



CELEBio

D4.4 NATIONAL BIOECONOMY DOSSIER: SLOVAKIA

DR. ŠTEFAN VRÁTNY, ING. PETER KOPKÁŠ,
PHD., ING. DOMINIKA JENDRUŠOVÁ, ING.
JANA GULAN, ŠTEFAN VRÁTNY
BIC BRATISLAVA

SCIENTIFIC COORDINATION:
B. ELBERSEN, WUR
C PANOUTSOU, IC

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BIC Bratislava
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| Author(s) | Dr. Štefan Vrátny, Ing. Peter kopkáš, PhD., Ing. Dominika Jendrušová, Ing. Jana Gulan, Štefan Vrátny |
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| Publishable executive summary in English | <p>Technical reports produced in WP2 and WP3 have been edited to be used as dissemination materials to the benefit of Bioeconomy stakeholders and potential investors, highlighting the strengths of the Target Countries.</p> <p>Six specific dossiers have been prepared for each Target Country, each of them including: (Part A) an updated assessment of sustainable biomass potentials, including techno-economic information regarding infrastructures logistics and relevant costs, as well as an overview of the legislative provisions; (Part B) an exhaustive map (listing of relevant stakeholders; (Part C) presentation of a set of value chains and time-based guidelines for the development of a national Action Plan proposing concrete measures to foster investments in the Bioeconomy basing on different development scenarios.</p> |
| Publishable executive summary in national language | <p>Technické správy vypracované vo WP2 a WP3 boli upravené tak, aby sa mohli používať ako materiály na šírenie v prospech zainteresovaných strán v oblasti biohospodárstva a potenciálnych investorov, zdôrazňujúc silné stránky cieľových krajín.</p> <p>Pre každú cieľovú krajinu bolo pripravených šesť konkrétnych dokumentácií, z ktorých každá obsahuje: (časť A) vrátane technicko-ekonomických informácií o logistike, infraštruktúre a príslušných nákladoch, ako aj prehľad právnych ustanovení; (Časť B) Podrobný zoznam relevantných zainteresovaných strán; (časť C) prezentácia súboru hodnotových reťazcov a časovo založených usmernení pre vypracovanie národného akčného plánu, ktorý navrhuje konkrétne opatrenia na podporu investícií do biohospodárstva na základe rôznych scenárov.</p> |

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Summary

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.

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.

Part A of this comprehensive 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. ¹ It aims to provide the

¹ 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



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

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.

Summary of Part C: Slovakia does not have a strategy for bioeconomy, however there are regulations, developmental goals and priorities that are encompassed in the national strategy. The country is involved in the BIOEAST initiative, which represents the Central and Eastern Europe initiatives for knowledge-based agriculture, aquaculture and forestry.

Key issues identified by stakeholders for the development of bioeconomy in Slovakia include:

- Availability of local resources
- Availability of working force
- Availability of necessary of knowhow
- Lack of government support
- Lack of investments
- Insufficient subsidies in the agriculture- direct farming

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.

Potential environmental impacts of the Croatian Bioeconomy Action Plan



Reduce emissions in food industry by 25%
Reduce emissions in agriculture by 30%



Contribute to the sustainable management of natural resources and foster efficient water use. Support a circular and sustainable bioeconomy in Europe.



Biodiversity



Local resources for products, energy and fuels

Potential socio-economic impacts of the Croatian Bioeconomy Action Plan



Create 1,000 new jobs in agriculture, forestry and food processing industry



Leverage 50 million € private investments within ten years



Cluster creation. At least ten new collaborations between raw material providers and industrial actors



Eight new biobased value chains embedded in agriculture, food, and forest industries. Produce ten new patents and IP rights, Support the creation of ten spin-offs and start-ups.



PART A

SUSTAINABLE BIOMASS AVAILABILITY AND SUPPLY IN SLOVAKIA

1. Sustainable Biomass Availability in Slovakia

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. Short characterisation of the country

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).

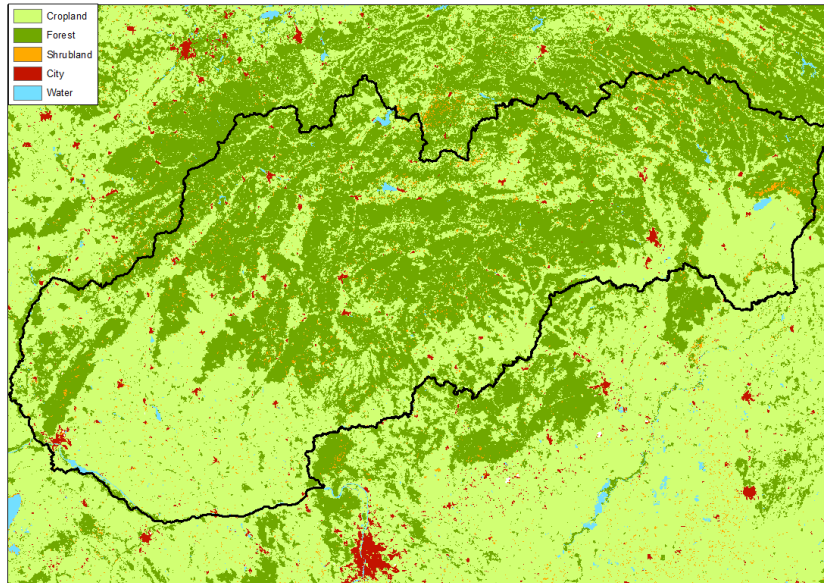


Figure 1: Main land cover distribution over Slovakia

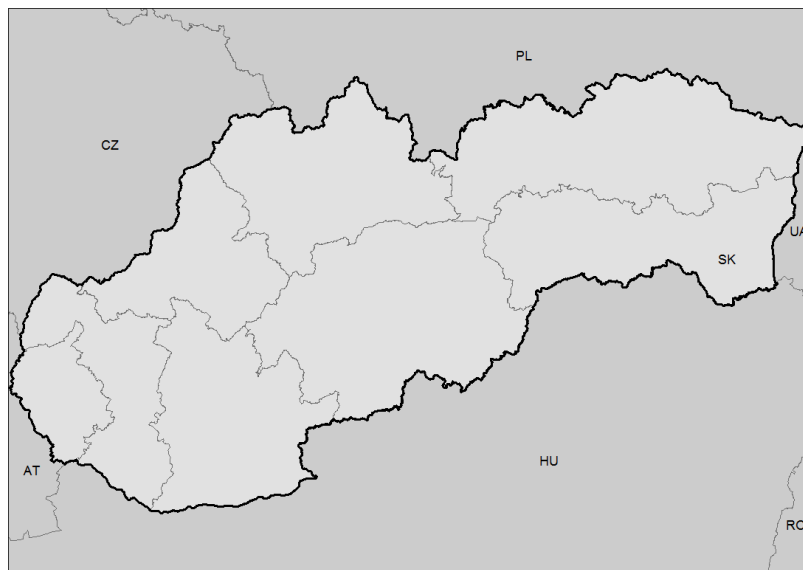
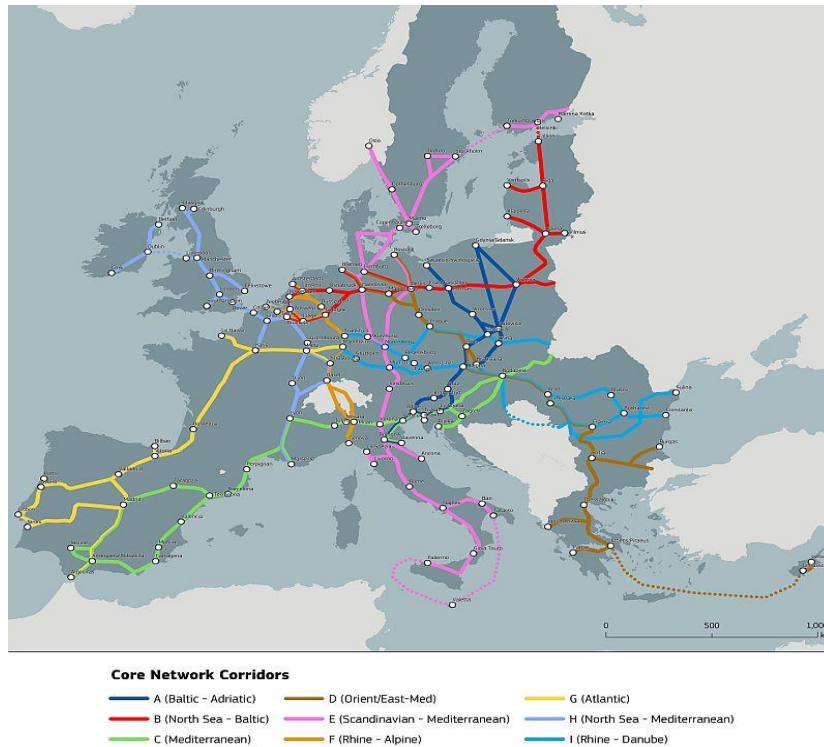


Figure 2: Slovakia and its bordering countries

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 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.

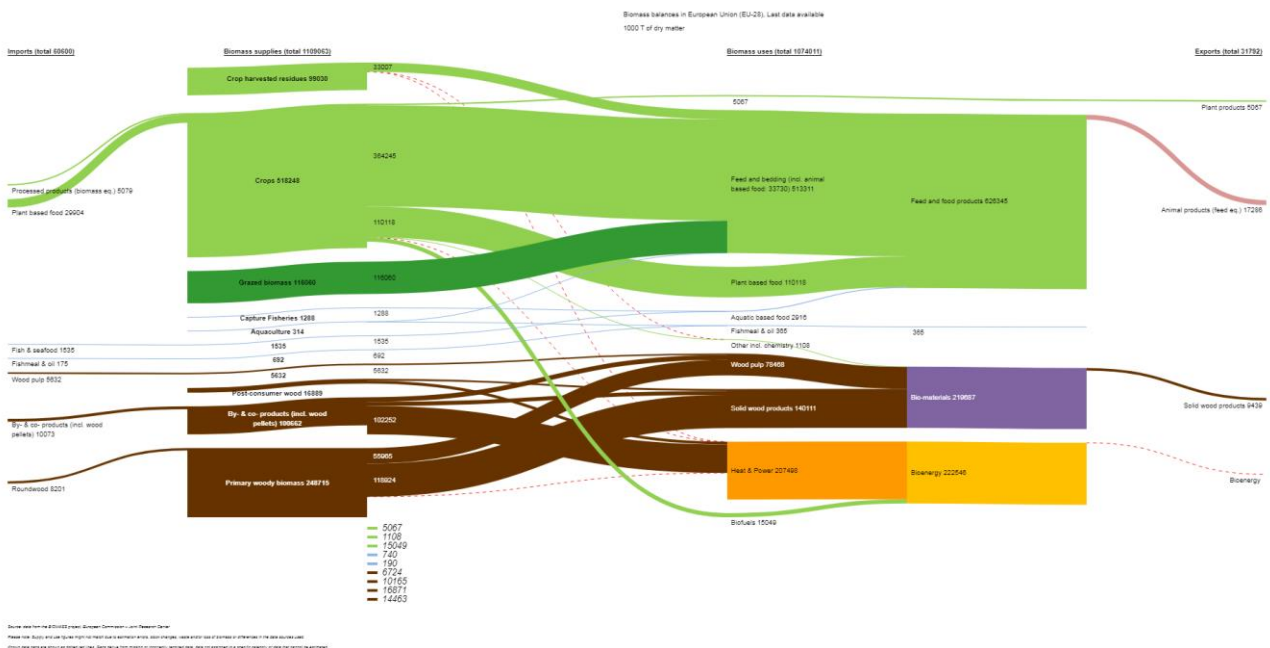
This project received funding from the BBI JU under the EU Horizon 2020 research and innovation programme under grant agreement No.838087



Source: https://www.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.



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

Figure 4: Biomass flows in Slovakia

Explanation of Sankey diagram (Errore. L'origine riferimento non è stata trovata.):

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 Ktonnes 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 farmer's 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.

2.2. Characterisation of current agricultural sector

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

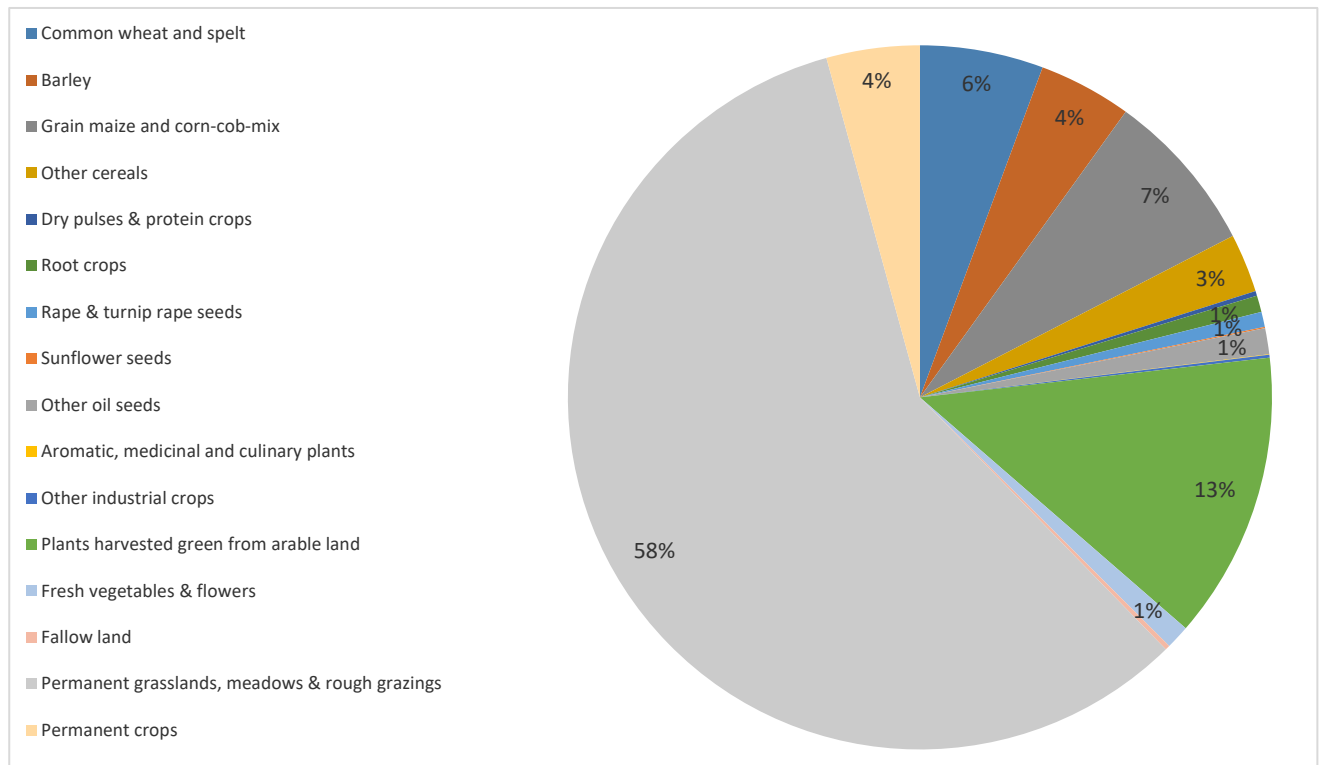
Table 2: Key characteristics for the agricultural sector in Slovakia

| 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>)

2.3. 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).



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

Figure 5: Main crops and land uses in Slovakia

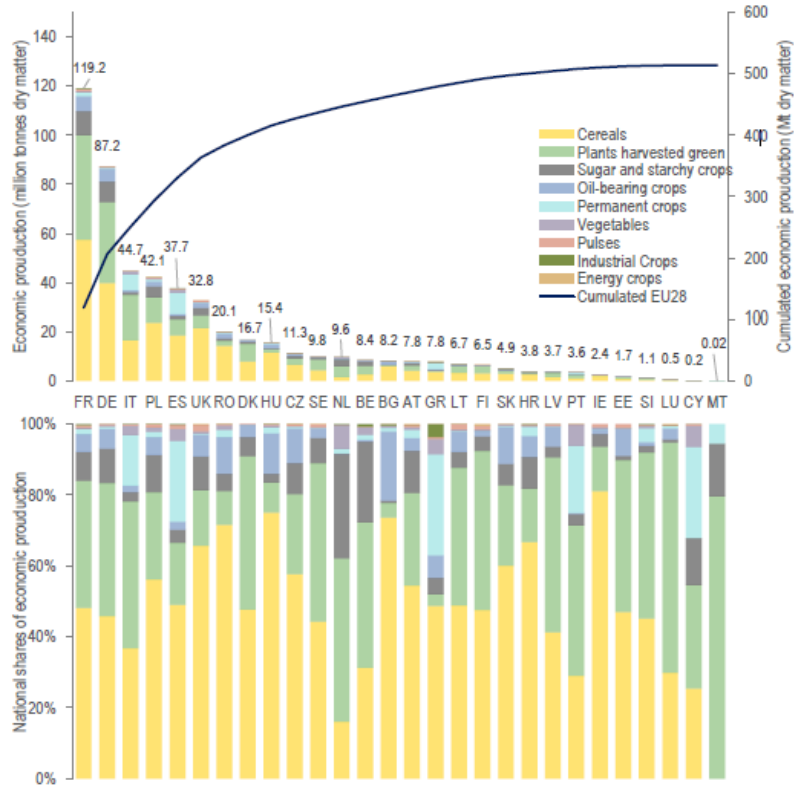
Growing crops heavily depends on the market economy, CAP payments and climatic conditions in a given year. The arable land is used mainly for growing cereals (60 % of the territory) like wheat, barley, corn and then potatoes. 20% of the area is used for forage, and most of the rest for oil crops.

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.

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

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

2.3.1. Arable crops

Cereals, especially winter wheat is grown on the acreage of 350 – 660 thousand ha.² 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 2017.³ Cereals are mainly used for the production of grain (including seed) which accounted for 3 996, 58 (1000 t) by 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.

² <http://www.fao.org/3/i/i1500e/Slovakia.pdf>

³ <https://knoema.com/atlas/Slovakia/Cereal-production>

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.⁴

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.

2.3.2. 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 registered more than 12 million fruit trees and bushes with harvest exceeding 38 000 tons in Slovakia in 2017.⁵

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% |

⁴ <https://www.mpsr.sk/en/index.php?navID=25>

⁵ www.sme.sk

| | | |
|---------------------|---------|-----|
| Permanent grassland | 858 601 | 36% |
|---------------------|---------|-----|

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

2.3.3. 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%.⁶

The production of beef and milk has also been declining in the long-term decline, from 1600 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).**

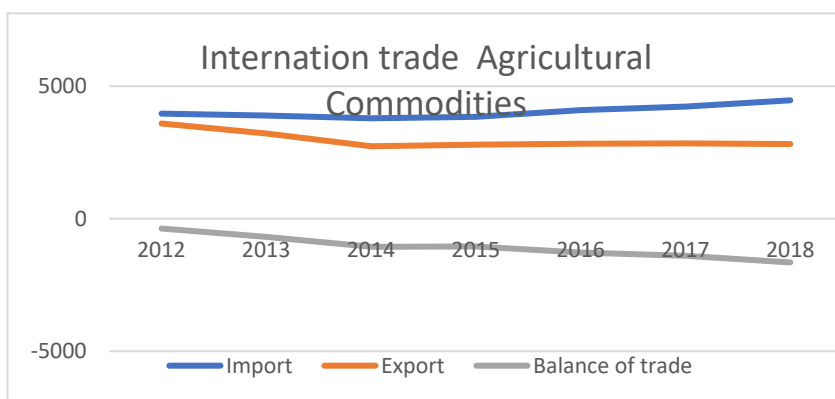
Table 4 International trade of Agricultural commodities, 2018

| 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.**

⁶ <http://www.nppc.sk/index.php/sk/>



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

Figure 7: International trade of Agricultural commodities, 2018

2.4. 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.

2.4.1. 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 |
| Trvský 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>

2.4.2. 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>

2.4.3. 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.⁷

⁷<https://reader.elsevier.com/reader/sd/pii/S096014811830301X?token=B06F9CEBED138780F938F3B6686B26476B07DADEC35344AD625255828307B6A0AD7FE4989E00DEEAB8888801C22310F4>

2.5. Agricultural processing industries

2.5.1. Main agro-food processing industries

Slovakia had 2100 registered food processing enterprises in 2018⁸, 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 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
- Trenčín region: Sugar Beet
- Banská Bystrica region: Grains
- Prešov region: Potatoes
- Košice region: Oil plants, Grains

The biggest companies are⁹:

- 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

2.5.2. 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/sk/investujte-na-slovensku/sektorove-prehlady/potravinarsky-priemysel>

⁹ <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.

2.6. 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

2.7. 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 labour 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> <ul style="list-style-type: none"> ▪ Appropriate size structure of agricultural holdings ▪ Great potential for the use of agricultural land and especially natural grassland, good traditions in agricultural and forest land management ▪ Favourable climate conditions ▪ High soil quality in the lowlands ▪ Sufficient water supply ▪ The possibility of growing organic agricultural products In Slovakia, ▪ Advanced information systems and sources of information on supply assessment and control | <p>Weaknesses</p> <ul style="list-style-type: none"> ▪ Low state subsidies, low competitiveness and productivity especially of agriculture and following processing industries ▪ Low transparency of the Structural Funds ▪ Cooperation with many other organizations and government is not sufficient enough on national and regional level. ▪ Lack of job opportunities ▪ Migration of rural population to urban regions ▪ Permanent loss of arable land, Indebtedness of farms ▪ Decrease of agricultural production and reduction of livestock breeding ▪ Unresolved ownership relationships to agricultural and forestry land ▪ Insufficient use of secondary valuable raw materials from waste management ▪ Low added value production |
| <p>Opportunities</p> <ul style="list-style-type: none"> ▪ Low added value production ▪ Job creation, respectively job maintenance ▪ Diversification of the rural economic base ▪ Exploitation of local natural resource ▪ Countryside capital inflow ▪ Promoting the sale of local products ▪ Farm production support | <p>Threats</p> <ul style="list-style-type: none"> ▪ A high percentage of the rural population in the post-productive age and an ongoing outflow of staffing capacities from rural areas. ▪ Inability to develop the land market as a prerequisite for business in agriculture ▪ Foreign competition of agricultural products |

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| | |
|---|---|
| <ul style="list-style-type: none">▪ Development of inter-communal and cross-sectoral cooperation▪ Large space for food processing in Slovakia, as the negative balance of food export / import is widening▪ European Green Deal and its implementation in the Slovak Republic | <ul style="list-style-type: none">▪ Unresolved ownership relations to agricultural and forestry land▪ Insufficient anti-erosion measures in the country▪ Absence of rural development coordination▪ Frequently changing legislation▪ Climate change▪ The reluctance of manufacturers to create sales organizations and to participate in the formation of shortened sales chains▪ There are no strategies for agriculture and food processing development |
|---|---|

3. Biomass supply: Forestry

3.1. Introduction

At present, forests account for about 45% of Slovakia's area, which represents 2, 21 million hectares.¹⁰ 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

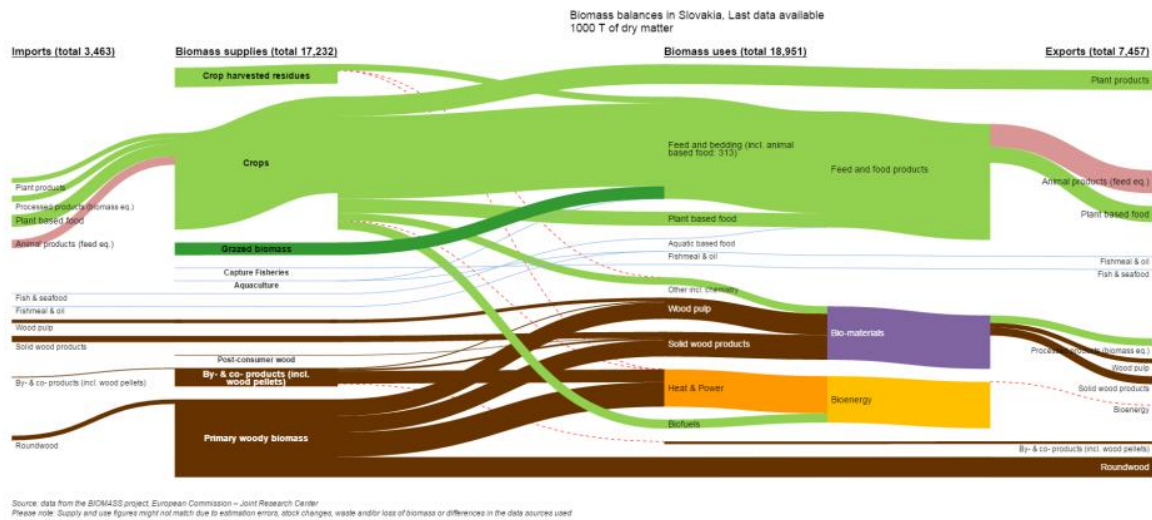
| | |
|---|--|
| Forest area | 2, 2 mil. ha |
| % Forest cover of total area | 45 % |
| Growing stock (thousand)- annual increment | 12 007,6 m ³ total or 6,25 m ³ /ha |
| Possible cut (thousand) | 9 800 m ³ |
| Coniferous trees (thousand) | 5 999 m ³ |
| Deciduous trees(thousand) | 3 801 m ³ |
| Length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

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.

¹⁰ Šebeň, V., 2015: Národná inventarizácia a monitoring lesov Slovenskej republiky 2015-2016. Lesnícke štúdie 65/2017. str. 47

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

Figure 8 Sankey diagram of roundwood flows in Slovakia, 2017

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

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)

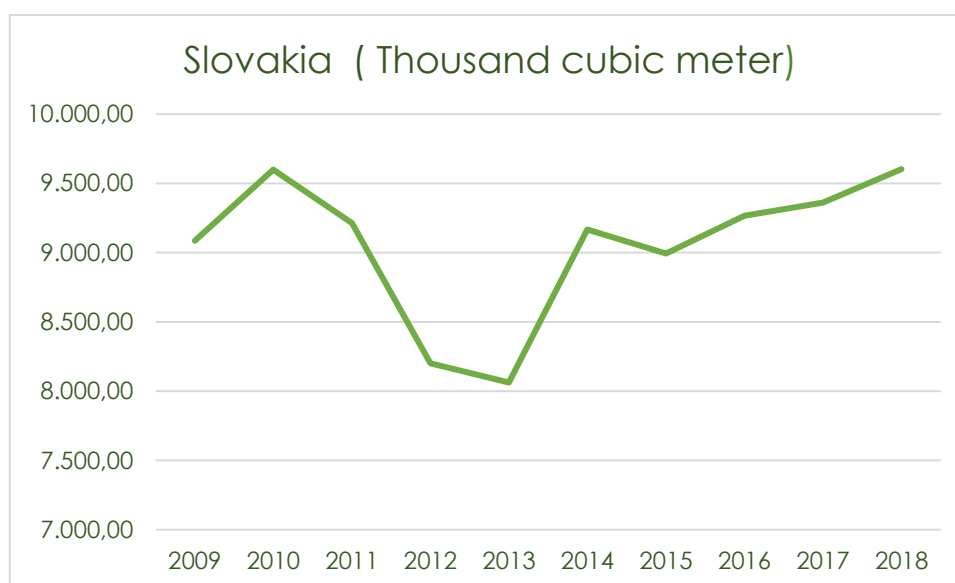
¹¹ <https://www.mpsr.sk/zelena-sprava-2019/123---14927/>
¹² <https://www.mpsr.sk/zelena-sprava-2019/123---14927/>

| County | Thinnings (Kton) | Logging residues from final fellings (Kton) | Logging residues from thinnings (Kton) | Total (Kton) |
|----------------------|------------------|---|--|--------------|
| Braťislavský 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.



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)

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

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>

3.3. 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 |
| Trvský 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.

3.4. 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

| | |
|---|---|
| <p>Strengths</p> <ul style="list-style-type: none"> ▪ 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 ▪ State forest policy of Slovak Republic characterizes forests as a national wealth; therefore, the goal of sustainable economy is to protect. ▪ Existence of well-functioning associations with accepted leaders ▪ High economic efficiency forest management ▪ Non-state forest owners own up to 52.3% of Slovak forests and they are more efficient managed as the state-owned ones ▪ 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. ▪ The existence of the National Forest Centre is a powerful instrument in the national forest management, www.nlcsk.org | <p>Weaknesses</p> <ul style="list-style-type: none"> ▪ Intensive influence of top politics on state forestry management ▪ The inability to diversify goods and services (timber trade is often the main source of income) ▪ Insufficient and unsystematic funding ▪ 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. ▪ A lack of processing capacity for the highest quality coniferous and hardwood round sorbents. ▪ Illegal logging ▪ Fragmentation and scattered forest ownership ▪ Value added in forestry is not high, it is created mainly in manufacturing industries |
| <p>Opportunities</p> <ul style="list-style-type: none"> ▪ Increasing demand for timber and other services ▪ Non-state forestry sector support through rural development program ▪ Use of external financial resource ▪ New legislation (explicit division into state and non-state forests) ▪ Investment in applied forestry and timber research ▪ Involvement Slovak entities in projects supporting bio-economy within the BBI-JU; ▪ Increasing share of renewable energy sources (RES) from forestry in total RES production in SR, research activities in bioenergy | <p>Threats</p> <ul style="list-style-type: none"> • Negative persistent public view of foresters • Non-governmental organizations (conservationists) and their particular objectives violating the principles of sustainable forest management (Bark beetle overgrowth treatment). • Frequently changing persons in respective ministries (central organs) • 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. |

- | | |
|--|---|
| <ul style="list-style-type: none"> ▪ 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 | <ul style="list-style-type: none"> • Demanding bureaucratic barrier from the side of the ministry when interested in applying from the EU funds and subsidies • Economic restriction by nature protection without financial compensation • Low law enforcement |
|--|---|

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.¹³

Table 16 summarises waste flow in 2018.

¹³ 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

4.2. 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, wastewater 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

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

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

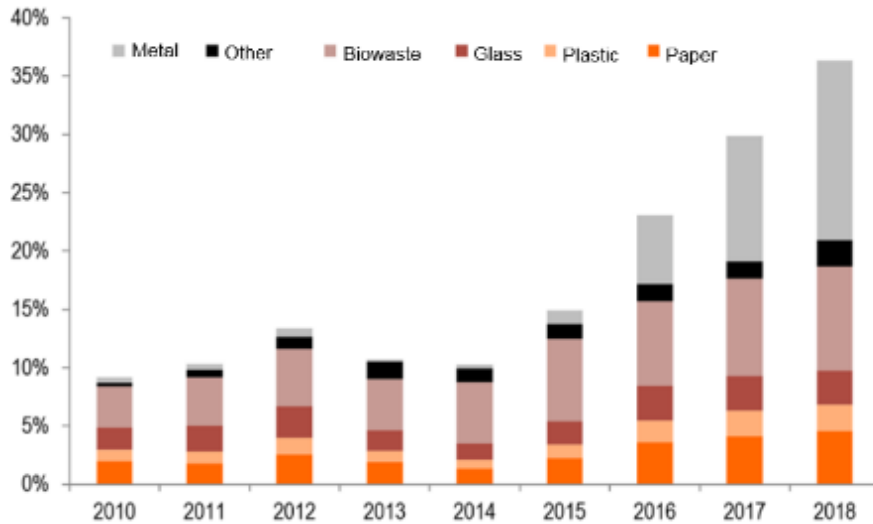


Figure 10 National figures of total waste generation in Slovakia in 2017

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 2018.¹⁴

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.

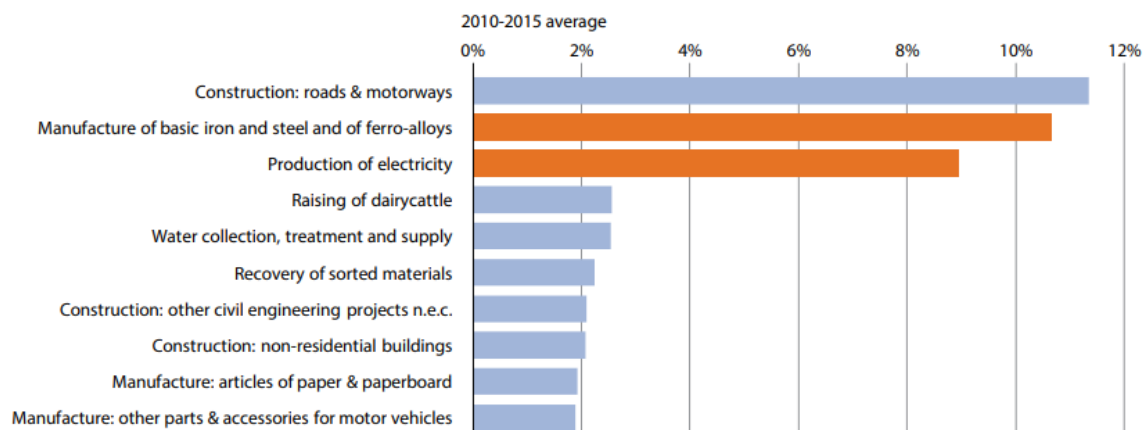
¹⁴ <https://euractiv.sk/section/obehova-ekonomika/news/slovensko-ma-lepsie-odpadove-statistiky-skladkuje-pritom-coraz-viac/>

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% 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

4.3. 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.

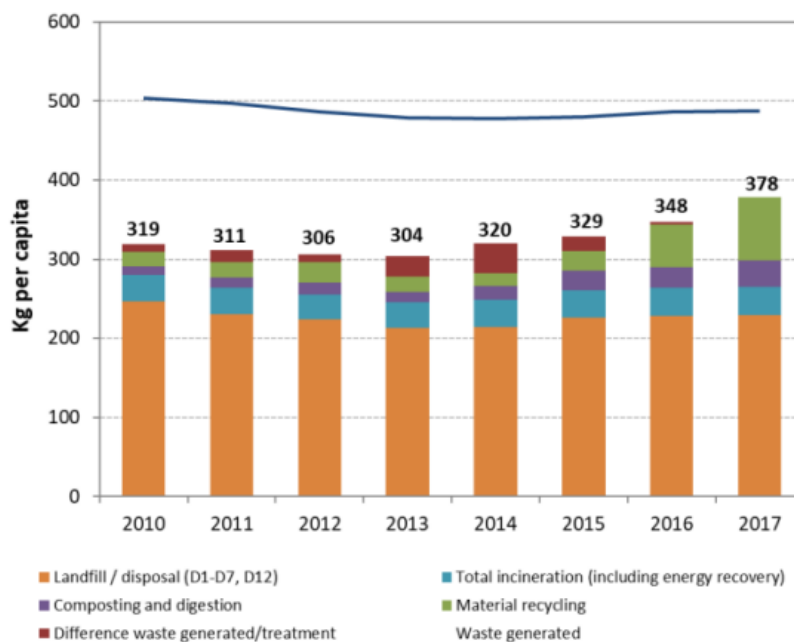
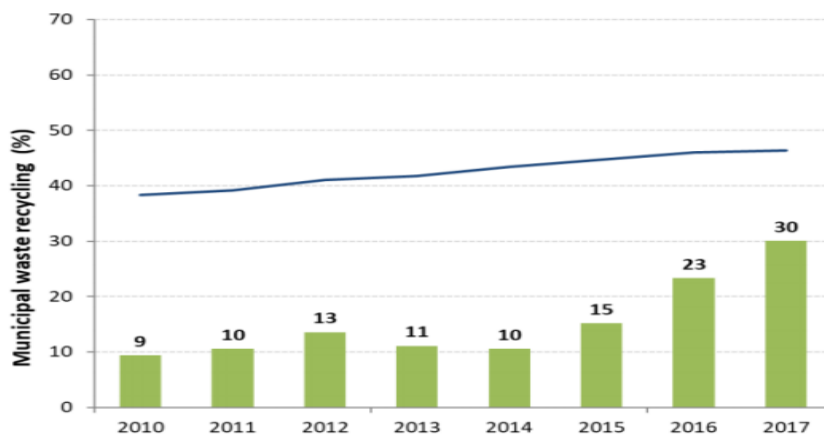


Figure 12 Municipal waste by treatment in Slovakia 2010-2017

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

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.

Figure 13 Recycling rate of municipal waste 2010-2017



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

4.3.1. 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 Kosif. 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

4.4. 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.¹⁵

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

| Strengths | Weaknesses |
|--|--|
| <ul style="list-style-type: none"> ▪ The country has substantially reduced its greenhouse gas emissions and the energy intensity of its economy ▪ More progress has been achieved in the management of industrial waste, where 39% now goes for recycling, while only 36% is landfilled. ▪ Positive changes in the legislation (growing landfilling costs) ▪ New policy and regulations on returnable PET & aluminium cans | <ul style="list-style-type: none"> ▪ Low sorting rates ▪ Low awareness among citizens and companies ▪ 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 ▪ The current policy framework is incomplete and lacks coherence |

¹⁵ <https://euractiv.sk/section/obehova-ekonomika/news/slovensko-ma-lepsie-odpadove-statistiky-skladkuje-pritom-coraz-viac/>

| | |
|--|--|
| | <ul style="list-style-type: none"> 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>Opportunities</p> <ul style="list-style-type: none"> 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 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. Increasing the efficiency of metal processing and of electricity generation from lignite could immensely increase the overall resource efficiency of the economy Gradually increase the landfill tax. Consider ICT for useful recycling. | <p>Threats</p> <ul style="list-style-type: none"> Insufficient municipal solid waste recycling. Only about 15% of the municipal solid waste is currently recycled. Municipal waste management is underperforming and lacks appropriate economic signals that would divert waste from landfills and stimulate recycling and reuse 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. Illegal dumping Bad air quality Air quality continues to suffer from heavy use of brown coal in power generation, and air pollution remains one of the main environmental challenges Low law enforcement |

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 eggshells. 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 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.¹⁶ 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 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

¹⁶ <https://spectator.sme.sk>

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.¹⁷

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 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.¹⁸

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.¹⁹

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.²⁰

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

¹⁷ <https://www.tvojeharmony.sk/o-nas/shp-group/>

¹⁸ <https://www.metsatissue.com/en/Pages/default.aspx>

¹⁹ <https://www.verytis.sk/>

²⁰ <https://www.mondigroup.com/en/about-mondi/where-we-operate/our-locations/europe/slovakia/mondi-scp/>

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

Bioeconomy Cluster²¹

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.

Members²²:

- 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.
- KELO 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 Cluster²³

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 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.²⁴

²¹http://www.interreg-danube.eu/uploads/media/approved_project_output/0001/30/a319626f134bfa2747eab95550024252de5b37c0.pdf

²² <http://bioeconomy.sk/clenstvo/clenovia/>

²³http://www.interreg-danube.eu/uploads/media/approved_project_output/0001/30/a319626f134bfa2747eab95550024252de5b37c0.pdf

²⁴ IT Valley, AT+R (robotics & automation), Cassovia Life Science ChemREG, MDR, BIOSKOH o € 21 million BIC/BBI grant ! BIOSKOH project (ENERGOCHEMICA)

5.3. 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.²⁵

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.**

5.4. 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 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"> ▪ Threats |

²⁵ <http://www.vupc.sk/sk>

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

| | |
|--|---|
| <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 | <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 211 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, foddors, 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, foddors, 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 up 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 | | 2 664 151 m ² | Nitriansky kraj | | 4696759 m ² |
| | 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 | 30 000 m ² |
| | | | | Dolné Krškany | |
| | Krupina | 220 000 m ² | | Levice | 650 000 m ² + 307 044 m ² |
| | Tornaľa | 38 120 m ² | | Diakovce | 82 890 m ² |
| | Útekáč | 32 976 m ² | | Hurbanovo | 150 000 m ² |
| | Víglaš | 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 | 2 382 0693 m ² |
| | Fíľakovo | 13 700 m ² | | Sereď | 363 761 m ² |
| | Detva | 114 824 m ² | | Skalica I | 80 000 m ² |
| Prešovský kraj | | 1309745,6 m ² | | 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 zóna | 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 |
| Myslina | 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 m² | | 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

6.2. 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.²⁶

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.

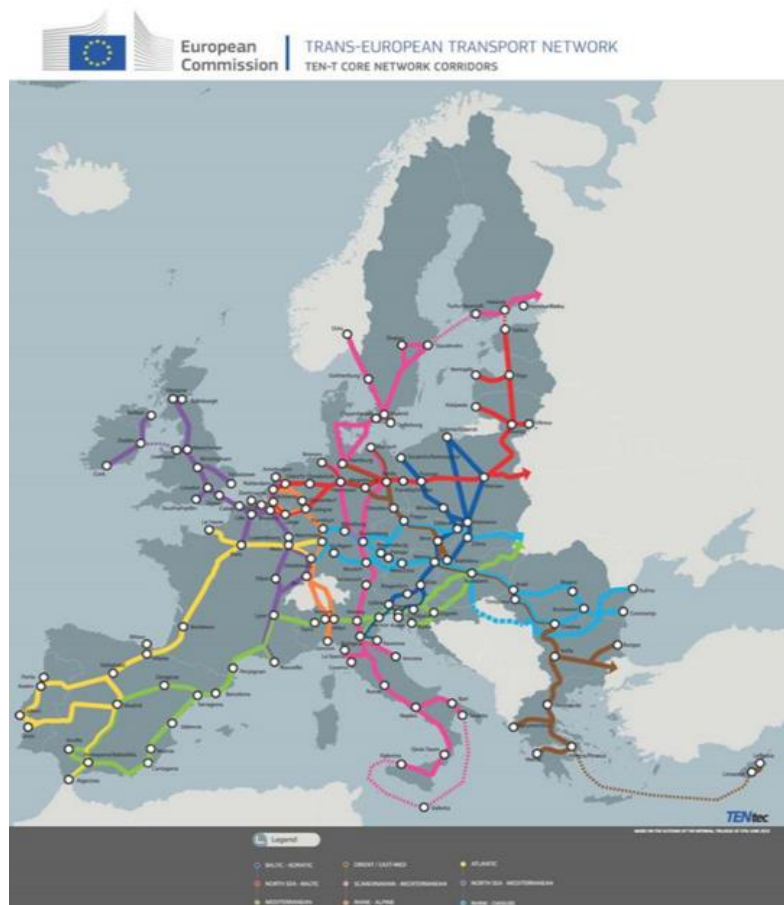


Figure 14 Position of Slovakia in the Trans- European Transportation Network

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

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

²⁶ <http://datacube.statistics.sk/#!/lang/en>

- 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.

6.3. 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).²⁷

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 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.²⁸ 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

²⁷http://www.sfpa.sk/wp-content/uploads/2018/01/Innovation-of-Energy-Sector-in-Slovakia_CEDE2017.pdf

²⁸https://www.connaissancedesenergies.org/sites/default/files/pdf/actualites/energy_policies_of_iaa_countries_slovak_republic_2018_review.pdf

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 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.²⁹

²⁹ https://www.sepsas.sk/Dokumenty/VyroczneSpravy/2019/SEPS_VS2018.pdf

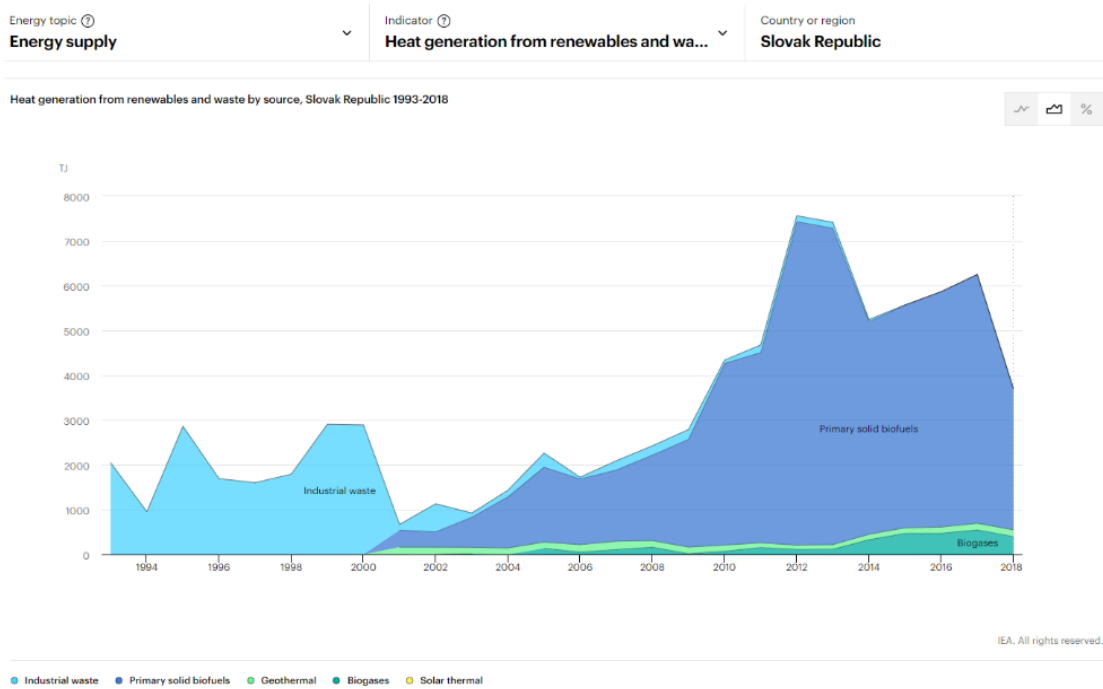
This project received funding from the BBI JU under the EU Horizon 2020 research and innovation programme under grant agreement No.838087

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).



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.

6.4. 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 SWOT elements of Infrastructure, logistics and energy sector of Slovakia.

| Strengths | Weaknesses |
|--|---|
| <ul style="list-style-type: none"> ▪ Sufficient groundwater resources of high quality. ▪ Transported performances by rail increased. ▪ Vouchers to co-fund the installation of renewable energy technologies. ▪ Energy sector plays an important role in the Slovak economy, its share in gross value added is higher than the European average. | <ul style="list-style-type: none"> ▪ The surface of Slovakia is very mountainous, which makes it difficult to build a road network in some sections. ▪ Unsatisfactory technical and qualitative state of railway infrastructure. ▪ Low share of upper-class roads in total road length. ▪ Low level of capacity utilization of an existing set of intermodal transport terminals. |

| | |
|---|--|
| <ul style="list-style-type: none"> ▪ In Slovakia already 90% of electricity generation is from renewable sources and nuclear installations with practically no GHG emissions ▪ The share of employment in the energy sector of Slovak republic is higher than the EU average ▪ Telecommunications market bringing above-the- standard innovations ▪ International transport corridors - highways, expressways and I class roads ▪ Dense railway network | <ul style="list-style-type: none"> ▪ One of the main barriers in further uptake and support of eco-innovation are ineffective policies and fragmented administrative framework. ▪ There is low investment into the ecology and eco-technologies, Innovators, Intellectual assets and attractive research systems develops slowly ▪ Slovakia lacks qualified human capacities in the area of eco-innovations. |
| <p>Opportunities</p> <ul style="list-style-type: none"> ▪ Strategic transport position. ▪ Interconnection of international airports Bratislava and Vienna by rail. ▪ Modernization of railway lines, completion of motorways build. ▪ Use of alternative approaches in the energy sector, introduction of a system for the use of secondary raw materials. ▪ Building interconnection points between transport modes - public intermodal transport terminals. ▪ Use of nuclear energy as a carbon-free source. ▪ Use of secondary energy sources. ▪ Reducing dependence on fossil fuel imports. ▪ Support for a science-based research base capable of producing innovations and commercially use. | <p>Threats</p> <ul style="list-style-type: none"> ▪ Low support for the use of alternative and renewable energy sources. ▪ Difficult to develop new renewable energy production in competition with relative cheap fossil gas coming from Russia. ▪ Own exports from the country have been decreasing in recent years by water transport. ▪ Decrease in the scale of transport on the railways and increase of negative effects of transport on the environment. ▪ Increasing costs of repair and maintenance of railway infrastructure and road infrastructure ▪ The long - term deficit of the TPS system. ▪ 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. ▪ High dependence on fossil fuels |

7. Skills, education, research and innovation potential

7.1. 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 agrobiolgy, 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: Agrobiolgy, 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).³⁰

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

³⁰ <http://www.agrobiotech.sk/en/about-us/>

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.
- To provide research, development and monitoring services meeting SK forestry needs.
- To support sectoral innovations.³¹

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 Economics³²

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.

Research Institute of Plant Production

³¹ https://web.nlcsk.org/?page_id=5124

³² <http://www.nppc.sk/index.php/sk/>

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.³³

7.2. 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.

³³ <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.³⁴

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 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

³⁴ <https://www.uniag.sk/en/science-and-research/>

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".³⁵

7.3. 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

7.4. 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.³⁶ 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 Bratislava Prievoz – Holice.³⁷ 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.³⁸

³⁵ <https://www.tuzvo.sk/sk/poslanie>, <https://tuzvo.sk/sk/veda-vyskum-0>

³⁶ <https://ppp-projekty.webnode.sk/ppp-na-slovensku>

³⁷ <https://www.mindop.sk/ministerstvo-1/ppp-projekty/ppp-projekty>

³⁸ <https://www.minzp.sk/ppp/>

At the end of 2007, the PPP Association was established in the Slovak Republic to support public-private cooperation projects.³⁹

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.⁴⁰ 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.**

7.5. 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.

³⁹ <http://www.asociaciappp.sk/>

⁴⁰ <https://euractiv.sk/section/regionalny-rozvoj/news/na-vychode-slovenska-ma-vyrast-najvacsia-2g-biorafinaria-v-europe/>

- **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> <ul style="list-style-type: none"> ▪ Relatively high level of educated workforce. ▪ Relatively high proportion of secondary school educated workforce. ▪ Implementation of targeted requalification courses. ▪ Potential for growth of expertise and skills. ▪ An extensive network of adult education institutions. ▪ Interesting workshops organized by companies, during events at some universities, study fests. ▪ Possibilities for Erasmus programs, home and abroad internships. | <p>Weaknesses</p> <ul style="list-style-type: none"> ▪ Inefficient interconnection between educational system and labour market. ▪ Inadequate systems for forecasting changes in the qualification needs of the labour market. ▪ Absence of a coherent system of another/further education training. ▪ Absence of a model securing participation of social partners on organizations and professional education financing. ▪ Lack of information and advisory services on education and the labour market. ▪ The absence of a lifelong learning strategy. ▪ Insufficiently developed advisory services and business education services. ▪ No or poor collaboration between faculties and universities. ▪ Outdated educational systems, tools. |
| <p>Opportunities</p> <ul style="list-style-type: none"> ▪ Intensive cooperation of the school system and employment sphere to adapt the content and | <p>Threats</p> <ul style="list-style-type: none"> ▪ Deepening the isolation of the education system from the needs of the labour market. |

scope of education to the labour market requirements.

- AgroBioTech project – innovative project for building cutting-edge research infrastructure,
- Research and education activities of the Slovak Agriculture University of Nitra, Research activities at the Technical University in Zvolen
- 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

- Existence of almost 40 “universities” in a country of 5.4 mill. Inhabitants

- Reducing the quality of professional training and preparation for work
- Teaching staff departure from education (mainly because of low salaries and lack of motivation).
- Deepening structural mismatches in demand and job offers.
- Negative development in the application of school graduates and other population groups.
- Departure of students and people with higher education to more economically advanced areas of Europe.

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:

9. 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.
10. 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.
11. Income Tax Act. 595/2003.
12. 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.
13. 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).
14. 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 Slovakia.
15. 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 litre 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.
16. 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

| Strengths | Weaknesses |
|---|---|
| <ul style="list-style-type: none"> ▪ The measures that are present are specific targeted bio economy development. ▪ 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. ▪ There is a growing awareness that structural changes in policies are needed for the development of bio economy | <ul style="list-style-type: none"> ▪ No explicit legislative bio economy support and stimulation, only measures that contribute to bio economy development. ▪ There is no strategy for bio economy development in Slovakia ▪ Most measures rely on voluntary pledges from the private sector. ▪ Limited resources for possible measure implementation. ▪ A lack of a circular agricultural policy. |

| | |
|---|---|
| | <ul style="list-style-type: none"> ▪ A lack of financial incentive/subsidies to foster bio economy development. |
| <ul style="list-style-type: none"> ▪ Opportunities ▪ Future policies should focus on clusters: pairing innovation centres with industry and state. ▪ Policies for improved biomass managing, increase in the use of forest wood and stimulation of the use of recognized certificates. ▪ Removing administrative issues, e.g. via voucher schemes (proposed in Poly4Eml, 2014 | <ul style="list-style-type: none"> ▪ Threats ▪ No new and bio economy-specific policies and legislation (status quo). ▪ Ignoring of the raising awareness of the need for structural change in policy. ▪ Continuous relying on voluntary pledges from companies. ▪ Slovak governments underestimate the meaning of bio economy for the economic, social and environmental development of the state |

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

The 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> <ul style="list-style-type: none"> ▪ The financial resources for bio economy development in Slovakia can be generated by public and private means ▪ Slovakia is one of ESIF funds largest beneficiaries ▪ ESIF funds help to mobilise private investment. ▪ Private sector investment | <p>Weaknesses</p> <ul style="list-style-type: none"> ▪ Financial constraints are limiting the wider use of modern technologies ▪ Lack of funds for investment in technologies from wood biomass. ▪ Lower biomass state subsidies than the former countries of the EU15 and lack of subsidies in general. ▪ Financial barriers: Low access to finance and low level of synergies in public-private funds and investments. ▪ Low added value generation in the domestic bio sectors, exception is the paper and pulp industry |
| <p>Opportunities</p> <ul style="list-style-type: none"> ▪ New government coming from elections in 2020 may have better attitude and show interest in the bio economy sector. ▪ Assumptions for the development and stabilization of food and processing industry and other bioeconomy sectors in Slovakia. ▪ 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>Threats</p> <ul style="list-style-type: none"> ▪ 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. ▪ Lack of interest of ministries in the development of a viable strategy for the development of the production and use wood biomass fuel. ▪ Insufficient grant, equity and loans means for bio-based initiatives. ▪ Overwhelming export of raw materials, e.g. cereals over the export of domestic bio-based products. |



PART B

BIO-ECONOMY STAKEHOLDERS IN SLOVAKIA

10. Actors in the agricultural and agro industrial sector⁴¹

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 aluminium 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 used 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.

10.1. Actors in primary agricultural sector

| | |
|---|---|
| Name: | Polnohospodárske výrobnobchodné družstvo Madunice/ Agricultural trade production association Madunice |
| Location: | Madunice |
| Region: | Trnava region |
| Type of activity: | Primary agricultural production |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Direct farming of onion, maize, etc. The company is a direct supplier of onions to the Slovak company Ryba KE, s.r.o. |

10.2. Actors in agro industries

| | |
|-----------|--------------|
| Name: | ENVIRAL,a.s. |
| Location: | Leopoldov |

⁴¹ Approach: In this report we present an overview of all actors and actor groups that need to be involved when setting up biomass delivery chains. To ensure a complete mapping of these actors several stakeholder exchanges at national stakeholder workshops were held.

The actors presented can be specific persons, companies, and other type of organisations (e.g. farmer's organisations. In case of listing companies in certain sectors we listed the top largest and/or most influential ones.

For the actors presented in this report the following information is provided:

Company name/person name

Company location in town/municipality

Company location in region

Type of activity (for company)/ type of function (for person)

(if company/organisation) specify number of employees

Already involved in bio-based activities (Y/N)

If yes, describe bio-based activity it is involved in

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

| | |
|---|--|
| Region: | Trnava region |
| Type of activity: | Bioethanol producer of the 1 st Generation |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | The bioethanol production in ENVIRAL is a wasteless process. The plant also operates its own wastewater treatment plant, which ensures the high purity of discharged wastewater. In the wastewater treatment process biogas with high methane content is produced, which is subsequently used to produce steam in boiler room. The whole process is focused on minimizing electricity and natural gas consumption, enabling the bioethanol produced in ENVIRAL to reach a reduction of greenhouse gas emissions of at least 60%, when compared with the fossile equivalent - gasoline. |

| | |
|---|--|
| Name: | BIORAFINERIA SK |
| Location: | Sučany |
| Region: | Banská Bystrica region |
| Type of activity: | Biofuels production |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | The company Biorafineria offers technologies for vegetable oil, biodiesel/FAME and <i>next generation</i> 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. |

| | |
|---|--|
| Name: | GLORTEX |
| Location: | Šenkvice |
| Region: | Bratislava region |
| Type of activity: | Biodiesel production |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | 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 |

10.3. Other actors related to agriculture & agro-processing chain

| | |
|---|---|
| Name: | RYBA Košice, spol. s r.o. (Fish meals production) |
| Location: | Košice |
| Region: | Košice region |
| Type of activity: | Sale and manufacturing of fish <i>meals</i> |
| Already involved in bio-based activities: | N |

10.4. Clusters and organisations

| | |
|---|--|
| Name: | Bioeconomy Cluster |
| Location: | Nitra |
| Region: | Nitra region |
| Type of activity: | Supporting organization |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | To support innovation in the field of bioeconomy by linking innovative companies with research organizations |

11. Actors in forestry and forest industry

11.1. Actors in primary forest sector

| | |
|---|---|
| Name: | LESY Slovenskej republiky / Forest of the Slovak republic |
| Location: | Banská Bystrica |
| Region: | Banská Bystrica region |
| Type of activity: | Forest management |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | To satisfy the public interest needs and protection of the natural environment with the aim of sustainable forest development of the state-owned forests. |

| | |
|-------------------|---|
| Name: | PRO POPULO Poprad, s.r.o. |
| Location: | Spišská Teplica |
| Region: | Prešov region |
| Type of activity: | Administration of forest and agricultural land owned by the Roman Catholic Church |

| | |
|---|---|
| Already involved in bio-based activities: | N |
|---|---|

11.2. Actors in forest industry

| | |
|---|--|
| Name: | DREVODOM ORAA, S.R.O |
| Location: | Podbiel |
| Region: | Žilina region |
| Type of activity: | Production and installation of wooden log houses and recreational cottages |
| Already involved in bio-based activities: | N |

| | |
|---|---|
| Name: | KRONOSPAN,s.r.o. |
| Location: | Zvolen |
| Region: | Banská Bystrica region |
| Type of activity: | Bučina DDD, s.r.o. is the largest producer of raw chipboard, laminated chipboard and glued wood in Slovakia |
| Already involved in bio-based activities: | N |

11.3. Clusters and organisations

| | |
|---|---|
| Name: | Zväz spracovateľov dreva / Association of Wood Processors |
| Location: | Zvolen |
| Region: | Banská Bystrica region |
| Type of activity: | The aim of the Association is to carry out activities for the benefit of the professional, economic, legal and social interests of its members, to represent them in relation to trade unions and other employers' associations, government, parliament, associations, abroad and others. |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | One of the priorities on which the association focuses is to increase the finalization of wood in Slovak conditions so that this strategic raw material, as far as possible, is enriched with the greatest possible added value. |

| | |
|-----------|--|
| Name: | Združenie obecných lesov Slovenskej republiky/ Association of Municipal Forests of the Slovak Republic |
| Location: | Zvolen |
| Region: | Banská Bystrica region |

| | |
|---|---|
| Type of activity: | The Association of Municipal Forests of the Slovak Republic is an interest association of legal <i>municipal</i> entities that own forests or manage forests. |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Participate in the creation and implementation of forestry policy of the state. |

12. Actors in the waste sector

12.1. Actors in waste sector

| | |
|---|---|
| Name: | ODVOZ A LIKVIDÁCIA ODPADU, a. s Waste treatment |
| Location: | Bratislava |
| Region: | Bratislava region |
| Type of activity: | To provide quality and efficient services in the field of collection, removal and disposal of municipal and small construction waste. |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | One of the company's priorities is a long-term program to support separate collection. |

| | |
|---|---|
| Name: | KOSIT, a.s. s Waste treatment |
| Location: | Košice |
| Region: | Košice region |
| Type of activity: | Collection, removal and disposal of municipal and small construction waste. |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | One of the activities of KOSIT, a s. it is also a center of environmental education, which has the main goal of spreading awareness in the field of environmental responsibility. |

12.2. Clusters and organisations

| | |
|---|---|
| Name: | Asociácia podnikateľov v odpadovom hospodárstve/ Association of Entrepreneurs in Waste Management |
| Location: | Bratislava |
| Region: | Bratislava region |
| Type of activity: | A voluntary professional association of entities doing business in waste management. |
| Already involved in bio-based activities: | Y |

| | |
|---------------------------------|--|
| Bio-based activity involved in: | Collection, collection of waste, its transport, treatment, energy and material use, recycling to ecological landfilling of unusable parts, but also consulting services dealing with waste management. |
|---------------------------------|--|

| | |
|---|--|
| Name: | Ponitrianske združenie obcí pre separovaný zber a nakladanie s odpadmi/ Ponitrian Association of Municipalities for Separate Collection and Waste Management |
| Location: | Výčapy- Opatovce |
| Region: | Nitra region |
| Type of activity: | The subject of the association's activities is long-term comprehensive waste management. |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Long-term implementation of separate waste collection in municipalities, sorting and subsequent recovery of separated components, ensuring the collection, transport and disposal of unsorted municipal waste, construction of own sorting equipment, solving problem phenomena in waste management. |

13. Actors in fisheries, aqua culture and other sectors

13.1. Actors in fisheries and aquaculture

| | |
|---|---|
| Name: | AGRO RYBIA FARMA,s.r.o. |
| Location: | Handlová |
| Region: | Trenčín region |
| Type of activity: | Fish farming |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | The integrated fish farm and greenhouse management project uses the energy potential of the mining water that flows out of the portal of the old and new tunnel mine. In addition to water management importance, it also has considerable heat and energy potential, which can be used for the production of heat, cold and hot water by transformation using heat pumps. |

13.2. Actors in sectors managing / maintaining large areas of land & water

| | |
|---|---|
| Name: | Slovenský vodohospodársky podnik, štátny podnik Slovak water management company, state enterprise |
| Location: | Banská Štiavnica |
| Region: | Banská Bystrica region |
| Type of activity: | Administrator of watercourses and river basins in Slovakia. |
| Already involved in bio-based activities: | N |

13.3. Clusters and organisations

| | |
|---|--|
| Name: | Združenie chovateľov rýb na Slovensku/ Association of fish breeders in Slovakia |
| Location: | Ivanka pri Dunaji |
| Region: | Bratislava region |
| Type of activity: | Promotion and protection of the interests of fish farmers in Slovakia. Gradually build a service information center for productive fish farming, be a partner for decision-makers in the process of globalization and integration and generally assist in the development of fish farming in Slovakia. |
| Already involved in bio-based activities: | N |

14. Actors in bio-based industries and markets

14.1. Chemical and petro-chemical industries

| | |
|---|---|
| Name: | SHP Group (Slovak Hygienic Paper Group) |
| Location: | Harmanec/ Slavošovce |
| Region: | Banská Bystrica region |
| Type of activity: | The largest sanitary paper producer. |
| Already involved in bio-based activities: | N |

| | |
|-----------|--------------|
| Name: | Metsä Tissue |
| Location: | Žilina |

| | |
|---|---|
| Region: | Žilina region |
| Type of activity: | Producing exclusively paper hygiene products from tissue paper. It produces toilet paper, kitchen towels and sanitary towels. |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | 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 |

| | |
|---|--|
| Name: | Mondi SCP |
| Location: | Ružomberok |
| Region: | Žilina region |
| Type of activity: | Producing paper and pulp |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | 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. |

14.2. Textiles

| | |
|---|---|
| Name: | Tatralan, s.r.o. |
| Location: | Kežmarok |
| Region: | Prešov region |
| Type of activity: | Manufacture of cotton, semi-linen, whole linen and mixed fabrics. |
| Already involved in bio-based activities: | N |

| | |
|---|--|
| Name: | Pohan, s.r.o. |
| Location: | Plavé Vozokany |
| Region: | Nitra region |
| Type of activity: | Textile production |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Manufacture of textiles from pure natural materials. |

| | |
|-------------------|-------------------------|
| Name: | SLOVENKA-Silver, s.r.o. |
| Location: | Banská Bystrica |
| Region: | Banský Bystrica region |
| Type of activity: | Textile production |

| | |
|---|---|
| Already involved in bio-based activities: | N |
|---|---|

14.3. Energy

| | |
|---|--|
| Name: | BIOPEL,a.s. |
| Location: | Kysucký Lieskovec |
| Region: | Žilina region |
| Type of activity: | Production and trade of wide range of wood fuels. |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | The company generates appropriate ecologic fuels from domestic renewable energy sources. |

14.4. Clusters and organisations

| | |
|---|---|
| Name: | Hemp Cluster |
| Location: | Viničné |
| Region: | Bratislava region |
| Type of activity: | Research and development of new and innovative hemp products. |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | The cluster is focused on the production of pressed boards and panels from hemp-shives (85-98% by volume) and recycled materials. |

| | |
|---|--|
| Name: | Združenie výrobcov ekologickej energie Slovenska/ Association of Biofuels Energy Producers of Slovakia |
| Location: | Považská Bystrica |
| Region: | Trenčín region |
| Type of activity: | To associate Slovak manufacturers of equipment used for the production of bioenergy. |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Supporting of biofuels energy. |

15. Actors in knowledge and innovation

15.1. Campus, incubators and technology parks & hubs

| | |
|---|---|
| Name: | Agrobiotech at the Slovak University of Agriculture |
| Location: | Nitra |
| Region: | Nitra region |
| Type of activity: | 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. |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | 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 agrobology, the processing technology of agricultural products and the agri-food industry, biotechnology, genetic technologies, agroecology, bioenergetics, and bioeconomy. |

15.2. Research and innovation organisations

Universities:

| | |
|---|---|
| Name: | Slovak University of Agriculture in Nitra |
| Location: | Nitra |
| Region: | Nitra region |
| Type of activity: | Research |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | The university provides education in the field of agriculture and related research areas such as: Agro biology, Food resources, sustainable agriculture, Agricultural production, biotechnology, food technology, Engineering of agricultural machinery and equipment, Computerization and automation of agricultural equipment, Operation of energy facilities on agricultural production, Gardening and landscape design, Economics and Management, International trade in agricultural commodities, Marketing, Development of rural tourism, Project management for rural development, Lifelong learning, etc. |

| | |
|-----------|--------------------------------|
| Name: | Technical University in Zvolen |
| Location: | Zvolen |

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| | |
|---|--|
| Region: | Banská Bystrica region |
| Type of activity: | Research |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | A unique specialisation 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. |

| | |
|---|--|
| Name: | University of Veterinary Medicine and Pharmacy in Košice |
| Location: | Košice |
| Region: | Košice region |
| Type of activity: | Research |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Health control and health treatment of animals. |

Research organizations

| | |
|---|--|
| Name: | National Agricultural and Food Centre |
| Location: | Lužianky |
| Region: | Nitra region |
| Type of activity: | Research |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | 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. |

| | |
|---|------------------------|
| Name: | National Forest Centre |
| Location: | Zvolen |
| Region: | Banská Bystrica region |
| Type of activity: | Research |
| Already involved in bio-based activities: | Y |

| | |
|---------------------------------|---|
| Bio-based activity involved in: | 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. |
|---------------------------------|---|

16. Government and semi-government organisations and NGO-s

| | |
|---|--|
| Name: | Ministry of Agriculture and Rural Development of the Slovak republic |
| Location: | Bratislava |
| Region: | Bratislava region |
| Type of activity: | Government |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | E.g. Bioeast projects. |

| | |
|---|--|
| Name: | Ministry of Economy of the Slovak republic |
| Location: | Bratislava |
| Region: | Bratislava region |
| Type of activity: | Government |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Bioenergy. |

| | |
|---|--|
| Name: | Ministry of Environment of the Slovak republic |
| Location: | Bratislava |
| Region: | Bratislava region |
| Type of activity: | Government |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Environment and waste treatment. |

| | |
|---|--|
| Name: | Ministry of Finance of the Slovak republic |
| Location: | Bratislava |
| Region: | Bratislava region |
| Type of activity: | Government |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Financing. |

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| | |
|---|----------------------------------|
| Name: | Bratislava self-governing region |
| Location: | Bratislava |
| Region: | Bratislava region |
| Type of activity: | Self- government of the region |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Regional government involvement. |

| | |
|---|---------------------------------------|
| Name: | Banská Bystrica self-governing region |
| Location: | Banská Bystrica |
| Region: | Banská Bystrica region |
| Type of activity: | Self- government of the region |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Regional government involvement. |

| | |
|---|----------------------------------|
| Name: | Košice self-governing region |
| Location: | Košice |
| Region: | Košice region |
| Type of activity: | Self- government of the region |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Regional government involvement. |

| | |
|---|----------------------------------|
| Name: | Prešov self-governing region |
| Location: | Prešov |
| Region: | Prešov region |
| Type of activity: | Self- government of the region |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Regional government involvement. |

| | |
|---|----------------------------------|
| Name: | Trnava self-governing region |
| Location: | Trnava |
| Region: | Trnava region |
| Type of activity: | Self- government of the region |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Regional government involvement. |

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| | |
|---|--------------------------------|
| Name: | Nitra self-governing region |
| Location: | Nitra |
| Region: | Nitra region |
| Type of activity: | Self- government of the region |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Agrofood enhancement. |

| | |
|---|----------------------------------|
| Name: | Trenčín self-governing region |
| Location: | Trenčín |
| Region: | Trenčín region |
| Type of activity: | Self- government of the region |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Regional government involvement. |

| | |
|---|----------------------------------|
| Name: | Žilina self-governing region |
| Location: | Žilina |
| Region: | Žilina region |
| Type of activity: | Self- government of the region |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Regional government involvement. |

NGOs

| | |
|---|--|
| Name: | "Biomasa" Association |
| Location: | Kysucký Lieskovec |
| Region: | Žilina region |
| Type of activity: | Contribution to the use of renewable energy sources, especially biomass in Slovakia. |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Participation in the process related to the use of renewable energy sources through the dissemination of information and the implementation of new biomass technologies suitable for the environment |

| | |
|-----------|--|
| Name: | Bratislava Regional Association of Environmentalists |
| Location: | Bratislava |
| Region: | Bratislava region |

| | |
|---|---|
| Type of activity: | A leading non-governmental organization in the field of protection and restoration of rare habitats. |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Especially in the Danube region, restoration of wetlands and river branches, floodplain forests, meadows and pastures. Support of traditional, nature-friendly forms of farming, such as cattle grazing, cane mowing or pruning of willows. |

| | |
|---|--|
| Name: | Centre of Environmental Activities - Trenčín |
| Location: | Trenčín |
| Region: | Trenčín region |
| Type of activity: | Ngo interested in the environment and on improving the quality of life in Trenčín and in the region of the White Carpathians. |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Helping to promote an environmentally friendly way of life. Taking positions on the problems of quality of life and the environment and participate in their solution. |

17. Financial organisations & banks

| | |
|---|-------------------|
| Name: | Tatra Banka, a.s. |
| Location: | Bratislava |
| Region: | Bratislava region |
| Type of activity: | Bank |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Financing. |

| | |
|---|-------------------------------|
| Name: | Všeobecná úverová banka, a.s. |
| Location: | Bratislava |
| Region: | Bratislava region |
| Type of activity: | Bank |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Financing. |

| | |
|-----------|----------------------------|
| Name: | Slovenská sporiteľňa, a.s. |
| Location: | Bratislava |
| Region: | Bratislava region |

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| | |
|---|------------|
| Type of activity: | Bank |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Financing. |

| | |
|---|-------------------------------------|
| Name: | Československá obchodná banka, a.s. |
| Location: | Bratislava |
| Region: | Bratislava region |
| Type of activity: | Bank |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Financing. |

| | |
|---|---|
| Name: | Agricultural Paying Agency at Ministry of Agriculture and Rural Development |
| Location: | Bratislava |
| Region: | Bratislava region |
| Type of activity: | Paying Agency |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Financing. |

Market actors: brand owners and consumer groups

| | |
|---|-------------------------------|
| Name: | Slovak Consumers' Association |
| Location: | Bratislava |
| Region: | Bratislava region |
| Type of activity: | Consumer protection |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Public consulting. |

| | |
|---|-------------------------------------|
| Name: | Slovak Agriculture and Food chamber |
| Location: | Bratislava |
| Region: | Bratislava region |
| Type of activity: | Chamber |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Public consulting. |

| | |
|---|---|
| Name: | Slovak Academy of Agricultural Sciences |
| Location: | Lužianky |
| Region: | Nitra region |
| Type of activity: | Research |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Public consulting |

| | |
|---|--|
| Name: | Slovenský potravinársky priemysel, a.s. |
| Location: | Bratislava |
| Region: | Bratislava region |
| Type of activity: | Retail sale |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Bring truly high-quality, honest and mostly local food to Slovak tables. Efforts to support local producers. |

| | |
|---|--|
| Name: | TERNO real estate, s.r.o. |
| Location: | Bratislava |
| Region: | Bratislava region |
| Type of activity: | Retail sale |
| Already involved in bio-based activities: | Y |
| Bio-based activity involved in: | Products from regional suppliers from Slovakia, healthy assortment (organic, raw, vegetarian, vegan or eco), including products for customers with food intolerance. |

18. Conclusions

▪ Key message

Bio economy has a huge development potential in Slovakia. While the automotive industry generates 26.5 bill. € while the bio economy creates just 11.1 bill. € (2016), it could grow to 25. bill. €, if the national bioeconomy strategy will be developed and implemented and the needed investment will be carried out.

▪ Exploitable results / lessons learnt

There are following main development areas within the Slovak bioeconomy sectors:

- Efficient agriculture implementation,
- Fodder production,
- Food processing development and modernization,

- Crop production,
- Animal production,
- Food processing industry development,
- Biofuels second generation from agro residues,
- Efficient forestry reacting on climate change incl. CO2 capturing,
- Furniture and construction wood industry,
- Paper and pulp industry,
- Wooden bio-based residues based renewable energy generation,
- Wooden polymers based biochemical,
- Waste treatment, recycling and energy generation.

▪ Value for target country/ stakeholders

- Bio based economy the gross nation product increase,
- Achievement of relative food self- sufficiency,
- Biomass- agro and forest residual based renewable energy generation,
- Enhancement of circular economy,
- Higher added value generation, e.g., food processing, paper and pulp industry,
- Climate change mitigation and CO2 capturing,
- Job creation in rural areas.

CELEBio activities generate benefits for local stakeholders. As there is no national strategy for bio development in Slovakia, the CELEBio work provides the main module for its development and implementation and thus contributes to the sustainable and climate friendly development and to the "Green deal" implementation in Slovakia.

▪ Value for BBI JU/BIC/EU stakeholders

CELEBio activities have identified following potential investment opportunities national and international BBI and bio economy general investors:

- Food processing: + 1, 5 bill. €
- Biofuels second generation from agro residues: + 250 million €
- Wood processing and furniture industry: + 500 million €
- Paper and pulp industry: + 1, 5 bill. €
- Renewable energy: + 300 million €
- Waste processing: + 500 million €

Concrete results of CELEBio work:

- Description of bioeconomy status and biomass feedstock availability in Slovakia,
- Development of national Action plan and basic modules for bioeconomy development in coming decade,
- Communication of bioeconomy development meaning to regional and national government, to the European commission and BBI JU,
- The important step to development and implementation of the bioeconomy strategy in Slovakia. (The strategy on bioeconomy development has not been elaborated yet).



PART C

GUIDELINES FOR SLOVAK ACTION PLAN

19. Slovak Bioeconomy Action Plan

The aim of this chapter is to present a set of specific, attainable, relevant value chains and time-based Action Plan for the development of bioeconomy in Slovakia. The work has capitalised on the findings of the work in CELEBIO⁴² and is structured in four sections.

The first presents the current state of bioeconomy, discusses the country's comparative strengths and opportunities, and provides an overview of the existing policy regime per value chain stage (i.e. biomass production, conversion, distribution, end use).

The second introduces the Bioeconomy Vision, the value chains selected by national stakeholders and outlines how they fit to the three main priorities⁴³ from the 2018 Update of the European Bioeconomy Strategy⁴⁴:

- Strengthen and scale-up the bio-based sectors, unlock investments and markets
- Deploy local bioeconomies rapidly across Slovakia
- Understand the ecological boundaries of the bioeconomy

The third provides facts tailored to each value chain in terms of current exploitation of biomass raw materials, future actions that could steer innovative and resource efficient market uptake for biobased products, potential interventions and expected added value. This information has resulted from the consultation with national stakeholders within the duration of the project. This section also includes information on the relevance to the UN Strategic Development Goals (SDGs), selected relevant projects and markets for the biobased products that will derive from each value chain.

Finally, the fourth part provides an implementation plan, jointly developed with stakeholders, which includes time specific goals for reaching the Vision.

20. Bioeconomy in Slovakia

20.1. Current state

Bioeconomy in Slovakia had an annual turnover of thirteen billion Euros in 2017 which translates to 77,000 Euros per person employed in the sector with the EU27 average figure being 127,000 Euros.

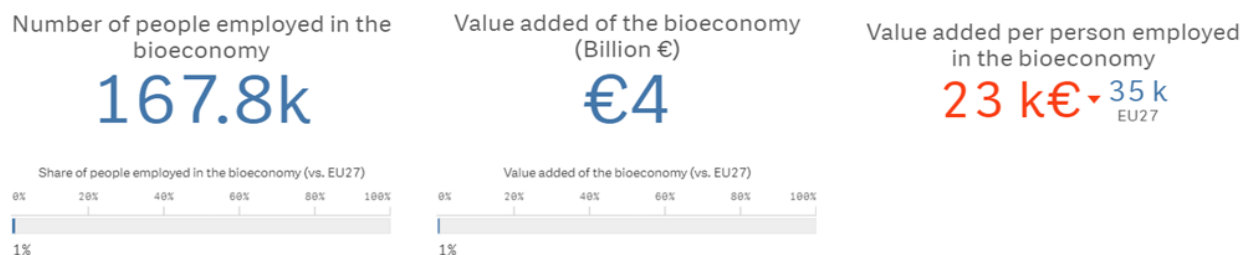


Figure 16 Jobs and wealth in the Slovakian bioeconomy in 2017 (source: datam.jrc.ec.europa.eu)

⁴² Slovakia-Country-Report.pdf (celebio.eu)

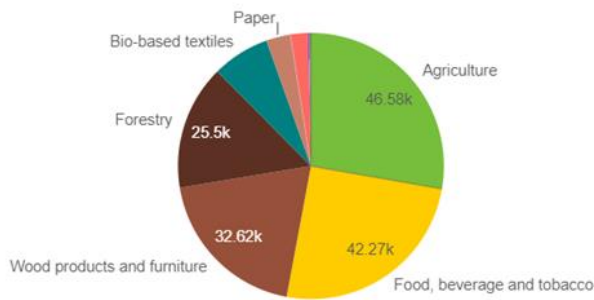
⁴³ https://ec.europa.eu/research/bioeconomy/pdf/bioeconomy_line_actions.pdf#view=fit&pagemode=none

⁴⁴ <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018DC0673&from=EN>

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The value added from the bioeconomy sector in the country was four billion Euros and in the same year there were 167,800 people employed.

Employment in the bioeconomy by sectors in Slovakia (2017)
(number of people employed)



Value added in the bioeconomy by sectors in Slovakia (2017)
(million €)

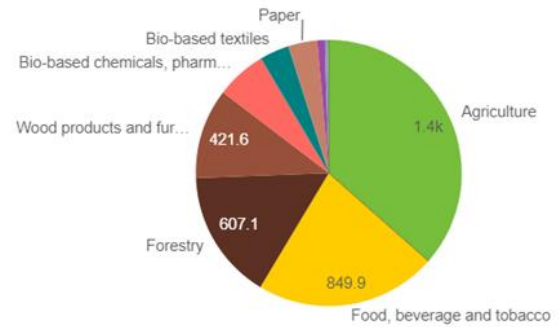


Figure 17 Employment and value added in the bioeconomy by sectors in Slovakia in 2017 (source: datam.jrc.ec.europa.eu)

Agriculture remains the biggest sector in terms of employment (27.7% of the total number of people employed) with food, beverage, and tobacco as well as wood products and furniture following (25% and 19.4% respectively). In terms of value-added agriculture is first with 1.4 billion Euros and the aggregate category of forestry, wood products and furniture is second with approximately 1 billion Euros. Food, beverage, and tobacco contribute with 0.85 billion Euros.

Slovakia has 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.

20.2. Strengths, opportunities and barriers

| | | | |
|---|--|--|---|
|  | <ul style="list-style-type: none"> • Appropriate size structure of agricultural holdings • Great potential for the use of agricultural land and especially natural grassland, good traditions in agricultural and forest land management • Favourable climate conditions • High soil quality in the lowlands • Sufficient water supply • The possibility of growing organic agricultural products in Slovakia, • Advanced information systems and sources of information on supply assessment and control | <ul style="list-style-type: none"> • Low added value production • Job creation, respectively job maintenance • Diversification of the rural economic base • Exploitation of local natural resources • Countryside capital inflow • Promoting the sale of local products • Farm production support • Development of inter-communal and cross sectoral cooperation • Large space for food processing in Slovakia, as the negative balance of food export / import is widening European Green Deal and its implementation in the Slovak Republic | <ul style="list-style-type: none"> • A high percentage of the rural population in the post productive age and an ongoing outflow of staffing capacities from rural areas • Inability to develop the land market as a prerequisite for business in agriculture • Foreign competition of agricultural products • Unresolved ownership relations to agricultural and forestry land • Insufficient anti-erosion measures in the country • Absence of rural development coordination • Frequently changing legislation • Climate change • The reluctance of manufacturers to create sales organizations and to participate in the formation of shortened sales chains • There are no strategies for agriculture and food processing development |
|  | <ul style="list-style-type: none"> • Increasing demand for timber and other services • Non-state forestry sector support through rural development program • Use of external financial resources • New legislation (explicit division into state and non-state forests) • Investment in applied forestry and timber research • Involvement Slovak entities in projects supporting bio-economy within the BBI-JU; • Increasing share of renewable energy sources (RES) from forestry in total RES production in SR, research activities in bioenergy • 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 | <ul style="list-style-type: none"> • Negative persistent public view of foresters • Non-governmental organizations (conservationists) and their particular objectives violating the principles of sustainable forest management (Bark beetle overgrowth treatment). • Frequently changing persons in respective ministries (central organs) • 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 • Demanding bureaucratic barrier from the side of the ministry when interested in applying from the EU funds and subsidies • Economic restriction by nature protection without financial compensation • Low law enforcement | <ul style="list-style-type: none"> • Insufficient municipal solid waste recycling. Only about 15% of the municipal solid waste is currently recycled. • Municipal waste management is underperforming and lacks appropriate economic signals that would divert waste from landfills and stimulate recycling and reuse • 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. • Illegal dumping • Bad air quality • Air quality continues to suffer from heavy use of brown coal in power generation, and air pollution remains one of the main environmental challenges • Low law enforcement |
|  | <ul style="list-style-type: none"> • 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) • State forest policy of Slovak Republic characterizes forests as a national wealth; therefore, the goal of sustainable economy is to protect. • Existence of well-functioning associations with accepted leaders • High economic efficiency forest management • Non-state forest owners own up to 52.3% of Slovak forests and they are more efficient managed as the state-owned ones. | <ul style="list-style-type: none"> • 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 • 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. • Increasing the efficiency of metal processing and of electricity generation from lignite could immensely increase the overall resource efficiency of the economy • Gradually increase the landfill tax. • Consider ICT for useful recycling. | <ul style="list-style-type: none"> • The country has substantially reduced its greenhouse gas emissions and the energy intensity of its economy • More progress has been achieved in the management of industrial waste, where 39% now goes for recycling, while only 36% is landfilled. • Positive changes in the legislation (growing landfilling costs) • New policy and regulations on returnable PET & aluminium cans |
|  | <ul style="list-style-type: none"> • The country has substantially reduced its greenhouse gas emissions and the energy intensity of its economy • More progress has been achieved in the management of industrial waste, where 39% now goes for recycling, while only 36% is landfilled. • Positive changes in the legislation (growing landfilling costs) • New policy and regulations on returnable PET & aluminium cans | <ul style="list-style-type: none"> • The country has substantially reduced its greenhouse gas emissions and the energy intensity of its economy • More progress has been achieved in the management of industrial waste, where 39% now goes for recycling, while only 36% is landfilled. • Positive changes in the legislation (growing landfilling costs) • New policy and regulations on returnable PET & aluminium cans | <ul style="list-style-type: none"> • The country has substantially reduced its greenhouse gas emissions and the energy intensity of its economy • More progress has been achieved in the management of industrial waste, where 39% now goes for recycling, while only 36% is landfilled. • Positive changes in the legislation (growing landfilling costs) • New policy and regulations on returnable PET & aluminium cans |

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20.3. Policy mechanisms relevant to bioeconomy in Slovakia

Slovakia does not have a strategy for the purpose of fostering bioeconomy, however there are regulations, developmental goals and priorities that are encompassed in the national strategy. Figure 18 outlines the policy mechanisms that are currently operational in Slovakia.

| | Production | Conversion | Distribution | End-use |
|---|---|---|---|---------|
| Agriculture, Forest, Waste | CAP: Slovakia Rural Development Programme | | | |
| | Act No. 57/2013 Agricultural soil- cultivation of fast growing trees | RES Act - Act No. 309/2009 Coll. on the Support of Renewable Energy Sources and High-efficiency Cogeneration | | |
| | Act No. 97/2013 Coll. on Land Associations | | | |
| | Act 478/2002 Coll. on Air Protection | | Excise Act: Mineral Oil Taxation Act (No. 268/2017 Coll. amended Act No. 98/2004 on excise duties on mineral oil. | |
| | Act No. 356/2019 Coll. on Nature and Land Protection | | | |
| | Act 478/2002 Coll. on Air Protection | | | |
| | Act No. 355/2019 Coll. on Forests (Amended the Forestry Act 326/2005) | Biofuel Quota | | |
| | Act No. 113/2018 Coll. on Placing Timber on the Market; Decree No. 232/2006 on Timber Harvesting, Labelling of Harvested Timber and Documents of Origin of Timber. | | | |
| | Act 79/2015 amended Waste Act: Act. No. 223/2001 | Green Households Programme: Operational Programme Quality of the Environment. | | |
| | The Slovak Energy Efficiency and Renewable Energy Finance Facility (SlovSEFF III) | | | |
| | Decree on biofuel Sustainability Criteria and transport fuel GHG targets | | | |
| | Feed-in Tariff: RES Act - Act No. 309/2009 Coll and Regulation No. 221/2013 amended in 2018 | | | |
| | National emissions target under the EU Effort Sharing Decision (406/2009/EC) Slovakia | | | |
| | 2014 Energy Policy (2035 and 2050 Horizon) | | | |
| The Environ Strategy 2030: The Strategy of the Environmental Policy of the Slovak Republic until 2030 | | | | |

Figure 18 Policy mechanisms relevant to bioeconomy in Slovakia (green: regulations; blue: financing; beige: information provision)

21. Vision and implementation plan

The Vision for the Slovakian Bioeconomy is to:

- ✓ **BECOME ONE OF THE MAIN PILLARS OF THE NATIONAL ECONOMY.**
- ✓ **ACHIEVE A RELATIVE FOOD SELF-SUFFICIENCY.**
- ✓ **GENERATE HIGH ADDED VALUE WITHIN THE WHOLE VALUE CHAIN CREATION OF THE BIOECONOMY PROCESSES.**
- ✓ **FOSTER CIRCULAR ECONOMY DEVELOPMENT.**
- ✓ **INCREASE REVENUE ENERGY SOURCES GENERATION.**
- ✓ **IMPROVE THE ENVIRONMENT AND TO MITIGATE OF THE CLIMATIC CHANGE.**

Consultations with experts in the field of bioeconomy have shown that the sector has significant development potential and its turnover can reach up to 2/3 of the turnover of the automotive industry in the course of a decade and can be compared to it in the future.

At the same time, bioeconomy can include the opportunities of the European Commission's "Green deal" initiative, contribute to increasing food self-sufficiency in the Slovak Republic, develop the circular economy based on domestic production and biomass use, increase waste treatment options, create domestic jobs, valorise domestic resources and contribute to increasing Slovakia's Gross Domestic Product (GDP).

22. Strengthen and scale-up the bio-based sectors, unlock investments and markets

This section focuses the Slovakian Action Plan on value chains selected by national stakeholders as promising ones that have significant potential for market uptake of domestic raw materials and are suitable to foster innovation for the existing industrial infrastructure.

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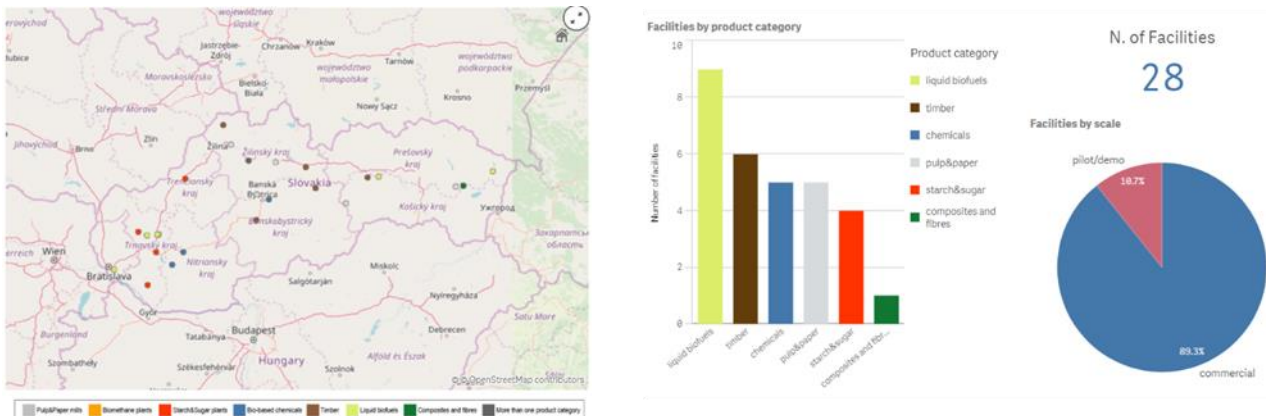


Figure 19 Biorefineries in Slovakia

(source: https://datam.jrc.ec.europa.eu/datam/mashup/BIODEBASED_INDUSTRY/index.html)

Figure 19 Biorefineries in Slovakia Provides and overview of the biorefineries in Slovakia. There are currently twenty-eight facilities operating in the country within the liquid biofuels, timber, chemicals, pulp and paper, starch and sugar and composites and fiber.

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 biobased economy and industry potential which could be used to develop sustainable and competitive production of food, feed, biomass and other biological raw materials.

CELEBIO has also engaged with national stakeholders to understand their perspectives of the Slovakian bioeconomy and select value chains with strong potential to uptake indigenous raw materials, foster the development of innovative products and contribute to the development of Slovakian bioeconomy.

22.1. Deploy local bioeconomies rapidly across Slovakia

The value chains mentioned below and selected by national stakeholders fit well the regional distribution of biomass raw materials across Slovakian regions.

22.1.1. Value chains from agriculture & food industry

Agricultural 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).

The value chains selected by the national stakeholders are:

- Agriculture
 - Efficient agriculture

- Soil care
- Irrigation systems
- Feed
- Food processing
 - Food production
 - Crop production
 - Food industry and processing capacity development
- Biofuel production
 - Production of biofuels from second generation agricultural residues
 - Use of agricultural biomass residues for agricultural purposes

The main aim of the selected value chains is to:

- Implementation of preventive measures for soil protection.
- Renewal of irrigation systems as well as the growth of new irrigation equipment using innovative technologies.
- Increasing domestic production of compound feeds.
- Use the country's potential to ensure relative food self-sufficiency.
- Development of a national strategy to achieve relative food self-sufficiency.
- Increasing value added, land yields per hectare and employment in agricultural production.
- Create an effective system of support for subsidies, including human resources, to ensure the gradual development of animal production.
- Soil care.
- Support for the production of bioethanol from non-food and / or feed residues of biomass.

22.1.2. Value chains from forestry

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 value chains selected by the national stakeholders are:

- Forestry
 - Effective forestry
 - Forestry systems: cultivation, protection & forest management
 - Ecological functionality of the forest
 - Forestry economics and policy Information systems and decision
 - Efficient logging technologies and mechanical processing
 - Wood processing
 - Wood processing, including cascade and recycling systems
 - Energy from wood biomass
 - Energy from wood biomass

The main aim of the selected value chains is to:

- Increasing the stability and vitality of forest stands.
- Strengthening forest functions in relation to climate change mitigation.
- Support and optimization of information and decision-making systems - development of forest management tools and increase of its efficiency
- Optimization of logging in the required structure and quantity corresponding to the needs of the bioeconomy.
- Creation of value chains.
- Increased efficiency of energy production from wood biomass, gradual replacement of fossil resources
-

22.1.3. Value chains from wastes

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.

The value chains selected by the national stakeholders are:

- Waste management
 - Waste treatment
 - Waste treatment
 - Reducing the number of landfills

The main aim of the selected value chains is to foster:

- Energy production from municipal waste.
- Reducing the number of landfills

23. Understand the ecological boundaries of the bioeconomy

23.1.1. Land use change

Land use is related to raw material production. Emissions from land use change can be significant in some circumstances, however, the simple notion of land use change emissions is not sufficient reason to exclude biomass from the list of worthwhile technologies for climate change mitigation, bioeconomy and circular economy.

The value chains selected for the Slovakian bioeconomy comprise of residual and waste fractions so there is no risk expected from their mobilisation and future exploitation.

23.1.2. Biodiversity

Forest biomass: High risks can be anticipated. Loss of dead wood and stumps may negatively influence species diversity and soil fauna. Contrary to this, leaving them all on the ground may result in increased fertilisation (N and wood ash) and negative impacts on vegetation

Agricultural biomass: medium risks can be anticipated without sustainable practices.

Biodiversity loss when harvesting too many crop residues

Absence of fertilisation with animal manure would reduce microbiological activity

Biowastes: Positive in regions where it avoids landfill

23.1.3. Soil & Carbon stock

Forest biomass: Increased risk of soil erosion; risk to lose soil organic carbon; risk to lose nutrients and risk of reduced soil fertility and soil structure when overharvesting forest residues

There are debates that using the wood in panel boards, creates a carbon stock in comparison to combustion of the wood

Agricultural biomass: Moderate risk to lose soil organic carbon when overharvesting crop residues; risk to lose nutrients when overharvesting

Absence of fertilisation with animal manure would reduce soil organic matter and soil nutrients,

Reduction of soil organic matter and soil nutrients

Biowastes: Positive in regions where it avoids landfill.

Digested organic waste is a source of soil improving material.

23.1.4. Water

Forest biomass: No effect on the quantity; If no removal leads to increased fertilisation the leaching on N to water may increase

Agricultural biomass: Reduction of soil water retention capacity, increasing risk of water erosion

Reduction of soil water retention capacity due to lower microbiological activity

Biowastes: Lower risk of water pollution in regions where it avoids landfill

Figure 20 Sustainability risks from the exploitation of biomass raw materials for bioeconomy in Slovakia (red: high risk; yellow: moderate risk; green: no/ positive impact)

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| Feedstock | | Sustainability risks (high- red; moderate- yellow; low- green) | | | |
|--|--|--|--|--|--|
| | | Land use (ILUC risk) | Biodiversity | Soil & Carbon stock | Water |
| Primary forestry production | Stemwood from thinnings & final fellings | None | Loss of dead wood and stumps may negatively influence species diversity and soil fauna. Contrary to this, leaving them all on the ground may result in increased fertilisation (N and wood ash) and negative impacts on vegetation | Increased risk of soil erosion; risk to loose soil organic carbon; risk to loose nutrients and risk of reduced soil fertility and soil structure when overharvesting forest residues | No effect on the quantity; if no removal leads to increased fertilisation the leaching on N to water may increase. |
| Primary forestry production | Stem and crown biomass from early thinnings | | | | |
| Primary forestry residues | Logging residues from final fellings | | | | |
| Secondary residues from wood industries | Saw mill residues | None | None | There are debates that using the wood in panel boards, creates a carbon stock in comparison to combustion of the wood | None |
| Secondary residues from wood industries | Other wood processing industry residues | | | | |
| Agricultural residues | Straw/stubbles | None | Biodiversity loss when harvesting too many crop residues. This may also have adverse effect on soil biodiversity | Moderate risk to loose soil organic carbon when overharvesting crop residues; risk to loose nutrients when overharvesting | None |
| Secondary residues of industry utilising agricultural products | By-products and residues from food and fruit processing industry | None | None | None | None |
| Biodegradable municipal waste | Biodegradable waste | None | Positive in regions where it avoids landfill | Positive in regions where it avoids landfill; Digested organic waste is a source of soil improving material. | Lower risk of water pollution in regions where it avoids landfill |

24. Value chains for the Slovakian bioeconomy

This section provides facts tailored to each value chain in terms of current exploitation of raw materials, future actions that could steer innovative and resource efficient market uptake for biobased products, potential interventions and expected added value.

This information has resulted from the consultation with national stakeholders within the duration of the project. This section includes information on the relevance to the UN Strategic Development Goals (SDGs), selected relevant projects and markets for the biobased products that will derive from each value chain.

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24.1. 6.1. Manure for biogas & organic fertilisers

| Value chain | SDGs | Examples of relevant projects |
|---|----------|---|
| Manure for biogas & organic fertilisers | | https://www.4p1000.org/ |

Current exploitation of biomass raw materials

- Manure utilization is approximately 10% of the known potential.
- The existing network of biogas plants (those of the order of 1 to 4 MW predominate) consists of oversized installations, causing excessive environmental loads (too little area for fertilization with digestate of biogas plants)

Future actions

Establishment of smaller biogas installations (range of 250 kW) on larger agricultural holdings, or in cooperation with other users (eg local communities) in collective investments

Potential interventions

Climate & Energy Fund: Subsidy schemes for biogas installations

Standards for agricultural biomass

Introduce premiums for manure

Regulation on agricultural raw materials for biofuels and bioliquids

Expected added value

Reduced nitrates in the soil

Sustainable energy

Soil carbon sequestration

| Product Group | Market size |
|--------------------|-------------------|
| Agro-chemicals | 1,000 – 10,000 kt |
| Fertilisers | |
| Sustainable Energy | >10,000 kt |

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24.2. Residues from agri- food industries

| Value chain | SDGs | Examples of relevant projects |
|--|----------------------|--|
| Dairy production (mainly sour whey) - > extraction / biotechnological processes -> food additives, enzymes / biorefinery -> platform chemicals -> biobased materials | | Web site http://www.agrimax-project.eu Web site https://www.agrichemwhey.com/ Web site https://www.excornseed.eu/ Web site http://www.demeter-eu-project.eu |
| Residues from cereal processing to biobased materials (bioplastic, biocomposites) & biogas plants for energy | | |

Current exploitation of biomass raw materials

Currently most of the agri-food residues end up as waste.

Future actions

- Processing of dairy production residues: extraction of individual fractions (e.g., lactose, proteins, bioactive peptides), or through biotechnological processes, related extraction of platform chemicals (eg alcohols, polysaccharides, organic acids, biosurfactants, biologically active components and enzymes) or as a raw material for microbial production biomass (e.g. meat substitute)
- Specialised installation for management of side streams from meat productions, technologically advanced processing with relatively high added-value products; currently, the main challenge is more efficient and environmentally sustainable use of digestate from biogas plant.

Potential interventions

Standards for agricultural biomass

Introduce innovation financing for food SMEs and industries

Regulation on agricultural raw materials for bioeconomy

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Expected added value

- Less wastes from food-processing, use of side streams and reduction of negative impact on the environment. Subsequently, improved revenues of all the involved stakeholders.
- Untapped potentials in obtaining functional components and materials (bioactive components, fibrous materials) before energy use

| Product Group | Market size |
|-----------------------|---------------------|
| Cosmetics | S <1,000 kt |
| Paints & coatings | |
| Plant based-chemicals | M 1,000 – 10,000 kt |
| Fertilisers | |
| Sustainable Energy | L >10,000 kt |

24.3. Forest based value chains

| Value chain | SDGs | Examples of relevant projects |
|---|------|---|
| Forest residues biorefinery -> platform chemicals for biobased materials) | | <p>Web site https://www.bioforever.org</p> <p>Web site https://www.luke.fi/efforte/</p> |

Current exploitation of biomass raw materials

- Increased logging (5-6 mill. m3 annually), largely on account of emergency logging due to damaged forest stands (climatic events, pests), emergency logging. 75% of coniferous wood (70% of timber harvested) sold as logs, other pulp&paper, plywood. 56% of deciduous wood used as firewood; From the point of view of the long-term perspective, this is a category that will gain in importance with changes in forest stands (growing share of beech). On the long-run (due to climate change), beech production will increase, bringing additional potential for biorefining processes and the subsequent production of new bio-based materials.
- Low value-added of timber harvested in Slovakian forests.
- Fragmented ownership structure, which makes it difficult to establish efficient supply chains; 76% of forests in Slovakia are privately owned, 314,000 owners, average size of forest holding is 2.9 hectares.

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Future actions

- Increased commercial use of roundwood within Slovakia, strengthening technologically more advanced alternatives to the energy use of lower quality wood assortments; optimization of logistics flows, primary processing at the local level and biorefining.

Potential interventions

- Forest Certification
- Introduce innovation financing for food SMEs and industries
- Regulation on agricultural raw materials for bioeconomy

Expected added value

- Bring lower quality wood to better use than energy use, i.e., bio-based processes (biorefinery)

| Product Group | Market size Europe |
|-----------------------|--------------------|
| Cosmetics | <1,000 kt |
| Paints & coatings | |
| Plant based-chemicals | 1,000 – 10,000 kt |
| Sustainable Energy | >10,000 kt |

24.4. Value chains based on biowastes

| Value chain | SDGs | Examples of relevant projects |
|---|----------------------|---|
| Biowastes to biogas installations for energy & composting | | Web site Web site Web site http://www.percal-project.eu |

Current exploitation of biomass raw materials

High cost of disposal of sludge due to cross-border transport (no disposal capacity in Slovakia)

Future actions

- Awareness raising about waste sorting and collection.

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- Development of biogas plants that would utilize untapped waste streams. Communication with all relevant stakeholders on improving the legislative framework

Potential interventions

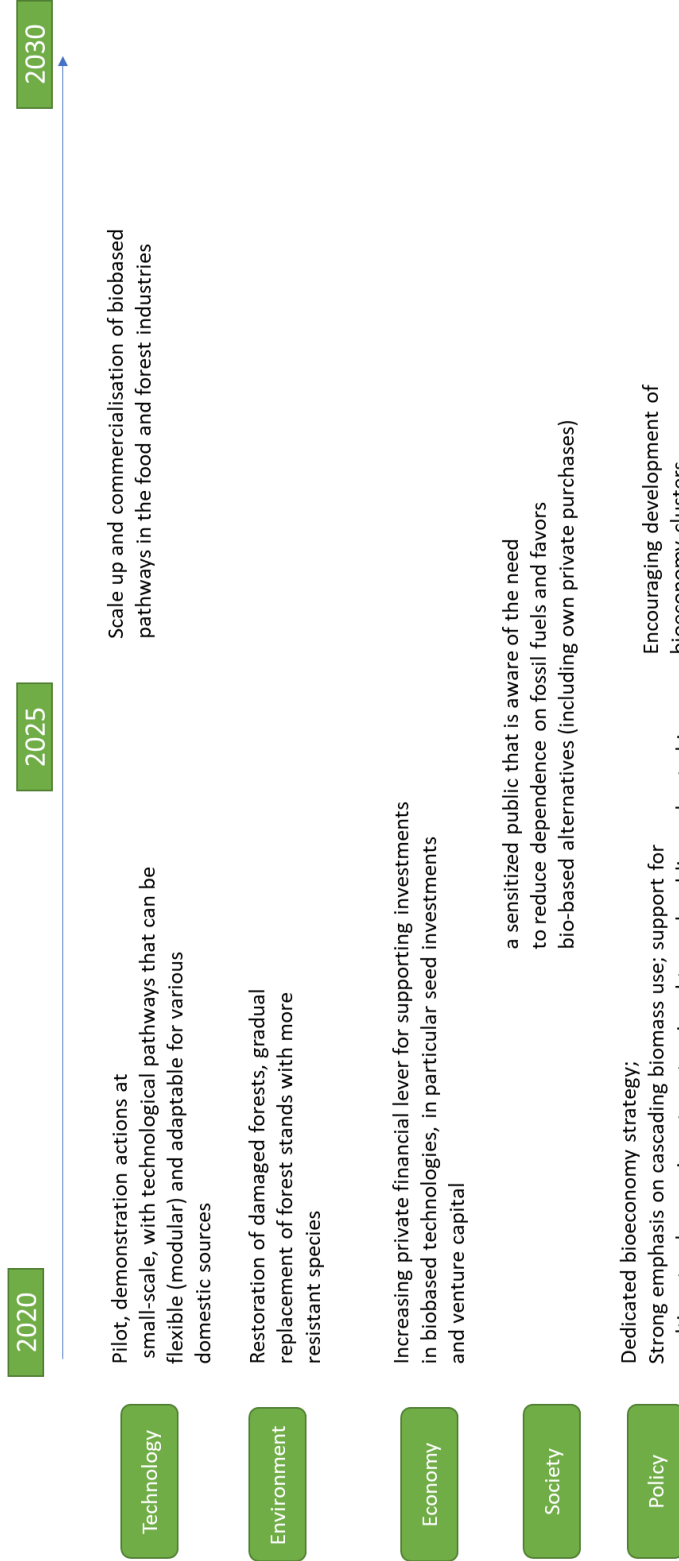
- Incentives for the use of waste for biogas production (subsidies) and fostering the development of clean and renewable energy production. This could include penalties and rewards for energy production, depending on their environmental impact.

Expected added value

- Increased use of urban/municipal waste, cleaner energy, reduced environmental impact, potential to improve revenue of all stakeholders
- Efficient system of urban waste collection, improvements possible in higher share of energy utilisation (biogas)

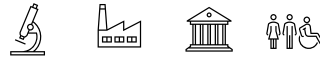
| Product Group | Market size |
|-----------------------|---------------------|
| Cosmetics | S <1,000 kt |
| Paints & coatings | |
| Plant based-chemicals | M 1,000 – 10,000 kt |
| Fertilisers | |
| Sustainable Energy | L >10,000 kt |

25. Implementation plan



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Actors and funding opportunities



| Action ⁴⁵ | Actors involved | Indicative cost | Funding instruments |
|--|-----------------|---|---|
| Pilot, demonstration actions at small-scale, with technological pathways that can be flexible (modular) and adaptable for various domestic sources (T) | | 2020-2025: 10 million € 2025- 2030: 20 million € | Eco-Fund: Loan, subsidy and tender for RES-E RES-H new building obligation |
| Scale up and commercialisation of biobased pathways in the food and forest industries (T) | | 2025- 2030: 50 million € | Next Generation EU Action Plan on financing sustainable growth |
| Restoration of damaged forests, gradual replacement of forest stands with more resistant species (Env) | | 2020-2025: 10 million € | Action Plan on financing sustainable growth CAP |
| Increasing private financial lever for supporting investments in biobased technologies, in particular seed investments and venture capital (Econ) | | 2020-2030: 50 million € private funds | Next Generation EU |
| Informed citizens that are aware of the need to reduce dependence on fossil fuels and favors bio-based alternatives (S) | | 2020-2030: 5 million € | Action Plan on financing sustainable growth |
| Dedicated bioeconomy strategy; Strong emphasis on cascading biomass use; support for multi-sectoral group investments, aimed towards adding value to biomass (P) | | 2020-2030: 1 million € | Action Plan on financing sustainable growth |
| Encouraging development of bioeconomy clusters (P) | | 2020-2030: 10 million € | Action Plan on financing sustainable growth |

⁴⁵ T: Technology; Env: Environment; Econ: Economy; S: Society; P: Policy



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