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Biomass Report (Bulgaria)

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The potential for exploitable organic residue for each participating country listing key aspects such as location, amount, transport options and costs.

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ABBREVIATIONS

DMC	Dry matter content
LHV	Law heating value
P2G	Power to gas
TH	Transport hub
Toe	tonne of oil equivalent
UWWTP	Urban wastewater treatment plant

1. METHODOLOGY

For the needs of our biomass database, which is a necessary prerequisite for the prefeasibility study about optimal locations of Power-to-gas (P2G) hubs under the current project, the following attributes about potential biomass sources in Bulgaria, segmented into five groups, were collected:

- Identification group
  - Type
  - Name and owners' info
  - Geocoordinates
- Quantity group
  - Amount
  - Status
- Characteristics group
  - Law heating value (LHV)
  - Bulk density
  - Moisture
  - Hemicellulose
  - Lignin
  - Cellulose
  - Ash content
  - Contaminants
  - Carbon
- Price group
  - Price
- Transport group
  - Transport price
  - Transport hubs

Data specification of each of the biomass attributes, assumptions made, along with the data sources used are provided in the following section.

As a start, the collection of biomass sources information was designed according to the table below:

Table 1 Biomass Source Data Specification

	Category	Description
Identification	BM-Number	For counting and reference purposes
	Type	Wood and woody biomass; Herbaceous biomass; Aquatic biomass; Animal and human waste biomass
	Sub-type	Per each Type (See Table 2)
	Owner address	Company address of biomass owner.
	Location name	Short name of the location
	Location long	Longitude coordinate
	Location lat	Latitude coordinate
Quanti	Amount	Amount of biomass available [tons/year]. Industrial amounts of over 1-5 tons per day are of main interest.

	Category	Description
	Status	in-use or idle
Characteristics	LHV	[MJ/ton]. Low heating value. Taken from reference books** or based on expert estimation.
	Bulk density	[tons/m^3]. Taken from reference books or based on expert estimation.
	Moisture	[%]. Needed for calculation of Dry Matter Content (DMC) and biochar yield. DMC = 1-(Moisture/100). Taken from reference books or based on expert estimation.
	Hemicellulose	[% dry]
	Lignin	[% dry]
	Cellulose	[% dry]
	Ash content	[% dry]
	Contaminants	[% dry]. S, Cl, Hg, Cd
	Carbon	[%]. Carbon content. Taken from reference books or based on expert estimation.
€	Price	For purchasing the biomass at the source. Annual average should be used in case of fluctuations. [€ per ton].
Transport	Transport price	[€ per ton per kilometres]. Applies to short distance raw biomass road transport (e.g., by truck)
	TH 1	Reference to the Transport hub table (e.g., nearest seaport) [TH-Number].
	TH 2	Reference to the Transport hub table (e.g., nearest train station) [TH-Number].

1.1 DATA SOURCES

The data collection effort for the biomass database concentrated on three types of biomass sources: (i) biomass from logging activity, (ii) biomass from industrial activity, and (iii) biomass from urban waste water treatment (UWWTP) plant activity.

There are nearly 200 public forest companies in Bulgaria. For the needs of the biomass database, a list with production of each forestry for the 2021 was used *[1]*.

Data about the seven biggest wood consumers in Bulgaria was taken from the National Biomass Action Plan (2018-2027) *[2]*.

The Annual Report on the UWWTP Situation (2020) *[3]*, published by the Ministry of Environment and Water in reference to article 15 of the Environmental Protection Act was used for information about the wastewater treatment plants in Bulgaria and their capacity to treat water.

1.2 IDENTIFICATION GROUP

- Type and Sub-type attributes

  On a consortium level it was agreed to classify biomass sources according to the following types and subtypes:

Table 2 Biomass Types and Subtypes Data Specification

Biomass Type	Sub-types
Wood and woody biomass	Wood-based raw materials (logging)
	Stems, branches, foliage, bark (logging residues)
	Pellets, briquettes, chips
	Sawdust, sawmill (industrial residues)
	Other
Herbaceous biomass	Straws (barley, wheat, sunflower etc.)
	Grasses and flowers (bamboo, cane, bana etc.)
	Other residues (fruits, seeds, grains, cobs etc.)
Aquatic biomass	Microalgae
	Seaweed
	Other
Animal and human waste biomass	Meat and bone meal (MBM)
	Sewage sludge
	Manure
	Municipal / industrial organic waste
	Other

The classification was based on a review paper *[3]* published in the Biofuel Research Journal.

- Owner's address and Location name attributes

  In most of the cases it was the company's name used as an input value for the owner's address. It is assumed that by knowing the company's name, the interested user would be able to contact the company.

1.3 QUANTITY GROUP

- Amount and status attributes

  Biomass quantities from logging activity were estimated based on the assumption that about 18.3% of the produced wood is in the form of logging residues and is practically wasted (or a negligible part of it is collected) *[2]*. It is assessed that 50% of that amount of residues can be utilized as a biomass source and, hence, is currently available for processing – marked with status "idle" in the database. The other 50% have to be left for environment reasons, i.e. to degrade and be absorbed by the soil to keep it fertile and in good condition.

  Biomass quantities from industry are based on the assumption that about 28% of wood consumption is wasted and can be utilized *[2]*. Wood supply quantities for 2016 *[2]* were taken into account in order to estimate the biomass quantities in each enterprise listed in the database. It should be noted that such kind of assessment is very approximate due to the absence of information from the private sector in the public domain.

  Biomass quantities from UWWTP are based on the information about the number of citizens served by the plant. The assumption made is that each citizen produces about 15 kg/y biomass *[5]*, which

can be estimated from the Report on Treatment of Sewage Sludge from UWWTP (2011), published by the Ministry of Environment and Water.

1.4 CHARACTERISTICS GROUP

The data in the characteristics group is based on the information from reference books with the exception of the cases when local biomass source characteristics differ from the reference values. In such cases expert opinion is taken into account and filled into the Biomass database. Several sources were provided to the project consortium members which can be used as a reference *[6], [7], [8], [9], [10], [11], [12],* and *[13]*.

The most important attributes that have to be filled in the group are the LHV, bulk density, and moisture.

- LHV attribute

  In reference to logging and industrial residues, an average value was calculated based on the LHV of coniferous and deciduous trees *[2]*. LHV for sewage sludge was taken from reference books *[6]*.

- Bulk density attribute

  Bulk density was taken as an average value calculated on the basis of the bulk density of coniferous and deciduous trees *[2]*. Bulk density of sewage sludge was taken from reference books [6].

- Moisture attribute

  In reference to sewage sludge, logging and industrial residues, the moisture value was taken from reference books *[6]*, *[2]*.

1.5 PRICE GROUP

All biomass sources in the database were selected to be with a zero (EUR 0.00) price level, i.e. to be regarded as waste by their owners. Surely, some costs should be foreseen in case of real P2G investment and operation, e.g., for collection of logging residue, which at the moment no one is processing (or it is processed in negligible quantities), for collection of industrial waste and/or sewage sludge in the cases when the biomass will be utilized elsewhere.

1.6 TRANSPORT GROUP

Transport group contains records about the transport price of the raw material for moving it from the biomass source to the P2G hub and contains references to the transport hubs table (TH), found in the infrastructure database.

- Transport price attribute

  In reference to logging and industrial residue, a price of EUR 0.15 / m^3 was assumed, taken from a number of media publications[1]. Other parameters that are factored in for the assessment are the bulk density and a distance of 150 km.

[1] https://www.24chasa.bg/biznes/article/10906965

In reference to the sewage sludge, a price of EUR 0.90 / km was taken into account[2] and the same distance as the one used for the logging and industrial residues was assumed.

- TH attribute

  References to the nearest for the biomass source transport hubs are not mandatory to be recorded because they will be calculated automatically by the Atlas platform. All relevant for the project transport hubs could be found in the TH table from the Infrastructure database.

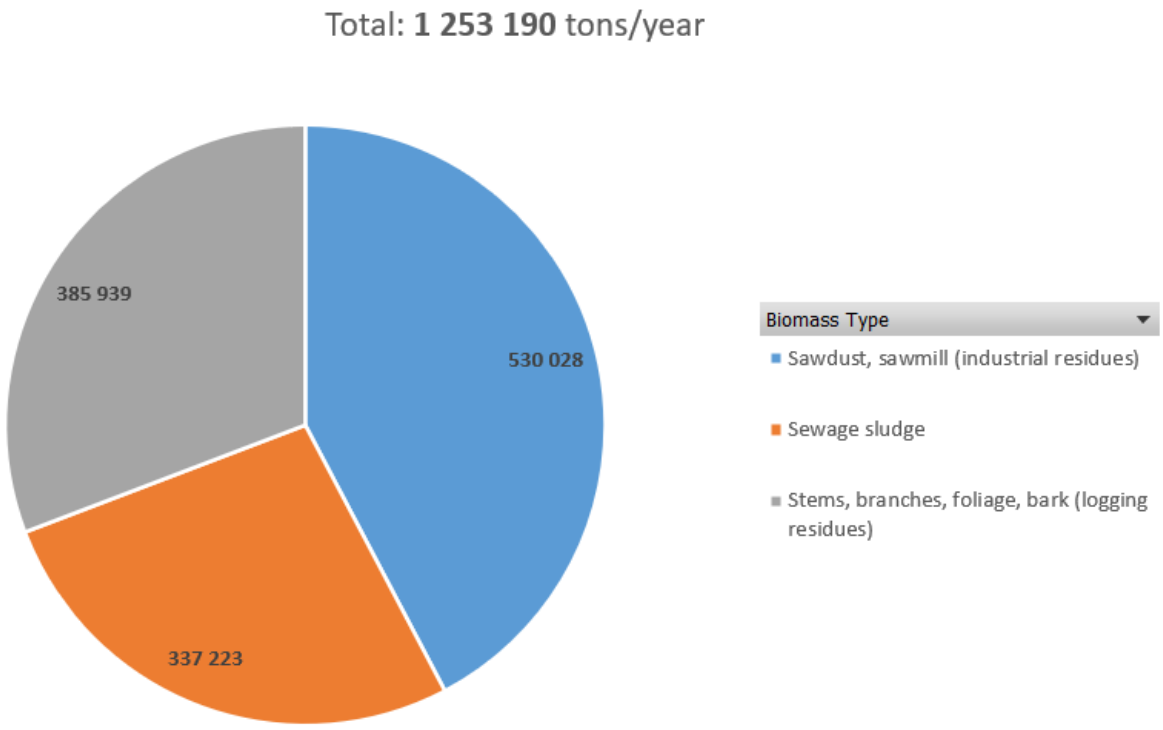
[2] Link

2. BRIEF DESCRIPTION OF BULGARIAN BIOMASS LANDSCAPE

The Bulgarian biomass database comprises biomass from sewage sludge, logging and industrial residues. Together they reach a significant annual biomass quantity of 1,253,170 tons (see Figure 1 below) that can be supplied to P2G hubs or for biochar production that can be exported along the Danube River and utilized by P2G hubs in other countries.

The focus in the next sections will be on the specifics and current developments of the three types of biomass sources that are reflected in the Bulgarian biomass database.

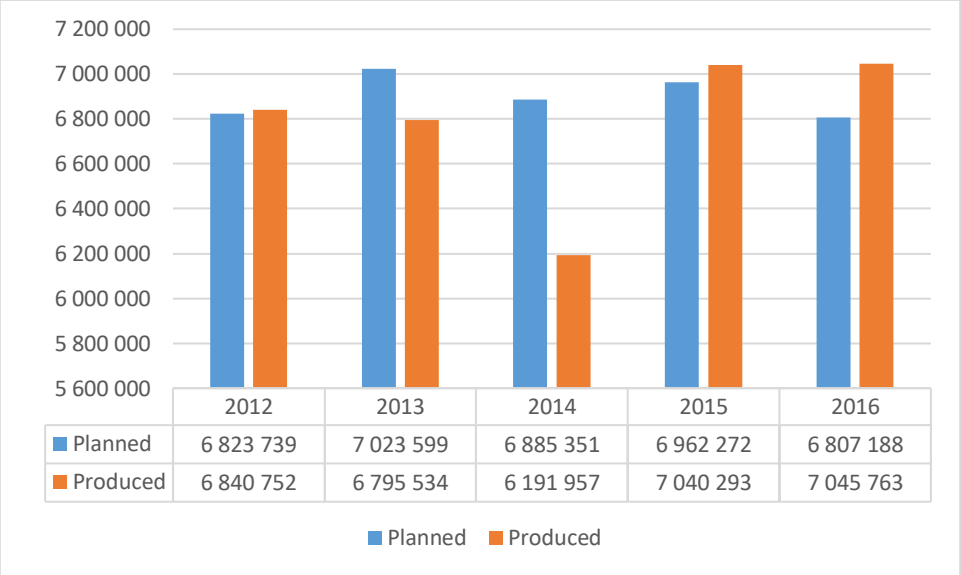
Figure 1 Estimated Biomass Quantities in Database



2.1 LOGGING RESIDUES

In order to outline some of the fundamental trends of the logging industry in Bulgaria, from perspective of using part of its products as a biomass source for P2G hubs, the period between 2012 and 2016 is investigated and reflected here. Data about planned and realized wood production can be seen on the figure below.

Figure 2 Planned and Produced Amount of Wood (m³)

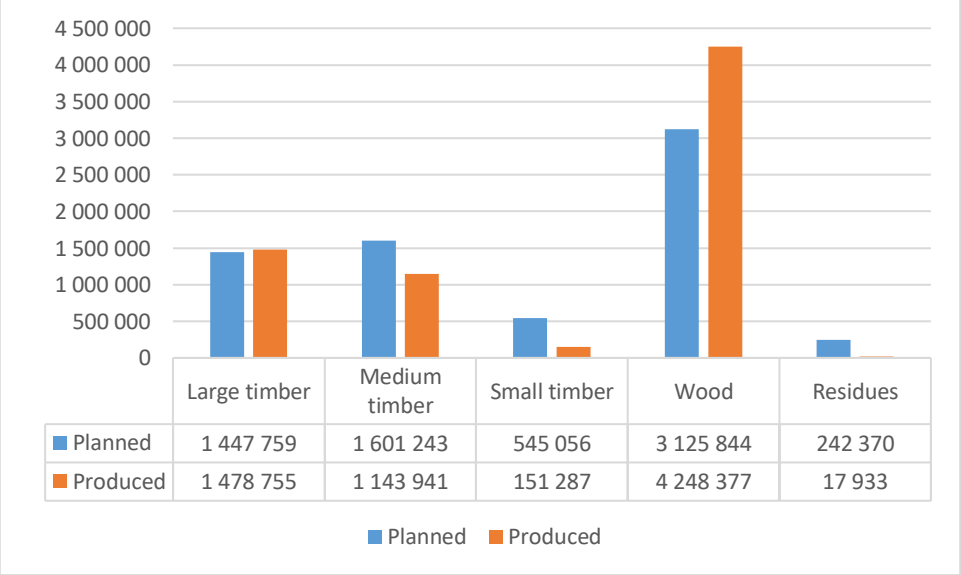


	2012	2013	2014	2015	2016
Planned	6 823 739	7 023 599	6 885 351	6 962 272	6 807 188
Produced	6 840 752	6 795 534	6 191 957	7 040 293	7 045 763

In general, the quantities of planned and actually produced wood from logging tend to stick together to a great extent throughout the years with the exception of 2014. In the last two years the quantities of wood being produced have been higher than the planned ones.

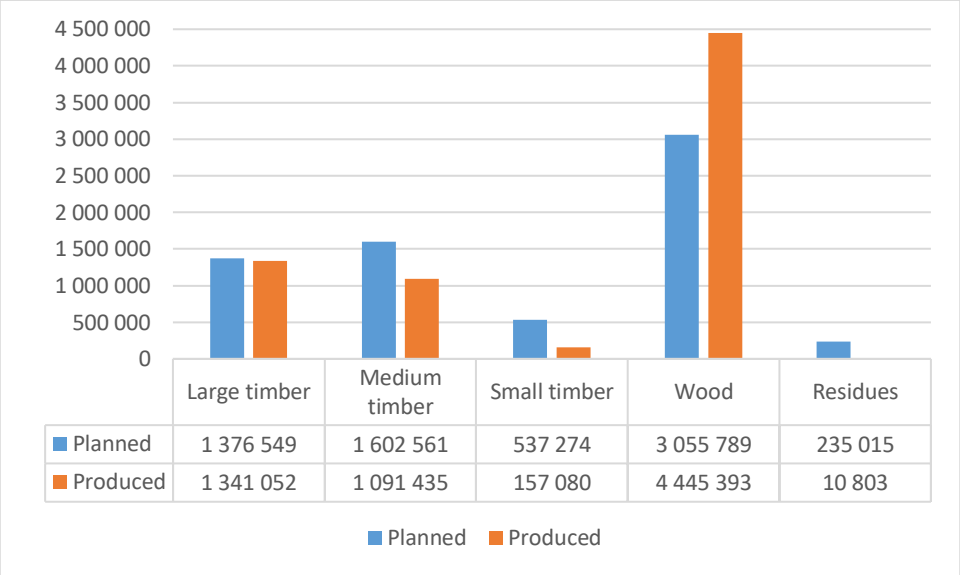
More important trends for our report are noticed when we examine the planned and produced amount of wood in terms of wood type. The figures for 2015 and 2016 are provided below as being the most illustrative for the cases in question.

Figure 3 Planned and Produced Amount of Wood (by type) for 2015



	Large timber	Medium timber	Small timber	Wood	Residues
Planned	1 447 759	1 601 243	545 056	3 125 844	242 370
Produced	1 478 755	1 143 941	151 287	4 248 377	17 933

Figure 4 Planned and Produced Amount of Wood (by type) for 2016



Both figures clearly demonstrate that much less than planned small timber and residues were produced. For the year 2016 it was just 29% of the planned quantity of small timber and around 4% of the residues. On the opposite side is the situation with wood. More than 1,000,000 m^3 were produced than planned in both years – 2015 and 2016.

The reason behind such deviations is that producers do not have economic incentive to collect logging residues and small timber as there is no current demand for them (which is the case with wood). These are left on the field. To some estimates *[2]*, between 1,091,000 and 1,402,000 m^3 annually for the years from 2014 to 2016 were left unused as waste biomass from logging. For this reason, logging residues have been identified as one of the biomass sources for P2G hubs in the Bulgarian Biomass Database.

On average there were 619,749 m^3 /year of logging residues (stems, branches, foliage, bark) for the years between 2014 and 2016 if we estimate that the biomass quantity for utilization is 50% of the total available biomass *[2]*. This is the approach adopted in our methodology for assessment of available biomass quantities. The reason behind is that part of the residues should be left on the field to nurture the soil and preserve it.

From energy perspective, the available biomass waste equals to around 137,200 toe/year *[2]* if we take a LHV between 10.42 and 10.54 GJ/t, depending on the type of wood, and bulk density between 0.45 and 0.65 t/m^3. The ratio between coniferous and deciduous type of wood, that make up the structure of biomass waste, is approximately 1:1.

Figure 5 Logging residues, coniferous (Source: DTI & Biowaste4SP)

2.2 INDUSTRIAL RESIDUES

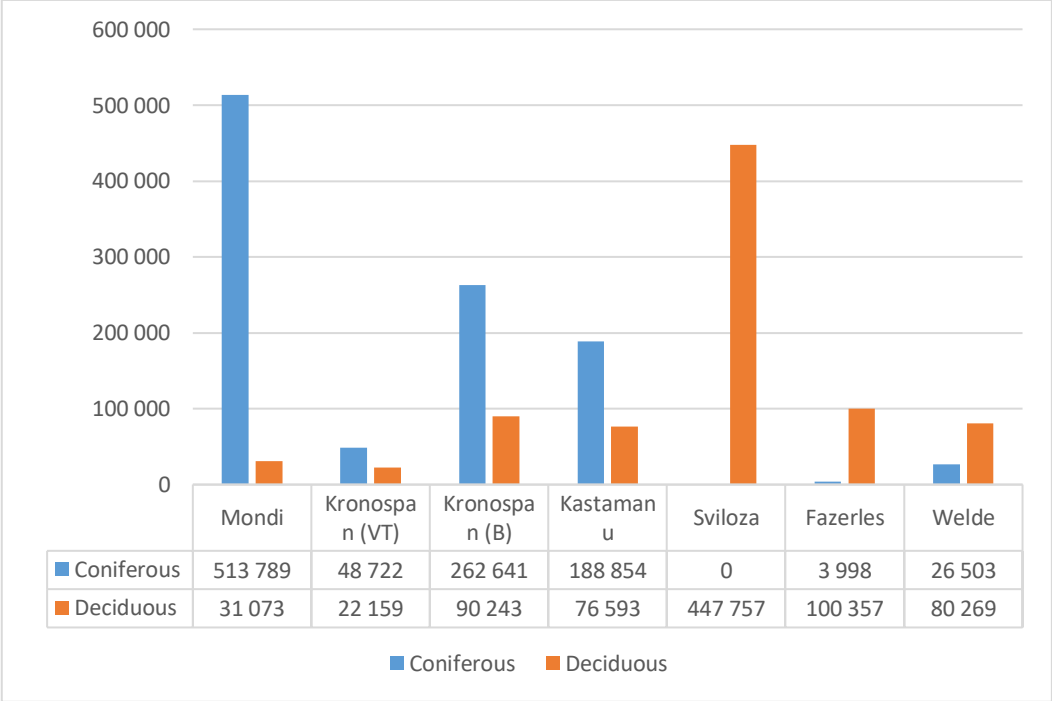
In this section a review is conducted on the consumption of wood from the manufacturers of paper, cellulose, wood tiles, etc. For the period 2012-2016 it turns out that seven of the biggest consumers of wood processed approximately 1,715,000 m^3 annually *[2]*.

The major consumers of wood in Bulgaria are:

- Mondi Stambolijski
- Kronospan – Veliko Tyrnovo
- Kronospan – Burgas
- Kastamanu
- Sviloza
- Fazerles
- Welde

The amount of processed wood for 2016 can be seen on the figure below. It corresponds to about 25% of the wood produced in Bulgaria *[2]*. From the year 2012 to 2016 there is a noticeable trend of increase in consumption with 0.34 million m^3.

Figure 6 Amount of Wood Processed by the Biggest Consumers in Bulgaria



	Mondi	Kronospan (VT)	Kronospan (B)	Kastamanu	Sviloza	Fazerles	Welde
Coniferous	513 789	48 722	262 641	188 854	0	3 998	26 503
Deciduous	31 073	22 159	90 243	76 593	447 757	100 357	80 269

Based on literature references *[2]* the estimates of waste from wood processing depend on the type and wood grade. The following values can be differentiated:

- Waste from coniferous large timber – 26%
- Waste from deciduous large timber – 30%
- Waste from the processing of technical wood (seven biggest consumers) – 28%

As a result, the amount of available industrial wood waste is summarized in the figure below. The value represents an annual average for the years 2012-2016.

Figure 7 Wood Waste from Industry

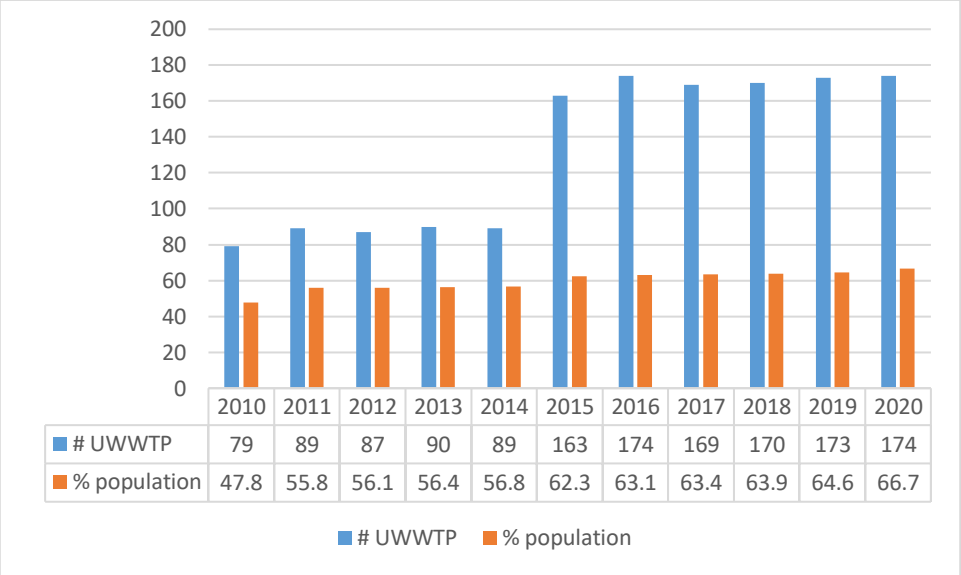
In that way, we obtain a total number of 856,119 m^3 of industrial residues. By taking into account the same parameters as the ones for logging residues, e.g. bulk density, moisture, etc. we come to the conclusion that there is 244,300 toe/y that can be utilized from industrial residues in energy terms *[2]*.

Figure 8 Industrial Residues (Source: DTI & Biowaste4SP)

2.3 WATERTREATMENT PLANTS

Sewage sludge from UWWTP is another biomass source of industrial significance. From 2010 to 2022, Bulgaria has seen a strong increase in the number of UWWTPs and the percentage of population served (see the figure below). This trend increases the potential number of biomass sources and the amount of biomass from sewage sludge. The Bulgarian Biomass database contains data about 62 UWWTPs, covering a population of 4,496,305 citizens *[3]*.

Figure 9 Number of UWWTPs and Population Serviced (2010-2020)



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
# UWWTP	79	89	87	90	89	163	174	169	170	173	174
% population	47.8	55.8	56.1	56.4	56.8	62.3	63.1	63.4	63.9	64.6	66.7

Additionally, the requirements of Directive 2008/98/EC to utilize sludges and prohibiting their depositing create a high demand for investments in UWWTPs. In that reference, 13 new UWWTPs will be built with funding from the Bulgarian National Resilience and Recovery Plan. Smaller settlements with a population between 5,000 and 10,000 inhabitants will be covered by UWWTP services. EUR 235 million have been allocated for this activity.

At present, 11 UWWTPs are in a process of construction or renovation under the Operational Programme "Environment". Beneficiaries are the water utility companies, which are publicly owned.

Figure 10 Sewage Sludge (Source: DTI & Biowaste4SP)

APPENDIX I LIST OF REFERENCES

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