tons (1,090,000 toe).

The use of biomass with a focus on biomass from waste and industrial and household waste are seen to increase the share of renewable energy in district heating and cooling systems. The potential for energy efficiency of the central heating and cooling infrastructure can be achieved by rehabilitation of heat transmission networks and replacing the obsolete direct subscriber district heating stations with

Modern highly efficient automated indirect stations which would reduce heat transmission and distribution losses and would result in reduction of CO_2 emissions.

With smart management of Bulgarian wood and deploying new technologies, it would be attainable to first extract as many high-added value products as possible and later on burn what remains to get heat and energy. In that manner Bulgarian wood has a potential of fuelling energy sector, pulp & paper sector, chemical industry, civil engineering sector (eco-bio-based material production and construction) etc. In parallel Bulgaria would reduce dependency on imported sources, increase energy security, and boost employment and development in rural areas.

6.5 Summary and Conclusions in Relation to SWOT Elements

Bulgaria is a significant part of Trans-European Transport Network (TEN-T), with 2 important ports at Black sea cost (Varna, Burgas) and 6 main ports on Danube river (Vidin, Lom, Oryahovo, Russe, Somovit, Silistra). Bulgarian strategic geographical position is favourable for supplying markets in Central and Eastern Europe and Asia. The ports are well connected with railway and the road network. Five Common European Transport Corridors are passing through the territory of Bulgaria: IV, VII, VIII, IX, X.

The railway connect industry hubs, transport of feedstock, new products, biofuels, etc.. Along with the marine and Danube river ports, it has great potential for utilization as a transport mean for bioeconomy purposes Railway and inland marine ports have potential to increase and strengthen Bulgarian connection with the EU through bioeconomy.

The energy sector is well connected all along the country, but also with neighbouring countries through the transmission network. Implementation of bioeconomy in Bulgaria would benefit energy sector. Utilizing biomass (agricultural, forestry and waste) as an energy source would prove to have a significant impact on energy autonomy and balance.

Strengths • Availability of 6 free custom zones • Large number of existing and active industrial hubs for local and international investors • Availability of coastal and Danube river • Good railroad network density • Good connection with European countries (Central and Eastern Europe) • Well-developed motorway network • Access to the sea • Five EU transport corridors • Well developed grid network and electricity supply system • Renewable energies objectives towards 2030 • Good biomass potential for renewble energy development	**Weaknesses** • Week connections with neighbour countries. • Obsolete railway network • Lack of sustainable planning • Lack of modernised transportation networks • Inefficient utilisation of firewood for households heating because of energy poverty • Low level of utilization of agrarian and food waste for biogas production
Opportunities • Development of intermodal transport • Increasing investments in ports, railways, airports and other transportation infrastructure • Strategic position of Bulgaria in TEN corridors (VII, VIII, IX and X) • Established strong position of road network (esp. in freight transport)	**Threats** • Condition of the railway network. • Lagging behind in modernization of road network • Competition of other corridors • Increased congestion in the country during tourist seasons

Figure 6.5-32 SWOT analysis of the infrastructure, logistics and energy sector in Bulgaria

7. Skills, education, research and innovation potential

7.1 Research infrastructure

Five out of 13 established centres of competency and excellence are related to different degree to the bioeconomy:

- Competency Center "Clean technologies for a sustainable environment - water, waste, energy for a circular economy" -coordinator University of Sofia " – Department of Biology
- Competency Center for the Sustainable Use of Bio-Resources and Waste from Medicinal and Aromatic Plants for Innovative Bioactive Products – coordinator Institute of Organic Chemistry- BAS
- Competency Center" Personalized Innovative Medicine (PERIMED)" - coordinator Medical University – Plovdiv
- Center of excellence "Mechatronics and Clean technologies" Coordinator Institute of General and Inorganic Chemistry – BAS
- Competency Center Technologies' and systems for generation, storage and consumption of clean energy, Coordinator Institute of Electrochemistry and Energy Systems Acad. E. Budevski-BAS

The Agricultural Academy is a unified scientific structure with centralized management with a coordinating function and research units that implement elements of globally and nationally significant scientific projects. Its role as a national autonomous budget organization to the Minister of Agriculture, Food and Forestry is for research, for application, servicing and auxiliary activities in the field of agriculture, livestock and food industry. It is carried out within the framework of the state agricultural policy and in compliance with the Common Agricultural Policy of the European Union

Agriculture Academy consists of 25 research institute, 4 scientific institutes and 13 research and production centres (test stations)

Accredited laboratory according to the ISO 17 025 for testing of biofuels, sewage sludge, compost, RDF, biodegradable wastes at the Energy Agency of Plovdiv is a modern research infrastructure in the field of bioeconomy, developing new technologies. The laboratory is a testing body for ENPlus for pallets and Good Chips Certification Schemes.

Technology Park Sofia is the largest innovation ecosystem for commercialization of knowledge and technology in Bulgaria in several fields, including bioeconomy.

Bulgarian Biomass Association and Biogas Association implement EU partnership projects for promotion of biofuels and bioenergy.

EIT Climate-KIC Accelerator within Cleantech Bulgaria is a pre-seed acceleration program for sustainable business, clean technologies and climate innovation.

7.2 EDUCATION INFRASTRUCTURE

The Bulgarian educational system falls within the continental European tradition. The main types of secondary schools are: general educational, vocational, language schools and foreign schools. Private schools are also being established and they are beginning to compete successfully with state schools.

There are fifty-one higher educational institutions in Bulgaria offering degrees at undergraduate and graduate levels. In the field of bioeconomy development there are several state and private educational organisations, namely:

The Higher School of Agribusiness and Regional Development (former Agricultural College) is a private higher school in Plovdiv, Bulgaria. There are branches in Ruse and Veliko Tarnovo.

University of Food Technologies covers wide range of food science, engineering and technology, tourism, biotechnology, economics, computer and information technology. Training is structured in three degrees – Bachelor's, Master's and Doctoral.

Agricultural University Plovdiv is established as a national center of agricultural science and education in Bulgaria. The University is specializing in the education and professional training of personnel in the field of agronomy. The University has four faculties - agronomy, viticulture, plant protection and agroecology, economics.

Since the university's inception, more than 30,000 agronomists, engineers, environmentalists and economists have received diplomas, of which more than 3,000 are foreign students from 76 countries.

Some bio-economy related activities are carried out within the Chemistry and Pharmacy Department at Sofia University, Food Technologies University and Agricultural University.

Energy agencies within the Association of Bulgarian Energy Agencies provide opportunities for involvement of schools, universities and business in pilot projects in the field of sustainable energy, energy efficiency, renewable energy sources with a focus on bio-energy.

7.3 Summary and conclusions in relation to SWOT elements

There is a good educational and research foundation in Bulgaria for expanding the activities in the field of bioeconomy development. Bulgaria's efforts to modernise its research and innovation ecosystem.

Two of four priorities of Bulgaria's smart specialisation strategy, based on local competitive strengths, are related to bioeconomy – biotechnology and mechatronics and clean technologies. The expectation are for improvement of the performance of Bulgaria's innovation system development through the 13 EU-funded centres. Four of them are related to the bioeconomy development. Hopefully, local researchers will turn their work into projects with high value added, for the economy. The known issues in the research and higher education system, such as fragmentation, low funding and limited knowledge and technology transfer, still need to be tackled. Bringing together local authorities, academia, business and civil society is key to identify the best ways to boost local economy and foster development.

This project received funding from the BBI JU under the EU Horizon 2020 research and innovation programme under grant agreement No.838087

Unfortunately establishment of several regional innovation centres under Operational program "Competitiveness and innovations" was cancelled and the funding was unexpectedly redirected towards other activities.

In terms of education there is a strong need for the intensification of the practical focus of training in the higher schools; employability – provision of up-to-date knowledge, skills, and competences.

There are a growing number of prospective private organisations with ability to gather interdisciplinary teams witch members understand the research together with stakeholders as well as to participate in common EU projects within European research programs. Usually they are well recognised at EU level but not at National level. Start-up companies in Bulgaria are also increasing although there is a lack of focused national policy.

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Strengths	Weaknesses
• Large academic community – about 40 universities, large Bulgarian Academy of science and Agricultural Academy of Sciences, Food Technologies University • High potential for knowledge transfer (quality schools, universities) • Establishment and development of Competency centres and Centres of excellence • Establishment of the Laboratory Compex at Sofia Hi-tech park • Laboratory equipment at universities and research institutes at Bulgarian Academy of Sciences	• High fragmentation in the research, • development and innovation • The insufficient connection between academia, public and the private sector • Very weak science-business links • Lack of interest of young people to work in the research and development • Underdeveloped potential of clusters • Lack of functioning innovation ecosystem • Academia reliance on grants • Lack of modern medium TRL (3–6) research/development infrastructure • Low number of patents • Low interest of young people in R&D
Opportunities	**Threats**
• Support and intensification of collaboration between universities and businesses, to enable the transfer of technology and commercialisation of research outputs • Intensify the practical focus of training in the higher schools; employability – provide up-to-date knowledge, skills, and competences. • Increase the efficiency of governance of the higher schools. • Introduce a new, results-oriented funding model for the higher education and research • Increase of quantity and quality of all types of research. • Support to competitiveness clusters • Establishment and development of innovation unfrustructures (hi-tech centers, regional innovation centers) • To improve competitiveness of small and medium-sized enterprises • Focus on pharmaceutical and biotechnology sectors • Involvement of young people in the country	• The demographic crisis and the reduced number of future students. • Lower interest in the Bulgarian higher • education • Lack of well-trained specialists in priority areas. • Deficit of academic staff • Lack of interest among young people to pursue academic careers. • Administration's capacity to design and implement public projects and policies. • Continuation lack of a performance-based • funding system • Alternative sources of finance such as venture capital, equity funding and to remain marginal for businesses. • Small share of private organisations (NPOs, SMEs) companies, involved in • innovation activities • Poor prioritisation of research • topics in areas of relevance for the economy • Emigration of top research talent and decline in research quality. • The loss of start-up companies

Figure 7.3-33 SWOT analysis of educational, innovation and skills sector in Bulgaria

8. Policy framework: Regulations, legislation, rule of law & taxes and tariffs

8.1 Introduction

There is no dedicated bio-based industry national/ regional policy developed in Bulgaria. But there are some related national strategies and programs that defines strategic goals, objectives and priorities. The Smart Specialization Strategy and Action Plan (S3), Energy Development Strategy by 2030, Rural Development Programme, Operational program "Competitiveness and Innovations", direct the use of funds for the execution of the European cohesion policy for the 2014-2020 period. Even though there is no specific regional bio-based industry, there are several other strategic documents related, supporting it.

CAP: Rural Development Programmes 2014-2020

The European Common Agricultural Policy (CAP) provides a framework for financial support to farmers (Pillar 1 Direct Payments), and national rural development programmes (Pillar 2 - Rural Development).

Bulgarian Rural Development Program for the period 2014-2020

The scope of the program defines 16 measures aimed at increasing the competitiveness of Bulgarian agriculture, forestry and the processing industry, as well as improving living and working conditions in rural areas. One additional measure is devoted to the small local initiatives. Program is resource efficiency and climate change resilience in agriculture, food processing and forestry, emphasizing that renewable energy production from these sectors is a priority for developing the bioeconomy and reducing greenhouse gases by 2020.

Furthermore, the importance of the use of wood biomass, biomass from agriculture and solar energy in agriculture and the food processing industry is emphasized.

Strategy for Strengthening the Role of the Agricultural sector in the Bioeconomy

Three strategic goals are set:

- Sustainable management and development of agriculture, forestry and fisheries for sustainable production and provision of renewable resources;
- Complete usage and development of research activities, of partnerships for exchange and transfer of innovations, of infrastructure for experimental purposes
- Improvement of knowledge and skills.

Smart specialization strategy 2014-2020 (IS3)

On the basis of proposals from businesses, and the established and declared interest of the academia to participate in international projects, including Horizon 2020, and on the basis of the potential, four thematic areas have been identified and certain product and technology niches, services and productions have been specified. One of the four (4) areas is closely connected with bio-based industry „Industry for healthy life-style and bio-technologies. The following priority bio-based related directions were identified:

- Methods for clean production, conservation and reaching the final consumer of specific Bulgarian products and elements (yogurt, honey, breads, milk products, essential oils, herbal products, bio- cosmetics and bio-products)

- Production of specialized food and drink (baby, children, "astronaut")

- Bio-technologies serving the needs of healthy life and aging

- "blue" technologies and application of new methods and technologies in sustainable use of sea and river resources

- Production plants for the extraction of clean electricity and industrial water

- Green Economy

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Energy from renewable sources act

This act regulates the public relations associated with production and consumption of:

- Electricity, heating and cooling from renewable sources;

- Gas from renewable sources;

- Biofuels and energy from renewable sources in transport

National long-term program for promotion of the usage of biomass 2008-2020 reveals the potential of the biomass in Bulgaria. According to this document the increasing consumption of biomass, especially wood for energy goals is a global trend. Biomass is a resource which wider usage allows reducing the dependence of importing energy resources, contributes for the security of the energy supplies and has relatively less impact on the environment, compared to conventional fuels.

The absorption of the biomass potential in Bulgaria depends on the availability of the following main factors:

- Usage of efficient technologies for direct biomass combustion;

- Implementation of energy production technologies;

- Availability of infrastructure allowing the usage of different types of biomass;

- Development of the biomass market in the country.

Common Action Plan for the Danube region

Common Action Plan towards better framework conditions for bio-based eco-innovation in Danube Region was issued in June 2019 within **DanuBioValNet** project. The aim of the Common Action Plan is to foster better institutional and infrastructural framework conditions on the policy level for closing the bio-based value chains and to facilitate bio-based eco-innovations of SMEs. The Action Plan includes 28 actions in 6 Focus Areas of the Joint Bio-based Industry.

Cluster Policy Strategy, including the findings and outcomes of the Policy stress testing reports and PLAs on the regional/country level of the project partners.

FOCUS AREA A: DEVELOP BIO-BASED BRAIN TRUST ACTIONS

1 Set up an ongoing bioeconomy dialogue across the relevant value chains involving actors of the quadruple helix in a macro regional brain trust.

2 Enhance collaboration of brain trust with relevant entities at the European level, such as the Commission's Knowledge Centre for Bioeconomy.

3 Implement bio-based brain trust actions:

- Provide business intelligence as basis for the other focus areas.
- Leverage networks between the actors of the quadruple helix.
- Demonstrate business opportunities in the bio-based economy for the identification of transformative activities to be addressed by smart specialisation strategies.
- Provide insights on synergies and gaps in bio-based value chains and revealing opportunities for cross regional cooperation projects.

FOCUS AREA B: USE REGIONAL INNOVATION STRATEGIES TO DEVELOP BIOECONOMY ACTIONS

1 Identify and develop Transformative Activities for the Bioeconomy.

2 Involve stakeholders in RIS (S3) decision making processes to alter project and product development plans.

3 Establish national /regional bioeconomy agency/coordination body.

4 Use tools such as S3-Synergy Diamonds, Entrepreneurial Discovery Workshops (EDW), and Action Development Workshops (ADW).

5 Assure bioeconomy support infrastructure for the RIS (S3) implementation.

6 Set up regional innovation management structures that involve cluster initiatives for the purpose of instituting consistent innovation in the bioeconomy with sustainable cooperation and networking structures, through the existing S3 framework.

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FOCUS AREA C: “BIO-ECONOMIZE” EXISTING CLUSTERS ACTIONS

1 Involve biomass feedstock providers in existing cluster initiatives.

2 Incentive packages for start-ups and SMEs within clusters to investigate bio-based options.

3 Support matchmaking venues.

4 Support workforce training programs.

5 Streamline portfolio of cluster initiatives and entities dedicated to support the bio-based economy in the Danube region.

FOCUS AREA D: BIOECONOMIC DISTRIBUTED MANUFACTURING ENVIRONMENTS ACTIONS

1 Foster new types of partnerships and collaboration for development of new business models.

2 Interlink various business sectors into demand responsive value added networks.

3 Incentivise business actors to use local raw materials and apply local manufacturing approaches.

4 Provide databases of locally available renewable raw and residual materials for conversion.

5 Demonstrate bio-based business opportunities on local level.

FOCUS AREA E: FOSTER CROSS-REGIONAL CLUSTER COOPERATION THROUGH SYNCHRONIZED FUNDING ACTIONS

1 Synchronize funding for the development of specific transformative activities of relevance for the bio-based economy.

2 Build on the recommendations from the Proposal for Alignment of National & EU Funding Schemes.

3 Implement Bio-Based Innovation Express Scheme (BIIE).

FOCUS AREA F: STRENGTHEN THE COLLABORATION BETWEEN RESEARCH INSTITUTIONS AND CLUSTERS ACTIONS

1 Assign roles to cluster initiatives in the regional research institution's strategies for knowledge transfer with the business community.

2 Foster synergies between the research and development of new products and services (market).

3 Involve clusters in education programmes that match the needs of their member firms and notably SMEs.

4 Engage clusters in increased and targeted interaction with available regional, national or macro regional funding instruments for research, development and innovation.

5 Develop specialized tools for streamlined projects like Innovation vouchers, contracted research and rewarding professional performance of R&D institutions.

6 Use OSIA as a platform to further develop initiatives to strengthen the collaboration between research institutions and clusters.

8.2 SUMMARY AND CONCLUSIONS IN RELATION TO SWOT ELEMENTS

Several national and EU frameworks reflect the topic of bioeconomy:

- Smart Specialization Strategy (S3) –focuses on economy and increase its competitiveness within two out of four priorities areas - Industry for a healthy life and bio-technology with its priority direction Production plants for the extraction of clean electricity and Green Economy as well as Mechatronics and clean technologies which includes the priority direction CleanTech in the transport and energy sector, technologies and methods for inclusion of waste products and materials in other production..
- the Rural Development Program - focus on the conventional use of agricultural and forest biomass

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In 2019 the Ministry of Environment and Waters announced a tender for development of Circular Economy Strategy and Actin plan. Expectations are for their public discussion in the forthcoming months to be adopted by spring 2021. Meantime, a National scientific program for health food for strong bio-economics and quality of life stablished to mobilise some academic and research institutions. At this moment, bioeconomy is not the central topic of any specific Bulgarian framework or policy. First draft of Bioeconomy strategy and action plan was issued under the leadership of the Ministry of Agriculture.

In order to develop the legal framework, all stakeholders from the bioeconomy sector need to be included and contribute to the creation of a quality strategy: Ministry of Energy, Ministry of Environment and Waters, Ministry of regional development, Ministry of education and science, bioeconomy related clusters and associations.

Strengths	**Weaknesses**
• Strong policy framework for biodiversity conservation and sustainable use • Raising awareness of bioeconomy potential for strengthening the agricultural sector and economy • National science program "Healthy foods for a strong bioeconomy and quality of life" • National Energy and Climate Action Plan for 2021-2030 • CAP post-2020 • BIOEAST initiative - development of a National bioeconomy strategy and • Continuation of DanuBioValNet project	• Fragmented institutional leadership on bioeconomy strategy development • Limited policy-making framework • Lack of support to the private sector • A lack of a circular agricultural policy • A lack of financial incentive/subsidies to foster bioeconomy development • Lagging behind in the process of the development of Bioeconomy Strategy
Opportunities	**Threats**
• Possibility to include circular economy as a key objective in national policy documents • Circular Economy Action Plan is under development • Policies for improved biomass managing, increase in the use of residues • Strong agri-food sector • Removing exhaustive administrative regulations	• Limited focus on agro-wood supply instead of common approach that would include resources treatment and processing • Ignoring the rising awareness of the need for structural change in policy

Figure 8.2-34 SWOT analysis of the Bulgarian policy framework

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9. Financing

9.1 Introduction

In Bulgaria researchers, research institutes, companies, networks, cluster initiatives and others have the possibility to apply to funding schemes only on national level. This does not include funding schemes that are directly aimed at bioeconomy as well as funding schemes that support one or various sectors of the bio-based industry. At the national level there are not specific calls dedicated to bioeconomy within any National strategy that might envisage topics is the structural change and transition from a fossil resource-based economy towards a bio-based economy as sustainable food production, bio-based energy, renewable bio-based material for materials, products based on renewable raw materials such as flax and straw insulation, bioplastics, natural fiber reinforced plastics, solvent based on lactic acid, rapeseed oil as a binder in road construction, vegetable oil based paints and varnishes or vegetable oil based inks etc.

In the absence of bioeconomy strategies, Bulgaria rely on programmes that can provide funding opportunities for clusters, companies and R&D institutions, and support at least a part of the relevant value chains.

Bulgaria currently supports an innovation-driven economy through:

- The Operational Programme Enterprise and Innovations for Competitiveness 2014 – 2020. The programme is directed at the achievement of dynamic competitive development of the economy, based on the innovations, optimization of the manufacturing chains and sectors with high added value and has two priority directions of potential relevance for the bioeconomy: entrepreneurship, export and production potential as a base for accelerated growth, and green and efficient economy as a guarantee for sustainable growth.
- R&D businesses and organizations for research and knowledge dissemination are in addition also supported through the National Innovation Fund.

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Support schemes at the European Level

Horizon 2020 is the biggest EU Research and Innovation programme, structured in pillars on excellent science, industrial leadership and societal challenges. The programme supports different size of projects for European collaborative projects (new knowledge, technologies, processes, products and services) and provides funding of staff, travel and organizational costs, consumables, depreciation costs of investment in technical machinery, devices, infrastructure (funding rate between 70-100%). The programme has specific rules regarding partnerships and topics and it is not subject to state aid rules. The argumentation for this distinction is that EU funding is centrally managed by the EC and therefore not directly or indirectly under the control of Member States.

COSME, EU programme for the Competitiveness of Enterprises and SMEs offers indirect support for SMEs in facilitating access to finance, supporting internationalisation and access to markets, creating an environment favourable to competitiveness, encouraging an entrepreneurial culture. The funding rate depends on the measures (from 60% and more) and on the financing instruments.

INTERREG modalities (funding schemes) by which the EU supports cross-border infrastructure, job market integration and cultural exchange (so-called INTERREG A). The thematic priorities are comparably broad (e.g. research and innovation). However, they are pre-defined and fixed over the entire programme period (currently 2014 – 2020). Funding rules are set be the EC. The related strategy and scope of the calls cannot be much influenced by the regions since the INTERREG scheme can be understood as a tool to implement macro-regional strategies. INTERREG also covers transnational cooperation in larger areas such as the Alpine Space Region aiming at territorial integration of these areas (INTERREG B). From 2014 to 2020, the EU is providing 1.39 billion euros for this type of cross-regional cooperation.

INTERREG C supports interregional cooperation between regions, but does not aim to directly support research, development and innovation.

The EUROSTARS approach supports international innovative projects led by R&D-performing SMEs. EUROSTARS is a joint programme between EUREKA and the European Commission, co-funded from the national budgets of 36 participating countries and the European Commission through Horizon 2020. For the period 2014-2020, it has a total public budget of

€1.14 billion. Consortium members apply in their home countries within the framework of existing national calls. Given the case that all international consortium partners receive approval from the national programme owners (or related programme management authorities), the international consortium receives funding. Under EUROSTARS, the national programmes are not aligned or synchronised.

Under the ERA-NET scheme, national authorities identify RDI areas and related programmes they wish to coordinate RDI activities mutually. The participants in these actions are therefore programme 'owners' (typically ministries) or programme 'managers' (typically funding agencies managing RDI programmes). Although invented by European member-states, the ERA-NET was well acknowledged by the EC. Involvement of the EC in the ERA-NET scheme of the European Member States has further increased over the last decade.

Under Horizon 2020, the EC contribution shifted from funding ERA-NET networks to 'topping-up' funding of single joint-calls for transnational research and innovation (prevailing activities during PF6 and FP 7) towards a more systematic contribution. ERA-NET under Horizon 2020 merged the former ERA-NET and ERA-NET Plus into a single financial instrument with the central compulsory element of implementing one substantial call with top-up funding from the EC (ERA COFUND). This was designed to increase substantially the share of funding that Member States dedicate jointly to challenge driven research and innovation agendas

The added value of ERA-NET COFUND primarily lies in strengthening transnational collaboration and building long-lasting relationships across countries, as well as achieving a critical mass of resources to address common challenges (in some cases the number of projects that the networks have been able to support has doubled because of the EC top-up funding). The ERA-NET scheme also contributes to increasing the quality of RDI activities (increased competition in research leading to higher quality and excellence). It allows countries to access complementary knowledge and/or research capacity from other countries to address specific societal challenges. It also contributes to increasing Europe’s visibility and attractiveness as an RDI location.

Business activities in Bulgaria are financed either through standard loans of commercial banks or institutions offering more favourable interest rates or issuing guarantees for bank credits.

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As of 31st of December 2019, there were 25 banks operating in Bulgaria, six of which were foreign banks' branches. The total assets of the banking system increased by 8,2% on an annual basis to the amount of BGN 114,2 billion (EUR 58,4 billion) compared to the end of 2018.

An important role in helping companies in their further developing and exporting activities has the Bulgarian Development Bank (BDB) is a financial institution 99.9%-owned by the Bulgarian state. Its main focus is to support small and medium-sized enterprises - start-ups and innovations, exporters of finished goods, manufacturing industry, extractive industries.

It is the only Bulgarian bank to provide direct financing as well as financing via other credit institutions. BDB is the best-positioned local bank to raise funds from international partners. Its subsidiaries are the National Guarantee Fund, which issues guarantees for bank loans to the non-financial sector; the Micro Financing Institution Jobs, which provide financing to SMEs and start-ups; the Capital Investments Fund as well as the BDB Leasing and BDB Factoring.

Additional support to business activities is provided by the Bulgarian Small and Medium Enterprises Promotion Agency (BSMEPA). It manages National Innovation Fund providing direct financial contributions to SMEs in a form of grants.

Additional financing options for entrepreneurs and investors in developing their projects in Bulgaria for the financial period 2014-2020 and the next period 2021-2027 are structural funds under Cohesion Fund (CF), the European Social Fund (ESF), the European Regional Development Fund (ERDF), the European Agricultural Fund for Rural Development (EAFRD), the European Maritime and Fisheries Fund (EMFF) and the Youth Employment Initiative (YEI).

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9.2 SUMMARY AND CONCLUSIONS IN RELATION TO SWOT ELEMENTS

It requires the formulation of an Action Plan that aligns and focuses on future R&D and innovation activities, cross-border collaboration. It furthermore tackles topics like raising awareness of customer markets and improving education. Transformative activities that lead to the bioeconomisation of industries are in focus since they proved to have a potential to be at the forefront of managing structural change required for reaching sustainability. The multilevel systemic approach shall also assure a critical mass of actors to be addressed under Joint Call schemes.

Bulgaria has a good potential for fostering bioeconomy, but the realisation of this potential depends on the financing. Definitely, there is a need for pilot projects in the field of bioeconomy. More Bulgarian organisations (both public and private) should be involved in partnership European projects within the EU programs supporting bioeconomy - rural development, waste to energy and new products development.

Strengths • Availability of EU funds • Establishment of Centres of Competence related to bioeconomy • Financial schemes available to entrepreneurs	**Weaknesses** • Lack of targeted bio-economy financing • Low investment activity in processing activities in the field of transitioning to bio-based alternatives • Insufficient supporting activity of financial institutions towards bioeconomy projects • Poor knowledge of public procurement procedures • Low level of trust in public institutions
Opportunities • Enhance the National funding and subsidies for fostering bioeconomy • Use of available EU funding in the field of bioeconomy	**Threats** • Reduced government funding and use of EU funds • Possible risky nature of investment • A lack of agencies providing equity and loans for bio-based initiatives

Figure 9.2-35 SWOT analysis of the Bulgarian financing sector

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Strategy for Strengthening the Role of the Agricultural sector in the Bioeconomy

Strategic plan for forest sector development (2014 – 2023) Ministry of agriculture, food and forest

NSI - statistical yearbook

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Environmental Protection Executive Agency - Report - Report "REGARDING ARTICLE 16, PARAGRAPH 2 - ORDINANCE ON THE ORDER AND MANNER OF RECOVERY OF Sludges FROM THE TREATMENT OF WASTEWATER THROUGH THEIR USE

Analysis of the condition and forecast for the type, quantities and sources of waste generated on the territory of the country, as well as for the waste that is likely to be subject to transboundary transport from or to the national territory

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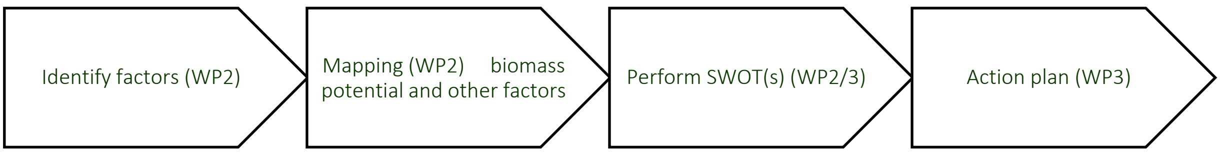
ANNEX 1 APPROACH GUIDING THE STRUCTURE AND CONTENTS OF THIS REPORT

Identification of factors that are important for establishing bio-based production chains in a country

One of the objectives of the CELEBio project is to map opportunities in the target countries for setting up bio-based business activities. This includes the mapping of the biomass feedstock potentials, and other key success factors for establishing bio-based production chains, e.g. business activities, what bio-based products can be generated, and what is the market demand of these products.

The BBI is focused on the next bio-based products and markets: Chemicals, Plastics (polymers, materials, packaging), Specialties (surfactants, lubricants, pharmaceuticals, nutraceuticals, and cosmetics), Textiles, Food ingredients and feed, Advanced biofuels.

To be able to perform SWOT(s) and generate action plans, the first step is to identify which factors are important. These factors should be determined based on the perspective of both entrepreneurs/business developers and governments. The identified factors should be mapped and will be the basis for performing a SWOT (Strength, Weakness, Opportunity and Threat) analysis for development of bio-based production chains.



Based on input from industry and business developers a logical set of factors was identified that guide the choice of investing in the bio-based economy and location of conversion plants (Van Dam et al., 2014). This set is expanded/updated (amongst others based on the BBI project BIOFOREVER (bioforever.org)). Via an interview sheet, different stakeholders (15) from different countries (the Netherlands, Croatia, Czech Republic, Hungary, and Slovenia) were asked to comment on the factors and rank them.

Highest ranked factors:

- Feedstock supply: price, security of supply, quality
- Product market: price, off-take security
- Regulations, legislation, and rule of law

Medium raked factors:

- Financing: investors, subsidies, guarantees, risk minimization options
- Taxes and Tariffs
- By-product valorization: heat, CO_2, fodder, lignin

Lowest ranked factors:

- Infrastructure: what part of the chain is already available (harbour, industries)
- Logistics: cost, reliable
- Technology: TRL, robustness, yield, CAPEX, OPEX
- Sustainability: economical, environmental, and social aspects

Overall, the ranking of the factors only differed slightly. Most of the experts mentioned that all the identified factors are important and that a system approach is key in developing bio-based initiatives. If one link in the chain is missing, the bio-based initiative will not succeed.

According the experts the most important stakeholders for establishing bio-based production chains are:

- Producers/suppliers of biomass
- Chemical industry
- Energy industry
- R&D organizations
- Regulatory authority
- Environmental organizations
- Public

ANNEX 2 EXPLANATION OF THE S2BIOM APPROACH TO ASSESSING LIGNOCELLULOSIC BIOMASS POTENTIALS FROM AGRICULTURE, FORESTRY AND WASTE

In S2BIOM project the core biomass cost supply data was generated in WP1 for 37 European countries at regional level. Lignocellulosic biomass assessed by S2BIOM includes biomass originating from the following:

- Primary residues from agriculture
- Dedicated cropping of lignocellulos biomass on agricultural area
- Wood production and primary residues from forests
- Other land use
- Secondary residues from wood industry
- Secondary residues of industry utilising agricultural products
- Waste collection/ tertiary residues

To consult and download biomass cost-supply data from the S2BIOM toolbox see: https://s2biom.wenr.wur.nl/web/guest/biomass-supply#_48_INSTANCE_nYA0VqOhoRGM_%3Dhttps%253A%252F%252Fs2biom.wenr.wur.nl%252Fbiomasscostsupplyviewer%252Findex.html%253Fclassic%2526

Data have been assessed for 2012, 2020 and 2030. They are provided for several 'potentials' including: a technical potential; a base potential considering currently applied sustainability practises; and further potential levels that are determined considering changing

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sustainability restrictions, mobilisation measures and different constraints to account for competing use.

The technical potential represents the absolute maximum amount of lignocellulosic biomass potentially available for energy use assuming the absolute minimum of technical constraints and the absolute minimum constraints by competing uses. This potential is provided to illustrate the maximum that would be available without consideration of sustainability constraints.

The base potential can be defined as the technical potential considering agreed sustainability standards for agricultural forestry and land management. The base potential is thus considered as the sustainable technical potential, considering agreed sustainability standards in CAP (Common Agricultural Policy) for agricultural farming practices and land management and in agreed (national and regional) forestry management plans for forests (equivalent to current potentials described in EFSOS II). This also includes the consideration of legal restrictions such as restrictions from management plans in protected areas and sustainability restrictions from current legislation. Further restrictions resulting from RED (Renewable Energy Directive) and CAP are considered as restrictions in the base potential as well. CAP sustainable agricultural farming practices include applying conservation of Soil Organic Carbon (SOC) (e.g. Cross Compliance issues of 'maintaining agricultural land in good farming and management condition' and avoiding soil erosion).

The user-defined potentials vary in terms of type and number of considerations per biomass type. Following the general nomenclature of potentials the user defined potentials can also be considered as sustainable technical potentials but differ in the constraints considered vs the base potential and among each other. The user can choose the type of biomass and the considerations he would like to employ and calculate the respective potential accordingly. This flexibility is meant to help the user to understand the effect on the total biomass potential of one type of consideration against the other. These can include both increased potentials (e.g. because of enhanced biomass production) or more strongly constrained potentials (e.g. because of selection of stricter sustainability constraints).

Technical, base and one user defined (UD) potential has been assessed for all biomass groups. For forest biomass many more user defined potentials were quantified. See underneath:

Table A-35 Overview of agricultural residual biomass potential types and considerations

	Area/ Basis	Yield, Growth	Technical & environmental constraints on the biomass retrieval (per area)	Consideration of competing use	Mobilisation
Technical (straw & stubbles)	Area in 2012, 2020, 2030 with cereals, rice, sunflower, rape, corn maize	Growth based on regional growing conditions & management. Yield according to regional averages including expected developments in yield towards 2020 and 2030	Maximum volume of straw and stubbles that could be harvested in 2012, 2020 and 2030	None	None
Technical (prunings permanent crops)	Area in 2012, 2020, 2030 with fruit trees, vineyards, olive & citrus	Growth based on regional growing conditions & management. Yield according to regional averages including expected developments in yield towards 2020 and 2030	Maximum volume of prunings and cuttings that could be harvested in 2012, 2020 and 2030	None	None
Technical (sugarbeet leaves & tops)	Area in 2012, 2020, 2030 with sugar beet	Growth based on regional growing conditions & management. Yield according to regional averages including expected developments in yield towards 2020 and 2030	Maximum volume of sugarbeet leaves and tops that could be harvested in 2012, 2020 and 2030	None	None
Base (straw & stubbles)	As for technical potential	As for technical potential	Only the biomass part can be removed that is not needed to keep the SOC stable. This is assessed according to carbon content that is removed with the residue and the SOC level in the soil that has to be maintained.	None	None
Base (prunings permanent crops)	As for technical potential	As for technical potential		None	None
Base (sugar beet leaves & tops)	As for technical potential	As for technical potential	Removal of leaves and tops from field is only allowed in Nitrate vulnerable zones where nitrogen surplus needs to be declined through removal of nitrogen rich biomass.	None	None
User potential (straw & stubbles)	As for technical potential	As for technical potential	As in base	In cereal straw a subtraction is applied according to demand for straw	None

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				for animal bedding & feed . For rice straw, corn stover and sunflower and rape stubbles no competing uses are assumed.	
User potential (prunings & cuttings)	As for technical potential	As for technical potential	All pruned material is available that is currently according to real practices NOT used to maintain the SOC and fertility of the soil. So the part that is now removed to the side of the field for energy uses or that is burned with & without energy recovery is seen as potential and can be removed. This follows the common treatment practices of prunings as assessed in the EUROpruning project.	None	The potential that is NOT used for SOC and fertility maintenance according to current practices needs to be mobilised gradually as it requires a change in management. It is therefore assumed; it becomes available from 50% in 2012 to 60% in 2020 and 70% in 2030.

Table A-36 Overview of woody biomass potential types used in S2BIOM

	Area/ Basis	Yield, Growth	Technical & environmental constraints on the biomass retrieval (per area)	Consideration of competing use	Mobili-sation
Technical	Forest area available for wood supply. This excludes protected and protective areas, where harvesting is not allowed according to protection purpose.	Growth based on regional to national growing conditions, including changes in biomass increment due to climate change. Yield according to regional management guidelines for age limits for thinnings and final fellings.	Maximum volume of stemwood that could be harvested annually during 50-year periods. Technical constraints on residue and stump extraction (recovery rate)	None	None
High	As for technical potential	As for technical potential	As for technical potential, but considering additional less stringent constraints (compared with base potential) for residue and stump extraction: Site productivity -Soil and water protection: ruggedness, soil depth, soil surface texture, soil compaction risk	None	None

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			-Biodiversity (protected forest areas) -Soil bearing capacity.		
Base	As for technical potential	As for technical potential	As for technical potential, but considering additional constraints for residue and stump extraction: -Site productivity -Soil and water protection: ruggedness, soil depth, soil surface texture, soil compaction risk -Biodiversity (protected forest areas) -Soil bearing capacity.	None	None
User potential - option 1	Reduction of FAWS by 5%	As for technical potential	Equivalent to increase of protected forest area by 5%.	None	None
User potential - option 2	Reduction of FAWS by 5%	As for technical potential	Increase of protected forest area by 5% and increase in retained trees by 5%.	None	Reductio n in harvest by 5%
User potential - option 3	As for technical potential	As for technical potential	No stump extraction.	None	None
User potential - option 4	Reduction of FAWS by 5%	As for technical potential	Increase in protected forest by 5% plus increase in retained trees by 5% plus no stump extraction	None	Reductio n in potential s by 5%
User potential - option 5	As for base potential	As for base potential	As for base potential	Roundwood production for material use (aggregate of FAO Production categories: Sawlogs & Veneer Logs + Pulpwood, Round & Split + Other Industrial Roundwood) in period 2010-2014) subtracted from BP.	None
User potential - option 6	As for base potential	As for base potential	As for base potential	Roundwood production for material use excl. for pulp and paper and board industry (aggregate of FAO Production categories: Sawlogs & Veneer	None

				Logs + Other Industrial Roundwood) in period 2010-2014) subtracted from UP4.	
User potential - option 7	As for user potential - option 4	As for user potential - option 4	As for user potential - option 4	Roundwood production for material use (aggregate of FAO Production categories: Sawlogs & Veneer Logs + Pulpwood, Round & Split + Other Industrial Roundwood) in period 2010-2014 subtracted from BP.	As for user potential - option 4
User potential - option 8	As for user potential - option 4	As for user potential - option 4	As for user potential - option 4	Roundwood production for material use excl. for pulp and paper and board industry (aggregate of FAO Production categories: Sawlogs & Veneer Logs + Other Industrial Roundwood in period 2010-2014) subtracted from UP4.	As for user potential - option 4

Table A-37 Overview of potentials calculated for biowaste and wood waste

Technical potential **The Technical potential represents the amount of biomass assuming only technical constraints and a minimum of constraints by competing uses.** **In case of biowaste no constraints are considered in the technical potential.** **In case of post-consumer wood, the technical potential assumes that 5% of all wood waste cannot be recovered and used for energy application for technical reasons. Competing uses (current material application of the wood) are not taken into account.**
Base potential **This is the sustainable technical potential, considering currently agreed sustainability standards.** **In case of biowaste the base potential equals the technical potential.** **In case of post-consumer wood, the base potential takes into account the current material application of recovered wood, and assumes that this material application remains constant in 2020 and 2030**
User defined potential **The user-defined potentials vary in terms of type and number of considerations per biomass type. The user can choose the type of biomass and the considerations he would like to add and**

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calculate the respective potential. This flexibility is meant to help the user to understand the effect on the total biomass potential of one type of consideration against the other.
In case of biowaste no user-defined potentials have been developed.
In case of post-consumer wood, one user-defined potential has been developed. This user defined potential on cascading use of post-consumer wood takes into account the current material application of post-consumer wood in 2012, and assumes that the material application of non-hazardous post-consumer wood will increase to 49.2% in 2020 and 61.5% in 2030, or remain stable if current (2012) material use is higher.

PRIMARY AGRICULTURAL RESIDUAL BIOMASS ASSESSMENTS

For the assessment in S2BIOM (like for Biomass Policies) land-use and livestock production levels are used based on the most recent CAPRI baseline run 2008-2050, providing intermediate results for 2010, 2020, 2030 and 2050.

The potential supply of agricultural residues was estimated for the period from 2012, 2020 and 2030. It uses as main input the cultivated land and main crop production and yield combinations made for these years by the CAPRI model. Residual biomass covered in S2BIOM from agriculture comes from primary residues from arable crops (straw and stubbles) and pruning, cutting and harvesting residues from permanent crops.

The assessment of residues from arable crops builds on methodologies and assessments already done in Biomass Policies and Bioboost. The assessment for vineyards, olive groves and fruit plantation residues bases builds on work done in EuroPruning project.

The aim of S2BIOM was to identify the part of the residues that can be removed from the field without adversely affecting the SOC content in the soil.

It is the carbon balance module in the MITERRA-Europe that has been further adapted in S2BIOM (and Biomass Policies) to take account of removal of straw (and also prunings, see next). This was done by incorporating the RothC model (Coleman and Jenkinson, 1999) into MITERRA-Europe. RothC (version 26.3) is a model of the turnover of organic carbon in non-waterlogged soils that allows for the effects of soil type, temperature, moisture content and plant cover on the turnover process. It uses a monthly time step to calculate total organic carbon (tonne C ha-1), microbial biomass carbon (tonne C ha-1) and Δ14C (from which the radiocarbon age of the soil can be calculated) on a years to centuries timescale

(Coleman and Jenkinson, 1999). For this study RothC was only used to calculate the current SOC balance based on the current carbon inputs to assess taking account of soil types (including Soil C levels) the sustainable crop residue removal rates at which the carbon C in the soil remains constant.

PRIMARY FOREST BIOMASS POTENTIAL ASSESSMENT

The potential supply of woody biomass was estimated for the period from 2012 to 2030 for stemwood; branches and harvest losses (further: 'logging residues'); and stumps and coarse roots (further: 'stumps'). First, we estimated the theoretical potential of forest biomass supply in Europe based on detailed forest inventory data. This theoretical potential was defined as the overall, maximum amount of forest biomass that could be harvested annually within fundamental bio-physical limits (adapted from Vis and Dees 2011, Dees et al. 2012), taking into account increment, the age-structure and stocking level of the forests. Second, multiple environmental and technical constraints were defined and quantified that reduce the amount of biomass that can be extracted from forests for different biomass potential types. Third, the theoretical potentials from the first step were combined with the constraints for the biomass potential types.

This sequence of steps is based on the approach developed and applied within the EUwood and EFSOS II studies (Verkerk et al. 2011; UNECE et al. 2011; Verkerk 2015). The approach in S2BIOM differs from previous studies in several ways, with the main difference being that that woody biomass potentials have been estimated using a typology of potentials developed within S2BIOM. Other changes include (i) an updated of the forest inventory data used as a basis to estimate biomass potentials; (ii) extension of the geographical scope to include all 37 S2Biom countries; (iii) improvements to set the of constraints; and (iv) improve the potential estimates at regional level by spatially disaggregating estimated biomass potentials. All improvements are described below.

The large-scale European Forest Information SCENario model was applied (EFISCEN) (Sallnäs, 1990) to assess the theoretical potential of forest biomass at regional to national level. Versions 3.1.3 (Schelhaas et al. 2007) and 4.1 (Verkerk et al. 2016a) were used because the former version is included in a script to estimated biomass potentials Verkerk et al. (2011), while the latter version has the ability to directly store results in a database, which is used to

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run the EFISCEN disaggregation tool (Verkerk et al. 2016b). EFISCEN describes the state of the forest as an area distribution over age- and volume-classes in matrices, based on data on the forest area available for wood supply (FAWS), average growing stock and net annual increment collected from NFIs. Forest development is determined by different natural processes (e.g. increment) and is influenced by human actions (e.g. management). A detailed model description is given by Schelhaas et al. (2007; 2016).

National forest inventory data on area, growing stock and net annual increment are used to initialize the EFISCEN model.

The amount of wood that can be felled in a time-step is controlled by a basic management regime that defines the period during which thinnings can take place and a minimum age for final harvest. Age-limits for thinnings and final fellings were based on conventional forest management according to handbooks at regional to national level (Nabuurs et al. 2007) and by consulting national correspondents (UNECE-FAO 2011). The amount of stemwood potential removed as logs was estimated by subtracting harvest losses from the stemwood felling potential. Harvest losses were estimated using the ratio between fellings and removals as reported by UNECE-FAO (2000) for coniferous and broadleaved species separately.

Branches together with harvest losses represent logging residues that can be potentially extracted as well. In addition, stumps could potentially be extracted, separately from logging residues. The volume of branches, stumps and coarse roots was estimated from stemwood volume (incl. harvest losses) using age-dependent, species-specific biomass distribution functions (Vilén et al., 2005; Romano et al., 2009; Mokany et al., 2006; Anderl et al. 2009). We assumed no difference in basic wood density between stems and other tree compartments, due to lack of information.

Climate change is accounted using results from LPJmL (Sitch et al. 2003, Bondeau et al. 2007). Data are an average for several climate models for the A1b SRES scenario. Annual tree Net Primary Production (NPP) in gC/m2 for 3 individual years (2010, 2020, 2030) was calculated with LPJmL and used to scale the increment functions used in EFISCEN.

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SECONDARY BIOMASS POTENTIALS FROM AGRO-FOOD INDUSTRY

For an overview of the calculation methods and assumptions of secondary biomass sources from agro-food industries see Table A-38.

Table A-38 Overview of assessment rules applied in S2BIOM to assess potentials for olive stones, rice husk, pressed grapes residues and cereal bran

Biomass type	Area / Source	Residue factor	Technical & environmental constraints
Olive-stones	CAPRI & national statistics: Area with all olive trees (table=oil olives) 2012, 2020, 2030	Olive pits make up between 10%-12.5% of the weight of olive according to Garcia et al. (2012) and Pattarra et al., (2010)	**Base=** pits from all oil olives + 30% of table olives
Rice husk	CAPRI & national statistics: Area with rice in Europe 2012, 2020, 2030	Rice husk is approximately 20% of the processed rice, with average moisture content of 10% ((Nikolaou, 2002)). It is assumed that all rice produced in the S2BIOM countries is locally processed	None
Pressed grapes residues (pressing residues & stalks)	CAPRI & national statistics: Area with vineyards in Europe 2012, 2020, 2030	Of the processed grapes 4.6% consists of dregs and 1.5% of stalks (*FABbiogas (2015)- Italian country report*)	None
Cereal bran	CAPRI total estimate of tonnes processed cereals per EU country	In wheat processing 20% to 25% wheat offals (Kent et al., 1994). Wheat bran represents roughly 50% of wheat offals and about 10 to 19% of the kernel, depending on the variety and milling process (WMC, 2008; Prikhodko et al., 2009; Hassan et al., 2008). . So the residue to yield factor used is 10% of cereals processed domestically.	None

For the calculation of the olive stonnees, rice husk and pressed grapes dregs we assumed that all domestic production would also be processed locally and that is no further processing of imported olives, rice and grapes. This implied that the residues would be available locally and that the regional distribution of the processing residues is a direct outcome of the cropping area distribution over regions in every country.

For cereal bran it is more logical to assume that the basis should be the total amount of cereals processed in every country. This implies that cereal bran needs to be calculated for a total net domestic cereal production and imports:

Domestic productioncereals – exportcereals + importcereals

The data on total domestic production, exports and imports levels were available from CAPRI for 2010 (extrapolated to 2012), 2020 and 2030 for all S2BIOM countries except for Ukraine.

To come to a regional distribution of the cereal bran potentials in every S2BIOM country 2 assumptions were made:

1) The bran based on the net domestic production (=domestic production – exports) is distributed regionally according to cereal production area share.
2) The cereal bran based on processing of imported biomass is distributed over largest (port) cities per country as it is expected that processing industries are there where imports enter the country and where population is concentrated. The residues were spatially distributed to regions with the large and medium sized cities (>100,000 inh.), every city was equally weighted.

METHOD USED TO ESTIMATE SECONDARY FOREST BIOMASS PRODUCED IN THE FOREST PROCESSING INDUSTRY

The EU-Wood study (Mantau, 2010) projects the demand for material use without considering competition with other sectors in order to explore if the increasing demand for energy will lead to a strong competitive situation where the demand substantially exceeds

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the supply. The EU-Wood project (Mantau, 2010) has aligned the prediction of the future demand to the real GDP (Gross domestic product) and thus the prediction that utilises the IPCC B2 scenario assumptions shows a strong increase (see Figure A-36).

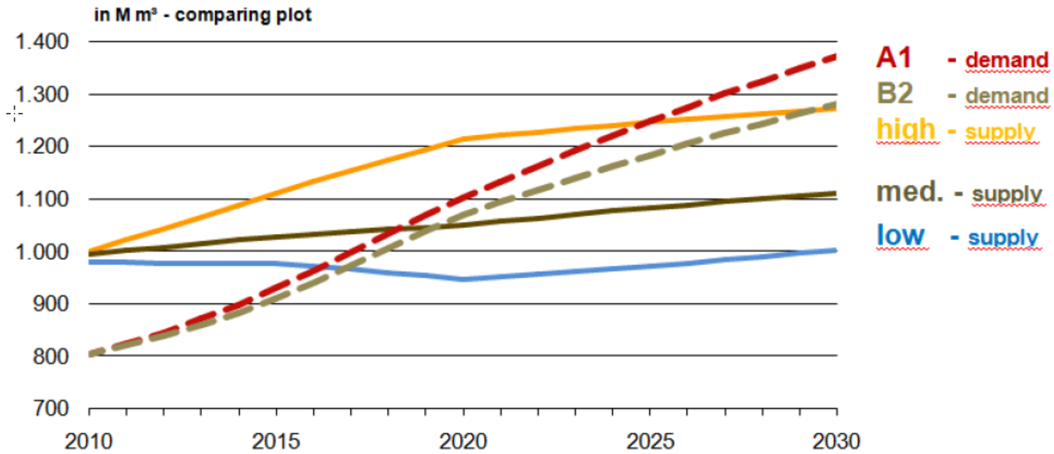

Figure A-36 Future development of demand and supply as projected by the EU-Wood project for different scenarios (Mantau, 2010)

Thus, to constrain the potentials by such demand projection would constrain the potential with strong preference to material use. The recent trends of the forest products consumption index indicate that the production has changed its relation to the GDP.

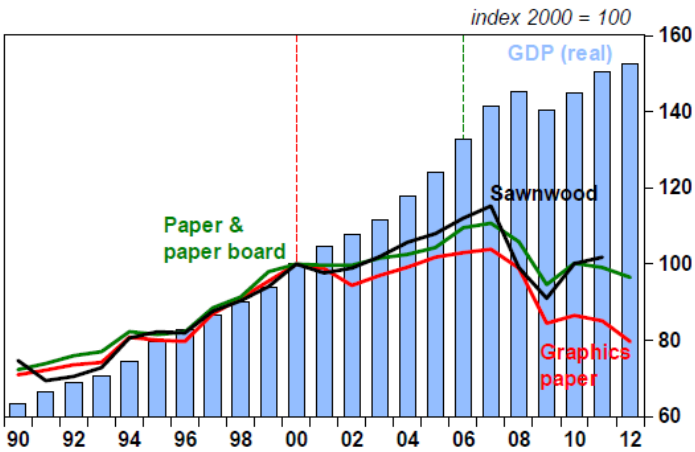

Figure 2.1.2. EU GDP (real) and forest products consumption index over the period 1990-2012 (2000 = 100). (Forest products data from FAO; GDP data from IMF, Gross domestic product based on purchasing-power-parity (PPP) valuation of country GDP).

Figure A-37 EU GDP and forest products consumption index

An alternative to use predict the future industry production results from modelling that considers economic competition. Such estimates are available from the EFSOS II study for 2010, 2020 and 2030. The trends of the EFSOS II study are utilised by S2BIOM. Figures A-38 and A-39 show for sawn wood and panels that the S2BIOM data for 2012 are close to EFSOS II reference scenario projections 2010.

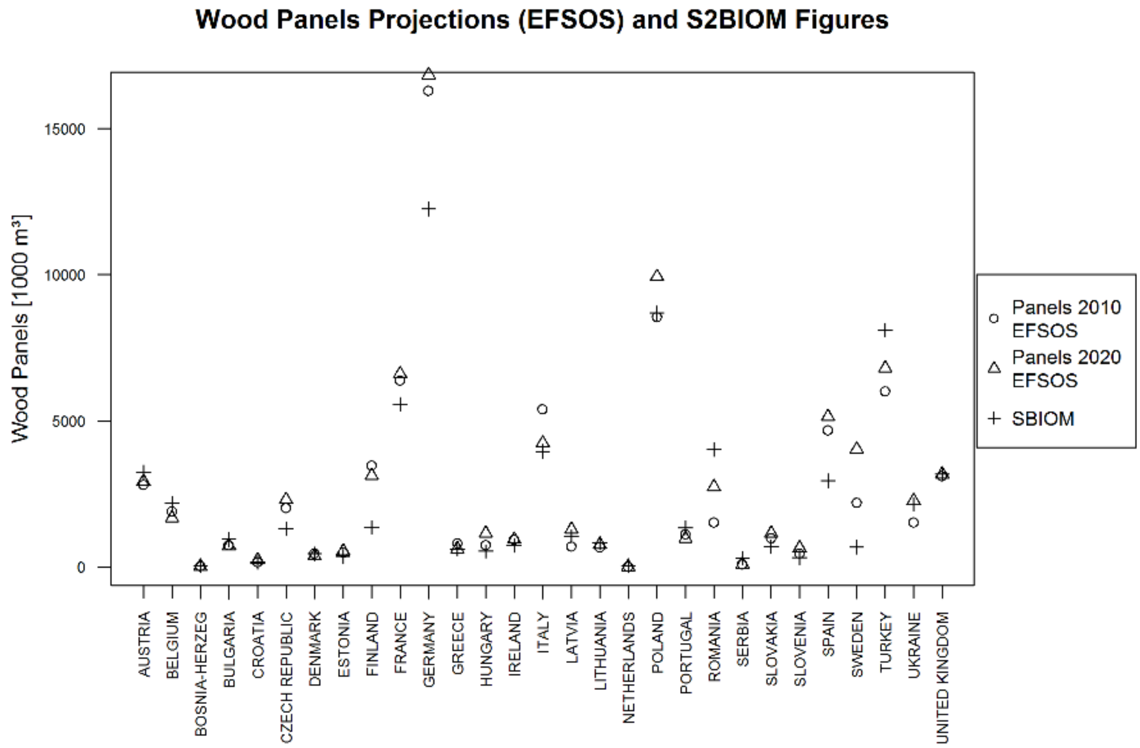

Figure A-38 Wood panel production, EFSOS 2 reference scenario projections, and S2BIOM 2012 estimates

The S2BIOM residue and production figures of the timber industry were thus projected to the years 2020 and 2030 using the growth rates of the reference scenario of the UNECE European Forest Sector Outlook Study II (EFSOS II) for sawnwood and wood based panel production.

For the pulp and paper sector there was a huge difference between S2BIOM 2012 quantities and the EFOS reference scenario projections.

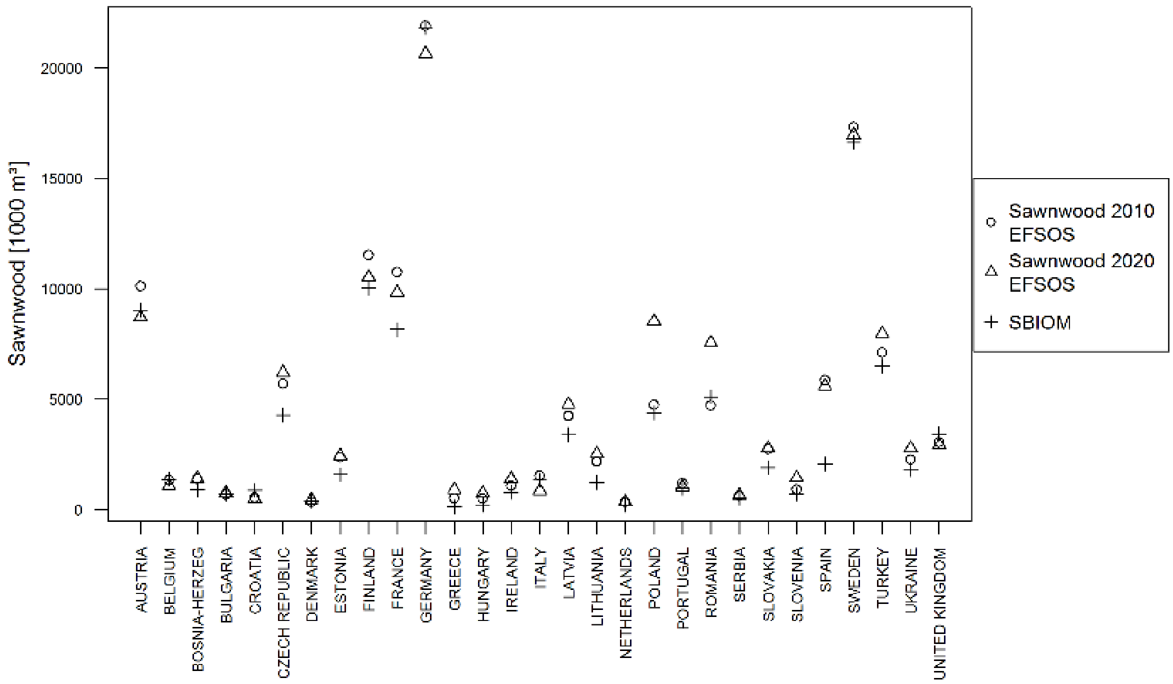

Figure A-39 Sawnwood production, EFSOS 2 reference scenario projections and S2BIOM 2012 estimates

The visualisation of the figures from the "Historic Statistics" report of CEPI on pulp and paper production are shown in Figure A-40. This figure shows the changes of pulp production for the CEPI member states which are: Austria, France, Netherlands, Romania, Sweden, Belgium, Germany, Norway, Slovak Republic United Kingdom, Czech Republic, Hungary, Poland, Slovenia, Finland, Italy, Portugal and Spain. It is for S2BIOM assumed that the changes in production after some bigger fluctuations in the past will be in 2020 and 2030 in the same dimension as in 2012. Hence the production quantities from 2012 are used for 2020 and 2030 as well.

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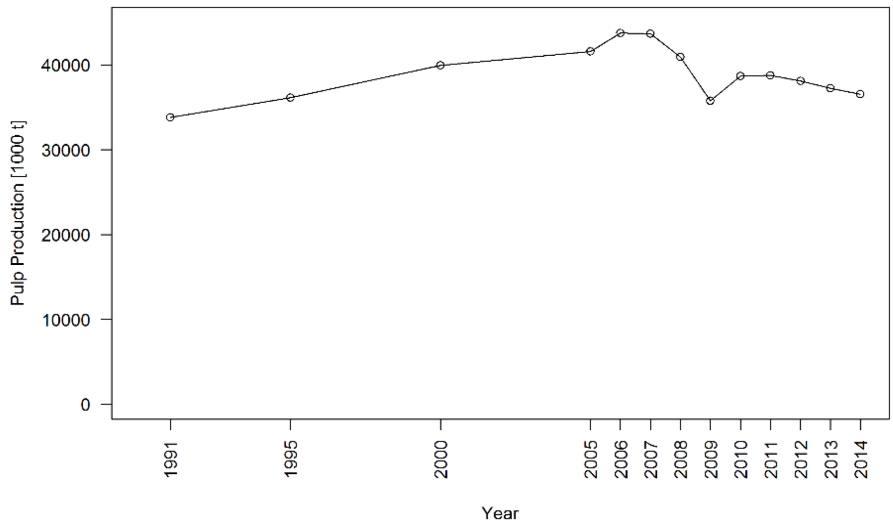

Figure A-40 Development of Pulp production, CEPI data

The approach used is summarised by category in Table A-39.

Table A-39 Approach used to estimate future production amount in the wood industry

Sector	Approach
Saw mill residues, conifers	EFSOS II sawnwood, reference scenario
Saw mill residues, non-conifers	
Residues from industries producing semi -finished wood based panels	EFSOS II wood based panels production, reference scenario
Residues from further wood processing	EFSOS II sawnwood, reference scenario
Secondary residues from pulp and paper industry	Kept constant

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Assessment of biowaste and post-consumer wood potentials

The availability of biowaste in 2012 on NUTS3 level was established as:

MSW generated per capita (kg/capita) x biowaste fraction (%)

x population of the NUTS3 area (persons).

A further distinction has been made between the separately collected biowaste and biowaste as part of mixed waste.

In Arcadis and Eunomia (2010) projections have been provided of the shares of biowaste going to the different treatment options like landfill, incineration, MBT, composting, backyard composting, anaerobic digestion and others have been made for the years 2008-2020. It has been assumed that all countries meet the requirement of the landfill directive, e.g. that maximally 35% of the amount of biodegradable waste generated in base year 1995 is landfilled in 2020, even if current developments show that diversion from landfill has not been successful yet. Furthermore, the projections are based on policy views and current changes in treatment of biowaste in the member state concerned. For instance, some countries have a strong preference for MBT, others for incineration with energy recovery. For the year 2030 the same shares between treatment options are used as in the year 2020. Currently no policies are known that influence the production of biowaste after 2030, therefore it is assumed that the projected status quo in 2020 will be maintained in 2030.

Projections on the development of the total quantity of biowaste are assumed to be proportional to population growth. The main scenario on population development from Eurostat has been used to predict the population in 2020. The calculation of the post-consumer wood potential is calculated according to the following formula:

$PCW_{technical\ potential} = PCW_{material} + PCW_{energy} + PCW_{disposed}$

$PCW_{base\ potential} = PCW_{energy} + PCW_{disposed}$

in which:

$PCW_{recovered}$ = PCW used for materials like panels and chipboards

PCW_{energy} = PCW used for energy production

$PCW_{disposed}$ = landfilled and/or incinerated with MSW.

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Eurostat gives data on "wood waste", but this includes not only post-consumer wood but processing wastes from agriculture forestry and fishing sectors. Because of this mixture of secondary wood processing and tertiary post-consumer wood within one category, Eurostat data could not be used to determine the potential of post-consumer wood. For S2BIOM, data on recovered wood were used from a forest biomass resource assessment done for the EUwood and EFSOS II studies (Mantau et al. 2010; UN-ECE/FAO 2011[2]). EUwood combines among others Eurostat and COST Action E31 data. The EFSOS II data on demolition wood is based on EU wood, but covers Europe as a whole instead of EU28. In order to determine the base potential PCW available for energy, it is necessary to estimate how much is used for material applications. In the Methodology report of the EUwood project[3], a table is given on the availability of *PCW recovered* [for material recycling] and *PCW energy* for 2007, page 119-120, which have been used in S2BIOM as well.

[2] *UNECE (United Nations Economic Commission for Europe), FAO (Food and Agricultural Organization of the United Nations) 2011: The European Forest Sector Outlook Study II; Geneva*

[3] *EU Wood (2010) Methodology report, real potential for changes in growth and use of EU forests EUwood. Call for tenders No. TREN/D2/491-2008.*

ASSESSMENT OF COST LEVELS FOR DIFFERENT BIOMASS CATEGORIES IN S2BIOM

Because we are still in the early stages of a transition of fossil based feedstock towards bio-based feedstock there is hardly any information of enough quality to conduct a meaningful market analysis. In this light it is important to keep in mind that a distinction needs to be made between different types of cost and price levels specific per biomass type:

- Market prices exist for already traded biomass types (e.g. straw, wood chips and pellets based on primary and secondary forestry residues).
- Road-side-cost for biomass for which markets are (practically) not developed yet (e.g. many agricultural and forestry residues, dedicated crops for ligno-cellulosic and woody biomass and waste streams such as vegetal waste). These may cover the following cost:
  - Production cost (in case of dedicated crops, not for residues or waste)
  - Pre-treatment in field/forest (chipping, baling)
  - Collection up to road side/farm gate
- At-gate-cost which cover the cost at roadside plus transport and pre-treatment cost of biomass until the biomass reaches the conversion plant gate (e.g. bioethanol plant, power plant).

The cost assessed in S2BIOM are limited to the **road-side cost**. So the cost from road side for transport and possible in-between treatment to the gate of the conversion installation or the pre-treatment installation are NOT included.

Cost assessment for agricultural biomass potentials

The overall methodology followed to gain insight in the minimum costs of production is the *Activity Based Costing* (ABC). It involves the whole production process of alternative production routes that can be divided in logical organisational units, i.e. activities. The general purpose of this model is to provide minimum cost prices for the primary production of biomass feedstock at the road side. ABC generates the costs of different components based on specific input and output associated with the choice of the means of production, varying with the local conditions and cost of inputs (e.g. labour, energy, fertilisers, lubricants etc.). Since the production of most biomass is spread over several years, often long term cycles in which cost are incurred continuously while harvest only takes place once in so many years, the Net Present Values (NPV) of the future costs are calculated. This provides for compensating for the time preference of money. To account for the fact that the cost are declining in different periods of time in the future the Net Present Value annuity is applied. In this way annual, perennial crops and forest biomass cost are made comparable (=all expressed in present Euros).

The costs are automatically calculated for all field operations per year in a 60-year cycle in the case of agricultural biomass. The cost of wood production were not considered in this study as these cost need to be allocated to the main product, while here the focus is on the cost of the residues. Cost are presented as NPV per annum and expressed in € per tonne dm or per GJ.

It is also important to note that the costs calculated in here are at the farm level cost. We are aware that the costs for the next link in the value chain might be higher because of rent seeking behaviour. However, in this approach we did not take account of it as we did not include a profit margin.

As explained in the former cost of agricultural biomass are calculated for *Net Present Value annuity* taking a 60 year coverage period. These 60 years are chosen to fit all possible cycles in the cost calculation as 60 is fully synchronizable to 1,3,5,10,15,20,30 and 60 years cycles. Cost differences after that period are negligible. In this way, cost for biomass from residues and from dedicated crops can be assessed with the same model and can be made comparable.

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First the Net Present Values of all activities are calculated as follows:

$NPv=Fv/(1+i)^n$

Where:

NPv = Net Present value

Fv = Future value

i = the interest rate used for discounting (set to 4%)

n = number of years to discount

Then the Net Present Value annuity is applied, assuming that the sum of NPVs cover the annual capital payments attracted against the same interest rate (4%) as the discount rate used for calculating the NPVs.

$NPVa=\Sigma NPv*(1/((1-(1+i)^{-n})/i))$

Where:

NPVa = Net Present Value annuity

ΣNPv = sum of NPVs

n = number of years

i = the interest rate (set to 4%)

The cost also allow for national differentiation of cost according to main inputs having national specific prices levels. This is organised through the **'Country inputs'** module in the ABC model. It contains detailed information concerning the prices of various resources needed as input for the production process of biomass specific per country. These are specified, either in absolute price levels or as an index related to the known price level in one or two specific countries (mostly Germany). This is necessary as prices of key production factors differ a lot at national level across Europe. National level price data (ex. VAT) included cover cost/prices for labour (skilled, unskilled and average), fuel, electricity, fertilizers (N, P2O5, K2), machinery, water, crop protection and land. Most of these data were gathered from statistical sources such as FADN (Farm Accountancy Data Network), Eurostat and OECD. Most cost levels were gathered for the year 2012.

The cost data elaboration also requires a feedstock specific approach. If cost are estimated for biomass that is specifically produced for energy or bio-based products, i.e. in the case of dedicated crops the cost structure is clear and all cost can be allocated to the final product. All cost should include the fixed and variable cost of producing the biomass including land, machinery, seeds, input costs and on field harvesting costs. If the biomass is a waste, i.e. cuttings of landscape elements or grass from road side verges, the cost could be zero, as cutting and removing these cutting is part of normal management. However, bringing the biomass to the conversion installation requires some pre-treatment costs, e.g. for drying or densifying and then transport costs have to be made to bring it to the conversion installation. These cost will not be assessed here however as we concentrate on the road side cost.

Crop residues also require a separate approach as harvesting cost can usually be allocated to the main products, i.e. grain in the case of cereal straw, and not to the residue. However, the baling of the straw and the collection up to the roadside can be included in the costs.

For the elaboration of cost levels account also needs to be taken of the local circumstances and type of systems used for the production and harvesting of the biomass. This is particularly complex in the case of dedicated crops for which cost estimates are mostly and/or only available from pilot plots and practically no commercial plantations. Costs vary strongly per type of management, soil and climate zone. Furthermore, cost need to be allocated per tonne harvested mass over the whole life-time of a plantation as harvest levels are very low in the first years and increase in time.

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The costs are determined for 2012, the reference year and are kept constant in the future years 2020 and 2030. The reason for keeping cost constant in time has several advantages:

1) Estimations of future changes in prices for (fossil) energy (fuel & electricity), labour, and machinery are difficult to predict. If predictions are used this implies automatically adding additional uncertainties in the cost assessment.
2) If cost levels do not alter in time the uses of the cost-supply data in other models in and outside S2BIOM (e.g. Resolve and BeWhere) deliver results that can only be explained from the internal logic of the models and not by differences in cost level increases based on a large number of uncertainties.
3) The cost levels presented in S2BIOM can still be further adapted by other users applying their own assumptions on future cost level changes. This enables them to use the S2BIOM cost-supply data consistently with their own modelling assumptions.

Cost assessment for forest biomass

The estimation of harvesting and comminution costs is following the approach presented earlier by Ranta (2002, 2005), Ilavský et al. (2007), Anttila et al. (2011) and Laitila et al. (2015). In contrast to the cost estimates for energy crops, the production costs are not considered in the cost estimates.

The data are mostly determined by the S2Biom project. A survey of cost factors related to forest harvesting operations was carried out in cooperation with INFRES project (Dees et al. 2015).

The methodology can be divided into two main components: 1) the estimation of hourly machine costs, and 2) the estimation of productivity. All the cost estimations pertain to current cost level (year 2012).

The general work flow is illustrated in Figure A-41.

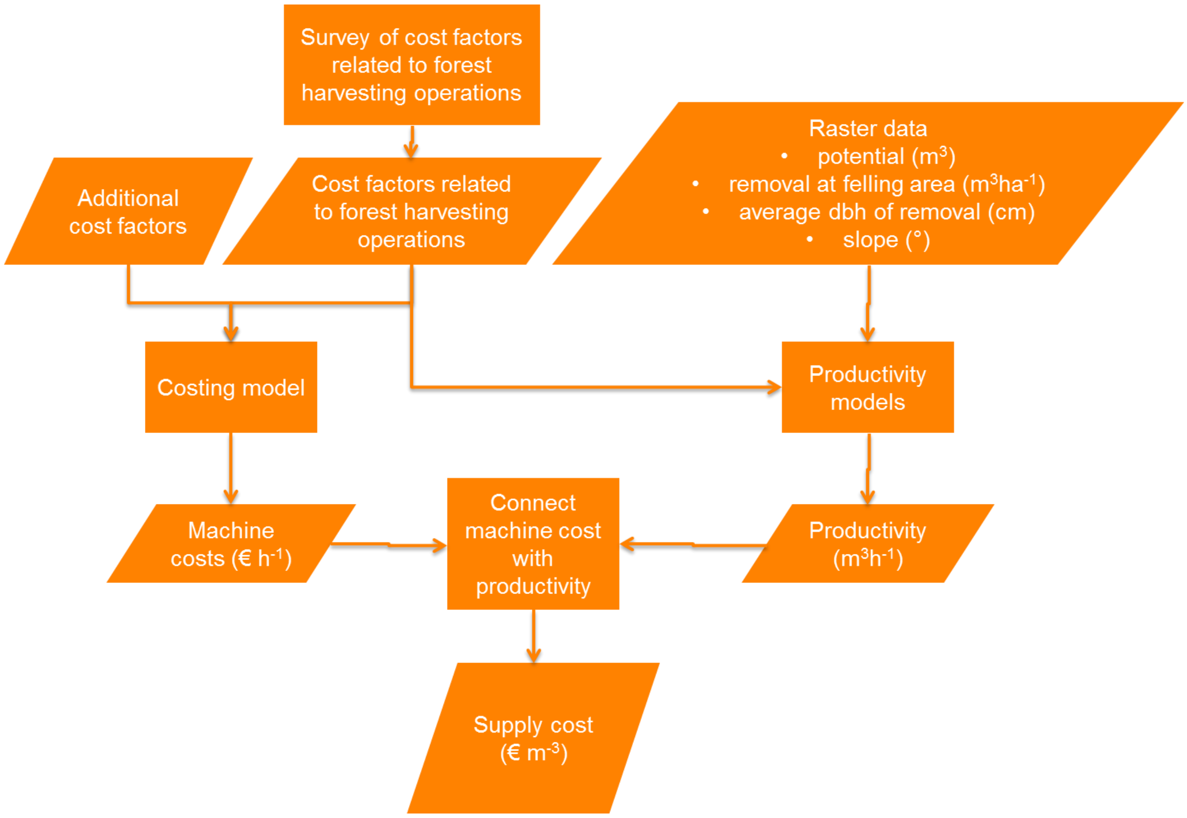

Figure A-41 General work flow of the forest biomass cost calculations

Cost estimates for biowaste and post-consumer wood

This study follows the activity-based costing approach. In principle, the costs of harvesting collection and forwarding to the roadside need to be considered. The cost to put the biowaste in a container at roadside is assumed to be zero. The cost of further collection and processing is covered by the households and organisations that need to discard the biowaste, regardless its possible further application for energy production. Waste collection and treatment is part of the public tasks and the cost for it cannot be allocated to the processor of the waste. In case of biowaste we could define the municipal collection point as "at roadside". From this municipal collection point, the municipality can select which waste treatment option is preferred, within the framework of European and national policy, considering costs and sustainability of the treatment methods.

The cost of discarding post-consumer wood in a container at roadside is regarded zero. For instance, demolition activities are performed to make space for another building, and not

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with the purpose to generate wood waste. Demolition activities will follow legal instruction, i.e. put waste wood fractions in separate containers if this is required by law. For other sources of post-consumer wood such as packaging materials or household waste a similar approach can be applied. Packaging waste is of no value to organisations. Consumers bring wooden furniture to a central collection point, or put it at roadside for pick-up, not the sake of providing energy wood. Once collected and sorted, waste wood fractions have an economic value, which can be considerable if there is sufficient demand. However, as said, S2BIOM follows an activity based costing approach, considering the costs, not the economic value of the material. The roadside cost of demolition wood is therefore assumed zero.

Annex 3 Bulgarian ports

Port Varna
Anchorage depth: 15.5m - 16m
Cargo pier depth: 4.9m - 6.1m
Oil terminal depth: 6.4m - 7.6m
Dry dock: Large
Harbour size: Large
Railway size: Large
Harbour type: Coastal Breakwater
Max size: Up to 500 feet in length
Repairs: Moderate Shelter: Good
Phone: +359 52 692232 (Open Skype)
Fax: +359 52 632953
E-mail: headoffice@port-varna.bg
Web site: http://www.port-varna.bg/

Port Burgas
Anchorage depth: 11m - 12.2m
Cargo pier depth: 6.4m - 7.6m
Oil terminal depth: 6.4m - 7.6m
Dry dock: Medium
Harbour size: Small
Railway size: Large
Harbour type: Coastal Breakwater
Max size: Up to 500 feet in length
Repairs: Limited
Shelter: Fair
Phone: +359 56 822 222 (Open Skype)
Fax: +359 56 822 156
E-mail: headoffice@port-burgas.co
Web site: http://www.port-burgas.com

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Region of operation of Branch-Territorial Directorate Lom serves the infrastructure of:

Port Terminal Lom
Berths: 13
Total Length of Berths: 1335 m
Maximum actual depth in front of Berths: 2,40 m
Opened storage area: 58 000 sq. m
Covered storage area: 8 343 sq. m
Operator Port Invest Ltd.
Address for correspondence with the Operator Port Invest Ltd:
7000 Ruse
2 Otetz Paisii Sq.
Phone/Fax: 082 825 101
E-mail: portinvest@brp.bg

Port Terminal Oryahovo
Berths: 3
Total Length of Berths: 221m
Maximum actual depth in front of Berths: 2,40 m
Opened storage area: 4 400 sq. m
Covered storage area: 962 sq. m
Concessionaire Slantchev dar AD
Address for correspondence with Concessionaire Slanchev dar AD:
9000 Varna
9 Maria Luiza Blvd.
Phone: 052 605 135
Fax: 052 605 139
E-mail: octopodm@yahoo.com

Port Terminal Vidin-North
Berths: 3
Total Length of Berths: 300 m
Maximum actual depth in front of Berths: 2,40 m
Opened storage area: 10 000 sq. m
Covered storage area: 0 sq. m
Concessionaire Bulgarian River Shipping J.S. Co.
Address for correspondence with the Concessionaire Bulgarian River Shipping J.S. Co.
7000 Ruse
2 Otetz Paisii Sq
Phone: 082 833 777
Fax: 082 822 130
E-mail: main@brp.bg
Site: http://www.brp.bg/brp.html

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Port Terminal Vidin-Center
Berths: 4
Total Length of Berths: 1 440 m
Maximum actual depth in front of Berths: 2,40 m
Opened storage area: 0 sq. m
Covered storage area:0 sq. m
Operator Port Vidin EOOD
Address for correspondence with Operator Port Vidin EOOD:
3700 Vidin
1 Dunavska Str P.B.. 86
Phone: 094 600 604
Fax: 094 600 645
E-mail: port.vd@gmail.com
Site: http://portvidin-center.com/

Port Terminal Vidin-South
Berths: 2
Total Length of Berths: 208 m
Maximum actual depth in front of Berths: 2,40 m
Opened storage area: 18 000 sq. m
Covered storage area: 0 sq. m
Operator TPP Sviloza
Address for correspondence with Operator TPP Sviloza:
1202 Sofia
41 Georg Washington Str. Fl. 4
Phone: 0887 465 320
Fax: 02 631 452 71
E-mail: office@tpp-sviloza.bg

Port Terminal Ferry Complex Vidin
Berths: 1
Total Length of Berths: 40 m
Maximum actual depth in front of Berths: 2,40 m
Opened storage area: 0 sq. m
Covered storage area: 0 sq. m
Concessionaire Bulgarian River Shipping J.S. Co.
Address for correspondence with Concessionaire Bulgarian River Shipping J.S. Co.:
7000 Ruse
22 Pristanistna Str.
Phone: 082 822 133; 082 833 777 - operator
Fax: 082 822 137; 082 822 130
E-mail: main@brp.bg
Site: http://www.brp.bg/brp.html

Region of operation of Branch-Territorial Directorate Ruse serves the infrastructure of:
Port Terminal Ruse-West
Berths: 12
Total Length of Berths: 1395 m

Maximum actual depth in front of Berths: 2,50 m
Opened storage area: 27 600 sq. m
Covered storage area: 8 900 sq. m
Operator BPI Co.
Address for correspondence with Operator:
Ruse
3 Matei Stoikov Str.
E-mail: portruse@bgports.bg

Port Terminal Ruse - East - 1
Berths: 8
Total Length of Berths: 820 m
Maximum actual depth in front of Berths: 2,50 m
Opened storage area: 74 920 sq. m
Covered storage area: 660 sq. m
Operator Port Complex Ruse J.S.Co.
Address for correspondence with Operator:
22 Pristanistna Str
7000 Ruse
Phone: 082 880 935
Fax: 082 825 148
E-mail: office@port-ruse-bg.com
Site: http://www.port-ruse-bg.com

Port Terminal Ruse - East - 2
Berths: 6
Total Length of Berths: 670 m
Maximum actual depth in front of Berths: 2,50 m
Opened storage area: 49 420 sq. m
Covered storage area: 14 760 sq. m
Operator Port Complex Ruse J.S.Co.
Address for correspondence with Operator:
22 Pristanistna Str
7000 Ruse
Phone: 082 880 935
Fax: 082 825 148
E-mail: office@port-ruse-bg.com
Site: http://www.port-ruse-bg.com

Port Terminal Ruse-Center
Berths: 3
Total Length of Berths: 270 m
Maximum actual depth in front of Berths: 2,50 m
Opened storage area: 0 sq. m
Covered storage area: 0 sq m
Operator Port Complex Ruse J.S.Co.
Address for correspondence with Operator:
22 Pristanistna Str.
7000 Ruse
Phone: 082 880 935
Fax: 082 825 148
E-mail: office@port-ruse-bg.com
Site: http://www.port-ruse-bg.com

Port Terminal Svistov
Berths: 8
Total Length of Berths: 902 m
Maximum actual depth in front of Berths: 2,50 m
Opened storage area: 22 300 sq. m
Covered storage area: 6 100 sq. m
Concessionaire Dredging Fleer -Istar AD
Address for correspondence with Concessionaire:
5250 Svistov
12 Dunav Str
Phone: 0631 60 342
Fax: 0631 60 341
E-mail: dfistar@abv.bg
Site: http://www.df-istar.com

Port Terminal Silistra
Berths: 3
Total Length of Berths: 300 m
Maximum actual depth in front of Berths: 2,00 m
Opened storage area: 0 sq. m
Covered storage area: 0 sq. m
Operator Port Compex Ruse J.S.Co.
Address for correspondence with Operator:
22 Pristanistna Str
7000 Ruse
Phone: 082 880 935
Fax: 082 825 148
E-mail: office@port-ruse-bg.com
Site: http://www.port-ruse-bg.com

Port Terminal Somovit
Berths: 3
Total Length of Berths: 300 m
Maximum actual depth in front of Berths: 2,50 m
Opened storage area: 8 780 sq. m
Covered storage area: 3 375 sq. m
Concessionaire Octopod – C Ltd.
Address for correspondence:
9000 Varna
9 Maria Luiza Blvd.
Phone: 052 605134
Fax: 052 605139
E-mail: trade@octopod.eu

Ferry Terminal Nikopol
Berths: 1
Total Length of Berths: 30 m
Maximum actual depth in front of Berths: 2,50 m
Opened storage area: 0 sq. m
Covered storage area: 0 sq. m
Concessionaire
Bulgarian River Shipping J.S. Co.
Address for correspondence:
7000 Ruse
2 Otetz Paisii Sq
Phone: 082 822 133
Fax: 082 822 139
E-mail: main@brp.bg
Site: http://www.brp.bg/brp.html

Port Terminal Tutrakan
Berths: 2
Total Length of Berths: 110 m
Maximum actual depth in front of Berths: 1,00 m
Opened storage area: 2 500 sq. m
Covered storage area: 0 sq. m
Operator Port Compelx Ruse L.S. Co
Address for correspondence with Operator:
7000 Ruse
22 Pristanistna Str.
Phone: 082 880 935
Fax: 082 825 148
E-mail: office@port-ruse-bg.com
Site: http://www.port-ruse-bg.com

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Ferry Terminal Silistra
Berths: 1
Total Length of Berths: 30 m
Maximum actual depth in front of Berths: 1,10 m
Opened storage area: 0 sq. m
Covered storage area: 0 sq. m
Operator BPI Co.
Address for correspondence with Operator:
Silistra
Promishlena zona - zapad