Horizon 2020
European Union Funding
for Research & Innovation

BBI JU

Bio-based Industries Consortium

Country report on Sustainable Biomass Assessment Hungary

This project has received funding from the Bio Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement ***No 838087***

Author(s): Hunyadi Borbélyné, É.
Kardon, B.
Szabó, M.
Trugly, B.

ISBN 978-615-6062-01-7

RCISD smart. flexible. innovative.

ÖMKi

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

TABLE OF CONTENTS

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

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

TABLE OF ILLUSTRATIONS

FIGURES

TABLES

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

EXECUTIVE SUMMARY

This report aims to provide the necessary background information needed to evaluate the possibilities for setting up bio-based production chains in Hungary. The information structure and analysis presented in this report was developed by building on the method designed and applied by Van Dam et al. (2014) and was further refined through the execution of interviews with biobased business developers and other experts.

This report is organized into 9 chapters. In chapter 1 (section 1.3) a first description is given of the key characteristics of the country of Hungary.In the chapters 2, 3, and 4 the biomass production including their current uses and opportunities for what biomass can be additionally mobilised, is summarized for respectively the agricultural, forest, and waste sectors. In Chapter 5 a description is given of the current biobased industries and markets, advanced biobased initiatives, and future biomass valorisation options.In Chapter 6 the infrastructure, logistics, and energy sector are described.Chapter 7 focusses on the innovation potential, particularly in the context of biobased research and development options. The research and educational infrastructure is described and the potential for developing biobased start-ups and Public-Private-partnerships will be discussed.Chapter 8 focusses on the policy framework and describes extensively what regulations, legislation, taxes and tariffs exist of relevance for the development of biobased production chains. In Chapter 9 potential financing options related to the development of biobased production chains are discussed

The main outcomes of the SWOT show that the Strength of Hungary is the regularly high amount of cellulose-based raw material (20 mio t/year). Oil plants are on 0,9 mio ha- the crop and by-products of crop cleaning could also be used for biodiesel. There are 50 biogas industries in the country, and high expertise regarding to using biomass (eg biogas). There is New Forestry Act (potential of forest residues for energy purposes), and well-organised solid communal waste collection. There are corn and other food processing industries with a high capacity of residue processing in the country. A large number of biobased research projects are executed at the universities and research institutes. Programmes related to biogas and biofuel exists in Hungary.

The main weaknesses are that second-generation (cellulose-based) bioethanol production processes are more expensive. There are long transportation distance and low capacity of transport. There are few decentralized smaller power plants, and the logistic is unorganized.

The main opportunities and threats are the higher price of the end product compared to conventional fuels for personal users. Seasonally working industries are less sustainable from economical aspect. The less biomass content in the soils are less sustainable from environmental aspect. Without mitigation and adaptation to the amount of forest biomass may decrease due to climate change. Infrastructure is not available to all areas of land (Biomass-industries and depos). Tariffs of cargo are high in country. Additional land use might lead to in- direct land use changes, in worst case to deforestations. There is high demand for upgrading the equipment and machinery regarding of energy sources.

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

1. INTRODUCTION

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

1.1 OBJECTIVES AND APPROACH

The main objective of CELEBio is to contribute to strengthening Bioeconomy-related activities in Bulgaria, Czech Republic, Croatia, Hungary, Slovak Republic, Slovenia and the neighbouring countries. To this end one of the key activities is to develop seven comprehensive reports for the target countries and the wider neighbouring region on the availability of sustainable biomass, logistics, costs and biomass business opportunities assessed through an analysis of the Strengths, Weaknesses Opportunities and Threats (SWOT).

1.2 SHORT CHARACTERISATION OF COUNTRY

Hungary is located between 7 different countries. Austria and Slovakia are at the Northern border, Slovenia at the West and Ukraine East; Croatia, Serbia and Romania at the Southern border (Figure 1).

Hungary is a medium sized country in the EU according to land surface with 9.8 million inhabitants resulting in a relatively low population density (See Table 1). The average income level is relatively low in comparison to the average of the EU. The export value expressed in €/capita is still relatively low.

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

Slightly more than half of the total land area of Hungary is agricultural land, with only around a quarter of the total is forested. GVA by agriculture, forestry and fishing is more than twice that of the European average.

Table 1 Main population, land surface, GDP and trade characteristics of Hungary benchmarked against EU average[1]

Category	Hungary	EU	Unit
Population	9.8	512.4	million (2018)
Area (total)	9	447	million ha (2018)
% population in urban areas	70.5%	44.9%	% of total population (2018)
% territory predominantly rural	22.1%	43.8%	% of total territory (2018)
% territory predominantly urban	1.2%	10.7%	% of total territory (2018)
Agricultural Area	4.7	173.3	million ha (2016)
Forest area	1.9	164.8	million ha (2016)
Population density	105.1	115	n°/km² (2018)
Agricultural Area per capita	0.48	0.34	ha/capita(2016)
Forest area per capita	0.19	0.32	ha/capita(2016)
GDP/capita	7 789	30 956	at current prices in 2018
	15 934	30 956	GDP at purchasing power in 2018
GVA by Agriculture, forestry and fishing	4.2%	1.6%	% of total GVA (2018)

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

Very little of the country is urbanized territory (1.2%), and nearly a fifth of the population lives in urban areas (Figure 2). The most populated being the capital city, with the road ways making that area most accessible (Figure 3) while most of the biomass is concentrated in the southern part of the country and is less densely populated and accessible by roads and other infrastructure. The GDP in Hungary is very low compared to Europe and even when corrected for purchasing power it is half of the average European.

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

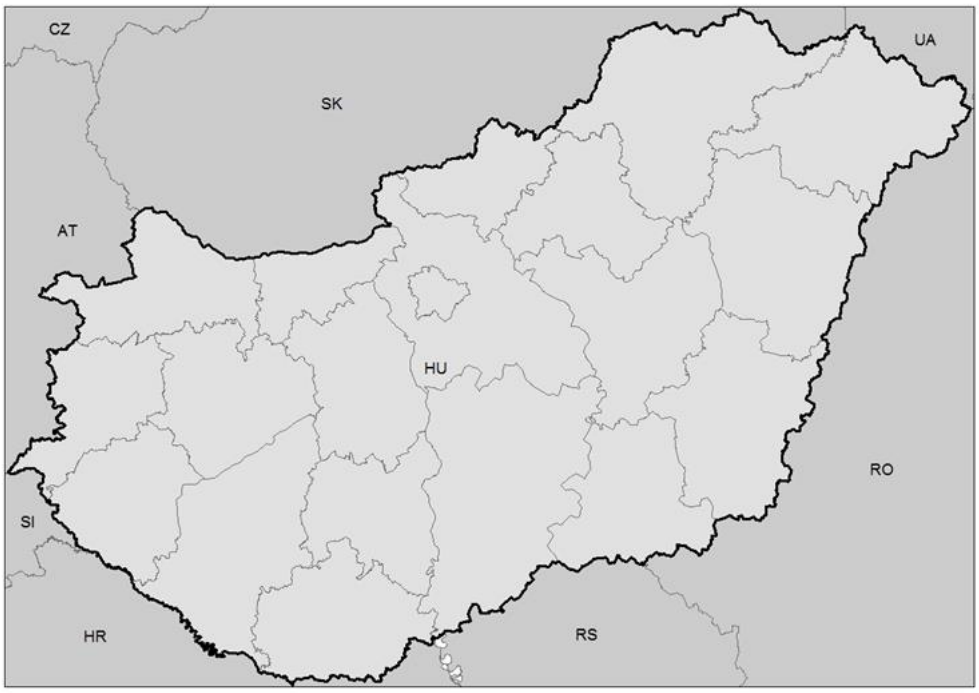


Figure 1 Hungary and it's bordering countries

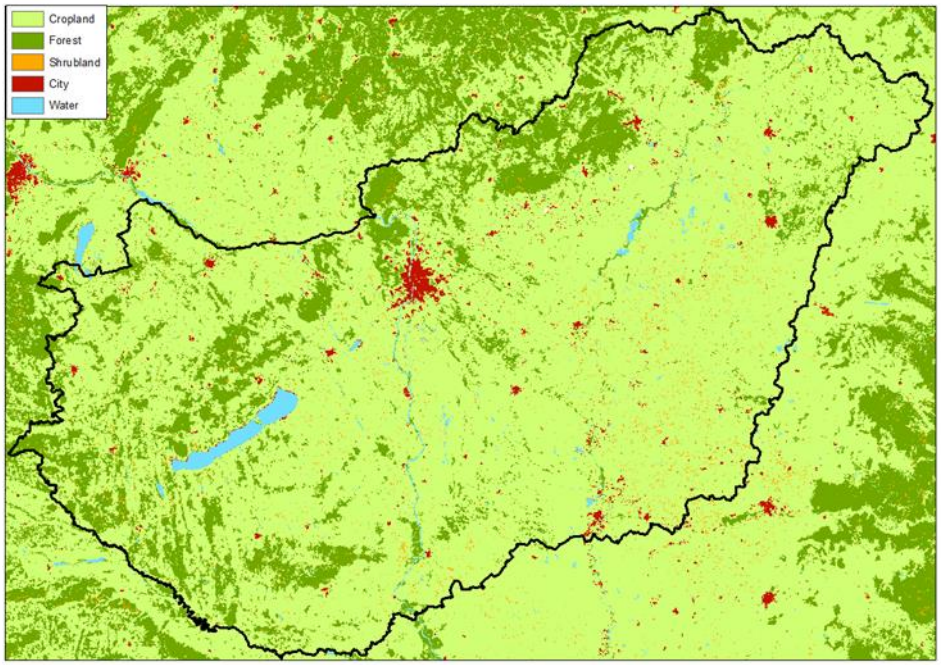


Figure 2 Main land cover distribution in Hungary

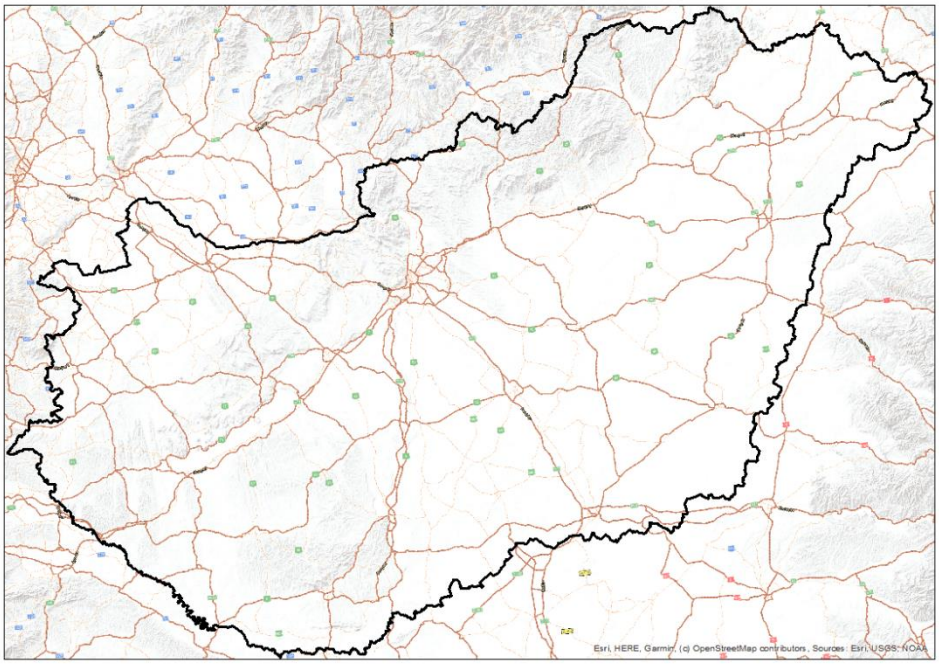


Figure 3 Major Roadways

From the Sankey diagram for Hungary (Figure 4) the following main observations can be made (quantities below are all expressed in million tons of dry matter). The main biomass supply produced in Hungary is from crops (17.8), crop harvested residues (5.35), primary woody biomass (3.02) and grazed biomass (1.11). Most of the crops, and residues and grazed biomass is used for food and food products (11.9); and the woody biomass is converted to heat and power (1.88), and solid bio-materials (2.11). Part of the bio-material uses from solid wood products (1.28) wood pulp (0.183) and partly from crop supplies (0.645). The largest export volume are plant products (6.37) and plant based food (1.13). Processed products from used bio-materials (from crop production) are exported (0.645). Imports consist mostly in volume of animal products (1.97).

The production of biomaterials and bioenergy is much smaller then food, feed and plant products. Interestingly all bio-materials from crop production are exported and bioenergy is produced only from primary woody biomass.

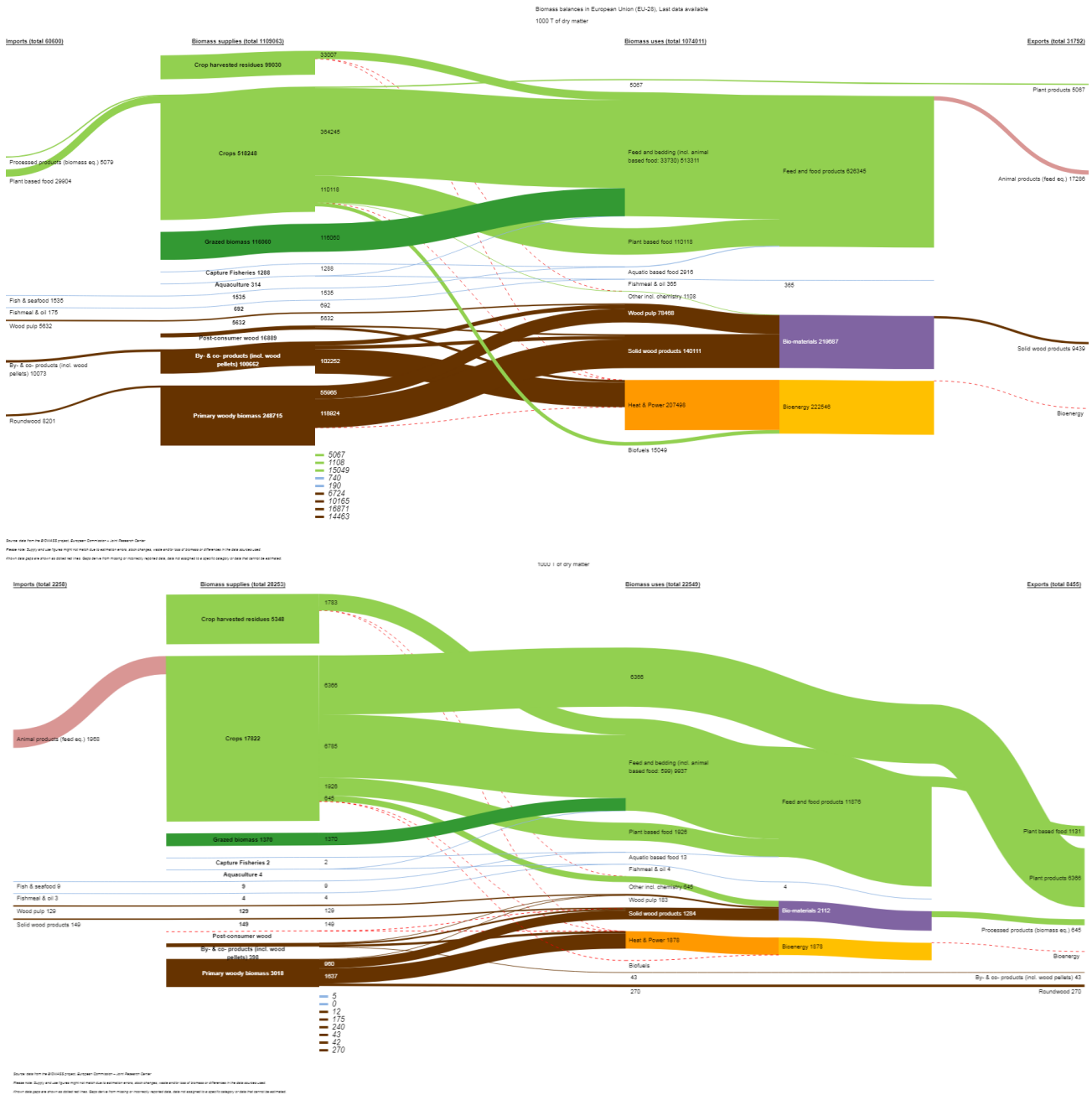


Figure 4 Biomass flows in Hungary (top) and EU-28 (bottom) JRC Sankey diagrams of biomass flows[2]

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

In general, the crop biomass supplies in Hungary are slightly higher in proportion to the primary woody biomass than the European Sankey diagram (bottom figure). The Biomass uses differ slightly in proportions in the amount of biomaterials produced from solid wood products and pulp. However, more biomaterials are used from crop production than in the EU. The Sankeys also differ in that Hungary exports a lot of unprocessed plant products, and mainly imports animal products.

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

2. BIOMASS SUPPLY: AGRICULTURE

2.1 INTRODUCTION

In this chapter the agricultural biomass production and main uses is described. A distinction will be made between the main economic products produced and their main process chains and residual biomass potentials from primary production and available as by-products of food processing industries. The residual biomass sources, certainly the ones from primary sources are largely not used as already became clear from Section 1.2. In addition to presenting the main biomass production attention will also be paid to the importance and the structure of the agricultural sector and to the main environmental challenges associated with agriculture in Hungary.

2.2 CHARACTERISATION OF CURRENT AGRICULTURAL SECTOR

Hungary has a higher percentage of agricultural area compared to European Union average (Table 2), and also more agricultural area per capita. Consequently, slightly more of the population is also employed by agricultural activities, and the agricultural income index is higher than the European average.[3],[4]

Crop output is relatively higher in Hungary compared to livestock output also when compared to the European average (Table 2).

[3] (https://www.agrarunio.hu/hirek/novenytermesztes/4793-van-meg-hova-fejlodni)
[4] *https://www.ksh.hu/docs/hun/xstadat/xstadat_eves/i_omn001a.html*

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

The Agricultural income in Hungary is high compared to Europe, and more than half of the farms are low input farms. Nitrogen and phosphorus balance is low compared to the European averages, and soil erosion is also lower than average. Not much agricultural land is irrigated (2.6%). The average size of a Hungarian farm is generally smaller than the European average, most of the holdings (81.4%) are less than 5 ha (Table 2).

Table 2 Key characteristics for the agricultural sector in Hungary[5],[6]

Category	Hungary	EU average	Unit
Agriculture in % of total employment	5.0%	3.9%	% of total employment 2017
Agricultural area per capita	0.48	0.34	ha/capita
Cereal yield	5.9	5.2	t/ha
Crop output in total output	63%	56%	% of total agricultural output value (2018)
Livestock output in total output	37%	44%	% of total agricultural output value (2018)
Agricultural income (2010=100)	172	121	Index 2010=100 (2018)
Livestock density	0,5	1.02	LSU/ha UAA
High input farms	12%	29%	%/ total farms 2016
Low input farms	56%	39%	%/ total farms 2016
Gross nutrient balance nitrogen	35	51	kg of nutrient per ha (average 2011- 2015)
Gross nutrient balance phosphorus	-1	1	kg of nutrient per ha (average 2011- 2015)
Irrigated utilised agricultural area	2.6%	6%	% of UAA 2016
HNV farmland			% of agricultural land
Soil erosion	1.57	2.4	tonnes/ha/yr 2012
Average farm size	10.9	16.6	ha UAA/holding (2016)
% of agr. holdings < 5 ha	81.4%	62.6%	%/total no. of holdings

HNV= High Nature Value

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

[6] (https://ec.europa.eu/eurostat/statistics-explained/index.php/Agri-environmental_indicator_-_livestock_patterns)

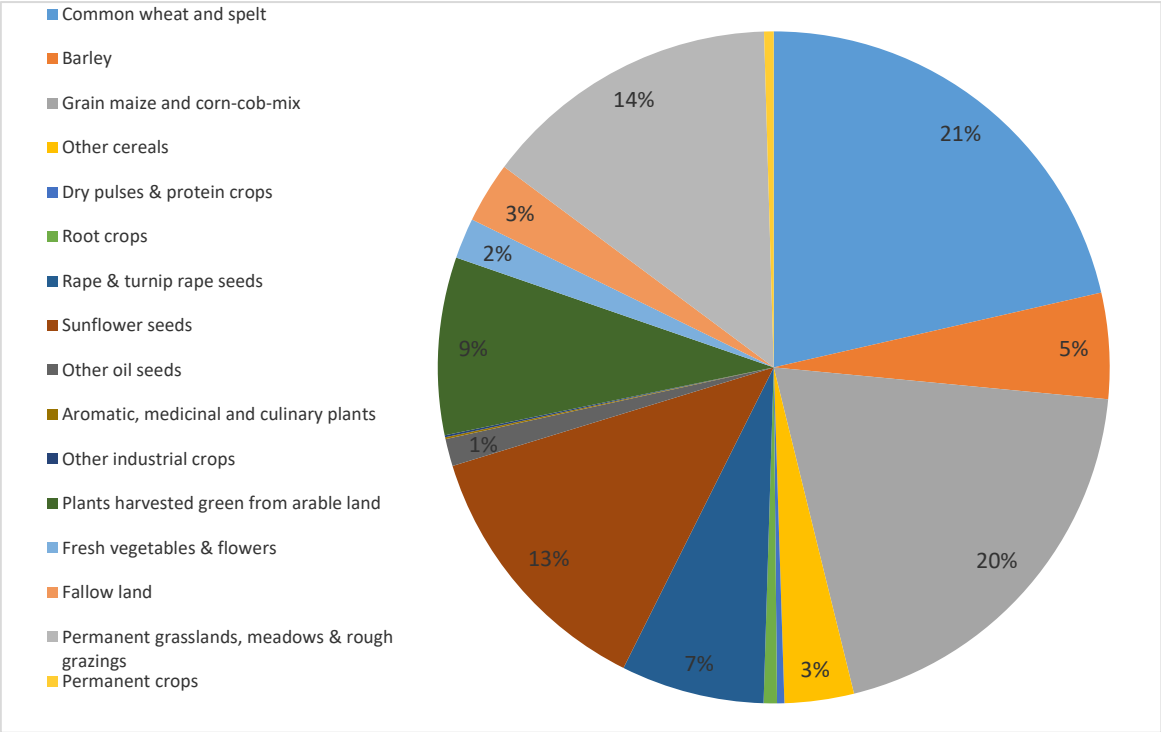
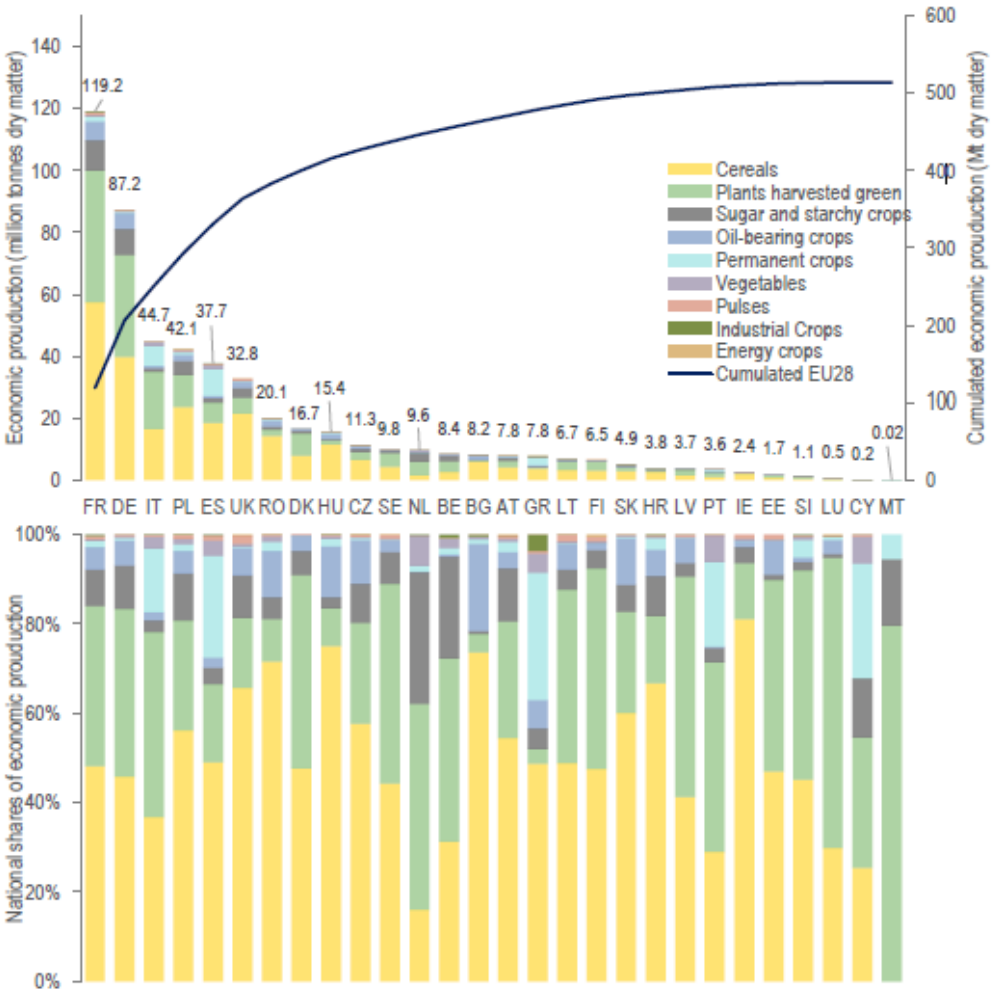


Figure 5 Main crops and land uses in Hungary Source: Eurostat, data 2016 (accessed July 2019)

From Figure 5 it becomes clear that the crop domination in agriculture is also reflected in the land use. Only 14% of the agricultural land use is in permanent grassland, meadows and rough grazing, while the rest is cropping land with most dominant crop groups: cereals, grain maize, oil crops (rape and sunflower). For further details, see next sections.

2.1.1 Crop production

When looking at the production of crops for existing food and feed uses the Hungarian production is in the average position at EU level with 15.4 mln ton d.m. production (see Figure 6). The most important crops in Hungary are cereals, crop harvested green (maize and other fodder crops), sugar and starchy crops and oil crops, e.g. sunflower and rape. Permanent crops cover a relatively small percentage of the cropping area, particularly in comparison to the majority of EU



countries.

Figure 6 Economic production (top pane) from the main crop groups per member state, expressed in Mt of dry matter per year; and the shares at national level (bottom pane). Average values over the reference period 2006-2015.[7]

Organisations

The number of agricultural cooperatives in agricultural production is 8442, and approximately 6000 cooperatives use arable land with an average area of 308 ha. The majority of the organizations has only 20-50 ha of arable land, while 25% (cca. 1500 cooperatives) have more than 300 ha, 84% of the total arable land cultivated by cooperatives. Nearly half of the farmer organizations (48%, cca. 4050) are exclusively engaged in crop production, while the proportion of pure livestock organizations is only 6%, cca. 500. The proportion of mixed profile organizations is 46%, cca. 3900 pcs. Cooperatives cultivate 40% of the agricultural land in Hungary.

Individual farms

The number of individual farmers is about 450 000. Nearly 80% of them, 383 000, have own agricultural fields. The proportion of those who have arable land is 57%, which represents ca. 276 000 farmers, with an average land area of 5.4 ha. One third of arable farms has less than 1hectare area, which means around 90 000 farmers. 28 000 farmers (10% of the arable farmers) have an arable land area farming between 10 and 300 hectares. The share of individual farmers without livestock is 52% of the total, which is about 243 000 farmers. Farms without crop cultivation make up 21% of the total (ca. 100 000 farmers), while the share of mixed farms is 27%, which is ca. 132 000 farms[8].

2.1.1.1 Cereals

Land under cereal production (hectares) in Hungary was reported at 2 367 962 ha in 2018 and yielded 14.931 million tonnes. The growing area increased by 1.4

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

[8] Source: www.kornyezetvedok.hu/vgt/vgt2/orszagos/3_2_hatteranyag_tanulmany_tragyatarolo_NAIK.pdf?picture=pic2

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

percent compared to the previous year, the yield increased by more than 6 percent. Cereals include wheat, rice, maize, barley, oats, rye, millet, sorghum, buckwheat, and mixed grains. In 2017 Cereal crop yield by hectare was 5779 kg[9],[10].

Table 3. summarizes the main use and use of residues as well in 2018.

Table 3 Main cereal production and uses in Hungary (2018)[11]

	Area ha	*Average yield t/ha*	*Yield gap*	*Main uses**	*Types of residues*	*Current uses**
Wheat	949.6	5.08		food (30 %) feed (30 %) export (30 %) seed (10%)	stem 5.08	litter and feed (50-55 %) maintaining soil nutrients 30 % Energy 15-20 %
Barley	27.1	3.03	2.0	food (60 %) feed (40 %)	stem 3.03	maintaining soil nutrients (70 %) feed (30 %)
Winter barley	206	4.87	1.5	feed (100 %)	stem 5.84	maintaining soil nutrients (70 %) feed (30 %)
Rye	29.9	3.44	1.5	food (40 %) feed (60 %)	stem 5.50	maintaining soil nutrients (100 %)
Triticale	87.2	3.75	2.5	food (10 %) feed (90 %)	stem 4.0	maintaining soil nutrients (100 %)
Oat	23.7	2.6	2.5	food (10 %) feed (90 %)	stem 3.38	maintaining soil nutrients (100 %)
Maize	898	8.3	1.5	food (10 %) feed (60 %) export 30 %	stalk and cob 9.96	litter and feed (10-15 %) maintaining soil nutrients 70 % energy 15-20 %

** data calculated from literature;* ' manure' is left in the field for maintaining soil fertility; 'litter'- bedding, this is what farmers put on the ground of stables or hutches

2.1.1.2 Oil crops

The land area for production of the main oil crops (sunflower and raps) was reported as 947 000 ha in 2018. Sunflower represents almost two third and rape one third.

[9] https://www.theglobaleconomy.com/Hungary/cereal_yield/
[10] https://www.ksh.hu/docs/eng/xftp/stattukor/vet/evet1906.pdf Statistical reflections 2019 september 17
[11] *https://www.ksh.hu/docs/eng/xstadat/xstadat*

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

Table 4 Main oil crop production and uses in Hungary (2018)[12,13]

	Area ha	*Average yield t/ha*	*Yield gap*	*Main uses**	*Types of residues*	*Current uses**
Sunflower	617	2.97	1.5	food (50 %) feed (20 %) energy (15%) export (15%)	stem and receptacle	feed (5-10 %) manure (80 %) energy (5-10 %)
Rape	330	3.03	2.0	food (60 %) energy (30 %) export (10 %)	stem	manure (90 %) litter (5 %) energy (5 %)

** data calculated from literature*

2.1.2 PERMANENT CROP PRODUCTION

The cultivation area of permanent crops is much smaller than that of arable in Hungary.

Table 5 Permanent land uses in Hungary (2019)[14]

	Area cultivared by farmer cooperations ha	Area of individual farms ha	State run area ha	Total ha
Orchard	20 500	65 700	8 100	94 400
Vineyard	15 100	43 300	10 000	68 400
Permanent Grassland	23 300	52 300	36 600	790 400
perennial crops for biomass (for energy)	792	1038	285	2110

https://www.ksh.hu/docs/hun/xstadat/xstadat_eves/i_omf001a.html

The primary purpose of the newly established SRC coppice plantations is to provide fuel for biomass operated powerplants. The composition of the recently planted SRC plantations has three dominant species. Namely, they are willow, black locust and poplar species.

Table 6 woody plantation in Hungary[15]

	Area poplar ha	Area of acacias ha	Area of willow ha	Total ha
SRC	3953	864	1639	6456

[12] https://www.ksh.hu/docs/eng/xstadat/xstadat_annual/i_omn018b.html

[13] https://www.ksh.hu/docs/eng/xstadat/xstadat_annual/i_omn019b.html

[14] *https://www.ksh.hu/docs/hun/xstadat/xstadat_eves/i_omf001a.html*

[15] Gockler L. (2010): Fás szárú energiaültetvények a mezőgazdaságban. 2. rész – A sarjaztatásos fás szárú energetikai ültetvény technológiájának megfontolandó elemei. Mezőgazdasági Technika, 51. évf. 11. sz. pp. 40-43

All agricultural soils are suitable for growing fast-growing species. The results of the NKFP 07 4 ENFATECH (2011) project, that in Hungary, the total area of plantations made for energy purposes is between 2.6 and 3 thousand hectares. This could be increased to 25-30 thousand hectares by 2020 and up to 100 thousand hectares by 2030 in places that are currently unused/abandoned lands. However, these investments require significant capital expenditure.[16]

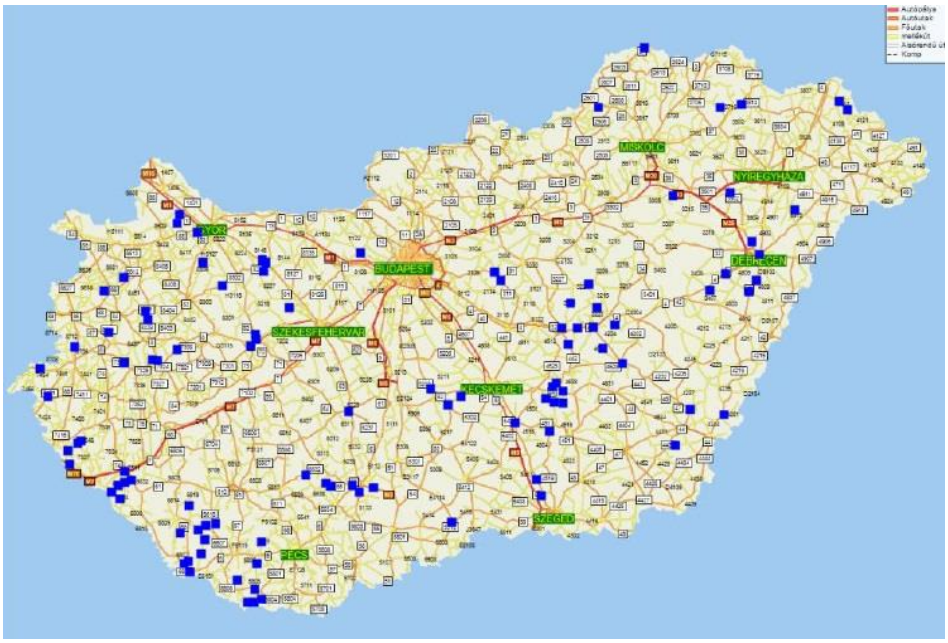


Figure 7 Location of woody plantations in Hungary by settlement – 2012[17]

2.1.3 Livestock production

The endowments of Hungary favour feed manufacturing and livestock farming, thus traditionally, livestock farming plays an important role in agriculture. The most important animal species are cattle, pig, poultry and sheep. The gross output of live animals and animal products was HUF 943 billion at current basic prices in 2018 and their production made up 35.3 percent of the agricultural output. The output volume was 5.7 percent higher in 2018 than in the previous year. The output

[16] http://www.econovum.hu/images/3munkbesz.pdf

[17] Source: http://erdo-mezo.hu/2014/12/20/energetikai-ultetvenyek-az-alfoldon/

increased by 13 percent in the poultry, 7 percent in the cattle and 3 percent in the pig sector. Based on preliminary data, domestic meat production reached 1.6 million tonnes representing an increase of 6.7 percent in 2018. Out of the animal products, the farms produced 1.9 billion litres of milk (1 percent less than a year before) and 2.5 billion eggs representing an increase of 2.5 percent.

Hungary was responsible for about 3.5% of the European Union's total poultry meat production.[18]

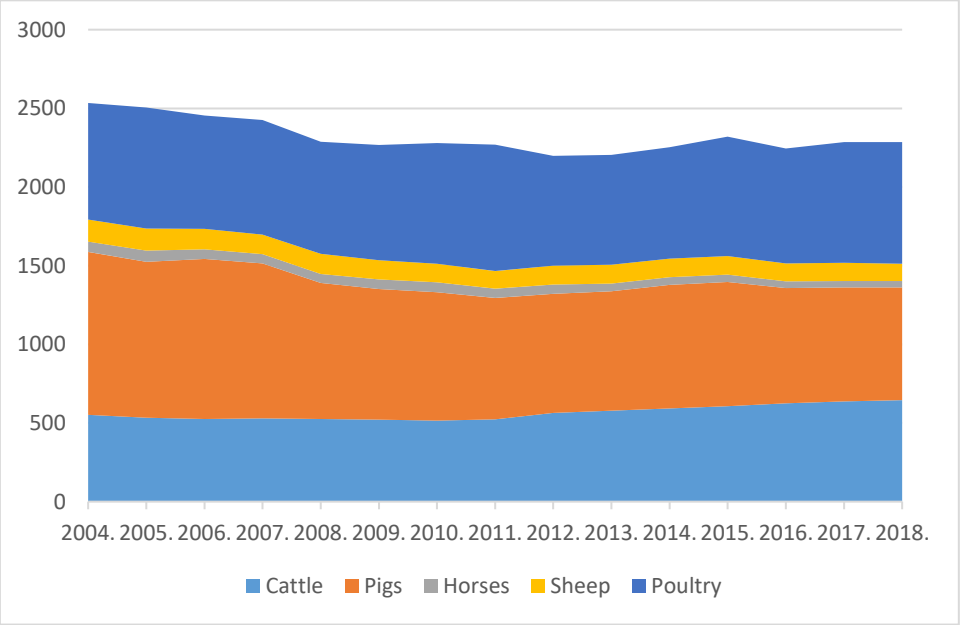


Figure 8 Livestock unit of animal production in Hungary (2004-2018)[19]

Table 7 Main livestock production in Hungary (2018)[20]

	Cattle	Pigs	Horses	Sheep	Poultry
Livestock unit	644,9	716,1	41,7	110,9	773
1000 heads	885	2 872	52	1 109	39 729

[18] https://bbj.hu/economy/hungary-farm-sector-output-expands-over-3-in-2018_158917

[19] *Data source:* https://www.ksh.hu/docs/eng/agrar/html/tabl1_5_1_4.html

[20] https://www.ksh.hu/docs/eng/agrar/html/tabl1_5_1_4.html

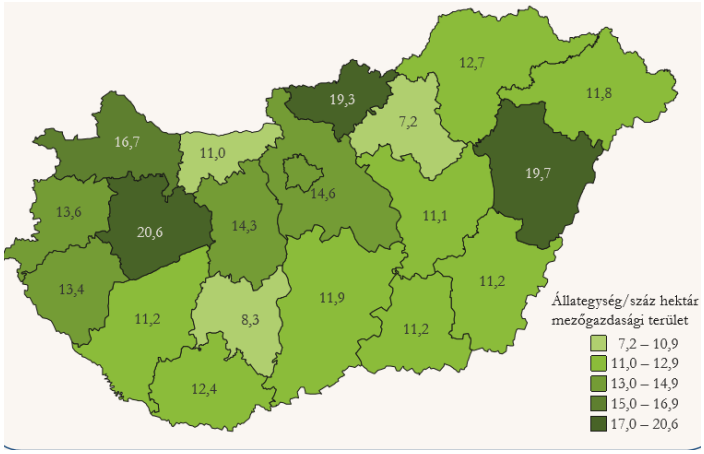


Figure 9 Cattle in livestock unit /100 ha in 2016[21]

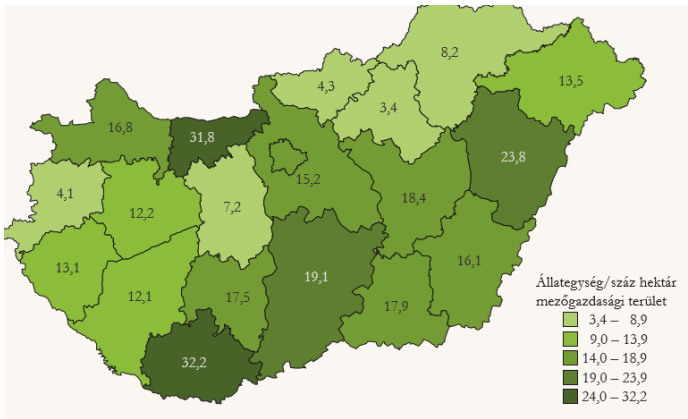


Figure 10 Pig in livestock unit /100 ha in 2016[22]

[21] *Source: https://www.ksh.hu/docs/hun/xftp/idoszaki/gszo/agrarium16.pdf*
[22] *Source: https://www.ksh.hu/docs/hun/xftp/idoszaki/gszo/agrarium16.pdf*

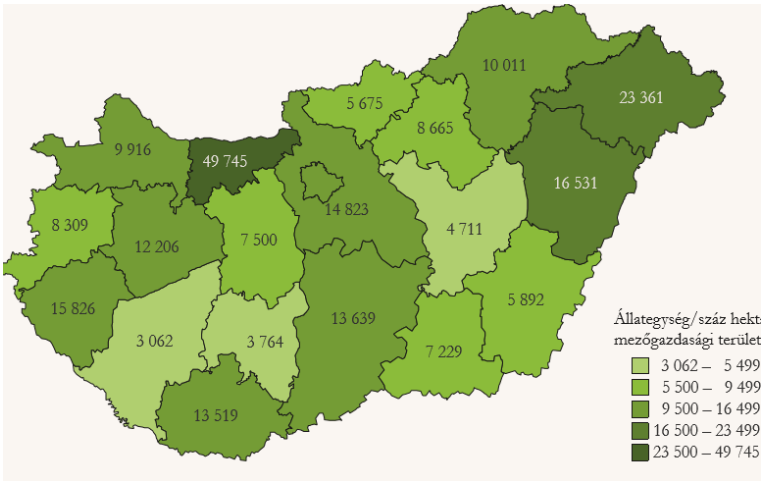


Figure 11 Poultry in livestock unit /100 ha in 2016[23]

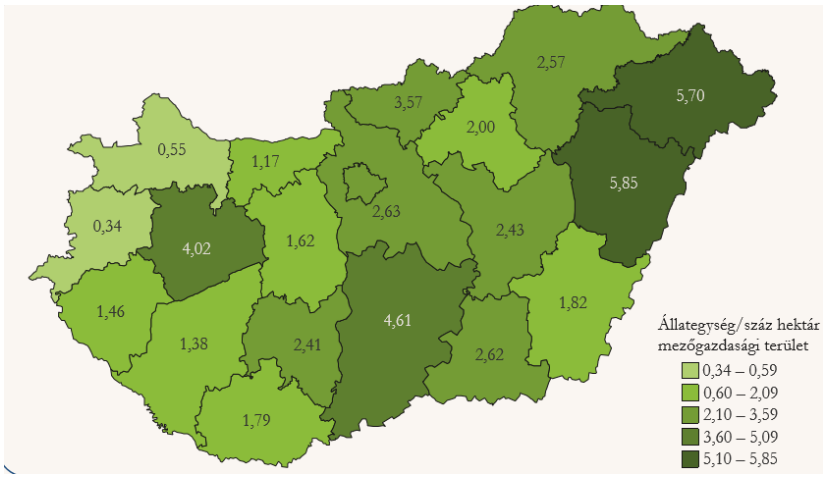


Figure 12 Ship in livestock unit /100 ha in 2016[24]

Nearly two-thirds of cattle farms, about 13,000 farms have fewer than 9 animals (heads), accounting for 6% of the total stock (45,000 animals) and more than half (ca. 380,000) is kept by units with more than 500 heads (ca.300 farms). More than 7,000 farms have a size range of 9 to 500 heads.

55% of pig farms had 1-2 pigs, 39% of them (equal 48,000 farms) has 3-9 pigs. 63% of the pig fams, have more than 5,000 pigs (some 1.8 million pigs). The structure of

[23] *Source: https://www.ksh.hu/docs/hun/xftp/idoszaki/gszo/agrarium16.pdf*

[24] *Source: https://www.ksh.hu/docs/hun/xftp/idoszaki/gszo/agrarium16.pdf*

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

the pig population is similar to that of bovine animals, with the smallest flocks appearing on individual farms. The majority of the stock is located in about 200 large farming organizations. The size distribution of sheep, goat, horse and poultry populations is similar to the above, with thousands or tens of thousands of small and in medium-sized categories.

A substantial share (HUF 25.2 billion) was fulfilled through the transitional national aid (TNA) related to the single area payment scheme and the associated de minimis subsidies. Within the framework of the TNA, primarily the milk, cattle, sheep and tobacco sectors have been financed.

The pig and poultry sectors do not benefit from EU funds; they are wholly subsidized from domestic budgets. In 2018, HUF 9.3 billion was divided between pig farmers, HUF 7.4 billion for breeding sows, while poultry holders could use HUF 13.2 billion under this heading and HUF 1.4 billion under the animal welfare support of hens producing table eggs and breeding poultry species. A significant amount (HUF 4.4 billion) was used for support for the removal and neutralisation of animal corpses and for support for the prevention and elimination of certain animal diseases (HUF 11.7 billion). The appropriation for supporting animal breeding tasks contributed HUF 1.3 billion to help the work of breeding organisations.[25],[26]

2.2 Biomass potentials from residues and unused lands

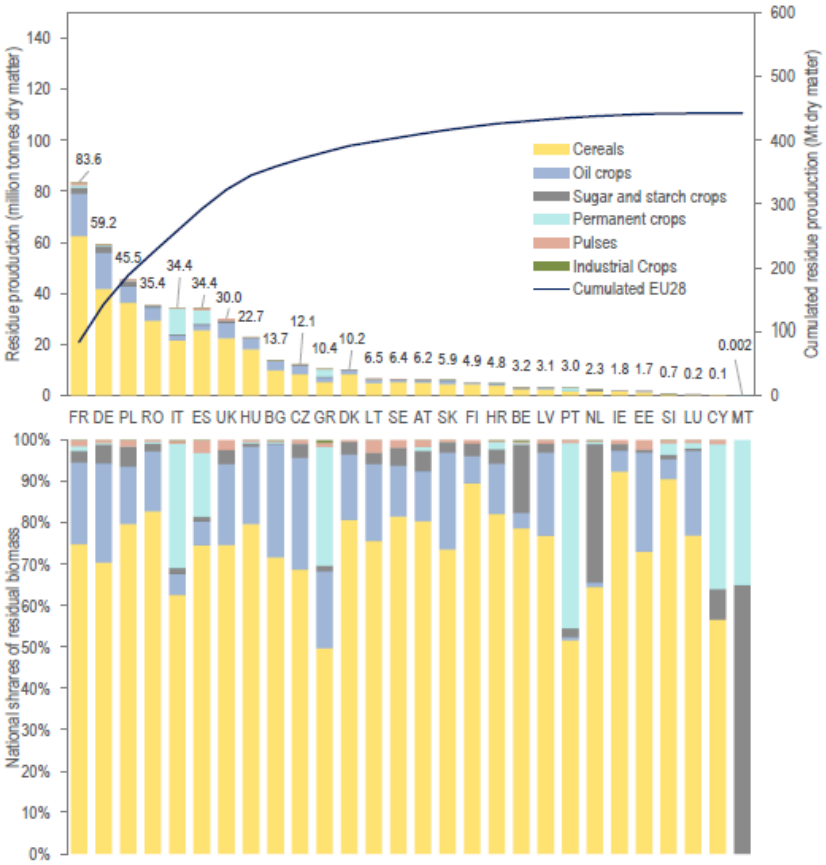
In terms of residual biomass production, Hungary scores quite well as compared to most EU countries as Figure 13 shows. According to these JRC estimates per year 22.7 mln ton of residues are produced of which the main sources are cereals and

[25] *http://www.kornyezetvedok.hu/vgt/vgt2/orszagos/3_2_hatteranyag_tanulmany_tragyatarolo_NAIK.pdf?pictur*

[26] *https://webcache.googleusercontent.com/search?q=cache:ThtXbHMUGIIJ:https://www.kormany.hu/en/ministry-of-agriculture/news/we-have-succeeded-in-protecting-the-interests-of-hungarian-farmers-in-brussels+&cd=3&hl=hu&ct=clnk&gl=hu*

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

oil crops. Based on the Sankey diagram data (presented in Chapter 1, Figure 4) only 5.3 mln ton are known to be harvested at this moment. How much can be mobilised of this technical residual biomass resource taking account of



sustainability considerations of which the main is the conservation of organic carbon in the soil, will be discussed in next sections.

After the timber, agricultural by-products provide the second highest amount of biomass in Hungary.

Although the heating value of these horticultural by-products is very similar to wood, and the pruning chips can easily be stored and transported, most of the residual biomass is either burnt on site or chopped and used as soil amendment.[27]

Figure 13 Residue production (top pane) from the main crop groups per member state, expressed in Mt of dry matter per year; and the shares at national level (bottom pane). Average values over the reference period 2006-2015.[28]

[27] *Source: ttps://klimainnovacio.hu/files/files/bioeconomy_study_final_draft_feb2014.*

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

2.2.1 LIGNOCELLULOSIC RESIDUAL BIOMASS FROM CROPS

As already became clear Hungary has a large cropping sector and therefore the residual biomass potential from arable crops is certainly of interest. However, how many crop residues (e.g. straw) can be removed sustainably depends on several factors. Especially the maintenance of soil organic matter is a relevant function of straw-removal. Also the nutrient balance should be maintained, but nutrients are often replenished, by mineral fertilizer application practices. The input of soil organic matter however is often only dependent on crop residues left behind. The amount of straw to be kept in the field is complicated to estimate as it depends strongly on the soil and climate characteristics and the long term management practices. To give a good estimate of residual biomass potentials that can be sustainably removed we use data generated in the S2BIOM project (Dees et al., 2017ab).

The annual volume of the biomass producing by pruning on vineyards is 150-200 thousand tons. Most of it is burned in the outdoors, the rest is crushed, then incorporated into the soil. Wood chips or bale has relatively high calorific value and it can be stored well. The annual thinning of fruit trees results 400-500 thousand tons of biomass, and every four to five years the tree regeneration produces an even greater amount of redundant biomass, its calorific value is close to its vine branch.

In S2BIOM a 'base potential' was assessed for residual biomass. It identified the part of the residues that can be removed from the field without adversely affecting the SOC content in the soil. The soil organic carbon balance is the difference between the inputs of carbon to the soil and the carbon outputs. A negative balance, i.e. outputs are larger than the inputs, will reduce the SOC stock

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

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

and might lead to crop production losses on the long term. To calculate the soil carbon balance at regional level S2BIOM used the MITERRA-Europe model (Lesschen et al., 2011) to provide the input data and the "RothC-26.3" model (Coleman & Jenkins, 1999) to calculate the soil carbon dynamics. Further details on the whole assessment of biomass potentials in S2BOM are presented in Annex 2 of this report. In the Table 8 and The use of agriculture residues from bioenergy today include mainly straw (bales or bundles) or agropellets produced from straw and other agricultural residues such as sunflower husks. The main markets are heat in domestic boilers and district heating, CHP and electricity plants with the largest consumption in Denmark and smaller markets in Hungary, Spain and the UK. The use of agricultural residues in bioenergy are however not reported in EU statistics and therefore difficult to quantify (AEBIOM, 2017). Cereal Straw consumption is mostly in livestock sector (2 mio t/year).,. This implies that there remains still 1.5 million ton cereal straw to be used for other purposes. The maize stover potential in Hungary is also large and largely unused (see Table 8).

Table 9 the S2BIOM residual biomass potentials are presented for Hungary.

After woody, agricultural by-products provide the next highest amount of biomass. Every year 4-4.5 million tonnes of straw are produced from the cultivation of grain cereals and of this about 2.4-2.8 million tonnes could be used for energy production or other biomaterial applications, in a sustainable manner. From Table 3 it can be seen that 70% of the wheat straw is already utilized and therefore also removed. In addition, 8-10 million tonnes of maize stover is produced annually (more than the weight of the grain) and 2.5-3.0 million tonnes could be utilised as biomass for energy production.

Table 8 Residual biomass potentials from arable crops 2020 in kton d.m. (=S2BIOM base potential) (see for approach Annex 2)*

	Rice straw	Cereals straw	Oil seed rape straw	Maize stover	Sugarbeet leaves	Sunflower straw	Total
Budapest	-	15	2	13	305	6	37
Pest	0	181	28	161	4	79	452
Fejér	0	177	20	211	3	64	476

Komárom-Esztergom	-	92	10	110	2	33	247
Veszprém	-	168	19	201	3	61	452
Győr-Moson-Sopron	-	225	44	220	10	40	538
Vas	-	179	36	175	8	31	429
Zala	-	201	40	196	9	35	481
Baranya	0	163	18	402	3	42	628
Somogy	-	215	24	532	4	55	831
Tolna	0	136	15	336	3	35	525
Borsod-Abaúj-Zemplén	0	197	53	91	3	98	441
Heves	0	99	27	46	1	49	222
Nógrád	-	69	19	32	1	35	155
Hajdú-Bihar	0,8	182	17	295	7	134	635
Jász-gykun-Szolnok	0,7	163	15	265	6	121	571
Szabolcs-Szatmár-Bereg	0,8	173	16	281	6	128	605
Bács-Kiskun	2,9	410	32	420	5	144	1014
Békés	1,9	273	22	280	3	96	676
Csongrád	1,4	207	16	212	2	73	512
Total	**8,5**	**3525**	**475**	**4476**	**83**	**1360**	**9927**

Significant amount of sunflower stem and oilseed rape straw are produced annually as well.

The use of agriculture residues from bioenergy today include mainly straw (bales or bundles) or agropellets produced from straw and other agricultural residues such as sunflower husks. The main markets are heat in domestic boilers and district heating, CHP and electricity plants with the largest consumption in Denmark and smaller markets in Hungary, Spain and the UK. The use of agricultural residues in bioenergy are however not reported in EU statistics and therefore difficult to quantify (AEBIOM, 2017). Cereal Straw consumption is mostly in livestock sector (2 mio t/year).[29],[30]. This implies that there remains still 1.5 million ton cereal straw to be used for other purposes. The maize stover potential in Hungary is also large and largely unused (see Table 8).

Table 9 Residual biomass potentials from permanent crops 2020 in ton d.m. (=S2BIOM base potential) (see for approach Annex 2)*

[29] *https://klimainnovacio.hu/files/attachments/page/bioeconomy_study_final_draft_feb2014_1_0.pdf*

[30] *http://www.advancefuel.eu/contents/reports/d21-report-on-lignocellulosic-feedstock-availability.pdf*

	Residues from vineyards	Residues from fruit tree plantations (apples, pears and soft fruit)	Total
Budapest	0	1,165	1,165
Pest	0	14,163	14,163
Fejér	0	2,447	2,447
Komárom-Esztergom	0	1,271	1,271
Veszprém	0	2,327	2,327
Győr-Moson-Sopron	0	3,894	3,894
Vas	0	3,123	3,123
Zala	0	3,502	3,502
Baranya	0	2,612	2,612
Somogy	0	3,456	3,456
Tolna	0	2,185	2,185
Borsod-Abaúj-Zemplén	1	6,160	6,161
Heves	0	3,093	3,093
Nógrád	0	2,162	2,163
Hajdú-Bihar	0	14,633	14,633
Jász-gykun-Szolnok	0	13,152	13,152
Szabolcs-Szatmár-Bereg	0	13,944	13,944
Bács-Kiskun	1	17,194	17,194
Békés	0	11,469	11,469
Csongrád	0	8,681	8,682
Total	**6**	**130,633**	**130,638**

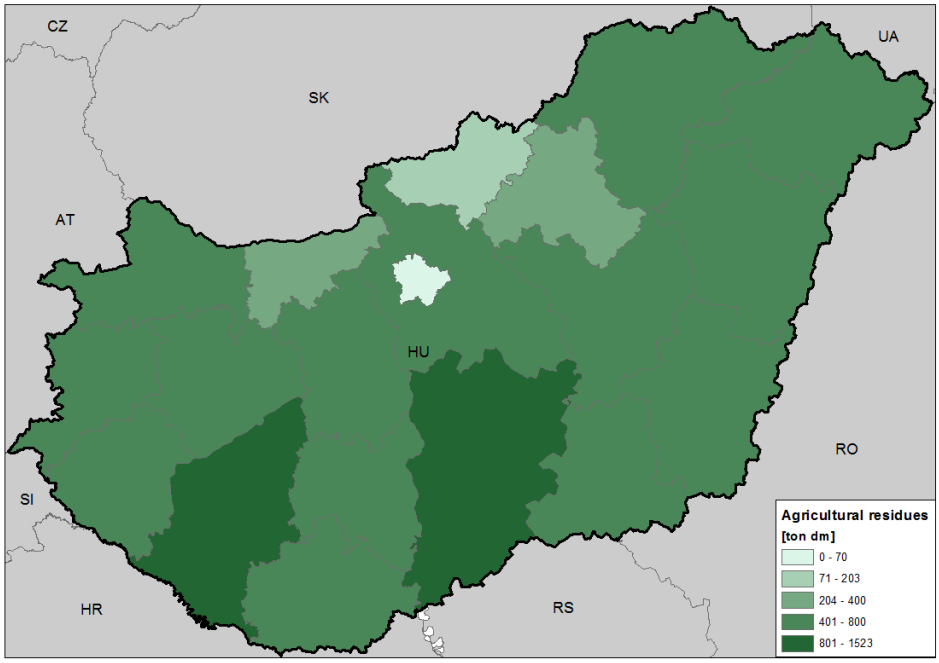


Figure 14 Total primary residual biomass potential from agriculture (S2BIOM Base potential)

2.2.2 Dedicated crop potentials from unused lands Lignocellulosic

There are 350,000 hectares of unused land (Fallow land). (Figure 15)

The fallow (unused) lands cover most of the landscape in the North Central Mountains (7.8%), mainly in its hills, followed by the Transdanubian Mountains (4.5%). The rate of the Great Plain (3.3%) and Western Transdanubia (3.2%) is slightly below the national average, even lower in the Transdanubian Hills (2.9%), while the lowest is in the Little Plain (1.3%). Most of the fallow land is in the Great Plain (164,000 hectares) and half is in the North Central Mountains (83,000 ha). 70% of the Hungarian fallow land is in these two large areas.

In S2BIOM an estimate was made of the potential for dedicated crops on unused lands. How this was assessed is described in the Annex 2. This S2BIOM assessment is not linked to the mapping of land abandonment by META. But both studies do indicated that the unused land potential is large.

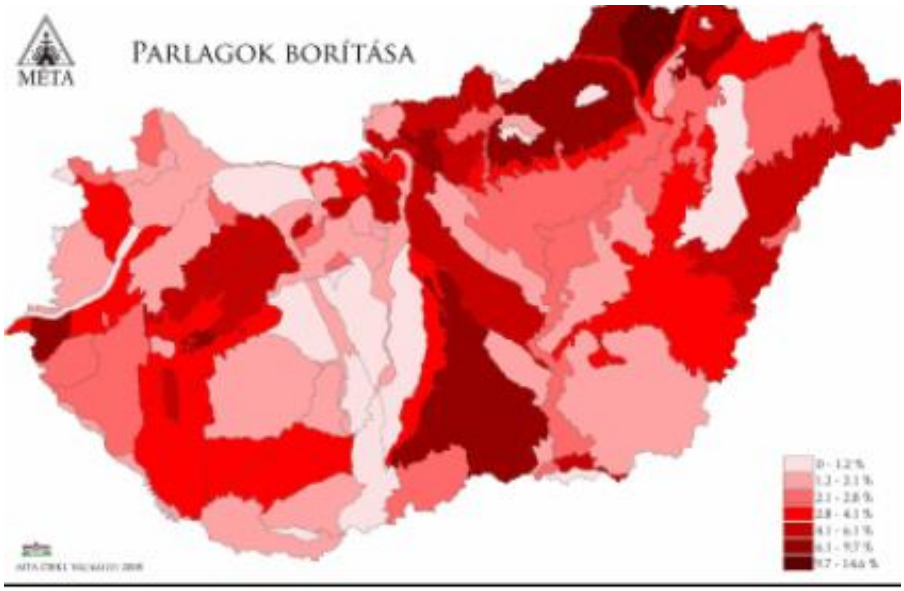


Figure 15 Fallow (unused) lands cover in Hungary[31]

Table 10 Biomass potentials from unused lands 2020 in ton d.m. (=S2BIOM base potential) (see for assessment approach Annex 2)*

[31] *Source: https://www.novenyzetiterkep.hu/node/15*

	Total
Budapest	56,507
Pest	632,977
Fejér	190,052
Komárom-Esztergom	81,244
Veszprém	164,406
Győr-Moson-Sopron	179,061
Vas	134,286
Zala	140,541
Baranya	205,333
Somogy	249,288
Tol	165,756
Borsod-Abaúj-Zemplén	298,925
Heves	135,002
Nógrád	139,192
Hajdú-Bihar	-
Jász-gykun-Szolnok	-
Szabolcs-Szatmár-Bereg	-
Bács-Kiskun	496,590
Békés	364,551
Csongrád	251,751
Total	3,885,463

2.2.3 Residual biomass potentials from livestock

Biogas plants utilize large quantities of animal by-products and other waste, such as slurry, barn and animal remains. Their use is governed by the MARD Regulation adapting the relevant EC Council Regulation. According to this, biogas plants can only use raw materials classified as so-called Class 2 (e.g. slaughterhouse waste) and Category 3 (e.g. kitchen waste, food waste). The use of co-substrates, i.e. fermentation additives such as solid or slurry, plant constituents and waste, is subject to a number of criteria. The most significant biomass in animal husbandry is the manure, which is only optimally utilized when it is immediately applied to the soil. The produced straw manure is 5-6 mio tonne, and other biomass are 4 million tonnes per year.[32]

[32] http://www.bioenergia-obekk.hu/celkituzeseink/

Table 11 Estimated manure and biogas potential from various livestock types and age groups[33]

	Livestock Unit	Manure	Manure	Methane yield	Methane yield	Electricity yield
	LSU	kg/head/day	t/head/year	m^3/head/year	MJ/head/year	kWh/head/year
calves	0.4	8.0	2.9	39.7	1426	139
bovine	0.7	20.0	7.3	99.3	3564	347
male bovine	1.0	25.0	9.1	124.1	4455	433
dairy cows	1.0	53.0	19.3	302.6	10,862	1056
other cows	0.8	25.0	9.1	124.1	4455	433
piglets	0.027	0.5	0.2	2.6	94	9
other pigs	0.3	4.5	1.6	23.7	849	83
sows	0.5	11.0	4.0	57.8	2076	202
sheep	0.1	1.5	0.5	26.3	943	92
goat	0.1	1.5	0.5	26.3	943	92
broilers	0.007	0.10	0.04	1.9	67	7
laying hens	0.014	0.20	0.07	3.7	134	13
other poultry	0.03	0.30	0.11	5.6	201	20

Source: www.sciencedirect.com/science/article/pii/S1364032118304714#bib29

The lowest yield of biogas feedstocks is due to the high moisture content of the animal manure, so this feedstock should only be processed in a biogas plant that can be fed locally or via pipeline to reduce transportation costs.

The agricultural biogas potential was estimated on the basis of the amount of manure from the largest livestock farms and the amount of straw needed for optimal fermentation of most of the methane produced. The estimated livestock in livestock units is about 60% of the national herd. The amount of straw calculated from the optimum incorporation rate is only 18-34% of the nationally harvested straw from cereal field production, depending on the scenario.

From the carbon, nitrogen, organic matter and dry matter content of the manure and the straw, we calculated the amount of straw that can be mixed with the manure volumes in natural units (raw or wet tons). The following table summarizes the fertilizer quantities calculated from the livestock forecast and estimates of the

[33] *Source: www.sciencedirect.com/science/article/pii/S1364032118304714#bib29*

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

lower and upper values of the mixable straw volume.

Table 12 Forecasts of all manure and all straw that can be blended during the fermentation of biogas in Hungary, thousand tons

	Manure	7% Straw	10% Straw
2018	11 503	805.2	1 150
2019	11 622	813.6	1 162
2020	11 741	821.9	1 174
2021	11 860	830.2	1 186
2022	11 979	838.5	1 198
2023	12 098	846.9	1 210
2024	12 217	855.2	1 222
2025	12 336	863.5	1 234
2026	12 455	871.8	1 245
2027	12 574	880.2	1 257
2028	12 693	888.5	1 269
2029	12 812	896.8	1 281
2030	12 931	905.1	1 293

Table 13 Produced and collectible farm manure and biogas potential for AD in Hungary.[34]

Manure		Biogas potential		Natural gas
produced [million t]	collectable [million t]	theoretic [million m^3 CH_4]	realistic [million m^3 CH_4]	consumption [million m^3 CH_4]
16.4	10.8	389	260	11,763

Currently, there are about more than 50 agricultural biogas plants in Hungary with a total electricity generation capacity of 37 MWe. (see detailed in Chapter 5.2.1.1.) In the absence of investment subsidies, the construction of new capacities has declined significantly in recent years

[34] https://rekk.hu/downloads/projects/2019_REKK_NEKT_megujulo_final.pdf

In addition to energy issues, anaerobic digestion of manure also reduces greenhouse gas emissions by preventing the release of methane into the atmosphere.

2.3 AGRICULTURAL PROCESSING INDUSTRIES

2.3.1 MAIN AGRIFOOD PROCESSING INDUSTRIES

The food industry is the third largest industrial sector in Hungary with a production value of around HUF 2,600 billion, making it the 16th place among the EU Member States and accounting for one percent of EU production. The agri-food sector in Hungary experienced very mixed results since its entry into the European Union. However, if Hungary used to be Europe's breadbasket, today agriculture and the agri-food sector play only a very small role in its economy, which has become very dependent on foreign trade. The food industry accounted for 1.9 percent of GDP in 2017.

Hungary is one of the 3 largest crop producers of the CEEC region, due to its exceptional geographical location, that enables the production of a multitude of crops. In Hungary agricultural production is 100 % GMO free.

The most relevant food industry (Figure 16) segments are:

- meat processing and preserving
- mineral water, soft drinks, alcoholic and other beverages
- pet food and feed production
- milk processing, dairy products
- sweets, snacks, convenience and other foods
- fruit and vegetable processing and preserving.

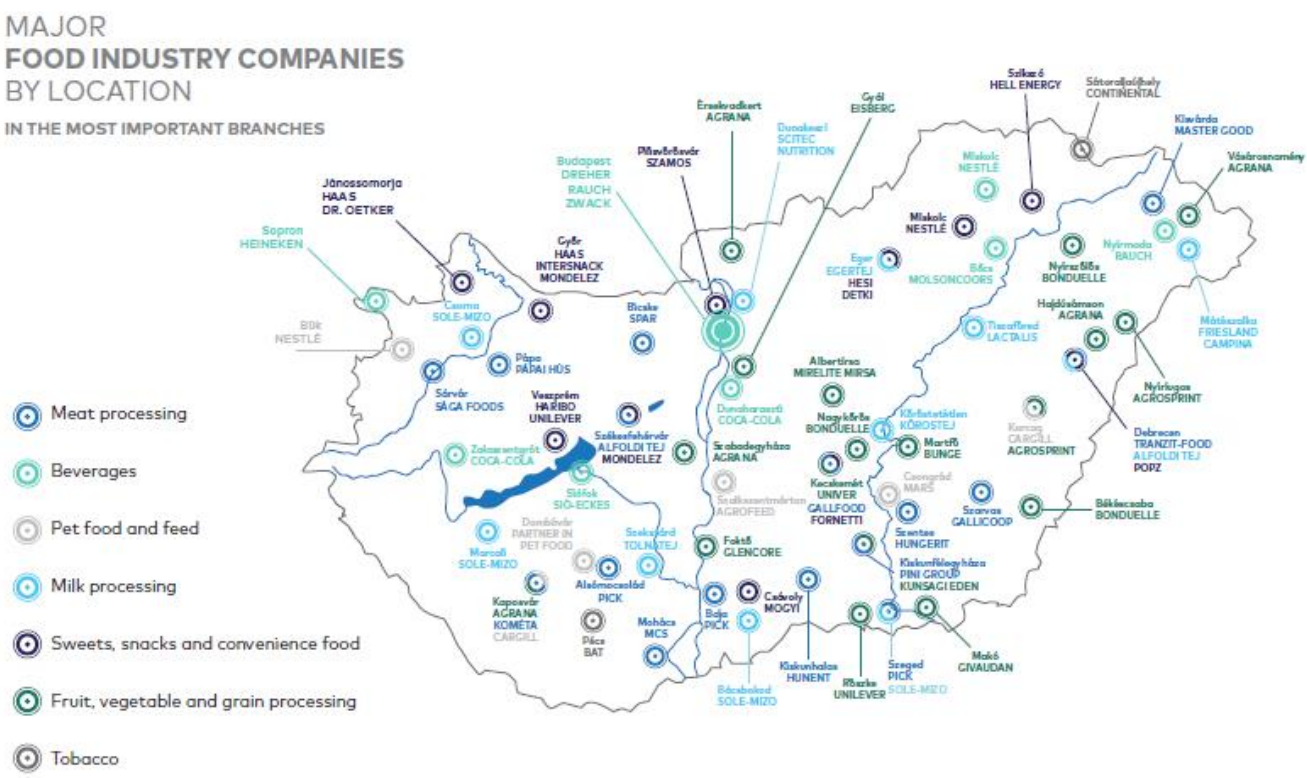


Figure 16 The geographical distribution of the food industry.[35]

Figure 17 The geographical distribution of the main food companies[36].

[35] https://mtu.gov.hu/documents/prod/Hungarys-industry-overview.pdf

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

Food production is moderately concentrated, with the top five sectors accounting for more than 40% of total production value in 2016. The three meat industries provided almost one quarter of the value of production (24.9%), within which the processing and preservation of poultry meat became the largest food industry with a share of 10.1%.

Table 14 The size of firms in the sector[37]

	Mikro	Small	Medium	Large
Firms	3 415	771	278	62
Revenue per company, Mio Euro	360.66	1147.40	2668.45	4774.90

Industrial output growth

Last year, output in Hungary's food industry increased by 1.4-1.5 percent, which exceeded the average rate of industrial output growth – the Deputy President for Food Industry of the Hungarian Chamber of Agriculture noted recently at a press conference. The value of output totalled 8730 million EUR (2 880bn HUF), up by 2 percent compared to the year 2015. In 2016, 20 percent of registered economic corporations were active in the food industry. Within the three branches of the food industry, the manufacturers of food products and beverages constituted the highest number of registered economic corporations. The number of these companies has been rising steadily, and it hit 8144 in the year 2016. Of these, 61 percent were corporations and 39 percent were unincorporated enterprises.

Regional positions

Concerning regional positions, 33 percent of food industry enterprises were registered in the Central Hungary region, but double-digit figures were also observed in Northern Hungary, and the Northern Great Plain and Southern Great Plain regions. The beverage manufacturing sector has seen consolidation that

[36] *http://www.sell-buy-machines.com/2014/04/hungarian-food-industry-cmea-eu.html*

[37] Source:*eta.bibl.u-szeged.hu/2105/1/Élelmiszer-gazdaság.pdf https://elir.aki.gov.hu/cikk/elelmiszeripari-kkv-k-reszesedese*

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

resulted in a shift towards higher quality products. Hungary's food strategy targets further expansion in output, the improvement of competitiveness and the bolstering of market positions. The fact that the sector was named as one of the priority fields worthy of development in Hungary's re-industrialization blueprint, the Irinyi Plan, also shows the importance of these industries. The major instruments aiming to bolster the sector through EU funding are the Rural Development Programme and the Economic Development and Innovation Operational Programme (EDIOP), while the Large Enterprise Investment Support Programme provides grants for large enterprises which are not entitled to EU funds but wish to expand production capacities. . For the latter scheme 45 million EUR was allocated in the year 2017, and since the start of the programme in 2015 49 large enterprises have received grants of 212 million EUR. Thus, the Government has helped create 1 650 new jobs[38].

Capacity utilization

In the meat industry, pig slaughtering companies operated an average of 193 days, seven hours a day, and overall capacity utilization was 72 percent, two percentage points lower than a year earlier. However, the slight decrease is partly due to the gradual start of production in new plants and units as new investments are completed. For cattle processing companies, the AKI report showed lower utilization rates.

According to this, cattle slaughterhouses operated an average of 122 days, four hours a day in 2017. Existing plants in the sector used 53 percent of their available capacity.

Processor's workload in the poultry sector was much higher. Overall, average capacity utilization in the sector was 80 percent.

38 https://www.kormany.hu/download/8/e7/21000/Hungarian%20Outlook_Hungary's%20food%20industry%20is%20competitive%20in%20the%20region.pdf

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

Production of the refrigeration and canning industry has declined over the past decade, and its product structure has been significantly simplified. Nowadays the business activity of enterprises is limited to the processing of two crops, green peas and sweet corn.

Fruit processing is essentially based on the production of industrial apples, followed by sour cherry processing. The production of the refrigeration and canning industry is strongly influenced by seasonality. For example, during the summer-autumn period, production was continuous in three shifts, in many cases at the end of the week, while production was in the rest of the year. Canneries working on sweet corn did more work last year than a year earlier - at least, according to AKI, which said production line capacity utilization was 78.5 percent, 11.4 percent higher than in 2016.

The mill industry was even more heavily loaded last year, with two-thirds of the plants operating at nearly 80 percent utilization. The average capacity utilization of cereal breakfast food, puffed, extruded food production line was 63 percent in 2017. Bakeries have also produced high revolutions last year. In 2017, 24 percent of bakery companies reporting bread production were very high, with more than a third belonging to the high capacity utilization group in 2017.

Major professional organizations in the food industry in Hungary

National Association of Food Processors (ÉFOSZ)

Since its establishment in 1989, the National Association of Food Processors (ÉFOSZ) has been the national economic and professional interest representation organization of Hungarian food companies. ÉFOSZ is a federation of 8 national food trade associations, and a federation of more than 50 direct individual members. In addition, the association cooperates with other non-federated national trade associations. The activities of the approximately 700 direct and direct members cover, by profession, the cross-section of the food and beverage

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

industry in terms of activity, size and form of enterprise. Their membership generates 1,800 billion HUF gross production value, buys 50-55% of agricultural commodity production and 75% of the workforce employed by the industry. This organisation is full member of FoodDrinkEurope, and the European Food Industry Confederation.

Member Associations:

- Hungarian Meat Industry Association
- Hungarian Bakery Association
- Sugar Association
- Hungarian Confectionery Manufacturers Association
- Hungarian Refrigeration and Canned Food Association
- Hungarian Mineral Water, Fruit Juice and Soft Drinks Association
- Dairy Association

2.3.2 SIDE-PRODUCTS FROM AGRI-FOOD PROCESSING

Main industries and residual biomass types and amounts.

Of the by-products of food production, the treatment of animal waste is regulated. Depending on how dangerous the product is, they are classified into three categories. The first category includes the most hazardous substances which must be incinerated, composted or disposed of in landfills.

The second and third categories are the less hazardous substances which, with a few exceptions, can be used as pet food. Otherwise, foods with an expired shelf life that have not yet deteriorated can benefit from this fate.

The meat industry sells by-products as pet foods, and the by-products of mills and oil mills are well-marketed feed materials. Large quantities of vegetable and fruit waste are difficult to sell for animal feed because modern livestock farms are strictly fed and have no demand for such by-products.

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

Composting is equally problematic as there is no demand for green manure in agriculture. Vegetable and fruit processors also complained that the Waste Act does not distinguish between municipal wastewater from animal production and sewage containing only plant parts in terms of wastewater and sewage sludge, which means extra investment, high treatment costs for these companies, it also makes it impossible to make better use of this valuable biological material.

In 2018, the Food Chain Research Department of the Agricultural Research Institute sent questionnaires to more than 4,000 food companies, which received 175 valid answers. The survey was conducted to explore methods for handling food waste. Underneath the results are discussed.

According to the results, nearly two-thirds of companies track food waste accurately, another 11 percent are able to calculate the amount generated from other records, and 22 percent of respondents are able to estimate the amount of waste generated. Not surprisingly, the existence and accuracy of the records were statistically demonstrable in relation to the size of the companies, their affiliation (most accurate records exist in the oil, meat and dairy industries), but also factors such as whether the company has an integrated corporate governance system, control department, website.

The majority of respondents did not consider the presence of losses to be a problem at all, which is probably explained by the fact that it was considered a natural part of the technological process.

This is also supported by the fact that more than half of the respondents said that technological losses account for more than 80% of all waste. At the same time, for companies where the management of losses is highly regulated and rather costly (typically within the sub-sectors processing animal products), the generation of losses was considered a more serious problem. It was also typical that larger companies, where there is a greater concentration of losses, companies with a controlling department and corporate governance, and those that accurately

record the resulting losses and thus deal with their size, rated the phenomenon as a significantly more serious problem.

The companies surveyed clearly treat food loss as a material issue: they therefore strive to achieve better yields, to utilize unavoidable losses as much as possible, or to dispose of them at least as cheaply as possible. This is also supported by the fact that three quarters of respondents have so far not perceived any external expectations (from society, consumers, public authorities, etc.) to reduce or make better use of their losses. There are also many regulatory obstacles to the use of animal feed (very strict requirements for feed for farm animals).

In most cases, it affected meat products by-products sold as pet food, as well as sought-after, well-marketed feed materials from the mill industry, oil by-products. However, other plant processing companies have often reported that it is impossible to sell large quantities of vegetable and fruit waste for animal feed because modern livestock farms follow strict formulas and there is no demand for such by-products.[39]

From S2BIOM we looked at a selection of agrofood potentials in Table 15.

Table 15 Biomass potentials from agrofood processing industries 2020 in Ton d.m. (=S2BIOM base potential) see also Annex 2

	Cotton gin residues	Rice husk	Pressed grapes dregs	Cereal bran	total
Budapest	-	-	19	55,509	55,528
Pest	0	0	234	30,489	30,723

[39] *Source:https://humusz.hu/hirek/nemcsak-fogyasztok-pazarolnak/25121*

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

Fejér	0	0	258	20,487	20,746
Komárom-Esztergom	-	-	134	10,638	10,772
Veszprém	-	-	246	19,477	19,722
Győr-Moson-Sopron	-	-	156	19,806	19,962
Vas	-	-	121	15,703	15,825
Zala	-	-	136	17,613	17,749
Baranya	0	0	280	20,267	20,547
Somogy	-	-	370	26,828	27,198
Tolna	0	0	234	16,949	17,184
Borsod-Abaúj-Zemplén	0	0	836	29,283	30,119
Heves	0	0	420	14,705	15,124
Nógrád	-	-	293	10,278	10,572
Hajdú-Bihar	140	131	58	32,079	32,407
Jász-gykun-Szolnok	125	118	53	28,841	29,137
Szabolcs-Szatmár-Bereg	133	125	56	30,584	30,898
Bács-Kiskun	377	445	567	47,772	49,161
Békés	251	297	378	31,852	32,778
Csongrád	190	225	286	24,115	24,816
Total	**1,216**	**1,341**	**5,136**	**503,276**	**510,969**

2.4 Cost of main biomass sources

Since for most agricultural residues no commodity market has developed yet it is very difficult to provide figures on prices. Instead cost estimates can be presented building on the S2BOM methodology and assessment. The cost refer to *Road side cost* and these covers all biomass production collection and pre-treatment cost up to the road where the biomass is located. The road side cost is a fraction of the total 'at-gate-cost.' For further details on the cost calculation in S2BOM see Annex 2.

Table 16 Road side cost levels (€/ton d.m.) for agricultural biomass sources based on S2BIOM cost calculations[40]

Road side cost for agricultural biomass	Average (€ ton dm) (2020 cost level)
Cereal straw	17
Rice straw	20
Rape seed straw	14
Sunflower straw	17
Grain maize straw (stover)	13
Residues from fruit tree plantations (apples, pears and soft fruit)	60
SRC unused lands	36
Dedicated perennial crops unsed lands	36

2.5 Summary and conclusions in relation to SWOT elements

What feedstock is there and can be realistically mobilised given land managers willingness and capabilities and given options for efficient logistical handling of the biomass? Biomass production/harvesting/collection is a challenge for different reasons. One of these is that biomass is produced dispersed (a low density per area) and is almost by definition bulky, low in energy density and generally contains considerable amounts of water. Furthermore, the facilities to collect, transport and pre-treat are not always well developed in the areas with highest biomass concentration. Local arrangements and regulations can also influence access and ownership rights to lands where biomass resources are available.

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

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

Table 17 SWOT factors regarding biomass feedstock

Strengths	**Weaknesses**
Regularly higher amounts of cellulose-based raw material (20 mio t/year) Oil plants are on 0,9 mio ha- the crop and by-products of crop could also be used for biodiesel Semi- Warm-demanding plant species may also be involved in the production in extensive areas (e.g. Sorghum species) for bio-ethanol Secondary biomass of livestock means 5-6 mio t manure Feedstock price is low by cereal production with low quality There are biogas industries in the country High expertise regarding to using biomass (e.g. biogas) There are worker training and engineer education in biomass skills There are labors where MSZ EN ISO 17025:2005 standard used for analyzation of biomass There are research projects of biomass-sector at the universities and research institutes A lot of employment opportunities Investors in biomass-processing: poultry farms, biogas-industries Own biomass processing by livestock-farms- to risk minimization	Second-generation (cellulose-based) bioethanol production processes are more expensive Long transportation distance Low capacity of transport There are few decentralized smaller power plants Logistic is unorganized Higher price of the end product compared to conventional fuels for personal users Additional land use (ILUC, particularly for oil crops if converted to diesel) Quality of plants is different in every harvest season Seasonally working industries are less sustainable from economical aspect The less biomass in the soils are less sustainable from environmental aspect
Opportunities	**Threats**
Public support for the use of biomass Discount on fuel oil tax on vegetable oil There are official regulations for productions and the market Clarified legal and ownership system Low rates of loan (good CAPEX possibility)	General organic matter deficiency in soils Increased imports of biodiesel into the EU due to tariff -it can influence the economical sustainability The product range is scarce, only the biomass used for heating is widely known Just on a few areas of land is infrastructure available Transport are mostly on route in Hungary, tariffs of cargo are relatively high in the country Additional land use might lead to in- direct land use changes, in worst case to deforestations Low price of biomass-based energy 0,1 Eur/kWh- (OPEX min.0,13 kFh)

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

3. Biomass supply: Forestry

This chapter gives an overview of the forest sector and will particularly explain the biomass potential situation. The potential can roughly be defined by the quantity and quality of the biomass. Aspects related to quantity are yield, availability and transportability. Aspects related to quality are storability, stability and composition.

3.1 Introduction

According to the information registered in the National Forestry Database, in 2006, at the beginning of the National Forest Program cycle, one fifth or 19.9% of Hungary's territory was covered by forests. By the end of 2014, the country's forest cover reached 20.8 percent, which is 1,939,263 hectares. The country's total forest management area is 2,059,678 hectares, or 22.1 percent.

Most of the forest area (89%) is occupied by deciduous species, with acacia (24%) and oak (21%) accounting for the largest share. 63 percent of the forests are indigenous and 37 percent are non-native species or breeds. Due to the afforestation, the forest area of Hungary has increased further in the last ten years. Spontaneous afforestation of unused agricultural land also contributes to this.

The stock of live wood in Hungary's forests now exceeds gross 360 million m3 and its growth trend has continued over the last ten years. The national average annual growth is 6.5 m3 per hectare. The positive change is due to the continuous increase of forest areas. On some areas increasing the ripening age of protected forests; and making more limited use of logging opportunities.

In recent years, a number of thermal power plants have been converted to large biomass firing, which came mostly from national forest resources. As these power plants require millions of tonnes of biomass each year to operate safely, it is easy to see that this amount cannot be sustained in the long term without the loss of forest land. About 9 million tonnes per year of renewable growth in forests, which can be

harvested in the frame of sustainable forest management and used for industrial or energy purposes.

In the forest sector stemwood, primary residues and secondary residues from forest industries are available. For bioenergy and bio-material potential assessment we particularly focus on availability of primary and secondary residues as stemwood conversion to energy is not the most resource efficient and therefore preferable use. The assessment of the stemwood and primary residue potentials is done by using the EFISCEN model and using national forestry inventory data as input. The secondary forestry residues from saw mills and wood processing industries build on the potentials assessed in EUWood and S2BIOM in combination with some up-dated data from national sources. These are presented in Section 3.2.

Primary forestry production accounts for an additional 4.8 mio dry tonnes / year. Estimated sustainable potential can reach up to 6.3 mio dry tonnes/ year. [41],[42]

Table 18 Overview of main characteristics of forestry sector in Hungary[43],[44]

Category	Hungary	EU average	Unit
Forest area	0.19	0.650	ha/capita
Forest increment	6.60	5.47	m^3/ha
		2.80	m^3/capita (2010)

[41] http://www.fao.org/forest-resources-assessment/current-assessment/country-reports/en/

[42] *https://www.kormany.hu/download/a/1a/d0000/Nemzeti_Erdőstratégia.pdf*

[43] *https://www.ksh.hu/docs/hun/xstadat/xstadat_eves/i_ome002b.html*

[44] *https://2010-2014.kormany.hu/download/1/11/70000/miniszteri%20tajekoztato_erdoallomany.pdf*

Figure 18 Forest areas in Hungary[45]

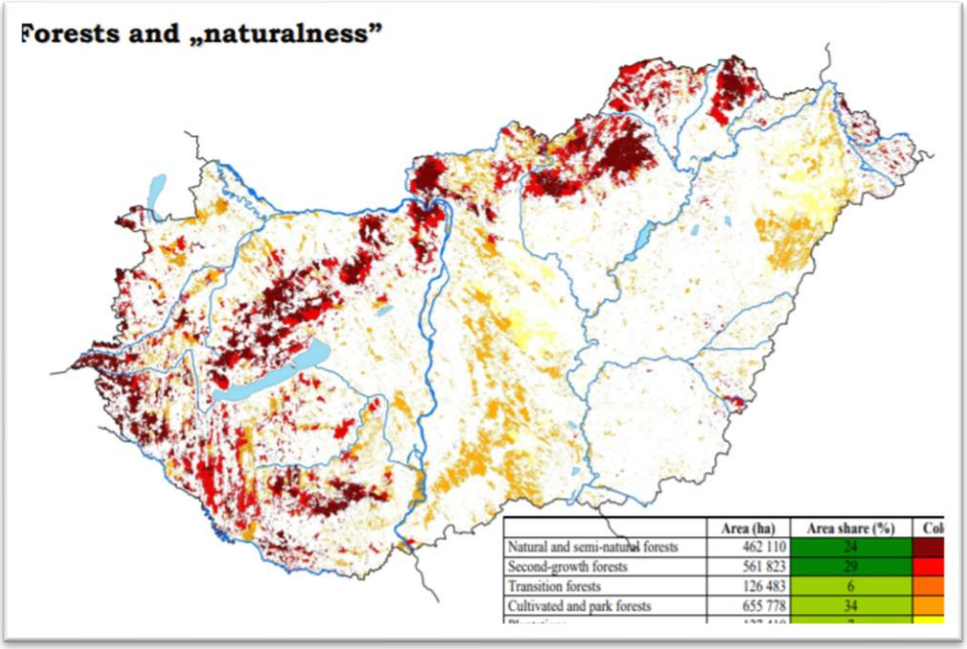


Figure 19 Forest naturalness in Hungary[46]

[45] Source: https://www.tankonyvtar.hu/hu/tartalom/tamop412A/2011-0038_35_kertesz1_en/ar01s04.html

[46] *Source: http://www.mecsekerdo.hu/_user/browser/File/pdf/Efol/EFOL_Forestry%20in%20Hungary.pdf*

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

3.2 Primary biomass resources from forestry

Table 19 Quantity Description Estimate Forest land[47] Category	1000 ha
With defined tree species	**1869.3**
Areas directly supporting production forest management (e.g. glade, nursery, lane, etc.)	129.1
Primary forest function	1188.9
Protective and protected forests	656.1
Health-care, social and tourist forests	18.7
Educational and research forests	5.6

Forest area for industrial utilisation

An increase of forest cover yields causes an increase of current growth and an increase of usable growing stock. However, exploitation is limited to 62.7% of the total forested area designated for industrial utilization. The remaining areas are protected (36.2%) and recreational (1.1%) forests where harvesting for industrial purposes is not allowed (NÉBIH 2014). The volume of tree harvesting is about 70–75% of the current grown.

The species composition of Hungarian forests is uniquely diverse. Angiosperms are dominant (88.9%) and only 11.1% of the total area are covered by conifers. Native hardwoods like oak, turkey-oak, beech and hornbeam comprise 63% of the forest. The remaining 37% is covered with introduced wood species such as black locust, red-oak, as well as some spruce and pine species. Consequently, this diversity in species determines the composition of split round-wood and fuel wood materials.[48]

Wood species

[47] *Source: https://link.springer.com/content/pdf/bbm%3A978-90-481-3233-1%2F1.pdf*

[48] http://real.mtak.hu/42314/1/ASLH_Vol_12_2016_Issue2_13_Laborczy_Winkler.pdf

Three wood species utilized for energy purposes are acacia, willow and poplar. Acacia, which is found mainly in flat areas, takes 2-5 years to cut and reaches 5-10 t / ha per year in a short and medium rotation system.

In flat areas, we also see willows, as trees growing up to 20-25 m in height provide the highest yields below 400 meters (35 t / ha / year). As opposed to acacia and willow, poplar trees can be grown mainly in areas over 700 meters. Although it has a significant yield (20-25 t / ha / year), due to its high environmental demand, cultivation is not typical in Hungary.

The great advantage of dendromass is that it can deliver a significant amount of energy to end users in a relatively short period of time. Its application improves the energy balance and helps the country to develop a decentralized energy market as soon as possible. The recovered raw material is suitable for both incineration and recovery as a green stream. 70% of wood use as firewood, which is mainly for residential use. Power plants use 22% of it.

Primary Forest Biomass potentials

The major advantage of plantation real forests is that fast growing, non-native species can be cultivated. This provides quick return of investments for the owners and lessens the extractions from the primary forests. However, there is a hazard that non-native species become invasive and may transmit dangerous infections to which the indigenous trees are not immune.[49]

Table 20 Primary biomass potential from forests Kton d.m. (S2BIOM Base potential 2020)

[49] *Source: http://real.mtak.hu/42314/1/ASLH_Vol_12_2016_Issue2_13_Laborczy_Winkler*

	Final fellings	Thinnings	Logging residues from final fellings	Logging residues from thinnings	Total
Budapest	13	5	4	1	23
Pest	272	100	63	13	449
Fejér	100	42	20	4	165
Komárom-Esztergom	98	41	17	4	161
Veszprém	235	99	34	8	376
Győr-Moson-Sopron	185	68	30	7	290
Vas	236	85	40	10	371
Zala	296	107	49	12	463
Baranya	273	108	66	13	460
Somogy	296	117	57	10	481
Tolna	148	59	39	8	255
Borsod-Abaúj-Zemplén	284	174	36	12	505
Heves	133	81	20	7	240
Nógrád	130	80	37	12	258
Hajdú-Bihar	133	56	17	3	210
Jász-gykun-Szolnok	78	31	7	2	119
Szabolcs-Szatmár-Bereg	189	78	26	3	296
Bács-Kiskun	234	114	59	16	423
Békés	58	19	10	2	89
Csongrád	63	26	13	4	106
Total	**3,453**	**1,489**	**646**	**151**	**5,739**

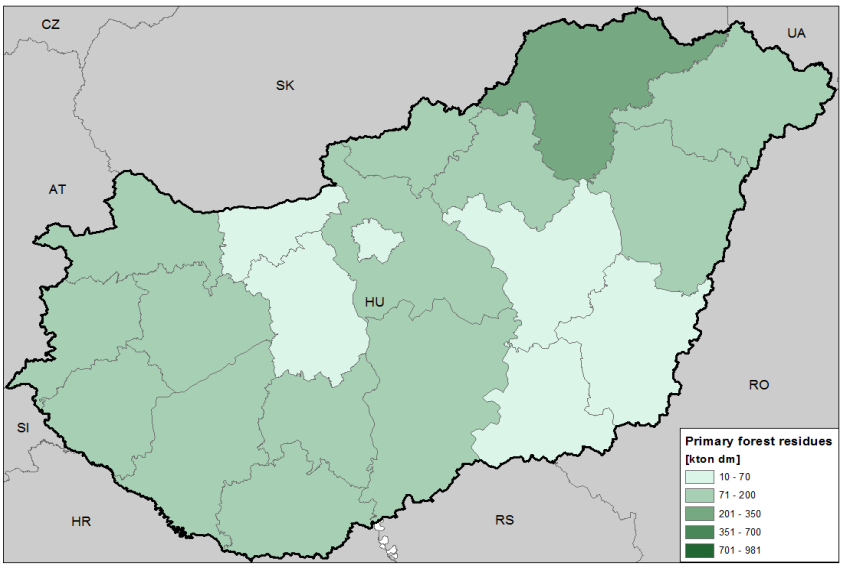


Figure 20 MAP 3.1. Distribution of primary residues potential from forests Kton d.m. (S2BIOM base potential 2020)

Table 21 The use of wood-based biomass in Hungary[50]

Application type	Domestic raw materials	Imported raw materials
Direct use for energy production	3.5 Million m3 firewood 5,000 tons pellets 2,000 tons wood briquettes	78,000 m3 firewood 15,000 tons and other archives
Indirect use for energy production (waste)	65,000 m3 wood residues for energy purposes	240,000 tons wood residues for energy purposes
Short rotation energy plantation	3,398 m3 (poplar and willow)	–
All energy	656.3 ktoe	89.5 ktoe

The use of wood-based biomass is based not only on domestic available supplies, but also on additional imported sources. The latter could be reduced or even completely replaced by further afforestation, which could affect major cost savings.

Further possibilities to increase the area of plantation forests are:

- Drained floodplains and flood-prone areas are excellent growing sites for near to nature plantation forests.
- By controlling water supply on former floodplains, the non-native species may result in plantations having different growing cycles.
- Planting drought resistant (xeromorphic) non-native species on arid growing sites may increase dendromass production.

[50] NÉBIH 2014

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

3.3 Secondary biomass resources from forestry: wood processing industries

The secondary biomass potential from forest in Hungary is summarized in Table 22.

Wood-based panel manufacturing

Hungary had a great tradition of wood-based panel manufacturing, but through the privatization of state-owned enterprises, several smaller plants emerged, while the larger facilities were soon acquired by foreign companies.

For several other Hungarian companies, merging with foreign enterprises meant not only survival, but prosperity as well: Derula Manufacturing and Trade Co. in Szolnok, in Central Hungary, OWI Zala Bt., Fibreboard Manufacturing Co. of Mohacs (MOFA) and KRONOSPAN Holding Limited formed KRONOSPAN-MOFA Hungary Fibreboard Manufacturing Co., Szombathely based FALCO, joined KRONOSPAN Holding in 2007. Since then, it has turned out to be the largest furniture and structural panel manufacturer in Central-East Europe. The primary goals of all modern manufacturing facilities are to use high technology and to optimize the price/quality ratio of their products.

The majority of Hungarian wood-based panel manufacturers fulfil the requirements of these environment protective regulations.

Some Hungarian wood-based panel manufacturers won national and European grants although these required some self-financing as well. Derula LLC received financial support for doubling its forest area in 2001, and for doubling production capacity in 2013. The MOFA-Hungary LLC received financial support to switch from using the wet process to a more environmentally friendly dry fibreboard manufacturing technology. This increased production capacity and by-product utilization. There are two segments of the industry competing for the same wood raw materials, namely the wood-based panel and the bioenergy generating enterprises.

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

Table 22 Secondary biomass potential from forests Kton d.m. (S2BIOM Base potential 2020)

	Sawdust	Other residues	Residues from industries producing semi-finished wood based panels	Residues from further wood-processing	Total
Budapest	1	1	1	71	74
Pest	9	18	10	50	87
Fejér	1	3	1	17	23
Komárom-Esztergom	1	3	2	13	19
Veszprém	3	7	4	15	28
Győr-Moson-Sopron	3	7	4	18	32
Vas	4	9	5	11	29
Zala	6	12	7	12	36
Baranya	2	4	2	16	23
Somogy	3	5	3	13	24
Tolna	1	2	1	10	14
Borsod-Abaúj-Zemplén	2	4	2	28	37
Heves	1	2	1	13	16
Nógrád	1	2	1	8	12
Hajdú-Bihar	3	5	3	22	33
Jász-gykun-Szolnok	1	2	1	16	20
Szabolcs-Szatmár-Bereg	4	9	5	23	42
Bács-Kiskun	4	8	5	21	39
Békés	1	1	1	15	18
Csongrád	1	2	1	17	21
Total	**51**	**106**	**60**	**409**	**626**

3.4 Forest biomass mobilisation options

Forest ownership and management

The proprietary rights of state-owned areas by the assignment of the Minister of Finances are practiced by the Hungarian National Asset Management Company. The supervisors of these proprietor are the Minister of Finances.

The Hungarian National Asset Management Company, as proprietor, assigns state-owned forest land areas into the custody of the 100% state-owned, mostly forestry corporations. Other areas are managed by forest managers registered by the

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

forestry authority. Forest managers are private entities or legal persons exercising proprietary rights or the right of use for the area.

Structure of the ownership

In Hungary the share of state-owned forests is 56% and that of community-owned is 1% and 43% of forests are private. A long-term purpose, primarily based on afforestation, is the large-scale increase of private and community owned areas. The highlighted objective of forestry policy is the structure improvement of the over-divided estate system that hinders private forest management, and the establishment of viable management organisations and partnerships.

Forest management system, tendency

The management of state-owned forests is primarily performed by the 22 forest management corporation under the supervision of the Hungarian National Asset Management Company and the Ministry of Defence.

However, other national institutions like water resource directorates, national parks are also managing state-owned forest land areas. The share of community ownership is relatively small, mostly managed by municipalities of villages and cities.

The total number of owners is 428 978, including natural persons and legal entities who own the shares at the time of the update of the database, except state organs. Of which 425,080 are natural persons, number of companies and other organizations 2990. Organizations include municipalities, churches and foundations. There are 131,370 owners 0.5 ha, mostly or non-peripheral area.

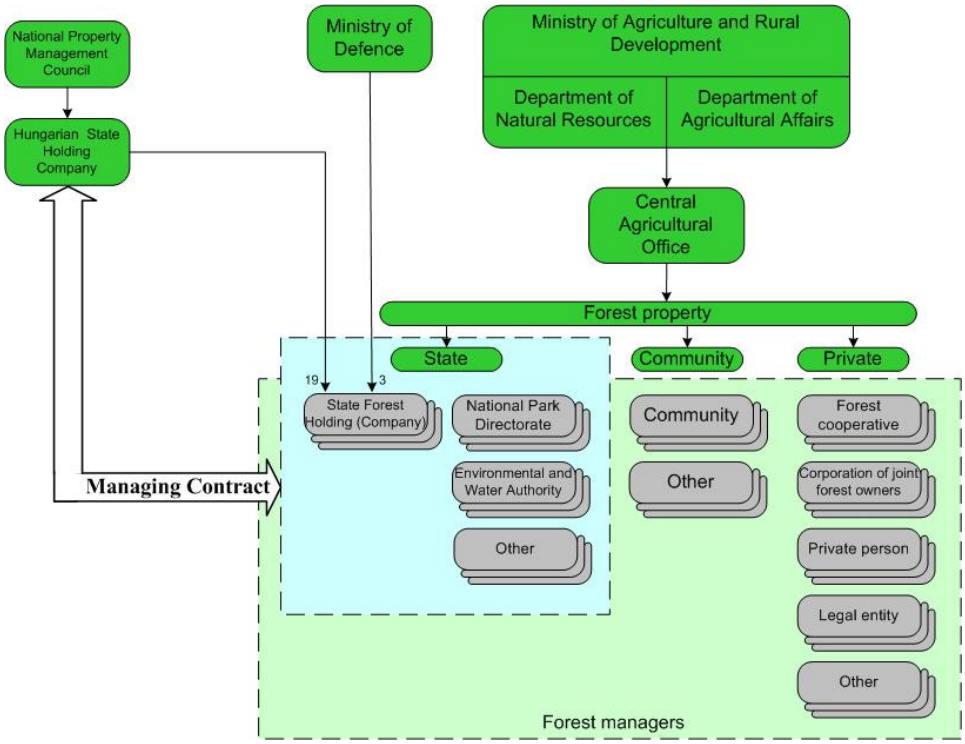


Figure 21 Forest Management in Hungary [51]

That Hungary still has a large potential to mobilise the harvesting of wood from forest, also becomes clear from Table 23. It shows planned harvest of roundwood and residues by 2010, 2020 and 2030 as proportion of the total forest increment. This proportion is only at 33% of the increment in 2020 (Table 23, first 3 columns for 2010, 2020 and 2030). This implies that also in the future (last 3 columns) an additional amount of biomass can be harvested if all appropriate mobilisation measures are taken. In 2020 and 2030 this is predicted that it can reach up to 75% and 66% of the increment. This however is only a potential, but it illustrates that Hungary is still underexploiting it's forest potential and that there is significant room for growth.

[51] Source:https://portal.nebih.gov.hu/iw/web/english/hungarian-forest-management/-/asset_publisher/pHBk9pq6UNxK/content/introduction/forest-act

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

Table 23 2010, 2020 and 2030 EFI-GTM harvest levels expressed as % of yearly average biomass increment level in forests.[52] (Source: Biomass Policies, Elbersen et al., 2016)

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

[52] (Source: Biomass Policies, Elbersen et al., 2016)

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

3.5 Cost of residual Forest biomass

Since for forest residues no commodity market has developed yet it is very difficult to provide figures on prices. Instead cost estimates can be presented building on the S2BOM methodology and assessment. The cost refers to Roadside cost and these cover all biomass production collection and pre-treatment cost up to the road where the biomass is located. The roadside cost are a fraction of the total 'at-gate-cost.' For further details on the cost calculation in S2BOM see Annex 2.

Table 24 Road side cost levels (€/ton d.m.) for agricultural biomass sources based on S2BIOM cost calculations[53]

	Road side cost for agricultural biomass
Thinnings from nonconifer trees	23
Thinnings from conifer trees	32
Logging residues from final fellings from nonconifer trees	17
Logging residues from final fellings from conifer trees	25
Logging residues from thinnings from nonconifer trees	18
Logging residues from thinnings from conifer trees	29

3.6 Summary and conclusions in relation to SWOT elements

Hungary is focusing on the expansion of renewable energy sources. Hungary has committed itself to increasing the share of renewable energy sources in energy consumption to 14.65% by 2020. Solid biomass has the highest potential in Hungary. Although the total capacity of bioenergy is around 250-300 PJ, the total amount of renewable energy sources utilized annually in Hungary does not even reach 100 PJ. In Hungary, the energy use of woody biomass can be considered as the

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

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

primary alternative energy source. Geographical conditions make it possible to cultivate and exploit trees with energy-efficient properties. The diversity of energy crops also means that each region is provided with woody plants to optimize energy production, adapted to different natural conditions.

The great advantage of dendromass is that it can deliver a significant amount of energy to end users in a relatively short period of time. The woody plants have good energetic properties, slightly higher calorific value than the herbaceous and their ash content is lower. Twigs, bark and other wood residues formed as a by-product of logging which cannot be used for industrial purposes but are suitable for energy purposes. The amount of sawmill waste in Hungary is approximately 1 million m3, however its production is decentralized, so its collection is difficult, and the labour demand is high. The contamination of these materials is significant therefore it has a high ash content and a lower calorific value than firewood. In northern European countries where significant forest management is carried out, special materials are used to collect these materials, which its cost is significant, so it is based on Hungarian size and production systems it can't be sustainable from economical aspect.

Table 25 SWOT factors regarding forestry feedstock

Strengths	**Weaknesses**
New Forestry Act (potential of forest residues for energy purposes) The volume of green trees increased continuously Regularly higher amounts of raw material (3-4 mio t/year) There are wood-based industries with high capacity in the country (300-360 MVH/year (Ajka, Pécs, Dorog) High expertise regarding in using biomass There are worker training and engineer education in forestry skills There are laboratories (MSZ EN ISO 17025:2005 standard) for analyzation of biomass There are research projects of biomass-sector at the universities and research institutes Forestry biomass boilers available in the market Clarified legal and ownership system	Harvest & residues potential is less than in the most of the countries in EU. Difficulty in forest biomass harvesting Fragmented ownership distribution Long transportation distance Low capacity of transport Lack of decentralized smaller power plants Without mitigation and adaptation to the amount of forest biomass may decrease due to climate change Higher price of end product compared to conventional fuels for personal users Problematic mobilization in mountainous areas and heavy weight transport High demand for equipment and machinery Use of traditional fuel and the fuel lobby activity
Opportunities	**Threats**

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

Public support for the use of biomass Stable internal market Available regulations for productions and the market Reduces soil erosion More employment opportunities Low interest rates of loan (good CAPEX possibility)	Biomass is competitive with other sectors Investor interested in biggest investments General organic matter deficiency in soils Infrastructure are available just a few areas of land (Biomass-industries and depos) Transport are mostly on route in Hungary, tariffs of cargo are high in country Additional land use might lead to in- direct land use changes, in worst case to deforestations Low price of biomass-based energy in value-change 0,1 Eur/kWh-(OPEX min.0,13 kFh)

4. Biomass supply: Waste

This chapter gives an overview of the waste sector and will particularly explain the biomass potential situation. The potential can roughly be defined by the quantity and quality of the biomass. Aspects related to quantity are availability and transportability. Aspects related to quality are storability, stability and composition.

4.1 Introduction

Hungary has recently introduced major waste sector reforms. A state-owned company called the National Waste Management Coordination and Asset Management Company (NHKV - Nemzeti Hulladékgazdálkodási Koordináló és Vagyonkezelő Zrt.) has been coordinating and overseeing the delivery of waste services at local level since 2016. NHKV is responsible for distributing waste fees to the relevant operators and also for selling recyclable materials, supervising infrastructure spending and the use of EU funds.

Hungary's 2014-2020 national waste management plan, adopted in 2013, has been under revision since the 2017 EIR (Environmental Implementation Review).

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

One reason was so that it could take account of the requirements of the new EU circular economy package, which was adopted in the meantime. There are no results on this exercise so far.

The new service standards have resulted in considerable consolidation, with the number of Hungary's waste service delivery companies decreasing from approximately 140 to around 25. In addition, since 2013, only those companies are allowed to carry out the collection services, where the ownership by the state or municipality is minimum of 51 %. Along with the development of the state company, these measures have reduced the role of the private sector in the country's service delivery in recent years.

2019 priority actions

Gradually increase landfill taxes to phase-out landfilling of recyclable and recoverable waste. Use the revenues for measures that improve waste management, in line with the waste hierarchy. Focus on implementation of the separate collection obligation to increase recycling rates, including collection of bio-waste. Develop and implement minimum service standards and support programmes for municipalities.

Municipal waste is the most important type of waste generated by the consumption of society with the consequent increase in the standard of living. One of the most important constituents of municipal waste is packaging waste, whose volume, weight and proportion are also constantly increasing. The amount of municipal waste generated in Hungary is currently about 3.8 million tonnes, of which the amount of waste deposited in landfill is around 2.2 million tonnes per year. In addition, about 400,000 tons of municipal waste is incinerated every year in the incinerator in Rákospalota, Budapest. The amount of waste recovered in its material is approximately 1.1 million tonnes. The deposited but recoverable waste

represents a significant lost value, and the estimated additional value from it is estimated at 60-140 million EUR per year. The value of waste is therefore in the public interest, which the European Union is trying to promote by imposing ever more stringent obligations on the recovery of waste.

The amount of biodegradable organic matter in the total waste alone is 800 000 tons.[54]

4.1 Waste from biological resources

The total waste generation reported by Eurostat in Table 26 (last column) is only the basis for assessing the biomass potential in this study. The waste assessment was done for 2010, but for several countries the waste generation data from Eurostat were fully (for all categories of waste) or partly (for some categories of waste) replaced by national figures of waste generation. For an overview of which source data were used per type of waste category see Table 26, last 2 columns. A distinction is made between data used to determine the total waste generation and data to determine the current waste treatments. The latter figures determine the final potential. As shown in the Figure 22 the highest distribution of total biowaste is concentrating in the middle of the country.

[54] *Source: https://nhkv.hu/en/ohkt-2/*

Table 26 Biowaste unseparately and separately collected Kton d.m. (S2BIOM Base potential 2020)

	Biowaste unseparately collected	Biowaste separately collected	Total
Budapest	99	90	189
Pest	70	63	133
Fejér	24	22	46
Komárom-Esztergom	17	16	33
Veszprém	20	18	39
Győr-Moson-Sopron	26	23	49
Vas	15	13	28
Zala	16	15	31
Baranya	22	20	42
Somogy	18	17	35
Tolna	13	12	25
Borsod-Abaúj-Zemplén	40	36	75
Heves	18	16	34
Nógrád	12	11	22
Hajdú-Bihar	31	28	59
Jász-Nagykun-Szolnok	22	20	43
Szabolcs-Szatmár-Bereg	32	29	62
Bács-Kiskun	30	27	57
Békés	21	19	40
Csongrád	24	21	45
Total	**570**	**518**	**1,087**

Organic waste management in Hungary

More than a hundred companies in Hungary are engaged in the recycling of waste, and large investments have been made in Hungary. The share of separately collected waste in total quantity increased from 22% in 2011 to 23% in 2016, while the volume (846 thousand tons) increased by 9 thousand tons. This is due to the collection method in a separate door to large-scale spread.[55]

[55] *(Source: www.ksh.hu/docs/hun/xftp/idoszaki/mo/mo2017.pdf)*

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

In garden houses, organic waste can be composted easily. Composting can be learned by anyone, and the resulting compost is perfect for soil improvement. Although not the most efficient way to recycle, it has been used for centuries for its simplicity and popularity.

On the other hand, city dwellers cannot compost on their balconies; they produce organic waste for landfill or incinerate. At landfills, organic matter begins to decompose, producing hydrocarbons (primarily methane). The released methane could be utilized, but in Hungary only a few settlements (e.g. Szeged, Szombathely, Sopron, Győr and Nyíregyháza) are using this opportunity. Incinerators are also not happy with waste containing a lot of organic matter, which, because of its high water content, reduces the efficiency of combustion. It would therefore be important if the problem can be solved through separate collection of organic matter everywhere. This would probably work with the placement of a composting plant and closed containers - though these collectors would need to be emptied more frequently due to rapid decomposition.[56]

Recovery of waste

Most of the Member States meet their current total recycling targets, while Hungary (since 2012) and Malta (since 2013) are lagging behind.[57]

In 2018, the Ministry of Agriculture (FM) published a tender for industrial development for the recovery of waste and the development of waste recovery systems.

Companies that collect and recover wood, paper, glass, plastic and metal waste, used tires, batteries and electronic equipment can bid for more than $ 1.2 billion, according to a recently released announcement.

[56] *Source: www.insinkerator.hu/szerves-hulladekok-kezelese/*

[57] *Source https://ec.europa.eu/transparency/regdoc/rep/1/2018/HU/COM-2018-656*

The basic objective of the call for proposals is to develop waste recovery systems in line with the objectives of the circular economy, utilizing the resulting waste as a secondary raw material, and separating multi-component waste into fractions to increase recovery efficiency.[58]

Hazardous and non-hazardous post-consumer wood

There is a huge market for recycling and energy recovery (see

[58] *https://ec.europa.eu/transparency/regdoc/rep/1/2018/HU/COM-2018-656)*

Table 27), although there are constraints. For example, wood treated with hazardous substances are difficult to recycle because of the composition of the protective agent they contain (e.g. copper, arsenic, chromium, etc.). It is essential to keep the carbon in the wood as long as possible and only to release it into the atmosphere where the trees can absorb CO_2 again. Inadequate regulation resulted the burning of raw materials of the sheet industry and the chipboard production. However, this has also resulted in further detrimental effects: - Hungary's dependence on foreign wood raw materials has. It is necessary to further separate the wood waste according to contamination.[59]

The distribution of total post-consumer wood potential shows similar picture to the total biowaste (see Figure 22 and Figure 23), the highest amount concentrates in the middle of country.

[59] *doktori.nyme.hu/251/2/magyar.pdf*

Table 27 Hazardous and non-hazardous post-consumer wood Kton (S2BIOM Base potential 2020)

	Hazardous post consumer wood	Non hazardous post consumer wood	Total
Budapest	8	32	40
Pest	5	23	28
Fejér	2	8	10
Komárom-Esztergom	1	6	7
Veszprém	2	7	8
Győr-Moson-Sopron	2	8	10
Vas	1	5	6
Zala	1	5	7
Baranya	2	7	9
Somogy	1	6	7
Tol	1	4	5
Borsod-Abaúj-Zemplén	3	13	16
Heves	1	6	7
Nógrád	1	4	5
Hajdú-Bihar	2	10	12
Jász-gykun-Szolnok	2	7	9
Szabolcs-Szatmár-Bereg	2	10	13
Bács-Kiskun	2	10	12
Békés	2	7	8
Csongrád	2	8	9
Total	**44**	**184**	**228**

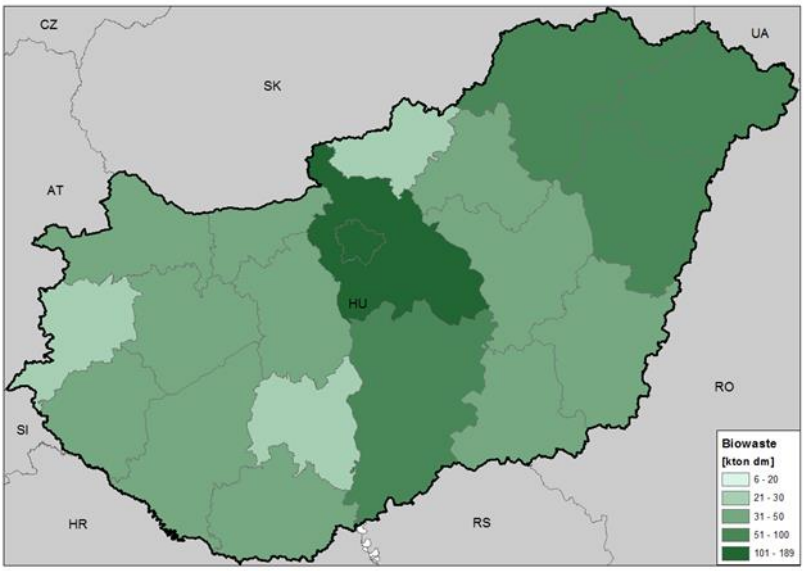


Figure 22 Distribution of total bio waste potential over country

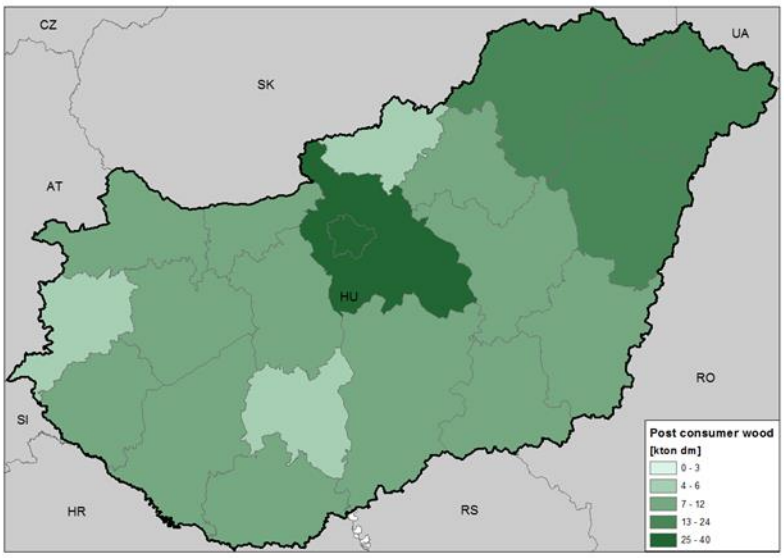


Figure 23 Distribution of total post-consumer wood potential over country

4.3 Sewage sludge treatment

Up-to-date, accurate data on sewage sludge volumes are not available, but professional estimates indicate that 160-170,000 tonnes of dry matter are produced annually, reaching approximately 1 million tonnes of dry matter at an average of 18-25% after dewatering (Table 28). This will continue to grow in the near future, which is a major professional challenge. There are several options for

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

treating sewage sludge from incineration to landfill, but in recent times composting and direct application of sludge on agricultural land as a fertiliser can be considered a sustainable and competitive solution based on ecological, economic and circular considerations.

Table 28 Predicting the annual amount of sludge produced

	Load	Amount of sludge
2013	8 750 148	179 378
2016	10 992 712	225 351
2023	11 603 418	237 8700
2027	12 214 124	250 390

Currently in Hungary less than 50% of sewage sludge is used for agriculture, and after composting it is even lower (Table 28).

Current Development Program for Sewage Sludge Treatment

1403/2017. (VI. 28.) on the approval of the "Sewage Sludge Management and Recovery Strategy (2018-2023)" .

Nowadays, water supply connection is close to 100% in Hungary. In 2013, the rate of wastewater drainage and treatment reached the figure of 82% nationwide, 8% of which did not involve connection to a public sewer.[60]

[60] http://www.kormany.hu/dokumentumok

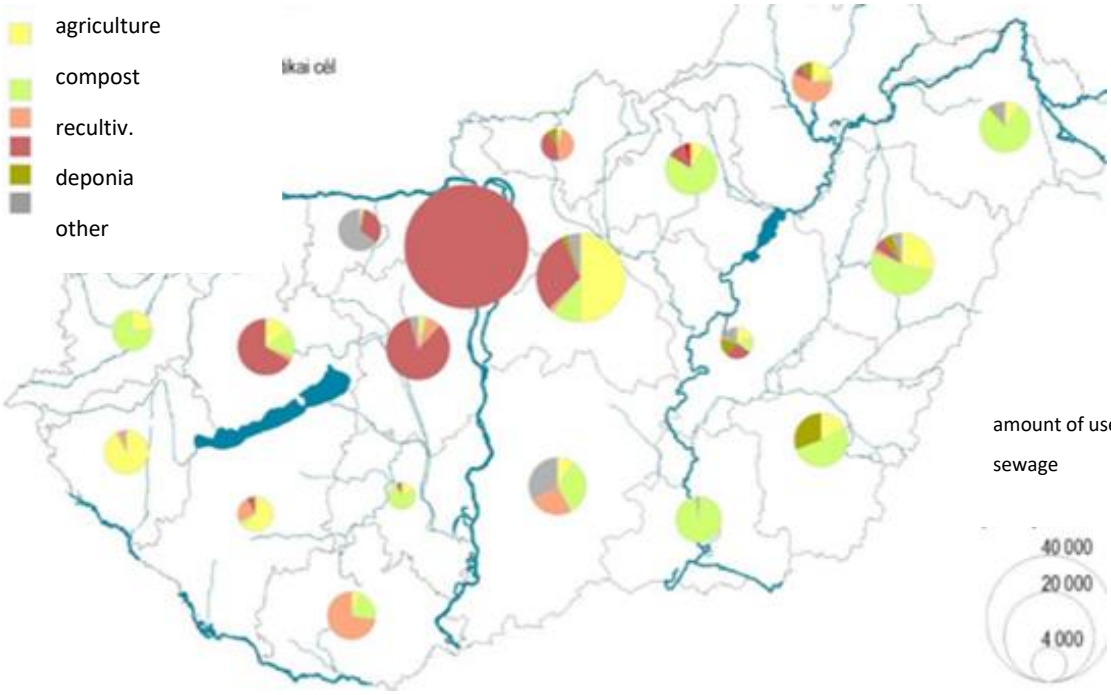


Figure 24 Utilization and disposal of sewage sludge in Hungary in 2013, by county

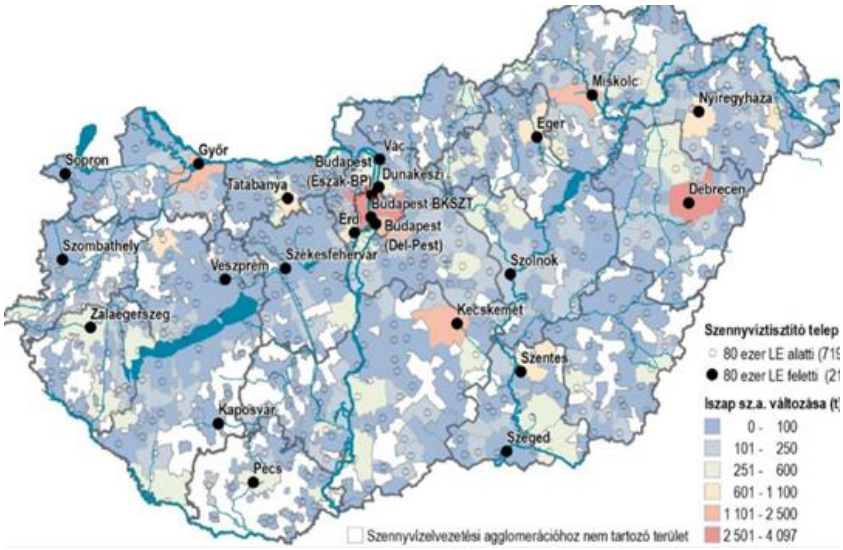


Figure 25 Change in sludge production by 2027

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

4.4 Summary and conclusions in relation to SWOT elements

During the utilization of municipal sewage sludge significant capacity shortages cannot be identified, but in some cases they can only utilize sludge at a higher than optimal cost. In the case of agricultural utilization, even in the case of one of the scenarios outlined above, capacity shortages can be identified at national level.

Territorially, the image is slightly more subtle. We address this issue in detail in defining regional systems. Utilization of sewage sludge for re-cultivation can be solved in the short and medium term (until 2017 and 2023). However, after 2023, significant reductions in areas requiring recultivation are expected. The energy utilization of sewage sludge in Hungary is still at an early stage. Short-term needs can be met by the Mátra Power Plant, after which capacity shortages can be forecast.

The utilization capacity of the existing cement factories 20,000-30,000 t / year take-up is uncertain. No additional capacity is required for the final disposal of municipal sewage sludge. In practice, this method is already used to a very limited extent.

Table 29 SWOT analysis

Strengths	**Weaknesses**
Well-organised solid communal waste collection Infrastructure are available most areas of land (Biomass-industries and depos) Collection of hazardous household waste Collection of green household waste Container supply is also organized for individuals and industry. There are waste incinerators throughout the country (24) Both civil society and business organizations are becoming increasingly aware of need for waste separation at source and separated collection and waste management	Lack of selective waste collection The problem of special waste (e.g. car batteries, green waste) partly unsolved Poor awareness of the environment among householdes, companies The amount of solid waste is constantly increasing There is little interest in recycled products Expensive waste sorting (after collection) while waste separation at source is still weakly developed

Opportunities	Threats
Developing integrated waste management through national and EU financing. Developing the waste utilization industry The waste management sector has become a public organization	Biomass is s competitor with other sectors Increased transportation costs can occur due to rising fuel prices In Hungary 67% of the waste is in landfill. Infrastructure are available just a few areas of land (Biomass-industries and depos) Low price of biomass-based energy in value-change 0,1 Eur/kWh-(OPEX min.0,13 kFh)

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

5. BIOBASED PRODUCTS INDUSTRIES AND MARKETS

In this chapter the facts on markets for biobased products and existing industries are presented.

5.1 CURRENT BIOBASED INDUSTRIES

The biobased industry comprises different product categories:

- Biobased chemicals
- Biobased plastics, polymers, materials, packaging
- Biobased specialty chemicals (i.e. surfactants, lubricants, pharmaceuticals, nutraceuticals, cosmetics)
- Textiles
- Food and feed ingredient
- Advanced biofuels

Local market demand is an important factor for setting up local biobased industries supplying these products. Therefore, currently existing industries that use these products or could demand these products in the near future, are mapped, including their location ad current scale.

The scale of processing is very important, especially for bulk products, i.e. chemicals and biofuels. Experts indicated that the minimum annual input for such large scale biorefineries (e.g. 2e generation ethanol plants) is 350 ktons of biomass input per year. Setting up new biobased production chains on such a scale is very difficult because of the need to guarantee such large amounts of biomass and having an outlet for the product(s) and residues generated. Starting at small scale is often not possible for economic reasons. Also for economic reasons, the plant should run year-round and therefore have a year-round supply of feedstock and

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

offtake of the products. At this scale, the local demand might not be sufficient. In that case it should be possible to export the products.

5.1.1 EUROPEAN CONTEXT

In Europe, the bio-based industries sector is already worth €700 billion and employs 3.2 million people directly, but it faces complex and substantial technology and innovation challenges. Full deployment of such technologies on to the market requires sustainable sourcing of biomass, as well as new business models, which integrate all the economic actors across the value chains. The complexity of such an endeavour dictates the necessity to foster collaborations not only across sectors, but also across borders. An institutional public-private partnership was therefore needed to ensure the full deployment of the bioeconomy in Europe.

Bio-based Industries Joint Undertaking (BBI JU)

On 6 May 2014, the Council adopted Regulation (EU) No 560/2014 establishing the Bio-based Industries Joint Undertaking (BBI JU) a new €3.7 billion Public-Private Partnership between the EU and the Bio-based Industries Consortium. Operating under Horizon 2020, it is driven by the Vision and Strategic Innovation and Research Agenda (SIRA) developed by the industry.

The objective of the BBI Joint Undertaking is to implement a programme of research and innovation activities in Europe that will assess the availability of renewable biological resources and the development of new bio-refining technologies to sustainably transform these resources into bio-based products, materials and fuels.

The two main positive effects of the BBI JU have been the structuring effect in organizing the value chains across sectors and the innovation-driven mobilizing effect of all key stakeholders. Through its 101 funded projects, this joint undertaking has been fostering new collaborations, transforming once-linear value chains into

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

more interconnected ones. The results have been impressive: BBI JU projects now expect to create 143 new cross-sector interconnections and 113 new bio-based value chains.

Those activities should be carried out through collaboration between stakeholders along the entire bio-based value chains, including primary production and processing industries, consumer brands, SMEs, research and technology centres and universities.

Bioeast

In 2018 the experts from the responsible ministries in the Visegrád Group (Czech Republic, Hungary, Poland and Slovakia), Bulgaria, Croatia, Romania, Slovenia and the Baltic States (Estonia, Lithuania and Latvia) together with the European Commission representatives agreed on a VISION for the "Central and Eastern European Initiative for Knowledge-based Agriculture, Aquaculture and Forestry in the Bioeconomy" –BIOEAST-. (Figure 26)

Through the BIOEAST Initiative, the Central and Eastern European (CEE) ministries set the Vision for 2030 to develop knowledge and cooperation based circular bioeconomies, which helps to enhance their inclusive growth and to create new value-added jobs especially in rural areas, maintaining or even strengthening environmental sustainability.

Statistics show that the BIOEAST macro-region is a biomass-rich region, with traditionally high importance of primary sectors of agriculture, forestry and fishery. Furthermore, the food industry, bioenergy and biofuels are important bioeconomy sectors in the whole macro-region. However, the unused or under valorised biomass potentials, including the side streams from the sectors, are gradually being recognized. The bio-based pharmaceuticals and chemicals are acknowledged as key sectors, however, they are still small, even though highly productive.[61]

[61] https://www.bioeconomy.fi/vision-for-the-central-and-eastern-european-sustainable-bioeconomies/

Figure 26 Focus of Bioeast[62]

Hungary's Renewable Energy Utilisation Action Plan

Currently, there is no dedicated strategy or policy framework aiming the formation of the Hungarian bioeconomy, and more importantly due to its complexity the responsibilities (agriculture, R&D, biomass, energy, etc.) are not clear and interfaces are not provided.

The Renewable Energy – Hungary's Renewable Energy Utilisation Action Plan, 2010-2020 is based on the EU directive 2009/28/EC. It specifies how Hungary intends to achieve the legally binding target of 13% by 2020, and to exceed it to 14.65% in terms of renewable energy ratio of final energy consumption. Regarding biomass use, which is the largest fraction of renewables in order to meet the target, the document puts it in a wider complex of agriculture and rural development and introduces the term of green economy. It is stated that the use of biomass for energy purposes, based on the favourable agro-ecological conditions of the country and taking into account sustainability criteria (especially the protection of

[62] *Source: https://www.bioeconomy.fi/vision-for-the-central-and-eastern-european-sustainable-bioeconomies/*

biodiversity and soil quality), can contribute to the retention of agricultural jobs and to the creation of new ones. The use of organic matter from animal husbandry for energy purposes (biogas) can enable productive waste management, increasing the competitiveness of the sector. The use of by-products and other solid wastes from agriculture and forestry (e.g. by-products from crop-lands, cuttings from orchards and vineyards) for local energy purposes and their conversion into end-products will result in additional income for farmers and producers, and can significantly reduce the need of communities for fossil energy sources. The above statements, however, can also be applied for biomass utilization, regardless the purpose (other than energy). In order to highlight the importance of biomass the document also adds that Hungary possesses excellent agro-ecological conditions for a competitive production of biomass. Hungarian agriculture is capable of sustainably producing biomass in excess of food and feed demands, and at the same time, there is a significant biogas production potential. The theoretical potential of energy sources from biological origin (bioenergy) could exceed as much as 20% of the energy source demand estimated for 2020. Regarding transportation, more than 10% of the estimated consumption for 2020 can be fulfilled from first generation biofuels only, while at the same time ensuring the fulfilment of food and feed provision objectives; and with the emergence of second generation biofuels through the expansion of the scope of raw materials, this volume can be increased even further depending on the seasonal variations in the amounts of agricultural production[63].

[63] *Source:https://www.buildup.eu/sites/default/files/content/national_renewable_energy_action_plan_hungary_en.pdf*

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

5.1.2 Industry with organic feedstock in Hungary

7.8% of the Hungarian chemical industry is characterized by organic matter. Some major bio-raw material processing plants are realizing new, innovative technology.[64]

5.1.2.1 Biofuels

Firm	Bio-based feedstock	Technology	Product	Volumen
Hungrana Starch and Isoglucose Manufacturing and Distributing Ltd) Szabadegyháza	Bioethanol fuel (GreenPower E85)	Extraction (distillation) Separation	Alcohol, denatured alcohol, tartaric acid, calcium tartrate and grape seed	3500 tons / day 1 mio tons/year 350 to/year bioethanol

Hungrana Starch and Isoglucose Manufacturing and Distributing Ltd. is the most important corn processing company in Europe for more than 100 years, a major player in the Hungarian food industry. This is a great example of the company producing bioethanol fuel from renewable energy source, marketed as GreenPower E85.

The factory has undergone constant development and expansion and continues to this day. In the mid-1990s the capacity of processing 400 tons / day of corn has grown to nearly 3500 today. The firm opened new bioethanol plant in 2008, and 100th anniversary was marked by further developments, the most significant of which is the construction of a 25% biomass power plant.

It procures its raw materials domestically, within 100 to 350 km of the plant.

[64] www.ommf.gov.hu

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

Firm	Bio-based feedstock	Technology	Product	Volumen
Pannonia Bio Zrt Budapest Dunaföldvár	Feed corn 1.1 mio tonns	New bio-based technologies	Bioethanol	325,000 tons of protein-rich animal feed, 500 million litres of bioethanol 12,000 tons of corn oil

Pannonia Bio operates a biorefinery in Tolna County, Hungary. The plant uses state of the art production processes and is a nursery for development of new bio-based technologies. From its beginnings as a bioethanol producer in 2012, the refinery has almost tripled in size and developed into a multiproduct facility. Today, nutrition, health, biochemical and fuel bioproducts are manufactured as alternatives to fossil materials.

The biorefinery is the largest ethanol plant in Europe, one of the most efficient refineries in the world. The plant's success is based on a continuous €250 million performance-based investment program. Engineering expertise in ethanol production has enabled diversification into new product streams using grain-based biotechnology.

Located on the banks of the Danube close to the town of Dunaföldvár, the refinery annually processes over 1.1 million tons of feed corn to produce 325,000 tons of protein-rich animal feed, 500 million litres of bioethanol and 12,000 tons of corn oil. Production of animal feed increases European food security while Pannonia Bio's ethanol protects the environment by having greenhouse gas emissions that are 30% those of the petrol it displaces.

The refinery creates a substantial market for locally produced feed corn, making the plant a key operator in the Hungarian maize market. The company continuously seeks opportunities to strengthen local partner relations, contributing

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

nearly 500 million euros (156,556m HUF) to Hungary's GDP and supporting over 3,000 jobs, mostly in rural communities.

Pannonia Bio is a subsidiary of ClonBio Group Limited (ClonBio), an Irish agribusiness headquartered in Dublin, Ireland.

Firm	Bio-based feedstock	Technology	Product	Volumen
Etanol-Line Ltd Vácszentlászló	60 thousand tons of maize per year	Fermentation	Bioethanol	7,300 t of bioethanol

Etanol-Line Kft's bioethanol plant started its operation in 2008 in Vácszentlászló and produces 7,300 t bioethanol. At present, the processing capacity of 60 thousand tons of maize per year. The plant started with a HUF 400 million investment, which was provided by domestic private persons. The low-capacity facility was created specifically to provide raw materials at a sub-regional level in a decentralized manner. Currently, the company is developing efficiency improvements as the price of maize for raw materials has risen sharply with the investment, which has had a negative impact on profitability.

Firm	Bio-based feedstock	Technology	Product	Volumen
Kall Ingredients Ltd Tiszapüspöki	maize	Fermentation	Raw materials for food industry, sugar and starch products, high-quality alcohol and feed	530 thousand tons of maize per year

In October 2017, the new isoglucose plant of Kall Ingredients Kft. was opened in Tiszapüspöki with an investment of HUF 45 billion. The plant processes 530 thousand tons of Hungarian maize a year, producing raw materials for food industry, sugar

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

and starch products, high-quality alcohol and feed, mainly for export. Similarly, Győri Szeszgyár Zrt. Produces ethyl alcohol for the chemical and food industry.

5.1.2.2 NATURAL FIBRES

Firm	Bio-based feedstock	Technology	Product	Volumen
Meshlin composites ZRT Budapest	Natural fibres (Flax) Bio-based resins	Pre-impregnation	Natural fibre composites	90,000 t

Natural fibres reinforced bioresin pre-pregs are fabricated by pre- impregnation of vegetable fibers, mainly flax, with a curable biobased resin, to have semi-finished products suitable for advanced composites lamination. The aim is to maximize the proportion of renewable resources used while getting outstanding material properties, suitable for technical and load-bearing applications. In this respect, fully bio-based composites could be produced by using bio-based resins, in replacing traditional thermosets.

The application of vegetable fibres remains limited due to difficult reproducibility in the manufacturing process.

In 2021, the Natural Fiber Composites Market will be worth USD 6.50 billions. In 2012 the European automotive industry used 90,000 tonnes of natural fibre composites.

5.1.2.3 HEAT ENERGY, ELECTRICITY

Firm	Bio-based feedstock	Technology	Product	Volumen
BIOFILTER Environment Ltd Törökbálint	Refined vegetable oils Food waste Animal and vegetable waste	New bio-based technologies	heat energy and electricity.	In 2018: 5600 tons of used cooking oil 7700 tons of food waste

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

BIOFILTER Environment Ltd. is an environmental social company operating in the bioenergy sector. Founded in 1990, it now has a nationwide collection and international processing network.

High priority is given to the production of energy from secondary raw materials and waste. The company is an expert in this segment, working closely with the Capital Sewerage Works, Hungarian Oil and Gas Plc. and the Association of Environmental Service Providers and Manufacturers.

The main profile of the company is the supply of second-generation, organic feedstock for the bioenergy sector by implementing a complex inverse logistic process for the waste it collects. The collection, processing and import of refined vegetable oils ensures the supply of raw materials for biodiesel plants in Hungary and the neighboring countries.

Collection, processing and transport to the biogas plants of food waste and of end-of-life waste and of non-marketable animal and vegetable waste from the HoReCa and FMCG areas.

In 2011, the company started the management of additional waste in order to expand its profile, so BioFilter Zrt. is responsible for 100% of the organic waste generated in Hungary.

The company activities also include the sale of fats for animal feed and wholesale of refined vegetable oils and fats.

The firm is a member, representing Hungary, of a 600-member organization based in Belgium that brings together environmental companies in the Member States of the European Union.

There are 7 premises throughout the country. The number of the cars are 40. The number of the contractors the firm collect organic waste and other side-products from: 4500.

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

The ttps: //lakossagi.biofilter.hu/ page provides detailed assistance to the public in collecting and disposing of used cooking oil, and through our collection point finder, everyone can find the most convenient place to access more than 450 used cooking oil: https: // biofilter .com / gyujtopont-finder.[65]

Firm	Bio-based feedstock	Technology	Product	Volumen
Pilze-Nagy Ltd Kecskemét	-wastes of oyster mushroom 3000 to - poultry manure 1000 to -sludge 500 to -other wastes 2000 to: slempe, fats, oils, expired food	fermentation	Biogas produced: 800,000 m3 / year Electricity: 1440 MWh / year Extensive fermentation juice: 8,500m3 / year	7-9,000 tons/year Biogas produced: 800,000 m3 / year Electricity: 1440 MWh / year Extensive fermentation juice: 8,500m3 / year

It is the sixth agricultural biogas plant in Hungary that utilizes the waste from the production of oyster mushrooms. In mushroom cultivation, about three thousand tons of fallen medium is produced every year, for which our company has been looking for an economical and environmentally friendly solution. After careful consideration of the options, the firm decided to use biogas technology. However, no cultivated fungus medium has been utilized in this way anywhere in the world, so research and development work has been linked to project preparation with the support of the Economic Competitiveness Operational Program. Following the positive research results, the investment started.

After the preparation of the project and obtaining the permits, the construction of the biogas plant started in June 2007. By September 2007, the investment had reached the point where the fermenter could begin to be filled and the gas

[65] Source: http://biofilter.hu/

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

engine was started in December. October 2008 is the next milestone: full capacity has been achieved.

The plant produces 1.2 million cubic meters of biogas per year, which requires 7,000-9,000 tons of agricultural organic matter per year. Most of it comes from mushroom cultivation, which is supplemented with dilute pig manure and silage maize. The biogas produced is converted into electric current and heat in the 330 kW electric and 400 kW thermal gas engines. The plant is capable of supplying 2.4 million kWh of electricity annually to the national electricity grid.100% of the organic matter needed for biogas production is agricultural waste or by-product. The dumped raw material is on site and pig manure is transported from nearby sites, so there is no significant freight flow. Almost 70% of the 1,1 million EUROinvestment was self-financed (part of it is credit), while another 320,000 EURO was provided by the support received from the Environment and Infrastructure Operational Program.[66]

5.1.2.4 Compost

Firm	Bio-based feedstock	Technology	Product	Volumen
NHKV Zrt Dunaújváros Dömsöd Polgárdi Oroszlány Cegléd	Green and biodegradable waste	Compostation, Fermentation	Compost	

Composting capacity is expected to increase in several Hungarian settlements, including Dunaújváros, Polgárd, Oroszlány, Dömsöd, Cegléd. The development can further increase the amount of green and biodegradable waste that is diverted from landfill and used as compost. See "KEHOP 3.1.2 Disposal of Biodegradable Waste from Landfill". In the framework of the tender, professional

[66] *Source: www.plerotus.hu*

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

waste composting can be carried out in more settlements in Hungary. In accordance with its legal obligation, the NHKV National Waste Management and Coordinating Co. Ltd. was responsible for the co-ordination and preliminary assessment of the application. It technically examined where on-site management of green waste is needed, while meeting the waste reduction targets to optimize logistics costs.

Firm	Bio-based feedstock	Technology	Product	Volumen
Elmolight Bt Tapolca	grape marc poultry manure	fermentation	"COFUNA" organic humus manure Biomass super compost COFHUMIN soil mix.	

The product was developed by the Pasteur Institute and has been manufactured by Thorigny French National Humus Society for nearly 30 years. The first preparation, used in about 50 countries, was based on oilcake, which was inoculated and fermented with a useful soil bacterial concentrate, which greatly accelerated or reduced the rate of organic matter degradation in the soil.

The plant carrier material of the bacterial concentrate is the large amount of grape marc produced in the crop area and the poultry manure necessary for optimal fermentation.

Developed in Hungary between 1985-90, manufacturing processes can produce satisfactory quality on other substrates, eg. beef and sheep manure, brewing by-products, other high carbohydrate and protein. Starch-containing agricultural by-products of animal feed or canning and pharmaceutical mycelium sludge.

In 2011, Cofuna Organic Humus Fertilizer received the Bio Certification.

In Hungary, the owner of the Cofuna license, represented by Cofuna Kft., Is Elmolight bt. manufacturers:

- Elmolight Bt.

- Cofuna Kft

- A.K.S.D. City Management Ltd.

- A.S.A. Hódmezővásárhely Municipal Cleaning Ltd.

- Florasca Hungary Kft

- Florasca Environmental Management Ltd.

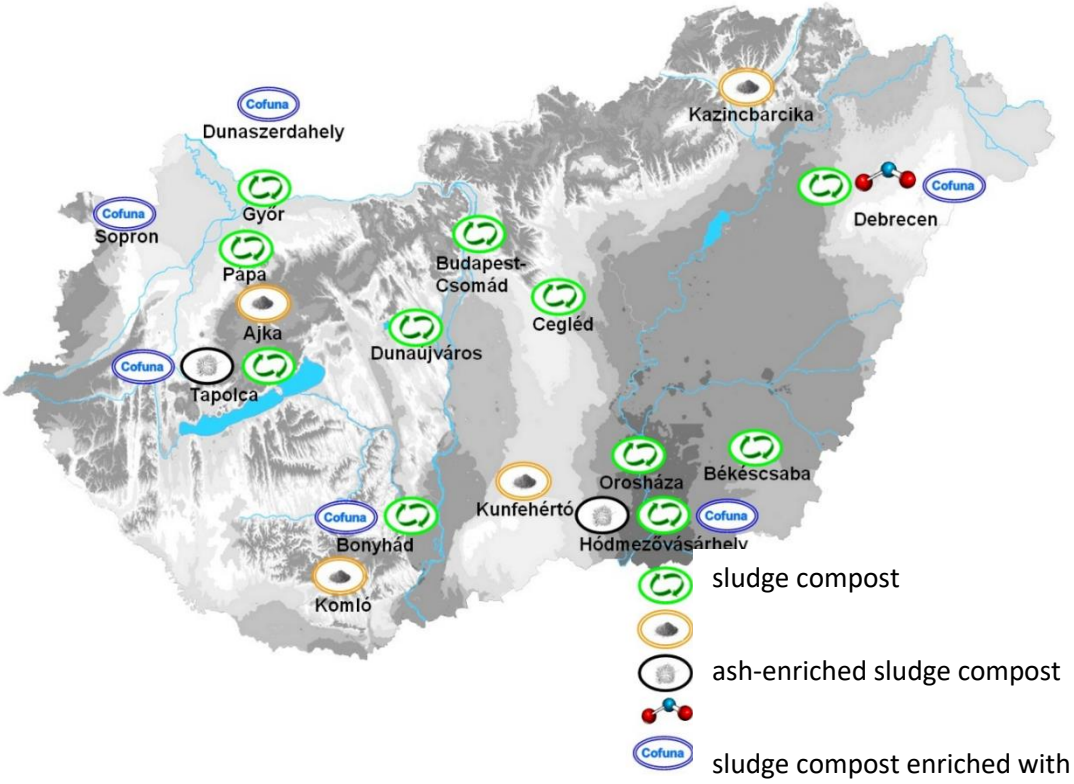


Figure 27 Emolight activity in Hungary Source: www.emolight.hu

Firm	Bio-based feedstock	Technology	Product	Volumen
Mancso Tojás Ltd Mátraterenye	poultry manure	fermentation	"COFUNA" organic humus manure Biomass super compost COFHUMIN soil mixture	

The poultry manure pellet is a high quality, natural plant nutrient, which is used to increase yields. It improves soil structure, activates its flora and preserves its fertility, all in an environmentally friendly way.

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

Ideal for autumn or spring base nutrient supply and continuous head fertilization. It is made from matured poultry manure. Extremely rich in nutrients (N4, P4, K4), organic matter (75%), micronutrients (Mg, Ca).

Advantages of poultry manure: it increases the organic matter content and thus heals the beneficial microorganisms in the soil. Provides gradual nutrient absorption for plants, reduces nitrogen leaching in soil, increases soil buffering capacity, adjusts optimum ph for plants, improves soil structure, reduces soil erosion, provides optimum humic acid uptake, increases soil water uptake, makes plants more resistant to drought. Promotes photosynthesis. The use of Manchopell fermented poultry manure pellets results in faster development, growth, protection against diseases, stress tolerance, richer flavour and aroma, higher yields. Due to its organic content it is essential for plants. We achieve better water balance on sandy soils and looser structure on hard soils. Environmentally friendly nutrient supply, can be used in organic gardening and is recommended. It enables more valuable operations in the field of crop production.

5.1.2.5 ORGANIC ESTER COMPOUND

Firm	Bio-based feedstock	Technology	Product	Volumen
Jákófa co. Veszprém	Sawdust	Prolysis	Organic ester compound	status: preparation phase, project started in 2018

Chemical conversion of process sawdust from woodworking plants using pyrolysis technology. The pyrolysis oil generated in the technology is sold as a fuel additive.

Timber mills produce a significant amount of sawdust during production. This sawdust must be removed from the technology because it impedes continuous production. This sawdust is a completely pure biological material, which is converted into an organic ester compound by pyrolysis technology, which according to the European Union guidelines is II. as a generation biological

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

component in fuel production. The technology generates renewable electricity from by-product heat.

Wood is definitely in this category, and wood is extremely good for this technology because it is one of the purest, most homogeneous organic materials. It is also important that the processing does not result in an environmental load or waste. Based on current fuel distribution estimates, 1.8 million tonnes of this type of material will be needed by fuel manufacturers by 2020. Currently, 25% of this is production capacity within the EU, with an additional 25-30% planned investment. If this is indeed the case by 2020, this material is expected to be in short supply on the market, so we are planning to implement such a technology at a site where wood technologies have been operating for decades with versatile and close partnerships with the wood industry.

5.1.2.6 Organic Manure

Firm	Bio-based feedstock	Technolology	Product	Volumen
Baromfi-Coop co.	Poultry manure	Fermentation	Organic fermented manure	60,000 t (can be expanded to 100,000 t/ year)

The R&D project uses an environmentally friendly process or mechanization that allows industrial processing and sterilization of deep litter poultry manure, and the resulting fermentation (fertilizer pellet) is sold as organic nutrient and reintroduced into the soil.

Annually, 60,000 tons of poultry manure will be processed by the organic poultry processing center, which is being implemented by the Poultry Cooperation Ltd. worth HUF 2.52 billion.

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

The new plant will handle an annual production of about 75 million poultry manure from chickens and hens, and the capacity can be expanded to 100,000 tonnes a year.

The investment will create about 15 new jobs at the premises of the Poultry Coop Ltd. The executive owner noted that the group still has a smaller fermentation plant, but that it can only process one-third of the amount of manure that comes out of cultivation. The investment is needed because of intensive developments, because Master Good wants to build twenty new poultry farms by 2020.

The new plant, which will be equipped with the state-of-the-art technical and biotechnological machine system, will be located on the outskirts of Nyírjákó, owned fermentation plant under a greenfield investment. Further elements of the project, a research and diagnostic laboratory and a fleet of instruments will be implemented at the University of Debrecen, as a consortium member, and at the Poultry Coop headquarters in Nyírkércs.

The development of mechanical and technological systems is carried out by another partner, Multimix Kft., Partly at its own site, partly at the site of the greenfield investment, while the small and medium-sized, large-scale nutrient utilization experiments are performed by Timac AGRO performs on multiple sites.

Firm	Bio-based feedstock	Technology	Product	Volumen
Terra Humana Ltd Kajászó	animal by-products	Pyrolysis	Biochar 'ABC' Animal Bone bioChar	2000 t/year

Terra Humana Ltd. is a technology-intensive company playing a leading role in zero emission pyrolysis technology engineering, phosphorus recovery and biochar industrial production. Since 2002, Terra Humana Ltd. has coordinated multiple international research and development programs in the specific field of carbon

refinery and phosphorus recovery. Terra Humana Ltd is the original source and inventor of the "3R" Recycle-Reduce-Reuse zero emission advanced pyrolysis technology. The 3R development has been financed by the company until 2002. From 2002, the European Commission selected the technology and co-funded the further developments through its research and development programmes. By the end of 2015, the R&D stages were successfully completed, finalized and the technology was made ready for market uptake. During the past years, Terra Humana has built up a wide network of stakeholders in both the scientific and industrial sector.

The flagship project of the company is recovering phosphorus and other nutrients from bio-waste via pyrolysis technology and biochar biotechnological formulation. Terra Humana Ltd. is the only biochar vendor in Europe with an official and accredited Authority permit. Recently the company also received Authority permits for the full-scale industrial installation and operation of an organic phosphorus recovery plant in Kajászó, Hungary.

The company has a staff of 12 people and a balance sheet with a total of EUR 3.3 million.

'ABC' Animal Bone bioChar, an innovative and recovered phosphorus fertilizer produced from food grade animal by-products in line with the EU bio nutrient circular phosphorus economy model, the comprehensive manufacturing process via "3R" pyrolysis technology.

In the EU, approximately 20 million tonnes of slaughter by-products are produced by the meat industry every year, including several million tonnes of food grade bones, which is far more sufficient to manufacture the targeted EU production of 250,000 t/y ABC before 2025.However, ABC processing requires high-end specialized technology for which Terra Humana Ltd. is the sole specialized vendor in Europe.

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

The 3R pyrolysis field demonstration equipment with a 2000 t/year throughput capacity is currently in operation in Polgardi, Hungary, with focus on applied research and development. For industrial scale production, a 20,800 t/h throughput capacity pyrolysis plant will be installed in Kajászó, Hungary, situated west of Budapest at an excellent logistics hub location.

5.1.2.7 ALCOHOL

Firm	Bio-based feedstock	Technology	Product	Volumen
Arany Kapu Borászati Melléktermék Feldolgozó Zrt. (Wine Byproduct Processing) Kunfehértó	Grape marc Wine lees	Extraction (distillation) Separation	Alcohol, denatured alcohol, tartaric acid, calcium tartrate and grape seed	40-45 thousand tons of grape marc 140,000 hectoliters of wine lees per year (80-90 percent of the total quantity in Hungary)

In Hungary, in accordance with the European Union directive, Decree 70/2012. (VII. 16.) VM regulates the withdrawal of wine by-products under control. Under the Decree, for the production of wine in quantities of 25 hectoliters or more, the winery must ensure that wine by-products are withdrawn in the manner prescribed by law. In accordance with the regulation, controlled, environmentally friendly processing of wine by-products in Hungary is carried out in a single industrial-scale plant, which has a history of nearly fifty years.

The Golden Gate Byproduct Processing Ltd. located in Kunfehértó has been able to fully process the by-products of wine production in Hungary due to continuous development and capacity expansion. The processing is carried out using the most sophisticated technology, which produces mainly alcohol, denatured alcohol, tartaric acid, calcium tartrate and grape seed from grape marc and lees.

The plant, which has close to 800 suppliers, processes 40-45 thousand tons of grape marc and 140,000 hectoliters of wine lees per wine year, which is 80-90 percent of

the total quantity produced in Hungary. The company has not only domestic but also Croatian, Austrian and Romanian partnerships, from where it also supplies at its own expense materials that are no longer needed for wineries. The state-of-the-art plant can process huge quantities of shipment in up to 200 days depending on the harvest season. The first step in the extraction process is the distillation of the grape marc delivered to the plant, from which the raw alcohol is extracted, and the tartaric acid compounds are dissolved in boiling water from the "boiled" marc. The remaining mass is squeezed and pre-dried. The dried grape is separated from the remaining grape seed and skin. Six thousand tonnes of dried grape seed are sold each year to Italian and Spanish oil extraction plants for the production of grape seed oil. As a final step in processing, unused dried grape shells are used to supply the plant with heat, so that almost one hundred percent of the raw material delivered is processed in an environmentally friendly manner.

Thanks to the Kunfehértó plant, Hungary is in a leading position in the processing of wine by-products, as there are no similar, complex processing plants in several neighboring countries, including Austria.

5.2 Advanced biobased initiatives: demo and pilot plants and major innovation activities

5.2.1 Activity to increase the use of biomass and improve efficiency in Hungary

5.2.1.1 Biogas activity

Association of Biomass-Plants

Figure 28: Biomass-plants in Hungary (Association of Biomass-Plants (Bakonyi Bioenergia Ltd.,Vértesi Erőmű Inc.,Veolia Energia, Magyarország Onc.,PANNONGREEN Kft. Pannon-Hő Ltd.)[67]

Objectives of the Association:

-Extending the mandatory take-up period for investor safety, biomass electricity

-Long-term predictable economic environment

[67] http://www.biomasszaeromuvek.hu/

-Promotion of "green heat"

-Establishing a support system for energy plantationsMembers: Bakonyi Erőmű Ltd.,

Hungarian Biogas Association

The aim of the Hungarian Biogas Association is to create an intellectual working environment, to assist in the presentation, research and education about scientific, technical and financial issues regarding the production and use of biogas.

The Hungarian Biogas Association intends to reach its aim through the organization of presentations, study trips, continuing education courses, panel discussions and conferences on biogas.

The Hungarian Biogas Association considers the following to be additional goals and tasks:

- the maintenance of relations and cooperative work with national and international partner associations, in the interest of disseminating information on the subject matter,

- scientific education, for interested individuals and corporate bodies, in the interest of disseminating the most recent national and international developments and results regarding the uses of biogas,

- the development of partnerships between Hungarian and international (particularly EU) biogas experts,

- the popularization of biogas, emphasizing it future importance to all parts of society,

- to be a partner to the government body dealing with the extensive propagation of biogas use and its legal regulation,

- to assist scientific researchers in all areas of biogas research.

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

There are currently 76 biogas plants in Hungary producing biogas with a total electricity generation capacity of 37 MWe. Of these, 31 are located on farms with a total capacity of 21 MWe. Currently, about 4-5 plants are under construction. The most common plants are 600-700 MWe. The oldest (started in 2003) and also the largest capacity plant is the Batortrade biogas plant in Nyírbátor, with a current capacity of 3.6 MWe after double expansion, which processes partly agricultural and partly poultry waste. One of the best-performing plants. There is a similar capacity plant at Gallicoop in Szarvas, which processes the waste from the poultry slaughterhouse and supplies the slaughterhouse with energy. The Beet Plant of the Kaposvár Sugar Factory, also operating in the food industry, will soon be doubling its capacity.

The Budapest Sewage Works operates two large-capacity biogas plants (2x3 MWe) on the southern and northern wastewater treatment plants of the capital, which provide energy for the treatment of sewage.

Most of the biogas plants in Hungary have a specific cost level of HUF 1.0-1.2 million / kWe, which in the case of a plant with an average capacity of 700 kWe has a cost of HUF 700-800 million depending on the technology. In addition to non-refundable subsidies and own resources, most of the plants also required bank loans. On average, the revenues from electricity sales amount to HUF 10-12 million per month. This represents an annual revenue of HUF 120-140 million. It bears the amortization spread over 15-20 years. The biggest expense is the maintenance and repair of the gas engine every 4-5 years, accompanied by the maintenance and repair of pumps, agitators, gate valves, valves, and adjusting the pH of the substrate. cost of additives needed to reduce sulfur (eg ferric chloride). Of course, at least one main salary and contributions are included, and other overheads are still charged to the operation. Taking all this into consideration, a 10-12 year return on investment in biogas plants can be expected in Hungary. The situation is more favorable in many European countries where the construction of biogas plants is faster than in our country. Most of the plants, with a total capacity of 7,100 units of

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

2970 MWe, are located in Germany, but the situation is better in the Czech Republic, Poland, Austria and Slovenia as well, in our immediate environment. The biogas plants operating in agriculture were built with UMVP EAFRD support in almost all cases. Most of the subsidized plants, with some but minor slippages, will be built by the end of this year, which will further increase domestic biogas production capacity. The plants were usually built with 50% non-refundable subsidy, which in some cases amounted to 350-400 million HUF.

The differences are in the support structures. While with us, investment subsidies provide incentives for investments and set a low level of green electricity feed-in, which today is favourable at around 30 HUF / kWh. In the countries that are ahead of us in the construction of biogas plants, they support investments at the green electricity feed price, which is one and a half to two times the Hungarian price. Sales and yields can be well planned for this, return on investment can be calculated, and the construction for lenders is good.

Several foreign (mainly German) investors would have set up biogas plants in Hungary, but these attempts failed due to low green electricity takeover prices and slow payback.

In the National Renewable Energy Action Plan, which is also required and accounted for by the EU by 2020, the share of renewable energies in total energy use in Hungary should be increased to 14.65%. Biofuels are a key part of this. In addition to increasing biomass for combustion and biofuel production, there are significant reserves for expanding biogas capacity. In the next eight years, with appropriate financing arrangements, the current number of biogas plants could (at least) be doubled, or even tripled. This would mean 90-120 biogas plants by 2020.

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

5.2.1.2 BIOMASS ACTIVITY

Biomass Product Line Association

Recently, the association has created a nonprofit Ltd. under the name KIBERDR, which will in the future specifically serve all the aspirations and developments that belong to the profile of the association. The service will be expanded with members, experts, and partners to provide advice, feasibility studies, competition writing, data provision and conferences.[68]

5.2.1.3 NATIONAL PROGRAMS FOR BIOMASS-UTILISATION IN HUNGARY

Food waste - 'Wasteless' programme

About 1.8 million tons of food waste is produced annually in Hungary. A significant proportion of this – about one third – is produced by households. According to the results of national research it means 68 kg per person, annually, and nearly half of it could have been avoidable. Although this amount lags behind some extremely wasting countries, it still accounts for a major part of Hungarian customers' baskets. Altogether we have to count with 300 000 tonnes of biodegradable waste.

Recognizing the problem, the National Food Chain Safety Office (NFCSO/NÉBIH) started its 'Wasteless' programme with the financial support of the European Union's LIFE (L'Instrument Financier pour l'Environnement) sub-programme, with the aim to decrease the amount of Hungarian food wasting. While determining the aims of the programme, the thematic priorities of the 7th Environmental Action Programme of the European Union were applied, with the main objectives like:

- Decreasing the proportion of food waste among Hungarian families, through changing consumers' attitude and behavioural patterns
- Increasing the foodwaste and food wastage awareness and the level of knowledge of children attending primary school

[68] https://www.bitesz.hu/

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

- Collecting good practices which contribute to prevention of food waste generating, and based on that, elaborating a guide book for the concerned food chain participants
- Collaboration and cooperation with other EU member states, in order to contribute to the international implementation of the project's results.[69]

5.2.1.4 Future Biomass valorisation options

Food waste

Food waste can come from raw and processed food, partly not in households during food preparation, partly in industrial processing, in commercial food production for sale, or by consumers of large quantities of food - restaurants, schools, hospitals, during the disposal of unused food.

Food waste is characterized by differences in its dry matter content and composition, which makes it not the weight but the energy content of the waste. Estimated by the European Commission

89 million tonnes of food are thrown away every year in Europe.

Many materials from agricultural production may be suitable for recycling: straw, beet by-products, by-products of pasture farming, orchards, grape-cutting and cutting material.

In a survey, more than half (56.0%) of the respondents found technology development and 35.4% of them a suitable method for improving the human resource, asking what steps could be taken to reduce the amount of waste generated. 28.6 percent of them thought they could help reduce the amount of

[69] *Source: www.maradeknelkul.hu*

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

waste they produce. Alternatively, comprehensive social awareness raising and awareness raising were also mentioned.[70]

By-products of product processing include vegetable oil by-products

The largest quantities of by-products are produced by the cultivation of cereals in the form of straw and mill waste. The energy content of agricultural by-products is estimated at between 1.7% and 5.7% of total energy consumption in the EU.

The efficiency of agricultural waste recycling is questioned by its high transport costs, transport distance and low value compared to the high weight of materials. These factors determine the economical collection, so the optimal location of the processing plants from the transport point of view is paramount.

The benefits of recycling can question the traditional practice of returning by-products to the soil to maintain fertility. Removal of organic matter from the production area results in a reduction of soil organic matter content, can reduce its fertility and soil biodiversity, and increase soil erosion.

Forest waste is the primary waste extracted from forestry activities during extraction, on-site processing and stock management. This includes large amounts of waste from orchards and vines during pruning and maintenance. By-products from the furniture industry - sawdust, wood waste - are processed by the industry itself.

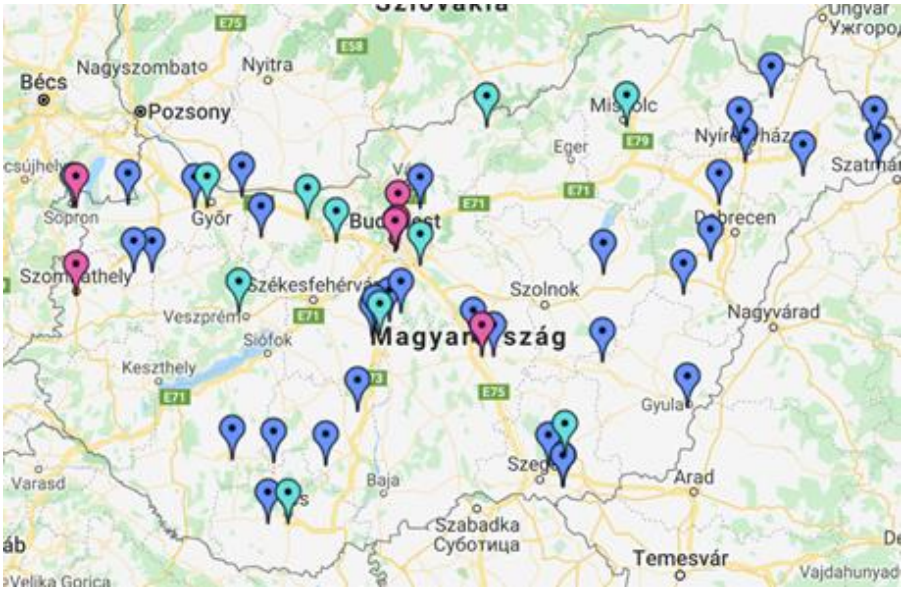
The limiting factors include the amount of raw materials available, the market demand for the listed by-products, and the decision on the material terms of the investment and operation.

Frequent fluctuations in the price of fossil fuels do not make it easy to plan long-term investments. It is undoubtedly positive that the technology for processing biomass is a well-known, long-standing process.

[70] *Source: http://pdf.wri.org/reducing_food_loss_and_waste.pdf*

Market demand for bio-based and chemical-based products is growing rapidly. Bio-based plastics production in Europe increased. The bio-based chemical industry is competitive in both the EU and the rest of the world and is growing fast.

Increasing the efficiency of biomass processing



Decentralized, smaller power plants could be one way to reduce transport costs.

Figure 29 Biogas-Plants in Hungary in 2016

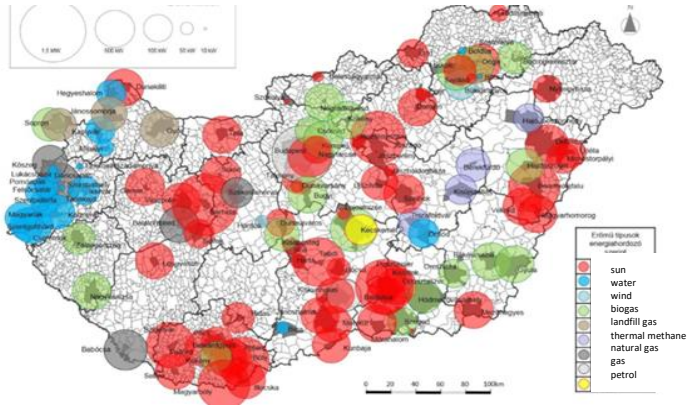


Figure 30 Location of non-licensed, non-household small power plants below 0.5 MW, 2016 [71]

[71] *Source: www.real.mtak.hu/84663/10/CIKK_DAB_MTeKMR_2018_Konferencia_Kiadvany-142-149.pdf*

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

Waste-free design of biogas plants

In Hungary, increasing the number of biogas plants is also a goal of the government. In many cases, technologies were adopted which did not care about the wastewater and sludge remaining after fermentation of anaerobic microbes and microorganisms, which were toxic from a plant physiological point of view. Mostly these are not sludges, because their dry matter content is about 4-6%, so they cannot be composted, utilized, only with an unreasonably high amount of lignocellulose additives, but their N content is not enough.

If the biogas plants use (design) an appropriate technology, which is closed at the end, and the digestion residues after the production of biogas, also known as fermentation residues, are condensed to above 12% (ideally 18 +%), they can be composted, utilized because these biotics "left behind" by methane producers can be degraded by appropriate vaccines and technologies.

Usually there is another problem: most animal waste enters the biogas system, so TPH - in some cases PAHs - has to be reckoned with, but this can be treated with the appropriate biological vaccine.

Thus, the fermentation residues of biogas plants are not expediently delivered, partly due to the presence of hazardous substances and partly due to the toxicity of seed-germinants, and present a specific biological risk. If agricultural use - as it is waste at present - is then subject to Regulation 50/2001, which is expected to be tightened to avoid adverse effects on soil, surface and groundwater, human health, plants and animals. So even time and space constraints have to be considered here.

The "raw material" itself - when replaced with the right additive to reduce the carbon content (some of it is expelled by gas), it approaches the nutrient base to sewage sludge, which has been proven and proven in several references.

The paradox is that we get one sale of biogas, but the second option (the sale of compost produced with proper treatment) is sometimes lost, and even the

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

elimination of untreated decomposition residue is money-intensive and risky and expensive to place.

Waste that is biotically toxic after biogas production can be decontaminated from toxic metabolites by appropriate biological treatment, and this is basically the start of the composting cycle, as during anaerobic processes one microorganism produces toxins, the other decomposes it.

If the technology for biogas production is well chosen, that is, it is finally "sealed" with an enzyme concentrate (dry matter content 18% minimum in sludge), then agricultural waste can reclaim coal sources and produce good compost, subject to Regulation 36/2006. so that, in addition to extracting biogas, we have a second income opportunity.

5.2.1.5 NATIONAL PROGRAMS TO INCREASE THE USE OF BIOMAS

Title	Basis	Duration	Activity
Renewable Energy Utilisation Action Plan	EU directive 2009/28/EC	2010-2020	to achieve the legally binding target of 13% by 2020, and to 14.65% in terms of renewable energy ratio of final energy consumption

The Renewable Energy – Hungary's Renewable Energy Utilisation Action Plan, 2010-2020 is based on the EU directive 2009/28/EC. It specifies how Hungary intends to achieve the legally binding target of 13% by 2020, and to exceed it to 14.65% in terms of renewable energy ratio of final energy consumption. Regarding biomass use, which is the largest fraction of renewables in order to meet the target, the document puts it in a wider complex of agriculture and rural development and introduces the term of green economy. It is stated that the use of biomass for energy purposes, based on the favourable agro-ecological conditions of the country and taking into account sustainability criteria (especially the protection of

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

biodiversity and soil quality), can contribute to the retention of agricultural jobs and to the creation of new ones. The use of organic matter from animal husbandry for energy purposes (biogas) can enable productive waste management, increasing the competitiveness of the sector. The use of by-products and other solid wastes from agriculture and forestry (e.g. by-products from crop-lands, cuttings from orchards and vineyards) for local energy purposes and their conversion into end-products will result in additional income for farmers and producers, and can significantly reduce the need of communities for fossil energy sources. The above statements, however, can also be applied for biomass utilization, regardless the purpose (other than energy). In order to highlight the importance of biomass the document also adds that Hungary possesses excellent agro-ecological conditions for a competitive production of biomass. Hungarian agriculture is capable of sustainably producing biomass in excess of food and feed demands, and at the same time, there is a significant biogas production potential. The theoretical potential of energy sources from biological origin (bioenergy) could exceed as much as 20% of the energy source demand estimated for 2020. Regarding transportation, more than 10% of the estimated consumption for 2020 can be fulfilled from first generation biofuels only, while at the same time ensuring the fulfilment of food and feed provision objectives; and with the emergence of second generation biofuels through the expansion of the scope of raw materials, this volume can be increased even further depending on the seasonal variations in the amounts of agricultural production.

Title	Basis	Duration	Activity
National Energy Strategy 2030	Hungarian Parliament	2010-2020	contains the elemental part of the renewable energy action plan, and new measures for the biomass based solutions.

The National Energy Strategy 2030, approved by the Hungarian Parliament in 2011, contains the elemental part of the renewable energy action plan, but also

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

introduces new measures for the biomass based solutions. This is the establishment of bipolar agriculture, possessing the required market-oriented flexibility enabling the shift between food production and energy-geared biomass production. The gradual conversion of the areas that are unsuitable for food production at the required efficiency, therefore currently left uncultivated, to arable lands by the cultivation of energy crops is encouraged. The strategy also recognizes that biomass and waste are also potential industrial feedstock, available for use in numerous areas of a fast developing biotechnology-based economy. It enables the production of pharmaceutical and fine chemical commodities by biotechnological processes considerably reducing the GHG emissions of recent industrial manufacturing processes. This statement is a clear development compared to the strictly energy orientated approach for biomass resources. Furthermore, the advanced biofuel production techniques and other biomass-based solutions are also pictured as driving forces for "greennovation" and potential contributors to economy with the provision that the required training, industrial and innovation knowledge base is developed.

Title	Basis	Duration	Activity
Hungarian National Environmental Technology Innovation Strategy	Hungarian National Reform Programme	2010-2020	Environmental innovation, to reduce primary material use and encourage reuse and recycling, and to ensure a paradigm shift from an "end-of-pipe" approach to prevention of environmental problems.

The Hungarian government adopted the National Environmental Technology Innovation Strategy at the end of 2011 as its framework for eco-innovation within the Hungarian National Reform Programme. The government's vision is to facilitate environmental industries and technology, to focus on environmental innovation, to reduce primary material use and encourage reuse and recycling, and to ensure a paradigm shift from an "end-of-pipe" approach to prevention of environmental

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

problems. The strategy contains targets and development areas around the following eight topics: 1) Waste 2) Water 3) Air 4) Noise and vibration 5) Agriculture and soil protection 6) Remediation 7) Renewable energy 8) Construction industry. The reason for selecting these priority groups is that they have a common feature: in each area there is great room for ameliorating the current level of environmental impact by various means. In each of the eight priority areas, considerable positive changes can be made. There is also a chapter, called horizontal type technological innovations aiming resource efficiency and containing biobased products as a development area. The strategy entails a systematic approach; environmental technologies are not just individual technologies, but total systems that include know-how, procedures, goods, services, and equipment, as well as organizational and managerial procedures. Regarding the bioeconomy vision the strategy states that environmental technologies use all resources in a more sustainable manner, recycle more of their waste and products, and handle residual waste in a more acceptable way than the technologies for which they are substitutes. In order to meet the targets the strategy introduces a set of tools including greening governance, legal tools (tax, public procurement) and social tools (environmental awareness, education).

Title	Basis	Duration	Activity
Darányi Ignác Plan Framework Programme	Implementation of the National Rural Development Strategy	2012-2020	Increasing rural employment, balanced and varied agriculture and forestry, diverse production structure, local food production and markets, rural-urban relations, coal energy production, rural local communities, conservation of ecosystems and biodiversity.

For the Implementation of the National Rural Development Strategy, The Ministry of Rural Development adopted the Darányi Ignác Plan – Framework Programme for the Implementation of the National Rural Development Strategy (2012-2020) in

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

2012. It fits into the EU and national policies and aims to reverse unfavourable processes predominant in the countryside. The vision is based on delivering sustainability, viable agricultural and food production and values of rural life. The strategy defines the objectives and principles of the country's rural development policy and provides a framework for the implementation of the relevant programs and measures. The main goals of the strategy are "increasing rural employment, balanced and varied agriculture and forestry that utilize resources in a sustainable manner, re-establishment of a diverse production structure, local food production and markets, rural-urban relations, the exploitation of export opportunities of high value-added food products, the strengthening of cooperative alliances, local energy production, rural local communities, improvement of the standard of living, a reversal in the rural population decline, and the conservation of ecosystems and biodiversity." Many of these goals are directly or indirectly connected to the bioeconomy, but there is no direct connection in the strategy established between advanced biomass processing and rural development.

Although the strategy highlights the major problem in the agribusiness, namely products with predominantly lower added value due to lack of further processing, and names the increase of added value as a preferable strategy. Despite this, it deals neither with the idea of the bioeconomy nor the advanced biomass technologies delivering opportunities for by-product valorisation.

The locally produced renewable energy appears in several parts of the strategy as an important factor of the rural development, but it is connected more to the wood utilization and then to the organic residues and wastes. There are more opportunities to use agricultural by-products, organic residues and wastes as valuable feedstock in various processes, as today it is an advantage to produce tradable, value added products besides energy.

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

Title	Basis	Duration	Activity
National Research and Development and Innovation Strategy 2020	Implementation of the National Rural Development Strategy	2013-2020	Investments in R&D&I in Hungary involving all kind of partners (including SMEs, research institutions and companies), and as a result, to mobilize our economy and to strengthen our competitiveness.

The strategy, approved by the Hungarian Government in June, 2013, recognizes that the support of research and development and innovation can be considered as a long-term investment in the future. The National Innovation Strategy aims to raise investments in R&D&I in Hungary involving all kind of partners (including SMEs, research institutions and companies), and as a result, to mobilize our economy and to strengthen our competitiveness. The strategy aims to raise the amount of R&D expenditures to 1.8% of GDP in Hungary by the end of the decade. It supports the formation of an environment in which public institutions, companies and innovative enterprises can develop and grow. The strategy focuses on the knowledge creation, knowledge transfer and utilization. It deals with the whole business sector, including small enterprises, medium-sized and big companies. The strategy also targets to raise the overall R&D capacities. Among others, the essential part of the strategy to create a Hungarian R&D infrastructure that is competitive in EU aspects and able to deliver more active participation in related programs, such as Horizon2020. In an effort to spring these processes to life in a more effective way, the strategy aims at (i) promoting the collaboration among all the relevant actors and (ii) supporting the diffusion of solutions that already exist, e.g. technological and service innovations. The strategy – in its form – functions as a general framework for R&D and innovation and avoids mentioning concrete sectors. The reason for this is that policy is not capable of predicting appropriately the innovative industries or sectors that should be promoted in the future.

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

Title	Basis	Duration	Activity
New Széchenyi Development Plan	Implementation of the National Rural Development Strategy	2014-2020	Improving Hungary's competitiveness, creating one million new jobs within ten years along seven break-out points

Improving Hungary's competitiveness, creating one million new jobs within ten years along seven break-out points – these are the main objectives of the New Széchenyi Plan launched on 14 January 2011. The economy development programme of the Hungarian government responds to the challenges what Hungary is facing, and ensures a growth scenario that can be sustained over long term. The break-out points for Hungary as identified in the plan are the followings: 1. Healing in Hungary – health industry 2. Renewal of Hungary – development of green economy 3. Network economy – development of business environment 4. Transport – transit economy 5. Knowledge economy - science – innovation – economic growth 6. Employment – work and performance oriented economy Common in the above break-out points is that all of them integrate numerous sectors and all of them carry the potential to create competitive Hungarian products, services and businesses already in the midterm. The main aim of the development plan is to identify the major principles for allocating funds from different sources (mainly Cohesion Policy) in a well aligned way with the respective policies as detailed above.

5.3 Summary and conclusions in relation to SWOT elements

Hungary is generally considered as a biomass rich country. Hungary's biomass potential is sufficient (and even more) to meet the 2020 renewable energy requirements with the existing technologies.

The annual quantity of required biomass is already available and it should be possible to meet the demand for solid biomass for direct combustion without the need for significant areas dedicated to energy crops. Moreover, Hungary has great potential to produce first generation biofuels, particularly ethanol, not only for domestic uses but also for export. Although numerous studies reviewed the Hungarian biomass potential, most of them claim that "there is very little reliable information on the available quantities of the different types of biomass and their energy potential in Hungary". Data are scattered throughout the literature and usually consist only of the calorific value of the different types of biomass, so this information cannot be used for estimating the potential of Hungarian biomass. A background study was written to the Hungarian Renewable Action Plan summarizing various existing potential estimations. The summary showed that Hungary has 420-500 PJ/year theoretical potential out of which 203-328 PJ/year is convertible in long-term (2050). The technical potential of all biomass sources is 215 PJ/year, the economic potential is 220 PJ/year and the sustainable potential would be 208 PJ/year on the long run (2030). In medium term (2020) 122 PJ/year sustainably exploitable potential can be estimated. Nevertheless, the concrete methodology and framework conditions may be not known and differ, thus leading to very diverse potentials. (As comparison the gross inland annual consumption of primary energy in Hungary is around 1000-1100 PJ).[72]

[72] *Source: https://klimainnovacio.hu/files/attachments/page/bioeconomy_study_final_draft_feb2014*

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

Table 30 SWOT -Analysis

Strengths	**Weaknesses**
Programmes related to biogas and biofuel exists in Hungary There is an economic potential for generating energy out of residues from the food processing industry The interest for biobased plastics and feedstock and organic fertilizer is continuously increasing There are corn and other food processing industries with a high capacity of residue processing in the country A large number of biobased research projects are executed at the universities and research institutes Producers of feedstock are processing their own residues	Problematic mobilization in mountain areas regarding heavy weight transport High cost demand for upgrade the equipment and machinery regarding recirculation of energy sources Not enough capacity for grid feeding – there is a need for grid development The fragmented ownership of the distribution network makes complicated the further developments Long transportation distances Low capacity of transport Lack of decentralized smaller power plants Higher price of biofuels compared to conventional fuels for individual users
Opportunities	**Threats**
Public support for the use of biomass Stable internal market There are official regulations for productions and the market Contributes to biodiversity More employment opportunities Clarified legal and ownership system Low interest rates for loans related to biobased initiatives The amount of available raw material is often higher than the capacity of the processing	General organic matter deficiency in soils Increased imports of biodiesel into the EU due to tariff -it can be influenced the economical sustainability The product range is scarce, only the biomass used for heating is widely known Infrastructure are available in just a few areas in the land (Biomass-industries and depos) Transport are mostly on road in Hungary, tariffs of cargo are high in country Additional land use might lead to in-direct land use changes, in worst case to deforestations The price of the biomass based energy is (0,1 Eur/kWh) is often smaller than the Opex (0,13Eur/kWh)

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

6. INFRASTRUCTURE, LOGISTICS AND ENERGY SECTOR

The economics of setting up biorefineries are determined by the costs of input, investment costs and the value of the main products. The existing infrastructure is an important factor for the feasibility of a biorefineries. Less investments are required if infrastructure already exists.

Large scale biobased production chains require transportation of large volumes of materials, i.e. the supply of biomass and the export of (intermediate) products. The only cheap options for transportation of large volumes are waterways and railways. Experts indicated that hubs are essential for establishing successful biorefineries. These hubs are usually located at (large) harbour (sea or inland) or at least have good railroad connections.

6.1 EXISTING INDUSTRIAL HUBS AND HARBOURS

Hungary is landlocked but has access to the North Sea and the Black Sea via the river Danube.

Hungary has excellent waterway connections, as the Danube crosses through the whole country from north to south. The Danube-Rhine- Main canal in Europe links the North Sea and the Black Sea (Figure 31). Several scheduled block train lines connect Hungary with the seaports of Hamburg, Bremerhaven, Rotterdam, and Antwerp (B) on the North Sea, and with Koper and Trieste on the Adriatic. The Adriatic seaports also offer alternative shipping routes from Asia. Lead times from these ports are within 16-36 hours.

TEN-T Core Danube ports: Komárom, Budapest Csepel (HUBUD)

TEN-T Comprehensive Danube ports: Győr-Gönyű, Dunaújváros, Paks, Baja, Mohács.

Major inland ports are located in Győr-Gönyű, Komárom, Budapest, Dunaújváros, Paks, Baja and Mohács.

Figure 31 Danube-Rhine-Main canal

6.2 Existing railway

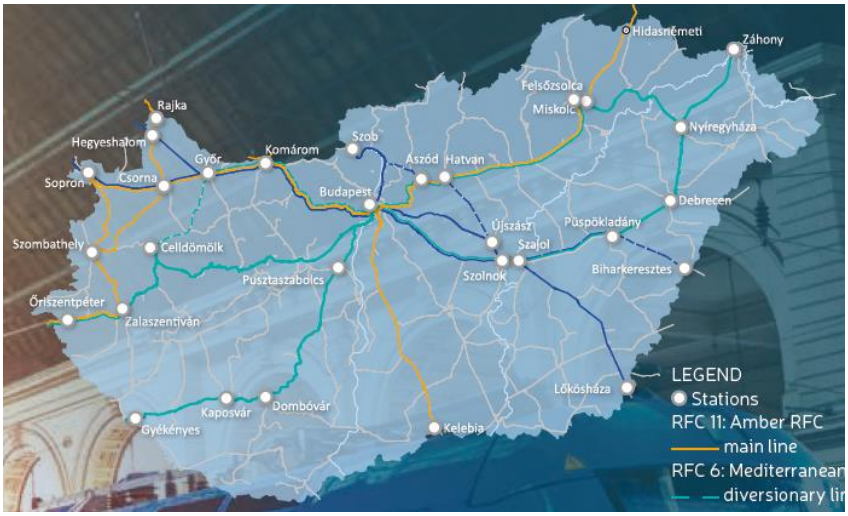


Figure 32 Hungarian Railway system

Due to its central location, Hungary has an extensive railway network (Figure 32). Rail transport carries more than 20% of total freight, which is well above the EU average. Several main train lines connect Hungary with the main ports of Western Europe (e.g. Hamburg, Bremerhaven, Rotterdam), the Adriatic (Koper, Rijeka, Trieste), the Mediterranean (Piraeus) and the Black Sea (Constanta) with regular block train services (Figure 33).

Hungary is ranked Nr. 6 by railway line density in Europe. The total length of the Hungarian railway system is 7,729 km, of which double-track is 1,335 km (17.3%) and the electrified railway network is 2,628 km (34%).

Záhony and its region is the junction and reloading centre for European standard-gauge railways and the wide-gauge system of the CIS states. Záhony, the Hungarian border city plays a significant role in the East-West rail transport: this is where the European standard gauge railway network meets the eastern broad gauge system, and the transfer takes approximately 19 to 22 days to China.[73]

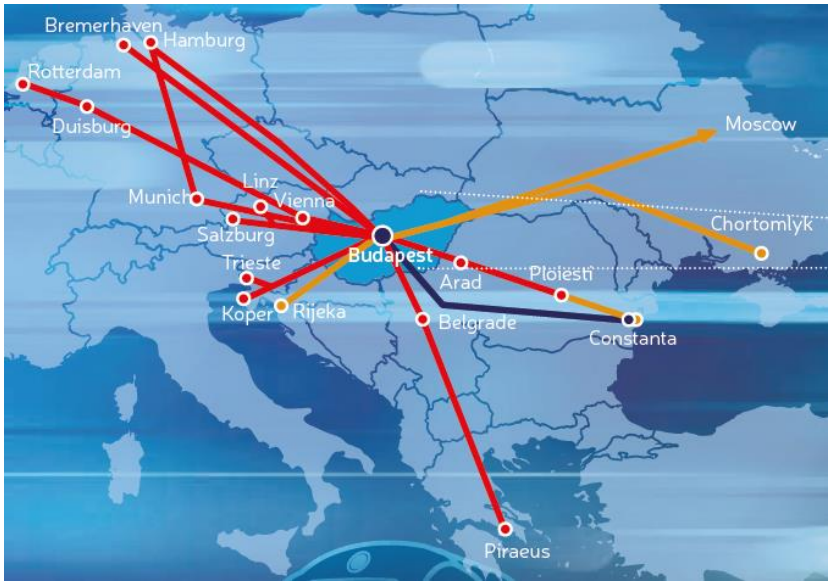


Figure 33 Railway network connections

[73] http://eugo.gov.hu/key-facts-about-hungary/infrastructure

6.3 EXISTING ROAD INFRASTRUCTURE

Hungary is Nr. 1 in length of motorways in CEE (EU Transport in Figures 2016). Hungary has one of the highest motorway densities in all of Europe and the third highest road density, after Belgium and Holland. Highways reach the borders of the country and the different regions of Hungary. Figure 34 shows the major roadways in Hungary.

Hungary has a central location in Europe, at the crossroads of four TEN-T Core Network Corridors (main European transportation corridors) (Figure 35), including:

- No. IV from northern Germany/North Sea to the Black Sea;
- No. V from the Adriatic ports to Kiev-Moscow;
- No. VII – the Danube River and Rhine- Main canal, from the North Sea; and
- No. X the north-south corridor from the Baltic states to Turkey and Greece.

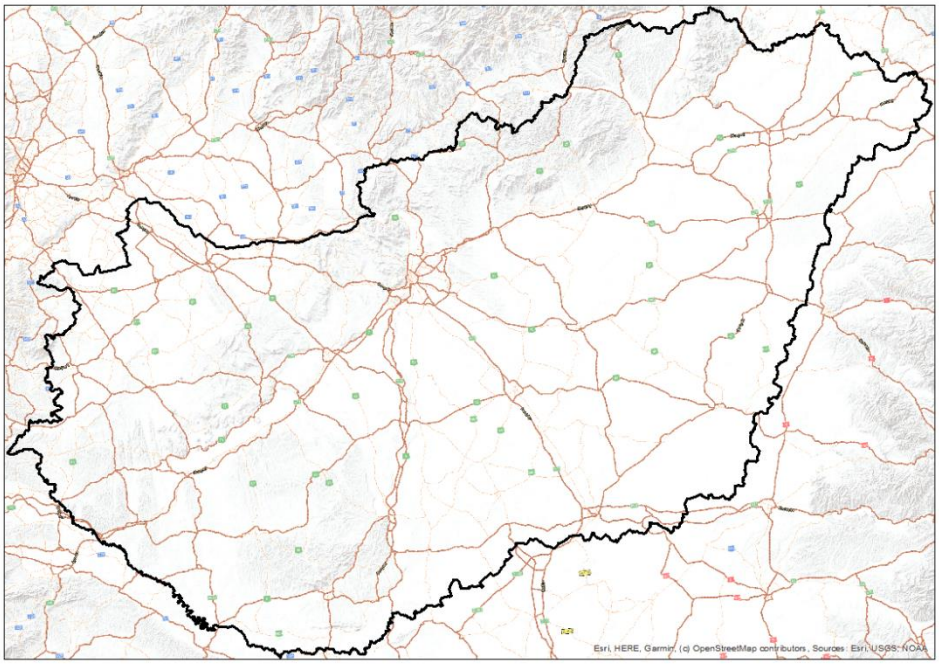


Figure 34 Major Roadways

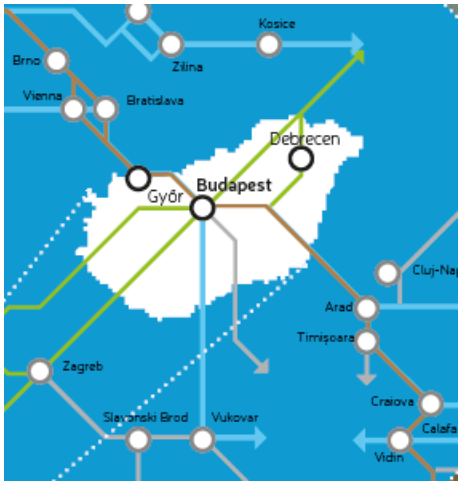


Figure 35 Crossroads of TEN-T Core Network Corridors in Hungary

All major Hungarian towns – Debrecen, Nyiregyhaza, Miskolc, Kecskemét, Szeged, Pécs, Győr, and Székesfehérvár – are all connected to the capital city, Budapest, by motorways (motorway total: 1,099 km).

Figure 36 Main motorways in Hungary

The main motorways in Hungary are (Figure 36):

M1: Budapest – AUT

M3: Budapest – RO/UKR/SK

M5: Budapest – SRB

M6: Budapest – Pécs

M7: Budapest – SLO

Logistics market

Due to its infrastructure and central position, large-volume development activity and transactions are concentrated in the vicinity of Buda pest. To date, more than 30 modern logistics centres and warehouse parks of approximately 1.3 million square meters have been developed in a 30 kilometre radius around the capital, primarily along the M0 ring road. More than 200 industrial parks offer greenfield or brownfield investment opportunities countrywide.

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

6.4 ENERGY SECTOR

Hungarian energy policy

As a small, land-locked Central European country with relatively unsubstantial amounts of domestic energy sources, the options facing Hungarian energy policy are often limited by external factors. The lack of, say, large-scale inland fossil fuel reserves or access to the sea strengthen the role of regional cooperation in energy matters

The first strategic priority is supply security, meaning the ability of the government and/or the market to ensure adequate access to energy and its products (i.e. electricity) at any given moment in time. In the case of Central Europe, this of course ties in to the role of Russian crude oil and natural gas exports to the region, and the implications of potential Russian leverage over domestic politics and business. Achieving supply security can imply both the diversification of energy import routes (i.e. through the construction of new pipelines or a liquefied natural gas (LNG) terminal), or the diversification of the energy sources we use (i.e. a greater reliance on nuclear or renewable energy to the detriment of natural gas). The legal framework for Hungarian energy policy is the "National Energy Strategy 2030" document, which was published by the Ministry of National Development in 2012. In line with the energy trilemma outlined above, its three stated goals are guaranteeing supply security, improving the competitiveness of the Hungarian economy, along with a paradigm shift in energy use and efficiency for environmental benefits.

When speaking about energy politics in Central Europe, the topic of Russian energy imports is usually the first to come to mind. This highly sensitive issue became the center of attention particularly after the gas crises of 2006 and 2009. The question of natural gas imports has always been more thorny than that of oil,

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

since natural gas pipelines create linear dependencies, whereas the market for crude oil is much more global in nature. According to data from the International Energy Agency (IEA), Hungary imported approx. 8.6 billion cubic meters (bcm) of natural gas in 2016, of which 95% came from Russia based on a longterm gas supply contract. (This in itself is not necessarily a problem, considering that Russia is generally seen as a fairly reliable supplier. Rather, the goal would be to ensure that Gazprom adheres to more flexible, market-based and transparent pricing towards its Central European customers.)

Hungary is geographically well-endowed to benefit from the use of renewable sources, be that solar power, biomass or even geothermal energy. On the diplomatic front, it is very active within the United Nations climate framework, and was the first EU country to ratify the Paris Climate Agreement signed in 2015.

According to the statistics, the annual amount of domestic biomass that can be used as an energy source is as follows: Crop production: 4-4.5 million tons, Animal production: 1.8-2.3 million tons, Food industry: 150-200 thousand tons, Forestry: 3-4 million tons, municipal waste: additional 25-30 million tonnes.

The installed total capacity of the power stations in Hungary is about 8.500 MW. Electricity production capacity is continuously decreasing mainly due to the power plants being antiquated. The express goal of the Government is to expand domestic production capacity. Hungary's gross electricity generation in 2017 was 32.2 TWh in total, with the gross consumption coming to 45.0 TWh. In 2017 the import ratio was 28.58%. The main import partners are Slovakia, Austria and Ukraine; the main export partner is Croatia (north – south direction flow).[74,75,76,77]

Table 31 Energy consumption and infrastructure

[74] *Source: https://kki.hu/assets/upload/16_KKI-elemzes_HUN_Szoke_20180423.pdf*
[75] *http://www.investhipa.hu/images/hipa_kiadvany_intro_greenenergy_web_201808.pdf*
[76] *https://kki.hu/assets/upload/16_KKI-elemzes_HUN_Szoke_20180423.pdf*
[77] *http://www.investhipa.hu/images/hipa_kiadvany_intro_greenenergy_web_201808.pd*

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

Category	Hungary	EU average	Unit	Assessment	Similar countries
3. Energy					
Primary energy consumption		3.22	toe/capita (2012)	Medium	ES, FR, PL, SI, SK, ME
Energy dependence		55.4	%	Medium	
Renewable energy share		17.9	%	Medium	
GHG emissions		9.47	ton CO_2-eq/capita	Medium	
8. Renewable energy (RE)					
Bioenergy in RE		69%	%	Medium	FR, SI
Bioenergy in total energy		10.6%	%	Medium	
9. Energy infrastructure					
Biofuels prod. Capacity		0.051	ton/capita	Low	
CHP		17.3%	% gross electricity generation	Low	
District heating		7,404	km		
		0.3	m/capita	medium	

CHP = Combined Heat and Power, GDP = Gross Domestic Product; GHG = Greenhouse Gas; LSU = Livestock units; MSW = Municipal Solid Waste, PPS = Purchasing Power Standard, RE = Renewable energy; UAA = Utilised agricultural area

Big power plants in Hungary

Big power plants in Hungary had a nominal capacity of 6,996 MW at the end of 2017. Small power plants' capacity stood at 1,621 MW. Renewable energy sources (RES) play an increasingly important role in the consumption mix. The share of RES in the total gross energy consumption was 14.2% in 2016. The main contributor being biomass based power generation. In addition, geothermal generation is forecast to expand in Hungary in the coming years.

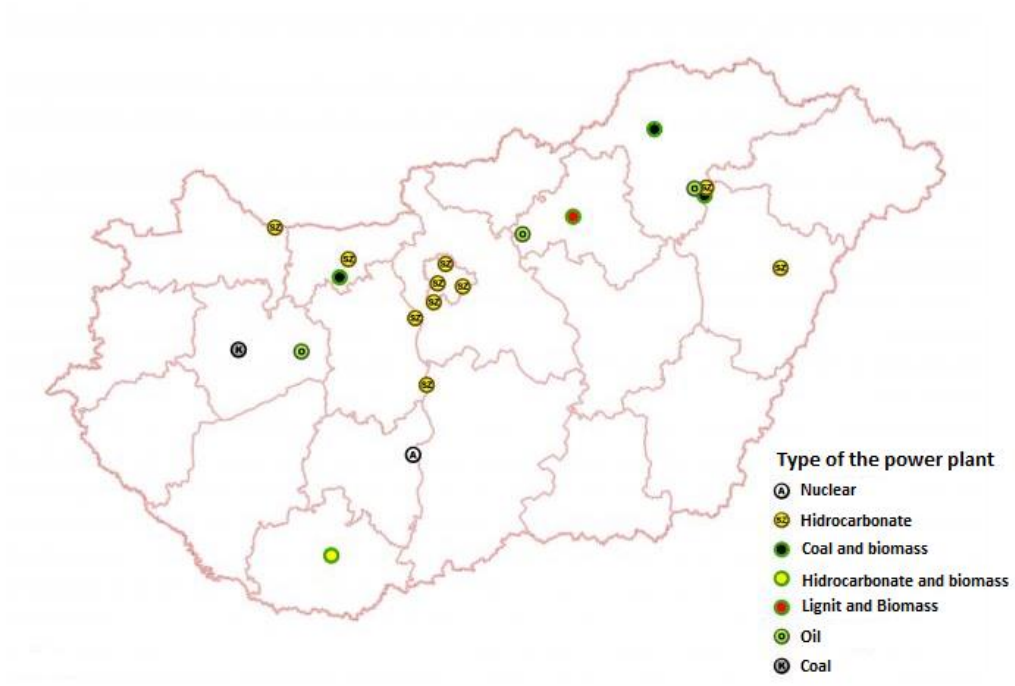


Figure 37 Map of the big power plants in Hungary[78]

Planned and realized investments on biomass basis

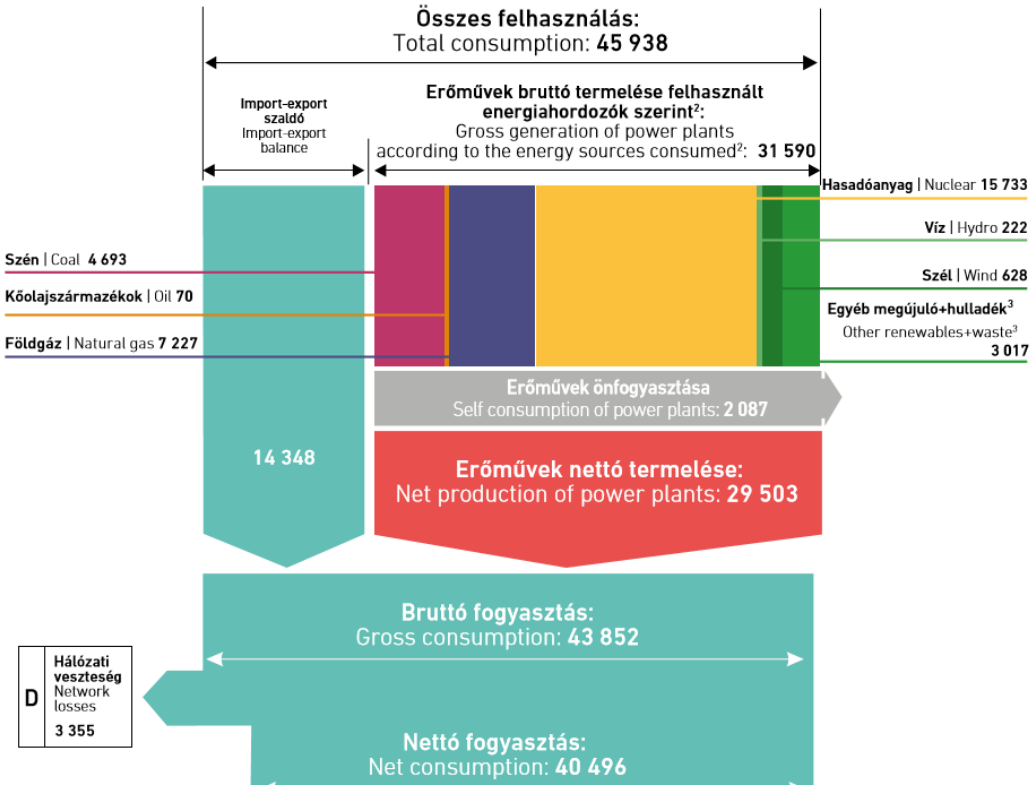
Heat and electricity production on biomass basis

- Balassagyarmat 2 MW 12e t / year 140 TJ 16 GWh
- Szentendre 9 MW + 1.4 MW 20e t / year 220 TJ 8 GWh
- Szigetvár 2 MW district heating biomass 2200 t / year 23 TJ
- Mátészalka 5 MW district heating biomass 6000 t / year 62 TJ
- Körmend 5 MW district heating biomass 6000 t / year 63 TJ
- Szombathely 7 MW district heating biomass 8000 t / year 92 TJ
- Papkeszi 5 MW industrial heat biomass 10000 t / year 120 TJ
- Nyírbátor 1.6 MW heat and electricity biogas 7.5 GWh

[78] Source: http://www.terport.hu/sites/default/files/imagecache/tematikusfull/eromuvek.jpg

Hungary's electricity generation and consumption

The total electricity consumption (gross production and importexport balance) was 45.94 TWh in 2018, which is a 0.83% increase compared to the previous year. The share of the production of domestic power plants (31.59 TWh) was 68.77%, and that of the import-export balance (14.35 TWh) was 31.23%. The figure of the import-export balance increased by 11.43%, while that of the domestic production



decreased by 3.34%.

Figure 38 Hungary's electricity generation and consumption, 20181 (GWh)[79]

[79] *Source: WWW.MEKH.HU/KIADVANYOK 2019 DATA OF THE HUNGARIAN ELECTRICITY SYSTEM*

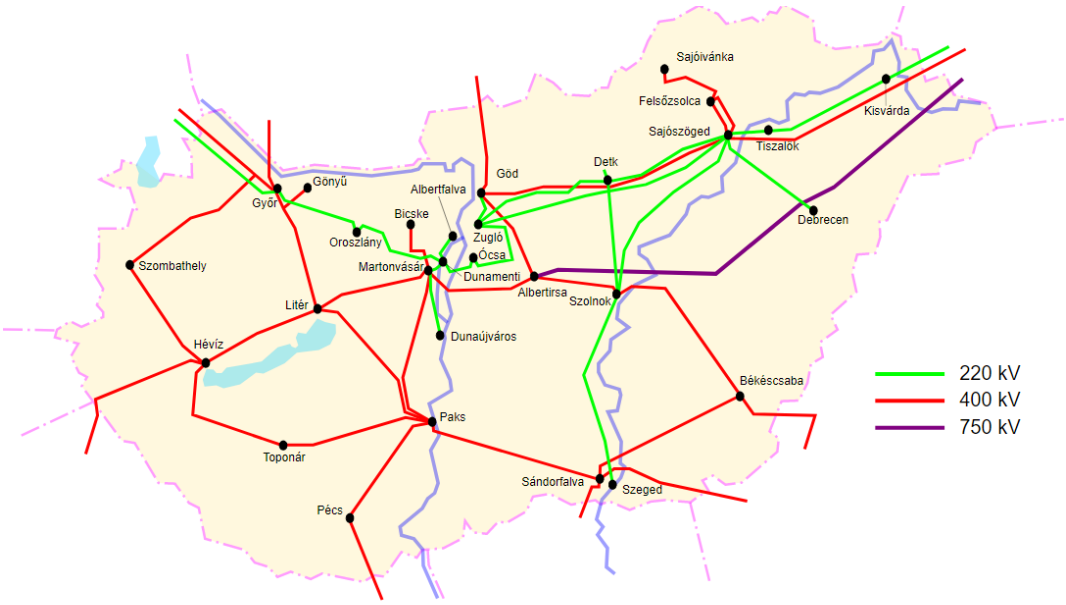


Figure 39 Map of power lines of Hungary [80]

[80] Source: https://hu.wikipedia.org/wiki/Magyarorsz%C3%A1g_villamosenergia-%C3%A1tviteli_h%C3%A1l%C3%B3zata#/media/F%C3%A1jl:Power_lines_Hungary.svg

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

6.5 Summary and conclusions in relation to SWOT elements

Table 32 SWOT -Analysis

Strengths	**Weaknesses**
legal framework for Hungarian energy policy Good coverage of the distribution network Stable internal market Renewable energy sources, solar power, biomass or even geothermal energy more than 30 modern logistics centres More than 200 industrial parks High motorway density Railway system is 7,729 km Train lines connect Hungary with the seaports Excellent waterway connections Big and small power plants	Strong dependence on external factors (mostly from Russian gas transport) Long transportation distance Low capacity of transport Fragmented ownership of the distribution networks
Opportunities	**Threats**
Central location in Europe The Government decided, that it is crucial to expand domestic production capacity A lot of heat power plant available to convert from fossil-based energy sources to biobased sources High activity within the United Nations climate framework	The main investments concentrated currently on the nuclear and solar power plants Production capacity is continuously decreasing mainly due to the power plants being antiquated Geothermal and solar-based energy generation is forecast to expand in Hungary in the coming years

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

7. Skills, education, research and innovation potential

Any biobased company will require a skilled labour force at competitive costs. Experts indicated for example that for biofuels skilled operators are required and therefore locations for establishing these companies should be attractive for these people, especially if they are not locally available. It was mentioned that in local rural areas there is lack of skilled operators. Education all along the biobased production chain is necessary. Not only skilled operators are important, but also service providers, people with knowledge of financing required locally.

In this chapter the availability of a skilled labour force, e.g. operators, engineers, service providers, the research (R&D of large companies) and educational (e.g. universities) infrastructure related to biobased production chains is described. The potential clusters and existing government agencies and trade organizations (e.g. Public Private Partnership) will be mapped, that promote or could promote biobased initiatives.

7.1 Availability of skilled operators and service providers

7.1.1 Consultancy relating to biomass utilization

Organisation/firm	Typ	Coverage	Activity	Volumen
National Chamber of Agriculture	National advocacy organization	Country	Consultancy, research	450 000 members

The National Chamber of Agriculture intends to play an active role in the domestic biomass-based economic transformation, taking into account the interests of

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

farmers as well. This is also assisted by the Biomass Economy Subdivision established within the Horticulture and Supply Division of NAK. The public body considers it important to involve the producers of primary products, the Hungarian farmers, in the formation of value chains, to strengthen their position, and to actively participate in the utilization of biomass.

7.1.2 STRATEGIC COOPERATION OF KNOWLEDGE-TRANSFER

A strategic cooperation agreement has been concluded between MVM Hungarian Electricity Plc., NKM National Public Utilities Ltd., Hungarian Association of Farmers' and Cooperatives (MAGOSZ), National Chamber of Agriculture (NAK) and National Center for Agricultural Research and Innovation (NAIK). on the long - term development of energy production.

The aim of the cooperation is to develop biomass-based energy production methods that can ensure sustainable and decentralized energy production in the long term along the lines of the National Energy Strategy. Biomass-based power generation solutions enable the setting up of technological and logistical systems that can address local environmental conditions more effectively than local needs. According to the agreement, in addition to developing new opportunities, the modernization and integration of existing supply chains is of paramount importance to the parties.

The contract provides a framework for cooperation in energy-related and R&D projects related to agriculture: sharing of knowledge and information, joint thinking in energy services, setting up joint research projects.

The signed document emphasizes the unquestionable role of MAGOSZ and NAK arising from the national organization, the successes and achievements of NAIK in biomass-based energy related research and the high level of competence of MVM Zrt. And NKM Zrt.

7.1.3 Relevant publications for education and knowledge transfer in the recent period

Title	Publisher	Availability	Authors	Year
Causes of food losses, their management and assessment among manufacturing companies	NAIK AKI	repo.aki.gov.hu/3469/1/AK_1902_ Elelmiszer_vesztesegek %202019_pass.pdf	Kürti Gyöngyi Dudás Gyula	2019
Use of biomass	Szaktudás Kiadó Ház Rt.	ISBN: 9789639422469	Bai Attila - Lakner Zoltán - Marosvölgyi Béla - Nábrádi András	2002
Biogas production	Szaktudás Kiadó Ház Rt.	ISBN: 9789639553392	Bai Attila	2005
Handbook for renewable energy	Center for Environmental Sciences	www.ktk-ces.hu/ENER-SUPPLY/megujulo_kezikonyv_kicsi.pdf ISBN 978-963-08-3749-1	Translation: Laczó Dániel	2012
Cost estimation of achieving the 2030 renewable energy ratio (study)	REKK	https://rekk.hu/downloads/projects/ 2019_REKK_NEKT_megujulo_final.pdf	Bartek-Lesi et al. Mária, Dézsi	2018

7.1.3 Initiatives of develop the biomass-production and using Leadership of Get-Energy Magyarország Kft

A project exploring the Hungarian cultivation experience of woody energy wood species was completed, and new varieties could be used in biomass production.

According to the announcement of Get-Energy Magyarország Kft., The consortium partner of the project started last year was the National Research and Consulting Institute. The research investigated the domestic viability of energy-efficient wood species internationally considered to be highly efficient, with a total of 30,000 Chinese emperors planted experimentally. Soil plots on 40 hectares of Somogy County were monitored for soil, meteorological and botanical data, allowing professionals to continuously monitor the evolution of experimental biomass variables.

According to the information, a detailed evaluation of the energetic and biological characteristics of the test species has been carried out, which makes it possible to select varieties and cultivation technologies suitable for domestic production (2013-2014).

been carried out on perennial, giant rhizome grasses which can be cultivated in marginal areas as energy plants. The term has emerged in recent years as a result of several initiatives involving a new generation of plants that can be propagated by biotechnology. In recent years, various effective reproductive technologies have been developed for plant species through various research programs[81].

In Hungary, the Agricultural Research and Development Company of Szarvas has already achieved significant results in the field of plant breeding for energy purposes. The calorific value of the so-called "Szarvasi-1" energy grass and the fuel made from it (the so-called pellet is produced by crushing and compacting) exceeds the calorific value of firewood and brown coal, although the calorific value of natural gas and fuel is approximately twice. The cost per unit of energy produced from energy grass fuel is about the same as the cost of energy from brown coal and firewood, slightly cheaper than natural gas and less than a quarter of the cost per unit of energy from gasoline[82].

[81] *Source: jems.lib.unideb.hu/file/9/5b374d43de8c7/szerzo/10.21791IJEMS.2018.*
[82] *Source: www.altherm.hu/hu/szakmai_hirek/biomassza-1.html*

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

7.1.4 Economic Development and Innovation Operational Program (GINOP)

Microbial degradation of high lignin-containing materials is very slow and relatively low biogas yields can be achieved. The temperature range of anaerobic fermentation is 5 - 66 ° C. Depending on the process, the gas yield is determined by the moisture content of the feedstock, the C / N ratio. The rate of biogas production depends primarily on the composition of the feedstock. Research has been carried out at the University of Sopron on pre-treatment to increase biogas yield. Black elderberries and oak bark with a diameter of 3-10 cm were used as the raw material. Raw materials are suitable for biogas production under thermophilic, anaerobic conditions. He also found that biological pre-treatment with fungi can improve methane yield. Further research has been conducted on the applicability of microalgae. Microalgae, sugar beet slices and spent cooking oil triplicate co-fermentation yielded a favourable methane yield of nearly 20% compared to algae monofermentation. An important aspect is the proper dosage of the micronutrient.

7.1.5 Trainings and conferences relating to biomass sector

Title	Organizer	Type	number of stakeholders	Date
„Food loss in the processing sector"	NAIK AKI Agrárgazdasági Kutatóintézet	Conference	80	26.09.2019 Budapest
Wood biomass cultivation and agro-forestry	Forestry of the University of Sopron	Engineering training	15	2019/2020
Skilled biomass worker	Adult education organizations	State registered vocational training	60-80	2019

7.2 RESEARCH INFRASTRUCTURE

There are 3109 research and development sites in Hungary with 60 thousand research participants. The number of research sites is 14. Relevant in biomass-sector:

Division for Biotechnology Szeged (BAY-BIO)

Division was the first established unit of Bay Zoltán Nonprofit Ltd. for Applied Research. Bay Zoltán Ltd.'s and BAY-BIO's activities form a technological bridge between the basic research and the experimental development within the biotechnological sector.

In close cooperation with the other divisions, BAY-BIO focuses on:

- providing an applied research background for domestic and international corporate partners
- implementing goal- and product-oriented development projects
- providing a modern service portfolio for partners
- practice-oriented education.

Due to our flexible approach and comprehensive professional background on the research area, we provide creative, innovative solutions and answers to the biotechnology-related problems and questions arising at our partners' sides. This also ensures the continuous development of our institute, helps our partners achieving their goals, and contributes the sustainable development of our environment.

Priority research and development areas

- complex agro-biotechnological development (in accordance with the 'bioeconomy' concept)
- environmental microbiology development
- biological recovery of secondary raw materials

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

- Departments of BAY-BIO Division for Biotechnology
- Department of Applied Microbiology
- Department of Recycling of Secondary Raw Materials
- Department of Biomass Production and Valorisation
- Agro-industrial developments in accordance with the 'bioeconomy' concept"

BAY-BIO plays an active role on this field, since the appearing of the bioeconomy concept.

BAY-BIO's Agro-industrial R&D activity – based on industral and agricultural by-products and plant based biomass – includes an active co-operation with our business partners for more than ten years in the following, agrarian-related areas:

- waste utilizing biogas production: it means utilizing waste-generated mushroom compost for biogas and organic fertilizers, which are produced in biogas plants of Pilze Nagy Kft. It reduces waste production and creates independence from fossil fuels.
- feeding at pig farming: we develop a neotraditional short-feed chain, supported by biotechnological tools at Kurucz Farm Lfd., for GMO-free food production.
- feeding at fish farming: producing immunostimulatory fodder supplements based on micro-algae strains for intensive fish farming, coordinated by NAIK HAKI
- organic nutrient supply for agricultural cultivation: developing an innovative, automated algae production system at Zöldségcentrum Kft.
- precision management at secondary vocational education: cooperating with Galamb József Agricultural Vocational Training School, in the fields of customized training of professionals and education methodology that takes into account the needs of producers and small and medium-sized business enterprises.

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

In the framework of KIC RAW MATERIALS program we set up our RAW MAT Laboratory in Szeged – in cooperation with our other institute in Miskolc – which is able to perform laboratory-scale metal extraction tasks and development. This infrastructure forms the basis for further research programs.

Creating partner networks

By involving our corporate partners, research institutes and governmental decision-making organizations, we have created a partner network that can represent the domestic secondary raw material utilization field. We established the professional background for enabling an effective, market-oriented task solving and technological development.

The institute's fermentation services include the definition of the culture conditions of the microorganisms to be fermented, and the upscaling of the quantities produced. During optimisation process of fermentaion, cells are first grown at laboratory-size 5-liter glass or steel fermenters. After successful setting up the main parameters, pilot scale fermentation takes place in a 150-liter steel bioreactor (all useful volume). The fermenter vessel and the instruments contained therein are made of stainless steel and glass and therefore are highly resistant to various chemical and physical effects.

During the fermentation process, various parameters (temperature, pH, dissolved oxygen concentration, stirring, nutrition) can be automatically maintained or modified in wide ranges, thus optimizing the culture conditions of microorganisms. The fermenter can be sterilized in SIP mode with steam locally, in an automated manner.

In addition to concrete developments, our experts are ready to provide support in the design and implementation of fermenter systems.

MGI - Plant Production Mechanization Department - Energy Testing Laboratory Gödöllő

The Laboratory, in response to market participants' requests, is conducting research into the development of bioremediation and automotive biofuel and autogenous combined and alternative solid fuel fueled and commercially fueled and alternative solid fuels.

The other main activity of the laboratory is to test the fuel of different types of solid biomass fueling equipment based on their energy parameters. The analytical department of the laboratory is also accredited according to the aforementioned standard MS EN ISO / IEC 17025: 2005. The laboratory is able to accept almost any type of biomass solids because of its well-equipped sample preparation facilities.

The energy parameters examined are as follows:

- elemental composition (carbon, hydrogen, nitrogen, sulfur, chlorine, oxygen)
- calorific value
- humidity
- ash
- ash temperature

University of Debrecen

The Faculty of Agriculture, Food Science and the Environment has been involved in the production of protein concentrates since 2001 and operates integrated aquaculture. The Faculty of Technology is involved in environmental and waste management research among others, while the Faculty of Science and Technology works with plant and animal biomass, such as thermal water, sewage sludge and algal strains.

The Faculty of Economics, which coordinates the Interdepartmental Committee of the Circular Economy of the Hungarian Academy of Sciences, and the Faculty of Informatics as a serving technology partner are also connected to the concept of circular biomass economy.

Biomass material science at the university is a separate subject.

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

NAIK Agro-Economic Research Institute (NAIK AKI)

The NAIK Agro-Economic Research Institute (NAIK AKI) - and its legal predecessor, the Agro-Economic Research Institute (AKI), established in 1954 - is today the most significant agricultural economic research center in Hungary. The Institute's main core activities are data collection and policy research related to the agricultural economy. The Information Systems Department operates EU and national information systems such as the Farm Information Network (FADN), the Market Price Information System (PIR) and the Agricultural Statistical Information System (ASIR). The two Research Divisions support their work on evidence-based policy making.

The main research areas of AKI are:

- policy evaluation of the functioning of a sustainable biomass-based economy;
- management of natural resources in agriculture;
- resource-efficient agri-food value chains;
- rural development and monitoring.

AKI is structured into three professional departments with 118 employees.

C Mobil Labor Trading and Service Ltd, Zalakomár

A laboratory-scale biogas reactor and an analytical measurement system have been developed as part of an innovation development supported by NKTH. Besides optimizing the fermentation parameters, they undertake to measure the gas yield of the raw biomass samples and to examine the dry residue.

Hydrosys Labor Kft., Budapest

The activities of the laboratory include the investigation of the radiocarbon activity of biomass-containing combustible samples (fuel, waste, plant, food) and determination of biomass content.

7.3 Educational infrastructure

Biomass is addressed at all levels of agricultural education. Training programs relating to the production, processing and utilization of biomass in Hungary:

7.3.1 BSc, MSc, and Doctoral Schools

Szent István University, Faculty of Agricultural and Environmental Sciences, Gödöllő educations:

BSc in Agricultural Engineering

BSc in Environmental Engineering

BSc in Wildlife Conservation and Management

MSc in Agricultural Biotechnology (Plant and Animal)

MSc in Crop Production Engineering

MSc in Wildlife Conservation and Management

MSc in Environmental Engineering

MSc in Agricultural Water Management Engineering

PhD education:

Agricultural Engineering

Animal Husbandry

Biological Sciences

Environmental Sciences

Management and Business Administration Sciences

Plant- and Horticultural Sciences

Food Sciences

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

University of Debrecen, Faculty of agricultural and Food Sciences and Environmental Management, Debrecen

educations: (BSc, MSc)

Agricultural Environmental Management Engineering

Agricultural Water Management Engineering

Animal Husbandry Engineering

Food Safety and Quality Engineering

PhD Education:

Doctoral School of Nutrition and Food Sciences

Crop Sciences and Horticulture

Doctoral School of Animal Husbandry

Széchenyi István University, Faculty of Agricultural and Food Sciences, Mosonmagyaróvár

educations: (BSc, MSc)

Food engineering

Agricultural engineering

PhD

Wittmann Antal Plant-, Animal- and Food Sciences, Multidisciplinary Doctoral School

Kaposvár University, Faculty of Agricultural and Environmental Sciences, Kaposvár

BSc programmes:

Animal Production Engineer (BSc)

Agricultural Engineer (BSc)

Plant Production Engineer (BSc)

Nature Protection Engineer (BSc)

MSc programmes:

Animal Science (MSc)

Animal Nutrition and Feed Safety (MSc) (in English as well)

Agricultural Engineering Teacher (Animal Production Engineer) (MSc)

Vocational higher education

Environmental Protection Technologist (Specialised in Waste Management)

Stud Manager

Master in Agriculture

Master in Nature Conservation

University of Sopron, Faculty of Forestry, Sopron

educations: (BSc, MSc)

MSc Forest Engineering Program (5 years undivided, full-time MSc education)

BDc, MSc Environmental Engineering Program

BSc Surveyor and Land Management Program

BSc Nature Conservation Program

BSc Wildlife Management Program

PhD

Doctoral School of Forestry and Wildlife Management Sciences

Faculty of Engineering, University of Pannonia, Veszprém

educations (BSc, MSc):

MSc in Environmental Engineering

MSc in Environmental Sciences

PGDip in Water and Wastewater Treatment System Operation

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

7.3.2 HIGH SCHOOL TRAINING

There are 61 agricultural schools in different regions of the country.

	Name of Region/School	Stite of Education
	Ministry of Rural Development (VM) Agricultural Training Center for Eastern Hungary	
1	VM Agricultural Training Center of East Hungary, Agricultural School and College	Jánoshalma
2	Batha János Horticular School	Szentes
3	VM ASZK Mátra Forestry, Agricultural and Wildlife Management School and College	Mátrafüred
4	VM ASZK Vocational Training School - VM Agricultural Vocational School and College	Pétervására
5	Szentannai Samuel Secondary School, Vocational Secondary School and College	Karcag
	VM Transdanubian Agricultural Vocational Training Center	
6	VM Transdanubian Agricultural Vocational Training Center, Csapó Dániel Secondary School, Agricultural Vocational School and College	Szekszárd
7	VM DASzK Vocational Training School Zsigmond Móricz Agricultural Vocational Training School	Kaposvár
8	VM DAszK, Vocational Training School - Apponyi Sándor Agricultural Vocational School and College	Lengyel
9	VM DASzK, Vocational Training School - VM Agricultural Vocational School and College	Sellye
10	VM DASZK, Vocational Training School - Imre Ujhelyi Vocational School and College of Agriculture and Economics, Szentlőrinc	Szentlőrinc
11	VM DASZK Vocational Training School Teleki Zsigmond Agricultural Vocational School and College	Villány
12	VM DASZK, Vocational Training School - János Lippai Horticultural Vocational School and College	Sopron
13	VM DASZK, Vocational Training School - VM High School, Agricultural Vocational School and College	Vép

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

	VM Agricultural Training Center of Central Hungary	
14	VM KASZK, Vocational Training School-Bercsényi Miklós Food Industry Vocational School, College and VM Practical School	Budapest
15	VM KASZK, Vocational Training School-Márton Varga Agricultural Vocational Training School, College and VM Practical School	Budapest
16	VM KASZK, Vocational Training School-Agricultural, Forestry Vocational Training School, College and VM Training School	Piliscsaba
17	VM KASZK, Vocational Training School-Táncsics Mihály Vocational Training School, College and VM Practical School	Vác
18	Abaújszántó Agricultural Vocational Training School	Abaújszántó
19	Bedő Albert Forestry Vocational School and College	Ásotthalom
20	Pettkó-Szadtner Tibor Equestrian Vocational School and College	Bábolna
21	Máté Bereczki Food and Agriculture Vocational School and Sports School	Baja
22	Vay Ádám Grammar School, Vocational High School, Vocational School and College	Baktalórántháza
23	Hungarian Gyula Horticultural Vocational School	Budapest
24	Barnabás Pest Vocational Training School of Food Industry	Budapest
25	Soós István Vineyards Training School	Budapest
26	örök János Agricultural and Health Vocational School	Cegléd
27	Bársony István Agricultural Vocational School and College	Csongrád
28	Zoltán Csukás Agricultural Vocational School and College	Csorna
29	Bethlen Gábor Agricultural and Food Vocational School and College	Gyomaendrőd
30	Veres Péter Agricultural and Food Vocational School	Győr
31	Veres Péter Vocational School of Agricultural and Food Industry	Csermajor
32	Széchenyi István Agricultural and Food Vocational Training School	Hajdúböszörmény
33	Gregus Máté Agricultural Vocational School	Hódmezővásárhely
34	Pál Kinizsi Food Vocational School	Kaposvár
35	Kenderes Agricultural Vocational School and College	Kenderes
36	Agricultural University and College of Vocational Education in Kétegyháza	Kétegyháza

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

37	Kiskunfélegyháza Agricultural and Food Industry Vocational School	Kiskunfélegyháza
38	József Galamb Agricultural Vocational Training School	Makó
39	Baross László Agricultural Specialist Building School	Mátészalka
40	Debreczeni Márton Agricultural and Surveying Vocational School	Miskolc
41	Damjanich János Secondary School and Agricultural Vocational School	Nagykáta
42	Toldi Miklós Food Industry Vocational School and College	Nagykőrös
43	János Lippai Agricultural Vocational Training School	Nyíregyháza
44	Vilmos Westsik Food Vocational School	Nyíregyháza
45	Pálóczi Horváth István Agricultural Vocational School and College	Örkény
46	Pápa Agricultural and Food Vocational School	Pápa
47	András Fáy Agricultural Vocational School and College	Pécel
48	Serényi Béla Agricultural Vocational Training School	Putnok
49	Szepsi Laczkó Máté Agricultural and Food Vocational School	Sátoraljaújhely
50	Széchenyi Zsigmond Agricultural Vocational Training School	Somogyzsitfa-Szőcsénypuszta
51	Lipthay Béla Agricultural Vocational School and College	Szécsény
52	Fodor József Food Vocational Training School	Szeged
53	Ferenc Kiss Vocational School of Forestry	Szeged
54	Szent István Agricultural and Food Vocational School	Székesfehérvár
55	Ottó Herman Vocational School and College for Environmental and Agricultural Education	Szombathely
56	Szombathely Vocational and Surveying Vocational School and College	Szombathely
57	Jávorka Sándor Agricultural and Food Vocational School and College	Tata
58	Tiszabercel Agricultural Vocational School	Tiszabercel
59	Tokaj Agricultural Vocational School	Tokaj
60	Elemér Székács Agricultural and Food Vocational School and College	Törökszentmiklós
61	Dr. Entz Ferenc Agricultural Vocational School and College	Velence

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

7.3.3 ADULT EDUCATION

Hungarian Chamber of Agriculture - educations:

Farmer
Organic farmers
Family farmer
Waste purchaser and manager
Waste management technician
Agricultural worker
Agricultural
Wild management
Water management

7.4 ENVIRONMENT FOR START-UPS

"Incubator"-system

While the majority of startup activity has grown out of Budapest, the country has also seen smaller scale startups scenes emerge in other parts of the country due to a strengthening support network. Debrecen, the largest city after Budapest, has an active scene; Gyor in western Hungary near the Austrian border and Miskolc are growing consistently too. The Hungarian government has tried to foster the country's startup ecosystem by providing funding for local incubators and accelerators in Budapest and further afield.

In 2016, eight incubators were funded using money earmarked from the European Union as well as the Hungarian government. Each of these incubators was given just under €2 million and was located outside of Budapest in a strategic move to boost rural development.

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

Despite a couple of success stories, many argue the idea was conceptually flawed from the start. Many entrepreneurs have sneakily played the system by founding their companies near one of the rural towns in attempt to secure funding, but have effectively lived and worked out of Budapest, where a staggering majority of the country's GDP — as much as 60% — is generated.

Design Terminal — one of the country's oldest and most well-recognized incubation systems — used to be fully run by government money, but now works from private money with some governmental partnerships. Another older incubator is Kitchen Budapest, which is run by Telekom Hungary. Newer startup support organizations such as Telenor Accelerate, Lab.Coop, and Impact Hub Budapest, along with innovation labs like xLaboratories and Sparklab have begun making a positive impact on the startup community as well.

Coworking spaces too have sprung up where entrepreneurs can flesh out their ideas through close collaboration. Some that have garnered the most attention and proven themselves as the most important community meeting points include Mosaik, Loffice Budapest, Kaptár, and Impact Hub Budapest. Mosaik in particular, though founded just two years ago, has been fundamental in cultivating the expanding startup ecosystem. In its first year, it hosted 152 high quality events focused on startups, innovation technology, and networking. Last year, it hosted more than one event per day.

Education

Education is critical for the development of a well-positioned and successful startup ecosystem. While Budapest has historically been behind in this regard, it has slowly begun making strides to catch up.

In the past, universities throughout the country were traditionally famous for their focus in the area of life sciences. Areas such as innovation and business studies

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

have never been truly competitive with Western European universities such as those in Copenhagen, however the tide has begun to change.

The most well-known university, for example, is the Budapest University of Technology and Economics (BME) which specializes in areas such as technology, math, and physics. There is also Corvinus University of Budapest which is best known for its studies of business and economics, and Central European University (CEU) with strong MBA programs and even an accelerator that recently won the title as the Best Accelerator and Incubator in Hungary.

While there has been a shift to place stronger focus on business education, however, most universities have accomplished this by partnering with large corporations that could guarantee jobs and high wages. Over the last two years, the country's most innovative educational strides have been taken in private developer and user experience schools sponsored by these larger corporations, in addition to an increasing number of coding bootcamps such as Le Wagon, Green Fox Academy, and Codecool.[83]

Associations for Startup in Hungary

Startup Hungary

Startup Hungary is an independent nonprofit association representing members of the Hungarian startup ecosystem. Startup Hungary was created by the shared vision of its founding members to strengthen the Hungarian startup ecosystem in its position as a digital economy hub. The association's activities are focusing on three key areas:

Coordination

Coordinating efforts to establish common objectives for accelerating the development of the startup ecosystem.

[83] *Source: https://sociable.co/technology/startup-ecosystem-hungary/*

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

Research

Gathering data on Hungarian tech startups to enable smarter policymaking and to increase transparency and visibility.

Representation

Uniting stakeholders to form a representative voice of tech startups in opening up a dialogue with policy-makers.

Ecosystem analysis

Startup Hungary is tracking the economic profile of Hungarian digital and technology startups, which released as annual reports. Using our data and insight of the Hungarian startup ecosystem, the firm provides our partners with in-depth analysis.

Scouting for startups

By leveraging the professional network the firm provides business scouting services for the partners interested in Hungarian startups. The firm also provides partners with easy to use tools for evaluating prospects from the database of Hungarian startups.

Facilitating partnerships

The firm provides business services that help to build partnerships between startups, technological integrators and investors interested in the field. The professional network allows to establish partnerships swiftly and directly between the parties.

Startup Hungary also aims to make a constructive contribution to policy affecting the startup ecosystem in Hungary.[84]

[84] *Source: http://startups.hu/*

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

Budapest Enterprise Agency (BEA)

Budapest Enterprise Agency (BEA), a certified EU Business Innovation Centre, was founded by the City Council back in 1993 as the sole organization of the capital city responsible for enterprise promotion. Thus, BEA is using the diplomatic ties of Budapest to represent the best startups at leading innovation events around Europe.

This Agency became the official country manager of the Startup Europe Award in Hungary and has been running the Be Smart startup competition for startups twice a year since 2013. This competition gives startups the opportunity to present themselves on the Startup Night, an annual event with close to 1000 participants from more than 10 countries. Also, BEA is using the diplomatic ties of Budapest to represent the best startups at leading innovation events around Europe, such as Futurescope in Dublin, 4YFN in Barcelona, the Ruhr Summit, or the Web Summit in Lisbon.[85]

Digital Startup Strategy of Hungary

Digitalisation is one of the most important driving forces of economic competition, national development and social wellbeing. Smart governance and government administration wish to be an active participant of natural development in order to take advantage of its benefits and minimise its disadvantages by all means. Therefore, the Hungarian Government wants to give impetus to digital transformation, ensuring that all Hungarian citizens and enterprises should benefit from that change of historic proportions. In Hungary, the digital economy accounts for 20 % of the gross value added (GVA) of the national economy as a whole, employing nearly 15 % of all employees. In terms of the weight of the digital economy within the national economy, Hungary is among the leaders in the European Union. While that advantage may be increased by conscious measures,

[85] *Source: https://startupeuropeawards.eu/call-for-startup-europe-awards-hungary/*

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

it may even disappear as a result of the fierce global competition for resources of the digital economy, i.e. skilled manpower.

Since digital economy may be an opportunity for growth for the Hungarian national economy, well-thought-out, comprehensive (startups, ICT businesses etc.) development projects are of key importance. The declaration of will by citizens during the national consultation campaign on the Internet and digital development projects (InternetKon) of the Government reinforced that awareness as the citizens' response was clear and unambiguous that the digital development of Hungarian businesses must be given extra support in order to improve the competitiveness of Hungarian ICT businesses as well as of small and mediumsized enterprises using infocommunication devices and services.

On the basis of the results of the InternetKon, the Government has drawn up the Digital Success Programme in order to facilitate the digital development of Hungarian society and the Hungarian national economy. The Digital Startup Strategy of Hungary, drawn up as part of the Programme, formulates the Government's vision of Hungarian digital enterprises up to 2020. First and foremost, it prefers a system of regulation that is flexible and open toward the changes involved by new technologies, recognising the competitive advantage of the ability to respond rapidly in the global economy. With the Digital Startup Strategy of Hungary, the Government aims at supporting and espousing the Hungarian startup ecosystem as a whole. Based on determining startups' objective and perceptional limits of growth, the strategy has identified policy, development policy and regulatory instruments constituting a balanced system, better suited to the actual needs, life-cycle and growth potential of startup companies.[86]

[86] *Source:https://digitalisjoletprogram.hu/files/89/ea/89eac5ce5f74178f3f527945f7edd08f.pdf*

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

7.5 PUBLIC PRIVATE PARTNERSHIP

The original purpose of PPP was to bridge the growing gap between the cost of infrastructure and its maintenance, and the resources available to finance it. PPP has since evolved to a higher level of risk sharing while ensuring a more manageable burden on the state budget. The key objective is to ensure that infrastructure is delivered efficiently and at the lowest possible cost. However, PPP may not always be the most suitable method of financing a project and decision-makers must assess the pros and cons of each individual case.

Several attempts have been made to define PPP and distinguish it from other methods of procuring public infrastructure/services. Current Hungarian legislation does not define PPP, so that it remains a 'best practice' rather than an acknowledged legal term. Some commentators describe the defining characteristics of a PPP project as follows:

- the project realises a public service that has previously been provided by a state monopoly;
- the private sector not only delivers assets, but also is involved in operating and, sometimes, financing the infrastructure;
- performance measurement is often a factor in the remuneration of private sector participants; and
- the public sector closely monitors performance and costs.

In Hungary the projects of the early 1990s, which had the characteristics described in the first two points above, were mainly concession projects and can be regarded as predecessors of the PPP concept.

Other commentators believe the key difference between PPP and traditional procurement is that in PPP structures payments made to the private sector are based on the outcomes and the performance of the asset throughout the project period. In PPP projects the private sector service provider is responsible not only for

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

the construction and delivery of the asset but also for managing the project and operating the asset delivered thereby becoming a provider of public services.

Legal Framework

As there is no official definition of PPP in Hungarian law, no clear distinctions can be made when categorising a project as a PPP project. Therefore, no one piece of legislation can be identified as the supreme law governing PPP; several legal provisions may be relevant depending on the characteristics of the project.

Generally speaking, the legal framework consists of laws that are relevant to all PPPs and laws that are project specific. The most important piece of legislation is the Act on Public Procurement (Act 129 of 2003), which sets out the entire bidding procedure. The Act on Concessions (Act 16 of 1991) provides for additional procedural rules where the project matter is exclusively state or local government property under the Civil Code (Act 4 of 1959). For local PPPs, the Act on Local Governments (Act 65 of 1990) is the relevant piece of legislation. For central government projects, the Act on the State Budget (Act 38 of 1992) and a number of corresponding government decrees apply. When preparing bids and project agreements, the Civil Code and sector-specific legislation must be taken into account.

The first thing to consider is the procedural framework, which in most cases is dominated by the public procurement rules. The question of whether the contracting entity is considered a public entity under the Act on Public Procurement and the nature of services procured, together with the gross value of the PPP, determine whether or not a public procurement procedure must be followed. The European and national legislation governing public procurement clearly defines the entities and project values that necessitate the use of a transparent and competitive public procurement procedure when purchasing goods or services or facilitating construction projects. In most cases these criteria are fulfilled, making public procurement mandatory. However, as most of the

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

public procurement rules were enacted before PPP projects became common, some provisions may hinder the development of PPP projects.

The nature of the services to be provided in a PPP structure may mean that the tendering procedure set out in the Act on Concessions is also applied. In certain cases both the public procurement provisions and the tendering procedure set out in the Act on Concessions must be applied at the same time. Both the Act on Public Procurement and the Act on Concessions contain provisions governing the interaction of the two procedures to resolve any inconsistencies.

The Hungarian government has set up an intra-governmental committee to coordinate the PPP projects organized by different ministries (the "PPP Committee"). Government Resolution No. 2028/2007 (II 28) provides guidance as to the role of the PPP Committee and its obligations for proposed PPP projects. The PPP Committee prepares enabling legislation, comments on and assesses planned PPP projects, monitors the progress of PPP projects throughout their lifetime and evaluates such projects once completed. PPP units also exist within some ministries, including the Ministry of Economy and Transport (which has its own department of property management); the Ministry of Finance (which has a PPP working group) and the National Sports Office (which has a PPP project office). This indicates the government's recognition of the importance of continued use of PPPs in Hungary.[87]

[87] *Source: http://pppstandards.org/hungary/*

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

7.6 Summary and conclusions in relation to SWOT elements

7.2. table SWOT -Analysis

Strengths	**Weaknesses**
There are incubator programs for start-ups Hungary has a favourable geopolitical location Economic consultancy is available A relatively high-level of education and research infrastructure A dynamically improving meet- up culture Hungary is an attractive country for young entrepreneurs.	Only a few investors take the risk. The taxation environment has a negative effect on the propensity to invest. The conditions of self-employment are complicated and have a deterring effect. There are only a few diversified co-working offices. There are few support offices in the countryside. The labour cost is relatively high because a lot of tax are payable on the employees.
Opportunities	**Threats**
Stable economic environment Banking background willing to finance Satisfactory level of training in engineering, economics, design and arts/social sciences. Ease of setting up a business. Existing preferential taxation schemes. An increasing portion of the new generation young people are willing to be self-employed; being self-employed is becoming increasingly attractive for them. The number of capital placements has increased at a dynamic rate. Sufficient capital is available for startup development. Legal certainty; Stabile legal environment	Low quality of financial culture. The focus of career advisors is overtly restricted to multinational and large companies. There is no relevant training for teachers. There are only a few young entrepreneurs. Entry to the international market is difficult. The lack of university partnerships reinforces the lack of market cooperation among young graduates. There is weak cooperation between large Hungarian companies and startups. The financing of both early-stage startups and scale-up companies is unresolved.

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

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

For establishing biobased initiatives, business and regulatory environment is of essence. This environment does not only include laws and regulations, but also include industrial standards, quality standards, sustainability regulations, financing regulations, and the option to obtain subsidies.

Experts indicated that taxes are an important factor which could enhance higher use of biobased materials and products, as the production costs of biobased materials and products is generally higher compared to fossil-based ones. This could for example be achieved by introducing CO2 taxes. Economic instruments can tilt the playing field towards biobased industry.

8.1 Biofuels

In Hungary, the use of biofuels has been regulated since 2005. For the first period up to 2009, biofuels received a tax credit for blended (up to 5%) bioethanol and biodiesel, and excise duty could be claimed for the bioethanol portion of up to 15% blended ETBE. The purpose of the tax reduction was to create industrial-scale biofuel production capacities and to market biofuels blended with conventional fuels (BAI, 2013). The biofuel tax advantage favoured biofuel producers in that they were compensated for the difference between the cost of producing biofuels and the market price of the fuels, which constituted State aid.

The exemption for biofuels was replaced by a differentiation in excise duty on bioethanol on 1 July 2007 and on biodiesel on 1 January 2008. This meant that if

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

the bio component content of the marketed mixture did not reach 4.4%, additional tax was payable, otherwise the excise duty payable was lower. Tax differentiation did not mean tax cuts in favour of more environmentally friendly fuels: biofuels were exempt and almost all fuels (including those containing a bio-component) were subject to excise duty. Thus, the regulation has been designed in such a way that it does not impose any additional burden on the national budget (POPP, 2010). Only the bioethanol component of E85 fuel remained exempt.

In the European Union, Member States either immediately or gradually reduced or abolished tax incentives by making biofuel mandatory (e.g. in Germany and Hungary).

8.2 FEED-IN TARIFF

In Hungary, electricity generated from renewable energy sources and waste is promoted through feed-in tariffs if the plant's capacity is between 50 kW and 0.5 MW or in case of a demonstration project. The eligibility period and the maximum amount of eligible electricity are determined for each eligible electricity producer by the Hungarian Energy and Public Utility Regulatory Authority (HEA).

The regulations for the feed-in tariff set out in Decree No. 389/2007 apply to renewable energy installations already approved eligible for the feed-in tariff before 31 December 2016 (§1 (6)): Within this decree, there are benchmark feed-in periods for biomass (<20 MW), biogas (<5 MW), landfill gas and PV installations <2 MW, which can be shortened if other investment schemes are used for the individual project. The feed-in tariffs are fixed and adjusted every year with the consumer price index or inflation minus one percentage point, depending on the application date (Annex No. 5 to Decree No. 389/2007). Tariffs are differentiated by plant size, time of licensing, time zones (three per day) and partly by technology.

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

For installations having applied for the feed-in tariff after 31 December 2016, the new Decree No. 299/2017. (X. 17.) applies. This decree sets out different regulations for renewable energy installations between 50 kW – 0.5 MW and for plants between 0.5-1 MW. Installations up to 0.5 MW are either eligible for the feed-in tariff or the green premium (market premium). The green premium is obligatory for plants with a capacity of 0.5-1 MW.[88]

8.3 Reduction of Greenhouse gas emissions

Compared to the 1990 baseline, Hungary's greenhouse gas emissions (GHG) fell by about 32% by 2017 and, according to their preliminary data, in 2018 there was a further 0.5-1% reduction

According to the forecasts, by 2030 final energy consumption in Hungary will stagnate, while GDP may grow at a robust pace, thus significantly reducing the proportion of GHG per unit of GDP.

It is possible that Hungary will be climate neutral by 2050, which means that it will reduce emissions by about 95% overall (compared to the current level by about 65%). Its price is still questionable.

Currently, Hungary has 65 million tonnes of GHG per year, of which about 45 million tonnes are linked to high-energy sectors and another nearly 20 million tonnes to non-energy emissions (eg agriculture, animal husbandry, fugitive emissions).

If the country were to reduce its 45 million tonnes to 17 million tonnes in order to meet its 2050 target, this would mean an annual expenditure of about HUF 670 billion, or 1.5% of GDP, in the coming years. If even more drastic emission reductions were to be planned, this would result in an even higher amount due to increasingly expensive technologies. A reduction of 20 million tonnes of non-energy related emissions would be accompanied by an annual cost of HUF 474

[88] Source: http://www.res-legal.eu/search-by-country/hungary/single/s/res-e/t/promotion/aid/feed-in-tariff-10/lastp/143

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

billion.

This would mean an annual cost of HUF 1,144 billion, or 2.6% of the current GDP, which, according to their estimates, would amount to at least HUF 40-50 billion over the next 30 years to reach the 2050 climate neutral target in Hungary.[89]

8.4 Summary and conclusions in relation to SWOT elements

There are a lot of different measures made by the government, however most of them are focusing on the small and medium sized plants. However, the aim of the Country is that increase the share of the renewable energy sources, the revision of the policy framework regarding to the renewable energy sources was not enough to increase the share of them as it was desired. Besides it, the lack of supporting the new, more sustainable production technologies, suggest that, there is more measure is necessary in the case of the currently system.

Table 33 SWOT -Analysis

Strengths	**Weaknesses**
The feed-in tariffs are fixed and adjusted every year with the consumer price index or inflation minus one percentage point. The biofuel tax advantage favoured biofuel producers in that they were compensated for the difference between the cost of producing biofuels and the market price of the fuels, which constituted State aid.	Renewable energy sources and waste is promoted through feed-in tariffs only if the plant's capacity is between 50 kW and 0.5 MW or it is a demonstration project. The currently framework do not support the conversation from the outdated technologies to the newer ones. (e.g. There is no additional aid for the 2nd generation or newer feed-in material for the bioethanol / biodiesel production)
Opportunities	**Threats**
Additional aid for providing the conversation from older to newer technologies. Support of the plants with more than 0.5 MW output, in order to provide foundation of the big scale, more cost-efficient plants.	Big and cost-efficient plants will be not installed. The currently operating factories with old technologies will not switch to the new, more sustainable ones.

[89] Source: https://www.portfolio.hu/unios-forrasok/20191107/vallalja-magyarorszag-a-2050-es-klimacelt-de-ki-fizeti-a-borzalmasan-nagy-szamlat-406407

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

9. FINANCING

Financing is an essential prerequisite for setting up biobased initiatives. Therefore, financial institutions providing loans, investments, or guaranties are essential. Every sound business case requires investment for further development. Financing also depends on local biobased strategy and policies. These factors can stimulate the growth of local initiatives or attract external companies. Often bank / investors / insurances exist that support the initiation of biobased initiatives.

Just limited public information available regarding to this topic, most of them is about the tenders ensured by the European Union and the Hungarian Government. In the case of the loans and investment opportunities the situation is the same or a bit more unfavourable. There is no Tax exemption in Hungary for the biobased production activities, but discount exist and also NGOs and some companies who specialised for the sustainable energy supply.

9.1 TENDERS

In 2016 in the frame of the Széchenyi 2020 program, a tender (TOP-6.5.2-15) was opened for the local governments for complex investments of renewable energy sources what can be easily integrate for the local conditions. This program supported the switch of the energy supply of the public buildings from fossil-based methods to renewable technologies and also make workplaces and support the local producing activities. The budget for this project was HUF 5.657 billion.

The latest tender regarding this topic was also in the frame of Széchenyi 2020 program of the Government (GINOP-4.1.4-19). The tender is opened in 11th of November 2019 and will close in 15th of January 2020. In total HUF 20.42 billion is available. The aim of this tender is to facilitate the investments regarding the renewable energy sources. This program offers non-refundable support from HUF 3 million up to 100 million for small and medium sized enterprises for reduce their energy demand, broaden / regenerate existing power plants or install new solar-

and geothermal systems and also biomass boiler systems. The self-cost have to be minimum 45 % of the total costs. After this project newer supporting programs are probable.[90,91,92,93,94,95,96]

9.2 Loans

There is no public information about big Hungarian investment company specialised for the biomass sector. For general investments in the case of small and medium sized enterprises HUF 500,000 – 50,000,000 loan with 3-6.5% interest rate available.

One possibility is ensured by the European Investment Bank (EIB), which is announced on 29th of April 2019 the launch of a loans package of nearly EUR 1 billion for agriculture and the bioeconomy. The sum will be matched by the implementing financial institutions, thereby mobilizing close to EUR 2 billion of long-term financing for companies in the sector.[97,98]

Further possibilities:

Commercial banks provide loans to agricultural players, such as

Agriculture development loan: https://www.otpagrar.hu/Fooldal

https://www.otpbank.hu/portal/en/Corporate/Financing/SpecialAgricultural

Local subsidies: Financial support for local Communities for energy recovery of biomass

https://palyazatmenedzser.hu/palyazat-helyi-biomassza-kozossegi-energetikai-hasznositasanak-tamogatasara/

Financing of infrastructure and energy recovery

[90] Source: https://www.palyazat.gov.hu/
[91] https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/key_policies/documents/rdp-factsheet-hungary_en.pdf
[92] https://www.nak.hu/tamogatasok/videkfejlesztes
[93] https://www.palyazatihirek.eu/mezogazdasagi-palyazatok
[94] https://www.mvh.allamkincstar.gov.hu/documents/123932/0/NHRDP_20140516.pdf
[95] https://enrd.ec.europa.eu/country/hungary_en
[96] https://enrd.ec.europa.eu/sites/enrd/files/hu_rdp_gnt_summary_v1.pdf
[97] Source: http://www.hitelkapu.net/beruhazasi_hitel.php
[98] Source: https://www.eib.org/en/press/all/2019-112-eib-to-unlock-eur-2-billion-for-agriculture-across-europe-with-special-support-for-young-farmers

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

https://www.erstebank.hu/hu/ebh-business/onkormanyzatok-intezmenyek/ingatlan-es-strukturalt-finanszirozas/infrastruktura-es-energetikai-finanszirozas

interest subsidies

https://www.kavosz.hu/index.php/hitelek/agrar-szechenyi-kartya - overdraft facility

9.3 Tax exemption

There is no tax exemption regarding bio based activates in Hungary, only tax preferment. In the case of the bioethanol the tax is 77,500-85,000 HUF/1000l (depends on the petrol content), what means 120,000 HUF/1000l in the case of the diesel 110,350-120,350 HUF/1000l and 120,000-125,000 HUF/1000l (depends on the prices of the petroleum) in the case of the petrol.[99]

9.4 Partners

There in a lot of NGOs whom working on propagation of the biomass based activities e.g.: Association of the Biomass Power Plants, Biomass Product Line Society. Among others, the ALTEO Group is a company specialised for the sustainable energy supply. Their strategic objective is to become a major energy service provider that ensures a sustainable energy supply for its consumers and solid returns for its shareholders through the optimum use of energy trade, decentralized energy production and efficient energy management. To achieve this aim, their company has created, and is continuously developing, an energy production portfolio including units which use renewable energy sources or gas-fuelled small decentralized energy plants as well as building a consumer-focused and resilient energy trading business. Moreover, they help their consumers in efficient energy management to enable them to minimise the environmental impact and energy costs resulting from their operations and maximise the utilisation of renewable energy sources that can be used economically. The ALTEO Group operates mainly in Hungary, but it is also their Company's goal to extend

99

Source:https://www.nav.gov.hu/nav/ado/jovedeki_ado/tajekoztatok_informaciok/fajtakodok_jogcimkodok/jovedeki_ado_fajtakodok.html

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

the geographical scope of its activities to other neighbouring countries and to the Central Eastern European region as a whole. Their consumer base includes small and medium-sized Hungarian enterprises as well as large corporations.[100]

9.5 Summary and conclusions in relation to SWOT elements

Regarding to the financing the easiest available resources are the tenders advertised by national and European projects. Only limited public information available about the loan conditions. There is no Tax exemption in Hungary for the biobased production activities, but discount exist. Several NGOs working on the popularisation of the renewable energy sources and some big companies like the ALTEO Group who specialised for the sustainable energy supply.

Table 34 SWOT -Analysis

Strengths	**Weaknesses**
Tenders were available in the past, and they are expected to be available in the future. There is tax preferment in the case of biofuel producing. A large number of NGO's are working on the on propagation of bio-based activities.	The public information regarding the financial aspect is limited. Most of the tenders only support small and medium sized enterprises and local governments.
Opportunities	**Threats**
Open tenders for big and more cost-efficient companies should be available. New tax preferment system should take into account the price of the feed-in materials or the price of the conventional fuels. Ensure tax exemptions for biobased initiatives. Biobased initiatives should be more attractive for investors and development banks.	Big and cost-efficient plants are not available to installing, because the investment costs are too high. Investments will not be made, because the lack of information on financial opportunities.

[100] Source: https://alteo.hu/az-alteo/leadership/strategiai-celok/

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

10. CONCLUSIONS

▪ KEY MESSAGE

Hungary is a country with a high biomass potential; however, there is a lot of space for improvement to handle it well in its complexity.

▪ EXPLOITABLE RESULTS / LESSONS LEARNT

- Bio-economy and nature:
  - Bio is not only organic matters produced for human consumption, but a complex system, an ecosystem. Taking into consideration planetary boundaries, bio-economy needs to consider the limits of environment, not only economic factor.
- Clarification of misperceptions
  - Biomass is more than burning agricultural by-products (organic raw-material of the energy sector)
  - Bio-economy does not mean production of bio-fruits and bio-vegetables
- Importance of the use of secondary residues; awareness raising for increased complex utilization of bio-economy resources
- Education / life-long-learning:
  - Education to a special target audience: - future players / employees in bio-economy business
  - Postgraduate education for those who are already involved in bio-economy business

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

▪ VALUE FOR TARGET COUNTRY/ STAKEHOLDERS

The main results that contribute to the growth of bio-economy in Hungary are strengthening bio-economy related activities in the country and the region, mapping the availability and supporting of the uptake of bio-based technologies. Local stakeholders will benefit from the work of CELEBio through the effective dissemination of information on the opportunities offered by BBI.

▪ VALUE FOR BBI JU/BIC/EU STAKEHOLDERS

The map of the local biomass sources that potentially could be used as sustainable feedstock for the bio-based industry as well as the map of bio-economy stakeholders will contribute to the growth of bio-economy in Hungary and in the region.

Matchmaking facilitated between stakeholders and the plan to be set up that will establish interest and commitment from the actors for expanding their bio-based activities will help make use of the information delivered by the project for different actors (institutions and investors)

REFERENCES

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

https://ec.europa.eu/eurostat/statistics-explained/index.php/Agri-environmental_indicator_-_livestock_patterns. (n.d.).

https://www.agrarunio.hu/hirek/novenytermesztes/4793-van-meg-hova-fejlodni. (n.d.).

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

http://www.hitelkapu.net/beruhazasi_hitel.php

https://www.eib.org/en/press/all/2019-112-eib-to-unlock-eur-2-billion-for-agriculture-across-europe-with-special-support-for-young-farmers

https://ec.europa.eu/eurostat/data/database

https://ec.europa.eu/agriculture/statistics/factsheets_en

https://datam.jrc.ec.europa.eu/datam/public/pages/index.xhtml)

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

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

https://ec.europa.eu/eurostat/statistics-explained/index.php/Agri-environmental_indicator_-_livestock_patterns

https://www.agrarunio.hu/hirek/novenytermesztes/4793-van-meg-hova-fejlodni

https://www.ksh.hu/docs/hun/xstadat/xstadat_eves/i_omn001a.html

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

*www.kornyezetvedok.hu/vgt/vgt2/orszagos/3_2_hatteranyag_tanulmany_*

tragyatarolo_NAIK.pdf?picture=pic2

https://www.theglobaleconomy.com/Hungary/cereal_yield/

https://www.ksh.hu/docs/eng/xftp/stattukor/vet/evet1906.pdf Statistical reflections 2019 september 17

https://mtu.gov.hu/documents/prod/Hungarys-industry-overview.pdf

https://www.ksh.hu/docs/eng/xstadat/xstadat

https://www.ksh.hu/docs/eng/xstadat/xstadat_annual/i_omn018b.html

https://www.ksh.hu/docs/eng/xstadat/xstadat_annual/i_omn019b.html

Gockler L. (2010): Fás szárú energiaültetvények a mezőgazdaságban. 2. rész – A sarjaztatásos fás szárú energetikai ültetvény technológiájának megfontolandó elemei. Mezőgazdasági Technika, 51. évf. 11. sz. pp. 40-43

http://www.econovum.hu/images/3munkbesz.pdf

http://erdo-mezo.hu/2014/12/20/energetikai-ultetvenyek-az-alfoldon/

https://bbj.hu/economy/hungary-farm-sector-output-expands-over-3-in-2018_158917

https://www.ksh.hu/docs/eng/agrar/html/tabl1_5_1_4.html

https://www.ksh.hu/docs/eng/agrar/html/tabl1_5_1_4.html

https://www.ksh.hu/docs/hun/xftp/idoszaki/gszo/agrarium16.pdf

http://www.kornyezetvedok.hu/vgt/vgt2/orszagos/3_2_hatteranyag_tanulmany_tragyatarolo_NAIK.pdf?pictur

https://webcache.googleusercontent.com/search?q=cache:ThtXbHMUGIIJ:https://www.kormany.hu/en/ministry-of-agriculture/news/we-have-succeeded-in-protecting-the-interests-of-hungarian-farmers-in-brussels+&cd=3&hl=hu&ct=clnk&gl=hu

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

https://klimainnovacio.hu/files/files/bioeconomy_study_final_draft_feb2014.

https://klimainnovacio.hu/files/attachments/page/bioeconomy_study_final_draft_feb2014_1_0.pdf

http://www.advancefuel.eu/contents/reports/d21-report-on-lignocellulosic-feedstock-availability.pdf

https://www.novenyzetiterkep.hu/node/15

http://www.bioenergia-obekk.hu/celkituzeseink/

www.sciencedirect.com/science/article/pii/S1364032118304714#bib29

https://rekk.hu/downloads/projects/2019_REKK_NEKT_megujulo_final.pdf

https://mtu.gov.hu/documents/prod/Hungarys-industry-overview.pdf

http://www.sell-buy-machines.com/2014/04/hungarian-food-industry-cmea-eu.html

https://www.kormany.hu/download/8/e7/21000/Hungarian%20Outlook_Hungary's%20food%20industry%20is%20competitive%20in%20the%20region.pdf

https://humusz.hu/hirek/nemcsak-fogyasztok-pazarolnak/25121

http://www.fao.org/forest-resources-assessment/current-assessment/country-reports/en/

https://www.kormany.hu/download/a/1a/d0000/Nemzeti_Erdőstratégia.pdf

https://www.ksh.hu/docs/hun/xstadat/xstadat_eves/i_ome002b.html

https://2010-2014.kormany.hu/download/1/11/70000/miniszteri%20tajekoztato_erdoallomany.pdf

https://www.tankonyvtar.hu/hu/tartalom/tamop412A/2011-0038_35_kertesz1_en/ar01s04.html

http://www.mecsekerdo.hu/_user/browser/File/pdf/Efol/EFOL_Forestry%20in%20Hungary.pdf

https://link.springer.com/content/pdf/bbm%3A978-90-481-3233-1%2F1.pdf

http://real.mtak.hu/42314/1/ASLH_Vol_12_2016_Issue2_13_Laborczy_Winkler.pdf

http://real.mtak.hu/42314/1/ASLH_Vol_12_2016_Issue2_13_Laborczy_Winkler

NÉBIH 2014

https://portal.nebih.gov.hu/iw/web/english/hungarian-forest-management/-/asset_publisher/pHBk9pq6UNxK/content/introduction/forest-act

Biomass Policies, Elbersen et al., 2016

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

https://nhkv.hu/en/ohkt-2/

www.ksh.hu/docs/hun/xftp/idoszaki/mo/mo2017.pdf

www.insinkerator.hu/szerves-hulladekok-kezelese/

https://ec.europa.eu/transparency/regdoc/rep/1/2018/HU/COM-2018-656

https://ec.europa.eu/transparency/regdoc/rep/1/2018/HU/COM-2018-656)

doktori.nyme.hu/251/2/magyar.pdf

http://www.kormany.hu/dokumentumok

https://www.bioeconomy.fi/vision-for-the-central-and-eastern-european-sustainable-bioeconomies/

https://www.bioeconomy.fi/vision-for-the-central-and-eastern-european-sustainable-bioeconomies/

https://www.buildup.eu/sites/default/files/content/national_renewable_energy_action_plan_hungary_en.pdf

www.ommf.gov.hu

www.plerotus.hu

http://www.biomasszaeromuvek.hu/

https://www.bitesz.hu/

www.maradeknelkul.hu

http://pdf.wri.org/reducing_food_loss_and_waste.pdf

www.real.mtak.hu/84663/10/CIKK_DAB_MTeKMR_2018_Konferencia_Kiadvany-142-149.pdf

https://klimainnovacio.hu/files/attachments/page/bioeconomy_study_final_draft_feb2014

http://eugo.gov.hu/key-facts-about-hungary/infrastructure

https://kki.hu/assets/upload/16_KKI-elemzes_HUN_Szoke_20180423.pdf

http://www.investhipa.hu/images/hipa_kiadvany_intro_greenenergy_web_201808.pdf

http://www.terport.hu/sites/default/files/imagecache/tematikusfull/eromuvek.jpg

WWW.MEKH.HU/KIADVANYOK 2019 DATA OF THE HUNGARIAN ELECTRICITY SYSTEM

https://hu.wikipedia.org/wiki/Magyarorsz%C3%A1g_villamosenergia-%C3%A1tviteli_h%C3%A1l%C3%B3zata#/media/F%C3%A1jl:Power_lines_Hungary.svg

jems.lib.unideb.hu/file/9/5b374d43de8c7/szerzo/10.21791IJEMS.2018.

www.altherm.hu/hu/szakmai_hirek/biomassza-1.html

https://sociable.co/technology/startup-ecosystem-hungary/

http://startups.hu/

https://startupeuropeawards.eu/call-for-startup-europe-awards-hungary/

https://digitalisjoletprogram.hu/files/89/ea/89eac5ce5f74178f3f527945f7edd08f.pdf

http://pppstandards.org/hungary/

http://www.res-legal.eu/search-by-country/hungary/single/s/res-e/t/promotion/aid/feed-in-tariff-10/lastp/143

https://www.portfolio.hu/unios-forrasok/20191107/vallalja-magyarorszag-a-2050-es-klimacelt-de-ki-fizeti-a-borzalmasan-nagy-szamlat-406407

https://www.palyazat.gov.hu/

https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/key_policies/documents/rdp-factsheet-hungary_en.pdf

https://www.nak.hu/tamogatasok/videkfejlesztes

https://www.palyazatihirek.eu/mezogazdasagi-palyazatok

https://www.mvh.allamkincstar.gov.hu/documents/123932/0/NHRDP_20140516.pdf

https://enrd.ec.europa.eu/country/hungary_en

https://enrd.ec.europa.eu/sites/enrd/files/hu_rdp_qnt_summary_v1.pdf

http://www.hitelkapu.net/beruhazasi_hitel.php

https://www.eib.org/en/press/all/2019-112-eib-to-unlock-eur-2-billion-for-agriculture-across-europe-with-special-support-for-young-farmers

https://www.nav.gov.hu/nav/ado/jovedeki_ado/tajekoztatok_informaciok/fajtakodok_jogcimkodok/jovedeki_ado_fajtakodok.html

https://alteo.hu/az-alteo/leadership/strategiai-celok/