



Bio-based strategies and roadmaps for enhanced rural and regional development in the EU



Bioeconomy Development Roadmap for Strumica region

November, 2021

SDEWES-Skopje and Strumica region stakeholders working group



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 818478.

ACKNOWLEDGMENT & DISCLAIMER

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EXECUTIVE SUMMARY

Chapter 1 presents the results of an enhanced PESTEL analysis of the Strumica region, including biomass profiling and a SWOT analysis. The bioeconomy potential in terms of biomass amount and its utilization and agricultural and forest residues is depicted. Furthermore, it dives deeper into regulatory, social-economic, technical and environmental conditions, essential for the municipalities to further develop the regional-bio-based sector. Additionally, existing weaknesses and threats that prevent the region to fully and more intensively develop the bioeconomy are recognized. Potential synergies and complementarities with the national level and with relevant documents are identified.

Chapter 2 is focused on the global, national and local drivers which are key for the bioeconomy transition in the Strumica region. At the same time, the main barriers that prevent effective regional bioeconomy development and should receive prioritised attention from policy-makers are detected.

Chapter 3 of the roadmap document outlines several groups of activities that should be realized in the future:

- *Increasing the flow of knowledge and strengthening the links between research and practice*
- *Strengthening advisory services for agricultural products within the Knowledge and innovation system in agriculture*
- *Improving interactive innovation through Operational Groups for agricultural innovation partnerships*
- *Supporting the digital transition in agriculture*
- *Introduction of a system for compulsory training and education in agriculture.*

The activities address **six thematic pillars**:

- *Business sector development;*
- *Research and Innovation capacities and activities;*
- *Use of diverse EU, national and regional funding streams;*
- *Synergies with other policy fields, related to rural and regional development, as well as smart specialization strategies;*
- *Education and information in relation to sustainability and International collaboration and sharing good practices among regions.*

The specific actions for each of the pillar are elaborated qualitatively, including the objective and the desired timeframe. Moreover, the type of the activity, the sector wo which it belongs, and its scope are identified. A connection with relevant legal and regulatory documents was established in order to perceive the acceptable conditions for a measure to develop. Initial assumptions how the activities will evolve have been made. To bridge the forthcoming challenges, some further steps are introduced. In order to follow the progress on the different activities, a set of indicators is suggested and recommended to be measured throughout the proposed period. Furthermore, the financing body and accordingly the implementing and monitoring entity are presented. Finally, synergies with the UN SDGs were specified in order to align the regional goals with overarching sustainability principles.

The business model assessed in the context of BE-Rural Mycelium-based Packaging and Insulation Material is briefly demonstrated with a business model canvas, because it is found that it has a potential to evolve in a successful bio-based project.

Chapter 4 depicts the potential impacts from a successful implementation of the bioeconomy roadmap in the region, focusing on enhanced stakeholder engagement, international collaboration, and transparent regulatory and financial support.

The expected impacts of the roadmap aim at enhanced stakeholder engagement, close international collaboration, fair and transparent regulatory and financial support. In addition, the creation of new, modern and green jobs extremely valuable for the progressing regional economy and stable markets. It is expected that the sustainability and circularity will be embedded in various aspects among quadruple stakeholder's helix and further promoted. Moving forward with a bio-based economic development would have better policy congruence, improved legitimacy and representation, enhanced business development, easier knowledge sharing and greater knowledge creation. It is anticipated that the bioeconomy will have the additional impacts on sustainability and circularity such as better utilization of agriculture and forest residues, improved energy security and local self-sufficiency and reduced biosphere degradation.

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Abbreviations

BAU	Business-As-Usual
CAGR	Compound Annual Growth Rate
CAP	Common Agricultural Policy
EC	European Commission
EU	European Union
EUREPGAP	European harmonized certification for food safety, sustainable production methods, worker and animal welfare, and responsible use of water, compound feed and plant propagation materials
GDP	Gross Domestic Products
GHG	Greenhouse Gas
HACCP	Hazard Analysis Critical Control Point
ICT	Information And Communications Technology
IPA	Instrument For Pre-Accession Assistance
IPARD	Instrument For Pre-Accession Assistance - Rural Development
JRC	Joint Research Centre
LCA	Life Cycle Assessment
LEADER	Links Between Actions for The Development of The Rural Economy
LEAP	Local Environmental Action Plan
NATO	North Atlantic Treaty Organization
NDC	Nationally Determined Contribution
NECP	National Energy and Climate Plans
NGO	Non-Governmental Organization
NUTS	Nomenclature Of Territorial Units for Statistics
PESTEL	Political, Economic, Social, Technological, Environmental and Legal
PhD	Doctorate
R&D	Research And Development
R&I	Research & Innovation
RES	Renewable Energy Sources
RIS3	Research And Innovation for Smart Specialisation
S3	Smart Specialization strategy
SDG	Sustainable Development goals
SMEs	Small And Mid-Size Enterprises
SWG	Stakeholder Working Group
UN	United Nations
WeBSEFF	Western Balkans Sustainable Financing Facility
WHO	World Health Organization

1 Introduction

The Strumica region is located in the southeastern part of North Macedonia, close to Bulgaria and Greece. The region consists of four municipalities – Bosilovo, Vasilevo, Novo Selo and Strumica with an area of 935 km² and a population of 93,024 inhabitants. Due to favourable climatic conditions, the Strumica region is the largest producer and exporter of agricultural products in North Macedonia. The richness of natural resources is a solid base for the future economic development with a number of prosperous SMEs. The closeness and connection to European borders and markets and the commitment of municipalities towards common development renders the Strumica region an excellent candidate for development of a bioeconomy roadmap.

Chapter 1 gives an overview of the current situation in Strumica region from various aspects. The bioeconomy potential in terms of biomass amount and its utilization and agricultural and forest residues is depicted. Furthermore, it dives deeper into regulatory, social-economic, technical and environmental conditions, essential for the creation of a successful roadmap for the municipalities to develop in bioeconomy context. Additionally, the common weaknesses and threats that prevent the region to fully and more intensively develop are recognized and should be bridged with the associated strengths and opportunities on national and regional level. Nonetheless, synergies with other relevant documents are identified and aligned with the bioeconomy roadmap for Strumica region.

Chapter 2 is focused on the global, yet national and local drivers which are key for the bioeconomy transition in Strumica region. Therefore, the existing pathways such as 2030 Agenda for Sustainable Development and EU Green Deal can ease and facilitate the bioeconomy development process in Strumica region. Downscaling the status quo of the rural development measures aimed at creating businesses or diversifying economic activities in rural areas are a contributing driver. Another driver which results from the synergies with other strategic and policy documents are the national and climate targets, moreover the climate changes impact on the agriculture. Nonetheless, an accessible and diverse funding streams are essential drivers for growing bio-based sector. At the same time, the main barriers that prevent the bioeconomy development are detected and will become a matter of urge improvement.

Chapter 3 is the key component of the bioeconomy development roadmap for Strumica region. It is developed within six different, but related focus areas, namely Business sector development; Research and Innovation capacities and activities; Use of diverse EU, national and regional funding streams; Synergies with other policy fields, related to rural and regional development, as well as smart specialization strategies; Education and information in relation to sustainability and International collaboration and sharing good practices among region. In each of the pillars a strategic goal has been envisaged accompanied with a brief action plan how to proceed with certain activity. In addition, a case study that receives the most attention is the Mycelium-based packaging and insulation material, which for a business model canvas was developed and go along side with the bioeconomy roadmap.

Chapter 4 reflect on the possible results from a successful implementation of the bioeconomy roadmap in the region. Enhanced stakeholder engagement, close international collaboration, fair and transparent regulatory and financial support are part of the expected impacts that the roadmap will have. In addition, the creation of new, modern and green jobs extremely valuable for the progressing regional economy and stable markets. It is expected that the sustainability and circularity will be embedded in various aspects among quadruple stakeholder's helix and further promoted.

The bioeconomy can help in reaching the strategic goals set for Strumica region, specifically in the climate, energy, agriculture, industry and environment, thus benefit from greater research, innovation, finance and regional development.

2 Setting the ground for roadmap development

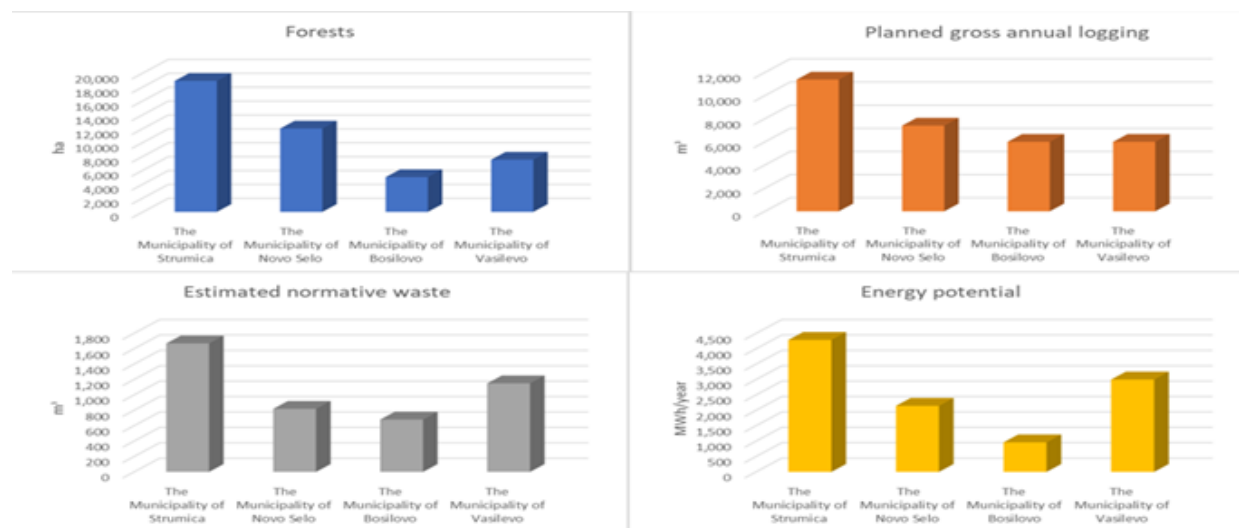
Chapter I gives an overview of the current situation in Strumica region from various aspects. The bioeconomy potential in terms of biomass amount and its utilization and agricultural and forest residues is depicted. Furthermore, it dives deeper into regulatory, social-economic, technical and environmental conditions, essential for the creation of a successful roadmap for the municipalities to develop in bioeconomy context. Additionally, the common weaknesses and threats that prevent the region to fully and more intensively develop are recognized and should be bridged with the associated strengths and opportunities on national and regional level. Nonetheless, synergies with other relevant documents are identified and aligned with the bioeconomy roadmap for Strumica region.

2.1 Biomass potential

In order to be able to develop bioeconomy strategies and roadmaps or even business models in a region, it is important to be able to estimate the potential of the required raw materials, the biomass potential. Biomass potential is a term used to estimate possible contributions of biomass to the energy or raw material market. As a target figure, the biomass potential indicates which cultivated areas or raw material quantities are available in a region for use as renewable raw materials. It is important to mention that these capacities are not only biomass for energy and material use, but also for food.

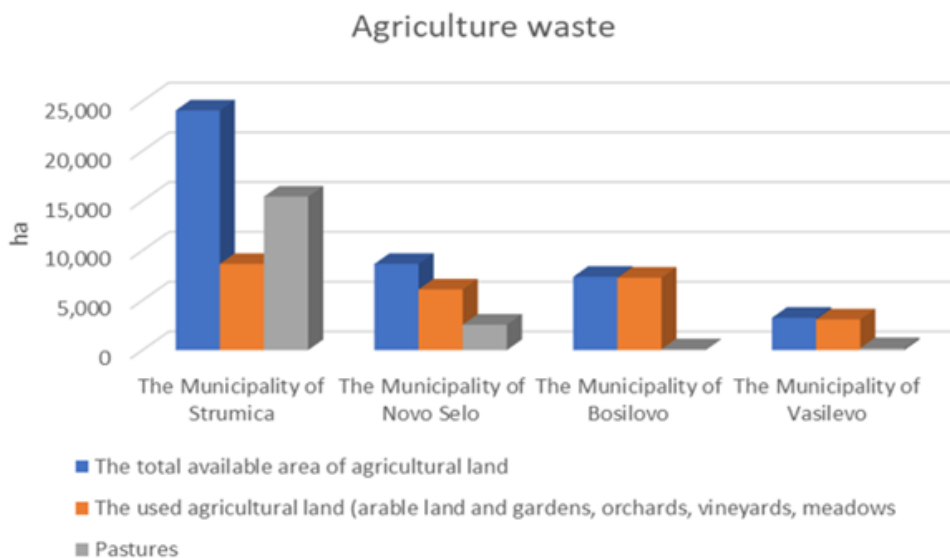
The region's natural resources and climate are excellent for various kinds of agricultural production and animal husbandry, including viticulture, vegetable and fruit cultivation, livestock breeding and forest industries involving wood. The focus will be the use of biomass materials generated in agricultural operations, including crop residues and by-products of processing. The region does not possess enough raw material from forest biomass to be used for a biorefinery concept, but this raw material could be sufficient to be used for other small-scale applications like pellets and wood chips production for energy purposes, or for the production of some bio-based lignocellulosic commodities, especially given that there is no competition over this raw material for other uses in the region (Figure 1).

Figure 1: Deforestation waste



Source: "Study on the potential and utilization of renewable energy sources in the cross-border region"

Concerning raw materials coming from agricultural residues, they are also not sufficient for a biorefinery concept, but as it is the case for forest biomass, the raw materials can be used in many other applications for energy purposes and for bio-based products (Figure 2). Statistical information on the type of agricultural residues is needed as the first step in order to propose the appropriate applications. Also, for agricultural residues, there is no competition for other uses. Furthermore, combining agricultural residues and forest biomass, a number of bio-based commodities can be produced such as pots, containers, construction boards etc.

Figure 2: Agriculture waste

Source: "Study on the potential and utilization of renewable energy sources in the cross-border region"

As for waste, there is no data on the type and quantity of waste generation, but there is a strong agri-food industry which consequently means that such waste exists. In the simplest scenario and even if this data is lacking, the waste from the agri-food sector – as it is mostly a wet waste – can be used for biogas production in an anaerobic digestion system and consequently produce electricity. In this case, the manure coming from animal husbandry can also be used in the same way. As the livestock farms are scattered in the region, agri-food industries and livestock farmers can cooperate to build up anaerobic digestion systems using both types of waste. As an alternative, these types of waste can be simply composted to produce fertilisers.

2.2 Political conditions

Political conditions that favour development of a bioeconomy roadmap include strong political will for EU integration and an ongoing process of structural reforms aimed at adopting EU policies, standards and best practices - including those related to bioeconomy. The Strumica region has a relatively well-developed capacity for strategic planning in a participatory manner, as shown by previous efforts of the region's municipalities to team up to build a Regional Centre for Local Economic Development. Though the Centre has been inactive the last five years, local authorities had started working together with partners from the public, private and non-governmental sectors. In the Strumica region, the Institute of Southern Crops¹ and the Agency for Promotion of Agriculture are the main responsible entities for the successful realization of vegetable production in greenhouses. In addition, many private consultants and advisors contribute to the education of agricultural producers in the application of new technologies for this sector. Individual agricultural producers in the Strumica region are organized in several associations and one regional union. Driven agricultural clusters should foremost be priority for expediting the communication and collaboration between key stakeholders.

Neither the country of North Macedonia nor the Strumica region have published bioeconomy strategies. However, existing local strategies for economic development and energy efficiency programmes provide a solid base for developing bioeconomy roadmaps and strategies.

As part of North Macedonia's Southeast Planning Region, the Strumica region borders two EU countries (Greece and Bulgaria) and participates in numerous cross-border projects funded by the EU. Strumica is the only one of the five BE-Rural regions located in an EU candidate country, so it could

¹ For more info see: <https://wbc-rti.info/object/organisation/9401>

contribute to diversifying the experiences and knowledge gathered regarding promotion and adoption of bioeconomy concepts across Europe.

2.3 Economic conditions

The main economic activity in the Strumica region is agriculture, especially production in greenhouses and vegetable production. The region is the largest producer and exporter of agricultural products in the country. Regional authorities are keen to integrate their market into the wholesale EU market for agricultural products, but so far investment toward this end has been ad-hoc rather than strategic and anticipated.

The Strumica region has mainly small and medium-sized enterprises that generally lack economic, financial, technical and administrative support. Although the last census was organized in September, 2021, by the time of conducting this bioeconomy roadmap, more updated data is not available. Therefore, according to data from the last census in 2002, the average GDP per capita for the Strumica region is €5,194, just below North Macedonia's capital, Skopje (€5333).²

The total number of active business entities in the region is 7,224. The number of business entities related to the bioeconomy and rural development is around 900 - these include mostly individual farmers, but also other enterprises related to agriculture as well as hunting and forestry.³ Domestic and foreign direct investment in such businesses has been lacking, and agricultural subsidies have not been structured in a way that produced expected results.

There are currently four industrial zones in the Strumica region. Startups and business incubators foster entrepreneurial behaviour and support start-up companies by sharing resources and services in the form of management advice, training, etc. One example is the Business Centre for Agricultural Development - Strumica, established in 1997 by the World Bank. However, there is a lack of experience and models to create associations of stakeholders united voluntarily to meet their common economic interests.

The Strumica region contains many attractions that have potential to be expanded into larger ecotourism sites, particularly in the area of balneology/wellness/spa tourism. These include Carevi Kuli, Smolare, Koleshino and Gabrovski Falls, Bansko thermal baths, and Belasica mountain. According to data from a 2018 development plan - capitalising on the area's ecotourism and wellness sites in connection with local culture and agriculture has excellent bioeconomy potential, given the rise in ecotourism over the past decade.

2.4 Social conditions

Strumica is characterised by disparities in the social and economic development of rural municipalities: compared to urban areas, there is less entrepreneurship, a lower living standard, lower availability of services, lack of infrastructure, and higher unemployment. The rate of unemployment and poverty index are relatively high, while the GDP per capita is relatively low. The average unemployment rate in Strumica region is 40.63%.⁴

Another significant social problem in the region is population decrease due to migration of the young population abroad, especially educated individuals. This so-called "brain drain" is increasing. The birth rate is also below replacement level, further decreasing the population. Measures to increase quality of life, as well as further development of the region's agriculture sector, could counteract the migration trend.

² For more info see: <https://www.stat.gov.mk>

³ For more info see: <https://www.stat.gov.mk>

⁴ For more info see: <https://www.stat.gov.mk>

As 2021 census data are not yet proceed, the educational attainment in the Strumica region from the census of 2002 was distributed as follows: 4.4% of the population held a graduate degree, 3% an associate's degree, 31.7% completed secondary education, 30.5% completed primary education, 25.40% had incomplete primary education and 5% had no school education. These figures have likely changed significantly over the intervening almost 20 years.⁵

The skilled workforce, the technical expertise and trainings are also critical for the development of the bioeconomy in a region. With regard to forest biomass, there is a suitable workforce for procurement activities, but not for bio-based and bioenergy applications. Furthermore, no training actions have been taken in this context. The fact that there is no high-level education in the field of biomass use and no centres of excellence beside the existing secondary vocational education is seen as an important barrier in the development of the bio-based economy in the region. To overcome this barrier, suitable workforce can be brought from other regions or countries, but for the further stable development of the bioeconomy in the region, it would be important to introduce the topic of biomass use and bioeconomy in schools and universities and offer trainings in the field.

Until recently, there has been little cooperation among various bioeconomy-relevant stakeholders in Strumica's population, especially minorities and vulnerable groups, given slow and inefficient administration at the national and local levels. More recently there are positive examples of integration of these groups in local governance, education and society as a whole, accompanied with adequate infrastructural support and social programs: recently cooperation and coordination between educational institutions and the business sector has improved. The cooperation has led to improved living conditions that may decrease the migration process in the region.

The bioeconomy is underestimated in North Macedonia, more so in rural areas. Only recently progress on raising the population's awareness, thinking and acting is being gradually achieved through forums, debates, social media, training courses, educational seminars, promotional events and gatherings, pop-up stores, printed promotion materials, audio and video materials, and prepared analyses.

2.5 Technical conditions

The Strumica region has potential to grow its technological base for the processing of agricultural products. However, outdated agricultural practices, underdeveloped infrastructure and limited inter-regional connectivity slows the modernization process and the uptake of new technologies.

Currently, Strumica's industry, service, energy, and transport sectors rely primarily on fossil fuels. Several feasibility studies and concrete project ideas have been discussed at the municipal and regional levels to change that status. Various local institutions, from building owners to schools, are open to renewable energy options. These include:

- Production of thermal energy (steam and hot water) from hot springs (with total thermal power ~20MW)
- Combined heat and power at an existing thermal power plant by replacing part of the feedstock with biomass and using a back pressure turbine and/or producing electricity with a biomass-condensation turbine
- Replacing solid fuel boilers with biomass boilers (woodchips or pellets) in municipal schools or connection with biogas plant
- Using biogas from agricultural operations for electricity production

Existing small-scale renewable energy facilities in the region, which could either be expanded as part of local bioeconomy development or serve as a model to be replicated, include:

- A planned new regional landfill in the Municipality of Vasilevo, which will take waste from all 10 municipalities in the Southeast Region and produce 2,400 MWh/yr from capture and combustion of landfill gas - enough to cover the annual electricity consumption of 370 households

⁵ For more info see: <https://www.stat.gov.mk>

- Beyond the area's existing waste water treatment plant, which processes the waste water of half the population in the region, a number of ongoing projects are constructing smaller waste water treatment facilities

Given the region's economic focus on agriculture, the most relevant applications of biotechnologies and bio-based products are:

- pelletizing and briquetting (of e.g., crop residues and forest biomass for combustion)
- gasification or pyrolysis (from the agricultural residues for production of biochar or energy)
- anaerobic bio-digestion (for production of biogas from manure at livestock operations)
- composting (from e.g., leaves from parks or municipal/residential landscape residue)
- production of bio-based additives (e.g., lubricants, paints, coatings, from nanocellulose root vegetables fibers).

2.6 Environmental conditions

The climate in the Strumica region is sub-Mediterranean intersecting with the eastern-continental climate - this makes for long, warm summers and cooler winter temperatures. The average annual temperature is 13.4°C. The region's abundant rainfall (average 459 mm/yr) is a significant asset to agriculture, as even in the driest months there is a lot of rain. These consistent precipitation levels render the area particularly conducive to growing fruits and vegetables (peppers, melons, potatoes, tomatoes, cabbage, cucumbers), cereals (wheat, maize, barley), forage crops (clover), industrial plants (tobacco), as well as fruit orchards and vineyards.

The agricultural area in the Southeast region alone makes up 8.83% of North Macedonia's territory. This agricultural area is predominantly privately owned. Wood is the most used biomass for heating of households and greenhouses in the region. The agriculture sector is the second biggest producer of solid waste (animal and plant) in the Southeast region after the mining sector. Available RES such as biomass, biogas, biofuels (eco-diesel), waste, geothermal energy, solar (260 sunny days), and hydro are not used sufficiently.⁶

2.7 Legal and regulatory conditions

The following laws are considered relevant to the development of the bioeconomy in the Strumica region:

- The *Law on agriculture and rural development* regulates the planning of agricultural and rural development, the goals of the national agricultural policy, partnership with social and economic partners, support of agricultural markets and national financial support.
- Other relevant agricultural legal framework involve: *Law on Agricultural Land*, *Law on Organic Agricultural Production*, *Law on the quality of agricultural products*, *Law on Seeds and Seedlings for Agricultural Plants*, *Law on fertilizers*, *Law on Plant Health*, *Law on Plant Protection Products*, *Law on Tobacco*, *Tobacco Products and Related Products*, etc.
- Management of forests and forest land on the territory of the Municipality of Strumica is regulated by the national *Law on Forests*.
- In accordance with the *Law on Waste Management*, municipalities are responsible for management of certain waste types, including organising its collection, transport and disposal. Decisions on the location of waste management facilities and local regulations on waste management are taken at the local level.

⁶ For more info see: <https://strumica.gov.mk/wp-content/uploads/2020/07/LEAP1.pdf>

- Legislation regulating the area of *Water Management* includes water supply systems, individual sources, water use by and needs of the population, as well as industry and agriculture. That law covers the largest hydro-reclamation systems "Bregalnica", "Tikves" and "Strumica" with total area of 72,881ha. Surface water quality assessment is carried out in accordance with criteria defined by *Legislation of the Water-economy Basis of Macedonia*.
- The responsibilities of the Municipality in relation to urbanisation are as follows: *Law on Spatial and Urban Planning, Law on Construction, Law on Construction Land, Legislation of the Spatial Plan of the Republic of Macedonia and General Urban Plan of the City of Strumica*.

Other pieces of legislation which would frame and thus could indirectly influence the deployment of a regional bioeconomy in the Strumica region include: *Law on Environment, Law on Ambient Air Quality, Rulebook on energy performance of buildings, Rulebook on RES, Rulebook on the emission limit values and types of pollutants in waste gases and vapours emitting stationary sources of air, Law on Environmental Noise Protection, etc.*

The municipality of Strumica, as the largest municipality in the region, has various laws, regulations, and plans that have counterparts at the national level. However, the other three municipalities, which are less populated, do not have proper documentation of local regulations or ordinances that reflect their current management in areas relevant to the bioeconomy. Further, the regional legal documents listed here remain only partially implemented in all the municipalities. Moreover, the Strumica region is undergoing a fiscal decentralisation process that requires new competences in the municipalities, as well as improvement of human and technical capacities. The main regulatory instrument relevant to bioeconomy development in the region is the Local Environmental Action Plan (LEAP) for the Municipality of Strumica under jurisdiction of the Ministry of Environment and Physical Planning and the Law for environment. Issued in 2016, this plan has a six-year timeframe and supports compliance with environmental requirements in the process of accession to the EU.

While a well-developed regulatory framework is in place in North Macedonia, implementation and enforcement remains an issue. Stricter inspection and enforcement are necessary, especially at the municipal level, when it comes to competition law, standardization of agricultural (organic) production, international quality standards like EUREPGAP AND HACCP, and construction.

2.8 Synergies with other relevant documents

The following rural development and agriculture strategies include provisions that could be favourable to the bioeconomy in North Macedonia:

- *The Smart Specialisation (S3) process* in North Macedonia started in March 2018 and the country intends to adopt its RIS3 in 2022 by following the JRC methodological framework for smart specialisation in the EU enlargement and neighbourhood countries. An improvement is foreseen with the development of a new strategy for local economy development with an emphasis on the bioeconomy, circular economy, and sustainability.⁷
- "*National strategy for agriculture and rural development for the period 2021-2027*" (2020) is operational document for the implementation of the national agricultural policy and rural development. It links strategic policy documents with annual operational programs and agricultural and rural policies.⁸
- "*Communication and visibility plan of the rural development network of the Republic of Macedonia 2019-2022*" (2019) should provide effective communication of the network and activities for successful promotion before defined target national and international groups. The plan includes media-related activities, public events, such as training, workshops, seminars, conferences, roundtables, forums.⁹

⁷ For more info see: <https://s3platform.jrc.ec.europa.eu/north-macedonia>

⁸ For more info see: <http://www.mzsv.gov.mk/CMS/Upload/HC3PP%202021-2027-converted%20final.pdf>

⁹ For more info see: <http://ruralnet.mk/wp-content/uploads/2019/08/Plan-za-komunikacija-na-MRR-2019-2022.pdf>

National policies and strategies relevant for the bioeconomy

The bioeconomy concept lines up with North Macedonia's priorities, especially those pertaining to regional development and addressing challenges posed by climate change. Aspects of the bioeconomy concept are pertinent to the following national climate change related documents:

- *"Macedonian enhanced nationally determined contributions"* (2021) is "To reduce the CO₂ emissions from fossil fuels combustion for 30%, by 2030 compared to the business as usual (BAU) scenario." The focus of the Macedonian NDC is put on climate change mitigation, that is, on policies and measures which lead to GHG emissions reduction, and particularly to CO₂ emissions from fossil fuels combustion which covers almost 80% of the total GHG emissions in the country.¹⁰
- *"The Strategy for Energy Development until 2040"* (2020) adopts the framework of the EU's National Energy and Climate Plans notably examines how to decarbonise the country's energy system, enhance energy efficiency, improve research, innovation and competitiveness, enhance legal and regulatory environment, and integration and security of energy markets. It sets a number of quantified targets per scenario based on different levels of ambition. It also details the national and international financing schemes available to promote renewable energy sources and energy efficiency measures.¹¹
- In the country's *"Third biennial update report on Climate change"* (2020), the government assesses the potential for reducing climate change impacts in several sectors including agriculture. Among the ways to reduce impacts are several bioeconomy activities such as fostering local ecological agricultural practices which increase drought resistance and preserve biodiversity. This builds upon the notions included in the First and Second biennial reports which presented climate change as a driver of opportunities to incorporate positive sectoral actions like creating new "green jobs", low carbon development and raising people's awareness.¹²

Regional and local policies and strategies relevant for the bioeconomy

- *"Regional plan for an integrated system of waste management in the South-East Planning Region"* aims to achieve an integrated and financially self-sustainable waste management system through preparation of regional waste management plans and strategic environmental assessments.
- *"Investment guide for the South-East Planning Region"* outlines the region's investment opportunities including support measures, characteristics of the existing industrial zones, and available investment locations.
- *"Programme for development of the South-East Planning Region 2015-2019"* is a mid-term planning document which defines the regional development goals (for investments, modern and quality education, health and social sectors, preserved and improved environment, agriculture and rural development facilities), as well as the priorities and measures which will contribute to the achievement of the mid-term goals.
- *"Strategy for Local Economic Development of the Municipality of Strumica 2016-2020"* was created with a partnership among representatives from the public, private and civil society sectors to build up the region's economic capacity. This document set five strategic goals and defined a set of activities to achieve them. The goals are: sustainable development of the econ-

¹⁰ For more info see:

<https://klimatskipromeni.mk/data/rest/file/download/0495e6333b90a37d5dd3017455f322da0af629251aa19a8f408c148c5be1e2cd.pdf>

¹¹ For more info see:

[https://economy.gov.mk/Upload/Documents/Energy%20Development%20Strategy_FINAL%20DRAFT%20-%20For%20public%20consultations_ENG_29.10.2019\(3\).pdf](https://economy.gov.mk/Upload/Documents/Energy%20Development%20Strategy_FINAL%20DRAFT%20-%20For%20public%20consultations_ENG_29.10.2019(3).pdf)

¹² For more info see:

<https://klimatskipromeni.mk/data/rest/file/download/b0653b1a493e77de21382486686f3ea6605d69796a1a900916f36071a36f0e87.pdf>

omy and competitive investment, improved agriculture and quality of life in rural areas, protected and healthy environment with energy efficient public and private facilities, improved infrastructure and urban planning in accordance with annual programs and citizens' needs, and highly developed and trained workforce for the needs of the economic capacities.

- „Local development plan for municipality of Bosilovo for the period 2019 – 2022“ involved local stakeholders with a focus on the environmental management plan that involves among other things resource conservation, pollution abatement, as well as recovery and reuse of waste products

All these regional and local development plans focus on gathering “clusters” in the agricultural sector and industry that can increase the employment rate in rural areas. Conditions for agricultural development are present in the region, but not yet sufficiently used toward faster economic development.

2.9 SWOT analysis

The SWOT analysis is up to date and in line with the National strategy for the agriculture and rural development for the period 2021-2027.¹³

Strengths	Weakness
<ul style="list-style-type: none"> • Tradition in various primary products production of and processed food; • High potential for agricultural production and wood mass production; • Available state-owned agricultural land that can be used in development policies; • Set policies to support agriculture and rural development with key elements of the European CAP; • Favorable agro-ecological potential; • Diverse soil and high natural value of arable land; • Favorable climate conditions; • Experience in applying traditional sustainable practices in agriculture; • Low use of chemicals in agricultural production compared to developed agricultural countries; • Adequate road infrastructure with provided access to settlements in rural areas; • Introduced ICT technologies that provide opportunities to improve access to services and develop new businesses, especially internet, television and radio coverage; • Increased investments in rural infrastructure, rehabilitation of schools and health facilities in rural areas; • Opportunity for polycentric development in larger rural settlements that will ensure that the migrant 	<ul style="list-style-type: none"> • Dual agricultural structure with a large share of agricultural holdings with very small average production capacities per holding; • High degree of parcelization of agricultural land and private forest land; • Aging labor and lack of seasonal labor; • Depreciated equipment and outdated technologies; • Lack of technological capacities for finishing products (drying, processing into final products); • Lack of equity and difficult access to loans to small agricultural holdings; • Poor integration of food chains and lack of vertical integration; • Resistance to horizontal market association of farmers and other stakeholders; • Problems with the organization of export of agricultural and finished products; • Unimplemented minimum quality standards and quality protection; • Undeveloped system for vocational education and training in agriculture, food industry and forestry; • Poor integration of R&I capacities for development of bio-based sector;

¹³ For more info see: <https://ipard.gov.mk/wp-content/uploads/2021/02/Национална-стратегија-за-земјоделство-и-рурален-развој-2021-2027.pdf>

- population from smaller settlements stays close to productive resources;
- National subsidies for agricultural production.

- Non-existent digitalization and resistance to the application of information technologies;
- Insufficient application of environment and climate focused agricultural practices;
- Intensive urbanization of agricultural land;
- Inefficient use of natural resources (water losses, trend of soil degradation, old low-stemmed forests);
- Lower incomes in rural areas.

Opportunities	Threats
<ul style="list-style-type: none"> • Increasing environmental awareness; • Interest in application of agro-ecological practices and organic agricultural production; • Production of energy from renewable sources and waste from agricultural and animal production; • EU support for diversification of economic activities, improvement of basic services in rural areas; • Digitalization and ICT that reduce the differences in terms of living in urban areas and improve the attractiveness of rural areas, especially those that are well connected to the larger development centers in the country; • Increasing the demand for rural tourism on the domestic and international market. 	<ul style="list-style-type: none"> • Loss of specialized labor in agriculture and forestry, due to migration; • Increased competition in the domestic and regional markets; • Increased costs of adjusting to increasing quality, food safety and environmental standards; • Prolonged decline in prices of agricultural products and negative impact on agricultural incomes; • Prolonged negative impact of COVID-19 and the possibility of other global market disruptions; • Global climate change and the risks associated with natural disasters, loss of biodiversity); • Increase of soil, water and air pollution due to the intensification of agriculture, industrial activities, transport and tourism; • Lack of funds for rural municipalities to invest, especially in smaller settlements.

3 Drivers and barriers for a bioeconomy in Strumica region

Chapter 2 is focused on the global, yet national and local drivers which are key for the bioeconomy transition in Strumica region. Transposing the wide-ranging documents, programs and criteria on local level is demanding, especially when the country is politically and economically lagging behind the great powers. Therefore, the existing pathways such as 2030 Agenda for Sustainable Development and EU Green Deal can ease and facilitate the bioeconomy development process in Strumica region. Another driver which results from the synergies with other strategic and policy documents are the national and climate targets, moreover the climate changes impact on the agriculture. Nonetheless, an accessible and diverse funding streams are essential drivers for growing bio-based sector. At the same time, the main barriers that prevent the bioeconomy development are detected and will become a matter of urge improvement.

3.1 Global drivers

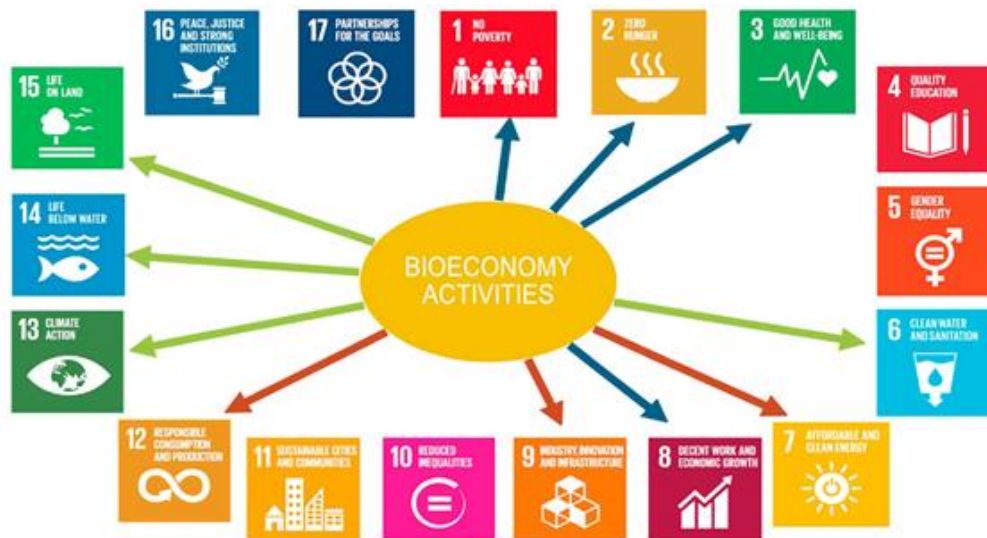
3.1.1 2030 Agenda for Sustainable Development

The United Nations' 2030 Agenda for Sustainable development, signed by 193 countries in 2015, is intended as a 15-year plan for action for the people and the planet, which should ensure prosperity, peace and global partnership. North Macedonia has also signed the 2030 Agenda and is committed to contribute in its implementation. The 2030 Agenda for Sustainable Development is outlined through a set of 17 Sustainable Development Goals (SDGs) and 169 specific targets to reach those goals by 2030. In particular, it aims to end poverty and hunger, in all their forms and dimensions, and to ensure that all human beings can fulfil their potential in dignity and equality and in a healthy environment. At the same time, it should help protect the planet from degradation, by sustainable consumption and production, sustainably managing natural resources and taking urgent action on climate change, so that the needs of the present and future generations are met. In all of this, the agenda envisions that the economic, social and technological progress are in harmony with nature, while maintaining global peace and prosperity, all through global partnership and cooperation.

The bioeconomy has been seen as a key contributor for the realisation of the SDGs, since it is expected to help reindustrialise and renew rural areas. The utilisation of waste biomass, along with the scientific and technological advances in the biological sciences, molecular and material engineering, as well as the increased demand for sustainable practices are expected to give rise to new business models and different strategies.

Figure 3 outlines the contributions between the bioeconomy and the SDGs of the 2030 Agenda for Sustainable development.

Figure 3: Relationship of the bioeconomy to the SDGs



Source: Heimann, T., 2019. Bioeconomy and SDGs: Does the bioeconomy support the achievement of the SDGs?. *Earth's Future*, 7(1), pp.43-57.

Based on recent reports, a sustainable implementation of a bioeconomy, where the negative effects of the increased biomass demand are minimized, can have a highly positive effect on almost all of the SDGs, as shown in Table 1.

Table 1: Potential contribution of the bioeconomy to the SDGs

Potential contribution	Relevant SDG
Productive models that take advantage of science and technology to use biological resources sustainably and efficiently to make substitutes for petrochemicals (for example, bioenergy, biofertilizers, or bioplastics) or to satisfy new consumer demands (for example, functional foods or biocosmetics).	<ul style="list-style-type: none"> • SDG 2: Sustainable Food Production • SDG 3: Good Health and Well-Being • SDG 7: Affordable and Clean Energy • SDG 9: Industry and Innovation • SDG 13: Climate Action
Use of productive practices that contribute to environmental sustainability and resilience while adding productivity and efficiency.	<ul style="list-style-type: none"> • SDG 13: Climate Action • SDG 15: Life on Land
Circular economy production systems, through the productive use of waste biomass derived from production and consumption processes.	<ul style="list-style-type: none"> • SDG 11: Sustainable Cities and Communities • SDG 12: Responsible Consumption and Production
Development of products, processes, and systems replicating processes and systems observed in nature.	<ul style="list-style-type: none"> • SDG 9: Industry and Innovation • SDG 14: Sustainable Use of Underwater Biodiversity • SDG 15: Sustainable Use of Land Biodiversity
Bioremediation to face environmental contamination problems (for example, recovery of degraded or contaminated soils, and treatment of water for human consumption and wastewater).	<ul style="list-style-type: none"> • SDG 6: Clean Water and Sanitation • SDG 15: Prevention of Soil Degradation

Increase in the economic density of rural territories from new industrialization processes and local use of biomass for the generation of bioproducts and bio services.

- SDG 8: Decent Work Sustainable of Economic Growth

Source: Chavarria, H., Trigo, E., Villarreal, F., Elverdin, P. and Piñeiro, V., 2020. Bioeconomy: A sustainable development strategy

3.1.2 European Green Deal

At a continental level, a key motivating factor for moving towards a bio-based economy is the European Green Deal. The EU Green Deal is a set of policy initiatives that are intended to align the economic and societal development of the EU with environmental protection and sustainable development. The EU Green Deal should transform EU into a modern, resource efficient and competitive economy, while ensuring:

- No net emissions of greenhouse gases by 2050,
- Economic growth decoupled from resource use and
- No person and no place left behind.

The strategic documents of the EU Green Deal have resulted in a set of goals for the EU. In general, Member States of the EU will need to undertake a number of actions in each of the sector mentioned in Table 2

Table 2: Goals and EU vision for different sectors in the European Green Deal

Sector	Goals and visions
Climate	<ul style="list-style-type: none"> • Build a strong green economy • Climate neutrality by 2050 • Reduce net greenhouse gas emissions by -55% by 2030 compared to 1990
Energy	<ul style="list-style-type: none"> • Secure and affordable EU energy supply • Fully integrated, interconnected and digitalised EU energy market • Prioritise energy efficiency, improve performance of buildings and develop power supply based on renewable energy
Agriculture	<ul style="list-style-type: none"> • Ensure food security in the face of climate change and biodiversity loss • Reduce environmental and climate footprint of the EU food system • Strengthen EU food system's resilience • Lead a global transition towards competitive sustainability from farm to fork
Industry	<ul style="list-style-type: none"> • Deploy low-emissions technologies, sustainable products and services • Unleash the full potential of European SMEs • Improve circularity and sustainability of industry
Environment and oceans	<ul style="list-style-type: none"> • Protect biodiversity and ecosystems • Reduce air, water and soil pollution • Move towards a circular economy • Improve waste management
Transport	<ul style="list-style-type: none"> • Reduce 90% of transport related emissions by 2050 • Zero emissions large aircraft • Investment in transport infrastructure

Finance and regional development	<ul style="list-style-type: none"> • Invest in a green future • Help EU Member States to implement investment for the EU Green Deals • Mobilise public and private investment • Ensure a just transition
Research and innovation	<ul style="list-style-type: none"> • Accelerate and navigating the necessary transitions • Deploy, demonstrating and de-risking solutions • Engage citizens in social innovation






The bioeconomy can contribute to meeting these goals by:

- Converting waste biomass into energy,
- Providing sustainable, fossil-free products and services,
- Making homes more efficient through the use of bio-based insulation materials,
- Promoting resource efficiency,
- Stimulating the production of high added-value products from side and waste streams,
- Stimulating job creation and rural development.

The bioeconomy can help in reaching the goals, specifically in the climate, energy, agriculture, industry and environment and ocean sector, and it will most notably benefit from greater research and innovation and finance and regional development. Strumica can will largely benefit from aligning its actions to help meet these goals, considering the EU aspirations of North Macedonia.

The advantages of the European Green Deal are given in Table 3.

Table 3: Expected benefits of the European Green Deal

	Fresh air, clean water, healthy soil and biodiversity		Cleaner energy and cutting edge clean technological innovation
	Renovated energy efficient buildings		Longer lasting products that can be repaired, recycled and re-used
	Healthy and affordable food		Future-proof jobs and more skills training for the transition
	More public transport		Globally competitive and resilient industry

3.1.3 Overcoming the socio-economic impacts of COVID-19

The COVID-19 outbreak, which was declared a pandemic on 30th March 2020 by the World Health Organisation (WHO), has been devastating both for the health of the global population, but also for the global economic development. The negative effect of the pandemic is reflected by the negative GDP growth (about -4%) which, among other thing, is related to:

- *Lockdowns*: In order to slow down the spreading of the COVID-19 virus, many countries, including the United States and those of the EU have made the decision to initiate lockdowns and travel restrictions. This decision heavily affected several industries, such as tourism, retail sector, malls and other service-related business that require direct human contact. As a result, many businesses laid off part of their workforce in order to reduce expenditures and therefore hope to survive the pandemic.
- *Issues in supply chain management*: According to McKinsey, 73% of executives said they had encountered problems in their supply base as a result of COVID-19. Certain challenges that gave rise to supply congestion were related to the fact that countries had a limited understanding of the virus and how it should be dealt with. As result, many countries introduce cross-border rules with a high degree precaution, which, to a certain extent, stalled the transfer of goods and services.
- *Price increase of building materials*: Due to the social distancing measures, the issues in supply chain management and the changing investment preferences, the cost of many building materials skyrocketed during the COVID-19 pandemic. Most notably, price increases of building bricks (3.6%), cement (about 3%), glass (2.4%), steel pipes, tubes and stainless steel (6.4%), hardwood lumber (19.6%), softwood lumber (78.8%). The surging building material prices have had a spill over effect, causing rising prices in the housing sector, making it difficult for many to afford to buy a new home.
- *Disproportionate effects across the income distribution*: The economic crisis has disproportionately affected low-skilled workers and low-income families. For example, during the second quarter of 2020, the risk of job loss or reduced working hours in the EU was about 25% lower for high income earners when compared to low-income earners. The reason for this is that many low-income earners work low-skilled jobs in manufacturing or the service sector, which were closed during the pandemic. On the other hand, many high-skilled workers mostly benefited from remote work, which reduced the risk of job loss.

Due to these challenges, the pandemic initiated a health and fiscal response which is incomparable to anything from the past, both with respect to speed and magnitude. Globally, the fiscal support reached about \$16 trillion (around 15 percent of global GDP) in 2020. The pandemic showed that increasing the resilience of businesses by including additional revenue streams is very helpful in dealing with economic uncertainty. Moreover, it showed that certain businesses can thrive even during the pandemic.

The bioeconomy could play a significant role in Europe's recovery from the COVID-19 crisis, if governments and industries capitalize on shifting demands and priorities, adapt to the new funding realities and learn some lessons regarding prevention rather than adaptation. Many bio-based businesses can be developed in these thriving sectors, especially in sustainable energy, pharmaceuticals, gifts and occasions, fashion, home and gardening.

3.2 National and local drivers

3.2.1 Rural development

The national and local strategic documents discussed in the introduction of this roadmap open many opportunities for a bioeconomy development. For example, one of the general goals highlighted in the “*National strategy for agriculture and rural development for the period 2021-2027*” is “ensuring the sustainable development of rural areas”. One specific target of this goal stands out, in particular, which is titled “Promotion of new jobs, growth, social inclusion and local development in rural areas, including bioeconomy and sustainable forestry”. Clearly, a shift towards a bioeconomy has been envisioned in the strategic documents, which can act as a driver for the bioeconomy.

Rural areas are characterized by higher poverty and unemployment rates than urban areas, especially among the young population. Rural development measures aimed at creating businesses or diversifying economic activities in rural areas that do not necessarily have to be related to agriculture (rural tourism, woodworking, services, crafts and processing) will continue to create jobs, especially in areas where agriculture is predominantly an ancillary activity or a restructuring process is taking place. Starting a micro and small enterprise business in rural areas will be supported with financial support of 10,000 euros. Projects to support income diversification in rural areas will represent 54 at least 35% of the total number of projects funded through Measure 7 of the IPARD program (compared to 23% at the beginning of the period). Additional incentives will be provided for the involvement of rural women in these processes. Eliminating gender inequality and empowering women can increase agricultural productivity and contribute to the development of the whole community. In order to ensure gender equality, the economic activity of women farmers will be supported with additional direct payments, with a grant for processing activities of the agricultural holding and benefits in the ranking of projects from the new IPARD program. Within the framework of the land policy, the status of women in the registration of changes in common property will be improved, such as in the consolidation procedures. Support will be provided to local development initiatives arising from the activities of local action groups through the LEADER measure.¹⁴

Additionally, the participants in the World Style Café workshop organized within the pop-store in Strumica mapped the stirring and driving areas in the process of the elaboration of the bioeconomy roadmap. The business sector and cross border cooperation got the highest ratings as most prominent topics to develop. In that sense the lower rate of technical readiness might be equalized with the other neighbouring counties. Therefore, the attendees believe that the business organisation should be consulted in the drafting of the roadmap. For instance, they already point out several practices that could serve as promising business ideas, such as the utilisation of eggs residues for yogurt packaging.

3.2.2 Energy and climate targets

Another driver which results from the synergies with other strategic and policy documents are the national and climate targets. In 2020, the country adopted a new Strategy for the Energy Development of Republic of North Macedonia until 2040, setting ambitious goals, that were again reiterated in the National Energy and Climate Plan (NECP). Moreover, an enhanced NDC was prepared against a backdrop of the country being a candidate for EU membership and becoming 30th member of the NATO Alliance.

Hence, North Macedonia has set ambitious goals which can more easily be reached if certain regions, such as in Strumica, move towards a bioeconomy. Among the goals is decarbonization which can be ensured with strongly increasing the usage of RES in a sustainable manner and participation in regional projects using carbon neutral technologies. It is necessary to stimulate electrification of the heating & cooling sector using more efficient heat pumps and district heating fuelled by CHP on gas and biomass, which will enable utilization of large heat pumps, waste heat and thermal storage capacities. In addition, North Macedonia can stimulate domestic production of efficient biomass technologies for heating, as well as usage of residual biomass and other by-products by supporting local manufacturers and industry, especially on small and medium scale.¹⁵

3.2.3 Climate change impact on agriculture

The changing weather and climate conditions introduce significant uncertainty for farmers. The main factor influencing agricultural yield are related to temperature, precipitation, evapotranspiration¹⁶. The changes in climate, the unsustainable farming practices and the changes in rainfall patterns are among

¹⁴ For more info see: <https://ipard.gov.mk/wp-content/uploads/2021/02/Национална-стратегија-за-земјоделство-и-рурален-развој-2021-2027.pdf>

¹⁵ For more info see:

[https://economy.gov.mk/Upload/Documents/Energy%20Development%20Strategy_FINAL%20DRAFT%200-%20For%20public%20consultations_ENG_29.10.2019\(3\).pdf](https://economy.gov.mk/Upload/Documents/Energy%20Development%20Strategy_FINAL%20DRAFT%200-%20For%20public%20consultations_ENG_29.10.2019(3).pdf)

¹⁶ For more info see:

http://www.unfccc.org.mk/content/Documents/ADAPTATION/Agriculture_final_MK%20so%20CIP.pdf

the main causes of soil erosion. In the Strumica region, two rainfall regimes are identified: a modified Mediterranean regime and a mountainous regime. Going forward, however, it is difficult to estimate which regime is going to dominate and how rainfall trends will develop. Big rainfalls, such that in the spring of 2013 can be devastating to the agriculture yield. During that spring, within 3 days 64.5-190mm of rainfalls had fallen – this is three to fourth time higher than the average rainfalls for the period 1961-2012. On the other hand, the changing rainfall patterns can also lead to periods of drought, which are equally bad for farmers. Periods of drought, in combination with poor irrigation practices are expected to decrease the agriculture yield in North Macedonia by 10% in 2025 and 40% in 2100¹⁷. To overcome these challenges, a number of adaptation measures are required in the agriculture sector that will ensure sustainable farming.

3.2.4 Funding

In terms of receiving funding to realise Strumica's technological potential, there is organisational precedent from prior activities with IPA funds (the EU's Instrument for Pre-Accession Assistance for countries in line to accede to the EU). A 2018 study of past implementation of IPA projects in the region cited Strumica municipality in particular as notable for promoting the importance and use of "direct involvement of public enterprises and other local actors in the absorption of EU funds" as a successful model of cooperation. This bodes well for the region's bioeconomy development, where such direct involvement in strategic planning is crucial. The IPA fund implementation infrastructure could be replicated for local bioeconomy strategy development.

Some outside funding (in the form of loans and grants) is available in the region for measures to support the use of renewable energy. These include the WeBSEFF Program for financing sustainable energy in the Western Balkans, an eco-loan from the Green Growth Fund for southeast Europe, and loans for renewable energy and energy efficiency through various regional banks.

Projects for the bio-based economy need financing and loan facilities to cover investment costs. Even though there are some difficulties to acquire appropriate financing, public entities and private banks, which can finance such projects, exist in the region. At the same time, no subsidies related to the use of biomass for energy and bio-based products exists. As foreign investment is significant, it can be of significant help for the region, but finding ways for attracting these investments is crucial.

According to the National strategy for agricultural and rural development there is an indicative financial plan for support from different funding streams until 2027 (Table 4).

Table 4: Indicative financial plan of national support in agricultural and rural development by policies for the period 2021- 2027

Policy and measures	2021		2022		2023		2024		2025		2026		2027	
	Mil €	%	Mil €	%	Mil €	%	Mil €	%	Mil €	%	Mil €	%	Mil €	%
Direct payments	100	70	105	64	105	58	107	50	107	50	108	50	110	51
Market management	0	0	1	1	3	2	5	2	7	3	10	5	12	6
Rural development - total	42	30	56	34	70	39	100	47	96	45	92	43	87	40

¹⁷ For more info see:

<https://agencija.gov.mk/download/Публикации/Влијание%20на%20климатските%20промени%20во%20Оземјоделството.pdf>

Rural development - national budget	36	26	45	28	56	32	80	37	76	35	72	34	67	31
- IPARD EU funding	4	3	8	5	10	6	15	7	15	7	15	7	15	7
- IPARD national share	4	1	3	2	4	2	5	2	5	2	5	2	5	2
Knowledge and innovation system	0	0	1	1	2	1	3	1	5	2	5	2	6	3
Total support	142	100	163	100	180	100	215	100	215	100	215	100	215	100
Total national budget	138		155		170		200		200		200		200	

Source: „National strategy for agricultural and rural development“

3.3 Barriers

Beside the many advantages of the region, on the less positive aspect, the stakeholders and the bio-based sector are facing some barriers.

After consultations with stakeholders at the World Style Café workshop, 15 barriers were identified:

1. Existing roads are not in optimal condition
2. Lack of regional market for bio-based products
3. Lack of logistics centres to handle the feedstock
4. Unexplored business potential
5. Reluctances of innovative and modern products and technologies
6. Lack of capacities of the research institutes
7. Deficiency of specific fundings for bioeconomy
8. Absence of concrete bioeconomy measures in the strategic documents
9. Deficit of suitable and up to date materials to depict the bioeconomy situation across countries
10. Language barrier
11. Lack of support institutions on all levels that could help the implementation of bioeconomy projects
12. Lack of interest and insufficient familiarity with the possibilities that bioeconomy and current market are offering
13. Insufficient staffing of Local Economic Development services
14. Lack of models for the consolidation of agricultural production or individual association with no financial models to support such an association
15. Ownership of agricultural land which is on small parcels and therefore is preventing efficient and enlarged production
16. Traditional farmers' beliefs, unambitious interest and distrust of inclusion in associations

The existing EU pathways (2030 Agenda and EU Green Deal) can drive the bioeconomy development process in Strumica region. Rural development measures aimed at creating businesses or diversifying economic activities in rural areas are a contributing driver. An accessible funding streams are essential drivers for growing bio-based sector.

Overcoming the barriers listed above is crucial for creating a bio-based economy in the Strumica region.

4 Bioeconomy roadmap

The stakeholders in the bio-based sector carry out their activity in a rapidly changing economic and technological environment as a result of resource depletion and pressure on population migrations, social change expectations, the rapid rise of new technologies and the growing impact of climate change. In such conditions the bio-based sector need new knowledge, skills and innovative ideas for development and management. Strong connection needs to be established with the elements that support the modernization of national policies aimed at achieving strategic goals. In the next strategic period, within this roadmap, several groups of activities will be realized that should enable the fulfilment of the envisaged goals, as follows:

- Increasing the flow of knowledge and strengthening the links between research and practice
- Strengthening advisory services for agricultural products within of Knowledge and innovation system in bioeconomy
- Improving interactive innovation through Operational Groups for bioeconomy innovation partnerships
- Supporting the digital transition in bioeconomy
- Introduction of a system for compulsory training and education in bioeconomy.

The bioeconomy development roadmap for Strumica region is developed within six different, but related *pillars*, namely:

1. Business sector development;
2. Research and Innovation capacities and activities;
3. Use of diverse EU, national and regional funding streams;
4. Synergies with other policy fields, related to rural and regional development, as well as smart specialization strategies;
5. Education and information in relation to sustainability;
6. International collaboration and sharing good practices among region.

In each of the pillars a strategic goal has been envisaged accompanied with a brief action plan how to proceed with certain activity. For each pillar, the following information is provided: **description, time frame, type, sector, scope, relevant documents, assumptions, indicators, finances, implementation institution, monitoring institution and synergies with SDGs.**

To bridge the forthcoming challenges, the below listed steps can serve as a guidelines:

- Target values set in relation to the relevant specific objective for results indicators;
- Data collection, storage and exchange
- Regular reporting on operations, monitoring and evaluation
- Ex-post evaluation and other evaluation activities related to the national Strategy to examine effectiveness, efficiency, relevance and coherence
- Capacity building for project applications
- Coordination between key stakeholders
- Cross-sectoral coordination
- Quantification of synergies and trade-offs of different measures

4.1 Pillar 1: Business sector development

Strategic goal: Facilitating the development of bioeconomy businesses in rural area	
Description	<p>Attracting young population in the rural areas to start an activity in the bio-based sector should be stimulated through a package of benefits offered through several policies:</p> <ul style="list-style-type: none"> - additional direct payments, - investment grant to start business, - facilitated access to agricultural land, - mandatory training and advisory support. <p>In order to support the businesses of young entrepreneurs or business idea holders a favourable credit line to start or expand businesses (land purchase, investment in assets and mechanization, etc.) should be introduced. Interested stakeholders should be awarded with scholarships for education and knowledge upgrade with new technologies in bioeconomy sector. Vital role in facilitating the development of bioeconomy businesses in rural area would have the developing of demonstration projects and dissemination activities (for example workshops, seminars, media campaigns) to share the results and lessons learned.</p>
 Timeframe	2022- 2027
 Type	Technical, education
 Sector	Business
 Scope	Regional
 Relevant legal and regulatory documents	<ul style="list-style-type: none"> - Law on Agriculture and Rural Development - Law on Legalization of Agricultural Buildings (to be adopted) - Law of performing agricultural activity - Program for financial support in agriculture for 2021
 Assumptions	<ul style="list-style-type: none"> - Better business environment and conditions - Young farmers and stakeholders with improved education and skills in the field of bioeconomy
 Indicators	<ul style="list-style-type: none"> - Number of new products - Number of capacity building activities organised - Number of bio-based business ideas completed
 Finance	<ul style="list-style-type: none"> - Local self-government units - Agency for Financial Support of Agriculture and Rural Development - Ministry of Agriculture, Forestry & Water Economy of the Republic of North Macedonia - IPARD Fund
 Implementing entity	Ministry of Agriculture, Forestry & Water Economy of the Republic of North Macedonia
 Monitoring entity	Local self-government units
 Synergies with the SDGs	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="background-color: #800040; color: white; padding: 5px; text-align: center;"> 8 DECENT WORK AND ECONOMIC GROWTH  </div> <div style="background-color: #ff8c00; color: white; padding: 5px; text-align: center;"> 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE  </div> <div style="background-color: #4CAF50; color: white; padding: 5px; text-align: center;"> 15 LIFE ON LAND  </div> </div>

Business models for pelletizing, briquetting, anaerobic digestion, pyrolysis and Spawnfoam business model may be relevant from Strumica region's perspective

The case study that receives the most attention is the Mycelium-based packaging and insulation material, which for a business model canvas was development.

Biopat offers an innovative and sustainable product that utilises the resources from the Strumica region. The product has applications in multiple sectors such as food & beverage, gastronomy and construction. Some of the benefits of this mycelium-based material include that it is biodegradable, flame resistant, lightweight and shock absorbent, durable and flexible. The production process generates no wastewater and uses significantly less energy than traditional solutions. The product is highly suitable for wineries commercialising luxury wine lines who are interested to reduce their plastic packaging and want to raise awareness on the importance of biodegradable materials.

The groups foresees that this segment will have a pressing need to replace traditional packaging materials with biodegradable alternatives in the near future. The mycelium-based packaging material is relatively new and unknown at the national level. This product at first might be more expensive than its traditional counterparts, but it will help position clients as innovative and eco-friendly in a market which is increasingly demanding environmentally sustainable solutions. It is expected that in most cases the current facilities of the target industry can be adjusted to adopt the new packaging materials with relative ease and without requiring large investments. Through the research they conducted as part of the assessment, the task force has identified over 30 active companies from the sector in North Macedonia that could become potential clients.

Based on their calculations, which assume a moderate willingness to adopt the new product, they expect a decent market share could be attained in the first year of operation, generating enough revenue to sustain the start-up. In terms of growth projections, the global market for biodegradable packaging solutions is expected to grow at a CAGR of 5.3%, propelled by increased consumer awareness driving interest and demand for recyclable and sustainable materials and a shift away from plastic counterparts.

The main conclusions can be found in Table 5.













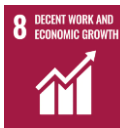

Table 5: Business model canvas

7) Key Partners	6) Key Activities	2) Value Propositions	4) Customer Relationships	1) Customer Segments
<ul style="list-style-type: none"> • Forestry and agriculture residues suppliers • Wineries • Stores 	Securing local feedstock <ul style="list-style-type: none"> • Successful production • Raising awareness • Acceptance from the market 	We provide innovative, biodegradable, sustainable, flame resistant, lightweight and shock absorbent, durable and flexible product, while the production process generates no wastewater and uses lot less energy than traditional solutions.	<ul style="list-style-type: none"> • Traditional sales operations • Phone/Email/social media interaction • Personalized support offered 	<ol style="list-style-type: none"> 1. Food and drink industry 2. Local authorities 3. Forestry 4. Building sector
	5) Key Resources		3) Channels	
	<ul style="list-style-type: none"> • Financial • Human • Intellectual 		<ul style="list-style-type: none"> • Direct communication with customers and promotion in market/flayers • Websites and social media 	
8) Cost Structure				9) Revenue Streams
Fixed costs: <ul style="list-style-type: none"> • Equipment/production Variable costs: <ul style="list-style-type: none"> • Feedstock, license, trainings, workforce 				<ul style="list-style-type: none"> • Fund for Innovation and Technology Development • Local or national subsidies • Interested business sector

4.2 Pillar 2: Research and innovation capacities and activities

Strategic goal: Strengthening market orientation and increasing competitiveness, with a special focus on research, technology and digitalization

Description
 With limited resources, empowering productivity is the only way to increasing the level of revenues of the holdings and in that direction the interventions of policies should co-finance equity investments in production costs and rationalization of labour. Support should be provided in order to change the structure in viticulture and fruit growing, as well as production support and application of certified seed and planting material. Special emphasis should be placed on introducing policies aimed at building capacity to utilise modern technologies with adequate trainings. The newly established Knowledge and Innovation System should connect all stakeholders in creating innovation, knowledge transfer and digitalization and enabled the exchange of digital technologies, smart bioeconomy and production methods based on knowledge and good management. The negative perception of modern technologies by farmers, should be changed by effective advisory services, demonstration holdings and trainings to facilitate the acceptance of new technologies. Reducing production costs and creating conditions for the application of modern technology should be achieved by improving the land structure with consolidation of plots, and with the increased availability of land for cultivation through lease and sale which should enable growth of the area per economy.














 Timeframe	2022- 2027
 Type	Education, research
 Sector	Education and technology
 Scope	Regional
 Relevant legal and regulatory documents	<ul style="list-style-type: none"> - Law on Agriculture and Rural Development - Law on Knowledge System and Innovation in Agriculture (to be adopted) - Law on Innovation Activity - Law on Seeds and Seedlings for Agriculture plants (in correspondence with VAT Law)
 Assumptions	<ul style="list-style-type: none"> - Increased innovation, knowledge transfer and digitalization - Reduced production costs
 Indicators	<ul style="list-style-type: none"> - Young holders of holdings with visited trainings - Number of newly founded companies (start-ups)
 Finance	<ul style="list-style-type: none"> - Agency for Financial Support of Agriculture and Rural Development - Ministry of Agriculture, Forestry & Water Economy of the Republic of North Macedonia - IPARD Fund - Donors - Local self-government units
 Implementing entity	<ul style="list-style-type: none"> - Ministry of Agriculture, Forestry & Water Economy of the Republic of North Macedonia - Local self-government units
 Monitoring entity	Local self-government units
 Synergies with the SDGs	  

4.3 Pillar 3: Use of diverse EU, national and regional streams

Strategic goal: Supporting key stakeholders interested in making use of diverse funding streams related to the bioeconomy	
Description	In order to support the key stakeholders interested in making use of diverse funding streams related to the bioeconomy there should be more trainings, support and information on how to use existing funds, but more importantly to use other funds for innovative business models. The IPARD program, the WeBSEFF Program, cross-border cooperation are amongst the international support to fund the innovative ideas in the bio-based sector in Strumica region. On national level there are some available options from the Fund for Innovations and Technology Development, Ministry for economy, Ministry of Agriculture, Forestry & Water Economy and the Agency for Financial Support of Agriculture and Rural Development. The banks have favourable funding schemes and offer support for many SMEs. Another option for obtaining finances are the municipalities in Strumica region which might be the most secure one, as it is from the region and for the region and its improvement.
Timeframe	2022- 2027
Type	Financial, regulatory, policy
Sector	Economy
Scope	International
Relevant legal and regulatory documents	<ul style="list-style-type: none"> - Law on Agriculture and Rural Development - EU Common Market Regulation regulations - Program for financial support in agriculture for 2021
Assumptions	<ul style="list-style-type: none"> - More funding streams on national and EU level - Enhanced bank collaboration
Indicators	<ul style="list-style-type: none"> - Number of total funding applications - Number of successful funding applications - Participation of the realized funds for rural development policies in total support funds
Finance	<ul style="list-style-type: none"> - IPARD Fund - Agency for Financial Support of Agriculture and Rural Development - Ministry of Agriculture, Forestry & Water Economy of the Republic of North Macedonia - Donors - Local self-government units
Implementing entity	<ul style="list-style-type: none"> - Agency for Financial Support of Agriculture and Rural Development - Ministry of Agriculture, Forestry & Water Economy of the Republic of North Macedonia
Monitoring entity	Local self-government units
Synergies with the SDGs	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="background-color: #c00000; color: white; padding: 5px; text-align: center;"> 8 DECENT WORK AND ECONOMIC GROWTH </div> <div style="background-color: #28a745; color: white; padding: 5px; text-align: center;"> 15 LIFE ON LAND </div> </div>

4.4 Pillar 4: Synergies with other policy fields, related to rural and regional development, as well as smart specialization strategies

Strategic goal: Improving the cross-sectors bioeconomy involvement

Description	<p>Development of a local bioeconomy has cross-cutting properties with different sectors, such as agriculture, energy, manufacturing industry, service and business sector. It should therefore be made sure that steps are taken to integrate aspects of the bioeconomy in each of these sectors.</p> <ul style="list-style-type: none"> - harmonization with EU legislation - exploiting synergies and similarities between different sectors - cross-sectors bioeconomy involvement - participation of working groups in the drafting of related policies and documents <p>Furthermore, with the adaption of the smart specialization strategy for North Macedonia is foreseen an improvement for local economy development with an emphasis on the bioeconomy, circular economy, and sustainability.</p>
 Timeframe	2022- 2027
 Type	Policy, information
 Sector	Public authorities
 Scope	National
 Relevant legal and regulatory documents	<ul style="list-style-type: none"> - Law on Agriculture and Rural Development - Law on Associations and Foundations
 Assumptions	<ul style="list-style-type: none"> - Improved cross-border cooperation - Functional agricultural cooperatives - Alignment with the S3 goals
 Indicators	<ul style="list-style-type: none"> - Degree of transposition of the European agricultural legislation and rural development in the national legislation
 Finance	<ul style="list-style-type: none"> - Agency for Financial Support of Agriculture and Rural Development - Ministry of Agriculture, Forestry & Water Economy of the Republic of North Macedonia - IPARD Fund - Local self-government units
 Implementing entity	<ul style="list-style-type: none"> - Ministry of Agriculture, Forestry & Water Economy of the Republic of North Macedonia - Agency for Financial Support of Agriculture and Rural Development
 Monitoring entity	Local self-government units
 Synergies with the SDGs	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>11 SUSTAINABLE CITIES AND COMMUNITIES</p> </div> <div style="text-align: center;">  <p>13 CLIMATE ACTION</p> </div> </div>

4.5 Pillar 5: Education and information in relation to sustainability

Strategic goal: Encouraging sustainable development via exchange platforms, mechanisms and information campaigns

Description	The basis for sustainable agricultural production are unpolluted and clean soil, water, and air, as they are the most important natural resources for this sector. Policy interventions aimed at protecting the soil from degradation should be strictly complying with the requirements in the field of cross-compliance for soil cover, erosion protection, investment support for precision agriculture with the use of sensors for optimal application of agro-technical measures and providing financial support for agri-environmental measures. Sustainable agriculture practices should be encouraged, in addition to the existing recommendations. Knowledge exchange platforms and mechanisms should be established, that will keep stakeholders in the agricultural sector informed of business opportunities in the bioeconomy. Simple information campaign could be established to motivate the initiation of new businesses that are in grounded in principles of circularity and sustainability.	
 Timeframe	2022- 2027	
 Type	Education, research	
 Sector	Education	
 Scope	Regional	
 Relevant legal and regulatory documents	<ul style="list-style-type: none"> - Law on Agriculture and Rural Development - Law on Knowledge System and Innovation in Agriculture (to be adopted) - Law on Seeds and Seedlings for Agriculture plants (in correspondence with VAT Law) 	
 Assumptions	<ul style="list-style-type: none"> - Achievement of the requirements for environmental protection and sustainable development - Increased knowledge and awareness for sustainable agriculture production 	
 Indicators	<ul style="list-style-type: none"> - Number of students by level of education related to bioeconomy and bio-based products - Number of campaigns and seminars promoting circularity and sustainability 	
 Finance	<ul style="list-style-type: none"> - Local self-government units - Agency for Financial Support of Agriculture and Rural Development - Ministry of Agriculture, Forestry & Water Economy of the Republic of North Macedonia - IPARD Fund - Donors 	
 Implementing entity	Ministry of Agriculture, Forestry & Water Economy of the Republic of North Macedonia via Agricultural Knowledge and Innovation System	
 Monitoring entity	Local self-government units	
 Synergies with the SDGs	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="background-color: #800000; color: white; padding: 5px; text-align: center;"> 4 QUALITY EDUCATION </div> <div style="background-color: #FFA500; color: white; padding: 5px; text-align: center;"> 11 SUSTAINABLE CITIES AND COMMUNITIES </div> </div>	

4.6 Pillar 6: International collaboration and sharing good practices among regions

Strategic goal: Gaining knowledge on how to overcome some local issue

Description	The farmers need to enhance their mutual cooperation to overcome the individual fragmented production of small quantities non-standard product that affects their disadvantage, weak receptivity to the policies of support and lack of bargaining power. International collaboration and sharing of good practices can be useful for gaining knowledge on how to overcome some local issues. The horizontal cooperation of primary producers due to supply concentration should be significantly upgraded. The collaboration with NGOs, which can act as gatekeepers to international collaboration, should also be upgraded. It is necessary to achieve an improvement of the horizontal integration of all stakeholders in the sector, and then their vertical integration. Lack of information from the international markets and the choice of the appropriate supply assortment need to be improved through closer cooperation and exchange of information, implementation of joint investments, scientific and other activities to better the situation, up to formal integration in cross-border organizations. Efforts for closer cooperation between all stakeholders and implementation of priority activities should be supported by policies. Lack of information, scientific knowledge and innovative good (inter)national practices should be supported through the Knowledge and Innovation System which should include advisory services, training and setting up applied demonstration practices in the region.
 Timeframe	2022- 2027
 Type	Education, regulatory
 Sector	Education
 Scope	International
 Relevant legal and regulatory documents	<ul style="list-style-type: none"> - Law on Agriculture and Rural Development - IPARD Program - EU Common Market Regulation regulations - Law on Quality of Agricultural Products
 Assumptions	<ul style="list-style-type: none"> - Improved cross-border cooperation - Sharing good practices from the region e.g., established horizontal integration
 Indicators	<ul style="list-style-type: none"> - Degree of transposition of the European legislation in national legislation - Number of knowledge-sharing events - Number of participations in international associations
 Finance	<ul style="list-style-type: none"> - IPARD Fund - Donors - Agency for Financial Support of Agriculture and Rural Development - Ministry of Agriculture, Forestry & Water Economy of the Republic of North Macedonia
 Implementing entity	<ul style="list-style-type: none"> - Agency for Financial Support of Agriculture and Rural Development - Ministry of Agriculture, Forestry & Water Economy of the Republic of North Macedonia
 Monitoring entity	Local self-government units
 Synergies with the SDGs	<div style="display: flex; gap: 10px;"> <div style="background-color: #800000; color: white; padding: 5px; text-align: center;"> 12 RESPONSIBLE CONSUMPTION AND PRODUCTION </div> <div style="background-color: #008000; color: white; padding: 5px; text-align: center;"> 15 LIFE ON LAND </div> </div>

5 Expected impacts on the Strumica region

Chapter IV reflect on the possible results from a successful implementation of the bioeconomy roadmap in the region. Enhanced stakeholder engagement, close international collaboration, fair and transparent regulatory and financial support are part of the expected impacts that the roadmap will have. In addition, the creation of new, modern and green jobs extremely valuable for the progressing regional economy and stable markets. It is expected that the sustainability and circularity will be embedded in various aspects among quadruple stakeholder's helix and further promoted.

5.1 Stakeholder engagement, collaboration and support

Cooperation between all stakeholders in the value chain has led to an increase of market opportunities, economic development and overall production in agricultural sector, while improving the competitiveness of the agricultural sector in line with EU accession requirements.

Moving forward with bio-based economic development would have the following effects:

- **Better policy alignment:** Cooperation between key stakeholders should facilitate the alignment of their goals and values. Once harmonized, the goals and values of key stakeholders in the Strumica region should be more easily incorporated into the policy, thus ensuring policy harmonization at the regional and national level.
- **Improved legitimacy and representation:** Organizing in the form of associations, organizations and unions, should legitimize local efforts for bioeconomic development. This makes it much easier to achieve vertical communication with relevant ministries or institutions.
- **Enhanced business development:** It is expected that acting in accordance with the six pillars of this roadmap should encourage young entrepreneurs to start a business based on sustainable practices. Timely action in the upcoming markets can have a positive effect on the local economy, by gaining larger shares in the national and regional market.
- **Easier knowledge sharing:** Traditional farmers, who are currently dumping or burning most of their agricultural residue, are expected to gain knowledge of new market opportunities and sustainable practices. It is likely that existing studies will be aggregated in one place, rather than dispersed and uncoordinated.
- **More opportunities for knowledge creation:** Communication with relevant institutions is envisioned in order to incorporate different educational programs related to this topic (trainings, courses, courses at university level). These programs should create new knowledge, based on local opportunities, but also through drawing on international experiences.

5.2 Job created

The European Commission (EC) has the goal of creating 1 million new green jobs within the bioeconomy by 2030. As of 2019, there were 18 million people employed in the EU bioeconomy with almost 80% of these individuals coming from the fields of agriculture and food and drink manufacturing. Given the plethora of opportunities in these sectors for the continuation of the creation of new green jobs, coupled with the EU's promise to allocate 10 billion euros towards a Horizon Europe budget that covers food and natural resources, which include the bioeconomy, it appears that the EU will continue to play a strong role in the promotion of green job growth.¹⁸

¹⁸ For more info see: <https://www.climatescorecard.org/2020/09/eu-focus-on-the-bioeconomy-holds-great-promise-for-the-growth-of-green-jobs/>

In rural areas, which cover about 87% of the total area of the country, lives 45% of the total population. Agriculture is the most important economic activity in rural areas that affects poverty alleviation and unemployment. One of the biggest problems in the agricultural sector in the country is the aging of labor force. In addition to the age structure, the educational structure in agriculture is unfavorable. On national level the share of the total active population engaged in agriculture in 2019 year is 13.9%. Out of a total of 111,033 people engaged in agriculture, 35% (38,478) are unpaid family workers, 49% are self-employed and about 15% are full-time employees. About 17% (18,379) of the total workforce engaged in agriculture are engaged on a part-time or seasonal basis. More than half of the total employees in agriculture are engaged in crop production, and the rest are engaged in mixed production and cattle breeding.¹⁹

Moving forward with jobs in the bio-based sector would have the following effects:

- **Improved economic resilience:** Current policies aim to improve the economic resilience of a particular sector by directly providing employment support to identified categories where labor shortages affect sustainability (sheep and cattle breeders, agricultural cooperative managers and wage subsidies from 3,000 denars per newly employed worker under the age of 25 in an agricultural holding). By using additional revenue streams, sectors that are currently economically unsustainable are expected to have improved revenues by diversifying their activities.
- **Job creation:** Existing policies are expected to improve rural employment by 50,000 jobs by 2027 (over 400,000 in 2027, compared to the current 350,000). Women's employment is expected to be approximately 2.6 times higher than men. As an example, around 15,000 for men and 35,000 jobs for women are expected to be created for the reporting period in the agricultural sector nationwide²⁰. Creating new businesses based on circularity and sustainability should further enhance this value, beyond the current projection.
- **Overcoming the impacts of the COVID-19 pandemic:** The key short-term priorities for overcoming the COVID-19 crisis faster is to attract investments that require rapprochement, develop a targeted strategy for promoting foreign direct investment to promote exports, create jobs and the green economy. Direct incentives to achieve policy goals such as skills development, research and development and innovation and local supplier development are very useful.

5.3 Sustainability and circularity

North Macedonia, as well as the EC foresees promising opportunity in the bioeconomy for achieving various policy aims related to sustainability, such as climate change mitigation, security of energy supply, rural development (Gawel et al. 2019), biodiversity (Lindqvist et al. 2019) and the achievement of the SDGs (Peterson and Kaaret 2020). The EU Bioeconomy Strategy is focused on: ensuring food and nutrition security; managing natural resources sustainably; reducing dependence on fossil fuels, unsustainable use of domestic and imported resources; mitigating and adapting to climate change; and strengthening competitiveness and creating jobs (EC, 2018a). In this document, the EC outlines the action „understanding the ecological boundaries of the bioeconomy” (EC, 2018), filling a gap in the previous strategy from 2012. Several initiatives are now underway that aim to improve the monitoring and understanding of the bioeconomy's effects on Europe's social, economic and environmental systems. This reflects the priority and commitment given to establish a bioeconomy based on solid knowledge foundations.

¹⁹ For more info see: <https://ipard.gov.mk/wp-content/uploads/2021/02/Национална-стратегија-за-земјоделство-и-рурален-развој-2021-2027.pdf>

²⁰ For more info see: <https://ipard.gov.mk/wp-content/uploads/2021/02/Национална-стратегија-за-земјоделство-и-рурален-развој-2021-2027.pdf>

The development of a sustainable bioeconomy is only possible if it is embedded within overarching socio-economic-ecological transformation pathways, e.g., the ones related to the achievement of the SDGs (Jarosch et al. 2020; Peterson and Kaaret 2020).

Furthermore, it is expected that the bioeconomy will have the following impacts on sustainability and circulation:

- **Better utilization of agricultural and forest residues**
- **Improved energy security and local self-sufficiency**
- **Reduced degradation of the biosphere**

6 Conclusion and recommendation

This bioeconomy development roadmap for Strumica region is final document that embeds previous gathered knowledge and work done in the scope of BE-Rural project involving regional stakeholders covering the public, academia, business and NGO sector. Exploring the new technology options, macroenvironment of the region, analysing the bioeconomy potential and shaping the suitable and relevant business models set the ground for further development of the bio-based sector.

The availability of natural resources in the Strumica region of North Macedonia is a sound base for the future economic development, also with regard to a rural bioeconomy. The Strumica region is the largest producer and exporter of agricultural products in North Macedonia. Agricultural residues as well as waste from the agri-food industry are important raw material sources that build a solid base for the development of innovative small-scale biorefining concepts. The raw material coming from the forest industry can be expected to be sufficient for the small-scale processing, too. Since the region's economic focus lies on agriculture, the most relevant applications of biotechnologies and bio-based products are pelletizing and briquetting, gasification or pyrolysis, anaerobic digestion and composting. Nevertheless, proven and innovative biorefining technologies that can process both, agricultural and forest residues, are interesting when it comes to the processing of larger amounts of biomass. The region has a favourable geographical position since the accessibility by roads from all directions is good. Thus, the region is well connected to the rest of the country as well as with its neighbouring countries. Currently some untapped business potential exists in the region (e.g. energy production from biomass), but there is a strong willingness to exploit it. Thus, Strumica's four municipalities are committed to a common economic development, aiming to benefit from existing resources and potentials. A strong will for EU integration triggers the genesis of political conditions that facilitate the development of bioeconomy strategies and roadmaps. Since the bioeconomy is a fixed component of EU policies since 2012²¹, the development of such strategies helps adopting EU policies at the same time. Financing options exist in this region. Those consist of public entities, private banks and payment agencies, which can finance and support bioeconomy-related projects.

In order to properly use such financial support, a roadmap for development of bioeconomy for the Strumica region was developed. More precisely, the roadmap is developed within six cross-cutting focus areas, namely business sector; R&I; funding streams; synergies with other policy fields, education and information, international collaboration and sharing good practices among region. The strategic goals are presented in the form of tables and are an initial step towards defining priorities in particular area. As such, they are a living document which might be subject to changes as a result of further development and should be continuously monitored based on the indicators.

The key part of this bioeconomy roadmap are the strategic goals aimed at:

- Facilitating the development of bioeconomy businesses in rural area;
- Strengthening market orientation and increasing competitiveness, with a special focus on research, technology and digitalization;
- Supporting for key stakeholders interested in making use of diverse funding streams related to the bioeconomy;
- Improving the cross-sectoral bioeconomy involvement;
- Encouraging sustainable development via exchange platforms, mechanisms and information campaigns;
- Gaining knowledge on how to overcome some local issue.

The impacts from a successful implementation of the bioeconomy roadmap in the region should be focused on enhanced stakeholder engagement, close international collaboration, transparent regulatory and financial support, creation of green jobs and emphasis on the sustainability and circularity issue on multi-level.

²¹ For more info see: https://ec.europa.eu/research/bioeconomy/pdf/201202_innovating_sustainable_growth_en.pdf

It can be concluded that the region does not have enough raw materials for large-scale applications, but there are sufficient resources for small applications (projects, processes and products) that will be used for bioeconomic development. Lack of qualified people, education and training in the field of bioeconomy and insufficient support of institutions can be a negative factor for the development of bioeconomy. A significant amount of awareness raising and direct dissemination activities about the opportunities that the bioeconomy can bring is crucial for its development, especially for farmers throwing out or burning the agriculture residues in the fields, instead of exploiting them. Since the agricultural and forestry sectors have the largest biomass potentials in the region, special emphasis should lie on developing and establishing bioeconomy businesses in these fields. The showcased business model canvas could serve as a basis for further development of innovative business idea utilization the regional residues. Even though financing options exist in the region, there is still a lack of direct investments which could hinder the development of bioeconomy businesses.

The main recommendations are aimed at improving the collaboration between key stakeholders (e.g. educational institutions, R&D units, etc.) is required in order to develop new business. Furthermore, an enhanced cross-border collaboration between Greece and Bulgaria will open many opportunities for the implementation of new projects. Regarding the educational system, there are many aspects that should be improved, for example a change in the secondary and higher education that should be in line with the needs and opportunities in this field. Then, trainings as part of the education system should be organised in the fields of agricultural production and reuse of by-products. New innovative technologies and their practical use should be integrated in Master and PhD research programmes. The civil society representative thinks that greater financial support and projects for different types of associations (co-operatives, local action group, etc.) are necessary, not only through subsidies, but also through the availability of different funds. This could contribute to the development of the bioeconomy.

The next steps shall be implemented by the members of the regional bioeconomy panel, which will be formed. Their task will be to define specific activities, which are in line with the six pillars of the bioeconomy roadmap listed above, and to communicate them to the key stakeholders through bilateral communication and workshops. The purpose of the regional bioeconomy panel will be to support the municipalities in the Strumica region for better cooperation between educational institutions, research and development units, business, public and non-governmental sector. Representatives of the four municipalities will be part of the regional panel for bioeconomy, which will continue to further promote bioeconomy and ensure prosperous development in the bio-based sector in the Strumica region. These so-called "bioeconomic ambassadors" will play a key role in the implementation of the roadmap activities.

In order to ensure the sustainability of the activities, it is envisaged that the monitoring, support and data collection will be by the regional bioeconomy panel, but also by SDEWES-Skopje, in order to be able to effectively measure the progress.