A I.2.
Country Analysis – Bulgaria
BIO SCREEN CEE

Bio Screen CEE project

2021

Consortium

Co-financed by:

The current document “A I.2. Country Analysis” is developed by the Bio Screen CEE project co-financed by the European Climate Initiative (EUKI). EUKI is a project financing instrument by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). Its implementation is supported by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. It is the overarching goal of the EUKI to foster climate cooperation within the European Union (EU) in order to mitigate greenhouse gas emissions.

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Welcome to Bio Screen CEE

The project will advance evidence-based knowledge and policy implementation in the energy sector in Romania, Bulgaria and Hungary for preventing an increase in the demand and therefore dependency on forestry biomass for energy, especially as a result of the coal transition.

The project will do so by evaluating energy use plans and data and their deficiencies, improving the capacity and engagement of stakeholders on recommendations of alternatives to forest biomass and sustainability criteria beyond those in Renewable Energy Directive II (REDII) for achieving climate targets. These recommendations will include alternatives for pilot local municipalities with firewood dependency and will be advocated towards national policy-makers.

The project seeks to have an impact on enhancing the implementation of the EU climate and energy framework, mainly through the national transposition and implementation of REDII and the implementation and future review of the National Energy and Climate Plans.

Scope

The analysis focuses on the current use of forest biomass in Bulgaria and on modeling its future market in light of legislation (including RED II, ecodesign regulation for space heaters, waste management hierarchy) and national plans (NECPs, national forest strategies, long-term renovation strategies) based on EU level models and methodologies. The Regional Centre for Energy Policy Research (REKK) led the development of such country analyses for Bulgaria, Hungary and Romania with the contribution of WWF teams in each country. Based on the common methodological framework for analysis we developed, we present the written interpretation and quantitative results of our research in 3 country reports.

Introduction

These three country reports are designed to lay down a solid evidence base for the perception of an integrated approach to biomass energy. This we intend to use for influencing public discourse, engaging stakeholders and formulating policy recommendations. We have worked with the hope to be able to make a difference in the next update of our National Energy and Climate Plans.

The structure of the three national reports is identical. Chapter 1 works out a complete picture of forest biomass resources in our countries: we describe the current regulatory framework in charge of forestry planning, management and inspection, then we review the most relevant policy documents for goals and measures that determine the coming years. We assemble comparative forestry factsheets, review the underlying statistical methods and processes, and assess data uncertainties. In Chapter 2, we discuss the use of forest biomass for energy purposes. Current regulatory framework and policy goals are examined, and we portray the planned future of biomass energy and the role that forests might get committed to. Biomass use for energy is presented in statistical factsheets, along with the statistical methodologies and the inherent uncertainties. In Chapter 3, we provide a quantitative analysis based on our factsheets to assess supply-demand adequacy and sustainability of policy targets. By creating a computable tool for an integrated evaluation, we hope to provide understanding why a

climate policy focusing on forests exclusively as biomass resources is a one-sided approach. We conclude the report by a discussion of our findings.

Abbreviations

EC	European Commission
EU	European Union
DW	deadwood
FRL	Forest reference level
FSC	Forest Stewardship Council
GHG	Greenhouse gases
GWh	GIgawatt hours
ha	hectares
HWP	harvested wood product
LULUCF	Land use land use change and forestry
MWh	Megawatt hours
NAPCC	National Action Plan on Climate Change
NECP	National Energy and Climate Plan
RED II	Renewable Energy Directive II
RES	Renewable Energy Sources
RP	reported period
toe	tons of oil equivalent
WAM scenario	“With additional measures” scenario

1. Forest biomass resources

In this chapter, we provide a comprehensive analysis of forest biomass supply. First, we describe the relevant regulatory framework, implementation of EU common regulations and national law, with a special focus on targets and measures in the national forestry and climate policies and institutional arrangements. Then we provide comparative factsheets about forest biomass resources with explanatory notes and assessment of data uncertainties.

1. Forestry policy – Current national regulatory framework

In order to determine the condition of the resources and prepare their assessment, an inventory of the forest territories is carried out. The subject of the inventory are the forest territories, as well as the territories having the characteristics of a forest in the sense of the Forest Act. All forest territories, regardless of their ownership, are subject to inventory. This inventory is the basis for forest management planning.

Self-afforested agricultural areas are not included in the balance of forest areas. During the inventory, silvicultural assessment studies and measurements are carried out to establish the quantitative and qualitative characteristics and assessment of the forest territories, as well as of the wood and non-wood forest products. As a final result of the inventory of the forest territories, an explanatory note and a forest management map are made.

The main purpose of the inventory of forest areas is to determine the type, condition and potential of forest areas and resources. The inventory of the forest territories is carried out in accordance with the adopted administrative-territorial division of the country and the forest territorial units.

The main tasks of the inventory of forest areas are:

- creation of an up-to-date database for forest territories and resources;
- making a forestry map;
- organization of the forest territory.

The inventory of forest areas is carried out by the state. The Regional Forest Directorate, on whose territory the forest territorial unit subject to inventory is located, assigns the elaboration of the assignment.

The Director of the Regional Forest Directorate presents the terms of reference prepared for approval by the Executive Director of the Executive Forestry Agency. Before approval of the assignment by the Executive Director of the Executive Forest Agency, the same shall be adopted by an expert council. The inventory assignment shall indicate methodologies, instructions and requirements according to which other activities related to the inventory shall be performed.

The contractor of the inventory activities shall mark on the terrain the boundaries of the forest territorial unit, the departments, the seed production plantations and the protected territories. Based on the performed field research and the processed information, groups and types of forests are formed and conditional economic classes / production groups are differentiated, regardless of the functions of the forests. As a result of the field research, an electronic forest mensuration description is formed according to a template, which includes all data from the field research.

The control over the inventory is carried out by the Executive Forest Agency, its structures and specialized territorial units according to a methodology approved by an order of the Executive Director of the Executive Forest Agency, and a protocol is drawn up for the results.

The approved inventory of the forest territories and the forest management map attached to it shall be submitted on an electronic carrier to the respective municipal service of agriculture or to the respective service of geodesy, cartography and cadastre for reflection in the map of the restored property or in the cadastral map.

Regulation (EU) (995/2010 of the European Parliament and of the Council of 20 October 2010, Regulation (EU) (995/2010 of the European Parliament and of the Council of 20 October 2010 lays down the obligations of operators who place timber and timber products on the market. This Regulation counteracts the trade with illegally harvested timber and illegally harvested timber products within the EU.

Operators who place timber and timber products on the internal market for the first time shall apply a systematic approach to ensure that illegally harvested timber and products are not placed on the internal market. To that end, operators shall carry out due diligence through a system of measures and procedures to minimize the risk of placing illegally harvested timber and products on the internal market.

The due diligence system includes three elements inherent in risk management: access to information, risk assessment and limitation of identified risk. The due diligence system provides access to information on sources and suppliers of timber and timber products placed on the internal market for the first time, including appropriate information on compliance with applicable legislation: country of harvest, tree species, quantity and where appropriate, the sub-national region and the logging concession. Based on this information, operators can make a risk assessment. When a risk is identified, operators should limit that risk.

According to the Forest Act, the wood harvested outside the forest territories, before transportation, is marked with a mark - property of the municipality on whose territory the harvesting was carried out. The marking is done by an official appointed by the mayor of the municipality. Control forest marks and production marks are not assigned. The Executive Forest Agency maintains a single register of the control forest marks, and the regional forest directorates - of the production marks.

The timber is transported from a temporary warehouse, accompanied by a transport ticket. The owners and users of sites where timber is imported, processed or shipped, or persons authorized by them, issue transport tickets for the timber transported from the site.

The origin of timber and non-timber forest products from imports and from intra-community supplies to the European Union shall be proved by the documents with which the import or supply took place.

Forest certification is a voluntary tool that is implemented through the assessment and validation of forest management practices using a set of standards. Forest certification is performed by independent, non-state certification bodies. For the performed certification of the forest territory manager a certificate is issued by the certification body according to a procedure determined by it. The certificate warrants that the management of forest areas is carried out in a responsible manner, balancing the environmental, economic and social benefits.

Forest certification is a continuous process and provides:

- reliable and independent inspection by a third party of the activities for management of the forest territories and tracking of the production from the forests;
- compliance with international norms for certification accreditation and development of standards;
- application of the world-established principles for balance between the economic, ecological and social dimensions in forest management;
- equality in importance and stakeholder participation in the creation of standards;
- achieving a balance in the interests of the parties interested in the management of forest territories;

- avoiding unnecessary barriers to trade in forest products;
- the use of objective and measurable standards, adapted to local conditions;
- prevention of conflicts of interest in the certification process by the participants;
- transparency in decision-making and mandatory consultation with stakeholders in the certification process;
- continuous improvement in forest management;
- accessibility for all those wishing to apply the system and cost-effectiveness for all parties in the certification process.

In Bulgaria, forest certification is performed according to the **FSC** system. The FSC forest certification system **aims to ensure and promote cost-effective forest management, while respecting social standards and the rights of the local population, while protecting the environment.** Forest certification is a direct economic tool to ensure the sustainable use and management of forest resources.

The certification body checks the holders of FSC certificates at least once a year whether they comply with the requirements of the standard, otherwise it revokes the certificate.

The labeling of the FSC is based on a **strict control system:**

- **The wood can be traced back to the forest** from which it originates - no matter the number of units through which it passes from the forest to the store.
- All FSC certificates are issued by **independent certification bodies.**
- To sell or manufacture an FSC-certified product, a company must have a **Production Tracking Certificate (COC)** indicating that it can track the wood from purchase to resale.
- Each company with a certificate **is subject to inspection at least once a year**. It is also checked suddenly if necessary.
- Certified companies must **at all times be able to demonstrate that they store FSC wood and raw materials coming from controlled sources, separately** from other materials in production or storage.
- The use of the FSC logo is constantly monitored. Each company has its own **unique code** and the origin of the product being purchased can always be checked by anyone.

At present, in December 2020, the area of FSC-certified forest areas amounts to more than two million hectares (2,308,422 ha), which is almost 55% of all forest areas in the country.

Bulgaria is the first among the EU countries to take concrete steps to protect their old growth forests - in state forest areas covered by Natura 2000. Currently 111,000 ha are declared by order of the Minister of Agriculture as old growth forests, in which no economic activities are carried out (including logging).

1.1 Forestry policy - Goals and measures

1.1.1. National Energy and Climate Plan

This Integrated Plan is prepared in accordance with the requirements of Regulation (EU) 2018/1999 and reflects all the recommendations of the EC. The Integrated National Energy-Climate Plan defines the main goals and measures for the implementation of the national

energy and climate policies, in the context of the European legislation, principles and priorities for energy development.

For the purposes of the Integrated National Energy-Climate Plan, the impacts assessed in the National Renewable Energy Action Plan have been reviewed and updated. An analysis is performed to inform decision-makers about the potential impacts, constraints and barriers to the development of certain RES and to give an idea of how these barriers can be overcome, minimized, mitigated and managed at the governmental level. The relevant recommendations of the National Action Plan for Renewable Energy are also updated and upgraded for the purposes of the Integrated National Energy-Climate Plan.

In terms of long-term effects, there are potential mitigation / restrictive measures that can be applied during planning and operation. The important impacts that could have lasting negative effects on Natura 2000 sites, protected areas, biodiversity and natural resources during the operational period of RES are the following in terms of biomass:

- Loss of natural habitats and habitats of species; ;
- Change in the hydromorphology and supply of rivers by water flows due to deforestation of watersheds;
- Deterioration of forest ecosystems due to deforestation;
- Deterioration of soil quality and fertility due to monocultures;
- Soil erosion due to deforestation and loss of forest residues;
- Change in the ecological status of forest habitats: loss / deterioration of protected habitats and habitats of protected species;
- Depletion and deterioration of soils from unsustainable energy crops, as well as soil pollution due to the use of artificial fertilizers and pesticides;
- Destruction of natural habitats and habitats of plants and animals for the purpose of clearing pastures;
- Reduction of biodiversity and conversion of habitats important for biodiversity (pastures, meadows, swamps) into energy crops;
- Entry of non-native species;
- Deforestation of watersheds leads to changes in water resources. Maintaining the good condition of forests is an important factor for the climate, as well as for the prevention of floods and changes in water quality due to erosion processes in the watershed;
- Water is also vulnerable to climate change, through droughts and floods, and the possible impacts of forest use may exacerbate this effect;
- The use of the water surface for drinking and domestic water supply from dams and river reservoirs is in the mountainous regions of the country and the catchments of these facilities are mainly forests that need to be protected.

By 2030, gross domestic consumption of biomass and waste is expected to increase by 25% compared to 2020[1], which will be covered by both increasing primary production and imports. Although no significant change in biofuel consumption is foreseen, there will be a significant reduction in demand for conventional biofuels (from 2,207 GWh in 2020 to 1,494 GWh in 2030),

[1] BG NECP, page 254, table 58
https://ec.europa.eu/energy/sites/default/files/documents/bg_final_necp_main_en.pdf

which will be offset by increasing use. of new generation biofuels (more than triple in 2030 compared to 2020), reaching almost 1,100 Gwh.

In 2030 The WAM scenario envisages a significant increase in biomass energy production. Currently, according to energy balances, Bulgaria exports solid biomass (1,188 GWh) and imports (conventional) biofuels (750 GWh). This trend is expected to continue over the forecast period, with exports of solid biomass declining while domestic consumption increasing. Imports of conventional biofuels and next-generation biofuels are expected to increase slightly over the forecast period to meet domestic demand. Domestic production capacity is also expected to develop over the forecast period.

Also, of the total biomass in 2030, 2,589 GWh are for biofuels for the transport sector, of which 1,650 GWh are expected to be imported.

1. Table: Biomass and waste development (GWh)

	2020	**2030**
Gross domestic consumption of biomass and waste, of which	18,634	23,280
Biomas		15,072
Waste, of which		826
Biodegradable waste	438	1,000
Non-biodegradable waste	388	1,326
Biofuels, of which	2,529	2,589
Conventional	2,207	1,494
From a new generation	322	1,095
Biogas and waste gases	207	681
Total supply of biomass and waste, of which	18,634	23,280
Primary production	18,576	22,751
Net import	58	529

Sourse: (B)EST model, E3-Modelling

The biomass needed to achieve the climate and energy goals may come from untapped opportunities for the use of large amounts of biomass from agriculture, aquaculture, livestock, etc., as well as from biodegradable waste (in the period 2020 - 2030 biodegradable waste amount to 1 416 GWh), which is also in line with the principles of the Circular Economy.

Many of the identified impacts can be managed during the stage of the Environmental Assessment procedure of the Integrated National Energy-Climate Plan. Consideration of these recommendations will support the process of approving the environmental assessment (EC) of the Integrated National Energy-Climate Plan and its further implementation.

The increase in biomass for energy production raises the question of the production of these quantities and the connection with the potential of GHG emitters mainly in the forest sector, which is declining due to the declining growth rate of forests and the average age of forests.

The National Action Plan for Renewable Energy, which is in force until 2020, sets the following biomass targets:

- Increasing logging to 7 million dense m3 per year by 2020;
- Utilization of up to 50% of straw, not used until 2008, utilization of up to 90% of sunflower husks, waste product from vegetable oil production;
- Consolidation of animal farms in the next 3-5 years, which will allow the construction of profitable biogas plants;
- Increasing the production of briquettes and pellets from wood waste, which will allow automation of the management of combustion processes;
- Gradual replacement of conventional heating stoves with combustion chambers using briquettes and pellets, as their efficiency increases.

Currently, at the national level there is only one plan assessing the potential of biomass after 2020 - the National Action Plan for Forest Biomass Energy 2018-2027[2]. The results of the three approaches applied in the National Action Plan for Forest Biomass Energy 2018-2027 for analysis and evaluation of forest biomass from wood, branches and waste biomass generated by the wood processing and furniture industry, which are used in the energy sector, are presented in the following table:

2. Table: Comparative table for the quantities of timber suitable for forest biomass and their energy potential by type of approach for their determination, on average for the period 2012-2016

Approaches to assessing the potential of forest biomass	Quantities of wood for wood biomass, m3	Energy equivalent (toe) *	Energy equivalent (GWh) *
Optimistic approach	4 291 842	1 056 400	12 286
"Formal approach	4 142 877	1 038 400	12 077
Realistic approach	3 192 338	790 800	9 197
Calculated energy potential		244 300	2 841
of wood biomass waste			
generated by wood processing			
and furniture industry			

Source: National Action Plan for Energy from Forest Biomass 2018-2027

**Calculations converting toe to GWh according to 1 toe (ton of oil equivalent) + 11.63 MWh*

[2] Page 116, table 6, National Action Plan for Forest Biomass Energy 2018-2027 http://www.iag.bg/data/docs/nationalen_plan.pdf

The National Action Plan for Forest Biomass Energy 2018-2027 takes into account the amount of forest biomass equal to 15,127 GWh, following the optimistic assessment approach and adds the calculated energy potential of wood waste from the furniture industry.

Taking into account the results of the optimistic approach of the National Action Plan for Forest Biomass Energy (12,286 GWh), it is clear that this is less than the required amount of 15,989 GWh in 2020 and 19,633 GWh in 2030 according to the WAM scenario. The National Action Plan for Forest Biomass Energy notes that there is significant potential for a possible increase in the use of forests in the country to 8.5-10 million m3 of standing wood by 2020, which will represent up to 70-75% of the average annual growth of forests in the country.

This Integrated National Energy-Climate Plan recognizes this as the only and reliable source for providing the required amount of biomass. Biomass extraction will have to meet the sustainability criteria of Directive (EU) 2018/2001 in order to be taken into account in achieving the RES objectives.

The WAM scenario is achievable in the current circumstances, as the model does not rely entirely on forest biomass to provide the required amount. The model uses EU averages, taking into account the characteristics of the Bulgarian economic sectors, and considers the possibility of using the untapped potential of other biomass sources such as the biodegradable part of products, waste and residues of biological origin from agriculture (including animal and plant substances), from forestry and related industries, from fisheries and aquaculture and biodegradable fractions of waste, including industrial and municipal waste of biological origin. Biodegradable waste (biodegradable fractions of industrial and municipal waste of biological origin) is also considered to contribute to the achievement of the objectives for renewable energy sources. We believe that these resources will also meet the criteria of Directive (EU) 2018/2001.

Here the integrated approach is applicable, relying on the promotion of the circular economy and the use of biodegradable residues and waste from economic sectors, which instead of being considered waste, can be used and returned to the economy as a resource to supply the Bulgarian energy system.

The National Forest Biomass Energy Action Plan itself recognizes that potential calculations have some shortcomings in terms of environment and sustainability, such as:

- The plan recommends conducting biological and ecological studies of the felling areas in order to determine the optimal percentage for the collection of logging waste;
- The estimated significant potential for waste wood extraction may lead to some economic and environmental difficulties. In addition, the conclusion of the plan states that the comparison between the total annual growth and the actual use shows that for the period 2010-2015 the total amount of actually used (felled) timber varies from 46.8% in 2010 to 60 % in 2015 of the total annual growth. This means that if, according to the optimistic approach, 4 291 842 m3 would represent 40% to 60% of the annual growth, the doubling of the annual forest yield would represent at least 80% to 120% of the annual growth.

Such a percentage increase would run counter to the principles set out in the Strategic Framework of the Forest Biomass Energy Action Plan, where for Priority 1 - Sustainable Biomass Production as a Renewable Energy Source and for Activity 1.2.3 - Increasing utilization of wood in the country, as long as the principle of sustainability is observed, the following goal is envisaged: Sustainable increase of wood use within below the average annual growth of forests in the country.

In addition, the significant increase in biomass production indicated in the National Action Plan for Forest Biomass Energy is not confirmed as an approach and assumption in the conclusions of the National Reporting Plan for Forests, containing the reference level for the forests of Bulgaria for 2021-2025. , prepared in accordance with Art. 8 of Regulation (EU) 2018/841 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the climate and energy framework by 2030, namely: “Reduction or drastic increase in yield of forests is not expected in the next 10-15 years.

The National Reporting Plan for Forests 2019 refers to the National Strategy for Development of the Forest Sector 2013-2020, where a number of conditions and requirements reorienting the investor's interest in the use of wood biomass in areas without risk of adverse environmental effects are introduced in order to ensure the protection of sensitive areas, incl. Natura 2000 sites, recommending the following:

1) Research, analysis and assessment of the potential of the forested areas in Bulgaria from the point of view of the possibilities for energy production from wood biomass;

2) Development of a National Scheme for sustainable production and consumption of wood biomass for energy purposes, which should include the relevant sustainability criteria.

As there is no reference to the National Action Plan for Forest Biomass Energy in the National Reporting Plan for Forests, it can be concluded that the assessments of the National Action Plan for Energy from Forest Biomass are not taken into account in the National Reporting Plan for Forests, land-use change and forestry as well as point 1) above, referring to another analysis that is still expected to be developed.

Recommendation 2 above is also still expected to be implemented, assuming that it will contain and take into account the sustainability criteria of Directive (EU) 2018/2001 to assist government and investors in making easy decisions on projects and means for supply of biomass, meeting the criteria, so that the produced energy can be taken into account for the fulfillment of the objectives for RES. These sustainability criteria include the following requirements and not only:

- ***Not using biomass from***:
  - forest territories with high conservation value and other habitats and land areas of high value that protect biodiversity and maintain the functions of the ecosystem, including residual biomass;
  - biodiversity-rich forests and other afforested lands that are species-rich or have been identified as high-biodiversity forests by the relevant competent authority, unless evidence is provided that the production of this raw material does not interfere with these nature conservation objectives;
  - from protected areas and others.
- In forest management, **the principles of sustainability** are the guiding principles;
- In the NECP it is mentioned that it is necessary **to leave at least 5% dead wood in managed forests** to avoid the negative effect on biodiversity (some conservation species are highly dependent on dead wood as a habitat or nutrient substrate) and on the microclimate, including soil characteristics and the cycle of substances, but this should be the subject of a special study as prescribed in the National Action Plan for

Forest Biomass Energy; [3]

- **Plantations for rapid biomass production - also of alien and invasive species**, e.g. paulownia, which can have a negative impact on the forest ecosystem; the resilience of forests to risks related to climate change should be studied specifically together with the site in order to demonstrate that it complies with the sustainability criteria;

According to the National Forest Accounting Plan on Land Use, Land Use Change and Forestry, no significant afforestation of new areas can be expected. Therefore, the WAM scenario does not envisage an increase in forest areas for biomass production and production.

1.1.2. National Forestry Accounting Plan

Bulgaria's National Forest Accounting Plan (NFAP) has been prepared in accordance with the requirements of Regulation (EU) 2018/841 of the European Parliament and of the Council from 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land-use, land-use change and forestry in the context of climate and energy by 2030 and amending Regulation (EU) № 525/2013 and Decision № 529/2013 / EU.

According to Regulation (EU) 2018/841 of the European Parliament and of the Council, **"forest reference level"** means the estimated value, expressed in tonnes of CO2 equivalent per year, of the average annual net emissions or removals due to managed forest areas in a Member State for the periods 2021-2025 and 2026-2030 based on the criteria set out in this Regulation.

The key aspects used to calculate forest reference levels are the basic approach proposed by Forsell et al (2018), which consists of six steps:

- Stratification of managed forest lands according to predefined criteria. This stratification was applied consistently at the time of design as well as in the description of the dynamic characteristics of the forests during the reference period (2000 - 2009).
- Identification and documentation of forest management practices (FMP) for the reference period (2000-2009) from the defined forest land layers and based on defined quantifiable criteria.
- The selection of an appropriate methodology for projecting the development of carbon pools is based on available data and national data.
- Calibration of the methodology based on real data.
- Projecting the future development of anthropogenic emissions and vapors from forests for the commitment period (2021-2025).
- Calculation of the reference level as an average value of greenhouse gas emissions in 2021-2025

The first step - stratification of the managed forest lands, aims to determine the level of projection, to collect and analyze information about the characteristics of forests. The stratification distinguishes between different forest management practices. The number of different layers and their significance depends on the type of data and the chosen methodology. It is good practice to demonstrate coherence between the layers used to develop the National Greenhouse Gas Inventory (NGHGI) and those used to design the reference levels. In the national inventory of greenhouse gases in Bulgaria, forests are divided into

[3] Page 259, Integrated Energy and Climate plan of the Republic of Bulgaria 2021-2030 https://ec.europa.eu/energy/sites/default/files/documents/bg_final_necp_main_en.pdf

coniferous and deciduous. In this regard, additional stratification of forest lands has been carried out in order to reduce uncertainty and increase the accuracy of forecasts. When choosing for further stratification of forest lands, the chosen method for forecasting the dynamic characteristics of forests, the national forest statistics and the information contained in them, the type of forest systems and the origin of the plantations were taken into account.

Second step - identifying and documenting forest management practices (FMP) for the reference period. The aim is to provide a qualitative and quantitative description of the actual forest management practices during the period 2000-2009. The collected and analyzed information was used as input information for the projection model at the reference level. The information on forest management practices that is introduced in the projection model remains constant during the simulation. The forecasts for the reference level for the commitment period derive from forest management practices during the reference period.

Third step - the selection of an appropriate methodology, aims to choose a method for forecasting the future development of carbon pools in the commitment period. The chosen method must correspond to the accepted layers of forest lands and the described forest management practices that are observed at each level. As a result of the application of the projection method, the future development of the growing stock by age classes is obtained. Vegetation is a function of tree species growth and the less projected annual yield is calculated based on documented practices during the reference period. The development of the growing stock of layers is simulated by certain criteria for constant and variable parameters. For example, the total area of each layer and the amount of yield, expressed as a percentage of the plant stock, are constant parameters, while the stock grown by tree species and age class varies over time.

Fourth step - by calibrating the model, the adequacy of the selected projection method is proven. It is necessary to demonstrate consistency with the actually measured and / or documented data, as well as with the results of the national greenhouse gas inventory.

Fifth step - projection of emissions and removals. It aims to assess the future development of emissions and removals from the carbon pool during the commitment period (2021-2025). Emissions and removals are calculated on the basis of reported changes in carbon stocks. The forecast for Bulgaria is made for the following carbon pools - biomass (total below and above ground), dead wood and harvested wood products. Emissions removals from soils and waste are not included in the projections, assuming that they are in equilibrium. The projections are prepared on the basis of the chosen methodology and the main input data collected from steps 1 and 2.

Sixth step - calculation of the reference level using the results of the fifth step. The forest reference level is calculated as the 5-year average of the forecasts for the commitment period 2021-2025.

It should be noted that the described approach is used as a basis for forecasts, but a number of other principles have also been used, which include the criteria that the reference level must meet under the LULUCF Regulation - the type of inputs, the specifics of forestry and the inventory of forests in Bulgaria, etc.

The main sources of quantitative information on forests in Bulgaria are the Forest Management Plans and the reporting forms of the forest fund. Both data sources were used in the preparation of the National Forest Accounting Plan of Bulgaria. The forecasts are based on the descriptions of the forest plantations from the Forest Management Plans (dendrometric description of the forest plantations), while the documentation of the layers and the forest management practices during the reference period is based on the reporting forms.

Forest reference level for 2021-2025

In preparing the forecasts for the reference levels of forests in Bulgaria, the following assumptions were taken into account:

1. ***Impact of the expected change in climatic conditions*** - the model does not take into account the future effects of climate change when forecasting the growth and use of forests for the reporting period.

2. ***Changes in forest areas*** - despite the tendency of continuous increase of afforested areas in Bulgaria, the level of forest area is assumed not to change over time, both as an area and between layers, when determining the reference level.

3. ***Starting year of projections*** - the first projected year is 2011. This is because the input data used in the model are from the descriptive sheets of the Forest Management Plans, whose data are average for 2010.

4. ***The 2010-2020 period*** -the defined area, as well as the assumption of a given tree species to the relevant area, remain from the first forecast year until 2025. The area by strata does not change during this period. In terms of forest management practices, the same harvesting ratio as calculated asan average for the RPis applied to the biomass available for wood supply.

5. ***Harvested wood products*** - a constant ratio between solid and energy use of forest biomass is assumed as documented in the period from 2000 to 2009.

The forest reference level in Bulgaria is calculated for the following carbon pools – biomass (total above-and belowground), dead wood and HWP. Carbon stock changes in the soils and litter are not taken into account due to a lack of data and capacity to calculate carbon stock changes of these pools for land remaining in the same land use category. According to the LULUCF Regulation, emissions and removals from these pools may be disregarded if information to justify that the pool is not a source is provided. For this purpose, we reviewed the current national scientific literature on the subject of soil and litter carbon stock in forests (Zhiyanski et al, 2008, 2009,2011, 2013, 2016, Sokolovska et al., 2007, 2009 and others). The soils in Bulgaria are mostly mineral soils and are characterized by the presence of carbon accumulation processes. Natural disturbances are common for Bulgaria but at relatively small areas, where we consider that cannot cause emissions in soils in particularly high dimensions. In addition, in the forestry practice Bulgaria the soil preparation through scarification is not applied. Significant part of Bulgarian forest regenerates naturally (79%, p. 24). In support of the above, there are also scientific publications confirming that changes in the management of forest ecosystems do not cause significant changes in soil organic carbon stock.

For the calculation of emissions and removals from biomass, the results of the model simulation, regarding growing stock by strata and age classes, have been used. The results are summarized within each year into the main strata –coniferous and deciduous forests, consistent with the GHG Inventory 2018.

Dead wood is a mandatory carbon pool, which shall be reported under the LULUCF Regulation. In Bulgaria, the quantity of deadwood is not measured systematically and there is no official data (see also FAO FRA 2015). This is expected to change as in 2018 a methodology for measuring the quantity and characteristics of dead wood is adopted. In addition to data on the amount of dead wood in Bulgarian forests, there are also no data of most of the parameters that are needed to calculate the changes in carbon stock in dead wood pool.

For the calculation of the projected development of ***carbon stock changes in harvested wood products***, it is necessary to trace the carbon stock changes in the pools since 1990. When forecasting the development of the carbon stock in harvested wood products under the LULUCF Regulation, a constant ratio between the solid and energy use of forest biomass, as documented in the period 2000-2009, was applied. To estimate the annual carbon inflow to the HWP pool we follow the production approach as set out in the LULUCF Regulation.

Consistency between the forest reference level and the GHG Inventory 2018. According to Annex IV, Part A (h) "the reference level shall be consistent with greenhouse gas inventories and relevant historical data and shall be based on transparent, complete, consistent, comparable and accurate information. In particular, the model used to construct the reference level shall be able to reproduce historical data from the National Greenhouse Gas Inventory". The FRL projections are made considering consistency in methodological elements with GHG Inventory 2018. The projections on the emissions and removals are estimated by applying an identical method to the GHG Inventory. The projected FRL considers all mandatory carbon pools and non-CO2 emissions associated with wildfires.

Consistency in forest management practices and with GHG Inventory. The models used to project the development growing stock are not able to project backward. So, to check the consistency with GHG Inventory 2018 the model begins with 2000. Everything else remains the same - constant area during simulation, constant ratio of the harvest to biomass available for wood supply and dynamic age-related forest characteristics. The output of this simulation confirms that the model is adequate and able to reproduce historical data on growing stock and harvest. Regarding reproduction of historical data on growing stock it can be noticed that the model projects lower growing stock compared to the historical data. This is explained by the fact that the model uses a constant area while historically during the RP there is a sharp increase in forested area and more precisely in deciduous forests (Table 4). The increase in the area in that period is mainly due to inclusion of forest territories which were outside the forest fund before that time. In most cases it is about low productive forests which were at disposal of agricultural cooperation during communist period. Since 2000 there has been a process of inclusion of these lands into the forest fund. The model is not able to project this since we applied constant area during simulation.

3. Table: Developments of carbon pools and proposed Forest Reference Level (FRL)

C pools and gases	2021	2022	2023	2024	2025	Average
biomass	-3209.20	-2886.34	-2608.25	-2313.91	-2033.96	-2610.33
DW	-174.34	-170.89	-167.37	-163.77	-160.09	-167.29
HWP	-279.83	-291.64	-300.83	-305.83	-311.50	-297.93
Biomass burning	54.43	54.43	54.43	54.43	54.43	54.43
FRL incl. HWP	-3608.94	-3294.43	-3022.01	-2729.07	-2451.12	-3021.11
FRL excl. HWP	-3329.11	-3002.79	-2721.18	- 2423.25	-2139.62	-2723.19

1.1.3. Sustainability

The Strategic Plan for Development of the Forest Sector in the Republic of Bulgaria 2014-2023, which in practice is an action plan for the implementation of the National Strategy, sets operational objective 17 for sustainable production and consumption of biomass as a renewable energy source.

The most important strategic document at national level at the time of development of the Action Plan is the National Development Program Bulgaria 2020. The Socio-economic analysis of this framework document states that the total technical potential for renewable energy production in Bulgaria is approximately 4,500 ktoe per year. Its distribution between the different types of sources is uneven, with hydropower (~ 31%) and biomass (~ 36%) having the largest share. Attention is paid to the fact that the country has significant forest resources and developed agricultural production - sources of both solid biomass and raw materials for the production of biogas and liquid fuels.

The National Program envisages reaching 16% of energy from renewable sources in gross final energy consumption by 2020 through the use of their significant potential for their development, and creating incentives for decentralized production of energy for heating and cooling from renewable sources. Also included is the promotion of investments in technologies for production and consumption of energy from renewable sources, stimulation of the decentralized production of energy for heating and cooling from renewable sources, etc.

The National Energy Action Plan from 2010 states that "biomass is a plant with the greatest potential in Bulgaria." This plan was subsequently further developed under the Model for National Renewable Energy Action Plans as set out in Directive 2009/28 / EC of the European Parliament and of the Council and in 2012 was adopted under the name "National Action Plan for Renewable Energy". energy from VI ". It states that biomass is the most widely used energy resource in Bulgaria - mainly as wood for domestic heating in combination with coal. The document notes that in recent years the consumption of firewood has increased significantly due to rising prices of other fuels and electricity.

The Forest Act also defines the Executive Forest Agency and its control structures in connection with the use of biomass obtained from wood used for electricity produced by renewable energy sources within the meaning of the Renewable Energy Act. It should be noted that this basic law on the forest sector also introduces certain restrictions. With its changes from 2012 in Art. 213. (2) the following is regulated: "The use of unprocessed timber from the categories of large construction timber and medium construction timber - III class of assortment for production of energy from biomass is prohibited."

In the National Strategy for Development of the Forest Sector in the Republic of Bulgaria (2013-2020), one of the main goals and two of the priorities are directly related to the topic of sustainable production and consumption of biomass as a renewable energy source and the impact of forests on climate change and forest-tree biomass.

National Strategy for Development of the Forest Sector in the Republic of Bulgaria 2013 - 2020 defines measure 4.1. "Sustainable production and consumption of biomass as a renewable energy source", which aims to create conditions for the implementation of the Energy Strategy of the Republic of Bulgaria to reach 16% share of renewable energy in gross final consumption after 2020.

The Strategic Plan for Development of the Forest Sector in the Republic of Bulgaria, 2014-2020, formulates operational objective 17 for the promotion of sustainable production and consumption of biomass as a renewable energy source. To achieve this goal, the following activities are defined as follows:

- Research, analysis and assessment of the potential of the forest territories in Bulgaria regarding the possibilities for energy production from wood biomass.
- Development of a National Program for Sustainable Production and Consumption of Wood Biomass for Energy Needs, which should contain the relevant sustainability criteria.
- Development and implementation of good practices for creation and management of intensive forest crops for biomass extraction and determination of norms for residues after felling (according to the Third NAPCC 2013-2020).

The Third National Report on Bulgaria's Progress in the Promotion and Use of Energy from Renewable Energy states that the use of biomass for energy production in 2014 has increased three times and solid biomass is the most widely used renewable energy sector in the district energy and cooling energy, as its share in the consumption of energy from renewable sources in this sector is nearly 90%. As a positive trend, it is noted that the use of wood, landfill renewable and vegetable waste, which is used mainly for energy production in the sectors of Industry and Agriculture, is increasing.

In the field of renewables, a large set of strategic and planning documents have been developed. The developed documents in all cases envisage specific goals, measures, activities related to renewable energy sources, in particular to forest-wood biomass. It is noteworthy that there is a lack of public systematized and mostly up-to-date information about the available resource, as well as its territorial distribution, there is also no information that would focus the interests of potential producers, the opportunities for public-private partnerships.

In addition to the standard incentives provided for at the national level in the Energy Energy Act, there is no active implementation of local or regional policies - the set municipal measures and goals mainly concern general provisions (eg informing potential investors about the opportunities).

In general, there is a lack of up-to-date information on the implementation of the measures and objectives in the planning documents (the last National Report on the progress in the promotion and use of renewable energy is from 2013).

So far, a large number of policies, laws, regulations, etc. have been developed, but they do not specify enough the possibilities and role of forest-wood biomass for its use for energy purposes.

In the Forest Act (of March 12, 2021) in the section Management of forest territories in Art. 88, para. 5, item 2 it is written that "Not managed as a forest: plantations of tree or shrub species established for the purpose of accelerated biomass production". But in Art. 213, para 2 of the same law has a specific text, which prohibits the large assortments to be used for burning: ,, The use of unprocessed timber from the categories of large construction timber and medium construction timber - III class of assortment for energy production from biomass. "

In this regard, the Executive Forest Agency has prepared Ordinance № 6 of October 7, 2019 on the requirements and control over wood used for domestic heating. This Ordinance regulates and prohibits large assortments from being used for burning and burning wood for energy. The ordinance does not apply to combustion plants with thermal power over 0.5 MW and to combustion plants for pellets and wood briquettes.

The wood used for domestic heating must meet the following requirements:

- to be dry;

- not to be surface treated with paints, varnishes, resins and glues;
- it has not been impregnated or has undergone other chemical treatment;
- to not be mixed with other substances and materials, including textiles, plastics, tires or other petroleum products.

Control over the implementation of the ordinance for the implementation of control activities in the use of wood for domestic heating is carried out by the mayor of the municipality or persons authorized by him, and by the Regional Inspectorate of Environment and Water. When carrying out inspections on the use of wood for domestic heating, the persons and bodies referred to above may involve representatives of other competent authorities.

All timber in Bulgaria in the forest areas is harvested sustainably on the basis of forest management plans and programs, which monitor the sustainable use of resources. They plan all forestry activities, including quantities of harvested timber for a period of 10 years. Over 55% of the state forests in Bulgaria are FSC certified.

FSC certification is considered the gold standard for responsible management of forest areas and the harvested wood is sustainable. This is the main reason why FSC is the most successful forest certification system in the world in terms of brand recognition and market distinction. Product Tracking Certification (CoC certification) helps ensure that FSC products are marketed with legitimate designations and trademarks.

Operational Program "Innovation and Competitiveness" (OPIC) 2014-2020 includes support for reducing the energy intensity of the economy by increasing energy efficiency and flexibility of enterprises, and hence the country's economy in accordance with the National Energy Strategy until 2020 and the National Action Plan for Energy Efficiency 2014-2020. Businesses are supported for measures with potential for energy savings, based on energy audit, and thus their implementation is expected to contribute more than 7% of the national target for additional energy savings set in the Plan.

As a result of the implementation of the planned activities, it is expected to improve the energy efficiency of enterprises, which will lead to a decrease in energy intensity, both at the level of individual manufacturing enterprises and for the economy as a whole. Support includes investments in:

- tangible and intangible fixed assets;
- energy management systems, incl. information and communication technologies (ICT) based energy efficiency management systems;
- reuse of residual heat in industry;
- support of highly efficient micro and small cogeneration and modernization of networks, etc., which lead to increased energy efficiency in the supported enterprises.

As ancillary activities are supported those related to the use of energy from renewable sources for own consumption (electricity and heat and cooling energy). Realized energy savings, in turn, will lead to a reduction in greenhouse gas emissions.

Under various Operational Programs in order to reduce air pollution with Fine Dust Particles (PM10) from domestic heating, measures for replacement of stationary individual and multi-family household solid fuel combustion devices are financed. Measures are proposed for alternative heating of residential areas, consisting of individual houses and / or small multi-family buildings using solid fuel for heating. Eligible ideas for the measures are the commissioning of installations for the production of energy from renewable sources for the

above-mentioned buildings to meet their own energy needs, if this is technically possible and economically feasible.

The RDP finances projects with included investments for production of electricity, heat and / or cooling energy for own consumption from renewable energy sources, in case they do not exceed the required amount of energy to cover the own needs of the farm. The capacity of the installations that are subject to support must not exceed a capacity of 1 MW.

1.2 Forestry data

In this section, we discuss forestry data that determine supply of forest biomass. We rely on national forestry data sources. See Annex for a factsheet of basic forestry data of concern for our study.

1.2.1. Statistical methods and processes behind the data

The Forest Act, last updated on March 12, 2021, describes why the forest inventory is carried out. In order to establish the condition of the resources and to prepare their assessment, an inventory of the forest territories is carried out. The inventory is carried out so that the forest management maps, the forest management plans and programs and the fire protection activities can be made.

The total area of the inventoried forest territories as of 31.12.2019 amounts to 4,149,351 hectares. The inventoried areas that have acquired the characteristics of a forest on agricultural territories are 114,979 hectares. The entire inventory process is described in more detail in the **"ORDINANCE № 18 of 07.10.2015** on inventory and planning in forest areas".

> All forest territories, regardless of their ownership, are subject to inventory. The inventory of the forest territories in the separate forest territorial units is carried out every 10 years and is valid until the approval of the next one. In cases of natural disasters, an extraordinary inventory of the entire forest territorial unit or part of it may be carried out at the expense of the state budget. In separate forest territorial units or for parts of them an additional inventory may be carried out at the request and at the expense of the owner of the forest territory or of the person to whom the forest territory has been given for management. The inventory data shall be provided free of charge to the Executive Forest Agency.

Forest management plans and programs are developed for each owner, by type of ownership of the forest territories and by the forest management units formed within its borders.

The inventory of the forest territories is made on the basis of a given task. The inventory assignment shall indicate methodologies, instructions and requirements according to which other activities related to the inventory shall be performed.

On the basis of the performed field research and the processed information groups of forests, types of forests are formed and conditional economic classes / production groups are formed regardless of the functions of the forests. The Executive Director of the Executive Forest Agency approves the nomenclature and structure of the database for processing the information from the assessment descriptions.

When charging the plantations, the eye-table method is applied with an accuracy of ± 15% for the wood stock. The inventory assignment may also require the application of the full clumping method, mathematical-statistical methods and other methods based on mathematical models with an accuracy of ± 10%.

As a result of the field surveys, an electronic tax return is formed according to a sample according to an appendix (Appendix № 4), which includes all data from the field surveys, as well as:

- area of the subdivisions and its distribution by tree species in mixed plantations;
- the wood stock (with branches and without branches), the quantity by categories of wood and the average annual growth of the plantations according to the adopted method of taxation;
- stocks of standing and lying dead wood in cases when other information required in the assignment is required.

The determination of the stock per 1 ha and the whole area is done by tree species according to a given appendix (Appendix №8). For a unit of measure in determining the stock of 1 ha and the whole area, a solid cubic meter with a rounding of 1 m3 is used.

The calculation of stems and the total stock of plantations in the measurement-tabular methods of charging is performed with bit volume and assortment tables according to an appendix (Appendix № 8) or with software products adopted by an expert council of the Executive Forest Agency and approved by the Executive Director of the Executive Forest Agency.

The calculation of the stem stock of the plantations, taxed by the Bitterlich method, is performed on the established circular area of 1 ha and species height according to a given appendix (Appendix № 8).

The stock for uncultivated plantations, charged by the tabular methods, is calculated using growth tables or simplified cubing tables according to an annex (Annex № 8).

How stocks are established in the field:

1. The method of full diameter measurement shall be applied in forests with selective cutting as well as in tall mature plantations with a density of 0,1 to 0,3 irrespective of the area. Also in mature plantations with an area of up to 2 ha, regardless of their completeness, as well as in mature plantations with a larger area and fullness of valuable tree species, which due to their location in the form of long strips or other shape are not suitable for the application of another method. Measured trees are recorded in a pruning cornet (form 2). The measurement is done in degrees of thickness in 4 cm from 10 cm upwards inclusive, and for the electoral forests - from 6 cm.

In sloping terrains, the measurement is done on the upper side of the slope.

In the case of resinous pine trees, if the stem is deformed at the height of the measurement, the shoulders of the bench are placed in the intact belts. When the full diameter measurement falls into an injured area, the next higher degree of thickness than the measured one is recorded.

Bifurcated trees are measured as separate stems if the measuring point (1.30 m from the base) is above the branch point.

The stock of cultivated plantations is determined by using volume tables. .

2. In mathematical and statistical methods the following are used:

- **Test strips.** With them is determined the stock of mature high-stemmed plantations, which are not subject to full diameter measurement and for which the relascopic methods cannot be applied - there is no good visibility and / or homogeneity (Bitterlich method).

The width of the test strips is constant - 10 m. The intensity of the sample range is determined depending on the required accuracy (±) 10% and the size of the plantations, namely: from 3 to 5 ha - 20%, from 5 to 10 ha - 15% and over 10 ha - 10%.

The minimum intermediate distance between the centers of the test strips is 30 m at an intensity of 20%. At more than 20% intensity, the method is not applied due to economic disadvantage.

On steep terrain, the direction of the lane follows the direction of the horizontals. In other cases, the test strips are placed in the direction of the short side of the plantation.

The measurement data is recorded in a test strip carnet (Form 3).

The determination of the wood stock and the assortment is done as in the case of full diameter measurement.

- **The Bitterlich method** is applied to establish the tree stock in plantations with good visibility, which are not measured by other methods. According to the area of the plantation designated for measurement and its homogeneity, the number of points (relascopic test areas) and the distance between them change.
- **The method of differentiated number and size of the sample areas** is applied in the mature plantations, for which full diameter measurement is not envisaged. It is based on the laying of test sites according to a certain system and determination of the entire wood stock on the basis of the established stock in the individual test sites in accordance with the theory of probabilities and mathematical statistics. Each site must contain at least 25-30 trees.
- **The distance method** is applied in pure one-age plantations of I and II groups of homogeneity with area over 10 ha and density over 0.6 inclusive.
- **The combined method** is used to establish the wood stock of pure plantations with a density of more than 0.5 and an area of more than 2.0 ha. The essence of the method is as follows: in stereoscopic observation of aerial photographs of plantations - the object of measurement is outlined in their average representative part in terms of density (compactness) and composition. A straight line is drawn in the middle of the areas thus delineated, along which 3 to 5 circular test plots are placed on the ground at equal distances. For pure plantations of the first group of homogeneity 3 test areas are used, of the second degree - 4, of the third degree - 5 sample areas. The trial areas include 40-50 trees.

3. The tabular (measured with naked eye) methods are to measure plantations, the stock of which is not determined by another method. The stock is determined by growth or volume tables for whole stands on the basis of data on age, average height, participation of each tree species, quality and density, which are established during the measurement of the plantation and are entered in the assessment description. The determination of the average age, the average height, the average diameter and the percentage of the crown is done with direct measurements, and the other indicators - with naked eye.

4. The deciphering method of assessment is based on analytical-measuring deciphering and qualitative and quantitative characteristics of the plantations according to their image in aerial photographs. This method can be applied in the presence of special decryption equipment and correspondingly developed technology.

5. ***Other methods*** can also be used to determine the stock of plantations that do not contradict the accuracy requirements, have advantages over the methods listed so far and are specified in the terms of reference for the development of a forestry plan.

6. In poplar plantations the stock of stands is established as follows:

For mature crops - by clustering representative rows - 5 - 10% of the number of trees in the subdivision.

For young and middle-aged crops - by means of a medium sample tree, the height and diameter of the middle tree being determined by measuring 10 representative trees in two directions or by means of growth tables.

In the case of poplar crops with a severely disturbed initial afforestation scheme, the stock is established by complete pruning or by some mathematical-statistical method.

When updating and forecasting the wood stock, the current growth of the plantations is used, taking into account the completeness of the plantations at the moment and the planned activities in the future.

The methods for calculating the stocks, the volume of the assortments and the type of the tables are determined according to the method of charging adopted in the inventory assignment.

The current growth in volume of cultivated plantations shall be calculated using tables approved by the Executive Director of the Executive Forest Agency or indirectly according to the Schneider formula according to Annex № 8.

The current increase in volume when charging according to the tabular methods is calculated using growth tables or indirectly according to the Schneider formula according to Annex № 8.

Cultivation is carried out during the period from the emergence of the plantation to its maturity. They are lighting, clearing, thinning, test tubes, selection felling and felling for individual production of high quality wood.

Thinning is carried out in the period of intensive growth of trees in height in order to provide favorable conditions for their growth and improvement, and maintaining vitality, and the formation of individual mechanical stability of trees. After felling, the fullness of the plantation is not allowed to be less than 0.7.

When carrying out the clearings and the first thinnings, schematic methods of the cultivation felling can be applied once in order to technologically ensure the assimilation of the plantations. Schematic methods include cutting part of the plantation in the form of strips, clearings, corridors and rows according to a predetermined scheme. The rest of the plantation is cleaned or thinned. The area of the cut corridors and / or rows is up to 25% of the area of the plantation.

Schematic methods shall not be applied in plantations with an average height of more than 10 m, in plantations on eroded terrains, on terrains with a slope above 25 degrees, in the area of the upper forest border, in protective forest belts, as well as in plantations with low mechanical resistance. In poplar crops and other intensive crops determined by a forestry plan or forestry program, thinning may be carried out with an intensity of up to 50%.

Thinning and test tubes are performed by a combined method with a predominance of the bottom or top method. In the combined method with a predominance of the top method, trees from the upper part of the complex are cut down with advantage, which suppress, directly compete or physically hinder the trees with desired qualities. In the combined method with a

predominance of the grass method, it is advantageous to remove trees that are stunted and permanently suppressed.

The annual timber yield is estimated on the basis of the logging certification protocols and the transport tickets for the transported timber.

The Executive Forest Agency does not have a methodology for assessing illegal logging. They make analyses of illegal logging only on the basis of what they have actually established with acts for administrative violations and the cases submitted to the prosecutor's office.

Since 2005 WWF Bulgaria has published three analyses for illegal logging in the country.[4]

1.2.2. Assessment of data uncertainties

A lack of information and gaps in the gathering of forestry data leads to its uncertainty. Moreover, Bulgaria is one of the few countries in Europe that are not carrying out a national forest inventory.

The annual reports of the Executive Forest Agency in the part on forest inventory data are also not including sufficient information. There is no electronic database for the period 2000 - 2006. The data for this period is on paper but there are again gaps in it:

- For 2000 and 2001. The Executive Forest Agency does not have any information;
- Data on the total forest stock are collected every 5 years;
- Stocks for deciduous and coniferous tree species are available only for 2010 and 2015
- Annual net growth - not included in the assessment/calculation of the Agency as it is not considered a forestry term;
- Gross residue data - not collected during fellings.

4. Table: Summary reference for the missing information for the period 2000 - 2019

Data	Status	Years
Other wooded land	not collected - not part of forestry planning	2002-2019
Total growing stock in forests	not collected	2002-2009; 2011-2014; 2016-2019
Growing stock of indigenous conifers	not collected	2002-2009; 2011-2014; 2016-2019
Growing stock of non-indigenous conifers	not collected	2002-2009; 2011-2014; 2016-2019

[4] Analysis of illegal logging and effectiveness of control measures in forest territories in Bulgaria 2013-2017 https://wwfeu.awsassets.panda.org/downloads/analysis_of_illegal_logging_in_bulgaria_2013_2017.pdf

Growing stock of indigenous broadleaves (non-conifers)	not collected	2002-2009; 2011-2014; 2016-2019
Growing stock of non-indigenous broadleaves (non-conifers)	not collected	2002-2009; 2011-2019
Total annual net increment of growing stock (gross increment minus mortality)	not collected	2002-2006; 2008-2019
Losses of stock from illegal logging	not collected	2002 and 2003
Total harvested stock	not collected	2002-2006
Harvested stock from final felling/principal cutting	not collected	2018
Gross felling residues (logging residues)	not collected	2002-2018

The following weaknesses in the information provided by Executive Forestry Agency can be pointed out:

- Difficulties in covering the resources of the logging residues;
- Lack of sufficient and reliable information about the available forest resource at national level;
- Imperfection of the sources of information, incl. national statistics for determining the potential of industrial wood waste from the woodworking and furniture industry;
- Lack of an annual national balance of round timber, which will allow more correct implementation of forestry policies in Bulgaria;
- Lack of biological and ecological research in the felling areas in order to determine the optimal percentage for collection of logging waste.

All the missing data is creating difficulties for the proper planning of the maximum amount of biomass that can be harvested for energy purposes.

2. Biomass use

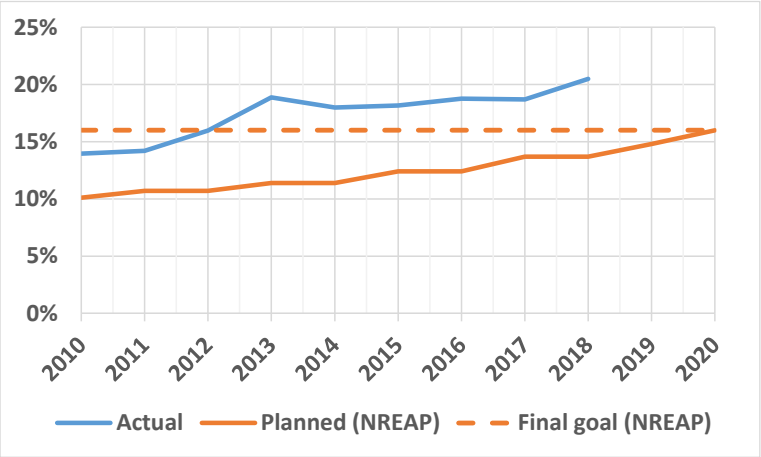
This chapter is dedicated, most importantly, to examine energy use of forest biomass and the factors that shape its prospects. Inevitably, we need to map other use categories to grasp flexibility of demand and room for substitution among wood products.

2.1. Forestry biomass use for energy – Current national regulatory framework

2.1.1. Support schemes for biomass-to-energy – power generation

Bulgaria introduced RES support scheme in 2007, providing for priority connection, Feed-in Tariffs with limited annual tariff adjustments and long-term (15-25 year) power purchase agreements (PPAs) signed with National Electricity Company (NEK) and public suppliers.[5] The generous supports triggered a boom in renewable investments: by 2012 wind and solar PV capacities increased up to 1013 and 677 MW respectively[6]. RES share increased up to 16,1% of total electricity generation/consumption as well as in gross final energy consumption in 2012, bringing the country ahead of schedule to meet its EU targets of 16% by 2020.[7]

1. Figure: Share of renewable energy sources in gross final energy consumption



Sorce: Fifth National Report on Bulgaria's progress in the promotion and use of energy from renewable sources (Republic of Bulgaria – Ministry of Energy, December 2019)

Jumping renewable electricity generation caused scarcity of transmission grid capacity, threatened the technical stability of the network[8], and resulted in sharp deterioration of the financial state of NEK „because of contractual obligations for high purchase prices and low administered selling prices" in relation to RES and CoGen producers benefiting from feed-in tariffs and the long-term contracts signed with private generators[9]. That situation (called „tariff deficit") forced the introduction of an additional „green" price element into the transmission tariff („obligation to society" fee), leading to an increase in end user tariffs, which provoked massive

[5] The support system was set forth in the Renewable and Alternative Energy Sources and Biofuels Act (RAESBA) passed following the EU accession in 2007.
[6] Eurostat
[7] Fifth National Report on Bulgaria's progress in the promotion and use of energy from renewable sources (Republic of Bulgaria – Ministry of Energy, December 2019)
[8] According to the regulator: „The significant growth of the newly connected power plants in 2012 generating RES electricity caused significant and sudden changes in the generation-consumption balance in the EPS. In order to ensure that balance a multiple curtailment, turning on and turning off of base capacities had to be performed, which in turn had influence on the respective plants effectiveness and led to deterioration of the key facilities technical characteristics." (EWRC Annual Report to the European Commission, 2014)
[9] By the end of 2013, NEK's debt reached EUR 1.2 billion (3 % of GDP) and one third of this amount consisted of liabilities to energy producers. (European Commission Directorate-General for Economic and Financial Affairs, Occasional Papers 213, Macroeconomic imbalances Country Report – Bulgaria 2015, p.52)

street demonstrations in 2013[10]. In addition to growing tensions, the achievement of targets has also contributed to the revision of the generous support system. A 2013 amendment to the Renewable Energy Act (Article 18 (2)) made it clear that "the achievement of the binding national target for 2020 constitutes grounds for discontinuation of certain previously available incentives"[11].

Bulgarian policy makers responded by various measures intended to stop further growth in renewable capacities: shortening the period of eligibility (PPAs), eliminating cap on annual downward tariff adjustment, introducing a quota system, retroactive temporary grid access fee and full balancing responsibility for RES producers, charging a fee on the revenues of PV and wind farms at the rate of 20% of their FiT, reducing the amount of energy that could be purchased at preferential FiT prices, and in 2015 it removed the feed-in tariff system for new projects above 30 kW installed capacity.[12] These interventions brought new investments to a halt: between 2012 and 2018 the total increase in wind and solar capacities was 61 MW.

The Electricity System Security Fund (ESSF) was established in 2015 in order to offer relief to the NEK and reimburse it for the electricity purchased under long-term PPAs *„by increasing existing and creating new revenue streams".* After switching from the FiTs to the premiums in 2018, the ESSF replaced NEK as a sole contracting party to the RES and cogeneration producers. The fund raises revenues from (i) 5 per cent contributions on the monthly revenues of electricity producers, importers, and network operators (electricity and gas transmission and distribution companies); (ii) from sales of EU ETS; and (iii) from the 'Obligation to Society' addition to the price of electricity paid by large-scale and small consumers.

The former support scheme relying on FiTs and PPAs was repealed in 2018: mandatory buy-out of renewable electricity by NEK was terminated for RES and CoGen producers above 4 MW (in 2019 reduced to 1 MW and in 2020 to 0,5 MW) and FiTs were replaced by fixed premiums. RES producers and CoGens must sell electricity at the Bulgarian power exchange IBEX realising the market price of electricity. The difference between the abolished FiT and the market price forecasted by the EWRC is defined as the premium, which is paid by the newly established Electricity System Security Fund (ESSF)[13]. Long-term PPAs with NEK was replaced by Contracts for Compensation with Premiums (CfCPs) signed with ESSF.[14]

New RES investment over 30 kW is not eligible for premium or feed-in tariffs: renewable project are expected to be implemented purely on a market basis. These plants are benefiting only from indirect support: (i) new RES producers are exempted from the 5% fee payable to the ESSF); (ii) consumer (industrial installation) connected by direct cable to a solar park next to it are exempted from transmission and distribution fee; (iii) supplier purchasing RES electricity from new installation is exempted from the "obligation to society fee" (close to 20 EUR/MWh).

The lack of robust support scheme would not bother Bulgarian energy policy makers: they assume that future investments into renewable energy sources will continue on market terms.

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[10] Tens of thousands join electricity protests across Bulgaria (Reuters, By Angel Krasimirov, February 17, 2013) https://www.reuters.com/article/uk-bulgaria-protests-electricity-idUKBRE91G08Q20130217

[11] Integrated Energy and Climate Plan of the Republic of Bulgaria 2021-2030 (Republic of Bulgaria – Ministry of Energy and Ministry of the Environment and Water), p.22.

[12] CMS Expert Guide to renewable energy law and regulation - Renewable energy law and regulation in Bulgaria https://cms.law/en/int/expert-guides/cms-expert-guide-to-renewable-energy/bulgaria

[13] Some sources use the acronym FSEF (Fund for Security of the Energy System)

[14] See: Anna Rizova – Radoslav Mikov (2018): RES/COGEN producers forced to the free market – amendments to the Bulgarian Energy Act and the Renewables Act repeal the RES and Co-Generation support schemes (Wolf Theiss Client Alert, April 2018). https://www.wolftheiss.com/fileadmin/content/6_news/clientAlerts/2018/V3_18_04_04_CA_EAAERS_RES_Scheme_Repeal_Sofia.PDF

Nevertheless, the NECP notes „If necessary for achieving the targets set after 2025, tenders for additional renewable energy capacity may also be conducted".

Most of the existing biomass power plants (commissioned before 2015) managed to lock into old support mechanisms through 20-year PPAs and preferential feed-in-tariff offtake of the electricity output. Until 2015 an individual tariff used to be available also for plants burning timber waste, and the FIT is updated by the energy regulator every year. For producers benefitting from old FIT regime the certificates of origin (transferred to ESSF or to the electricity distribution companies EDCs) are crucial to receive the premium component of the FIT. However, current support measures for renewable energy are limited and only available to specific types of biomass energy producers using waste from their own agricultural activities. Thus the weight of certificates of origin is none or negligible for new power plants, which sell their energy at free market prices. According to energy traders these certificates have very little value (ca. €0.25/MWh, although there is little visibility on this over-the-counter market) and are rarely traded separately from the actual electricity. SEDA expects to join a hub for certificates of origin within the EU by the end of 2021, which is expected to streamline and facilitate trading, but so far there is little trading volume in Bulgarian certificates.

The most recent and significant support measure for renewable energy was implemented only in early 2021 for plants commissioned after Jan 1. Unlike existing local energy producers, all of which are obliged to pay to ESSF 5% of their electricity sales revenues, new RES producers will not have to pay this type of fee to the Fund. There is no certification requirement in order to qualify for the exemption so the support measure creates no incentives for new producers to seek their certificates especially in a market that offers little or no additional value.

Guarantee of origin

The energy regulatory framework provides for the issuance of a guarantee of origin for each MWh of electricity produced from renewable energy sources (RES) including biomass.[15] The Energy Law and the Renewable Energy Law require that producers transfer those certificates to the electricity end-buyers or to the off-takers. RES producers with installed capacity equal or above 500 kW with long term Power Purchase Agreements (PPAs), eligible for payments of premia from the Electricity System Security Fund receive their premia payments only after transferring the guarantees of origin to the Fund.

From the perspective of energy regulation, two state bodies are responsible for issuing guarantees of origin and for administering related public registries. The Energy and Water Regulatory Commission (EWRC) issues the guarantees of origin for electricity from highly efficient co-generation, which includes district heating power plants and industrial cogeneration facilities. The Sustainable Energy Development Agency (SEDA) administers the certification process for all other renewable energy producers and maintains a registry of the certificates issued for renewable energy including biomass. SEDA inherited this function from EWRC back in 2012.

The document providing the rules for certification is Regulation № RD-16-1117 from 14.10.2011 for the issuance, transfer, revocation and acceptance of the guarantees of origin for energy from renewable sources. The information required from RE producers in the certificate application includes: name and location of the power plant, quantity of electricity and/or heat generated from renewable energy sources, type of energy source, lower heating value for biomass energy producers, type of technology and equipment, installed capacities (separately for heat and electricity), date of commissioning, period for which the energy

[15] Since 1 January 2012, the certificates of origin for renewable electricity have been replaced with guarantees of origin for renewable energy

production should be certified, invoices for the sold electricity/heat and energy metering protocols, certification issuance fee payment order. SEDA may initiate documentary or site inspections to verify information and data provided in the certificate application request. Certificate application and issuance does not require any proof of origin for the biomass sourced for energy production. No information is required on the quantities and the source of the biomass used for generation of the quantity of electricity/heat output for which a certificate is applied for.

Since taking up the certification role in 2012 SEDA has not visited physically and checked each and every electricity producer within the agency's scope. Nevertheless, according to SEDA Executive Director the agency does perform random checks of installations, and no major issues have been identified within the scope of competences of SEDA. SEDA however has no expertise and capacity to check and verify neither the sources of the biomass nor the actual ratios for installations where certain percentages of certain type of biomass need to be utilized in order for the power plant to be eligible for a specific type of feed in tariff (FIT). Compliance with FIT ratios (the ceiling for compulsory takeover) is within the monitoring scope of the energy regulator EWRC[16], which also checks renewable energy producers on ad hoc basis. Verification of origin of raw materials is within the scope of competences of the Ministry of Agriculture, Food and Forestry.

With relatively few biomass installations in the background of hundreds of photovoltaic parks and wind power generators, the use of biomass esp. of timber for electricity generation purposes is not yet recognized as a source of sustainability issues. At the same time the use of firewood by households for heating purposes contributes a large share of the country's targets for renewable energy consumption however is seen by SEDA as energy inefficient.

2.1.2. Support schemes for biomass-to-energy – heat generation

In Bulgaria, the use of renewable energy for heating and cooling is promoted through financing grants (direct loans and credit guarantees) offered by the Energy Efficiency and Renewable Sources Fund (EERSF),[17] grant assistance provided by EU Operational Programmes, and through an exemption for building owners from property tax. Eligible projects are aiming at improving the energy efficiency and supporting the use of renewable energy (refurbishment of building, fuel replacement, installation of renewable heating equipment, thermal insulation, reconstruction of heating systems etc). Annual project volume supported by EERSF in 2019 amounted to EUR 47 million. Main beneficiaries of financing grants are municipalities and corporate clients (sharing 42% and 38% respectively of financial grants offered by EERSF), other clients are hospitals, universities, government organisations, and private persons[18]. Direct loans have interest rate of 3,5-7%, credit maturity period of up to 7 years and required equity contribution of 10-25%.

Financial support provided by Operational Programmes during the 2014-2020 programming period aimed at wide rage of projects, including energy efficiency improvement, utilisation of renewable energy in buildings, and cogeneration, adding up to around EUR 10-15 million

[16] The the obligation for mandatory buy-out of renewable electricity generation is limited to the amount of "net specific generation of electricity"set out for the specific type of power plant.

[17] EERSF operates as a public private partnership established in 2005. It got initial funding from the Global Environment Fund (GEF) through the World Bank's International Bank of Reconstruction and Development (IBRD), from the Government of Bulgaria, the Government of Austria and from the Bulgarian private sector.

[18] Energy Efficiency and Renewable Sources Fund - Financial Statement 2019

annually[19]. Use of renewable energy in buildings is promoted by tax incentives: period of property tax exemptions varies between 3 and 10 years depending on the age of the building and classification of energy performance certificate.[20]

Along with the use of renewable energy resources, increasing access of households to natural gas and replacing electricity with natural gas for heating are another fixed elements of the Bulgarian energy strategies. Programme for accelerated gasification has been adopted by the government in 2011 aiming at increasing „gasification" (percentage of household consumers having access to the gas network) from 1,5% in 2010 up to 30% by 2020[21]. However ambitious this strategy is, the transition to highly efficient natural gas-fired heating systems is lagging behind schedule: by 2020 only around 4% of Bulgarian households have access to natural gas[22]. As stated by the regulatory authority in its 2016 report: „...the household gasification development is slow and rapid increase in the potential fulfilment of the network cannot be expected."[23]

The main reasons behind slow progress are high investments costs and low electricity prices. The investments of households for switching to natural gas are estimated at approximately 5000 BGN (€ 2550) according to a study, adding up to € 400 million investment requirement to connect 1 million household consumers to the gas network.[24] Depressed electricity prices are another disincentive for residential consumers to switch: final electricity price for Bulgarian households averaged at 9,8 eurocents/kWh in 2019, being the lowest in the European Union, less than half of EU average.[25]

In spite of unfulfilled ambitions, accelerated expansion of gas distribution networks and promotion of gasification of households has remained a priority for the Bulgarian government. In 2015, a project funded by the Kozloduy International Decommissioning Support Fund was launched to support the transition from carbon-intensive sources of energy to natural gas by supporting the network connection and installation of high-efficiency boilers in about 10 000 households.[26] Project DESIREE GAS (Demand Side Residential Energy Efficiency Through Gas Distribution Companies In Bulgaria) offered grants for Bulgarian households' gasification up to 30% of eligible expenditure for housing installations and the connection fee.

Household gasification gets much more attention in the new energy strategy than introduction of renewable heating technologies. The main reason behind the forced gasification is the intended improvement in energy efficiency, and the concern about air pollution caused by the use of wood and coal for heating by old, inefficient heating devices.

Poor air quality is an important element of Bulgarian energy policy considerations. In the European Environment Agency's annual reports on air quality, Bulgaria is among the worst in

[19] Source: REKK's estimate based on Fifth National Report on Bulgaria's progress in the promotion and use of energy from renewable sources (Republic of Bulgaria – Ministry of Energy, December 2019)
[20] RES Legal - http://www.res-legal.eu/search-by-country/bulgaria/single/s/res-hc/t/promotion/aid/tax-regulation-mechanism-3/lastp/111/
[21] Energy Strategy of the Republic of Bulgaria till 2020, June 2011 and https://climate-laws.org/geographies/bulgaria/policies/programme-for-accelerated-gasification-of-republic-of-bulgaria-until-2020
[22] Source: REKK's estimate based on data of National Statistical Institute and Energy and Water Regulatory Commission.
[23] Sorce: EWRC (2016): Annual Report to the European Commission
[24] Source: Ministry of Environment and Water (2012): Third National Action Plan on Climate Change for the Period 2013-2020 (p. 120-121)
[25] Source: ACER Market Monitoring Report 2019 – Energy Retail and Consumer Protection Volume (p. 19)
[26] Source: https://desireegas.bg/en/

terms of most premature deaths caused by fine particles (PM2.5) in all of Europe[27]. When compared to their total population, Bulgaria finds itself first in terms of „years of life lost" attributable to PM2.5 exposure in the EU 28.[28] Air pollution also have political consequences: after several years of (violation of EU's air quality legislation) infringement the European Commission took Bulgaria to court over poor air quality.[29]

The relationship between high exposure to fine particles and reliance on biomass in residential heating is also recognized by the National Air Pollution Control Programme:„The dominance of fine particulate matter (PM2.5) emissions in Bulgaria results from the extensive use of firewood for residential heating."[30]

Energy poverty is considered another factor/feature of Bulgarian households to be taken into account when formulating energy policy. High share of energy costs in household expenditures, arrears on energy/utility bills and inability of poor households to keep their home adequately warm are the conventional indicators of energy poverty. According to the above indicators Bulgaria is the worst performing country within the EU: depending on indicators used 30-35% of households are living in energy poverty.[31] High exposure to energy prices poses serious obstacles to policy measures to give price signals for fuel switching, and results in ad-hoc interventions aiming at mitigating fuel price increase.

The main instrument of alleviating fuel poverty is heating allowance (subsidy in cash) granted to -low-income families during the heating season (from November to March). For the 2019-2020 heating season more than 200,000 households (7-8% of the Bulgarian families) benefited from the allowance, amounting to €50 million in the course of a year (equal to the annual budget of the EERSF)[32]. As more than 90% of beneficiaries use solid fuel (coal or firewood), allowances worked against gasification: social policy concentrating on social cohesion get into conflict with energy policy aiming at decarbonisation.

Along with the gasification strategy, the National Air Pollution Control Programme introduced mandatory decommissioning (accelerated discontinuation) from 2020 to 2024 of the use of traditional polluting solid-fuel stoves and boilers. In addition to fuel switch, several standards have been introduced concerning the characteristics of solid biofuels used for heating purposes – in particular the maximum humidity in firewood, their moisture and ash content, and calorific value. Ordinance № 6/07.10.2019 impose limitations to the moisture content of firewood used in residential heating and obliges end-users to meet the requirements for storage and drying of firewood. Nevertheless, according to World Bank analysis, it „seems

[27] Among air pollutants fine particles smaller than 10 or 2.5 micrometers (PM10 and PM2.5) pose the greatest health risk, as they can get deep into lungs and some may even get into the bloodstream.
[28] European Enviromental Agency (2020): Air quality in Europe – 2020 report
[29] Bulgaria failed to ensure full compliance with the Court judgement of 5 April 2017 which found that Bulgaria had breached its obligations under the EU's ambient air quality, „systematically and continuously" exceeding limit values for PM10. Source: Air quality: Commission decides to refer BULGARIA to the Court of Justice over its failure to comply with previous judgement (European Commission Press Release, 3 December 2020)
[30] World Bank (2019): National Air Pollution Control Programme, Bulgaria 2020-2030, p.31.
[31] 40% of Bulgarian household are unable to keep their home adequately warm, and 35% of the population have equivalised income after statutory energy expenditure below the official poverty line (60% of the median household income). See: European Commission (2020): Access to essential services for low-income people: Bulgaria
[32] See: European Commission (2020): Access to essential services for low-income people: Bulgaria

unlikely to be effective as a legal instrument" as it „does not provide the controlling authorities with any practical tools to enforce the requirements for the quality of firewood"[33].

The district heating is regarded by NECP and NCCAP (National Climate Change Action Plan) as one of the best tools for energy efficiency improvement and decarbonisation of the heat sector. Modernisation and reconstruction of district heating cogeneration systems is supported by investment subsidies of European Structural Fund: cogeneration projects using biodegradable waste [and] sludges from water treatment plants[34] and a highly efficient CHP plant in Sofia relying on fuel derived from unrecyclable municipal waste have been granted support[35].

2.1.3. Certification and verification

As described in Section 2.1.1.1 of the report, the Renewable Act (Article 33-35) provides for the issuance of a guarantee of origin for each MWh of electricity produced from renewable energy sources (RES) including biomass, which is a precondition for receiving premia payments from the ESSF. Certificate application and issuance does not require any proof of origin (or a document certifying the sustainability of logging) for the biomass sourced. No information is required on the quantities and the source of the biomass used for generation of the quantity of electricity/heat output for which a certificate is applied for. The agency responsible for issuing the guarantee of origin (SEDA) has no expertise and capacity to check and verify neither the sources of the biomass or the sustainability of logging. Verification of origin of raw materials is within the scope of competences of the Ministry of Agriculture, Food and Forestry.

2.2. Biomass use for energy – the data

In this chapter we use the SEDA registry of RES certificates, data published by the EWRC and Electricity System Operator (ESO), the European Network of Transmission System Operators (ENTSOE) and National Energy Balance as of the EUROSTAT submission to draw a full picture of biomass use for energy – we focus on primary solid biomass, referring, as appropriate, to electricity and/or heat generation facilities burning biogas, biomethane and liquid biofuels.

See Appendix for the most important factsheets of biomass energy in Bulgaria.

Bulgarian statistics on the use of biomass for energy purposes give a very controversial picture of biomass-based electricity generation. On the one hand, data published by SEDA, EWRC and ESO show unchanged capacities and stagnant production. On the other hand, Eurostat data and progress reports by the Bulgarian Ministry of Energy show extraordinary increase in biomass-based electricity production.

One possible explanation for the differences is that the former institutions (SEDA, EWRC and ESO) take into account only electricity produced under the subsidy scheme, while the latter

[33] https://openknowledge.worldbank.org/bitstream/handle/10986/34145/Supporting-the-Implementation-of-Residential-Heating-Measures-in-Bulgaria-s-National-Air-Quality-Improvement-Program-NAQIP-and-National-Air-Pollution-Control-Program-NAPCP-Technical-Note.pdf?sequence=4&isAllowed=y

[34] Fifth National Report on Bulgaria's progress in the promotion and use of energy from renewable sources (Republic of Bulgaria – Ministry of Energy, December 2019)

[35] https://ec.europa.eu/commission/presscorner/detail/en/ip_19_6349

also include unsupported co-firing in coal-fired power plants. However, we cannot rule out the possibility that some data may be incorrect and unjustified.

Biomass power plants operating under the support scheme

SEDA registry of certificates contains data on total 31 biomass power plants - all but one commissioned in the period 2011-2015 and one operational since 2018. The total installed capacity of those biomass power plants is 55 MW. (see Table 1) The largest electricity generating installation, with installed capacity 17.2 MW, operates on black liquor and is part of the largest pulp and paper manufacturer in the country Mondi Stamboliiski. The majority of producers generate electricity from biogas (33.2 MW total installed capacities) using either manure or agricultural plants and plant waste.

Only one producer uses timber as energy source for electricity production. Eco Energy Management EOOD operates a timber-fired power plant in Sarnitsa, Pazardjik district, with installed capacity of 1.3 MW commissioned in October 2018. According to a protocol from a regular inspection from the Regional Inspectorate for Environment and Waters made in 2020 the authorities checked the origin of the timber waste found on the plot the power plant, which uses some 60 tons of timber per day to generate electricity. The inspection was designed to monitor compliance with the Law on Waste Control and the Law on Clean Air.

5. Table: List of biomass power plants receiving certificates from SEDA for their electricity output

Producers of electricity from biomass in Bulgaria receiving certificates of origin from SEDA

#	Company	UIN	Installation	Location	Municipality	Installed capacity MW	Energy source	Fuel Code	Date of commissioning
1	Eko Energy Management OOD	200214458	Eco Energy Surnitsa	Sarnitsa	Surnitsa	1.3	Timber	F01010302	Oct-13
2	Mondi Stamboliiski EAD	130839571	Mondi Stamboliiski	Stamboliiski	Stamboliiski	17.2	Black liquor	F01020200	Apr-12
3	Sofiiska voda AD	130175000	Wastewater treatment plant Kubratovo	Kubratovo	Sofia	3.189	Gas from wastewater treatment plant	F01030200	Jun-11
4	Sofia Municipality	000696327	Landfill gas station Suhodol	Sofia	Sofia	0.834	Landfill gas	F01030100	Jan-11
5	Biona gas OOD	202289566	Biona gas Tsalapitsa	Tsalapitsa	Rodopi	1.5	Biogas	F01030501	Jun-14
6	Komso OOD	115580058	Chernozemen	Chernozemen	Chernozemen	1.5	Biogas	F01030501	Dec-15
7	Elit 95 OOD	115206021	Elit 95 Popovitsa	Popovitsa	Sadovo	1.499	Biogas	F01030501	Jun-15
8	Aleksia 2002 OOD	131020169	Slivata	Slivata	Lom	1.499	Biogas	F01030501	Dec-13
9	D Franchise Ko - Bulgaria AD	175036036	D Franchise - Peshtera	Peshtera	Peshtera	1.487	Biogas	F01030501	Jun-14
10	Petpetuum Mobile BG AD	202009651	Momchil	Balchik	Balchik	0.999	Biogas	F01030501	Aug-13
11	Sofia Municipality	000696327	Han Bogrov	Gorni Bogrov	Sofia	0.855	Biogas	F01030501	Dec-13
12	SD Dobromir Yordanov-Ognian Iliev	835014843	Slavianovo	Slavianovo	Popovo	0.85	Biogas	F01030501	Jul-15
13	Green Forest Project AD	201418442	Green Forest	Etropole	Etropole	3.798	Biogas	F01030500	Jun-18
14	Energy 2 OOD	123655788	Gradus Nova Zagora	Nova Zagora	Nova Zagora	1.5	Biogas	F01030500	Sep-14
15	Eko Energia Dospat EOOD	200929042	Ecoenergy park Dospat - gasification and cogeneration	Barutin	Dospat	1.5	Biogas	F01030500	Dec-11
16	Bio Power Invest EOOD	203265689	Bio Power Invest	Kula	Kula	1.5	Biogas	F01030500	Jun-15
17	Nedko Nedkov-Biogas-Ovcharovo	202685067	Ovcharovo	Dobrich	Dobrich	1.499	Biogas	F01030500	Dec-15
18	Bioen -2015 OOD	203380570	Bioen - Kapitan Dimitrievo	Kapital Dimitrievo	Peshtera	1.487	Biogas	F01030500	Jun-15
19	Svikom AD	122046115	Svikom Apriltsi	Apriltsi	Pazardjik	1.487	Biogas	F01030500	Dec-15
20	Bild Invest Sit OOD	201233027	Bild Invest Sit - Trud	Trud	Maritsa	1.487	Biogas	F01030500	Mar-15
21	Eko Build Project OOD	203138236	Eko Build Project - Yambol	Yambol	Pazardjik	1.487	Biogas	F01030500	Mar-15
22	Delton OOD	202031997	Green Forest Project Suedinenie	Suedinenie	Suedinenie	1.487	Biogas	F01030500	May-14
23	Tsarevets Energy OOD	201672370	Tsarevets	Tsarevets	Mezdra	1.2	Biogas	F01030500	Jun-15
24	Malinovets Energy OOD	131016683	Malinovets	Tsarevets	Mezdra	1.2	Biogas	F01030500	Jun-15
25	Atanasov Group EOOD	124524172	Dobrich	Dobrich	Dobrich	0.8	Biogas	F01030500	Apr-14
26	Rubin 08 OOD	200333245	Rubin	Blagoevgrad	Blagoevgrad	0.5	Biogas	F01030500	Feb-12
27	Orangerii Gimel AD	175479761	Orangerii Gimel - Mokrishte	Mokrishte	Pazardjik	0.495	Biogas	F01030500	Jun-15
28	Orangerii Gimel AD	175479761	Orangerii Gimel - Zvunichevo	Zvunichevo	Barutin	0.495	Biogas	F01030500	Jun-14
29	Vladimpeks EOOD	119613687	Vladimpeks Yambol	Yambol	Yambol	0.4	Biogas	F01030500	May-14
30	ET Nenko Trifonov	201448186	Nenko Trifonov - Bania	Bania	Bania	0.4	Biogas	F01030500	Sep-15
31	Eskom OOD	128579274	Eskom Okop	Okop	Tundja	0.33	Biogas	F01030500	Jun-12
	TOTAL					**55.764**			

Source: SEDA

Energy production from timber waste is scarce despite the existence of a flourishing wood processing industry in the country and the fact that more than half of the timber waste generated in woodcutting remains unutilized. The major critical barriers for biomass energy

installations include cost of investment, quality of technology, and security of supplies of raw material (energy source). Unlike huge technology evolution and decreasing prices of equipment in the photovoltaic industry in the last decade and more moderate trends in wind power technologies, biomass energy generation technologies have advanced more slowly both in terms of technical improvements and costs. In order to make sure gas emissions from biomass equipment will be in the allowed ranges it is hard for investors to experiment with non-established less costly new technology and put the whole investment at risk. The country has seen such bad project examples including Green Forest Project in Etropole. The project was initially executed with cheaper technology but proved incompliant with emissions thresholds, so the equipment had to be changed in order for the installation to remain operational.

Security of supplies and predictable cost of raw materials presents another major hurdle for energy from biomass. According to experts from Encon Services, a major technical advisory house in Bulgaria specialized in energy, even the largest wood processing companies in the country cannot secure quantities of timber waste sufficient to operate installations larger than 100 kW. At the same time, if the raw material is not available within short distance from the installation, the transport costs of outside supplies could have substantial negative impact on the economics.

Few biomass-fueled installations that generate only heat have been commissioned in Bulgaria, some of them using timber as energy source. Most projects were implemented to meet the heat needs of their investors' main activities and play a support role rather than prove a standalone business model. One example is TEC Sviloza, an industrial cogeneration plant related to the major pulp manufacturing company Sviloza. In 2004 TEC Sviloza installed a 11 MW boiler burning timber waste to supply steam necessary for the pulp manufacturing processes. The heat generation capacity was increased to 20 MW in 2012. In the case of Sviloza the pulp production business benefits from sales of emissions allowances or savings on the cost of CO2 quotas needed for the main activities.

Two heating installations, one in Bansko and another one in Ihtiman, were commissioned relying heavily on consumption from public buildings and private end-users. Both plants went into financial troubles shortly after starting operations. Lacking a cogeneration function and sales of electricity and heat at preferential prices both projects proved unviable. After creditor banks enforced execution against the owners the two installations were temporarily operated by Veolia (owner of the district heating network in Varna), and the installation in Bankso was acquired by the municipality of Bansko.

There is no public register of heat-only generating installations - the following list of installations using biomass is based on research performed for this study and may be incomplete.

6. Table: Selected producers of heat from biomass in Bulgaria

Selected producers of heat from biomass in Bulgaria

Company	Installation	Installed heat capacity MWth	Energy source
Veolia Energy Bulgaria EAD	Heating installation Bansko	10	Timber
Veolia Energy Bulgaria EAD	Heating installation Ihtiman	3	Timber
TEC Sviloza AD	Industrial heating plant	20	Timber
Ahira		2.1	Timber
Eko Energia Dospat EOOD	Cogeneration power plant	1.33	Timber
Fazerles	Steam boiler	10	Timber
Vinprom Peshtera	Steam boiler	9.375	Timber

Without state support mechanisms and with the levels of energy prices on the free market, standalone biomass projects have remained generally unattractive so far. Even if electricity market prices follow a steady upward trend going forward, which is the general expectation for Bulgaria, biomass will compete with other renewable energy sources and technology in order to draw interest from RES investors looking to maximize returns. Large biomass installations are unlikely to materialize due to security of supply risks and higher cost of raw material in case not immediately available in the location of the power plant.

Biomass co-firing without support

According to the Bulgarian RES progress report, biomass-based electricity generation has increased nearly fourfold in the last couple of years. During the period 2017 – 2018 installed capacity for the production of electricity from biomass quadrupled „owing to the transition of existing plants from conventional fuels to biomass, reaching 195 MW in 2018…".[36] Eurostat presents similar increases of biomass-based electricity production, jumping from 0,4 TWh in 2017 up to 1,8 TWh by 2019. Taking all modes of energy production (electricity and heat generation) into account, the growth is even greater: primary solid biofuels used in the transformation sector has increased tenfold in the same period.

On the other hand, the transmission system operator (ESO) and the European Network of Transmission System Operators (ENTSOE) present totally different numbers. According to the Statistical Pocketbook of ESO and the Statistical Factsheets published by the ENTSOE, installed biomass capacity remained unchanged at 77 MW throughout the same period, generating 0,35 TWh electricity in 2019.[37] The EWRC publishes even lower numbers, below 0,1 TWh for biomass-based electricity production in 2019.[38]

The latter electricity statistics presumably only consider the production of biomass-only power plants registered by SEDA and may not be able to capture the use of biomass in conventional fossil thermal power plants. This seems to be supported by the data published in the progress report on renewable generation: according to the table 3. of the report presenting the volume of „electricity generated from renewable sources purchased at preferential prices", only 287 GWh electricity generated by biomass was purchased at preferential prices (less than one-fifth of total).[39] This suggest that several thermal power plants started co-firing biomass with lignite or coal, without applying for certificate of origin or claiming any support for the electricity produced by biomass.

Although the fact of biomass co-firing is acknowledged, we do not have precise information on the source of the biomass used in power plants. Firewood is an option, although its purchase cost may significantly exceed that of wood wastes, forestry and agricultural residues, or municipal waste containing biomass. In addition, the steady increase in firewood prices over the past 5 years does not indicate any sudden increase in demand triggered by a surge in power plant use in 2018.

Agricultural residues are an affordable and attractive alternative, but they are not yet able to replace wood due to difficulties in collection, storage and transport. Increasing biomass statistics are unlikely to be explained by the rapid increase in the use of these materials.

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[36] Fifth National Report on Bulgaria's progress in the promotion and use of energy from renewable sources (2019). The Bulgarian NECP reports the same number for biomass based electrity generation for 2018

[37] …

[38] EWRC's Annual Report to the European Commission p.19-20

[39] Fifth National Report on Bulgaria's progress in the promotion and use of energy from renewable sources (2019).

From an economic point of view, taking over and incinerating waste is considered to be the most favorable alternative. Since the recipient of the waste receives a disposal fee ("gate fee"), waste-derived fuel (WDF) can be considered a negatively priced fuel. Based on information received from Hungarian market participants, the negative price (the disposal fee paid to the recipient) of the most common grade waste, the refuse-derived fuel (RDF) may range from 20 to 50 €/tonne, depending on the composition of the waste. According to Bulgarian press informations, this could be even higher, reaching 120-150 euros excluding transport costs.[40]

In addition to the negative fuel price, waste incineration has another advantage: since the biodegradable part of the waste can be considered as a renewable energy source (biomass), the electricity generated in this way is exempted from the carbon quota obligation, providing additional revenue to the generator.

In the last years, a number of articles appeared in the Bulgarian press reporting about illegal waste imports and incineration, leading to the dismissal and prosecution of deputity environmental minister.[41] According to these reports, the Bulgarian authorities secretly allowed several coal power plants to burn huge quantities of waste, alongside coal, without the required permits. According to the letters obtained by Greenpeace, the Ministry of Enviroment allowed Bobov Dol Thermal Power Plant to burn up to 500,000 tons of waste for "experimental purposes".[42]

There are no precise and reliable information on the amount of waste co-fired in Bulgarian thermal power plants, and what proportion of the biomass consumption for energy generation purposes in the statistics can be explained by illegal waste incineration. However, it is worth noting that by burning 500,000 tons of waste, 0.3-0.6 TWh of electricity can be produced, half of which can be considered as renewable (biomass-based) electricity.[43]

Although recent scandals may hamper waste combustion, it is undoubtedly a very attractive alternative for old coal-fired power plants: according to a Polish advocacy group, "there is very strong pressure and a lucrative market for new waste combustion energy plants" in Central Eastern Europe.[44] According to Sandbag calculations, about 11 PJ of biomass co-firing can take place in Bulgaria in the next decade, part of which may come from waste.[45]

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[40] https://www.mediapool.bg/vnosat-na-bokluk-za-gorene-se-obvarzva-s-mestnite-rdf-otpadatsi-news323345.html

[41] See: „How does junk imports start in Bulgaria" (by Nikolay Stoyanov, Velina Gospodinova, 13 september 2019) https://www.capital.bg/politika_i_ikonomika/bulgaria/2019/09/13/3962426_kak_zapochva_vnosut_na_bokluci_v_bulgariia/ and „Bulgaria's deputy enviroment minister, facing criminal charges, dismissed" (by Sofia Globe, June 1. 2020) https://sofiaglobe.com/2020/06/01/bulgarias-deputy-environment-minister-facing-criminal-charges-dismissed/

[42] „Challenging Bulgarian coal plants' new waste burning obsession" (by Dominique Doyle and Janek Vähk and Meglena Antonova; March 2, 2020) https://www.euractiv.com/section/air-pollution/opinion/challenging-bulgarian-coal-plants-new-waste-burning-obsession/ and „According to the disclosed secret correspondence, Bobov Dol Thermal Power Plant burns thousands of tons of garbage" (by Greenpeace, 13th October 2020) https://cee.press.greenpeace.org/bobov-dol-burns-thousands-tons-of-garbage/

[43] According to he International Energy Agency: „If it is not possible to distinguish between renewable and non-renewable municipal solid wastes, then the total quantity should be divided equally between both categories." See: IEA (2004): Energy Satistics Manual, p. 117.

[44] „In Europe, a Backlash Is Growing Over Incinerating Garbage" (by Beth Gardiner, April 1, 2021) https://e360.yale.edu/features/in-europe-a-backlash-is-growing-over-incinerating-garbage

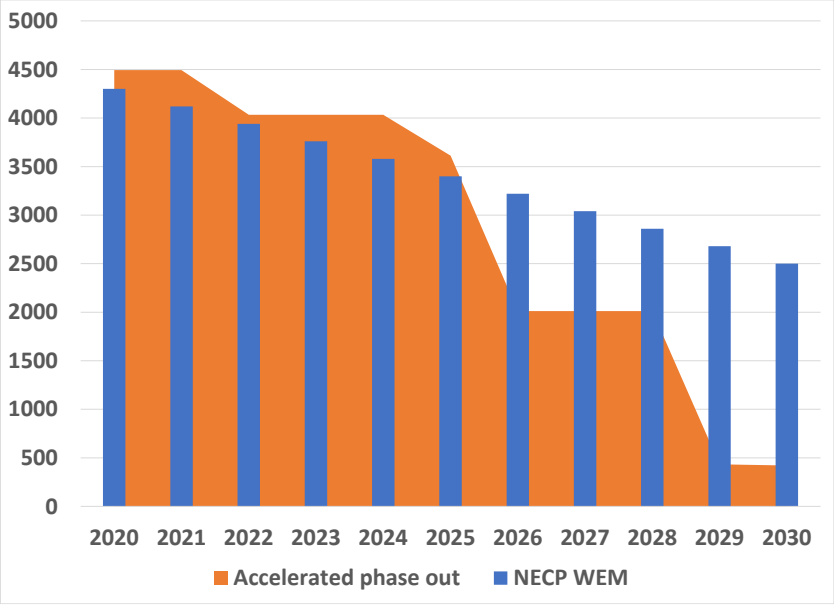
[45] EMBER (2019): Playing with fire. An assessment of company plans to burn biomass in EU coal power stations

The potential of co-firing is determined by the size of the available coal and lignite-fired power plant capacities: significant coal-fired power plant capacities would, by definition, allow more space for switching to biomass or waste. In contrast, the rapid phasing out of coal capacities would severely limit co-firing and fuel switching.

However, the future of coal capacities (and thus the potential for co-firing) is surrounded by great uncertainty. The Bulgarian energy strategy seeks to maintain coal and lignite-fired power plant capacity in the long term for security of supply reasons. Although coal-fired power plant electricity generation is expected to decrease significantly over the next decade, it will still account for over 30% of total electricity supply in 2030: according to NECP's WEM scenario (which is not significantly different from the WAM scenario), about 60% of current coal and lignite capacities (2500 MW) would still operate in 2030, leaving significant room for maneuver for the conversion of these capacities to biomass.

By contrast, the closure dates set out in the power plant operating licenses (unless the power plants concerned request an extension of the license) would result in faster dismantling of capacities, leaving barely 400 MW of operational coal-fired power plant capacity in the Bulgarian electricity system by 2030. Press reports seem to confirm the possibility of accelerated phase out: according to the Balkan Green Energy News, the "combination of measures and investments from the current version of the National Recovery and Resilience Plan may lead to a rapid coal exit in Bulgaria".[46]

2. Figure: Installed capacity of Bulgarian coal and lignite-fired power plants 2020-2030 (MW)



Source: REKK chart based on power plant operating licenses issued by the energy authority and NECP

Given that the measures envisaged in the National Recovery and Resilience Plan (e.g. replacing the 1.6 GW Maritsa East 2 coal plant with 1 GW gas fired capacity by mid 2025) are in stark contrast to those envisaged in the National Energy and Climate Plan or the draft Sustainable Energy Development Strategy (e.g. introduction of capacity mechanism to keep

[46] Bulgaria hints at possible closure of all coal-fired power plants by mid-2025 (Igor Todorovic, August 2, 2021) https://balkangreenenergynews.com/bulgaria-hints-at-possible-closure-of-all-coal-fired-power-plants-by-mid-2025/

coal fired capacities alive), it is difficult to predict the size of the future coal-fired fleet and biomass co-firing space.[47]

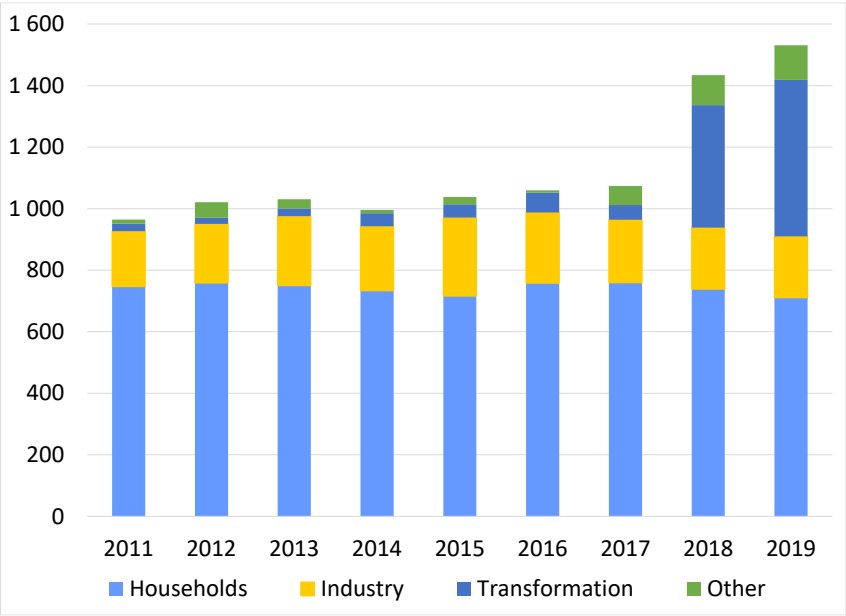
2.2.1. National Energy Balance

We summarize biomass use for energy in time series of 8-10 years based on EUROSTAT Energy 3 Balances and SHARES database

- biomass-to-electricity
- biomass-to-heat
- final energy consumption of biomass

As in other Central Eastern European countries, primary solid biomass consumption has long been dominated by the household sector in Bulgaria: domestic heating accounted for more than 70% of total biomass consumption, while the industrial sector accounted for an average of one-fifth. Until recent years, the use by the transformation sector of biomass was insignificant, accounting for just a few percent of total consumption.

3. Figure: Consumption of primary solid biofuels by sector (ktoe)

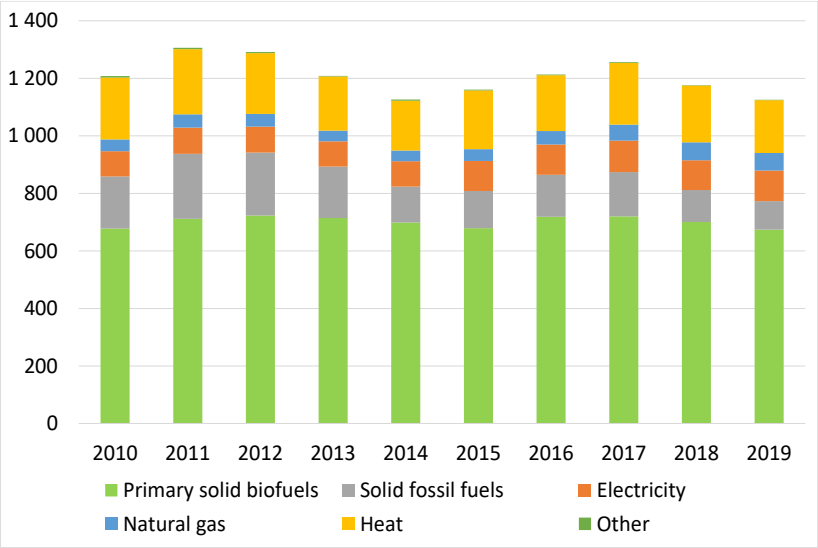


Source: Eurostat

In 2018, the structure of biomass consumption changed drastically: while consumption in the household and industrial sectors remained unchanged, utilization in the transformation sector jumped more than tenfold in two years. According to the evidence of consumption data, the increase was mainly due to the increasing use of biomass in combined heat and power generation.

[47] Bulgaria plans to burn coal until 2050 – energy minister (by Vladimir Spasić, August 13, 2020, Balkan Green Energy News). https://balkangreenenergynews.com/bulgaria-plans-to-burn-coal-until-2050-energy-minister/

4. Figure: Fuel mix of residential heating (ktoe)



Source: Eurostat

The consumption of biomass in the household sector is determined by the use for heating purposes. Data from the last decade show that the inertia of this consumption element is quite high: although coal and firewood prices have almost doubled during this period, there is no visible effect on household biomass consumption. Within the energy consumption of households for heating purposes, there is only a significant decrease in coal consumption. It is also worth noting that while residential natural gas prices have not changed significantly during this time, the pace of the shift to natural gas heating called for in energy policy is far behind expectations.

2.3. Biomass-to-energy – goals and measures

In this chapter, we explore how biomass-to-energy fits into the country's currently approved climate policy objectives and renewable energy targets. We have to understand the role of forest biomass use for energy purposes within your national climate policy, so we need to focus on how solid biomass energy is considered in the context of greenhouse-gas emissions and renewable energy. We summarize all narrative policy objectives and quantitative targets that directly or indirectly rely on biomass-to-energy.

2.3.1. National Energy and Climate plan and Energy Strategy

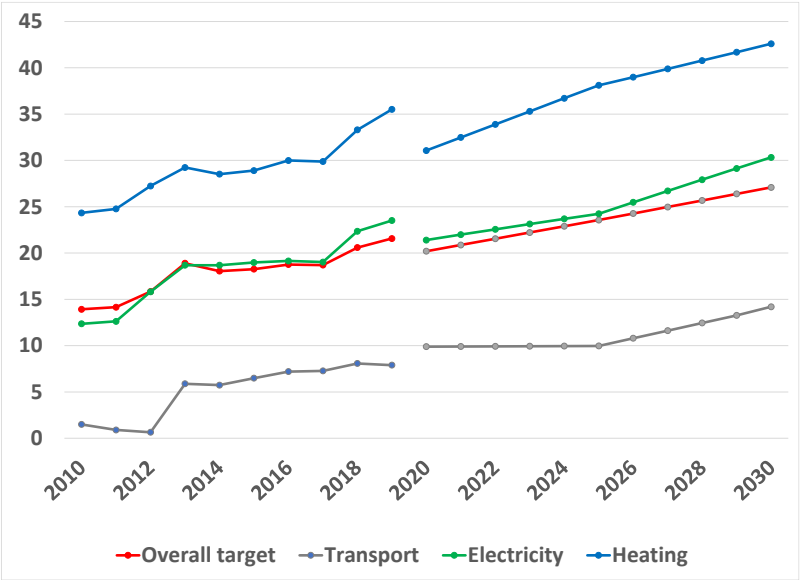
The Bulgarian NECP intends to achieve a 49% emission reduction by 2030 (as compared to 2005). As the energy sector accounts for 74% of total GHG emission, the lion's share of emission reductions must be implemented by the sector. In sharp contrast to the energy sector, no significant emission reductions are expected in the other sectors: in fact, due to the increase of national income and industrial production, the households and services, industry and transport sectors are expected to increase their emission.

Decarbonisation in the electricity sector is planned to be achieved mainly through a gradual reduction in coal-based electricity generation and a strong increase in renewable production (around 50%), resulting in a partial fuel-switch from fossil (coal and lignite) to renewable energy sources (PV and biomass). The lion's share (three-quarters) of the targeted increase would

come from a strong boost in PV capacity, while the planned 220 MW capacity expansion in biomass combustion will play only a marginal role.

Due to its higher energy consumption, the heat sector is responsible for 70% of the planned reduction in carbon emissions in the Bulgarian economy. The decarbonisation of the heat sector therefore requires a much higher use of renewable energy sources than the electricity sector. The planned 34% increase in renewable heat production is based almost entirely on biomass, more precisely on the increase in biomass-based cogeneration. In contrast, the biomass consumption of the household sector, which currently dominates the use of biomass in the heat sector, is expected to increase only moderately, by 11%. That is in line with the intention to replace solid fuels with natural gas in domestic heating.

5. Figure: Shares of renewable energy sources in gross final energy consumption (%)



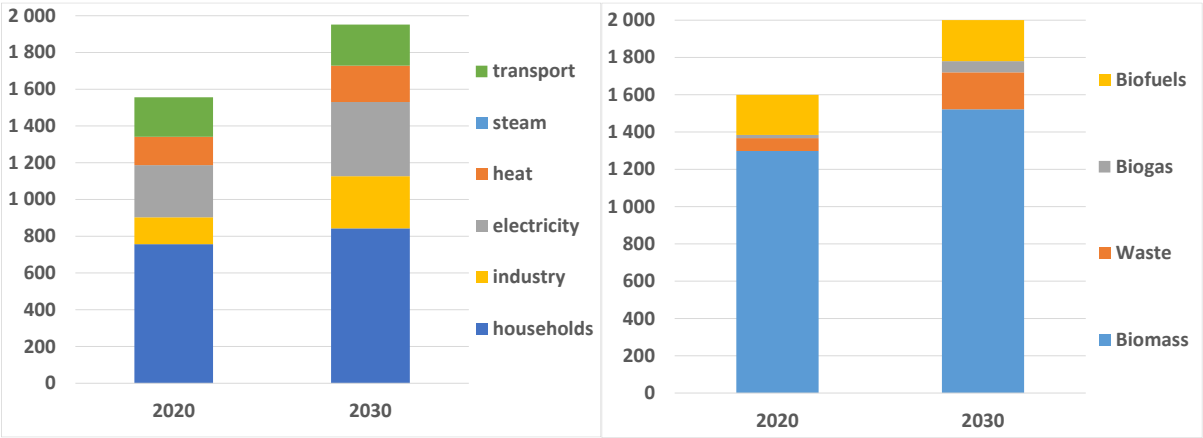
Source: Integrated Energy and Climate Plan of the Republic of Bulgaria 2021-2030 (Republic of Bulgaria – Ministry of Energy and Ministry of the Environment and Water)

Thanks to the fuel shift in cogeneration and the rise in biomass co-firing between 2017 and 2019, Bulgaria is well on track to meet its 2030 renewable targets. As a result, the NECP does not even plan to re-introduce a support system, and policy makers are confident that the planned PV investments will also take place on market terms. However, it was not ruled out that they would change their minds if necessary, in the light of developments in the coming years. As formulated in the NECP: „If necessary for achieving the targets set after 2025, tenders for additional renewable energy capacity may also be conducted".

Before examining the impact of renewable targets on biomass demand, it is important to clarify that the Bulgarian NECP sets targets for the "Biomass and waste" mix. These targets can be partially broken down into biomass and waste (biodegradable and non-biodegradable), but it is difficult to distinguish between forestry and agricultural biomass, woody and herbaceous biomass, harvested and waste wood, and other sources of biomass.[48] It is therefore difficult to estimate the pressure generated by the decarbonisation and renewable targets set out in the NECP for forest biomass production.

[48] See: Table 58: Biomass and waste dynamic, setting out the gross domestic consumption of biomass and waste for 2030 (Integrated Energy and Climate Plan of the Republic of Bulgaria 2021-2030, p. 253.)

6. Figure: Projected biomass and waste demand and supply (ktoe)



Source: REKK calculation based on Integrated Energy and Climate Plan of the Republic of Bulgaria 2021-2030

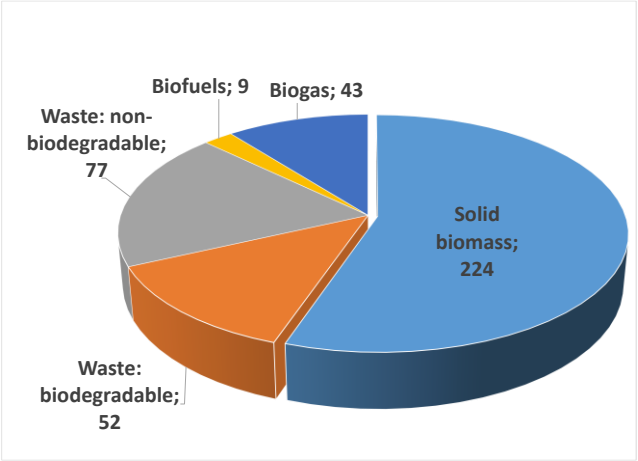
Achieving renewable targets requires an increase in "Biomass and waste" use of around 25%, from 1600 ktoe up to 2000 ktoe. Three-quarters of the increase in demand is generated by the transformation sector (electricity and heat production) and the industrial sector. The projected moderate increase in consumption of the residential (and commercial) sector, which currently dominates biomass consumption, will have a relatively small effect on additional biomass demand.

Nearly half (45%) of the 404 ktoe increase in „Biomass and waste" demand is expected to come from sources other than forestry solid biomass: „unutilised potential of the biodegradable fraction of products, waste and residues from biological origin from agriculture, including vegetal and animal matter from forestry and related industries, including fisheries and aquaculture, and the biodegradable fraction of waste, including industrial and municipal waste of biological origin".[49]

Solid biomass supply is expected to increase by 17% (up to 1522 ktoe), which is still just below the biomass potential identified in the 2011 Energy Strategy. However, it is above the forestry wood potential of 1056 ktoe indicated by the National Action Plan for Energy from Forest Biomass. As the NECP put it: „solid biomass is expected to be mostly derived from residues", mainly wood waste generated by the timber processing and furniture making industry.[50]

[49] Integrated Energy and Climate Plan of the Republic of Bulgaria 2021-2030, p. 55.
[50] Integrated Energy and Climate Plan of the Republic of Bulgaria 2021-2030, p. 55.

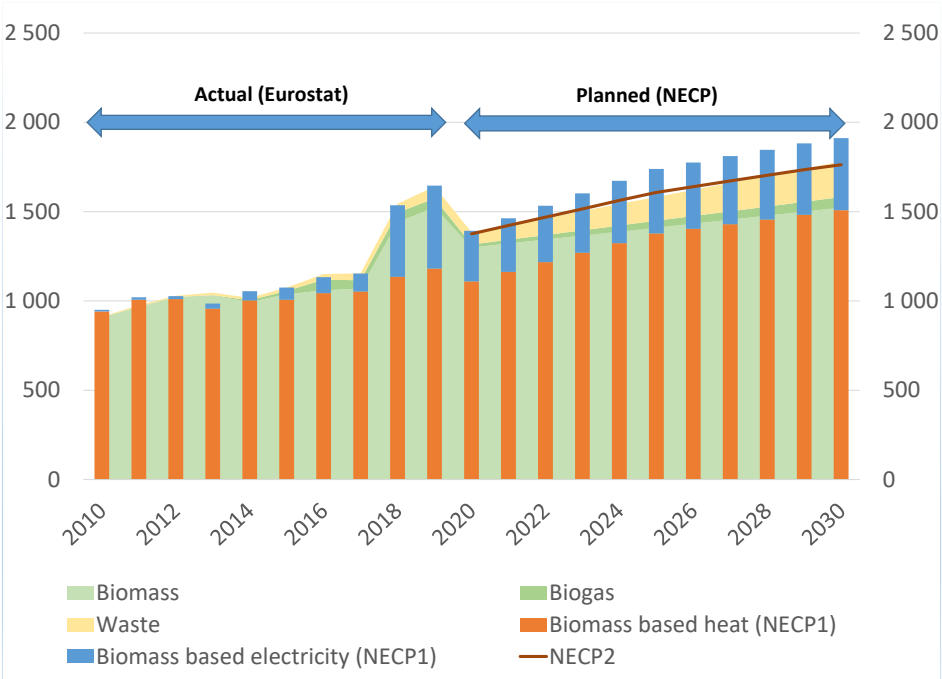
7. Figure: Sources of expected increase in biomass and waste supply 2020-2030 (ktoe)



Source: REKK calculation based on Integrated Energy and Climate Plan of the Republic of Bulgaria 2021-2030

The following figure shows the components and drivers of biomass use for energy purposes and the sources from which it is planned to meet the expected increase in demand. It is clear that the bulk of biomass use will be in the heat sector, although the electricity sector will also play a role in the projected increase in demand between 2020 and 2030. Examining the supply side, we can also state that the non-negligible part of the increase in biomass demand envisaged by the NECP will be met from waste and biogas.

8. Figure: Actual and planned biomass use in energy production (ktoe)*, **



Source: NECP

* *Biomass based electricity and heat (NECP1) columns show projected biomass consumption of heat and electricity generation. The source of data are Table 15 (Projection curves by technology for renewable energy generation the period 2020—2030, GWh — electricity) and 16 (Projection curves by*

technology used to generate energy from renewable sources for the period 2020-2030, ktoe — heating and cooling) of NECP.

** *"NECP2" shows projected biomass consumption in the transformation sector (heat and electricity generation) and the final use in household, services and industry sectors. The source of data are Figure 11 (Projection curve of consumption of energy from biomass until 2030 by consumption and origin (TWh)*) and Figure 12 *(Final consumption of energy from biomass by sector (TWh))*

The figure clearly shows the extraordinary increase in use in 2018-19, as a result of which the use of biomass for energy purposes is now approaching the target level for 2030. In addition, according to official data, the vast majority of the increase in demand is met by biomass (not waste or biomass). This means that if the achievement of strategic goals pushes the limits of sustainable logging or the available biomass potential, then these tensions must already be felt in the forestry sector or in agriculture.

3. Supply-demand adequacy

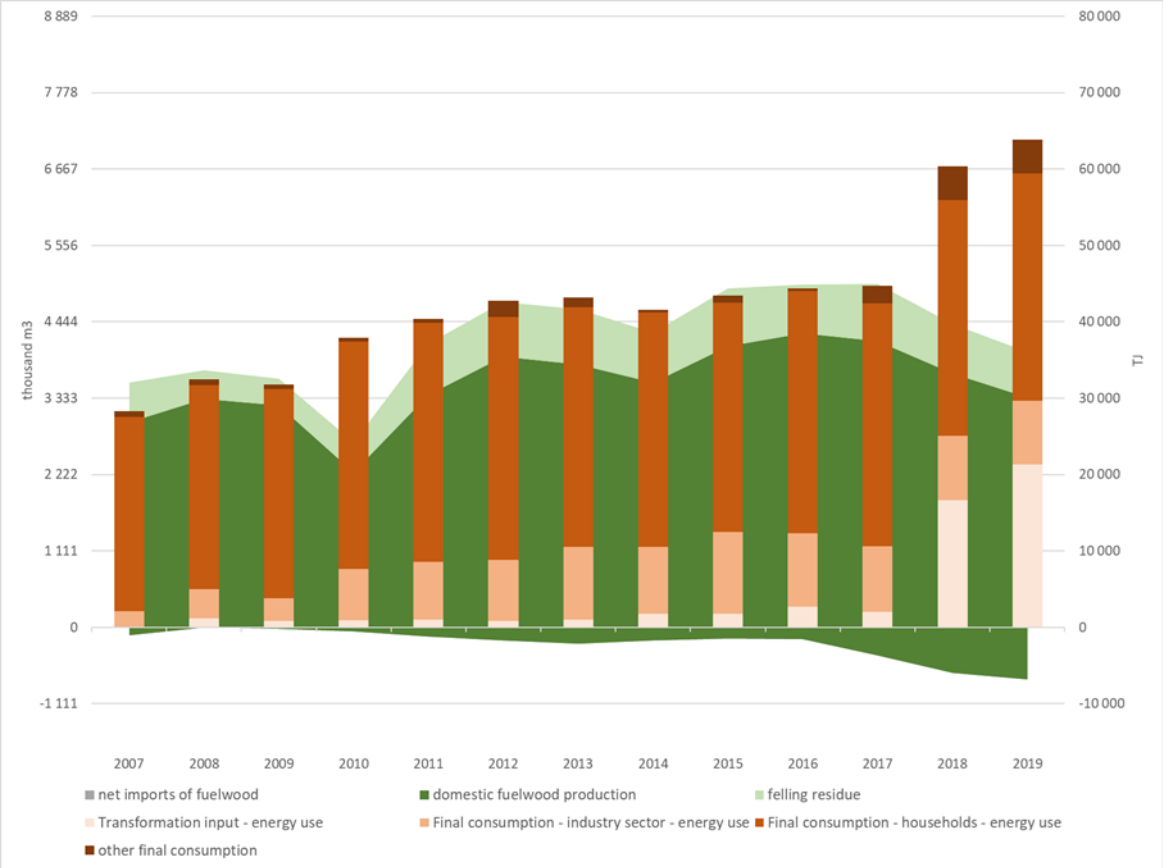
This analysis targets the most basic question regarding biomass energy: sustainability. Demand for biomass energy is mostly driven by administrative tools. Supply of forest biomass is finite and loaded with data uncertainty. This section is finding out (i) if forest biomass resources and their use for energy are balanced and, (ii) if biomass energy targets can be met with forest biomass harvested at sustainable rates

Below we compare the officially available data which depict the supply and the demand side of biomass.

Unit transformations were made with an eye on utilization technologies. In energy balances, the authorities assume a certain amount of energy recovered from the steam generated from the water content in biomass, thus the applied transformation of biomass volume to energy is made with factors somewhat higher than the Net Heating Value (but lower than the Gross Heating Value). Conversely, in the household sector the biomass heating facilities are suitable only for simple incineration of firewood with no technical capacity to recover the energy content of the water steam, which is assumed to be lost to the environment. Accordingly, the applied specific energy content of household firewood is the Net Heating Value of firewood[51].

[51]NHV: the heat of combustion less the heat of water condensation per unit mass of wood with observed moisture content. The parameters we use in our calculations are as follows: GHV: 19 MJ/kg, water moisture content: 30% v/v, ash content: 1% v/v, the latent heat of water evaporation: 2.2 MJ/kg. Calculation with these parameters returns a NHV of 12,5 MJ/kg. Basic wood density is set according to the highest value of national assortment of firewood species, resulting NHV of 9 GJ/m3.

9. Figure: – Gap between the supply and demand side of solid biomass energy consumption in volume (thousand m3) and in energy units (TJ) – Bulgaria, 2007-2019



Source: chart by REKK and WWF BG based on EUROSTAT and information from the Executive Forestry Agency of Bulgaria

In the 2010s biomass consumption did not exceed the sum of domestic fuelwood production and residues. The situation changed radically in 2018 when biomass use in the electricity and heat generation increased sharply, creating a significant deficit. However, due to the uncertainty of the available data, it is difficult to judge and explain the gravity of the shortfall. There are conflicting statistics on the amount of biomass that suddenly appears in electricity and heat production, and we do not have any information on its origin. Also, lack of data about non-forest solid biomass does not mean that there is no energy utilization from agricultural wastes or side-products.

4. Discussion of results

To conclude this country report, we discuss our findings and look for relevant policy recommendations.

1. Thanks to the jump of wind and solar power generation in the early 2010s (driven by generous FiT system) and the rise in biomass co-firing in the late 2010s, Bulgaria is well on track to meet its 2030 renewable targets.
2. Bulgarian policy makers removed the feed-in tariff system for new projects in 2015, and since then, new RES entrants (including biomass fired power plants) are not eligible for support (neither under the FiT nor the premium scheme).

3. Lack of subsidies for new RES investement discourage new biomass to energy projects. However, partial conversion of existing lignite or coal fired blocks to biomass or waste (co-firing) has taken place without subsidies in 2018-2019, resulting huge biomass consumption in the transformation sector.
4. Although the Bulgarian NECP does not plan to introduce a new support system, co-firing may continue on a market basis. Carbon quota savings and negative fuel price of waste are powerful driver of converting coal fired capacities into biomass or waste. It is difficult to predict the size of the future coal-fired fleet and thus the potential for coal - biomass co-firing because two important strategic documents of Bulgaria, the National Energy and Climate Plan and the National Recovery and Resilience Plan are in stark contrast regarding the envisaged timeline for coal phase-out.
5. Bulgarian statistics on the use of biomass for energy purposes give a very controversial picture of biomass-based electricity generation. Even if the large increase can be justified, the origin of the biomass used is still to be clarified. It is currently unknown whether firewood, residual from forestry or agriculture, or selected municipal waste, are the source of the biomass used.
6. The current form of the certification system is not suitable for verifying and tracing the origin of the fuels used for new biomass capacities to be commissioned in the future.
7. The Bulgarian NECP has targeted a relatively modest, 17% increase in the use of solid biomass for energy purposes, mostly derived from residues of timber processing or furniture making industry. In addition to forestry solid biomass, the strategy also considers municipal solid waste and agricultural residues to be significant sources of fuel.
8. The planned increase in biomass use in the transformation sector has been largely achieved by 2020, and the planned 11% increase in household biomass consumption by 2030 is quite unlikely. Air protection measures, incentives for domestic gas heating, and the mandatory phasing out of solid fuel boilers discourage any further growth.
9. A number of data suggest that the sudden increase in the use of biomass for energy has come under serious sustainability constraints in recent years: use is more than double the amount extracted, and further growth expected over the next decade will only exacerbate the situation.
10. However, the lack of a support system, moderate targets and the intention to replace forest biomass with other sources and residues suggest that while achieving the biomass potential indicated in the energy strategy may indeed be a major challenge, the planned increase in biomass energy use in NECP is unlikely to pose an insurmountable threat to biomass production sustainability.
11. In case biomass-to-energy programs gain momentum later as Bulgaria is making its way towards full carbon-neutrality, the ailing traceability and certification system must be substantially developed and safeguarded by strong institutional environment.
12. In addition to the above, we must also note that the available statistics are quite contradictory, the composition of the data is often unknown, and the reason for the discrepancies could not be revealed. Therefore, the conclusions drawn carry a high degree of uncertainty.

5. Annexes

5.1. Forestry Factsheets

7. Table: Forest Fund harvest and firewood production, Bulgaria, thousand cubic metres

thousand cubic metres	2 007	2 008	2 009	2 010	2 011	2 012	2 013	2 014	2 015	2 016	2 017	2 018	2 019
harvested stock, total, gross m3 (overbark)	**5 697**	**4 185**	**3 828**	**4 333**	**7 414**	**7 937**	**8 055**	**7 282**	**8 389**	**7 094**	**8 322**	**7 138**	**6 692**
production of industrial wood, net m3 (underbark)	2 571	2 710	1 662	2 363	2 666	2 691	2 715	2 430	2 774	2 590	2 361	2 666	2 565
production of firewood, net m3 (underbark)	3 104	3 330	326	232	3 519	4 125	4 059	3 743	4 248	4 445	4 565	4 358	4 095
total removal/production, net m3 (underbark)	**5 676**	**6 040**	**1 988**	**2 595**	**6 185**	**6 815**	**6 774**	**6 173**	**7 022**	**7 035**	**6 926**	**7 024**	**6 661**
estimated felling residues	21	0	1 840	1 738	1 229	1 122	1 281	1 109	1 367	59	1 396	114	31
residue rate	0,4%	0,0%	48,1%	40,1%	16,6%	14,1%	15,9%	15,2%	16,3%	0,8%	16,8%	1,6%	0,5%
residue assumed to be collected for energy	21	0	1 840	1 738	1 229	1 122	1 281	1 109	1 367	59	1 396	114	31
rate of residue for energy	100%	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
total firewood + residue assumed for energy	**3 125**	**3 330**	**2 166**	**1 970**	**4 748**	**5 246**	**5 340**	**4 852**	**5 615**	**4 504**	**5 961**	**4 471**	**4 127**

Source: table by REKK and WWF BG based on EUROSTAT and information from the Executive Forestry Agency of Bulgaria

5.2. Energy Factsheets

8. TABLE - Gross renewable energy generation of Bulgaria in GWh, 2010-2019

Table 1b - Total actual contribution (GROSS ELECTRICITY GENERATION) from each renewable energy technology in Bulgaria to meet the binding 2020 targets and the indicative interim trajectory for the shares of energy from renewable resources in electricity

[GWh]	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Hydro (normalised)	3,985.5	4,003.1	4,126.3	4,190.4	4,247.6	4,222.1	4,169.9	4,280.7	4,339.0	4,272.5
Solar	14.9	100.9	813.9	1,360.9	1,252.5	1,383.3	1,386.3	1,403.0	1,342.8	1,442.5
Wind (normalised)	604.3	802.4	1,039.2	1,220.2	1,300.6	1,365.6	1,407.7	1,427.7	1,408.8	1,406.7
Solid biomass	19.7	37.2	65.3	95.0	138.8	151.1	162.8	180.2	1,280.0	1,545.8
Biogas	15.5	18.5	0.6	16.8	62.0	119.1	190.8	215.8	212.3	230.7
TOTAL	**4,639.8**	**4,962.2**	**6,045.3**	**6,883.2**	**7,001.5**	**7,241.2**	**7,317.5**	**7,507.4**	**8,583.0**	**8,898.2**
of which in CHP*	35.2	55.7	65.8	109.9	182.2	233.9	254.4	289.4	685.9	1,382.1

* this is an estimate only, countries are encouraged to perform their own calculations

Table 1b (complementary info)

[GWh]	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Renewable Municipal Solid Waste	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	80.6	44.3
Renewable electricity acounted in transport	-74.1	-75.9	-64.4	-64.7	-77.0	-94.5	-101.5	-112.0	-97.6	-111.8
ADJUSTED TOTAL	4,565.8	4,886.3	5,980.9	6,818.6	6,924.5	7,146.7	7,216.0	7,395.4	8,566.0	8,830.7

Source: EUROSTAT SHARES

9. TABLE - Renewable energy consumption for heating and cooling in Bulgaria, in PJ, 2010-2020

Table 1c - Total actual contribution from each renewable energy technology in Bulgaria to meet the binding 2020 targets and the indicative interim trajectory for the shares of energy from renewable resources in heating and cooling (PJ)

[PJ]	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Geothermal	1.4	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.5
Solar	0.4	0.6	0.6	0.8	0.8	0.9	0.9	1.0	1.0	1.1
Solid biomass	37.2	39.7	42.3	42.4	40.4	42.2	42.4	43.7	48.1	49.3
Biogas	0.0	0.1	0.0	0.0	0.1	0.2	1.1	0.5	0.5	0.5
Heat pumps	1.6	1.8	2.0	2.7	2.7	3.1	3.4	3.7	3.9	4.4
TOTAL	40.6	43.5	46.3	47.3	45.4	47.9	49.3	50.3	55.0	56.8
of which biomass in households	29.8	31.3	31.8	31.4	30.7	30.0	31.8	31.8	31.0	29.8

Table 1c (complementary info)

[PJ]	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Renewable Municipal Solid Waste	0.0	0.0	0.1	0.7	0.5	0.6	1.1	1.2	1.5	2.0
ADJUSTED TOTAL	40.6	43.5	46.3	48.0	45.8	48.5	50.4	51.5	56.5	58.8

Source: EUROSTAT SHARES

10. TABLE: Complete energy balance for primary solid biomass, Bulgaria, unit: TeraJoule, TJ

NRG_BAL/TIME	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Primary production	23 037	22 897	26 941	28 943	30 842	30 050	32 182	29 671	33 133	32 965	39 633	43 309	46 548	47 068	45 576	48 695	47 039	47 148	63 822	67 845
Imports	0	0	0	0	0	0	0	0	0	0	15	36	551	222	4	1 162	1 450	848	1 207	2 080
Exports	103	255	266	341	804	1 104	1 331	1 046	746	754	2 058	3 077	3 803	3 994	4 173	5 522	4 076	4 228	4 950	5 761
Gross available energy	22 883	22 730	26 769	28 539	29 622	28 981	30 826	28 280	32 472	31 768	37 919	40 378	42 791	43 151	41 599	43 437	44 370	44 758	60 318	63 809
Total energy supply	22 883	22 730	26 769	28 539	29 622	28 981	30 826	28 280	32 472	31 768	37 919	40 378	42 791	43 151	41 599	43 437	44 370	44 758	60 318	63 809
Transformation input - energy use	0	0	0	0	0	40	38	2	1 184	845	952	1 035	831	1 032	1 778	1 799	2 702	2 001	16 687	21 296
Available for final consumption	22 883	22 729	26 769	28 538	29 620	28 940	30 787	28 278	31 288	30 923	36 967	39 343	41 960	42 119	39 821	41 638	41 668	42 726	43 631	42 513
Final consumption - industry sector - energy us	1 418	2 413	2 519	3 289	3 445	3 013	3 311	2 141	3 776	2 969	6 716	7 540	8 033	9 474	8 782	10 688	9 610	8 567	8 361	8 344
Final consumption - other sectors - households	20 465	19 757	23 814	24 578	25 720	25 111	26 587	25 415	26 769	27 345	29 769	31 274	31 767	31 386	30 702	29 982	31 737	31 803	30 927	29 750

Source: EUROSTAT

11. TABLE: Imports and exports of fuelwood and other basic forestry products available for energy, EU ad non-EU, *Bulgaria*, unit: thousand cubic metres

Fuelwood, (including wood for charcoal) wood chips, particles and residues	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
imports	7,1	7,8	8,6	8,2	3,9	10,4	4,1	21,4	11,7	6,3	5,9	17,4	22,1	12,9	6,3	4,1	537,0	2,3	2,0	2,3
exports	123,8	13,1	31,5	67,0	138,5	200,6	242,6	208,1	172,2	174,4	409,9	680,3	779,6	690,4	984,0	1 386,1	936,0	1 120,7	564,5	360,5
net imports	**-116,7**	**-5,3**	**-23,0**	**-58,8**	**-134,6**	**-190,1**	**-238,6**	**-186,7**	**-160,5**	**-168,1**	**-404,0**	**-662,8**	**-757,5**	**-677,4**	**-977,7**	**-1 382,0**	**-399,0**	**-1 118,4**	**-562,5**	**-358,3**

Source: EUROSTAT

12. TABLE: Solid biomass supply and demand in TJ and thousand cubic metres, Bulgaria, 2002-2019

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
SUPPLY in TJ	**27 077**	**29 926**	**19 284**	**17 201**	**41 521**	**45 504**	**45 915**	**41 984**	**49 093**	**39 027**	**50 014**	**34 278**	**30 323**
domestic fuelwood production	27 937	29 974	2 931	2 085	31 669	37 121	36 532	33 685	38 235	40 009	41 087	39 219	36 859
felling residue	191	0	16 559	15 645	11 063	10 095	11 530	9 980	12 302	532	12 563	1 023	282
net imports of fuelwood	-1 050	-48	-207	-529	-1 211	-1 711	-2 147	-1 681	-1 444	-1 513	-3 636	-5 965	-6 818
DEMAND in TJ	**28 280**	**32 472**	**31 768**	**37 919**	**40 378**	**42 791**	**43 151**	**41 599**	**43 437**	**44 370**	**44 728**	**60 318**	**63 809**
Transformation input - energy use	2	1 184	845	952	1 035	831	1 032	1 778	1 799	2 702	2 001	16 687	21 296
Final consumption - industry sector - energy use	2 141	3 776	2 969	6 716	7 540	8 033	9 474	8 782	10 688	9 610	8 567	8 361	8 344
Final consumption - households - energy use	25 415	26 769	27 345	29 769	31 274	31 767	31 386	30 702	29 982	31 737	31 803	30 927	29 750
other final consumption	722	743	609	482	529	2 160	1 259	337	968	321	2 356	4 343	4 419
GAP in TJ	**1 203**	**2 546**	**12 484**	**20 718**	**-1 143**	**-2 713**	**-2 764**	**-385**	**-5 656**	**5 343**	**-5 287**	**26 040**	**33 486**
SUPPLY in thousand m3	**3 009**	**1 470**	**2 143**	**1 911**	**4 613**	**5 056**	**5 102**	**4 665**	**5 455**	**4 336**	**5 557**	**3 809**	**3 369**
domestic fuelwood production	3 104	3 330	326	232	3 519	4 125	4 059	3 743	4 248	4 445	4 565	4 358	4 095
felling residue	21	-1 855	1 840	1 738	1 229	1 122	1 281	1 109	1 367	59	1 396	114	31
net imports of fuelwood	-117	-5	-23	-59	-135	-190	-239	-187	-160	-168	-404	-663	-758
DEMAND in thousand m3	**3 142**	**3 608**	**3 530**	**4 213**	**4 486**	**4 755**	**4 795**	**4 622**	**4 826**	**4 930**	**4 970**	**6 702**	**7 090**
Transformation input - energy use	0	132	94	106	115	92	115	198	200	300	222	1 854	2 366
Final consumption - industry sector - energy use	238	420	330	746	838	893	1 053	976	1 188	1 068	952	929	927
Final consumption - households - energy use	2 824	2 974	3 038	3 308	3 475	3 530	3 487	3 411	3 331	3 526	3 534	3 436	3 306
other final consumption	80	83	68	54	59	240	140	37	108	36	262	483	491
GAP in thousand m3	**134**	**2 138**	**1 387**	**2 302**	**-127**	**-301**	**-307**	**-43**	**-628**	**594**	**-587**	**2 893**	**3 721**

Source: table by REKK and WWF BG based on EUROSTAT and information from the Executive Forestry Agency of Bulgaria