



CELEBio

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D.2.1

COUNTRY REPORT: SLOVAKIA

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Publishable executive summary in national language	Správa je rozdelená do 9 kapitol. V prvej kapitole je uvedený popis základných charakteristík Slovenska. V kapitolách 2, 3 a 4 zahŕňa témy ako produkcia biomasy vrátane jej súčasného ako aj budúceho využitia v rámci poľnohospodárskeho lesníckeho a odpadového sektora. V kapitole 5 je uvedený opis súčasných priemyselných odvetví a trhov v oblasti biomasy, kapitola 6 opisuje sektor infraštruktúry, logistiky a energetiky. Kapitola 7 sa zameriava na inovačný potenciál. Kapitola 8 sa sústreďuje na politický rámec, v kapitole 9 sa diskutuje o možnostiach financovania súvisiacich s rozvojom výrobných reťazcov na biologickej báze. Kapitoly sú uzavreté SWOT analýzou

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SUMMARY

Slovakia is a highly industrialized country, the share of the industry sector in the national GDP exceeds 20 % and belongs to the highest in the EU. There are 4 automotive companies in a country with 5.4 million inhabitants, large steel and aluminum production, mechanical engineering, chemical, electro- technical and other industries. On the other hand, the food processing industry is underdeveloped and **the bio economy**, except for pulp and paper industry, **lags far its potential**. The automotive industry generates 26.5 bill. € while the bio economy just 11.1 bill. € (2016). The potential of the bio economy is not use by far, although Slovakia has ALL preconditions to develop it. In the land with the whole area of 49 000 km² i.e. 49 000 ha, there are 2.2 mil. ha forests – 45 % of the whole area, 1.4 mil. ha arable land – 29 % of the country surface and 0.8 mil. ha pastures – 17 %. There are also sufficient water resources, rivers and water reservoirs and still relative enough rainfall. There is also a solid potential of human resources and a relative developed education, research and development and innovation base.

On the other side **there is no national strategy on bio economy development in Slovakia**, neither in general nor for the next decade. This sector is characterized by low added value generation, Slovakia exports raw material as round wood, wheat and oil seed plants and imports final products. The negative balance of export and import of food is increasing every year and a once self-sufficient country now depends on import of food.

This report aims to describe and qualify the present status in the different fields of the bio-economy, especially agriculture, forestry, waste management and bio-based industries with a special attention for options for waste reuse, residuals availability and use and circular economy development.

According to the experts consulted for this study the Bioeconomy potential could at least double its present output within the next decade. This requires that National strategy on Bioeconomy development in Slovakia will be elaborated and implemented by the government, the EU and the private sector and that financial, human and R&D and entrepreneurial resources similar to the automotive industry will be invested accordingly.

This country report was reviewed by the main experts and institutions in Slovakia, especially with the Ministry of Agriculture, the Nitra regional government, Slovak University of Agriculture, the National Agriculture and Food Center, the Slovak Food and Agriculture Chamber the National Forest center, the Research Paper and Pulp institute and the Slovak Environmental Agency.

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 Slovakia, Czech Republic, Croatia, Hungary, 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 a SWOT. This report is the country report developed for Slovakia.

This report aims to provide the necessary background information needed to evaluate the possibilities for setting up biobased production chains in Slovakia.

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 (see Annex I for further details). In these interviews further information was obtained on key factors that guide the choice of setting up biobased activities in countries. Most of the experts stressed that all the identified factors are important and that a system approach is key in developing biobased initiatives. If one link in the chain is missing, the biobased initiative will not succeed. The identified factors are mapped in this report and are the basis for performance of the SWOT (Strength, Weakness, Opportunity and Threat) analysis for development of biobased production chains that is also presented at the end of every chapter in this report.

This report is organised in 9 chapters. In chapter 1 (section 1.3) a first description is given of the key characteristics of the country of Slovakia. In the chapters 2, 3 and 4 the biomass production, their current uses and what biomass can be additionally mobilised is described for the agricultural, forest and waste sectors. First the main traditional production and availability of biomass for food, feed and forest biomass and wood products is discussed

and how this is handled in further processing industries and/or used for domestic markets and exports. Subsequently an overview is given of additional biomass potentials that are likely to still be unused or only partly used and that are a good basis for development of new biobased activities.

In Chapter 5 a description is given of the current biobased industries, markets and advanced initiatives and a description is given of the future biomass valorisation options Slovakia has.

In Chapter 6 the infrastructural, logistics and energy sector situation in Slovakia is described and future options are discussed for further bioenergy applications.

In Chapter 7 the skills, research and innovation potential of Slovakia is described particularly in the context of biobased research and development options. It will also be discussed whether there are already Public-Private-partnerships established and what options there are for developing these further.

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

1.1.1. SHORT CHARACTERISATION

Slovakia is a small European country with 5 million inhabitants, the population density is similar to the European average (See Table 1). The average income level is relatively low in comparison to the average of the EU, but relatively high for the eastern European countries.

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

Category	Hungary	EU	Unit
Population	5.4	512.4	million (2018)
Area (total)	5	447	million ha (2018)
% population in urban areas	18.8%	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	1.9	173.3	million ha (2016)
Forest area	2.2	164.8	million ha (2016)
Population density	64	115	n°/km ² (2018)
Agricultural Area per capita	0.35	0.34	ha/capita(2016)
Forest area per capita	0.41	0.32	ha/capita(2016)
GDP/capita	7 789	30 956	at current prices in 2018
	15 934	30 956	GDP at purchasing power in 2018
GVA by Agriculture, forestry and fishing	4.2%	1.6%	% of total GVA (2018)

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

Source: Eurostat most recent statistical data sources (Accessed August/September 2019) (<https://ec.europa.eu/eurostat/data/database>)

The area in Slovakia is predominantly rural (22.1%) leaving the area covered to a greater extent by forest (2.2 million ha). The population percentage living in urban areas (18,8%) is deeply under the European average which correlates with half of the population density. The GDP in Slovakia is significantly below the European average and purchasing power is just half of it as well. The Nitra region in Slovakia is of the highest biomass production (around 700 Ktons DM).

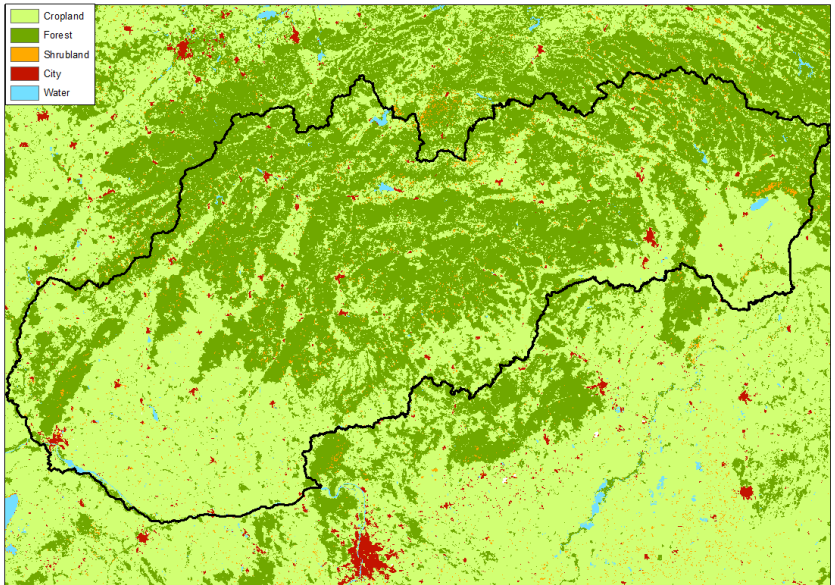


Figure 1 Main land cover distribution over Slovakia

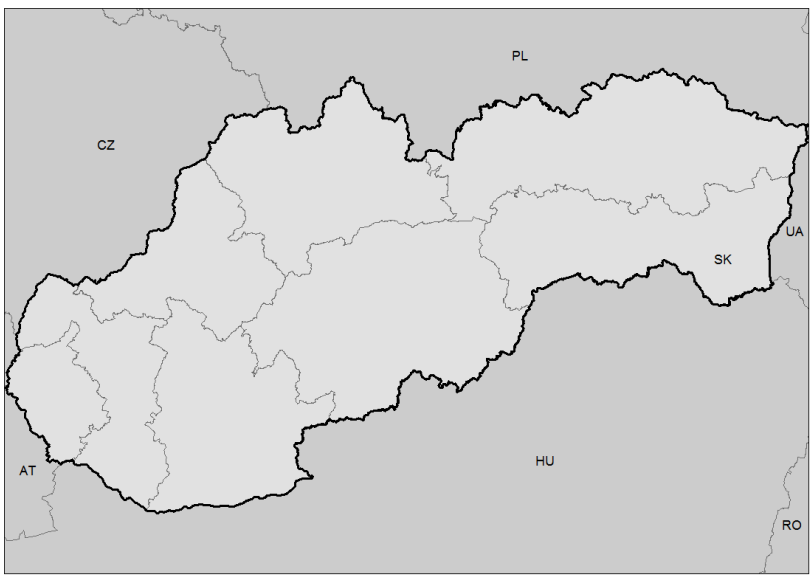
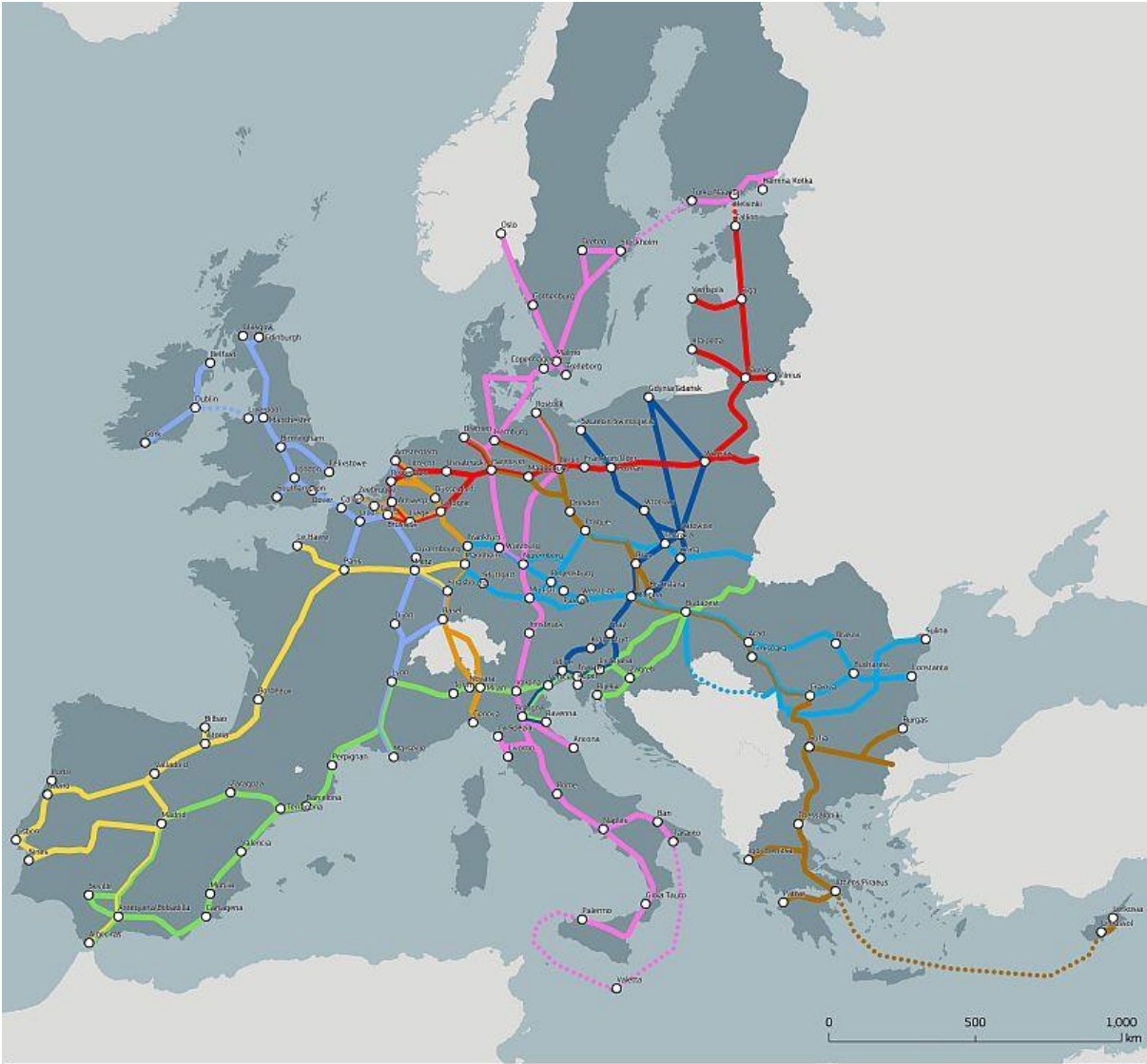


Figure 2 Slovakia and its bordering countries

Slovakia is a land locked country southeast of the Czech Republic and south of Poland. The southwestern tip of Slovakia neighbours Austria. Hungary lies in the south and Ukraine at the eastern border.

There are three Trans- European corridors that cross the Slovakia. Namely the Baltic-Adriatic Corridor (RFC 5), The orient/ East – Med Corridor and The Rhine- Danube Corridor. Figure 3 shows the position of Slovakia in the Trans-Europe Transportation network.

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- Core Network Corridors**
- A (Baltic - Adriatic)
 - B (North Sea - Baltic)
 - C (Mediterranean)
 - D (Orient/East-Med)
 - E (Scandinavian - Mediterranean)
 - F (Rhine - Alpine)
 - G (Atlantic)
 - H (North Sea - Mediterranean)
 - I (Rhine - Danube)

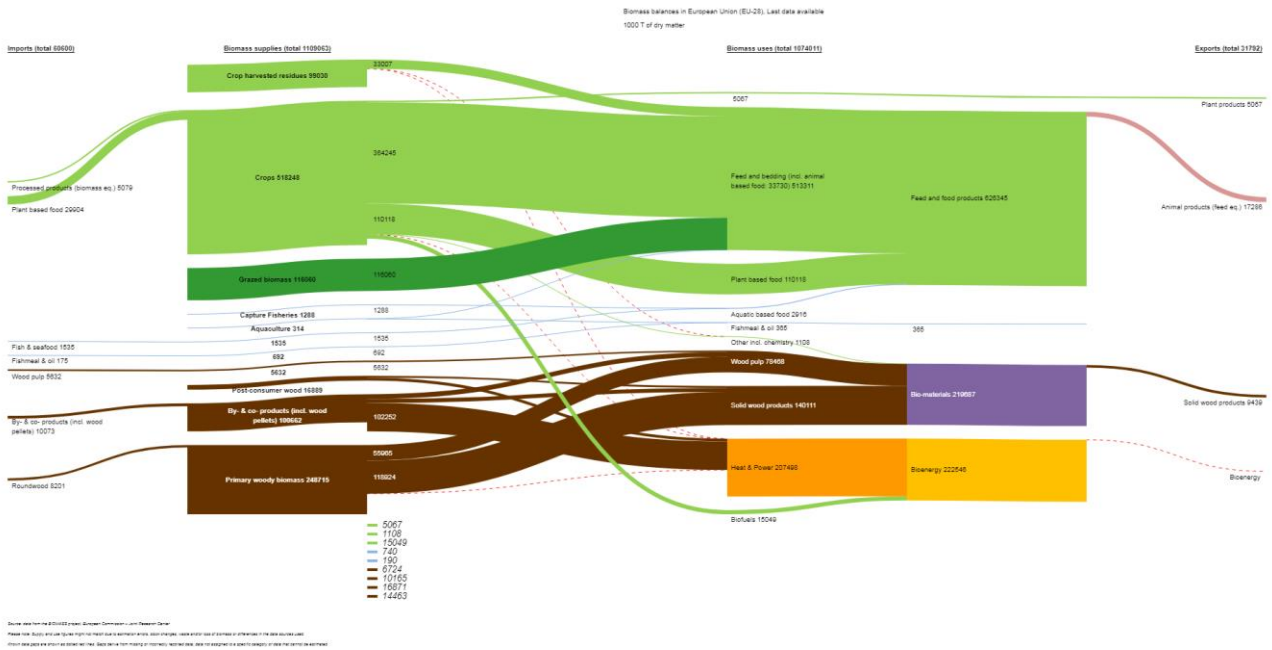
Cartography: IRE, August 2014
© IRE, EC, 2014. 100% for TEN-T network
© Eurographics 2014 for the alternative scenarios

Source: https://www.researchgate.net/figure/Trans-European-Transport-Network-TEN-T-indicative-extension-to-the-Core-Network_fig1_313862204

Figure 3 Position of Slovakia in the Trans-European Transportation Network

Figure 4 gives an insight into biomass flows in Slovakia.

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Source: (<https://datam.jrc.ec.europa.eu/datam/public/pages/index.xhtml>)

Figure 4 Biomass flows in Slovakia

Explanation of Sankey diagram (Figure 1.3.4):

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

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

From the Sankey diagram for Slovakia (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 Slovakia is from crops (7.9), primary woody biomass (4.70) and the by- and co-products thereof (1.71). Biomass from crop harvested residues (1.5) and grazed biomass (0.95) is also produced. Most of the crops, and residues and grazed biomass is used for food and food products (5.64) or exported as plant products (1.57).

The woody biomass is converted to wood pulp (1.56), solid wood products (2.08), heat and power (1.99). Some of the bioenergy also comes from the crop production (0.66) however, yet bio-materials (3.74) are primarily produced from the woody biomass.

For the amount of crop production, relatively little is exported as plant products (1.57), which is the largest biomass export from Slovakia. Roundwood is also exported (1.10), and small amounts of products and processed biomass (0.4) as well, mostly from wood. Imports consist primarily of animal products such as feed (2.73).

Crop-based and wood-based biomass are almost equally used, and relatively little crop-based biomass is used for biofuels. Exportation of biomass in general is quite low in Slovakia.

Slovakia's Sankey is similarly proportioned to the EU Sankey, though much of their woody biomass is exported directly. Another interesting feature is that proportionally more biofuels are used from crop production than in the EU

2. Biomass supply: agriculture

2.1. INTRODUCTION

In this chapter the agricultural biomass production and main uses is described. Agriculture is an important part of the state's economy, employs about 3 % of the economically active population, is closely linked to industry and plays an indispensable role in ensuring nutrition and maintaining rural employment.

Despite many shortcomings, which in agriculture existed before the World War II, Slovakia managed to increase yields per hectare three times more by mechanization and intensification. In spite of the large decline in agricultural work force the republic of Slovakia became self-sufficient in the production of most food produced in the temperate zone. After 1989 there were also changes in agriculture. Cooperatives were transformed into shared cooperatives (land and property were divided among co-operative members or were sold off). State properties were privatized, the most land was returned to the original owners. In the end of the 1990s the farm production became a loss-making sector. This has been the result of several factors - faster increase in production costs compared to a rise in product prices, a reduction in state subsidies to farm production, lower prices of some types of imported food compared to domestic one and the European Common Agricultural Policy regulations.

In 2018 - agricultural land area was 2.38 mil. ha (of which arable land consists of 1.4 mil. ha). There was a loss of farmers land. Forest land covers around 2.2 mil. Ha. The use of land depends mainly on natural conditions, but also on distance from the market, mechanization, use of fertilizers and pesticides. Best field conditions for agricultural production with high soil quality are lowlands in the south of Slovakia: Podunajská nížina, Východoslovenská nížina, Juhoslovenská kotlina – Danube lowland, Eastern Slovak lowland and South Slovak basin.

2.1.1 CHARACTERISATION OF CURRENT AGRICULTURAL SECTOR

The key characteristics of the Slovakian agricultural sector is shown in table 2.

Table 2 Key characteristics for the agricultural sector in Slovakia

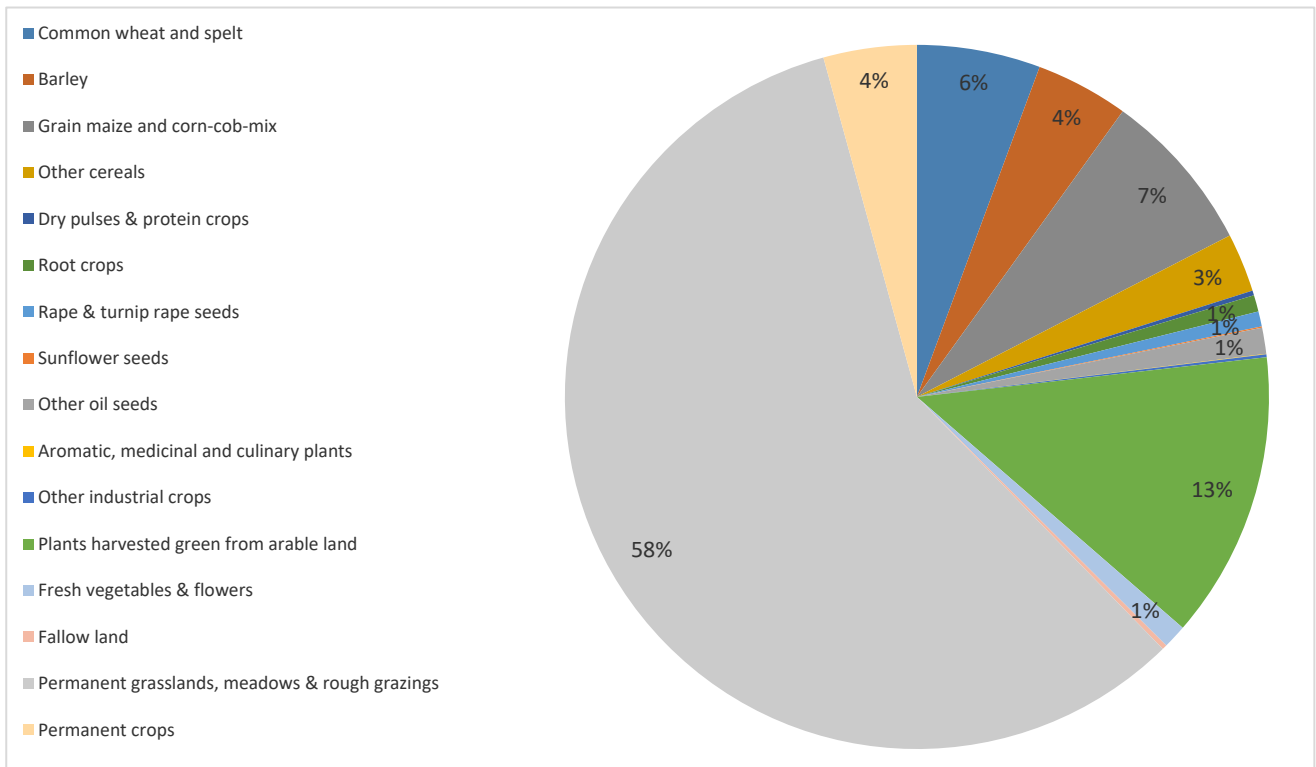
Category	Slovakia	EU average	Unit
Agriculture in % of total employment	2.7%	3.9%	% of total employment 2017
Agricultural area per capita	0.35	0.34	ha/capita
Cereal yield	4,856	5.2	t/ha
Crop output in total output	60%	56%	% of total agricultural output value (2018)
Livestock output in total output	40%	44%	% of total agricultural output value (2018)
Agricultural income (2010=100)	195	121	Index 2010=100 (2018)
Livestock density	0,3	1.02	LSU/ha UAA
High input farms	6%	29%	%/ total farms 2016
Low input farms	49%	39%	%/ total farms 2016
Gross nutrient balance nitrogen	34	51	kg of nutrient per ha (average 2011- 2015)
Gross nutrient balance phosphorus	-5	1	kg of nutrient per ha (average 2011- 2015)
Irrigated utilized agricultural area	1.5%	n.a.	% of UAA 2016
Soil erosion	2.12	2.4	tones/ha/year 2012
Average farm size	73.6	16.6	ha UAA/holding (2016)
% of agr. holdings < 5 ha	55.7%	62.6%	%/total no. of holdings

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>)

2.1.2 CROP PRODUCTION

The most important crops in Slovakia are cereals and oil crops, e.g. sunflower and rape. Permanent crops cover a relatively small percentage of the cropping area (see Figure 5).

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Source: <https://ec.europa.eu/eurostat/web/agriculture/data/database>

Figure 5 Main crops and land uses in Slovakia

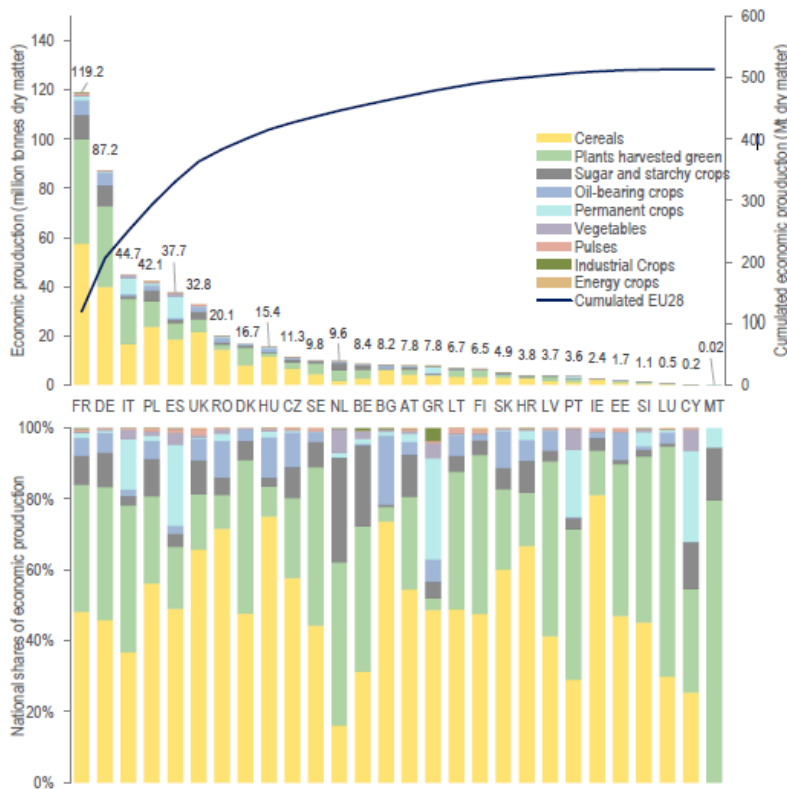
Growing crops heavily depends on the market economy, CAP payments and climatic conditions in a given year. The arable land is used mainly for growing cereals (60 % of the territory) like wheat, barley, corn and then potatoes. 20% of the area is used for forage, and most of the rest for oil crops.

The total production mainly comes from cereals: wheat (Danube and East Slovak lowlands), barley - mainly surroundings of Nitra and Trnava, rye and oats - production increases due to changes in eating habits of the population (rye bread, oat flakes), are grown in higher areas, corn - lowlands and basins of southern Slovakia. Further crops are sugar beet, rape and sunflower, potatoes, poppy and soy, hop and vegetable (cabbage, tomatoes, onions, peppers, carrots, parsley, and cucumbers).

In Figure 6 for all EU28 countries the values for economic production from the main crops, expressed in Mt of dry matter per year, are shown.

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When looking at the production of crops for existing food and feed uses, the Slovakian production is relatively modest with a total contribution of 4.9 million-ton d.m. per year (see Figure 6). The most important crops in Slovakia are cereals and plants harvested green (for fodder).



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

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

Arable crops

Cereals, especially winter wheat is grown on the acreage of 350 – 660 thousand ha.¹ Based on the information from fact fish the cereals production in the year 2017 was 3 484 061 tons which is a decrease of 0, 6 million tons compared to the previous year. Though Slovakia cereal production fluctuated substantially in recent years, it tended to increase through 1998 - 2017 period ending at 3.48 million metric tons in 2017.² Cereals are mainly used for the production of grain (including seed) which accounted for 3 996, 58 (1000 t) by production

¹ <http://www.fao.org/3/i1500e/Slovakia.pdf>

² <https://knoema.com/atlas/Slovakia/Cereal-production>

in 2018. Though Slovakia cereal yield fluctuated substantially in recent years, it tended to increase through 1998 - 2017 period ending at 4,856 kg per hectare in 2017.

Based on the annual yield values the average yield from cereals accounts for 4,71 ton/ha/yr which is just under the EU28 average of 5.2 ton/ha/yr.

Due to the enormous increase in the growing area of oilseed rape, the oil crops became the second most important group of crops with the acreage 200 thousand ha (14% of arable land).

The average yield from main oil seed crops in the time period 2009- 2014 represents 2.32 t/ha, based on knoema.com data. Though Slovakia yield (100 kg/ha) - other oil seed crops fluctuated substantially in recent years.

The decisive crop in Slovakia is winter wheat, grown on an area of approximately 350 - 660 thousand ha, representing 29 % of arable land. The second crop is spring barley, with an average area of 200 thousand ha (14 % of arable land). The third important crop, with area of about 140 thousand ha (10.2 %), is maize.³

Thus, cereals in total, including maize, represent the group of crops most cultivated in Slovakia, with an average area of 780 thousand ha, which is 58 % of arable land. Due to the enormous increase in growing areas of oilseed rape in the 1990s, oil crops became the second important group of market crops, with an area of 200 thousand ha (14%). Of that, the previously mentioned oilseed rape is grown on an area of 100 thousand ha (7 % of arable land).

Among other oil crops, soya planting areas have developed, to approximately 10 thousand ha (0.7 % of arable land), and planting is localized mainly in Východoslovenská nížina (East Slovakian Lowland). On the other hand, the formerly traditional Slovak oil crop, poppy, is losing in importance, with an area of 5.5 thousand ha in the years 1994-1995.

Permanent crop production

Permanent crops and gardens occupy only approximately 5% of all agricultural land in Slovakia. Regarding hops production, its level reached 104 tons in 2017. There were

³ <https://www.mpsr.sk/en/index.php?navID=25>

registered more than 12 million fruit trees and bushes with harvest exceeding 38 000 tons in Slovakia in 2017.⁴

The fruit trees production according to the number of fruit trees is dominated mainly by plums and apple trees, followed by peaches, pears, apricots and cherries the number of fruit trees has been about the same level since 1990, while the total area of vineyards has decreased by a quarter. The best-known wine regions in Slovakia are Small Carpathian, South Slovakian, Nitra, Central Slovakian, Eastern Slovakian and Tokay region.

The Table 3 represents total agricultural land in Slovakia, which represents 2.39 million ha. The total number of arable lands is 1, 4 million ha. The number of hops is 511 ha-, the number of vineyards is 26, 3 thousand ha, the number of gardens is 76.3 thousand ha, the number of fruit trees is 16.5 thousand ha. The total number of permanent grasslands is 858.6 thousand ha.

Table 3 Agricultural land structure in Slovakia, 2017

Type of land	Area (ha)	Share from agricultural land (5)
Agricultural land together	2 389 616	100 %
Arable land	1 411 294	59%
Hops	511	0.02%
Vineyards	26 359	1%
Gardens	76 287	3%
Fruit trees	16 565	1%
Permanent grassland	858 601	36%

Source: <https://www.mpsr.sk/en/index.php?navID=25>

Livestock production

Livestock production - consumes a large proportion of the crops produced in Slovakia, is less dependent on natural conditions. It is very important to increase the production of fodder for livestock and to use more intense pastures.

Animal production is characterized by a long- term decline in all commodities. E.g. Slovakia was self- sufficient in pork production, producing 2.5 million pigs a year. Nowadays it is about 600 thousand, which represents 24 % of the original state. This caused the country's self- sufficiency in pork consumption to fall below 47%. Poultry production also fell significantly, with self-sufficiency below 77%.⁵

⁴ www.sme.sk

⁵ <http://www.nppc.sk/index.php/sk/>

The production of beef and milk has also been declining in the long-term decline, from 1 600 thousand pieces in 1990 to 630 thousand of pieces in 2003 up to 433 thousand pieces in 2018, 27 % compared to 1990.

The number of dairy cows is also decreasing, from 166 thousand pieces in 2009 to 125 thousand pieces in 2019 causing a deepening decline in the self-sufficiency of milk production. One of the main reasons for this is the rising price of forage. In this case, from the total production of cereals in 2019 (approx. 2 million tons) more than 1.2 million tons – 60 %, will be exported. **At least a part of exports could be used to produce compound feeding stuff for domestic animal production or could be processed to food products.**

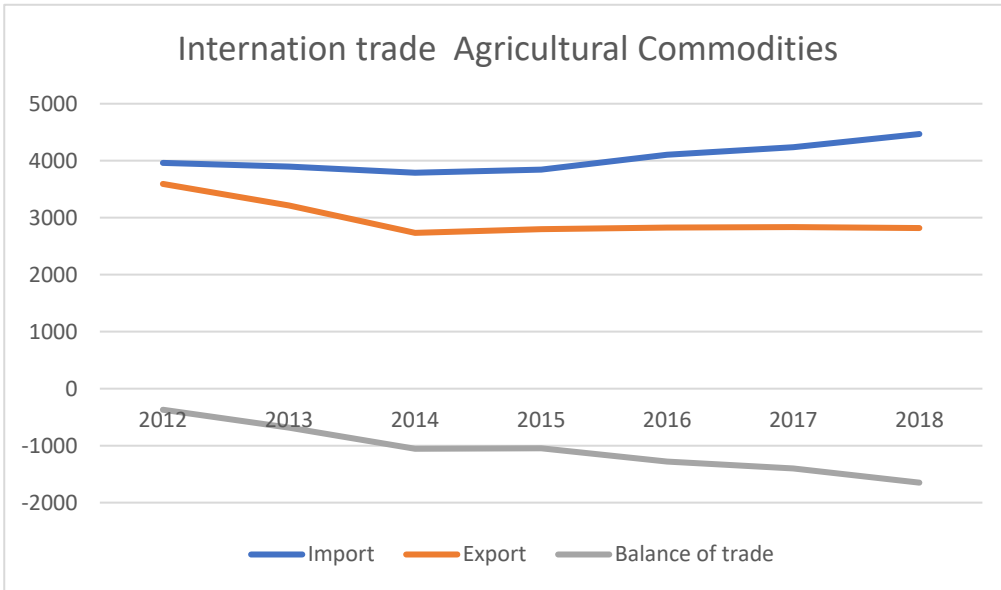
Paradoxically, Slovakia exports live animals and imports pork halves. The construction of sufficient slaughterhouse capacity and the subsequent sale of meat in the Slovak Republic is a prerequisite for a gradual reduction of the **rapidly growing negative trade balance in agricultural commodities (see Table 4).**

Table 4 International trade of Agricultural commodities, 2018

Slovakia	2012	2013	2014	2015	2016	2017	2018
Import	3963	3898	3789	3845	4104	4237	4468
Export	3593	3214	2734	2799	2826	2836	2819
Balance of trade	-370	-684	-1 055	-1 046	-1 278	-1 401	-1 649

Source: <http://datacube.statistics.sk/#!/lang/en>

The table 4 and the figure 7 represent international trade of agricultural commodities. Since 2012, the negative balance of food exports and imports has been increasing steadily, from € 370,000 in 2012 to € 1 648,000 in 2018. **This means that the negative balance has increased 4.9-fold over the past seven years. This represents indirect damage to the national economy, reduces GDP growth and the Slovak consumer pays job creation abroad.**



Source: <http://datacube.statistics.sk/#!/lang/en>

Figure 7 International trade of Agricultural commodities, 2018

2.1.3 BIOMASS POTENTIALS FROM RESIDUES AND UNUSED LANDS

When it comes to residual biomass production, Slovakia's scores quite well as compared to most EU countries as – residue production of about 2 103 759 ton as shown in table 5.

Lignocellulosic residual biomass potential from crops

As already became clear Slovakia has a large cropping sector and therefore the residual biomass potential from arable crops is certainly of interest. By-products from arable crop production are mainly in a form of straw, stalk corn and corn cobs. They are used for traditional purposes (bedding) but many remain unused at this moment.

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) Table 5 represents residual biomass potentials in Slovakia.

Table 5 Residual biomass potentials* from arable crops 2020 in ton d.m. (=S2BIOM UD1 potential) (see for assessment approach Box 2.1 and Annex 2)

County	Cereals straw	Oil seed rape straw	Maize stover	Sugar-beet leaves	Sunflower straw	Total
Bratislavský kraj	57,230	6,057	28,959	1,972	11,076	105,293
Travský kraj	260,384	36,321	136,854	18,647	41,500	493,705
Trenčiansky kraj	282,734	39,442	148,603	20,251	45,059	536,089
Nitriansky kraj	398,376	55,574	209,383	28,534	63,488	755,355
Žilinský kraj	254	77	112	9	48	500
Banskobystrický kraj	185	32	101	13	32	363
Prešovský kraj	61,389	26,690	20,204	0	12,940	121,223
Košický kraj	46,200	20,086	15,205	0	9,739	91,231
Total	1,106,752	184,279	559,421	69,425	183,881	2,103,759

Source: S2BIOM project: Dees et al (2017) D1.6 A spatial data base on sustainable biomass cost supply of lignocellulosic biomass in Europe - methods & data sources <https://www.s2biom.eu/en/publications-reports/s2biom.html>

Dedicated crop potentials from unused lands

Biomass crops (e.g. lignocellulosic biomass crops, perennials) cannot compete with food or feed crops, because the latter have higher yields – the exception being if the soil is low-productive, in which case such crops could have better yields or economic returns if a market demand for these crops comes in place.

However, this exception does not change the fact that such biomass is generally not competitive to food and feed. That is why in case there is a market for lignocellulosic biomass crops in the future, the land used to grow it would be unused and abandoned feed and food crop lands. They could be partly re-utilized to grow miscanthus, switchgrass, giant reed etc. Therefore, it would be wise to consider lands that have lost use or effectiveness of food/feed crop production for growing of such biomass crops. Areas that are limited or unsuitable for agricultural production, are in fact suitable (and are encouraged to be used) for the cultivation of energy crops. The biomass potentials from unused lands are presented in Table 6 as estimated in the S2BIOM project.

Table 6 Biomass potentials* from unused lands 2020 in ton d.m. (=S2BIOM base potential)⁶ (see for assessment approach Annex 2)

Municipality	Total
Bratislavský kraj	33,333
Trnavský kraj	79,276
Trenčiansky kraj	73,658
Nitriansky kraj	124,327
Žilinský kraj	44,811
Banskobystrický kraj	84,885
Prešovský kraj	89,952
Košický kraj	65,699
Total	595,940

Source: S2BIOM project: Dees et al (2017) D1.6 A spatial data base on sustainable biomass cost supply of lignocellulosic biomass in Europe - methods & data sources <https://www.s2biom.eu/en/publications-reports/s2biom.html>

Residual biomass potentials from livestock

According to a study by the JRC (Scarlat et al. 2018) on the development and perspective for biogas in Europe, Slovakia produces 6.223 TJ of biogas, which amounts to 173 million cubic meters. Overall natural gas use in Slovakia is 4512 million cubic meters, which makes the use of biogas in particular at 3.8 % of natural gas use. Anaerobic digestion (including that of manure) is the leading way of producing biogas in Slovakia, the share of this process being about 85 %. Other processes for biogas productions are recovery of landfill gas and recovery of sewage gas.

In a more general sense, the electricity production yield from electricity in Slovakia is about 132 GWh, and the heat production from biogas is 2122 TJ, of which derived heat accounts for 473 TJ.⁶

2.1.4 AGRICULTURAL PROCESSING INDUSTRIES

Main agro-food processing industries

Slovakia had 2100 registered food processing enterprises in 2018⁷, and this number has been growing for at least the last five years. The total revenues of the Slovak food processing industry in 2019 was 4.4 billion € and the number of employees was 50 500. The Revenues of

⁶<https://reader.elsevier.com/reader/sd/pii/S096014811830301X?token=B06F9CEBED138780F938F3B6686B26476B07DADEC35344AD625255828307B6A0AD7FE4989E00DEEAB8888801C22310F4>

⁷ <https://www.sario.sk/sk/investujte-na-slovensku/sektorove-prehlady/potravinarsky-priemysel>

the biggest food processing segment-meat & poultry processing was 796 million €. The average gross monthly salary in the food processing industry. 87,5 % of the national average as of 2018 was 887 €.

The companies can be divided into various sectors:

- Bratislava region: Wheat
- Trnava region: Sugar Beet, Potatoes
- Nitra region: Grains, Oil plants, Sugar Beet
- Trenčin region: Sugar Beet
- Banská Bystrica region: Grains
- Prešov region: Potatoes
- Košice region: Oil plants, Grains

The biggest companies are⁸:

- Milk producer: Rajo a.s.
- Meat producer: Mecom Group s.r.o., Tauris a.s.
- Beer producer: Plzeňský prazdroj, Heineken Slovensko a.s.
- Sweets and baking producer: I.D.C. Holding a.s.
- Poultry producer: Hyza a.s.
- Pastry producer: MPC Cessi

Side-products from agro-food processing

Residues from food and fruit processing represent an excellent opportunity to improve cost efficiency of agro-food processing companies. This is particularly urgent for fruit processing companies. While fruit growing agro-techniques are outdated, food processing industry is able to keep up the pace with the technological development. Generating yield from waste streams just started to be considered as a good opportunity to improve competitiveness. It is likely that hesitation lies in the necessity to step out from the current marketplace and food processing as core business. Particularly the cereal bran potential is very large, considering very large cereal production area in Slovakia. From the former is clear that there are more types of secondary residual biomass sources but estimates on their size are difficult to find.

In Table 7 an overview is given of secondary residual biomass sources from the grapes, cereal bran (how these potential estimates were assessed is explained in Box 2).

⁸ <https://www.sario.sk/sites/default/files/data/sario-food-processing-industry-in-slovakia-2019-10-04.pdf>

Table 7 Biomass potentials from agro-food processing industries 2020 in Ton d.m. (=S2BIOM base potential)¹¹ (see also Annex 2)

County	Pressed grapes dregs	Cereal bran	Total
Bratislavský kraj	83	6,723	6,806
Trnavský kraj	89	19,857	19,945
Trenčiansky kraj	96	21,563	21,659
Nitriansky kraj	135	30,380	30,515
Žilinský kraj	39	18,670	18,709
Banskobystrický kraj	54	25,921	25,975
Prešovský kraj	54	29,235	29,290
Košický kraj	41	22,003	22,043
Total	590	174,352	174,942

Source: S2BIOM project: Dees et al (2017) D1.6 A spatial data base on sustainable biomass cost supply of lignocellulosic biomass in Europe - methods & data sources <https://www.s2biom.eu/en/publications-reports/s2biom.html>

Box 2.3: Methodology of S2BIOM to calculate the secondary residue potentials from food processing in Table 2.4.1

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

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

The largest potential from secondary residues is from cereal bran with a total amount of 174 Kton d.m. per year. Another 590-ton d.m. of pressed grape dregs should be available from the wine industry.

2.1.5 COST OF MAIN BIOMASS SOURCES

Since for most agricultural residues no commodity market has developed yet it is very difficult to provide figures on prices. Instead cost estimates can be presented building on the S2BOM methodology and assessment. The costs refer to Roadside costs and these cover all biomass production collection and pre-treatment costs up to the road where the biomass is located. The roadside cost is only a fraction of the total 'at-gate-cost.' The roadside costs are presented in Table 8 below; for further details on the cost calculation in S2BOM see Annex 2.

Table 8 Road side cost levels (€/ton d.m.) for agricultural biomass sources based on S2BIOM cost calculations 16

Road side cost for agricultural biomass	Average (€ ton dm)
	(2020 cost level)
Cereals straw	19
Oil seed rape straw	17
Maize stover	15
Sugarbeet leaves	40
Sunflower straw	18
Residues from vineyards	199
Residues from fruit tree plantations (apples, pears and soft fruit)	133
Dedicated crops on unused lands	28

Source: Consulted with experts

2.2. SUMMARY AND CONCLUSIONS IN RELATION TO SWOT ELEMENTS

Summarizing the residual biomass potential from agriculture – 2110 Ktons and unused lands – 596 Ktons and biomass potential from food processing industries – 175 Ktons, together 2 880 Ktons, the main meaning has the residual biomass potential from agriculture 74 % while the potential biomass from unused land makes 20 % and the potential biomass from the food processing industries makes 6%.

Considering this 74 %, the residual biomass potential from agriculture, the cereal straw makes 52 %, the maize stover 27 %, oil plants straw 18 % and sugar –beet leaves just 3 %.

The farm managers are normally willing to sell the biomass residuals, mostly cereal and maize straw, the main problem is the logistics, especially the transportation to the processing facilities.

One illustrating example is the bio-refinery Enviral 60 km far from Bratislava, refinery in Western Slovakia. The present input is 420 Ktons of biomass. For the second generation this bio-refinery is contracting farmers not only from Western Slovakia but also from Western Hungary and from Moravia (south- east part of the Czech Republic), although the Slovakia cereal straw residual production is 1 100 Ktons. Due to the long transportation distances the logistics costs from Central and Eastern Slovakia are too high.

Another issue is the development of potential biomass from not used lands, there is a potential of almost 600 Ktons and the potential use is bioenergy production. It makes economic sense in the regions where there is no natural gas connection.

The potential biomass from the food industries of 175 Ktons will be a subject of further consideration as the processing capacities are not developed yet.

The prices for residual biomass are depending on the concrete **market situation**. E.g. the sawdust was offered almost for free, since it will be used for pellet production the price has increased considerably so the sawdust makes 40 % of the pellets manufacturing costs. Similar situation is with cereal and other straw residues.

The by-product valorisation is either for heat and electricity production or for bio-fuel generation. The known problem for use of the residual biomass from agro activities it is dispersion, low density and following high collection, transportation and processing costs.

The industrial infrastructure is partially developed, e. g. the bio-fuel production for the Bratislava refinery, the roads and railway infrastructure are built.

There are different levels of technology development and robustness, from state-of-the-art bio-fuel manufacturing, modern dairies to obsolete food processing equipment.

The labor force in the rural areas is available, although many young people don't prefer working on the fields. This problem is being solved by bringing people from the Ukraine and Balkan states.

The financing, taxes and regulations are discussed in following chapters.

There is one important issue to be mentioned, the irrigation of the fields. Fortunately, Slovakia has a lot of rivers and thanks to the Carpathian Mountains elative enough rain and water reservoirs. However, the majority of the old socialist watering systems have been destroyed and there is need to install new and technology upgraded ones.

Generally, there are a lot of investment opportunities in the Agro - sector in Slovakia, especially in the feed processing, pork, beef and poultry production, dairy cattle and dairies, fruit and vegetables production and its further processing.

Table 9 SWOT factors regarding biomass feedstock

<p>Strengths</p> <p>Appropriate size structure of agricultural holdings</p> <p>Great potential for the use of agricultural land and especially natural grassland, good traditions in agricultural and forest land management</p> <p>Favourable climate conditions</p> <p>High soil quality in the lowlands</p> <p>Sufficient water supply</p> <p>The possibility of growing organic agricultural products in Slovakia,</p> <p>Advanced information systems and sources of information on supply assessment and control</p>	<p>Weaknesses</p> <p>Low state subsidies, low competitiveness and productivity especially of agriculture and following processing industries</p> <p>Low transparency of the Structural Funds</p> <p>Cooperation with many other organizations and government is not sufficient enough on national and regional level.</p> <p>Lack of job opportunities</p> <p>Migration of rural population to urban regions Permanent loss of arable land, Indebtedness of farms</p> <p>Decrease of agricultural production and reduction of livestock breeding</p> <p>Unresolved ownership relationships to agricultural and forestry land</p> <p>Insufficient use of secondary valuable raw materials from waste management</p> <p>Low added value production</p>
<p>Opportunities</p> <p>Low added value production</p> <p>Job creation, respectively job maintenance</p> <p>Diversification of the rural economic base</p> <p>Exploitation of local natural resources</p> <p>Countryside capital inflow</p> <p>Promoting the sale of local products</p> <p>Farm production support</p> <p>Development of inter-communal and cross-sectoral cooperation</p> <p>Large space for food processing in Slovakia, as the negative balance of food export / import is widening</p> <p>European Green Deal and its implementation in the Slovak Republic</p>	<p>Threats</p> <p>A high percentage of the rural population in the post-productive age and an ongoing outflow of staffing capacities from rural areas</p> <p>Inability to develop the land market as a prerequisite for business in agriculture</p> <p>Foreign competition of agricultural products</p> <p>Unresolved ownership relations to agricultural and forestry land</p> <p>Insufficient anti-erosion measures in the country</p> <p>Absence of rural development coordination</p> <p>Frequently changing legislation</p> <p>Climate change</p> <p>The reluctance of manufacturers to create sales organizations and to participate in the formation of shortened sales chains</p> <p>There are no strategies for agriculture and food processing development</p>

3. Biomass supply: Forestry

3.1. Introduction

At present, forests account for about 45% of Slovakia's area, which represents 2, 21 million hectares.⁹ 51, 4% of the forests are owned by state or municipalities, and the rest is privately owned by landowner or churches.

The representation of individual trees reflects natural conditions and human interventions. In total, deciduous forests dominate (63.1%) followed by coniferous (33, 9%). Of coniferous trees, spruce (22, 5%), pine, fir, larch and dwarf wood are the most widespread. From deciduous trees - beech (32%), oak, hornbeam, acacia, maple and birch are most common.

The most common cause of calamity is whirlwind, wood-destroying insects, frost, drought, fires, and others. In some regions, wood thefts occur.

Table 10 summarises the main characteristics of Slovakian forests.

Table 10 Slovakian forests in numbers, 2018

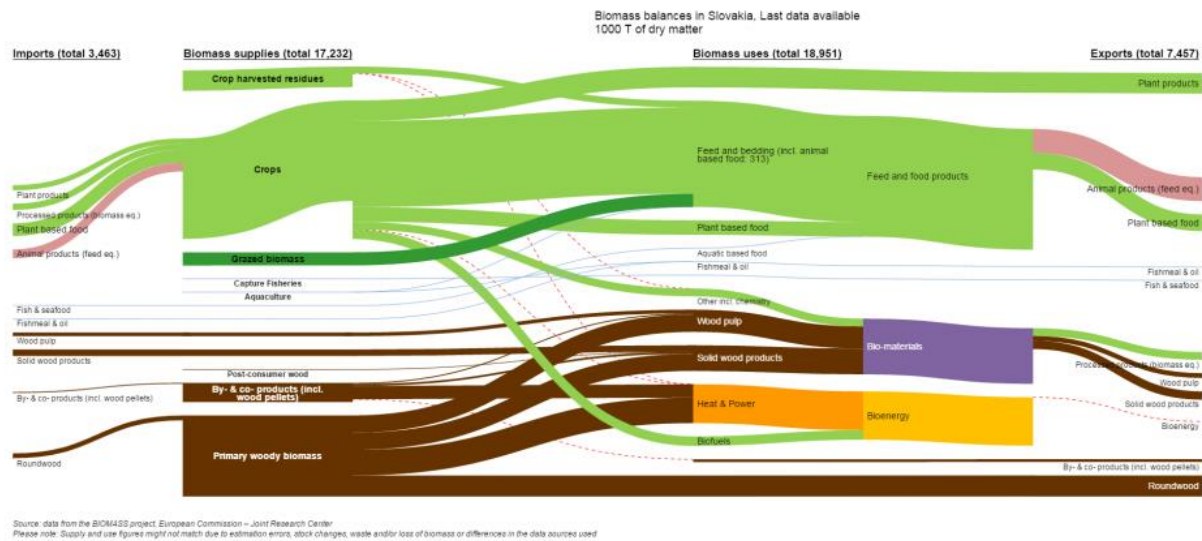
Forest area	2, 2 mil. ha
% Forest cover of total area	45 %
Growing stock (thousand)- annual increment	12 007,6 m ³ total or 6,25 m ³ /ha
Possible cut (thousand)	9 800 m ³
Coniferous trees (thousand)	5 999 m ³
Deciduous trees(thousand)	3 801 m ³
Length of forest roads	38 241km

Source: <https://www.mpsr.sk/?navID=123>

WoodChainManager's web page offers an access to an interactive schematic representation of roundwood flows in Slovakia (shown on figure 8). Data, which are for the year 2017, suggest that a substantial amount of Slovakian wood is exported around 1/3 of the production. Mainly it is exported as roundwood and firewood. Only a little fragment is exported as added-value products such as chemicals, pulpwood, fibreboard and particleboard.

⁹ Šebeň, V., 2015: Národná inventarizácia a monitoring lesov Slovenskej republiky 2015-2016. Lesnícke štúdie 65/2017. str. 47

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



Source: <https://core.ac.uk/download/pdf/84886777.pdf>

Figure 8 Sankey diagram of roundwood flows in Slovakia, 2017

3.1.1. Primary biomass resources

The assessment of the roundwood and primary residue potentials in S2BIOM is done by using the EFISCEN model and using national forestry inventory data as an input. The secondary forestry residues from sawmills and wood processing industries build on the potentials assessed in EU Wood and S2BIOM in combination with some up-dated data from national sources.

The total timber stock reached 481.8 mil. m³ of free bark.¹⁰ The volume of coniferous wood (198.63 million m³) is decreasing due to frequent damage of mainly spruce forests. The trend of increasing the supply of hardwood continued (283.17 million m³). The average stock of wood per hectare was 248 m³. Currently, due to the current age composition of forests in Slovak republic historically, the highest wood reserves are in history. Their volume, however, culminates; it is expected that in the coming years and decades wood stocks will decrease due to a gradual change in the age structure. Timber harvesting in 2018 was 9.86 mil. m³. 60.8% of coniferous and 39.2% of deciduous wood were harvested. Of the above-mentioned volume of logging, 5.72 mil. m³ (58.0%) harvested the effects of harmful agents

¹⁰ <https://www.mpsr.sk/zelena-sprava-2019/123---14927/>

in forests, of which 87.1% was coniferous wood. Timber harvesting was lower than the total current increase (12 million m³).¹¹

Table 11 describes the primary biomass potential from Slovakian forests in 2020. Data was obtained during the S2Biom project. It should be noted that biomass potential is expressed in thousands of tons (Kton) of dry matter (d.m.). Taken this into consideration, volumetric results above (expressed in m³) coincide relatively well with estimated data for 2020 (expressed in Kton d.m.)

Table 11 Primary biomass residues potential from forests in Kton d.m. (S2Biom Base 2020 potential)

County	Thinnings (Kton)	Logging residues from final fellings (Kton)	Logging residues from thinnings (Kton)	Total (Kton)
Bratislavský kraj	39	4	1	43
Trnavský kraj	47	8	3	57
Trenčiansky kraj	162	37	12	211
Nitriansky kraj	84	27	10	121
Žilinský kraj	343	84	20	447
Banskobystrický kraj	379	136	46	561
Prešovský kraj	276	122	31	429
Košický kraj	178	32	9	219
Total	1506	449	133	2088

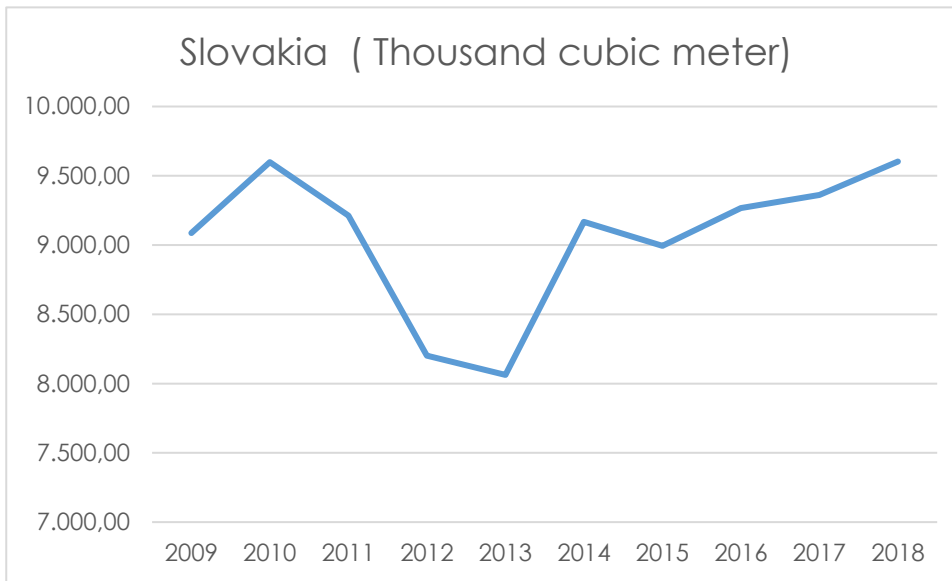
Source: S2BIOM project: Dees et al (2017) D1.6 A spatial data base on sustainable biomass cost supply of lignocellulosic biomass in Europe - methods & data sources <https://www.s2biom.eu/en/publications-reports/s2biom.html>

Looking at table 11 one can conclude that the current average yearly harvest in 2020 amounts to a total of 2088 Kton d.m. The exploitation of forest biomass from Slovakia forest is relatively in line with what can also be potentially harvested from the forest.

The total harvested roundwood in 2018 was 9, 86 million cubic meters. The export of roundwood in 2018 was approximately 2, 1 million cubic meters compared to 1, 4 million cubic meters of imported roundwood. The movement dynamic in external trade is an important indicator of the processing state and timber use and, consequently, adding added value to the domestic renewable raw material. The most important exporting area for Slovakia is the European Union.

¹¹ <https://www.mpsr.sk/zelena-sprava-2019/123---14927/>

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



Source: https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=for_remov&lang=en

Figure 9 Distribution of primary residues potential from forests Kton d.m. (S2BIOM Base potential 2020)

Table 12 summarises how the harvest levels and the total additionally harvestable stem wood and residue resource relate to the total yearly forest biomass increment. It becomes clear from this table that in almost all countries the common harvest levels are considerably below the yearly increment level, this also applies to Slovakia. Part of this low level can be explained by a skewed age structure in the forest population but may also refer to a large unused potential.

Table 12 2010, 2020 and 2030 EFI-GTM harvest levels expressed as % of yearly average biomass increment level in forests. (Source: Biomass Policies, Elbersen et al., 2016)

	Country	% Harvest & residues potential/Increment			% Harvest & residues potential + Maximum additional harvestable potentials/increment		
		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%

Source: S2BIOM project: Dees et al (2017) D1.6 A spatial data base on sustainable biomass cost supply of lignocellulosic biomass in Europe - methods & data sources <https://www.s2biom.eu/en/publications-reports/s2biom.html>

3.1.2. Secondary biomass resources from wood processing industries

In Table 13 wood potentials from forest industry are presented. How these were assessed is explained in Annex 2.

Table 13 Secondary biomass potential from forests in Kton d.m. (S2BIOM Base potential 2020)

County	Sawdust	Other residues	Residues from industries producing semi-finished wood panels	Bark	Black liquor	Total
Bratislavský kraj	8	38	1	0	0	46
Travský kraj	8	36	1	0	0	45
Trenčiansky kraj	27	78	3	0	0	109
Nitriansky kraj	12	50	1	0	0	62
Žilinský kraj	40	109	4	57	388	599
Banskobystrický kraj	51	130	6	14	97	298
Prešovský kraj	31	95	3	14	97	240
Košický kraj	18	67	2	14	97	198
Total	194	604	21	100	680	1,598

Source S2BIOM project: Dees et al (2017) D1.6 A spatial data base on sustainable biomass cost supply of lignocellulosic biomass in Europe - methods & data sources <https://www.s2biom.eu/en/publications-reports/s2biom.html>

According to the data provided by WoodChainManager for the year 2018, the majority of roundwood was processed by sawmill, followed by the industry of wood composites, mechanical pulp and chemical industry.

Among large players are also households, which annually consume over 1 million m³ of wood, but it partially derives from non-forest resources. Given the large forest production area in Slovakia the wood processing industry is an important sector also producing a large amount of secondary forestry residues which have also been assessed in the S2BIOM project. Table 14 summarises forest derivatives produced in Slovakia in 2018. In total, 1,598 Kton of secondary residual biomass is produced in the wood processing industry. The largest concentration of this biomass is in the region of Žilinský kraj.

Table 14 Forest products in Slovakia (2018).

Slovakia (Thousand cubic meter)	2009	2010	2011	2012	2013	2014	2015	2016	2017
Roundwood (wood in the rough)	9 086	9 559	9 212	8 201	8 062	9 167	8 994	9 267	9 361
Fuelwood (including wood for charcoal)	586	509	643	587	689	560	559	515	591
Fuelwood- coniferous	351	293	324	292	356	259	237	251	318
Fuelwood- nonconiferous	234	216	318	294	332	301	322	264	273
Industrial roundwood	8 500	9 809	8 569	7 614	7 372	8 607	8 434	8 752	8 770

Source <https://www.mpsr.sk/?navID=123>

In 2018, continued growth in timber products on international markets. The total volume of exports it received in 2017 with an estimate of 8 272 mil. m³ to 8 899 mil. m³, t. j. by 7.6%. Increasing wood profit achieved better economic parameters in 2017. DSP revenues increased by 4.85% to EUR 3,129 million. € and also 23 434 jobs have been created. Profit before tax decreased from 182 mil. € in 2017 to 169 mil. €. Due to the lower efficiency of wood processing, the subcontractors of domestic enterprises are mostly subcontractors of semi-finished products with lower finalization rate for foreign companies. With possible international companies operating in the Slovak Republic, no significant opportunities for modernization of organizations were realized.

In Slovakia, an increased incidence of coniferous logs and deciduous pulpwood is expecting, which is partially protected by imports. In particular, there is no production of high value-added wood products, namely cut and peeled veneers, plywood and fiber boards. On the other hand, cellulose-paper products belong to the most efficient ones in the Slovak bioeconomy. A total of 11 companies associated in the Union of Pulp and Paper Industry of the Slovak Republic cover 100% production of goods and exports to other countries. This implies that the current trade balance of the forestry and woodworking industries represents a surplus of EUR 918.63 mil. €. Negative is trade in furniture in the export of raw wood 77.35 mil. €, export of timber 140.81 mil. €. Similarly, the negative trade balance in the production of veneers in the amount of 19.91 mil. €. A positive phenomenon is the trade surplus with high value-added products, such as the production of panels 54,4 mil. €), cellulose and food production 167 mil. € and secondary wood products in the amount of 437.2 mil.

3.2. Summary and conclusions in relation to SWOT elements

The Slovak Republic is one of the European countries with the highest forestry area, 45 % of the area is covered by the forest.

The fact that the area of forest land in Slovakia has been stable in recent years can be evaluated positively. In the long term, however, the area of forest land and forest land has been increasing. The gradual increase in the area of forest soil foil and stand area is mainly involved afforestation of non - utilizable land, transfer of agricultural land covered by forest trees as well as gradual reconciliation of forest land registers with real estate cadastre. The slow growth of forest land resources is expected to continue in the future.

Table 15 summarises SWOT elements of forest sector in Slovakia.

Table 15 SWOT elements of forest sector in Slovakia

Strengths	Weaknesses
<p>Large woody biomass potential from standing forests, landscape elements and forest with a multifunctional use (combined nature protection with wood production, which has a wealth of biomass materials, products and full ecological functions available)</p> <p>State forest policy of Slovak Republic characterizes forests as a national wealth; therefore, the goal of sustainable economy is to protect.</p> <p>Existence of well-functioning associations with accepted leaders</p> <p>High economic efficiency forest management Non-state forest owners own up to 52.3% of Slovak forests and they are more efficiently managed as the state-owned ones.</p> <p>Dynamic development of circular bioeconomy in conditions in Slovak Republic; Slovakia's involvement in the BIOEAST initiative and in the BIOEASTsUP project and building cooperation with the countries of Central and Eastern Europe to promote the bioeconomy;</p> <p>The existence of the National Forest Centre is a powerful instrument in the national forest management, www.nlcsk.org</p>	<p>Intensive influence of top politics on state forestry management</p> <p>The inability to diversify goods and services (timber trade is often the main source of income)</p> <p>Insufficient and unsystematic funding</p> <p>A high proportion of adult and old forests in Slovakia right now, which are much more vulnerable to pests and diseases, than the young ones.</p> <p>A lack of processing capacity for the highest quality coniferous and hardwood round sorbents.</p> <p>Illegal logging Fragmentation and scattered forest ownership Value added in forestry is not high, it is created mainly in manufacturing industries</p>
<p>Opportunities</p> <p>Increasing demand for timber and other services Non-state forestry sector support through rural development program</p> <p>Use of external financial resources</p> <p>New legislation (explicit division into state and non-state forests)</p> <p>Investment in applied forestry and timber research Involvement Slovak entities in projects supporting bio-economy within the BBI-JU;</p> <p>Increasing share of renewable energy sources (RES) from forestry in total RES production in SR, research activities in bioenergy</p> <p>The development of rural business activities (including the involvement of business entities in cooperation projects) in relation to the creation of new value chains in the circular bioeconomy and the long-term improvement of the position in the value chains</p>	<p>Threats</p> <p>Negative persistent public view of foresters</p> <p>Non-governmental organizations (conservationists) and their particular objectives violating the principles of sustainable forest management (Bark beetle overgrowth treatment).</p> <p>Frequently changing persons in respective ministries (central organs)</p> <p>Lack of financial resources from the state, Slow solution to the fragmentation of forest ownership - necessity to implement land consolidation at a higher pace and state funding</p> <p>Demanding bureaucratic barrier from the side of the ministry when interested in applying from the EU funds and subsidies</p> <p>Economic restriction by nature protection without financial compensation</p> <p>Low law enforcement</p>

4. Biomass supply: Waste

4.1. Introduction

In Slovakia, almost 1.9 million tonnes of municipal waste are produced annually, which is about 350 kilograms per capita. Yet the country is still lagging behind in the European Union's waste separation level. Slovakia is implementing novelisation of the Waste Act from January 2020 with a lot of changes for companies and municipalities as well.

Slovakia is at the tail of the EU in waste separation. It still has a high landfilling rate of municipal waste. At 60 % (66 % in 2016), it is among the highest in the EU. Recycling (including composting) remains low (30 % vs the EU average of 46 %).

Moreover, Slovakia still struggles to comply with the 2013 target to divert 50 % of bio-degradable municipal waste from landfills. Incineration accounts for 10 % of municipal waste treatment. The high number of dump sites 25, like around Bratislava, is also a huge problem, as are old industrial sites. Slovakia has a very high number of municipalities (around 3 000). This leads to fragmentation, inefficiencies and a lack of economy of scale in waste collection and treatment.

The landfill fee in place as of 2004 has been too low to sufficiently incentivise separate collection. Following several years of negotiations, a new Act to increase the fees entered into force as of January 2019. This is a positive development and together with an amendment of the national Waste act also in force as of January 2019 (to increase the sorting of packaging municipal waste and non-packaged products and to strengthen the rules for operation and closure of landfills) is aimed at the landfilling decrease. It remains to be still seen whether these developments will bring the necessary incentives for a change in Slovakia's waste performance.¹²

Table 16 summarises waste flow in 2018.

¹² https://ec.europa.eu/environment/eir/pdf/report_sk_en.pdf

Table 16 Waste flow in Slovakia, 2018

YEAR: 2018		Tons
Municipal waste total		2 325 177 ,5
Of which: Material recycling		506 841,6
Incineration with energy recovery		156 769,6
Reclamation of organic substances		378 558,4
Of which: composting		215 014,7
Backfilling		564,4
Other recovery		1 148,5
Landfilling		1 250 279,5
Incineration without energy recovery		30 047,1
Other disposal		72,5
Waste temporary stored in place of origin		895,8
Other final disposal		152,982

Source http://datacube.statistics.sk/#!/view/en/VBD_SK_WIN/zp1005rs/v_zp1005rs_00_00_00_en

4.1.1. Waste from biological resources

In order to calculate the potential, the following approach was implemented:

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

The total waste generation reported by Eurostat in Table 4.2.1 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 17 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.

Table 17 Waste categories selected from Statistical Office of Slovak Republic's publication *Waste in the Slovak Republic in 2017*)

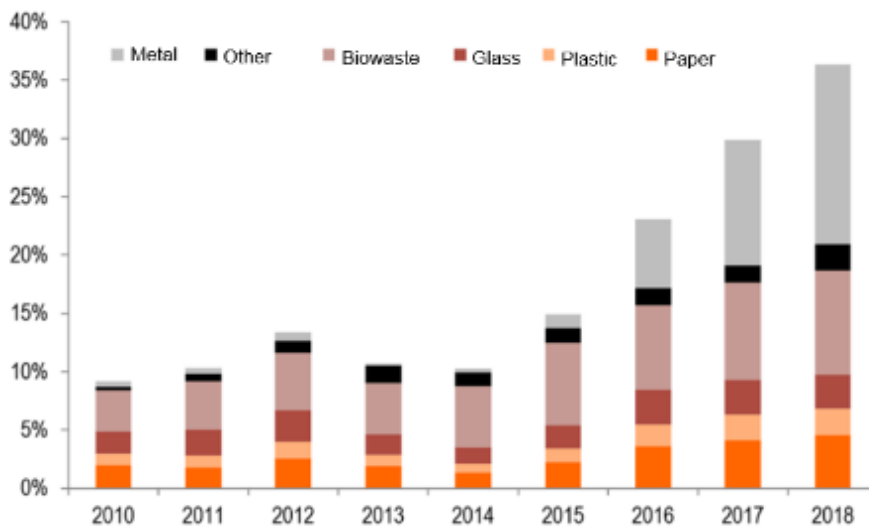
Types of waste (in Ktons)	Waste in total
Non-hazardous waste total	9 713,70
Wastes resulting from exploration, mining, quarrying and further treatment	311,02
Wastes from the leather, fur and textile industries	7,25
Wastes from petroleum refining, natural gas purification and pyrolytic treatment of coal	0,35
Wastes from inorganic chemical processes	1,85
Wastes from organic chemical processes	48,70
Wastes from coatings, adhesives, sealants and printing inks	3,17
Wastes from the photographic industry	0,02
Wastes from thermal processes	8,15
Wastes from chemical surface treatment and coating of metals and other materials	0,01
Wastes from shaping, physical and mechanical, surface treatment of metals and plastics	725,56
Waste packaging, absorbents, cloths, filter, materials and protective clothing	400,70
Wastes not otherwise specified in the list	316,74
Construction and demolition wastes	3 136,84
Wastes from human or animal health care or related research	3,67
Wastes from waste management facilities, waste water treatment plants and the preparation of water for consumption, use	1 300,16

Source: <http://datacube.statistics.sk/#!/lang/en>

There are several barriers for biomass mobilisation from waste:

- Low sorting (separation) rates
- Low awareness among citizens and companies of waste separation
- Frequent changes and lots of exceptions in waste legislation (apartment buildings are not obliged to separate biological waste, if municipality provides detached houses with composting container, they are not obliged to collect bio-waste etc.)
- Low landfilling fees (they should grow continuously in next couple of years)
- High transportation costs
- Low state stimulations/ interventions

As we can see from the figure 10 there are growing tendencies in the past years, however the bio-waste improved only slightly.



Source: Ministry of Environment of the Slovak Republic released statistics concerning industrial bio-waste . Material recovery was used for 60% of the bio-waste, energy recovery for 8% and 8% was landfilled

Figure 10 National figures of total waste generation in Slovakia in 2017

Between 2017 and 2018, municipal waste recycling increased from 30 to 36 percent in Slovakia. Landfill share decreased from 61 to 55 percent. All types of waste - metals, biowaste, paper, plastics, glass and other municipal waste - were recycled more.

Between 2017 and 2018, the absolute amount of recycled metals increased from 220 to 347 thousand tonnes. If metals were not included in municipal waste recycling, the increase would not be from 30 to 36 percent, but from 21 to 25 percent.

Bio-waste increased from 170 to 202 thousand recycled tons, paper from 85 to 103 thousand tons. Plastics jumped from 44 to 50 thousand tons, glass from 62 to 66 thousand tons. In the category of other municipal waste, the volume of recycled waste increased from 31 thousand tonnes in 2017 to 51 thousand tonnes in 2018.¹³

In S2BIOM 2 waste categories were assessed in terms of potentials. These are the organic waste and the post-consumer wood potential (see Table 18). Especially the separately collected biowaste has a large potential. Currently this is mostly going to landfill but given the new legislation measures will need to be taken to process this waste in another way. Energy recovery from this waste is an opportunity but will require important investments in post-separation and digestion installations for biogas and/or compost production.

Table 18 Biomass potentials from waste sector 2020 in Kton- d.m.

County	Biowaste unseparately collected	Biowaste separately collected	Hazardous post consumer wood	Non hazardous post consumer wood	Total
Bratislavský kraj	41	18	2	5	66
Trnavský kraj	37	16	2	5	60
Trenčiansky kraj	40	17	2	5	65
Nitriansky kraj	47	20	2	6	75
Žilinský kraj	47	20	2	6	75
Banskobystrický kraj	45	19	2	6	72
Prešovský kraj	55	24	3	7	89
Košický kraj	54	23	3	7	86
Total	365	156	18	48	587

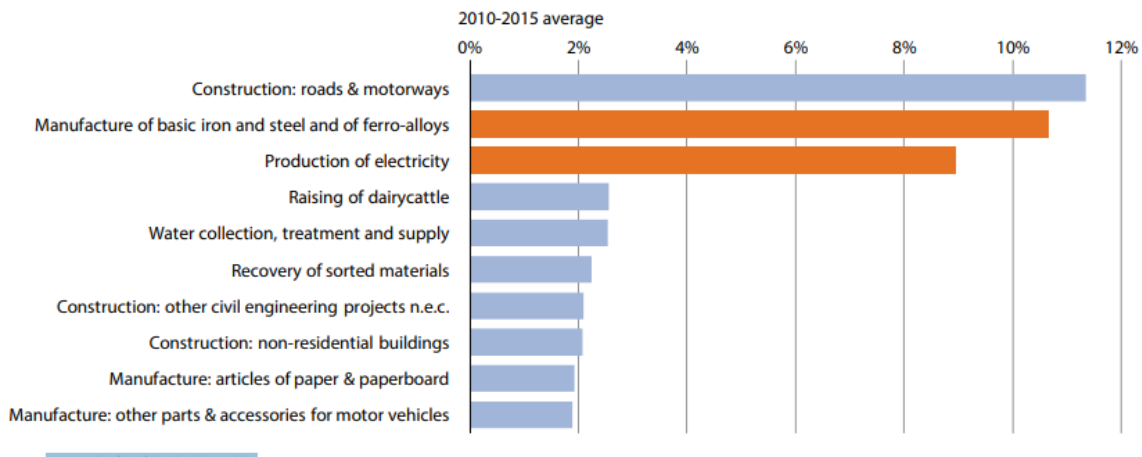
Source: S2BIOM project: Dees et al (2017) D1.6 A spatial data base on sustainable biomass cost supply of lignocellulosic biomass in Europe - methods & data sources <https://www.s2biom.eu/en/publications-reports/s2biom.html>

Increasing the efficiency of metal processing and of electricity generation from lignite could immensely increase the overall resource efficiency of the economy. These two sectors alone generate more than 20% of the country's industrial waste. Half of this waste (i.e. 11%) comes from the manufacture of basic iron and steel and ferro-alloys. Many of these wastes are landfilled, some of them being hazardous. Coal fired power stations produce only 10-12% of the country's electricity supply (Slovenské elektrárne, 2017), but generate more than 90%

¹³ <https://euractiv.sk/section/obehova-ekonomika/news/slovensko-ma-lepsie-odpadove-statistiky-skladkuje-pritom-coraz-viac/>

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

of all waste from electricity supply. Not to forget the waste from mining of lignite (about 1.5% of total waste generation).



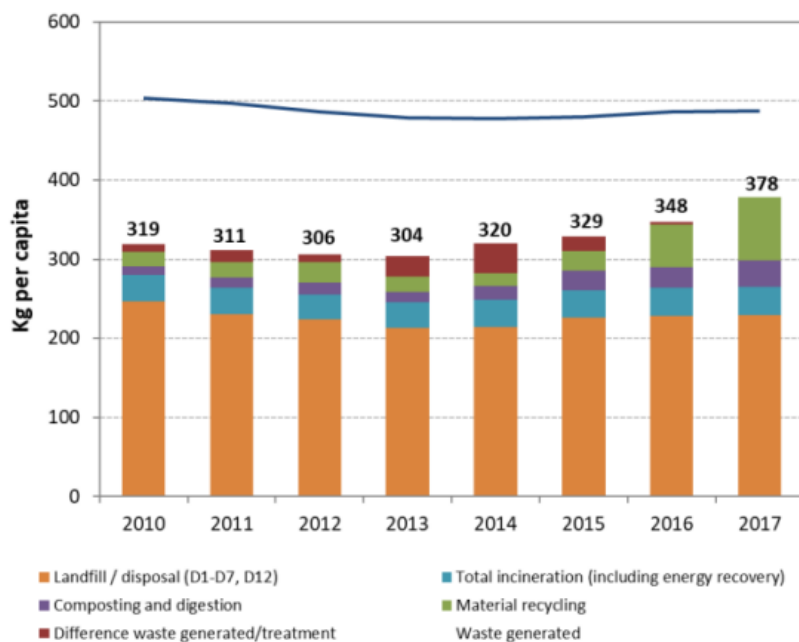
Source: <https://www.oecd.org/environment/waste/Policy-Paper-Making-the-Slovak-Republic-a-more-resource-efficient-economy.pdf>

Figure 11 Waste by sector

4.1.2. Current waste treatment and unused potentials estimates

According to the new legislation within Waste management law 79/2015 Z. z. there are goals that need to be achieved, like to shift more recycling responsibility on companies and importers, make producers directly responsible over waste management, be successful in waste separation at least by 50% by 2020, make municipalities responsible for the separation of glass, plastic and metals, the costs covered by the producers and make agreements with organisations responsible for packaging waste recovery.

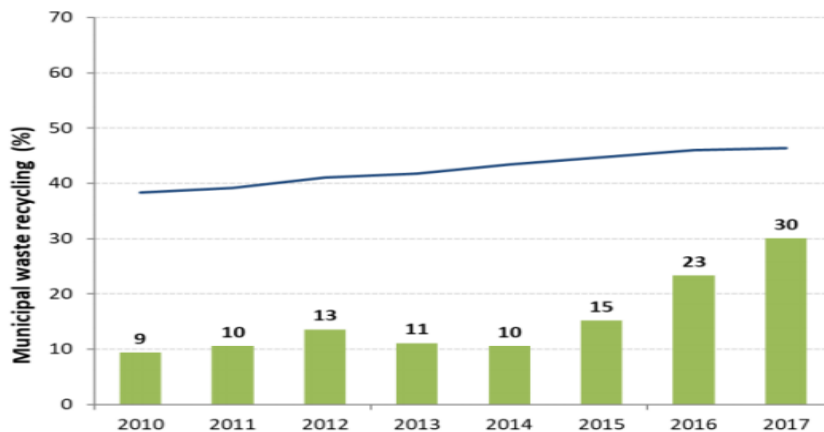
As we can see from the above facts there is still big potential in the mobilisation of biomass from the waste, especially from municipal waste. According to the Environmental Implementation Review 2019 – Country report Slovakia the generation of municipal waste increased in Slovakia in 2017. It remains considerably below the EU average (378 kg/y/inhabitant vs around 487 kg/y/inhabitant). Despite some recent improvements to ensure more consistency in the reports to the European Commission, there are still differences between national statistics and those of Eurostat. A pilot phase of New Waste Management Information System, which should improve data collection also for international reporting as well as waste management planning, has been launched in summer 2018.



Source: The Environmental Implementation Review 2019 – Country report Slovakia, European Commission

Figure 12 Municipal waste by treatment in Slovakia 2010-2017

Although the generation of municipal waste increased in Slovakia in 2017, it remains considerably below the EU average (378 kg/y/inhabitant vs around 487 kg/y/inhabitant see Figure 12 Slovakia still has a high landfilling rate of municipal waste. At 60 % (66 % in 2016), it is among the highest in the EU. Recycling (including composting) remains low (30 % vs the EU average of 46 %). Moreover, Slovakia still struggles to comply with the 2013 target to divert 50 % of bio-degradable municipal waste from landfills. Incineration accounts for 10 % of municipal waste treatment. A high number of municipalities leads to fragmentation, inefficiencies and a lack of economy of scale in waste collection and treatment. In addition, the capacity of many small municipalities to adequately design and procure high quality collection services based upon international good practice, is likely to be very limited. See Figure 13.



Source: The Environmental Implementation Review 2019 – Country report Slovakia, European Commission

Figure 13 Recycling rate of municipal waste 2010-2017

Key players in waste collection and treatment

It is complicated to find comprehensive data on the waste in connection to the biomass. Association of biomass producers, processors and consumers in Slovakia was established in 2004, however, it seems that it is not active anymore. We were not able to identify website or contacts of the Association.

Above all the documents based directly on the Waste Act law is the Waste Management Program. It is a document that is drawn up in accordance with the waste hierarchy and objectives and the ways of achieving it in accordance with the Waste Act. The program includes an analysis of the current state of the waste management of the geographical area for which it is issued and measures to be taken to improve environmentally sound preparation for re-use, recycling, recovery and disposal, as well as an evaluation of how the program will support the achievement of these objectives; provisions of the Waste Act. There are Waste Management Programs on different levels: state level, regional level and municipal level.

It is complicated to identify biggest players in the waste management sector, because in addition to waste management, many of them also carry out municipal work, street cleaning, or transportation activities, making them important players in transport. The biggest players are definitely metal-collecting and recycling companies such as: TSR Slovakia, ŽP EKO QELET, Zberné suroviny, ADA WASTE, SAKER. Biggest municipal waste

collecting and sorting companies are: Marius Pedersen, FCC Environment, Brantner, T+T, AVE SK odpadové hospodárstvo, OLO and Kosit. These companies can play roles in collection of bio waste. As of mid-2016, new financing for separate collection and other waste commodities began to be funded under the responsibility of the manufacturer and importer. Key players became two producer responsibility organizations: ENVI-PAK and NATUR-PACK, who play important and complicated role in the packaging and non-packaging product collection, recovery and selection.

Important Slovak waste-management companies are members of FEAD. FEAD is the European Waste Management Federation. FEAD members are national associations associating waste management companies from 20 EU Member States. Companies represented in FEAD provide waste management for 60% of households and for more than 75% of industrial clients in Europe

4.2. Summary and conclusions in relation to SWOT elements

The recycling rate in Slovakia increased year-on-year by 7 % and landfilling is declining. In 2015, more than two thirds of municipal waste were landfilled, in 2018 it was only 55 %. Changes for the better underline the year-on-year comparison of municipal waste recycling. In 2017, about 29% of municipal waste was recycled and in 2018 it was already 36%. By 2020, Slovakia wants to achieve a recycling rate of municipal waste of 50%.

Slovakia, 12.3 mil. tonnes of all waste, of which 41% was recovered (recycling, energy recovery), 35% was disposed of (landfill, incineration without energy recovery) and 24% was disposed of in a different way. Municipal waste accounts for only 17% of all waste. The amount of municipal waste in the period 2005 - 2013 showed no significant upward or downward trend and fluctuates in the range of 1.5 - 1.8 mil. ton. On the contrary, in the period 2013 - 2018 the average rate of growth of 136 thousand. tonnes per year. There is a growing number of municipal wastes that is generated or collected separately. The landfill rate of municipal waste has been decreasing evenly and slightly since. 2010 approx. tonnes per year.¹⁴

¹⁴ <https://euractiv.sk/section/obehova-ekonomika/news/slovensko-ma-lepsie-odpadove-statistiky-skladuje-pritom-coraz-viac/>

Mixed municipal waste is the most important part of municipal waste, it is about 1.2 mil. tonnes, that is exactly half the weight of municipal waste. Recycling of mixed municipal waste and subsequent recycling / recovery does not exist to a relevant extent in Slovakia, although over the past 13 years, several waste legislation has been adopted and implemented: the establishment and functioning of the Recycling Fund, the introduction of producer responsibility and extinction of the Recycling Fund, support for waste processing in the form of EU grants, waste management programs at the level of the republic, regions, districts, towns and waste producers, obligatory rates of recycling of packaging waste and other parts of municipal waste, measures to support the collection and recycling of biologically degradable municipal waste (BDMW) waste, tightening conditions for landfill permits, landfill treatment plans, etc

Table 19 summarises SWOT elements of waste sector in Slovakia.

Table 19 SWOT elements of waste sector in Slovakia

<p>Strengths</p> <p>The country has substantially reduced its greenhouse gas emissions and the energy intensity of its economy</p> <p>More progress has been achieved in the management of industrial waste, where 39% now goes for recycling, while only 36% is landfilled.</p> <p>Positive changes in the legislation (growing landfilling costs)</p> <p>New policy and regulations on returnable PET & aluminium cans</p>	<p>Weaknesses</p> <p>Low sorting rates</p> <p>Low awareness among citizens and companies</p> <p>Frequent changes and lots of exceptions in waste legislation (apartment buildings are not obliged to separate biological waste, if municipality provides detached houses with composting container, they are not obliged to collect bio-waste etc.)</p> <p>Low landfilling fees (they should grow continuously in next couple of years)</p> <p>High transportation costs</p> <p>Low state stimulations/ interventions</p> <p>The current policy framework is incomplete and lacks coherence</p> <p>Waste management is in hands of high number of small municipalities and their capacity adequately design and procure high quality collection services is very limited</p>
<p>Opportunities</p> <p>Still an enormous amount of waste that is not separated and that can be recycled, reused, used for energy generation once the separation and waste treatment system become further developed</p> <p>Empowering bioeconomy through circular economy. Good opportunity for companies to invest in and improve the circular economy. E.g. instead of landfilling, using biowaste like retail food waste to empower the bioeconomy potential. More recycling.</p> <p>Increasing the efficiency of metal processing and of electricity generation from lignite could immensely increase the overall resource efficiency of the economy</p> <p>Gradually increase the landfill tax. Consider ICT for useful recycling.</p>	<p>Threats</p> <p>Insufficient municipal solid waste recycling. Only about 15% of the municipal solid waste is currently recycled.</p> <p>Municipal waste management is underperforming and lacks appropriate economic signals that would divert waste from landfills and stimulate recycling and reuse</p> <p>Wastewater insufficiently recycled. The generation of wastewater is relatively high and only a small share is "recycled". Wastewater treatment levels are among the lowest in the OECD; only 65% of the Slovak population benefit from a connection to a wastewater treatment plant. Water use is under-priced; and the user pays principle is not applied to all types of users.</p> <p>Illegal dumping</p> <p>Bad air quality</p> <p>Air quality continues to suffer from heavy use of brown coal in power generation, and air pollution remains one of the main environmental challenges</p> <p>Low law enforcement</p>

5. Bio-based products industries and markets

5.1. Introduction

5.1.1. Current bio-based industries

In addition to other industrial sectors, domestic chemical industry tends towards going bio-based. Regarding bio-based products already presented in Slovakia the company Biotika (www.biotika.sk), which produces bio pharmaceuticals is very interesting. The company, among others, owns a patent for the calcium production from egg shells. Another company that makes a natural medicine is Natures (www.natures.sk), Ltd., which specializes in the development, research and production of natural polysaccharide, fungal beta-1.3 / 1.6-D-glucane etc. There are more manufacturers of natural cosmetics in Slovakia. In Slovakia, there are companies that produce paper-based materials for packaging and are in process of developing bio-based waterproof coating materials.

5.1.2. Food and feed ingredients industries

Until the end of the Second World War Slovakia has been more agricultural than industrial country. The main present challenge is the is the low competitiveness, coupled with climate change that shifts locations of cultivation, excessive yields of certain crops, foreign ownership of local land and distribution channels and low self-sufficiency in essential food products. In 2016, production and revenues of the agricultural sector declined and only one-fifth of companies in the sector expected growth.¹⁵ The production of food ingredients in Slovakia is only marginal, there are a few companies that do this, for example SOLČANKA, that produces flavourings (<https://www.solcanka.sk>), THYMOS, that focuses on spices (<http://www.thymos.sk>) and CHILLIS, whose main activity is the production of red pepper (<https://chillis.sk/>).

Almost 90% of Slovak farms are large farms (more than 100ha), which is a result of the collectivisation during communist period. Research Institute of Agricultural and Food Economics released a report of SR Challenge: expensive feedstock production in Slovakia

¹⁵ <https://spectator.sme.sk>

because of low competitiveness with Western European countries, which have higher subsidies. Low competitiveness with Asian and South American countries with cheaper workforce. These challenges have to be considered and solved on the regional, national and European level.

5.1.3. Commercial biorefineries

ENVIRAL

ENVIRAL was established in 2004 as the first producer of bioethanol in Slovakia. The commercial production of bioethanol was launched in July 2007. Current annual production capacity is 145,000 m³ of bioethanol, the input is 400 Ktons of biomass from Slovakia and Hungary. The company's premises are large and aside from the production plant itself there are storage capacities for 1/3 of annual raw material needs. This raw material is delivered using own railway siding, connected to a rail junction located in City of Leopoldov, 60km from the refinery in Bratislava. There is a direct railway connection from bio-refinery to the national refinery in Bratislava, the whole bioethanol production is transported there by train. Enviral has long term delivery contracts with the national refinery and is the main commercial bio – refinery in Slovakia.

Source: <https://www.enviral.sk>

BIORAFINERIA SK

The company Biorafineria offers technologies for vegetable oil, biodiesel/FAME and next generation biofuels production such as: biodiesel plants, edible oil plants, distillation equipment, and production of methyl esters from fa, two stage pressing, recycling of used mineral oils, gasification, pyrolysis and depolymerization. Biorafineria cooperates with the Technical University in Bratislava.

Source: <http://www.biorafineria.sk/>

GLORTEX

Glortex's uses waste, incl. food waste and petrochemical residues or residues from other industries like Fat, Oil and Grease from the sewer as well as used coffee grounds to explore new fields of sustainable biodiesel production and maximize waste to energy production.

Company recently bought premises near Bratislava in Šenkvice and turns them into biorefinery products.

Source: <https://glortex.eu/>

BIOSKOH

The BIOSKOH bio refinery of the second generation was planned as the largest project in Slovakia within the cooperation the BBI JU and private investors. After large PR activities the project was finally not implemented, the reason is probably no profit generation.

5.1.4. Regional bio- based initiatives

The most developed regional bio-based initiatives are biogas stations located at the local farms. Their production compared to the gas consumption is quite limited.

5.1.5. Pulp and paper initiatives

The paper industry has a tradition of almost 200 years in Slovakia and belongs to the oldest bio-based industries in the country. There are following paper and pulp initiatives in Slovakia.

SHP Group (Slovak Hygienic Paper Group)

Multinational company associating a group of manufacturing and trading companies from the pulp and paper industry. SHP Group covers 10 companies in 6 European countries, 2 of them in Slovakia in Harmanec and in Slavošovce. SHP Group is the largest sanitary paper producer in Central and Southeastern Europe and is an active member of the European Tissue Symposium (ETS). The paper mill in Harmanec was built in 1829 a similar history of the paper mill began in 1972, when a paper machine for the production of sanitary papers was put into operation and a new raw material - waste paper - was used.¹⁶

Source: <https://www.tvojeharmony.sk>

Metsä Tissue

The plant in Žilina was put into operation in 1905, when the production of cellulose for paper and synthetic fiber products started. The production of sulphite alcohol started in 1941 and since 1983 the plant has been producing exclusively paper hygiene products from tissue

¹⁶ <https://www.tvojeharmony.sk/o-nas/shp-group/>

paper. In 2006, the former This a.s. and the plant in Žilina became part of the Finnish corporate company Metsä Tissue, which has a total of 9 tissue paper plants in 5 countries. Žilina plant produces toilet paper, kitchen towels and sanitary towels. Since March 2011, the plant has been using electricity generated in a nearby hydroelectric power plant on the VVB Žilina, the river Váh dam. At present, this volume represents 70% of the plant's total electricity demand.¹⁷

Source: <https://www.metsatissue.com>

Convertis, s.r.o.

Convertis, s.r.o. was established in 1994 in Štúrovo with a focus on the production, processing and sale of sanitary paper products. The production machines and capacities of the company are optimized for the processing of pure cellulose as well as recycled paper. The main objective of the company is focused on quality management with sustainable development of production capacities with acceptable price level for customers.¹⁸

Source: <https://www.verytis.sk/>

Mondi SCP

Mondi SCP in Ružomberok is one of Mondi's largest plants and is the biggest integrated mill producing paper and pulp in the Slovak Republic, with a production capacity of 560,000 tonnes of uncoated fine paper, 66,000 tonnes of packaging paper and 100,000 tonnes of market pulp. After its latest investment into a new recovery boiler, the mill is 100% energy self-sufficient with over 94% of its energy coming from renewable resources. The increased volumes of production thus go hand in hand with continuously decreasing our footprint on the environment.¹⁹

Source: <https://www.mondigroup.com/en/home/>

¹⁷ <https://www.metsatissue.com/en/Pages/default.aspx>

¹⁸ <https://www.verytis.sk/>

¹⁹ <https://www.mondigroup.com/en/about-mondi/where-we-operate/our-locations/europe/slovakia/mondi-scp/>

5.1.6. Advanced bio-based initiatives: demo and pilot plants and major innovation activities

Bioeconomy Cluster²⁰

Bioeconomy Cluster was established in 2015 as a networking of different stakeholders, in particular the members involve universities, research centres, advisory companies, small and medium sized enterprises in the sector of agriculture, food, paper industry, eco-construction, bio-polymers, etc. The main objective of the cluster is the practice and current preparation of practice with science and research.

Members²¹:

- PROUNION a.s.
- Projektové služby, s.r.o.
- Pivovar Trogár, s.r.o.
- Slovenská poľnohospodárska univerzita v Nitre
- Národné poľnohospodárske a potravinárske centrum
- Agroinštitút Nitra, štátny podnik
- KONDOR EU, s.r.o.
- KEĽO A SYNOVIA, s.r.o.
- KORO, s.r.o.
- FRUCTOP, s.r.o.
- Konopné družstvo
- BOONEX, s.r.o.
- Poľnohospodárske Družstvo BADÍN
- Agro Divízia Selice, s.r.o.
- Poľnohospodárske Družstvo Žemberovce
- AGB Group, s.r.o.
- PEDAL Consulting, s.r.o.

Hemp Cluster²²

International Hemp Cluster based in Slovakia is focused on the research and development of new and innovative hemp products. s. The main role of the cluster is to develop the hemp industry and its technologically oriented companies, to ensure the sustainable development of hemp-based production with high added and ecological value, all

²⁰ http://www.interreg-danube.eu/uploads/media/approved_project_output/0001/30/a319626f134bfa2747eab95550024252de5b37c0.pdf

²¹ <http://bioeconomy.sk/clenstvo/clenovia/>

²² http://www.interreg-danube.eu/uploads/media/approved_project_output/0001/30/a319626f134bfa2747eab95550024252de5b37c0.pdf

through strong and synergistic network of businesses and research institutes in Slovakia and neighbouring countries. Currently, the cluster is focused on the production of pressed boards and panels from hemp-shives (85-98% by volume) and recycled materials.²³

5.1.7. Future Biomass valorisation options

Based on the Enviral I generation, it is likely that in the near future the operators of this refinery will be interested in the construction of Refinery II generation. For this purpose, agro residuals biomass should be imported from 3 countries: western Slovakia, Czech Republic - South Moravia, and from northwest Hungary, as the Slovak production of agro residual biomass waste is insufficient.²⁴

Slovakia can produce 400,000 cubic meters of wood mass per year for the paper and pulp industry. With regard to wood biomass production and paper recycling, there is **a possibility for at least one more paper factory to be built.**

Slovakia has enough wood biomass to produce furniture and wood as a building material, with 10 million cubic meters cut per year, but growing up to an average of 14-15 million cubic meters a year, of which 4 million cubic meters are exported, and 2 million cubic meters are imported, **there is a potential to process more round wood in the country.**

5.2. Summary and conclusion in relation to SWOT elements

In terms of history, climatic conditions and geographical location Slovakia is a country with large rural areas where a part of the population has a relationship towards land and forest, and with a huge production potential in agricultural, forestry and water resources and a significant bio based economy and industry potential which could be used to develop sustainable and competitive production of food, feed, biomass and other biological raw materials. Permanent stimulation should be the main ambition for future sustainable development of bio-based industries based on the synergies of excellent science and principles of green economy, circular economy and the whole complex of bioeconomy

²³ IT Valley, AT+R (robotics & automation), Cassovia Life Science ChemREG, MDR, BIOSKOH o € 21 million BIC/BBI grant ! BIOSKOH project (ENERGOCHEMICA)

²⁴ <http://www.vupc.sk/sk>

development at national and regional level. **Slovakia has unfortunately not yet developed its own strategy for bioeconomy.** The country is involved in the BIOEAST initiative, which represents the Central and Eastern Europe initiatives for knowledge-based agriculture, aquaculture and forestry

The main SWOT analysis findings considering the bio-based industries, products and markets are summarised in table 20.

Table 20 SWOT analysis of bio-based industries, products and markets in Slovakia

<p>Strengths</p> <ul style="list-style-type: none"> Abundant biomass resources Availability of soil, forests and water resources, Long term tradition in paper and pulp production State of the art paper and pulp industry Tradition in wood processing and furniture production First generation Bioethanol production Second generation Bioethanol production under preparation 	<p>Weaknesses</p> <ul style="list-style-type: none"> Insufficient industrial capacities for agricultural products processing Lack of food processing industry Obsolete food processing technologies Lack of investment means Insufficient systems of subsidies for food processing Extreme high dependency on foreign food selling chains
<p>Opportunities</p> <ul style="list-style-type: none"> Large space for investments in food processing Possibilities for investments in furniture industry Opportunities in investments in pulp and paper industry Space for investments in biochemical production 	<p>Threats</p> <ul style="list-style-type: none"> Low interest of the government for bioeconomy development and high preferences for the automotive Insufficient subsidy system for bioeconomy development Absence of capital market Strong financial superiority of foreign competition Risk adversity of domestic entrepreneurs

6. Infrastructure, logistics and energy sector

6.1. Introduction

6.1.1. Existing industrial hubs and harbours

There are 3 Danube inland harbours in Slovakia accord with AGN (European agreement on main international traffic arteries) - Bratislava, Komárno and Štúrovo. In addition to Danube ports, there are two transshipment points on river Váh in Šaľa and on river Bodrog in Ladmovce.

Table 21 Water transport

Indicator	2013	2014	2015	2016	2017
Registered number of vessels in total as of Dec. 31	191	182	114	115	113
of which					
Cargo motor vessels	20	17	3	1	1
2 Tugboats	34	34	23	23	22
Boats	128	120	82	85	84
Passenger vessels	9	11	6	6	6
Transport of goods in total (thous. t)	1685,5	1694,4	1514,1	1519,2	1709,6
Performances in total (mill. tkm)	641,5	620,1	627,1	634,8	645,5
Average transport distance in freight transport (km)	360,6	366	414,2	417,9	377,6
Transported passengers in total	102 523	134 519	117 374	126 877	113 675
Performances in total (thous. pass. - km)	4539	10393	12469	7619	8683
Average transport distance of passenger transport (km)	44,3	77,3	106,2	60,1	76,4

Source: <https://www.mindop.sk/ministerstvo-1/doprava-3/vodna-doprava>

Bratislava Port

Bratislava port is the biggest and the most important in Slovakia. The port is located in the capital of Slovakia in Bratislava on the river Danube, be specific between 1 865 and 1867 rkm with the area 143 hectare. The transshipment points are divided into 8 parts. The port consists of 2 parts - winter harbour (the original part) and pool Pálenisko (the new part). The winter port is used as winter – housing of vessels, but also for transshipment activities. In term

of transhipped cargo is a universal harbour. Pálenisko serves as transshipment of petroleum products (petrol, diesel, light and heavy fuel oils and other derivatives). There is transshipment location for heavy and oversized shipments, horizontal transshipment (Ro-RO), intermodal transport terminal (container term), duty-free warehouse of bulk shipments, liquid cargo transshipment in this part of port. The construction of a new tri-modal terminal of intermodal transport is planned for the future. There is also a container terminal of intermodal transport in the port of Pálenisko. At present, the trains consist of regular combined transport of containers ISO A A and C between Bratislava and German ports on the North Sea coast. There are container bridge cranes with rotary cat or universal spreads with load capacity 36 or 32 tones. Loading operators can be performed in three layers on a reinforced concrete surface with a capacity of 3500 TEU. The Bratislava port is directly connected to rail, road and indirectly to M.R. Štefanik International Airport in Bratislava and to the Austrian airport Schwechat.

Table 22 Bratislava port

Transshipment of ferro materials	Artificial fertilizers, cement, agricultural products, grain, peas, sunflower seeds, coal, coke, iron ore, ore concentrates, gravel, stone and sand, scrap, construction materials,
Transshipment of bulk goods	Artificial fertilizers of different kinds, cement in bulk, agricultural products, grain, pease, sunflower seeds etc., mixtures, fodders, coal, coke, iron ore and ore concentrate, gravel, stone and sand, iron scrap, construction materials,
Transshipment of liquid cargoes	Gasoline, crude oil, light and heavy oils and other heavy oil derivates
Transshipments of overweight and over dimensional cargoes	All kinds of goods up to weight of 560-600 tones. The load limits are the diameter of 10m and the length of 60 m.
The RO-RO facility	Vehicles and goods, loaded on wheeled vehicles (saddle trailers, trailers, roll trailers and fork lifts) using horizontal method. Suitable for units up to 60 tons. Cars and goods are carried by specialized single- or more decker belonging to shipping companies

Source: <http://www.spap.sk/en/container-terminal>

Komárno Port

The port is located at 1766 - 1769 rkm. The port area is 54 hectares. The port is used for transshipment of bulk goods - forage, fertilizers and agricultural products. The port also allows the transshipment of bulk cargo, including intermodal transport cargo units. The port is connected by a railway siding to the railway network as well as to roads near the border crossing points to Hungary-

Table 23 Komárno port

Transshipment of bulk goods	Artificial fertilizers of different kinds, cement in bulk, agricultural products, grain, pease, sunflower seeds, etc., mixtures, fodders, coal, coke, iron ore and ore concentrate, gravel, stone and sand, iron scrap, construction materials (e.g. sinter)
Transshipment of general cargo	Steel semi-products, coils, plate sup to 25t/piece, different castings of non- ferrous metals, goods on pallets, in big- bags, soda, sugar, rice, wood and boards, marble blocks, etc.

Source: <http://www.spap.sk/en/port-bratislava>

Štúrovo port

Štúrovo port is located between 1767 - 1766 rkm. This port serves as an industrial transfer station. It is used for mooring vessels, unloading oil fuel oils, waste paper and loading paper products and semi-finished products.

In table 24. are illustrated industrial zones in Slovakia.

Table 24 Current industrial zones in Slovakia

Municipality	Town	area m ²	Municipality	Town	area m ²
Banskobystrický kraj			Nitriansky kraj		
	Banská Bystrica	364 000 m ²		Čab	741 300 m ²
	Detva PPS	29 517 m ²		Vráble	180 000 m ²
	Poltár - Jelšovany	257 500 m ²		Vlčany	205 525 m ²
	Malý Krtíš	234 134 m ²		Palárikovo	150 000 m ²
	Žarnovica	154 204 m ²		Nitra Sever	2 200 000 m ²
	Rimavská Sobota	100 000 m ²		Nitra Juh Dolné Krškany	30 000 m ²
	Krupina	220 000 m ²		Levice	650 000 m ² + 307 044 m ²
	Tornaľa	38 120 m ²		Diakovce	82 890 m ²
	Utekáč	32 976 m ²		Hurbanovo	150 000 m ²
	Viglaš	380 000 m ²	Trnavský kraj		32 762 336m ²
	Žarnovica - Pod Lipou	198 000 m ²		Dobrá voda	28 000 m ²
	Žarnovica - Pod Hrbom	516 000 m ²		Voderady (Zeleneč, Majcichov)	1 300 000 m ²
	Lučenec	62 000 m ²		Trnava	29 549 m ²
	Hnúšťa	64 000 m ²		Sereď - juh	2 3820693 m ²
	Filakovo	13 700 m ²		Sereď	363 761 m ²
	Detva	114 824 m ²		Skalica I	80 000 m ²
Prešovský kraj				Skalica II	520 000 m ²
	Bardejov	13 544,6 m ²		Sládkovičovo priemyselná zóna Juh	575 800 m ²
	Vranov nad Topľou - FeroVo	127 767 m ²		Sládkovičovo - priemyselná zón	770 000 m ²
	Stropkov	21 076 m ²		Senica	1 609 829 m ² + 140 000 m ²
	Svidník - Juh (Petrova dolina)	194 000 m ²		Piešťany	150 000 m ²
	Snina	4 707 m ²		Hlohovec	250 000 m ²

	Prešov - Záborské	246 376 m ²		Kostolné Kračany	3 000 000 m ²
	Poprad - Matejovce	90 886 m ²		Galanta	124 704 m ²
	Medzilaborce	46 865 m ²	Žilinský kraj		1 773 777 m ²
	Petrovany	85 312 m ²		Dolný Kubín	77 000 m ²
	Myslína	27 054 m ²		Sučany	60 000 m ²
	Lipany	101 305 m ²		Strečno	266 358 m ²
	Levoča	120 830 m ²		Nededza	20 419 m ²
	Kežmarok	176 000 m ²		Kysucké Nové Mesto	1 350 000 m ²
	Humenné	54 023 m ²	Trenčiansky kraj		1 857 007 m ²
Košický kraj		6 427 419 m ²		Myjava	144 677 m ²
	Gelnica	3 241 m ²		Prievidza	400 000 m ²
	Veľká Ida	300 298 m ²		Rudník	162 330 m ²
	Trebišov - Milhostov	90 600 m ²		Trenčín	1 150 000 m ²
	Jaklovce	31 300 m ²			
	Spišská Nová Ves - Drevárska 2	10 500 m ²			
	Spišská Nová Ves - Podskala	67 866 m ²			
	Sobrance – obec Bunkovce	733 673 m ²			
	Sobrance – obec Bunkovce	733 673 m ²			
	Kechnec	3 320 000 m ²			
	Kojšov	5 032 m ²			
	Košice IMMOPARK	975 000 m ²			
	Krompachy	20 236 m ²			
	Rožňava	136 000 m ²			

Source: https://www.priemyselneparkyslovenska.sk/pz_a_pp_06_2019_dat.pdf

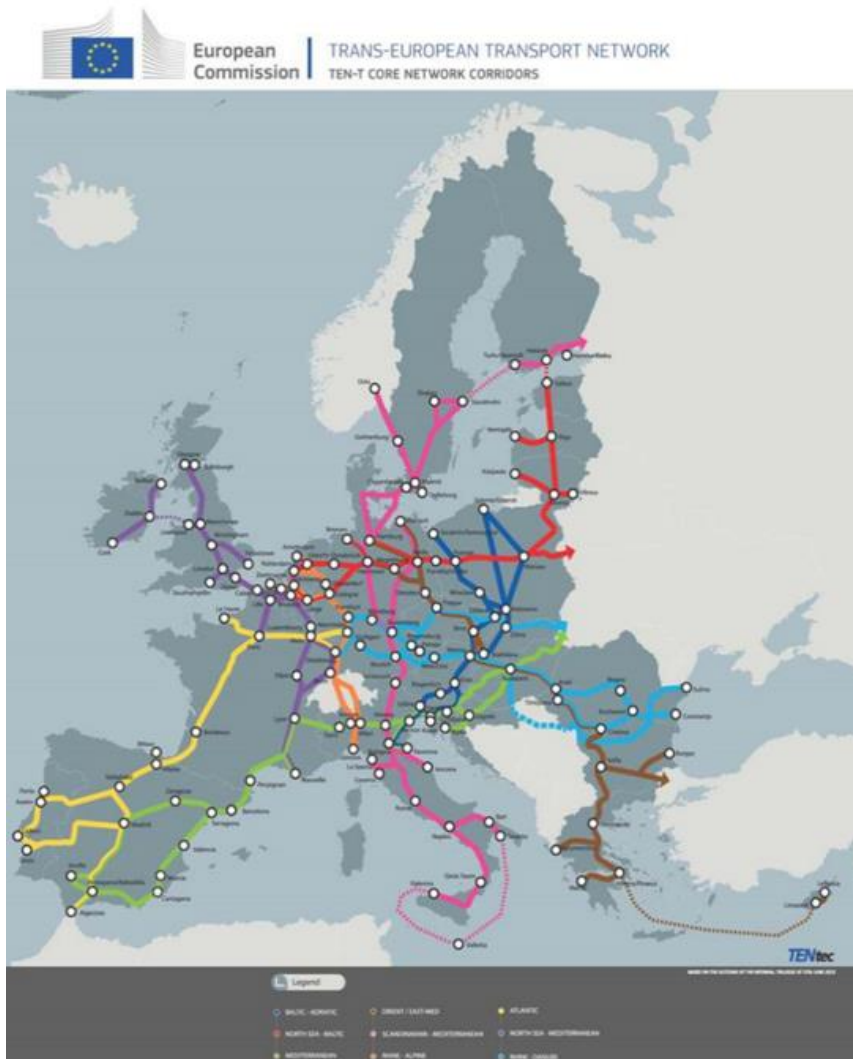
6.1.2. Existing roads, railways, water infrastructure

Transport in Slovakia is one of the most important part of the tertiary sector. Slovakia has a convenient geographical location - the centre of Europe, the crossroads of European trade routes. Slovakia is thus an important transit country, but development within transport is complicated for the mountainous surface, where road transport follows mountains that lengthen the road and make it more expensive, and there are few rivers for shipping

The total length of roads is 18 052 km.²⁵

The Trans-European Transport Network (TEN-T) is a network of road and rail corridors, international airports and waterways. The basic reason for its establishment was to improve the transport infrastructure in the international sphere. Figure 14 presents position of Slovakia in the Trans- European Transportation Network.

²⁵ <http://datacube.statistics.sk/#!/lang/en>



Source: https://www.researchgate.net/figure/Trans-European-Transport-Network-TEN-t-indicative-extension-to-the-Core-Network_fig1_313862204

Figure 14 Position of Slovakia in the Trans-European Transportation Network

There are three Trans-European corridors that cross the Slovakian rail network:

- Rhine-Danube Corridor, with two branches; one crossing the north area of the country between Czech Republic and Ukraine, via Žilina; and the southern branch from Vienna to Budapest via Bratislava.
- Baltic-Adriatic Corridor, between the Austrian and Polish borders, via Bratislava and Žilina.
- Orient / East Med Corridor, between the Czech and Hungarian borders, via Bratislava.

ZSR (Železnice Slovenskej Republiky) is the national Infrastructure Manager of Slovakia, with the main objective of managing and operating more than 3 600km of tracks

Water transport

In terms of transport natural watercourses with length of 250 km and artificial canals with length of 38.5 km are used in Slovakia. The port in Bratislava is in the middle of the waterway between the Black Sea and the North Sea. The port in Komárno connects roads, rail and shipping. The port Štúrovo is mainly used by company AssiDoman. The water transport is currently carried out on the Danube waterway, which connects the North Sea and Black sea. This connection was achieved by building the Danube-Mohan-Rhine Canal

Air transport

The advantage of air transport is a speed and a long-distance transport. In Slovakia there are 36 airports, the main airports are in Bratislava (the biggest), Piešťany, Žilina, Poprad, Košice and in Sliač. At present, the potential of airports in Slovakia is not fully exploited. Besides the airport in Bratislava, the Vienna airport, just 60 km far from Bratislava, is being frequently used.

6.1.3. Energy sector

Table 25 shows the Energy Sector in Slovakia. The value of Primary energy consumption is 3.1 toe/capita, which is comparable to the EU average. Energy dependency of Slovakia is 36.6%. The share of Renewable energy in the energy mix in Slovakia is 14%

Table 25 Energy sector in Slovakia

Category	Slovakia	EU average	Unit	Assessment	Similar countries
3. Energy					
Primary energy consumption	3,1	3.22	toe/capita (2012)	Medium	ES, FR, PL, SI, SK, ME
Energy dependence	36,6	55.4	%	Medium	
Renewable energy share	14	17.9	%	Medium	
GHG emissions	4	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					

Pipe line is highly efficient and cheapest sort of oil or gas transport. According to Slovenské elektrárne (Local electricity producing company), as much as 90% of electricity produced in Slovakia is generated without greenhouse gas emissions. That includes energy from nuclear, photovoltaic, hydroelectric and biomass sources. IEA states that in 2016, from total Slovak electric energy generation, 57% was generated in nuclear power plants, and 25% from renewables (biofuels and waste, hydro and solar).²⁶

Metal processing and electricity generation also consume two thirds of all fuel used in industry, the majority in the manufacturing of basic iron and steel and ferro-alloys. Over the past 10 years, the metal processing sector consumed almost half of the fuel used in industry, most of it in one factory (U.S. Steel Košice). Electricity production uses more than 15%. Finally, these two sectors are big emitters of air and greenhouse gas (GHG) emissions. Two

²⁶ http://www.sfpa.sk/wp-content/uploads/2018/01/Innovation-of-Energy-Sector-in-Slovakia_CEDE2017.pdf

companies US Steel and a coal powerplant Nováky are the top two emitters contributing respectively to 20% and 6% of all GHG in the economy. One of these companies, a steel company, is also by far the greatest emitter of particulates contributing to 50% of all emissions from industry; this is ten times more than the second greatest emitter.

The coal powerplant in Nováky should be closed in 2023, the last coal powerplant in Vojany should be transformed either to gas and biomass powerplant (wooden chips). This still to be decided. All Slovak powerplants will be CO₂ emission neutral because of the mix of nuclear, water, gas and photovoltaic powerplants.

The Slovak Republic does not have any official strategy towards innovation in the energy sector. The country's electricity generation is dominated by low-carbon sources and baseload is largely met by nuclear power and hydropower. The share of renewable energy has increased and, after the commissioning of two 470-megawatt (MW) nuclear units at the Mochovce plant in 2018-19, more than 80% of the Slovak Republic's electricity generation will be low carbon.²⁷ The Slovak Republic depends on imports for practically all of its crude oil and natural gas supply. Traditionally, these imports have come from a single supplier, the Russian Federation (hereafter, "Russia"). The Slovak Republic remains a large and reliable transit country for Russian gas to other EU countries. However, the annual gas transit has fallen from 80 billion cubic metres (bcm) to around 60 bcm as a result of the commissioning of the Nord Stream 1 pipeline. A growing industry is the main reason behind the growing energy consumption in Slovakia, especially electricity. Electricity consumption was 30.103.000 GWh in 2016 and the trend has been growing steadily.

In 2018, the electricity consumption of Slovakia similarly as in 2016 and 2017 was above the level of 30 TWh. In 2018, the volume of the consumed electricity was 30,947 GWh what means mild decrease compared to 2017 (-109.5 GWh, year-to-year index of 99.6%). The share of consumption of pump-fed hydroelectric power plants for re-pumping in the aforementioned consumption was 392 GWh (1.3% of the Slovak Republic consumption). From the year 2015, high share of the imported electricity in the consumption is obvious and this trend continued also in 2018. The share of import in the electricity consumption was increased to the value of 12.3% (in 2017 it was 9.8%). Since 2007, when the electricity system

²⁷ https://www.connaissancedesenergies.org/sites/default/files/pdf/actualites/energy_policies_of_jea_countries_slovak_republic_2018_review.pdf

of Slovakia became an import electricity system, the import volume and its share in the electricity consumption of Slovakia was the highest one.

Table 26 Electricity production and consumption in Slovakia

GWh	2017	2018
Nuclear power plants	15,081	14,843
Fossil-fuel power plants	5,711	5,893
Hydro-electric power plants	4,677	3,92
Renewable energy sources (see below)	2,445	2,399
Other	112	94
Production	28,026	27,149
Balance (Import +)	3,03	3,797
Consumption	31,056	30,947

Source: <http://datacube.statistics.sk/#!/lang/en>

The electricity production from renewable sources in 2018 was mostly from biomass (49.4%). Biogas and photovoltaic power plants participated by one fourth in the electricity production from renewable sources (24.9% and 24.4%). In the category of renewable sources significant decrease in electricity production from biogas (94.4%) was recorded. Mild decrease in production was recorded also by photovoltaic power plants (98.8%). Electricity production from biomass was on the same level (100.1%). In 2018, hydro-electric power plants produced the lowest electricity volume from 2004, their production against y. 2017 was significantly lower (83.8%). Slump in electricity production from water was caused by extreme draught in summer and autumn months.²⁸

²⁸ https://www.sepsas.sk/Dokumenty/VyročneSpravy/2019/SEPS_VS2018.pdf

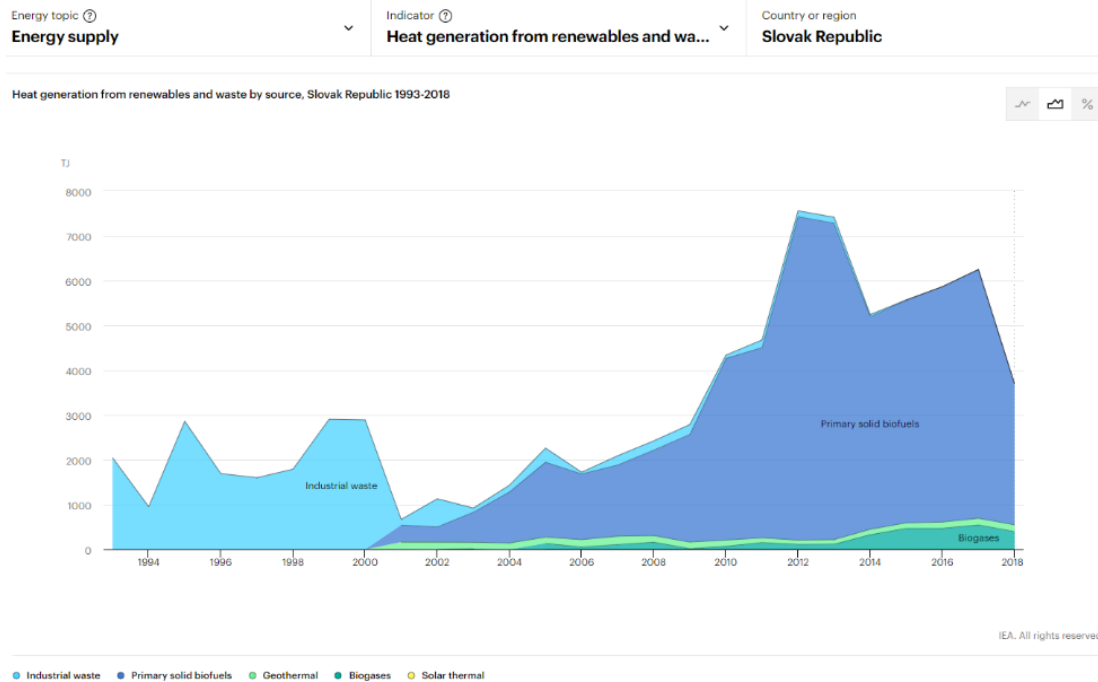
Table 27 Electricity flow

Slovakia in thousand tones	2008	2010	2015	2016	2017
Import of solid fossil fuels	6,064.000	5,064.000	4,317.000	4,244.000	4,665.000
Export of solid fuels	245.000	381.000	63.000	72.000	70.000
Import of oil and petroleum products	7,300.000	6,824.000	7,562.000	7,551.000	7,563.000
Export of oil and petroleum products	3,703.000	3,451.000	4,391.000	4,125.000	3,951.000
Import of natural gas	6,266.000	6,098.000	4,407.000	4,378.000	5,248.000
Export of natural gas	186.000	0	0	0	0
Import of biofuels	0	0	0	0	0
Export of biofuels	0	0	0	0	0
Import of electricity and derived heat	9,412.000	7,334.000	14,999.000	13,249.000	15,563.000
Export of electricity and derived heat	8,891.000	6,293.000	12,611.000	10,598.000	12,535.000

Source: <https://ec.europa.eu/eurostat/data/database>

Electricity production in Slovakia is ensured by several types of power plants. Slovenské elektrárne has 5,267.46 MW of installed capacity. More than half of the electricity in the Slovak Republic is from nuclear power plants, followed by hydroelectric, thermal and other (steam-gas, photovoltaic, solar, wind plant).

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



Source: <https://www.iea.org/data-and-statistics>

Figure 15 Heat generation from renewables and waste

Nuclear plants

In Slovakia there are power plants in Jaslovské Bohunice with an installed capacity of 2x 506 MW and in Mochovce with installed capacity of 2x 470 MW. Four reactors units, two at Bohunice and two in Mochovce supply more than half of the electricity consumed in Slovakia. Two more units in Mochovce are under construction and are expected to start in 2019 and 2020.

Thermal power plants

In 2018, the thermal power plants supplied around 5400 GWh of electricity. Here are two thermal power plants in Slovakia - the Nováky power plant with the output of 518 MW, which burns brown coal, fuel oil and biomass, and the Vojany power plant with the output of 1320 MW, which burns black coal, fuel oil, natural gas and biomass. The share of power stations producing carbon-free electricity should be increased.

Hydroelectric power plants

The two most important hydro power plants which are in Slovakia power system are Gabčíkovo HPP and Čierny Váh HPP. The most efficient power plants are PVE Čierny Váh

(735 MW) and Gabčíkovo Water Works (720 MW), while the Váh Cascade plays an irreplaceable role with 22 water works and an installed capacity of 1,515 MW. In addition to the system of large waterworks, a network of small hydroelectric power stations is being built, which mainly use smaller watercourses: Čierny Váh, Gabčíkovo, Liptovská Mara, Mikšová, Žilina, Nosice, Ružín, Považská Bystrica, Kráľová, Madunice, Lipovec, Sučany, Hričov, Nové mesto nad Váhom, Horná Streda, Kostolná, Krpelany, Čunovo, Dobšiná, Orava.

6.2. Summary and conclusions in relation to SWOT elements

Slovakia is a part of the Trans-European Transport Network (TEN-T). Its strategic geographical position is extremely favourable for supplying markets in Central and Eastern Europe. Two priority railway freight corridors cross Slovakia: the Baltic-Adriatic Corridor (RFC 5) and the Slovakia possesses of 3 626.441 km of railway tracks and approximately of 18 052 km of public roads.

According to Statistical Office of Republic of Slovakia, in 2018 the share of renewable energy sources was 4%. This amount of renewable energy was further composed of 49.4% of energy produced by biomass, biogas 24.9%, photovoltaic power 24.4%.

Table 28 summarises SWOT elements of Infrastructure, logistics and energy sector of Slovakia.

<p>Strengths</p> <p>Sufficient groundwater resources of high quality.</p> <p>Transported performances by rail increased.</p> <p>Vouchers to co-fund the installation of renewable energy technologies.</p> <p>Energy sector plays an important role in the Slovak economy, its share in gross value added is higher than the European average.</p> <p>In Slovakia already 90% of electricity generation is from renewable sources and nuclear installations with practically no GHG emissions</p> <p>The share of employment in the energy sector of Slovak republic is higher than the EU average.</p> <p>Telecommunications market bringing above- the-standard innovations</p> <p>International transport corridors - highways, expressways and I class roads</p> <p>Dense railway network</p>	<p>Weaknesses</p> <p>The surface of Slovakia is very mountainous, which makes it difficult to build a road network in some sections.</p> <p>Unsatisfactory technical and qualitative state of railway infrastructure.</p> <p>Low share of upper-class roads in total road length.</p> <p>Low level of capacity utilization of an existing set of intermodal transport terminals.</p> <p>One of the main barriers in further uptake and support of eco-innovation are ineffective policies and fragmented administrative framework.</p> <p>There is low investment into the ecology and eco-technologies, Innovators, Intellectual assets and attractive research systems develops slowly</p> <p>Slovakia lacks qualified human capacities in the area of eco-innovations.</p>
<p>Opportunities</p> <p>Strategic transport position.</p> <p>Interconnection of international airports Bratislava and Vienna by rail.</p> <p>Modernization of railway lines, completion of motorways build.</p> <p>Use of alternative approaches in the energy sector, introduction of a system for the use of secondary raw materials.</p> <p>Building interconnection points between transport modes - public intermodal transport terminals.</p> <p>Use of nuclear energy as a carbon-free source.</p> <p>Use of secondary energy sources.</p> <p>Reducing dependence on fossil fuel imports.</p> <p>Support for a science-based research base capable of producing innovations and commercially use.</p>	<p>Threats</p> <p>Low support for the use of alternative and renewable energy sources.</p> <p>Difficult to develop new renewable energy production in competition with relative cheap fossil gas coming from Russia.</p> <p>Own exports from the country have been decreasing in recent years by water transport.</p> <p>Decrease in the scale of transport on the railways and increase of negative effects of transport on the environment.</p> <p>Increasing costs of repair and maintenance of railway infrastructure and road infrastructure</p> <p>The long - term deficit of the TPS system.</p> <p>High electricity prices also affect the economy as a whole, because large customers also have a significant number of jobs and contribute to GDP. High prices also influence the investment attractiveness of Slovakia.</p> <p>High dependence on fossil fuels</p>

7. Skills, education, research and innovation potential

7.1. Introduction

7.1.1. Research Infrastructure

AgroBioTech

The AgroBioTech Research Centre (ABT RC) of the Slovak University of Agriculture in Nitra is a university-wide, specialized facility which performs concentrated innovative research in the relevant fields aimed at conducting new methods and procedures in research, especially within applied research, with the express goal of transferring its results into practice. ABT RC was established in 2015 under the project ITMS 26220220180 "Creation of the AgroBioTech Research Centre", the Research and Development operational programme, priority axis 2 Support to Research and Development, measure Knowledge and Technology Transfer from Research and Development into Practice. The ABT RC is equipped with state-of-the-art research infrastructure, thereby enabling the centre to conduct research at the highest level, applicable in practice, and consistent with the core needs of the priorities of agrobiological, the processing technology of agricultural products and the agro-food industry, biotechnology, genetic technologies, agroecology, bioenergetics and bio economy. Its mission is to act as a regional centre for applied research, integrating crucial research activities that will allow the centre to achieve a synergetic effect in using and enhancing the research potential of the Slovak University of Agriculture. The role of the AgroBioTech Research Centre is to carry out state-of-the-art research, and especially research with a direct impact on social practices, in order to create innovation, develop modern technologies and consulting services for the implementation of ABT RC research, and put development results into practice. The creation of the AgroBioTech RC became a stimulus for carrying out scientific research and development activities of the highest quality with excellent instrumental equipment in a collegial, interdisciplinary, and teamwork-based environment. The ABT RC is an open workplace. Its infrastructure, i.e. the equipment and personnel of the ABT RC, can be used

for research by different departments of the Slovak University of Agriculture as well as by other research and development institutions. As part of its activities, the AgroBioTech Research Centre of the Slovak University of Agriculture in Nitra focuses on these main fields: Agrobiology, Applied Ecology and Bioenergy, Bio economy, Biosystems Engineering, Biotechnics and Landscape Modelling, Food Technology and Biotechnology. The main mission of the ABT RC is to create new knowledge that is useful in both research and practice. Its outputs can be described as follows: Scientific outputs in different types of scientific publications, project activities, other outputs (patents, utility models, cooperation agreements).²⁹

National Forest Centre (NFC) Zvolen

NFC's aim is the development and promotion of sustainable forest management and its implementation in practice. NFC aims at providing forestry practice, forest owners and other stakeholders with new knowledge on forests and practical solutions enhancing stewardship of existing forest resources. NFC focuses on supporting the transfer of appropriate know-how to state and municipal authorities on forestry, nature conservation, environment, rural development and urban planning. Their goal is to provide fully-fledged services relevant to and supporting strategic priorities and interests of forestry.

Aims of NFC

- To assist national administration on forests in achieving its high-profile objectives.
- To take lead in development and promotion of sustainable management of national forest resources.
- To contribute to rural development through diversification of land based economic activities.

Objectives of NFC

- To provide high-quality services to stakeholders involved in forest and associated sectors.
- To ensure active and appropriate transfer of knowledge on forest ecosystems and their dynamics with respect to multiple needs of various stakeholders.

²⁹ <http://www.agrobiotech.sk/en/about-us/>

- To provide research, development and monitoring services meeting SK forestry needs.
- To support sectoral innovations.³⁰

National Forest Centre secures the tasks of forestry research development in all areas of forestry and nature environment bonded with forest ecosystems. The centre is directly involved in monitoring the forests health status and their ecosystems. The centre helps and ensures the realization of research results and the use of current scientific knowledge in forest management by state and non-state owners. The current direction of forestry research is based on European and world trends in research and development of the forest-wood complex.

National Agricultural and Food Centre

The National Agricultural and Food Centre consists of seven institutes:

- Soil Science and Conservation Research Institute
- Research Institute of Plant Production
- Research Institute for Animal Production Nitra
- Agroecology Research Institute
- Grassland and Mountain Agriculture Research Institute
- Food Research Institute
- Research Institute of Agricultural and Food Economics³¹

The National Agricultural and Food Centre focuses on comprehensive research and gathering of knowledge in the sustainable use and protection of natural resources, especially soil and water resources for crop production and animal husbandry, quality and safety, innovation and competitiveness of food and non-food products of agricultural origin, productive and non-productive impact of agriculture on the environment and rural development and the transfer of knowledge from agricultural and food research to end users.

³⁰ https://web.nlcsk.org/?page_id=5124

³¹ <http://www.nppc.sk/index.php/sk/>

Research Institute of Plant Production

At present, the research activity of the RIPP Piešťany in the field of technological research is primarily focused on the regulation of factors influencing the quantity and quality of crops of main, field and special crops; sustainable improvement and innovativeness of crop systems and technologies in crop production, including integrated, alternative and ecological forms; sustainable production of biomass and its uses for energy and non-food purposes; the greening and biologicalisation of crop production and research of the impact and consequences of climate change on the course of the crop production process and the possibility of adapting agriculture to these changes. The research activities of the Institute are primarily focused on cereals and oilseeds, followed by field fodder, legumes, grape vine, energy crops, medicinal and aromatic plants and some special crops.

Research Institute for Animal Production Nitra

The main purpose of the centre is finding scientific and research solutions of problems in the sphere of biology and breeding farm animals (cattle, pigs, sheep, goats, rabbits, game bred on the farms, poultry, fish, bees) perform goal oriented fundamental and applied research up to the verification of realization in the user's sphere.

Agroecology Research Institute

The Institute is involved in research and also in dissemination of novel scientific and technological information about farming systems and crop growing technologies on land from the viewpoints of economy, energy and ecology. The Institute fulfils social functions in advancements of agricultural scientific knowledge and education, in formation and conservation of the environment, in human health and nutrition. An information system is built, and other activities are performed within the complex of agricultural sector. Agricultural extension service is provided, and projects are designed specializing in the growing techniques for field crops, special and medicinal plants as well as in the utilization and reclamation of available agricultural land.

Food Research Institute

The main activity of the Institute is the research and development activities in the field of food chemistry, analytical chemistry, microbiology, molecular biology, genetics, food informatics and the whole complex of technologies including processes of hygiene and

sanitation for various branches of food industry. The principal activity of the institute is the solution of international and national projects focused on current issues of food quality and its safety. The institute supports transferring science into practice by consulting and expert activities.

Research Institute of Agriculture and Food Economics

The Institute is responsible for applied economic research in agriculture and food sectors, collecting and processing of knowledge generated in the field of basic economic research and in other related scientific disciplines. The institute provides sectoral economic analyses and surveys on agricultural products' economics. It is also monitoring the agro-food market situation. It conducts research on socio-economic issues of agriculture and rural areas. The Institute contributes to setting up governmental documents and strategies. Research teams of the Institute work on several projects on assessment of economic and social impacts of EU membership on agriculture and rural areas.

The Institute participates in international research projects and also cooperates with international institutions, such as FAO, OECD, DG AGRI and World Bank. The Institute was established back in 1919.

Pulp and Paper Research Institute Bratislava

Pulp

Research and development in the sphere of pulp production technology are oriented towards the reduction in the consumption of raw materials, chemicals and energy as well as towards a decrease of environmental impacts when producing the pulp.

Research and development of pulp bleaching technologies are oriented towards complying with the environmental regulation limits in compliance with legislation requirements as expressed by values of COD, TOC, BOD, colour and AOX in effluents as well as those of OX in pulp with regards to minimization of total production cost.

Research and development in the sphere of pulp production technology are oriented towards the reduction in the consumption of raw materials, chemicals and energy as well as towards a decrease of environmental impacts when producing the pulp.

Paper

Development of fibre processing technologies (virgin pulp, secondary fibres, TMP, CTMP, etc.) if manufacture of various kind of final products.

Improvement of properties of current paper products, development of new types, innovation and improvement of quality, Pilot plant verification of paper technology, raw materials and papermaking aids in the area of fibrous and non-fibrous, manufacture and surface treatment of paper, cardboard and board

Assessment of the processability of paper and final products. Pilot plant manufacture of special and tailor-made paper products (stickers, rollers, cut-outs, etc.), puzzles as required by the customer, water marked representative letter paper meeting customer's needs and paper with special fibres, letter writing paper, etc.) Surface treatment and converting papers and boards using pilot plant facility.³²

7.1.2. Education infrastructure

Slovak University of Agriculture in Nitra

Scientific research activity is one of the main activities of each university. It focuses on basic research, i.e. obtaining results for the development of knowledge, applied research as well as on effective linking of research activities with educational process and support of professional growth of employees.

Scientific research orientation of the SUA covers a wide range of agricultural, technical and social and economic sciences in the field of basic and applied research. Research is conducted mainly through research, educational and other projects focused on current issues in terms of regional and national perspective, respectively contribute to addressing the complex issues in a global context. The SUA scientific and research activities under the "Green University" label are made up of a mosaic of projects funded by national grant agencies, projects of international scientific and technological cooperation with partner institutions in the Czech Republic, Hungary, Poland, Bulgaria, Russia, France, but also China, South Africa, Syria, etc., but also of the challenges of the EU framework programmes.

³² <http://www.vupc.sk>

Science and research at the SUA in Nitra are associated with cognition of biological, technical, economic and social phenomena and laws, ensuring better utilization of the biological potential of plants and animals, production of safe food while protecting nature and the environment with respect to the transformation processes in society and the rural development. Regulatory mechanisms of the primary processes of production of biomass of agricultural and energy plant species are studied at experimental workplaces. Advanced molecular and biotechnological processes in the agro-food sector are specifically developed. Complex issues of maintaining agricultural biodiversity in changing environmental conditions and potential impacts of climate change in agriculture are addressed. Several departments of the university acquired the status of centres of excellence. Their modern infrastructure is co-funded by the mechanisms of EU Structural Funds. They create the space for new research projects and enable the production of quality outputs from research projects. Together with the established Centres of Excellence oriented on basic research in the field of biodiversity (ECOVA and ECOVA Plus), integrated river basin management (CoE for Integrated River Basin Management in changing environmental conditions) and protection and sustainability of the soil (CoE for White and Green Biotechnology). The SUA actively participates in the production growth potential of both agriculture and food processing industry, as well as in the development of the city of Nitra and other regions of Slovakia.

Newly established research centre AgroBioTech brings brand-new possibilities for scientific research at the university.³³

Technical University in Zvolen

The Technical University in Zvolen (also known as TUZVO) is a modern higher education institution providing education in all three levels of studies within the European Higher Education and Research Area. In the higher education system in Slovakia, the TUZVO has a unique specialization within a focus on the spheres of forest – wood – ecology – environment with an appropriate expansion in other technical, natural, security, economics as well as design spheres.

In the field of research, the TUZVO fulfils its mission by solving research projects and programmes of national and international character in seven research areas: agricultural

³³ <https://www.uniag.sk/en/science-and-research/>

and forestry sciences, construction engineering and technologies, ecology and environmental sciences, manufacturing sciences, economics and management, security services, design; as well as in other related and applied areas.

Furthermore, the TUZVO accomplishes its mission in six groups of study programmes: forestry, construction engineering, manufacturing technologies, ecology and environmental sciences, security services, economics and management, and design; with an emphasis on the second and third level of study programmes and also accreditation and implementation of study programmes in foreign languages. In the academic year 2017/2018, the TUZVO provides 37 bachelor study programmes, 35 master study programmes, and 34 PhD study programmes. The university study programmes can be studied full-time and part-time. In addition, the University offers different educational courses and studies as a part of the University of the Third Age.

The TUZVO is proud of its mission of a green university issuing from the traditions of the Mining Academy in Banská Štiavnica from 1762, one of the oldest universities focused on the technical and forestry fields in Europe and the world. The TUZVO together with some other universities in Central Europe preserve heritage of the Mining Academy in Banská Štiavnica. In 1762, it started its educational pilgrimage on the basis of the edict by Empress Maria Theresa of Habsburg. In 1770, the Mining Academy grew up to a higher education institution and by involving teaching forestry disciplines also to an institution of green higher education. Nowadays, the TUZVO meets the concepts of the green university by providing the modern research findings for consistent observing principles.

Scientific and research activity at TUZVO originates from fundamental directions of particular faculties and covers these areas "Forest – Wood – Ecology – Environment – Manufacturing and environmental technology – Renewable energy sources." The content of science and research of TUZVO in 2007-2013 was in accordance with "Long-term aim of state, science and technical policy of Slovakia".³⁴

³⁴ <https://www.tuzvo.sk/sk/poslanie>, <https://tuzvo.sk/sk/veda-vyskum-0>

7.1.3. Environment for start-ups

Start-up ecosystem in Slovakia is fast growing environment with several interesting events, competitions and boot camps, such as FutureNow conference coupled with the Start-up Awards or Central European Start-up Awards. Several organisations search for start-ups and provide them services, such as Neology Ventures or Crowdberry. State financing and investments is not developed (or very partially) there is only support through Slovak Business Agency.

Start-up scene is developed in Bratislava and in the second biggest city of Košice. There are various co-working spaces and labs open for start-ups.

In addition, entrepreneurial support institutions are:

- Regional development agencies
- Entrepreneurial centres
- Entrepreneurial incubators (more and more involved are student entrepreneurs' incubators)
- Technology parks
- Entrepreneurial education institutions
- Entrepreneurial accelerators

7.1.4. Public private partnerships

In Slovakia, PPP projects came to the forefront in 2002. In 2006, the government set the rules for PPP projects and expressed support for the creation of PPPs in the area of administration and creation of public goods and provision of public services. At the Ministry of Finance of the Slovak Republic, after 2006, a department of partner projects was established in charge of PPP issues. PPP projects are managed by the Ministry of Finance of the Slovak Republic. As part of its activities, the Department also provides consultations to the public sector and publishes various methodologies to help prepare PPP projects.³⁵ The ministry of transport and construction of Slovak Republic is an active user of PPP projects, currently it is in charge of the implementation of two PPP projects, namely concessions for the design, construction, financing, operation and maintenance of sections of expressway R1 and concessions for the design, construction, financing, operation and maintenance Rača and expressway R7

³⁵ <https://ppp-projekty.webnode.sk/ppp-na-slovensku>

Bratislava Prievoz – Holice.³⁶ Ministry of environment of the Slovak republic has not implemented any project in the form of a public-private partnership, nor does it plan to act as a partner in the PPP project in the future.³⁷

At the end of 2007, the PPP Association was established in the Slovak Republic to support public-private cooperation projects.³⁸

The list of public-private partnerships of the Slovak Republic can be found at: <https://www.mfsr.sk/sk/financie/ppp-projekty/zoznam-verejno-sukromnych-partnerstiev/>

The first PPP Bio based project was supposed to be the BIOSKOH bio-refinery, whose aim in the first phase was to use the industrial park in Košice for a second-generation bio-refinery with 55 thousand tons of ethanol per year. In the second phase, the capacity was to be expanded to 110 k tons, making it the largest bio-refinery in Europe.³⁹ It was supposed to be the first project in the territory of Slovakia, which was supported by the European Union within the framework of the Public Private Partnership (PPP) with the consortium Bio-based Industries. **After large PR activities the project was finally not implemented, the reason is probably no profit generation.**

³⁶ <https://www.mindop.sk/ministerstvo-1/ppp-projekty/ppp-projekty>

³⁷ <https://www.minzp.sk/ppp/>

³⁸ <http://www.asociaciappp.sk/>

³⁹ <https://euractiv.sk/section/regionalny-rozvoj/news/na-vychode-slovenska-ma-vyrast-najvacsia-2g-biorafinaria-v-europe/>

7.2. Summary and conclusions in relation to SWOT elements

The most relevant research/development infrastructure equipment, related to bio-based industrial development may be found at the:

- **AgroBioTech:** the research centre specialized facility which performs concentrated innovative research in the relevant fields aimed at conducting new methods and procedures in research, especially within applied research, with the express goal of transferring its results into practice
- **National Forest Centre:** development and promotion of sustainable forest management and its implementation in practice, it secures the tasks of forestry research development in all areas of forestry and nature environment bonded with forest ecosystems
- **National Agricultural and Food Centre:** focuses on comprehensive research and gathering of knowledge in the sustainable use and protection of natural resources, especially soil and water resources for crop production and animal husbandry, quality and safety, innovation and competitiveness of food and non-food products of agricultural origin, productive and non-productive impact of agriculture on the environment and rural development and the transfer of knowledge from agricultural and food research to end users
- **Research Institute of Plant production:** focused on the regulation of factors influencing the quantity and quality of crops of main, field and special crops; sustainable improvement and innovativeness of crop systems and technologies in crop production, including integrated, alternative and ecological forms; sustainable production of biomass and its uses for energy and non-food purposes; the greening and biologicalisation of crop production and research of the impact and consequences of climate change on the course of the crop production process and the possibility of adapting agriculture to these changes
- **Research Institute for Animal Production Nitra:** finding scientific and research solutions of problems in the sphere of biology and breeding farm animals, perform goal oriented fundamental and applied research up to the verification of realization in the user's sphere

- **Agroecology Research Institute:** is involved in research and also in dissemination of novel scientific and technological information about farming systems and crop growing technologies on land from the viewpoints of economy, energy and ecology.
- **Food Research Institute:** research and development activities in the field of food chemistry, analytical chemistry, microbiology, molecular biology, genetics, food informatics and the whole complex of technologies including processes of hygiene and sanitation for various branches of food industry
- **Research Institute of Agriculture and Food Economics:** The Institute is responsible for applied economic research in agriculture and food sectors, collecting and processing of knowledge generated in the field of basic economic research and in other related scientific disciplines.
- **Pulp and Paper Research Institute:** Research and development in the sphere of pulp production technology are oriented towards the reduction in the consumption of raw materials, chemicals and energy as well as towards a decrease of environmental impacts when producing the pulp.

Start-up ecosystem in Slovakia is fast growing environment with several interesting events, competitions and boot camps, such as FutureNow conference coupled with the Start-up Awards or Central European Start-up Awards. Several organisations search for start-ups and provide them services, such as Slovak Investment Holding (<https://www.sih.sk/>) or Crowdberry (<https://www.crowdberry.eu>). State financing and investments is not developed (or very partially) there is only support through Slovak Business Agency.

The main SWOT analysis of skills, education, research and innovation potential summarises table 29.

Table 29 summarises SWOT elements of skills, education, research and innovation potential

<p>Strengths</p> <p>Relatively high level of educated workforce.</p> <p>Relatively high proportion of secondary school educated workforce.</p> <p>Implementation of targeted requalification courses.</p> <p>Potential for growth of expertise and skills.</p> <p>An extensive network of adult education institutions.</p> <p>Interesting workshops organized by companies, during events at some universities, study fests.</p> <p>Possibilities for Erasmus programs, home and abroad internships.</p>	<p>Weaknesses</p> <p>Inefficient interconnection between educational system and labour market.</p> <p>Inadequate systems for forecasting changes in the qualification needs of the labour market.</p> <p>Absence of a coherent system of another/further education training.</p> <p>Absence of a model securing participation of social partners on organizations and professional education financing.</p> <p>Lack of information and advisory services on education and the labour market.</p> <p>The absence of a lifelong learning strategy.</p> <p>Insufficiently developed advisory services and business education services.</p> <p>No or poor collaboration between faculties and universities.</p> <p>Outdated educational systems, tools.</p>
<p>Opportunities</p> <p>Intensive cooperation of the school system and employment sphere to adapt the content and scope of education to the labour market requirements.</p> <p>AgroBioTech project – innovative project for building cutting-edge research infrastructure,</p> <p>Research and education activities of the Slovak Agriculture University of Nitra, Research activities at the Technical University in Zvolen</p> <p>Use of knowledge, experience and techniques of The National Agricultural and Food Centre (NPPC), Research Institute of Paper and Cellulose and The Forestry Research Institute</p>	<p>Threats</p> <p>Deepening the isolation of the education system from the needs of the labour market.</p> <p>Existence of almost 40 “universities” in a country of 5.4 mill. Inhabitants</p> <p>Reducing the quality of professional training and preparation for work.</p> <p>Teaching staff departure from education (mainly because of low salaries and lack of motivation).</p> <p>Deepening structural mismatches in demand and job offers.</p> <p>Negative development in the application of school graduates and other population groups.</p> <p>Departure of students and people with higher education to more economically advanced areas of Europe.</p>

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

8.1. Introduction

Slovakia does not have a strategy for the purpose of fostering bio-economy, however there are regulations, developmental goals and priorities that are encompassed in the nation strategy.

Important legislation Forest:

- Act No. 355/2019 Coll. on Forests.
- Act No. 356/2019 Coll. on Nature and Land Protection.
- Act No. 113/2018 Coll. on Placing Timber on the Market.
 - The law came into effect of 01. July 2018.
 - It implements regulations EUTR, FLEGT in Slovakia.
 - Act implements rights and obligations of:
 - operators who place wood and timber products on the internal market, traders of timber, transporters of timber, monitoring organisations, importers with FLEGT licence, competency of state administration bodies.
 - Violation of law related to placing timber and timber product on the market, Penalty.
- Decree No. 232/2006 on Timber Harvesting, Labelling of Harvested Timber and Documents of Origin of Timber.
- Act No. 97/2013 Coll. on Land Associations.
- Decree No. 24/2003 on Nature and Land Protection.
- Emissions from stationary sources constitute a regulated trade, The person wishing to conduct the activity must obtain a certificate of trade authorisation issued by the relevant District office, acting as the Point of Single Contact (PSC), according to the place of residence of a natural person, registered office of a legal person, the address of a place of business of a foreign person's undertaking or the address of a place of business of an organisational unit of a foreign person's undertaking, based on a trade notification.

Important legislation Agriculture:

- Rural Development in Slovakia is managed nationally through one Rural Development Programme (RDP), funded under the European Agricultural Fund for Rural Development (EAFRD) and national contributions. The RDP sets out priority approaches and actions to meet the needs of the specific geographical area it covers. Rural development funding through the EAFRD is part of a broader framework of European Structural and Investment Funds (ESI Funds), including also Regional Development, Social, Cohesion, and Fisheries Funds. These are managed nationally, by each EU Member State, on the basis of Partnership Agreements, strategic plans outlining the country's goals and investment priorities.
- Slovakia adopted a support scheme for green energy via the so-called feed-in tariffs. In 2018, the Economy Ministry prepared an extensive revision of the Act on Support for Renewable Energy Sources (RES) and Highly Efficient Cogeneration (CHP), which the parliament adopted on October 17. It became effective on January 1, 2019, while some of its provisions will become effective as of 2020 or 2021.
- Income Tax Act. 595/2003.
- Subsidy II (Operational Programme Bratislava Region) - Measure 2.1. "Innovation and technology transfer" (Opatrenie 2.1 Inovácie a technologické transfery) is a sub-programme of the Operational Programme Bratislava Region, which awards grants to projects in the field of renewable energy. Slovakia | country profile Energy support 2005-2012 2 Grants are awarded through calls for applications under either the de minimis scheme (Scheme DM 13/2008) or the state aid scheme (Scheme ŠP 01/2009). During 2012, there are no calls for applications planned for Measure 2.1. The Operational Programme ends in 2013.
- Tax regulation mechanisms (exemption from excise tax) - In Slovakia, the consumption of electricity is subject to an excise tax (§ 1 Act No. 609/2007). The use of renewable energy is encouraged by exempting it from this tax (§ 7 par. 1 Act No. 609/2007).
- Subsidy II (Programme for the Higher Use of Biomass and Solar Energy in Households) - Investment support for the use of solar energy and biomass for heating and hot water for apartments and houses is available for individuals in the form of subsidies for biomass boilers and solar thermal systems. The scheme was optimised through the

approval of a new law, Act No 181/2011 on the provision of subsidies within the competence of the Ministry of Economy of the Slovakia.

- Biofuel quota - There is a target for biofuels, determined as the biofuel energy content share calculated from the energy content of the total quantity of petrol and diesel fuel placed in the market. There are also targets for the minimum content of biofuels in each litter of a particular type of fuel (diesel and petrol). The minimum content of biofuels for the years 2011 to 2020 is established in Annex 1 to RES Act.
- Tax regulation mechanism - Since 2011, the support of fuel from renewable energy sources has taken the form of a reduced rate of excise duty on diesel or petrol provided that it contains the minimum proportion of biofuels set for diesel and petrol. Mineral oil solely from biogenic material is exempt from mineral oil tax (§ 10 par. 3 Act No. 98/2004).

Important legislation waste:

- Act No. 79/2015
 - Implementation of provisions on boat recycling, adjustment of the procedures on illegally placed waste,, changes of the special purpose financial reserve, cancellation of the agreement obligation between the packaging producer fulfilling his individual obligations and respective coordination centre, introduction of collection targets for separated collection of the municipal waste components – packaging waste and waste from non-packaging products in the municipalities in Slovakia.
- Act No. 587/2015 - Act on the Environmental Fund and on amendments to certain laws

Important legislation Biofuels, bio liquids and biomass:

- Act No. 309/2009 on Support of Renewable Energy Sources and High Efficiency CHP. The Act addresses the basic roles and responsibilities of competent authorities and economic operators in demonstrating compliance with sustainability criteria in the production of biofuels and bio liquids, as well as the obligations of economic operators to reduce greenhouse gas emissions during the life cycle of motor fuels.

- At the end of 2018 entered into force REGULATION (EU) 2018/1999 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2018 on the Governance of the Energy Union and Climate Action.
- As well as DIRECTIVE (EU) 2018/2001 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2018 on the promotion of the use of energy from renewable sources (recast).
- State aid SA.49509 (2017 / N) - Slovakia - Tax advantage for biofuels.
- Forestry act 326/2005 Z. z. amendment valid from 1.1.2019.
- Act No. 543/2002 Coll. on Nature and Landscape Protection.
- Act 478/2002 Coll. on Air Protection.

8.2. Summary and conclusions in relation to SWOT elements

Bio economy is not the central topic of any specific Slovakian framework or policy. There are, however, several national and EU frameworks that touch on the topic of bio economy: Transition signpost towards a green economy (emphasises the opportunities Slovakia has to transition into a circular economy, mostly pertaining to agriculture and forest-wood chains) and the Rural Development Program (mentions the conventional use of agricultural and forest biomass, as well as energy production). There are also some far more general support frameworks for bio economy: Sustainable urban strategies of municipalities and the Government framework program for the transition to a green economy.

Following table 30 summarises SWOT elements of Bio economy Policy Framework of Slovakia

Table 30: SWOT analysis of Bioeconomy Policy Framework of Slovakia

<p>Strengths</p> <p>The measures that are present are specific targeted bio economy development.</p> <p>Mentioning bio economy in policies of agriculture etc. is progress, because it shows the understanding that these sectors play a role in Slovakia's transition into a circular economy.</p> <p>There is a growing awareness that structural changes in policies are needed for the development of bio economy</p>	<p>Weaknesses</p> <p>No explicit legislative bio economy support and stimulation, only measures that contribute to bio economy development.</p> <p>There is no strategy for bio economy development in Slovakia</p> <p>Most measures rely on voluntary pledges from the private sector.</p> <p>Limited resources for possible measure implementation.</p> <p>A lack of a circular agricultural policy.</p> <p>A lack of financial incentive/subsidies to foster bio economy development.</p>
<p>Opportunities</p> <p>Future policies should focus on clusters: pairing innovation centres with industry and state.</p> <p>Policies for improved biomass managing, increase in the use of forest wood and stimulation of the use of recognized certificates.</p> <p>Removing administrative issues, e.g. via voucher schemes (proposed in Poly4Eml, 2014</p>	<p>Threats</p> <p>No new and bio economy-specific policies and legislation (status quo).</p> <p>Ignoring of the raising awareness of the need for structural change in policy.</p> <p>Continuous relying on voluntary pledges from companies.</p> <p>Slovak governments underestimate the meaning of bio economy for the economic, social and environmental development of the state</p>

9. Financing

9.1. Introduction

Financing is an essential prerequisite for setting up biobased initiatives. Therefore, financial institutions

Financing is an essential prerequisite for setting up bio-based 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 bio-based strategy and policies. These factors can stimulate the growth of local initiatives or attract external companies. Often banks, investors and insurances provide support the initiation of bio-based initiatives.

The EU's rural development policy helps the rural areas of the EU to meet the wide range of economic, environmental and social challenges of the 21st century. Frequently called "the second pillar" of the Common Agricultural Policy (CAP), it complements the system of direct payments to farmers and measures to manage agricultural The EU's rural development policy is funded through the European Agricultural Fund for Rural Development (EAFRD) worth €100 billion from 2014-2020, with each EU country receiving a financial allocation for the 7-year period. This will leverage a further €61 billion of public funding in the Member States. There are 118 different rural development programs (RDP) in the 28 Member States for this period, with 20 single national programs and 8 Member States opting to have two or more (regional) programs.

Ministry of Agriculture and Rural Development of the Slovak Republic

Ministry of Agriculture and Rural Development of the Slovak Republic is representative decision maker in all areas connected to agro-bio sector in Slovakia. Ministry is providing following support to local subjects:

National support

These are subsidies provided in accordance with the Decree of the Ministry of Agriculture and Rural Development of the Slovak Republic of 5 May 2011 no. 536/2011 - 100 on details in the granting of support for agriculture and rural development.

State aid

State aid in the agriculture sector is granted to businesses active in primary agricultural production, food processing, forestry and fisheries.

Aid in agriculture is granted as (more):

- State aid - any aid, in whatever form, provided by the provider, directly or indirectly from the state budget, for or in business.
- Minimum aid (de minimis aid) - which shall not exceed EUR 15 000 per undertaking active in the agricultural production sector, EUR 200 000 in the processing, marketing and forestry sector and EUR 30 000 over any period of three fiscal years in the fisheries sector.

Direct support

Slovak farmers can annually apply for direct support (direct payments and selected measures of the rural development program), which are paid from the state budget of the SR and refunded from the EU budget, transitional national payments are paid from the State Budget of the SR.

Rural Development Program of the SR 2014 - 2020

The Rural Development Program of the SR 2014-2020 (RDP 2014-2020) focuses on six main areas: support for knowledge transfer and innovation, increase of viability and competitiveness, innovative technologies and sustainable management, support for organization, processing, animal welfare and management risks, restoring, preserving and strengthening ecosystems, promoting resource and climate efficiency and promoting social inclusion, poverty reduction and economic development.

Operational Program Fisheries 2014-2020

The global objective of the OPRH is to support the sustainable and competitive development of the aquaculture and fish processing sector through the use of innovations in terms of resource efficiency, environmental protection and compliance with CFP rules.

Integrated Regional Operational Program 2014-2020

The objective of the Integrated Regional Operational Program (IROP) is to contribute to improving the quality of life and to ensuring the sustainable provision of public services to regions, cities and municipalities.

Cross-border cooperation programs 2014-2020

The cooperation programs are the result of a concerted effort by all participating countries to facilitate the financing of activities that will lead to increased cooperation between regions with a common inter-state border.

Regional Operational Program

The main objective of the operational program is to increase the availability and quality of civic infrastructure and facilities in the regions. Projects submitted on the basis of calls are co-financed from the European Regional Development Fund and the state budget of the Slovak Republic. ROP projects are funded by providing a non-repayable financial contribution, the maximum amount of which is 95% of the total eligible project costs.

Operational Program Bratislava Region

The global objective of the Operational Program is to strengthen the region's competitiveness by developing a knowledge-based economy and building an attractive region for life. One of the priorities of the Operational Program is the possibility of development of the informatization of society in the territory of the Bratislava self-governing region.

Ministry of Economy of the Slovak Republic

Green to Household Project II (2019 - 2023)

National project Green to households II is aimed at supporting the installation of small appliances for the use of renewable energy sources in households, which are used for residential purposes. Small equipment for electricity production is equipment with output up to 10 kW. In heat generation, a small device is a device that covers the energy consumption of a building. The project is implemented in the whole territory of the Slovak Republic with the exception of the Bratislava self-governing region. The main communication tool is the website www.zelenadomacnostiam.sk.

The subject of support for the installation of small RES installations is to provide a financial contribution for the installation of RES or electricity generation facilities, which are:

- Photovoltaic panels (electricity generation);
- Wind turbines (electricity generation);
- Solar collectors (heat generation);
- Biomass boilers (heat generation);
- Heat pumps (heat production).

The Ministry of the Environment of the Slovak Republic

Operational Program Environment Quality

The Ministry of the Environment of the Slovak Republic is the Managing Authority for the Operational Program Environment Quality in the programming period 2014 - 2020 in Slovakia.

LIFE Program

LIFE is a Community program of the European Commission and EU Member States for the environment and climate protection.

The Ministry of Education, Science, Research and Sport of the Slovak Republic

The Ministry of Education, Science, Research and Sport of the Slovak Republic is the central body of the state administration of the Slovak Republic for elementary, secondary and higher education, educational facilities, lifelong learning, science and for the state's support for sports and youth.

The Operational Program Research and Innovation

The Operational Program Research and Innovation (OP R&I) is based on the Europe 2020 priorities as well as the main recommendations of the Small Business Act and the Entrepreneurship 2020 Action Plan. Its focus, structure and content of activities is directly based on the analysis of needs and development potential as well as expected results defined in the Partnership Agreement of the Slovak Republic for 2014-2020. National Reform Program of the Slovak Republic. The OP RDI is a key implementation tool of the Strategy "Knowledge for Prosperity - Research and Innovation Strategy for the Smart Specialization of the Slovak Republic" ("RIS3 SK").

9.2. Summary and conclusion to SWOT elements

Slovakia has a great potential for fostering bio economy, but the realization of this potential ultimately depends on the financing. The present output of the bioeconomy in Slovakia is above 11 billion €. (Ministry of agriculture, 2016). In the case of proper investments, it and efficient public and private management it could reach 25 billions in the coming decade and thus reach the level of the present output of the automotive industry, the most robust sector in present Slovakia.

Table 31 summarises SWOT elements of Financing of bioeconomy of Slovakia:

Table 31: SWOT analysis of Bioeconomy Financing of Slovakia

<p>Strengths</p> <p>The financial resources for bio economy development in Slovakia can be generated by public and private means</p> <p>Slovakia is one of ESIF funds largest beneficiaries</p> <p>ESIF funds help to mobilise private investment.</p> <p>Private sector investment</p>	<p>Weaknesses</p> <p>Financial constraints are limiting the wider use of modern technologies</p> <p>Lack of funds for investment in technologies from wood biomass.</p> <p>Lower biomass state subsidies than the former countries of the EU15 and lack of subsidies in general.</p> <p>Financial barriers: Low access to finance and low level of synergies in public-private funds and investments.</p> <p>Low added value generation in the domestic bio sectors, exception is the paper and pulp industry</p>
<p>Opportunities</p> <p>New government coming from elections in 2020 may have better attitude and show interest in the bio economy sector.</p> <p>Assumptions for the development and stabilization of food and processing industry and other bioeconomy sectors in Slovakia.</p> <p>Nitra regional government as a member of the Power4Bio project which aims at increasing the capacity of regional and local policy makers and stakeholders to structure their bio economy and to support the emergence of a thriving bio-based sector.</p>	<p>Threats</p> <p>Lack of funds for the implementation of development activities in forestry, wood processing, agriculture, food processing, pulp and paper industry, bio energy and other related sectors.</p> <p>Lack of interest of ministries in the development of a viable strategy for the development of the production and use wood biomass fuel.</p> <p>Insufficient grant, equity and loans means for bio-based initiatives.</p> <p>Overwhelming export of raw materials, e.g. cereals over the export of domestic bio-based products.</p>

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