Bioeconomy Development Strategy for Mazowieckie Voivodship

Mazovian Energy Agency
2021-03-31

MONITORING COMMITTEE:

MAREK PSZONKA

ALEKSANDRA LUKS

AUTHORS:

PROF. PIOTR GRADZIUK, PHD

PROF. ANNA GRZYBEK, PHD, ENG.

WORKS ON THE BIOECONOMY DEVELOPMENT STRATEGY FOR MAZOWIECKIE VOIVODSHIP WERE CARRIED OUT IN COOPERATION WITH MEMBERS OF THE REGIONAL COUNCIL FOR THE DEVELOPMENT OF BIOECONOMY:

URSZULA PAWLAK, DEPARTMENT OF WASTE MANAGEMENT, EMISSIONS, AND INTEGRATED PERMITS OF THE MARSHAL'S OFFICE OF MAZOWIECKIE VOIVODSHIP

RADOSŁAW RYBICKI, DEPARTMENT OF AGRICULTURE AND RURAL DEVELOPMENT OF THE MARSHAL'S OFFICE OF MAZOWIECKIE VOIVODSHIP

ADAM STRZELECKI, EIT FOOD POLAND

MAŁGORZATA MŁYNARSKA, EIT FOOD POLAND

PIOTR PASYNIUK, FOUNDATION FOR BIOSECURITY

MONIKA SZYMAŃSKA, FOUNDATION FOR THE DEVELOPMENT OF POLISH AGRICULTURE

MAREK HRYNIEWICZ, INSTITUTE OF TECHNOLOGY AND LIFE SCIENCES, WARSAW BRANCH

SEBASTIAN BULKUĆ, KEZO RESEARCH CENTRE PAN

URSZULA GADOMSKA, MAZOWIECKIE REGIONAL PLANNING OFFICE, REGIONAL BRANCH IN SIEDLCE

ELŻBIETA POLAK, MAZOVIA REGIONAL PLANNING OFFICE, REGIONAL BRANCH IN SIEDLCE

RYSZARD GAJEWSKI, POLISH CHAMBER OF BIOMASS

DARIUSZ MATUSZEWSKI, PRZEDSIĘBIORSTWO GOSPODARKI KOMUNALNEJ W PŁOŃSKU [MUNICIPAL ECONOMY COMPANY IN PŁOŃSK] SP. Z O.O.

BOGUSŁAW SZYMAŃSKI, LIW COMMUNAL OFFICE

LEONARD MILEWSKI, FACULTY OF ENGINEERING, UNIVERSITY OF TECHNOLOGY AND COMMERCE

List of contents

1. INTRODUCTION

The global social and economic mega-trends of the 21st century are not beneficial to European regions. After the year 2000, a weakening of the economic position of the EU and its Member States, as well as regions, in relation to other developed countries of the world (mainly the USA, Japan and South Korea) and the New Industrial States (mainly China and India) was observed. The way for the EU and its Member States to respond to such challenges is to increase R&D spending, stimulate innovation and economic competitiveness, including the development of smart specialisations. Another mega-trend of a global nature is climate change. There is a worldwide consensus on the need to slow it down, and the EU is among the leaders of the circular economy. Climate change is causing a much higher frequency of extreme weather events (floods, hurricanes, droughts, etc.) and higher costs for the society and economy due to the need to finance various safeguards and undertakings to mitigate adverse changes. The answer to this challenge is waste-free (circular) economy and protection of ecologically sensitive natural resources. Improving the resilience of regions and cities to structural and cyclical disturbances in development processes has become an important element of territorial strategies. These new socio-economic mega-trends require a comprehensive response to the fundamentally modified challenges of the 21st century. All these conditions are met by the “Bioeconomy” strategy.

2. EXTERNAL REASONS FOR UNDERTAKING WORKS ON THE STRATEGY FOR BIOECONOMY DEVELOPMENT IN MAZOWIECKIE VOIVODSHIP

2.1 European Union’s Policy

The interest in raw materials from agriculture, forestry and fisheries, which can also be used in industries other than food production or the wood industry, has been growing together with the increasing symptoms of the raw material and energy crisis and a very high rate of environmental pollution. Hence the need to increase the efforts to use renewable biological resources more rationally. Such a conclusion was included, inter alia, in the European Commission's Communication of 13 February 2012. *"Innovating for Sustainable Growth: A Bioeconomy for Europe"*[1]. The Bioeconomy Strategy and its Action Plan aimed to lay the foundations for a more innovative, resource-efficient and competitive society where food security does not conflict with the sustainable use of renewable resources for industrial

[1] COM(2012) 60.

purposes, while ensuring environmental protection. Such policies are intended to drive research and innovation in bioeconomy sectors and contribute to a more coherent policy environment, better relations between national, EU and global policies and a more engaged public debate. The above-mentioned documents will contribute to achieving synergies and maintaining interdependence with other policies, instruments and sources of funding that share the same objectives, namely the Common Agricultural Policy (CAP) and the Common Fisheries Policy (CFP) and the policy on environment, industry, employment, energy and health.

In 2017, the European Commission carried out the *"Review of the 2012 European Bioeconomy Strategy"*[2]. It stated that the objective of the strategy, which was "*to pave the way to a more innovative, resource efficient and competitive society that reconciles food security with the sustainable use of biotic renewable resources for industrial purposes, while ensuring environmental protection*", remains valid. The review recognises that the actions taken so far have been successful, in particular in implementing research and innovation, stimulating private investment, developing new value chains, promoting the use of national bioeconomy strategies and involving stakeholders.

The conclusions of the review were the basis for updating the 2012 Strategy, which was presented in the Communication of 11.10.2018. "*A sustainable bioeconomy for Europe: strengthening the links between economy, society and environment*".[3] This document contains, inter alia, a definition of the term "bioeconomy". ***"The bioeconomy covers all sectors and systems that rely on biological resources (animals, plants, micro-organisms and derived biomass, including organic waste), their functions and principles. It includes and interlinks: land and marine ecosystems and the services they provide; all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture); and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services. To be successful, the European bioeconomy needs to have sustainability and circularity at its heart. This will drive the renewal of our industries, the modernisation of our primary production systems, the protection of the environment and will enhance biodiversity."***

It was confirmed that the following objectives of the Bioeconomy Strategy adopted in 2012 remain valid:

[2] SWD(2017) 374.
[3] SWD(2018) 431.

Objective 1. Ensuring food and nutrition security

Food and farming systems account for about three quarters of the overall bioeconomy employment and about two thirds of bioeconomy turnover. However, their sustainability is challenged by a growing world population, changing consumption practices and nutrition, unsustainable biomass use and waste, and climate change threats. The transformation towards sustainable, healthy, nutrition-sensitive, resource-efficient, resilient, circular and inclusive food and farming systems needs to accelerate. This includes turning organic waste, residues and food discards into valuable and safe bio-based products, for instance by deploying small-scale biorefineries, helping farmers, foresters and fishermen to diversify their revenue sources and better manage market risks, all while achieving the goals of the Circular Economy.

Objective 2. Sustainable management of natural resources

Timely action is needed to avoid ecosystem degradation, restore and enhance ecosystem functions, which can increase food and water security, and contribute substantially to the adaptation and mitigation of climate change through "negative emissions" and carbon sinks. In particular, the preservation and productivity of healthy marine ecosystems, oceans, forests and soils depend on biodiversity, hence the need for action to improve monitoring and forecasting capacities for the state and development of natural resources.

Objective 3. Reducing dependence on non-sustainable non-renewable resources, whether sourced domestically or from abroad

Bioenergy is vital to deliver the EU's energy and climate targets as bioenergy, currently the EU's largest renewable energy source, is expected to remain a vital component of the energy mix in 2030. A stronger bio-based sector can accelerate the substitution of non-renewable resources in line with the EU's commitments under the Paris Agreement. Moreover, industrial symbiosis and innovative industrial biobased processes contribute to the greening of industries and development of circular bioeconomies and products, for instance by innovating the way cities add value to their significant share of bio-waste.

Objective 4. Mitigating and adapting to climate change

Mitigating and adapting to climate change, has established itself as the global challenge of this generation. Within the Long-Term Greenhouse Gas Emission Reductions Strategy, a sustainable and circular bioeconomy is key to achieve a greenhouse gas neutral Europe. Furthermore, a sustainable bioeconomy has large potential to reduce greenhouse

gases emissions by promoting more resource efficient, active and sustainable primary production practices on land and sea, as well as by enhancing the capacity of ecosystems to regulate climate, for instance through the deployment of carbon farming innovations.

Objective 5. Strengthening European competitiveness and creating jobs

Providing frameworks for developing and deploying innovations and fostering the development of markets for bio-based products, e.g. through public procurement, creation of standards, renewable energy policies and carbon pricing, will support the global competitiveness and transformation of European industries. The bioeconomy offers important opportunities for new jobs regional economic development and improved territorial cohesion, also in remote or peripheral areas. It has the potential to provide an important source of income diversification for farmers, foresters and fishermen, and to boost local rural economies through increased investment in skills, knowledge, innovation and new business models, as recommended in the 2016 Cork 2.0 declaration.

The updated strategy proposes three main areas of action:

1. **Strengthen and scale-up the bio-based sectors, unlock investments and markets:**
   - 1.1. Mobilise public and private sector stakeholders for research, demonstration and deployment activities related to sustainable and inclusive circular biotechnology solutions;
   - 1.2. Launch a thematic investment platform for a circular bioeconomy with a budget of EUR 100 million,
   - 1.3. Study and analyse enabling factors and bottlenecks and provision of voluntary guidance on the implementation of bio-innovation,
   - 1.4. Promote or develop market standards and incentives and improve labelling of bioproducts on the basis of reliable and comparable data on the achievement of environmental and climate objectives,
   - 1.5. Facilitate the development of new sustainable biorefineries and confirm their type and estimated potential,
   - 1.6. Invest in research and innovation to develop materials that will replace fossil-based materials and build on biological resources. Recyclability and biodegradability should be essential features of such materials.

2. **Deploy local bioeconomies rapidly across Europe:**

2.1. Draw up a strategic implementation programme for sustainable food and agricultural, forestry and bio-production systems in a circular bioeconomy,

2.2. Pilot actions for the development of local bioeconomies (rural, coastal, urban) through Commission instruments and programmes,

2.3. Create a policy instrument to support the EU bioeconomy and a European Bioeconomy Forum for Member States,

2.4. Promote education, training and skills in different fields of the bioeconomy.

3. Understand the ecological boundaries of the bioeconomy:

3.1. Deepen the knowledge on the bioeconomy, including biodiversity and ecosystems, so that it can be implemented within safe environmental constraints, and make this knowledge available through a bioeconomy knowledge centre,

3.2. Strengthen observation, measurement, monitoring and reporting capacities and create an EU-wide monitoring system that is internationally consistent to track economic, environmental and social progress towards a sustainable bioeconomy,

3.3. Provide voluntary guidelines for the functioning of the bioeconomy within safe environmental boundaries,

3.4. Integrate the benefits of highly biodiverse ecosystems into primary production through specific support for agro-ecology, the development of microbial solutions and new tools for integrating pollinators into value chains.

The following priority areas are particularly important for regions such as Mazowieckie Voivodship:

- bio-innovation, including in agriculture, development of new chemicals, products, processes and value chains for the benefit of rural and coastal biotechnology markets, together with raw material producers and resulting in increased benefits for them;
- new opportunities for the forest sector to replace unsustainable raw materials in construction, to pack products in biomaterials and to provide more sustainable innovation in sectors such as textiles, furniture and chemicals that rely on forest resources, as well as new business models based on valuation of forest ecosystem services;
- addressing issues such as food waste, waste and by-products (including ensuring nutrient recycling), resilience, and the need to ensure nutritionally sound food production.

The European Commission has recognised the contribution of the Bioeconomy Strategy to both the circular economy and the Energy Union, while stressing that the scope of its objectives should be adapted in line with overall European priorities. Actions should therefore be redirected so as to maximise their impact on these priorities, in particular those identified in the following documents:

- "Closing the loop - An EU Action Plan for a Circular Economy" of 2 December 2015[4],
- "Clean energy for all Europeans" of 30 November 2016[5].
- "Investing in a smart, innovative and sustainable industry. A renewed EU industrial policy strategy" of 13 September 2017[6],
- "The future of food and farming" of 29 November 2017[7],
- "European Green Deal" of 11 December 2019[8].

2.2 National circumstances

In Poland, the process of raising awareness on the importance of the bioeconomy and of the construction of a coherent economic sector is in its initial phase, and Poland's obligations resulting from its membership in the EU have contributed to the acceleration of this process. There is no separate bioeconomy strategy, but references are made in the following documents:

- "The Strategy for sustainable development of rural areas, agriculture and fisheries"[9] for the years 2012-2020, in which the main objective is "Improving the quality of life in rural areas and efficient use of their resources and potential, including agriculture and fisheries, for sustainable development of the country";
- "The Strategy for Innovation and Economy Efficiency"[10] promoting the increase of economy's productivity, rational resource management, increasing economy's innovation;

[4]COM(2015) 614.
[5]COM(2016) 860.
[6]COM(2017) 479.
[7] COM(2017) 713.
[8] COM(2019) 640

[9] M.P. 2012 poz. 839
[10] M.P. [Official Gazette] of 2013, item 73

- the strategy "Energy security and environment - a perspective until 2020"[11], which promotes the increase in the efficiency of the use of natural resources and raw materials;
- "The state ecological policy 2030 - development strategy in the field of environment and water management"[12]
- "The Strategy for Responsible Development until 2020 (with an outlook to 2030)"[13], which sets out key areas for the implementation of the strategy, including: human and social capital, agriculture, environment and energy;
- "The National Strategy for Regional Development"[14], which assumes innovative development of regions and improvement of the approach based on Regional Intelligent Specialisations;
- List of national smart specialisations in force from 1 January 2020[15], half of which relate to bioeconomy;
- The roadmap of Transition towards a circular economy of 2019.

2.3 Regional documents

The self-government of Mazowieckie Voivodship focuses its activities on ensuring sustainable and balanced development, maintaining social, economic and territorial cohesion, increasing the competitiveness of the region's economy and creating new jobs. Integrated development planning of Mazowieckie Voivodship combines social, economic and environmental aspects and is implemented in accordance with the provisions contained in strategic, planning and programming documents.

Development strategy for Mazowieckie Voivodship until 2030. Mazovia as an innovative region[16]

The main strategic document of the region is "Development Strategy for the Mazowieckie Voivodship 2030. Mazovia as an innovative region". The arrangement of its objectives is of a hierarchical and horizontal nature. The development goals have been set in

[11] M.P. [Official Gazette] of 2014, item 469
[12] M.P. 2019 item. 794.
[13] M.P. [Official Gazette] of 2017, item 260
[14] M.P. [Official Gazette] of 2019, item 1060
[15] file:///C:/Users/Dell/Downloads/Opisy_KIS__werja_6_FINAL_01012020%20(2).pdf.
[16] https://www.mbpr.pl/user_uploads/image/PRAWE_MENU/STRATEGIA%20ROZWOJU%20WOJEWODZTWA%20MAZOWIECKIEGO%20DO%20ROKU%202030/SRWM_do_2030.pdf

six areas of action:

- Industry and manufacturing;
- Economy;
- Space and transport;
- Society;
- Environment and energy;
- Culture and heritage.

Particular measures of the Strategy were defined in the territorial dimension - separately for cities, Warsaw and WMA, and rural areas. The development strategy for Mazowieckie Voivodship 2030 was created on the basis of experience from the implementation of previous strategies and problems that emerged during the previous and current programming period. The document is a response to the challenges that the Voivodship has to face in order to improve the quality of life, reduce social exclusion and unemployment, implement the territorial cohesion policy and the policy of smart and sustainable development. In the strategy, the following have been adopted:

Priority strategic objective:

- **Development of export-oriented production in the high- and medium technology industry and the agri-food industry and processing.**

Strategic goals:

- **Increase the competitiveness of the region through the development of its economic activity and transfer and use of new technologies;**
- **Improve accessibility and territorial cohesion of the region and shape its spatial order;**
- **Improve the quality of life and use human and social capital to create modern economy.**

Strategic framework objectives:

- **Ensure a diversified energy supply, as part of the economy, with sustainable management of environmental resources;**
- **Use the potential of culture, cultural heritage and natural environment for the economic development of the region and for improving the quality of life.**

Achieving them requires the implementation of many activities, those relating to the bioeconomy concern the following:

- Creating conditions for the generation and absorption of innovation;

- Production development: creation of conditions friendly to investors and entrepreneurs;
- Supporting the creation and development of production enterprises;
- Creating conditions for increasing non-agricultural investments - mainly in the agri-food industry;
- Benefiting from and strengthening regional specialisations;
- Supporting the development of new technologies, in particular biotechnology and biomedicine, nanotechnology, photonics and optoelectronics, information and communication technologies (ICT) and space technologies;
- Strengthening the development and absorption potential of rural areas;
- Development of environmentally and resident-friendly forms of transport;
- Development of priority scientific areas for the region;
- Diversification of sources of energy and its efficient use;
- Supporting the development of the eco-industry and eco-innovation;
- Ensuring sustainable and balanced development and preserving high environmental values;
- Modernisation and development of local power networks and improvement of transmission infrastructure;
- Improvement of water quality, waste recovery/disposal, rehabilitation of contaminated sites and reduction of pollutant emissions;
- Production of energy from renewable sources.

Regional Innovation Strategy for Mazovia 2020[17]

The great economic and scientific diversity of Mazovia is the reason for emergence of specialisations which are the interfaces between the selected areas, technologies and processes that respond to the needs of its inhabitants and fit in with global trends. The areas, processes and technologies form a kind of network in which the concentration of links determines the smart specialisation of the region. Based on the conducted diagnosis and consultation process, four areas of regional specialisation of Mazovia were selected, including "**Food Safety**". The aim is to contribute to the availability and development of high quality, sustainable food

[17] https://innowacyjni.mazovia.pl/assets/uploads/Regionalna-Strategia-Innowacji-dla-Mazowsza-do-2020-roku.pdf

products that are safe for both the end user and the environment throughout the production and distribution cycle, including through:

- crop/breeding monitoring systems, production and packaging processes, quality assessment systems for raw materials and products (e.g. agri-food sector, IT sector, ICT, photonics, electronics, chemistry, biotechnology, electro-machinery sector),
- automation and robotisation of production, precision farming (e.g. agri-food sector, IT sector, information and communication technologies, photonics, electronics, electrical engineering sector);
- living organisms used in the production process (e.g. agri-food sector, biotechnology);
- packaging (e.g. agri-food sector, chemical sector, nanotechnologies);
- logistics, supply cycle management, storage (e.g. agri-food sector, IT sector, ICT, B2B services);
- quality classification systems (e.g. agri-food sector, B2B services);
- quality assurance and research apparatus (e.g. agri-food sector, chemical sector, medical sector, nanotechnologies, photonics, electronics);
- crop protection measures and techniques, veterinary measures, biopesticides (e.g. agri-food sector, chemical sector, medical sector, biotechnology);
- management of by-products of agri-food production and processing, circular solutions (e.g. agri-food sector, energy sector, chemical sector, biotechnology, nanotechnologies, B2B services);
- biologically active substances, functional food, nutraceuticals (e.g. agri-food sector, medical sector, chemical sector, biotechnology).

Provincial Waste Management Plan for the Mazowieckie Voivodship for the years 2016-2021, including the years 2022-2027[18]

In a modern and environmentally friendly economy, great importance is attached not only to reducing the production of waste, but also to recycling it. The idea is that the used product should not become a waste, but a raw material for further production. The basic document relating to the circular economy model in the region is the "Waste management plan for the Mazowieckie Voivodeship 2024" adopted in 2018, and then updated by Resolution 91/19 of the Mazowieckie Voivodeship Assembly of June 18, 2019[19]. The main objective of the study

[18] file:///C:/Users/Dell/Downloads/plan_gospodarki_odpadam_2024.pdf
[19] https://www.mazovia.pl/samorzad/sejmik/uchwaly-sejmiku/uchwala,3841,9119.html.

is to indicate the directions of development of the waste management policy and to achieve the objectives and requirements set out in the environmental protection policy, including those resulting from European Union law. The Plan indicates the directions of activities in waste management leading to the implementation of the idea of circular use of resources with rational use and maintenance of an integrated and sufficient network of waste management installations that meet the environmental protection requirements. This document includes, inter alia:

• Investment plan which includes, inter alia, planned investments, estimation of the costs of planned investments and sources of their financing along with the schedule of implementation of the planned investments;

• Waste prevention program for the Mazowieckie Voivodeship - indicates the goals and directions of activities, formal and legal, technical and technological and organizational solutions leading to extending the durability of products, and then to organizing repair and recovery points. The document indicates the need for cooperation between the system's manager, scientists and entrepreneurs, which in turn should lead to innovative solutions consistent with the European goals of pursuing a resource-efficient economy.

Spatial Development Plan for Mazowieckie Voivodship[20]

The basic tool for implementing a spatial policy at the level of the region is the "Mazowieckie Voivodship Spatial Development Plan", which is a representation of the spatial policy of the Voivodship's self-government. It is also the main tool for its implementation, through the set areas of land use. The consistency between the development policy and the spatial policy in the areas of activities and development goals defined in the "Development Strategy for Mazowieckie Voivodship 2030" and the guidelines included in the "Mazowieckie Voivodship Spatial Development Plan" is presented in Table 1.

Table 1. Consistency between the development and the spatial policy in the main strategic and planning documents of Mazowieckie Voivodship

Spatial development plan of Mazowieckie Voivodship - status and guidelines for spatial planning	**Development strategy for Mazowieckie Voivodship until 2030. Mazovia as an innovative region - areas of action and development objectives**

[20] https://www.mazovia.pl/wojewodztwo/plan-zagospodarowania-wojewodztwa-mazowieckiego/.

Functional areas - boundaries and rules of development Land-use structure Strategic areas of agricultural production	**Industry and production** Development of export-oriented production in the industry of high and medium technology and in the agri-food industry and processing
Basic elements of a settlement network Functional areas - boundaries and rules of development Functional and spatial structures Land-use structure Strategic areas of agricultural production	**Economy** Increase the competitiveness of the region through the development of its economic activity and transfer and use of new technologies
Land-use structure Basic elements of a settlement network Functional areas - boundaries and rules of development Functional and spatial structures Transport links	**Space and transport** Improve accessibility and territorial cohesion of the region and shape its spatial order
Accessibility to services (problem areas)	**Society** Improve the quality of life and use human and social capital to create a modern economy
Energy infrastructure Water and sewage infrastructure and sewage treatment Waste management Protection of the environment and natural resources Areas of particular flood risk Critical infrastructure - entrepreneurs of particular economic and defensive importance	**Environment and energy** Ensure, as part of the region's economy, a diversified energy supply, with sustainable management of environmental resources
Protection of cultural heritage and the cultural landscape Tourism	**Culture and heritage** Use the potential of culture, cultural heritage and natural environment for the economic development of the region and for improving the quality of life
Functional areas - boundaries and rules of development	Strategic intervention areas (Polish: OSI)

Source: Spatial development plan of Mazowieckie Voivodship. MBPR Warsaw, 2018, p. 12.

3. BIOECONOMY AS A SMART SPECIALISATION

The development of bioeconomy is based on raw materials produced from the resources such as air, water, soil and nutrients as well as biological diversity of plants, animals and microorganisms. Given the limited availability of these resources, their conservation and sustainable use is essential. This concept assumes “meeting the needs of the present generation without compromising the ability of future generations to meet their own needs.” This definition refers to the conflict between the environmental threats caused by modern

economic growth and the demand for this growth that results from social needs. This dilemma leads to the idea of three dimensions of sustainable development: environmental, social and economic dimensions, which are interdependent and must be taken into account in development of policies and strategies.

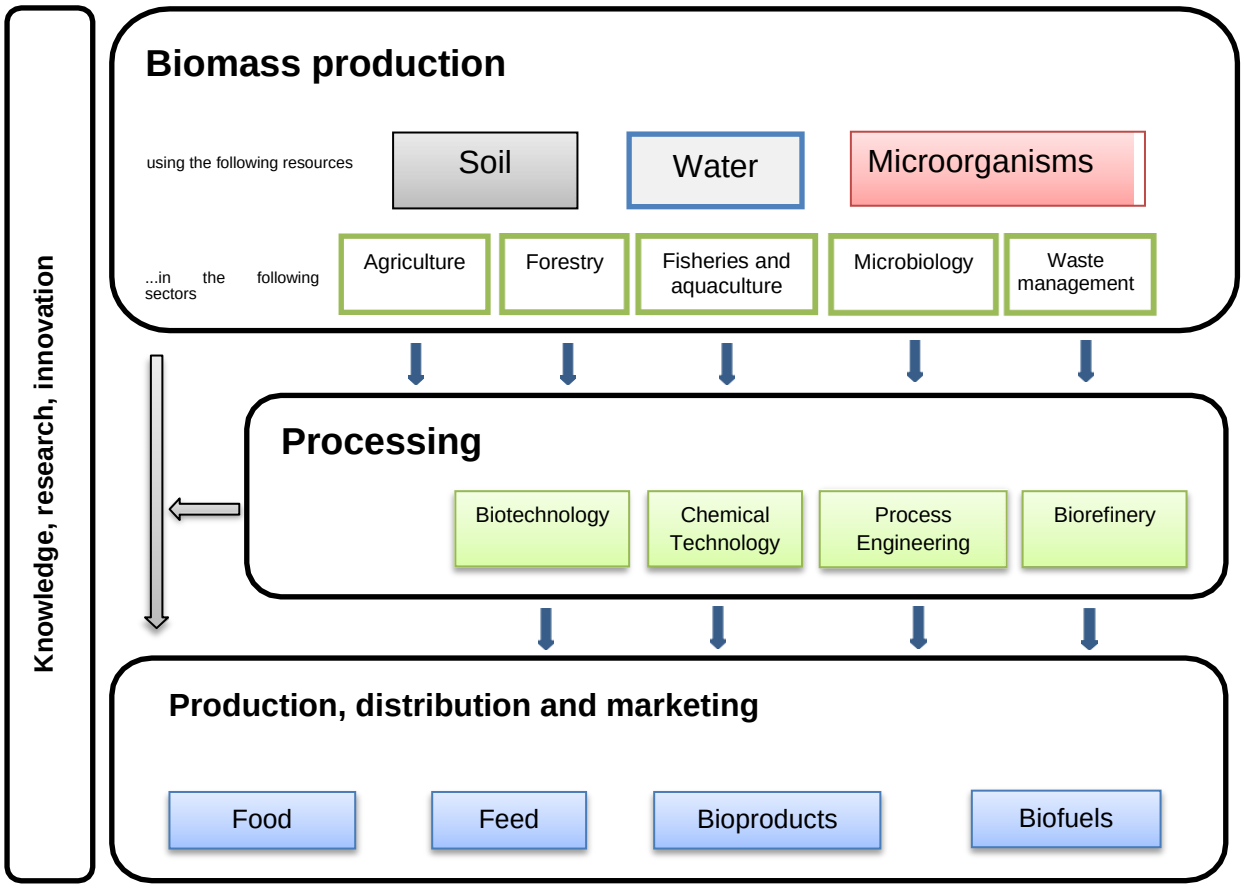


Figure 1. Bioeconomy system

Source: Gołębiewski J., Zrównoważona biogospodarka - potencjał i czynniki rozwoju. (Sustainable bioeconomy - potential and development factors) http://www.pte.pl/kongres/referaty/Go%C5%82%C4%99biowski%20Jaros%C5%82aw/Go%C5%82%C4%99biewski%20Jaros%C5%82aw%20-%20ZR%C3%93WNOWA%C5%BBONA%20BIOGOSPODARKA%20-%20POTENCJA%C5%81%20I%20CZYNNIKI%20ROZWOJU.pdf (available on: 12. 04. 2020).

Development of bioeconomy is based on knowledge and research. Innovations resulting from research, introduced in agriculture, food industry and other sectors, enable the development of new products and production techniques and increase the economic efficiency of new products compared to traditional forms of processing and processes and interdependent supply chains. The concept of Knowledge-Based Bioeconomy assumes that the European economy cannot compete at global level just by providing basic agricultural products, but must develop the production of innovative, high-tech products. The bioeconomy should therefore be combined with efficient management of raw materials and recycling. It should be remembered that the hierarchy and cascade principle should be applied in the use of biomass and that biomass should be used in such a way that its management ensures the highest possible added value. The diagram presented in Figure 2 shows that the best economic effects are obtained by using biomass to produce substances with the properties of drugs and nutraceuticals, which are the products for which the demand in modern living conditions is and will be increasing. Favourable economic effects are also obtained by converting biomass into food and feed. At the second pole of the economic effects of biomass use is the generation of energy and heat from its combustion, as well as the acquisition of chemical substances and fuels. This shows the directions to be taken by works on the development of the bioeconomy and on establishing smart specialisations within it.

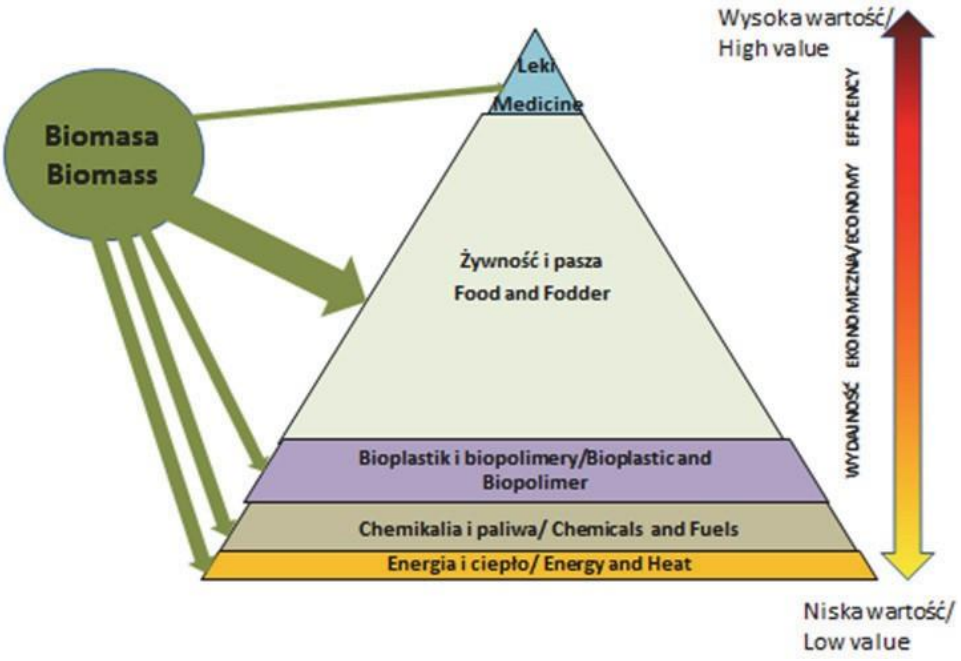


Figure 2. Possibilities of using biomass with graphical indication of economic efficiency
Source: Chyłek E. K., Kopiński J., Madej A., Matyka M., Ostrowski J., Piórkowski H. 2017. "Uwarunkowania i kierunki rozwoju biogospodarki w Polsce" (Conditions and directions of development of bioeconomy in

Poland). Ministry of Agriculture and Rural Development, Institute of Technology and Life Sciences in Falenty, Warszawa-Falenty, p. 28.

Therefore, the bioeconomy fits into the concept of developing smart specialisations and creating an effective network of cooperation between the sectors of science, economy and business environment and business entities. Intelligent specialisations are to contribute to the transformation of the national economy through its modernisation, structural transformation, diversification of products and services and creation of innovative social and economic solutions, which would also support the transformation towards an economy in which resources, including natural resources, are used efficiently. The development opportunities of the bioeconomy should be seen in the following National Intelligent Specialisations (Polish: KIS):

- KIS 1. Medical engineering technologies, including medical biotechnologies;
- KIS 2. Manufacture of medicinal products;
- KIS 3. Innovative technologies, processes and products of the agri-food and forest-wood sector;
- KIS 4. High-quality food;
- KIS 5. Biotechnological and chemical processes, bioproducts and specialised chemistry and environmental engineering products;
- KIS 6. Environmentally friendly transport solutions;
- KIS 7. Circular economy - water, fossil resources, waste;
- KIS 8. Multifunctional materials and composites with advanced properties, including nanoprocesses and nanoproducts.

4. STRATEGIC DIAGNOSIS

4.1 General characteristics

Mazowieckie Voivodship is the largest Voivodship in Poland, both in terms of area (35.6 thousand km^2, i.e. 11.4% of the whole country) and population. As of 31 December 2019, the population amounted to 5,423 thousand people, i.e. 14.12% of the country's population.[21] According to the Classification of Territorial Units for Statistics, Mazowieckie Voivodship constitutes a separate NUTS 1 level (Fig. 3) and is divided into the following units:

[21] Population. Status, structure and natural increase in 2019. Status as at 31 December. GUS Warsaw, 2020, p. 14.

NUTS 2 the capital city of Warsaw region:

NUTS 3:

- City of Warsaw;
- Eastern Warsaw;
- Western Warsaw,

NUTS 2 regional Mazowieckie region:

NUTS 3:

- Ciechanów;
- Ostrołęka;
- Płock;
- Radom;
- Siedlce.
- Żyrardów.

[borders of NUTS 2 regions, borders of NUTS 3 regions, borders of poviats, borders of communes]

Figure.3. Administrative and statistical division of Mazowieckie Voivodship
Source: Spatial development plan of Mazowieckie Voivodship. MBPR Warsaw, 2018, p. 21.

It is the region with the highest economic potential in the country; in 2018 the gross

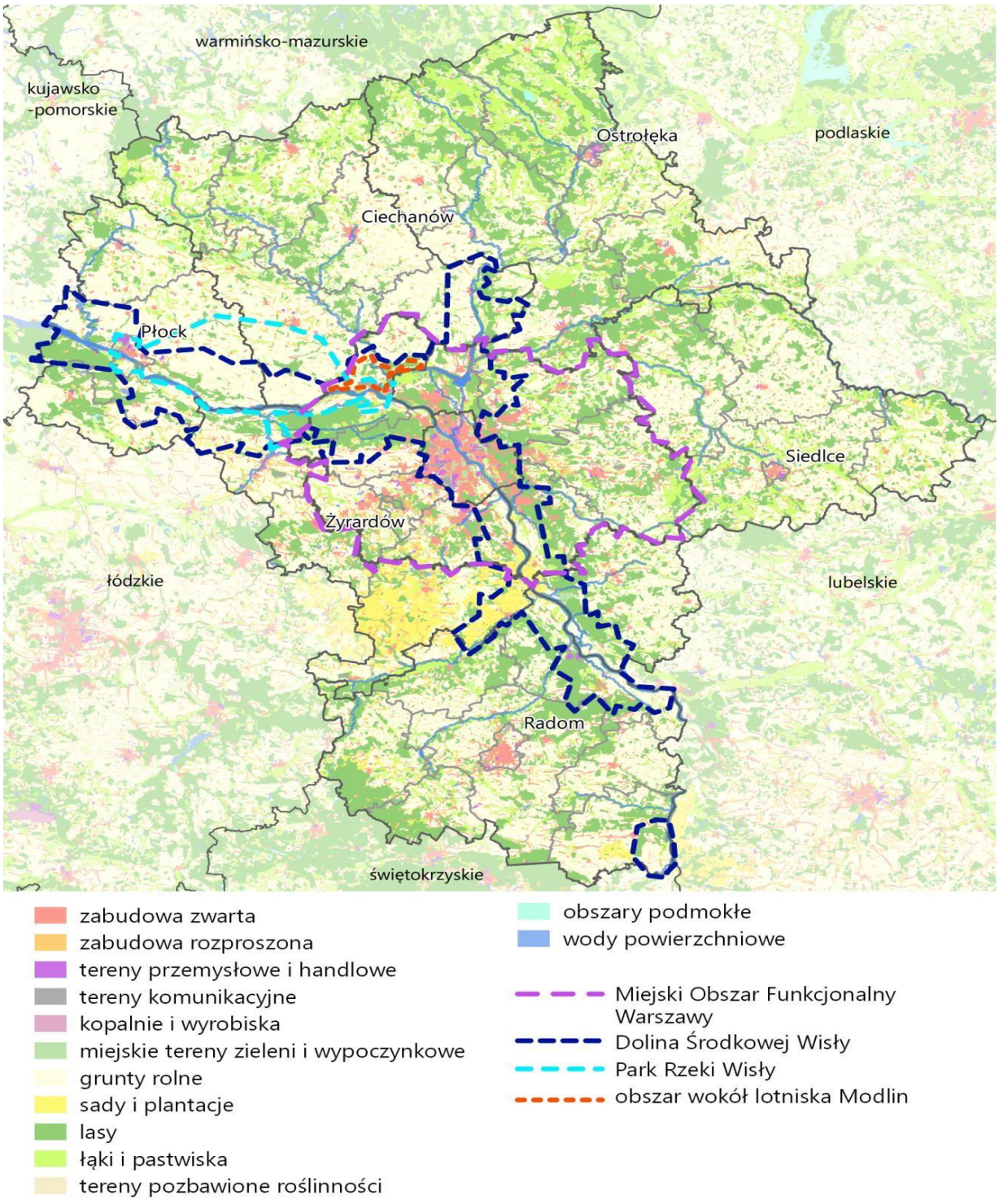
domestic product (GDP) amounted to PLN 477.9 billion, i.e. 22.52% of the country's GDP.[22] It is also one of the fastest growing European regions. A distinguishing feature of Mazowieckie Voivodship is that Warsaw, which is a capital city and a centre of social and economic development on a regional, national and even European level, is located within its borders. In the region of the capital city the generated GDP amounted to PLN 368.0 billion and in the remaining part of the Voivodship to PLN 109.9 billion.

Apart from Warsaw, the settlement network of Mazowieckie Voivodship consists of regional centres - Radom and Płock, and sub-regional centres - Ostrołęka, Ciechanów and Siedlce. Due to their economic and demographic potential, these centres play a balancing role in relation to Warsaw and are of key importance to ensuring the internal cohesion of the region. The elements of the settlement network of Mazowieckie Voivodship consist also of the remaining poviat and commune centres, which act as local development centres for functionally-related rural areas.

An important feature affecting the spatial structure of Mazowieckie Voivodship is the intersection of international and national transport corridors on its territory, where Warsaw is the main transport hub. The basic element of the transport infrastructure of Mazowieckie Voivodship is based on complex routes designated within the Trans-European Transport Network (TEN-T). The facilities and infrastructural connections located in the area of Mazowieckie Voivodship, forming the systems for the transmission of electricity, gas and liquid fuels, are of great importance for ensuring the energy security in the country. The Kozienice power plant and the Płock refinery are deemed to be the key objects, just like sections of infrastructure of international importance running through the Voivodship: the Poland-Lithuania power connection, the “Yamal-Europe” gas pipeline and the “Friendship” oil pipeline. Mazowieckie Voivodship has also a significant potential for obtaining energy based on renewable sources.

Large forest complexes and river valleys located in the area of Mazowieckie Voivodship are of great importance to ensure continuity of European and national ecological networks. Areas of nature conservation in the Voivodship account to about 11% of all protected areas in the country. Areas of high natural value together with objects of great historical and cultural importance shape the natural and cultural ranges of Mazowieckie Voivodship with special natural and landscape values and recreational functions (Fig. 4).

[22] Gross domestic product - regional accounts 2016-2018. Statistical Office in Katowice, 2020, p. 14.



[compact, dispersed housing, industrial and commercial areas, transport areas, mines and excavations, urban greenery and recreation areas, agricultural land, orchards and plantations, forests, meadows and pastures, vegetation-free areas, wetlands, surface water, Urban Functional Area of Warsaw, Central Vistula Valley, Vistula River Park, area around the Modlin airport]
Figure 4. Functional and spatial structures in Mazowieckie Voivodship
Source: Spatial development plan of Mazowieckie Voivodship. MBPR Warsaw, 2018, p. 18.

On the territory of Mazowieckie Voivodship, open areas, free from urbanization processes, apart from nature protection areas, also include areas of strategic importance for food production, that perform agricultural functions. These areas are not only important for

the food self-sufficiency of the Voivodship, but they are also of supra-regional importance.

4.2 Social conditions

Mazowieckie Voivodship is the region with the largest demographic potential in the country. Since the establishment of Mazowieckie Voivodship, a systematic increase in the number of its inhabitants has been observed. While in 1999 the population of the Voivodship amounted to 5,070 thousand people, as of 31 December 2019 it was 5,423 thousand. (7.0% more). The annual population growth rate ranged from 0.05% to 0.35%. In 1999-2019 the population of the Voivodship increased by 353 thousand people. So far, the positive balance of inter-Voivodship permanent migration has been the decisive factor in the population growth of Mazowieckie Voivodship. The population growth was much less affected by natural growth and the balance of foreign migration.

Mazowieckie Voivodship is characterised by the highest migration in the country. Between 1999-2018, the sum of inflows and outflows of people in internal migration concerned almost 2.5 million people; for comparison, it was followed by Silesia, whose internal migration amounted to 1.8 million. It should be added that the majority of internal migration takes place within the Voivodship. In the period under study, 0.9 million people migrated within this type of migration; cities lost and rural areas gained 75.3 thousand inhabitants. In the inter-voivodship flows, every year there are significantly more inflows than outflows - since 2001 the number of permanent residence registrations is twice as high as the number of de-registrations. Most of the new residents came from the neighbouring voivodships. The areas subject to the most intense population inflows are the communes directly adjacent to Warsaw that are subject to suburbanisation.

In the districts surrounding the capital city, the average annual migration intensity coefficient calculated for the years 1999-2019 ranged from 4.54‰ in Minsk poviat to 15.53‰ in Piaseczno poviat, while in the Voivodship it totalled to 2.46‰.[23] In the areas of the most intense migration inflow, the natural increase rate is generally positive. This is because they are settled mostly by people who are at the reproductive age. The average annual natural increase/natural decrement ratio was 0.15‰ (among poviats: from 3.23‰ in Siedlce to minus 4.69‰ in Lipsko). Natural decrement was recorded in half of the districts. On the basis of the accumulated natural increase and the accumulated balance of migration from 1999-2019, it

[23] 20th anniversary of the Mazowieckie Voivodship. Statistical Office in Warsaw, 2019, pp. 23-37.

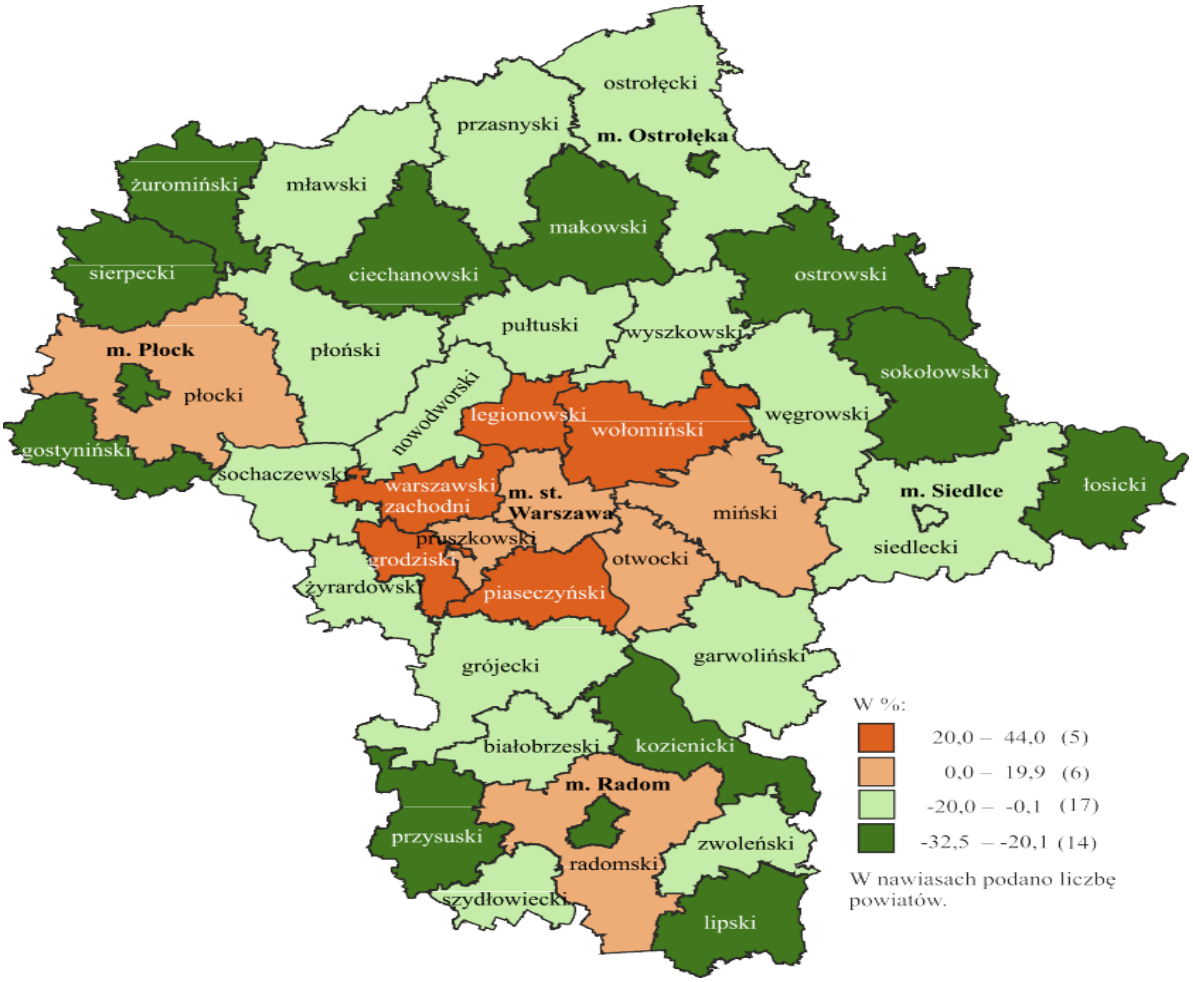
was found that the areas of a progressive character are concentrated in the central part of the Voivodship, i.e. in the metropolitan area of Warsaw.

There are three depopulation areas - in the north, east and south of the voivodship, mostly formed by typically agricultural communes. Moreover, the depopulation of large cities (Radom, Płock, Ostrołęka) and the simultaneous development of adjacent areas is characteristic for the region. The demographic situation of Mazovia, compared to other voivodships in the country, is positive. This is due to the positive balance of migration as well as the relatively high fertility rate. However, a serious problem is posed by the strong spatial diversity of demographic processes - most of the positive trends concern the Warsaw agglomeration and neighbouring communes, while peripheral areas are characterised by accumulation of negative demographic and socio-economic phenomena.

The continuous outflow of population from peripheral areas (generally towards Warsaw and its metropolitan area), that has been observed for the last 20 years, results above all in the intensification of population ageing in these areas. It should be noted that the process of population ageing concerns the entire voivodship (as well the country) and is caused, among others, by the large decrease of the birth rate lasting since the 1990s, the increase of persons aged 65 caused by the baby boom in the 50s, and the beneficial phenomenon of extending life expectancy. The progressing demographic ageing of the voivodship's inhabitants is also evidenced by a gradual increase in the value of the ageing index, which illustrates the numerical relations between grandparents and grandchildren. While in the period 2000-2013 there were an average of 78-99 people over 64 per 100 children aged 0-14, in 2014 there were already 101 people, and in 2018 - 108 people. In the countryside, in the discussed period, the ageing index was still below 100, but it increased from 67 to 91. In cities, since 2004, the ageing index has assumed values above 100 - from 101 to 118 in 2018.

As a result of changes in the age structure of the population, the ratio of the post-working age population to the total working age population in the Voivodship increased from 27.1 in 2000 to 36.0 in 2018 (by 8.9 points), and the ratio of the population at pre-working age decreased from 37.6 to 32.0 (by 5.6 points). In cities, the greater intensity of changes concerned the post-working age dependency ratio, which increased by 13.8 points (from 25.5 to 39.3). On the other hand, a significant decrease in the pre-working age dependency ratio was recorded in rural areas - by 15.8 points (from 48.6 to 32.8).

The results of the long-term population forecast for the years 2014-2050, developed by the Central Statistical Office (GUS)[24], indicate that the increase in the number of people in the post-working age range will continue until 2028; and after that period, a decrease in the population is forecasted (Fig. 5).



[The number of poviats is indicated in the brackets]
Figure 5. Changes in population numbers in 2050 compared to 2013 (in %)
Source: Kozłowska Z. 2017. Sytuacja demograficzna województwa mazowieckiego – stan obecny i perspektywy. (Demographic situation of Mazowieckie Voivodship - current status and prospects.) In: Hrynkiewicz J., Potrykowska A. (ed.), Sytuacja demograficzna Mazowsza jako wyzwaniem dla polityki społecznej i gospodarczej. (Mazovia's demographic situation as a challenge for social and economic policy). National Population Council, Warsaw, p. 22.

Between 2010-2018, in Mazowieckie Voivodship, a systematic increase (from 25.4% to 33.7%) of the share of people with higher education in the population aged 15 and more was observed; in Poland it increased by 6.6 percentage points, up to 24.4%. Women were the

[24] CSO (2014), Forecast for poviats and cities with poviats rights and subregions 2014-2050, Warsaw.

better educated social group than men - in 2018 37.3% of women had higher education diplomas compared to 29.7% of men (in the entire country: 27.6% compared to 20.8%). At the same time in Mazowieckie Voivodship in comparison to 2010 there was a decrease in the share of persons with lower-secondary, primary and incomplete primary education (by 5.7 p.p.), upper-secondary general education (by 1.9 p.p.), basic vocational education (by 0.5 p.p.) and post-secondary and secondary vocational education (by 0.3 p.p.).

The analyses presented above show that Mazovia is a highly polarised region in demographic terms. Warsaw, together with its immediate surroundings, concentrates more than half of the demographic potential of Mazowieckie Voivodship, 2/3 of the population with higher education and 3/4 of larger business entities. At the other end, there are peripheral, handicapped or at least disproportionately weak areas in terms of human capital resources, production capacity and other production forces.[25] The most important specific features of the region are

- the capital city and its influence on the organisation of social and economic processes (Warsaw as the "organiser" of settlement and spatial processes, especially migration. Concentration of people with higher education and with entrepreneur skills in the Warsaw Metropolitan Area with simultaneous impoverishment of peripheral regions in this respect);
- growing disproportions concerning mainly qualitative features, related to the knowledge and skills of employees, between the Warsaw Capital Region and the Mazowieckie Regional Region;
- strong internal disparities affecting most socio-economic phenomena.

The above regularities concern not only demographic processes and structures but also economic ones. This requires an application of a different spatial and regional policy in relation to the functional and settlement specificity, historical and cultural, environmental and economic conditions.

Economy

[25] Śleszyński P. 2017. Sytuacja demograficzna województwa mazowieckiego i jej uwarunkowania dla polityki rozwoju. (The demographic situation of Mazowieckie Voivodeship and its effects on the development policy.) In: Hrynkiewicz J., Potrykowska A. (ed.), Sytuacja demograficzna Mazowsza jako wyzwaniem dla polityki społecznej i gospodarczej. (Mazovia's demographic situation as a challenge for social and economic policy). National Population Council, Warsaw, p. 32-65.

Mazovia is the most dynamically developing region of Poland with a huge economic potential. However, the economy of Masovian Voivodship is very diversified, covering sectors from agricultural production and food processing, through traditional industry, to modern production in the medium-high and high-tech industries. In 2018, out of the total number of national economy entities registered in the national business register REGON (excluding persons running individual farms) 18.7% had their seat in Mazowieckie Voivodship. As in 1999, the private sector accounted for over 95% of the entities. In the years 1999-2018, high dynamics of registered entities was recorded for commercial companies with foreign capital (increase by 130%). In comparison to 1999, the number of entities registered as natural persons increased by 40%. Within 20 years, the entrepreneurial activity rate, expressed in terms of the number of entities per 1000 people, has increased from 98 to 151. In relation to the national average, this indicator was 19 points higher in 1999 and 37 points higher in 2018.

In 2018 the Voivodship's share in generating Poland's GDP was 22.6% and was 0.2 p.p. higher than in 2017 and 0.4 p.p. higher than in 2014. In the Warsaw region, 17.4% of the national GDP was generated, while in the Mazowieckie region - 5.2%. Gross domestic product per capita in 2018 amounted to 88.7 thousand PLN and was higher by 6.7% than the year before; and by 23.6% than in 2014. Mazowieckie Voivodship has for years reached the highest level of this indicator in Poland - in 2018 it exceeded the national average by 61.0%; in 2017 it was higher by 60.5% and in 2014 – by 60,4%. The level of GDP per capita in the Warsaw Capital Region was 2.6 times higher than in the Mazowieckie Regional Region and amounted to PLN 121.2 thousand compared to PLN 46.5 thousand. This means that this indicator in the Warsaw Capital Region was 120.2% higher than the national average and 15.6% lower in the Mazowieckie Regional Region. On the basis of data from the years 2014-2018, it can be concluded that in Mazowieckie Voivodship the GDP, according to purchasing power parity per capita (in PPS), is systematically growing, constituting from 108% to 113% of the average calculated for 28 European Union countries. Mazowieckie is the only Voivodship in Poland where the GDP per capita equals to at least 90% of the EU average, i.e. it meets the criterion of being classified as a more developed region.[26]

The Voivodship's economy has a modern structure, which is proved by the dominant share of the service sector in generating gross value added. In 2018, the share of this sector

[26] Report on the social and economic situation of Mazowieckie Voivodship 2020. Statistical Office in Warsaw, 2020.

was 72.3% (in 2000 - 72.8%) and was 9.6 p.p. higher than the national average, and 1.3 p.p. lower compared to 28 EU countries. Entities conducting industrial and construction activities generated 17.6% and 7.4% of GVA in 2018 respectively; while the share of the agricultural sector was 2.7%.

Eurostat data confirm very high disproportions in the level of economic development of the regions forming the macro-region Mazowieckie Voivodship. In 2018, the Warsaw Capital Region reached 155% of the EU average, while the Mazowieckie Regional Region - only 59%, i.e. did not meet the criterion of being classified as a transition region (it did not fall within the 75-90% of the EU average). In 2018, the shares of individual sub-regions in generating the Voivodship's GDP ranged from 2.5% (in Żyrardów) to 60.5% (in the city of Warsaw); in 2014 from 2.7% to 60.3%. Compared to 2014, two sub-regions increased their share in the creation of gross domestic product - Płock (by 0.3 p.p.) and the city of Warsaw (by 0.2 p.p.). The shares of three sub-regions (Żyrardów, Siedlce and Radom) decreased slightly (by 0.1-0.2 p.p.), while the shares of the remaining sub-regions (Ciechanów, Ostrołeka, Western Warsaw and Eastern Warsaw) did not change. In 2018, the GDP generated in the Warsaw subregion was 13.6% of the total value generated in the whole country; compared to 2014, this share increased by 0.2 percentage points. In Mazowieckie Voivodship, the value of GDP per capita is clearly differentiated in individual subregions - in 2018, this ratio ranged from PLN 37.5 thousand in Radom to PLN 163.4 thousand PLN in the city of Warsaw, i.e. respectively from 42.6% to 185.4% of the Voivodship average. Within three years, the span between sub-regions decreased by 0.1 (to 142.8 percentage points). In terms of GDP per capita, the city of Warsaw is ranked first in Poland, exceeding the national average by 195.9% (in 2014 by 197.8%). In the remaining sub-regions of the Voivodship, GDP per capita constituted from 67.9% of the national average (in Radom) to 150.9% (in Płock); in 2014 from 70.0% (in Radom) to 143.1% (in Western Warsaw). Thus, the span between the sub-regions with the lowest and the highest rate decreased by 0.1 (to 227.7 percentage points). Over three years, the per capita GDP dispersion rate calculated at the level of sub-regions decreased by 0.1 p.p.; in 2018 it amounted to 55.4%, while in 2014– 55,6%. Tables 2 and 3 present the structure of gross value added (GVA) by type of activity in particular regions forming the macro-region of Mazowieckie Voivodship.

Table 2. Gross value added by type of activity and subregions (in million zlotys, basic prices)

Sub-region	Year	Total	Agriculture	Industry		Construction	Trade	Financial activities	Other services
				total	Processing				
City of Warsaw	2016	218117	79	20815	11562	14165	85408	36159	61491
	2017	235981	91	21972	12222	15317	92875	38545	67180
	2018	253107	87	23389	13075	17456	100862	39193	72121
Eastern Warsaw	2016	22345	947	5853	5157	1831	5640	2054	6020
	2017	23875	1137	5905	5195	2074	6210	2102	6447
	2018	25507	1072	6293	5532	2448	6531	2165	6998
Western Warsaw	2016	38375	753	10422	7838	2995	13521	2730	7955
	2017	39887	908	10201	7519	3100	14450	2694	8534
	2018	43543	856	10815	8027	3867	15970	2696	9338
Ciechanów	2016	10561	1428	2989	2707	741	2288	799	2316
	2017	11729	1886	3491	3200	768	2391	802	2391
	2018	12306	1739	3714	3394	898	2632	819	2504
Ostrołęka	2016	11916	1536	2982	2697	939	3105	887	2468
	2017	13134	2012	3240	2751	1074	3324	905	2578
	2018	13893	1856	3634	3157	1177	3599	907	2720
Płock	2016	22386	890	12855	12355	1286	3654	847	2855
	2017	22471	1175	12128	11642	1368	3960	856	2983
	2018	24024	1083	13263	12739	1594	4048	863	3137
Radom	2016	17690	1398	4920	3428	1456	4359	1385	4441
	2017	19296	1835	5295	3941	1525	4859	1407	4644
	2018	20102	1692	5326	3934	1784	4969	1425	4905
Siedlce	2016	13732	1556	3899	3415	1059	3302	994	2921
	2017	14705	2045	3859	3378	1156	3575	1012	3057
	2018	15277	1888	4052	3510	1269	3825	1041	3202
Żyrardów	2016	9910	694	2972	2862	552	3329	622	1741
	2017	10278	918	2848	2723	614	3448	624	1827
	2018	10618	846	3014	2872	656	3555	648	1900

Source: Gross domestic product - regional accounts 2016-2018, tables. Warsaw, Katowice 2020.

Table 3. Structure of gross value added by activity and sub-region (%)

Region	Years	Total	Agriculture	Industry		Construction	Trade	Financial activities	Other services
				total	Processing				
City of Warsaw	2016	100.0	0.04	9.54	5.30	6.49	39.16	16.58	28.19
	2017	100.0	0.04	9.31	5.18	6.49	39.36	16.33	28.47
	2018	100.0	0.03	9.24	5.17	6.90	39.85	15.48	28.49
Eastern Warsaw	2016	100.0	4.24	26.19	23.08	8.19	25.24	9.19	26.94
	2017	100.0	4.76	24.73	21.76	8.69	26.01	8.80	27.00
	2018	100.0	4.20	24.67	21.69	9.60	25.60	8.49	27.44
Western Warsaw	2016	100.0	1.96	27.16	20.42	7.80	35.23	7.11	20.73
	2017	100.0	2.28	25.57	18.85	7.77	36.23	6.75	21.40
	2018	100.0	1.97	24.84	18.43	8.88	36.68	6.19	21.45
Ciechanów	2016	100.0	13.52	28.30	25.63	7.02	21.66	7.57	21.93
	2017	100.0	16.08	29.76	27.28	6.55	20.39	6.84	20.39
	2018	100.0	14.13	30.18	27.58	7.30	21.39	6.66	20.35
Ostrołęka	2016	100.0	12.89	25.03	22.63	7.88	26.06	7.44	20.71
	2017	100.0	15.32	24.67	20.95	8.18	25.31	6.89	19.63
	2018	100.0	13.36	26.16	22.72	8.47	25.91	6.53	19.58
Płock	2016	100.0	3.98	57.42	55.19	5.74	16.32	3.78	12.75
	2017	100.0	5.32	53.97	51.81	6.09	17.62	3.81	13.27
	2018	100.0	4.51	55.21	53.03	6.64	17.00	3.59	13.06
Radom	2016	100.0	7.78	27.39	19.09	8.11	24.27	7.71	24.73
	2017	100.0	9.51	27.44	20.42	7.90	23.78	7.29	24.07
	2018	100.0	8.42	26.49	19.57	8.87	24.72	7.09	24.40
Siedlce	2016	100.0	11.33	28.39	24.87	7.71	24.05	7.24	21.27
	2017	100.0	13.91	26.24	22.97	7.86	24.31	6.88	20.79
	2018	100.0	12.36	26.52	22.98	8.31	25.04	6.81	20.96
Żyrardów	2016	100.0	7.00	29.99	28.88	5.57	33.59	6.28	17.57
	2017	100.0	8.93	27.71	26.49	5.97	33.55	6.07	17.78
	2018	100.0	7.97	28.39	27.05	6.18	33.48	6.10	17.89

Source: Gross domestic product - regional accounts 2016-2018, tables. Warsaw, Katowice 2020

The described generic structure of the economy is regionally differentiated. While in the Warsaw region the largest share in GVA is made up by units operating in trade; repair of motor vehicles; transport and warehouse management; accommodation and catering; information and communication (38.3% in 2018; 37.2% in 2014), in the Mazowieckie region - it is made up by industrial units (34.3% and 33.3% respectively).

Gross added value (GVA) generated in Mazowieckie Voivodship in 2018 amounted to PLN 418.4 billion. The largest share in the generation of GVA was achieved by entities operating in trade, repair of motor vehicles, transport and storage, accommodation and catering, information and communication; and the smallest - by entities operating in agriculture, forestry, hunting and fishing. In 2018 units operating in the field of trade; repair of motor vehicles; transport and warehouse management; accommodation and catering; information and communication generated 34.9% of the Voivodship's GVA, i.e. 1.0 p.p. more than in 2016 and 0.9 p.p. more than in 2014. The share of entities providing other services (including public administration and national defence; compulsory social security) accounted for 25.5% of the Voivodship‘s GVA and increased by 0.4 percentage points in comparison with 2016 and by 0.8 percentage points in comparison with 2014. Industrial units generated 17.6% of the gross value added of the Voivodship, i.e. less by 0.9 pp. in relation to 2016 and by 0.4 pp. in relation to 2014. Units conducting financial and insurance activities; real estate market services generated in 2018 11.9% of the Voivodship's gross value added, i.e. less by 1.5 pp. than the year before and by 1.1 pp. than three years earlier. Construction units generated 7.4% of the Voivodship's GVA, i.e. 0.8 percentage point more than in 2016, but 0.2 percentage point more than in 2014. The share of agriculture, forestry, hunting and fishing in the generation of the Voivodship's gross value added in 2018 was 2.7%, i.e. 0.3 and 0.1 p.p. more than in 2016 and 2014 respectively.

Mazowieckie Voivodship is ranked first in the country in terms of the volume of sales in the industry, which in 2018 reached the value of PLN 308 billion
(in basic prices) and was 5.5% (in basic prices) higher than in 2018 and 28.8% higher than in 2015. On a national scale, in the analysed period, the sales in the industry (in basic prices) increased by 4.0% and 21.0% respectively. The total value of sales in the industry (in basic prices) in 2019 in Mazowieckie Voivodship consisted of production in the following sections: industrial processing - PLN 253.7 billion, production and supply of electricity, gas, steam and hot water - PLN 46.7 billion, water supply; sewage and waste management; reclamation - PLN 6.9 billion, mining and extraction - PLN 1.1 billion. The increase in the volume of sales

in the industry in 2019 compared to 2018 was a result of an increase in sales (in basic prices) in water supply; sewage and waste management; reclamation (by 15.3%) and industrial processing (by 7.1%). The decrease occurred in mining and quarrying (by 2.7%) and in the production and supply of electricity, gas, steam and hot water (by 1.3%). The largest share in the structure of sales in the industry was recorded in the section of industrial processing - 82.3% (an increase by 3.1 p.p. compared to 2010) and the production and supply of electricity, gas, steam and hot water - 15.1% (a decrease by 3.5 p.p.). Among the departments of industrial processing, the following had a significant share in the sales in the industry: production of food products - 19.2%, chemicals and chemical products - 5.7%, computers, electronic and optical products - 5.5%, electrical equipment - 5.3%. The share of the Voivodship's sales in the country's revenue was 20.1% (the highest in Poland).

In the traditional industry group, a significant role is played by the agri-food industry, which comprises 15% of businesses in the country. Mazowieckie Voivodship produces nearly 1/4 of the national sales in the food industry. This is due to the fact that agriculture holds a special position in the economy of Mazowieckie Voivodship - agricultural land constitutes about 2/3 of its area. Despite the low quality of agricultural land, above-average agricultural production specialisations have developed here: fruit, vegetables, meat and milk. The areas of production are spatially diversified - the south-western and central part of Mazovia are regions with dynamically developing vegetable and fruit production, the north-eastern part specialises in dairy and the north-western part is dominated by poultry farming. Mazovia is a significant food producer, as evidenced by the high share of domestic agricultural output. In 2017 it amounted to (similarly to the Wielkopolskie Voivodship) 17.4%. Mazowieckie agriculture is distinguished in particular by its high share in the domestic production of fruit (41% in 2017), as well as milk, meat, eggs and vegetables (19-22%). The position of the region in these areas is increasingly strong, which is confirmed by an increase in the share compared to 1999. Thus, the share in meat production increased by 9.1 percentage points, hen eggs by 8.0 percentage points, fruit by 6.9 percentage points, cow's milk by 5.9 percentage points and vegetables by 1.2 percentage points. The production possibilities of agriculture are provided by individual farms - in 2018 they produced over 97% of the Voivodship's agricultural production.

The raw material base of the region's agri-food processing sector is a highly commoditised agriculture, which results from the developed specialisation of plant (fruit and vegetables) and animal (slaughterhouse livestock, milk) production. Distinctive specialisation of the agri-food industry in the following districts: Nowy Dwór, Western Warsaw, Pruszków,

Piaseczno, Kozienice, Grójec, Lipsko, Płońsk (fruit and vegetable production), Sochaczew (fruit and vegetable and meat production), Żuromin, Płock, Gostynin (meat production) and Ostrołęka, Przasnysz, Ostrów Wielkopolski, Mława and Żuromin (milk production). The largest concentration of business entities in the agri-food industry can be found in the Wołomin poviat and in Warsaw. In 2019, over 6.0 thousand business entities operating in the area of agri-food processing were registered in Mazovia (1st place in Poland).

Mazowieckie Voivodship is also characterised by a very high potential of the industry focused on the production of wood and paper products as well as of the furniture and printing industries. This is related to the existing industrial traditions in the region, mainly the operation of large and medium-sized enterprises and the significant potential of raw material resources, mainly wood. The area of forests in Mazowieckie Voivodship is gradually increasing. At the end of 2018, the forests covered 830.9 thousand hectares, i.e. 51.6 thousand hectares more than in 1999. The forestation rate increased from 21.9% to 23.4%. The most forested districts in Mazovia are: Wyszków, Szydłowiec, Ostrołęka, Kozienice, Przasnysz, Przysucha, Legionowo and Garwolin, where forests constitute at least 1/3 of the area. The share of private forests increased from 41% in 1999 to 45% in 2018. Within 20 years, timber harvesting (coarsewood) increased by 68%. Therefore, in 2/3 of the districts there are companies producing wood, paper, printing equipment and furniture products. These companies play an important role in the local market. The potential of the industry based on the production of textile, leather and clothing products is present in Warsaw, Radom, Płock, Siedlce and the poviats of Radom, Garwolin, Wołomin, Legionowo and Piaseczno.

In Mazovia, an important role is played by the petrochemical industry due to fact that the largest oil refinery in Poland is located in Płock. The potential for the development of industry based on the production of chemical and pharmaceutical products is concentrated mainly in Płock and Warsaw, as well as in the districts of: Garwolin, Mińsk, Otwock, Wołomin and Nowy Dwór. Due to the volume of production, the energy industry, electrical machinery and the production of transport equipment are of great importance.

On the basis of diagnoses, surveys and working meetings conducted as part of the work on the Regional Innovation Strategy for Mazovia, the following areas of high development potential were proposed as a basis for determining the region's specialisation:

Economic areas:

- chemical sector,
- medical sector,
- agri-food sector,

- energy sector,
- IT sector,
- construction sector.

Leading technologies:

- biotechnology,
- information and communication technologies,
- nanotechnologies,
- photonics,
- electronics.

Service processes:

- B2B services,
- R&D services,
- S2B services (science and business).

Most of the above-mentioned economic areas, leading-edge technologies and service processes are directly or indirectly included in the activities concerning Bioeconomy.

4.3 Competitiveness and innovation of the enterprise sector

The innovativeness of economic entities is a determinant of transformation and development processes of countries and regions. Although the region stands out from the country in terms of innovation, this is not reflected on a European scale. According to the classification of the Regional Innovation Scoreboard (RIS)[27], Mazowieckie Voivodship is divided into two NUTS2 - "Mazovian regional region", which according to this assessment is "low-innovative +" and "Warsaw-capital region" defined as "moderately-innovative +". In each of the NUTS2 categories taken into account in the study, the Warsaw capital Warsaw-capital region is better than the Masovian regional region. Only in some cases (scientific publications, citations, R&D expenditure and patent applications) both regions received the same number of points. Generally, the Mazowieckie Voivodship is classified as a moderate innovator and remains outside the group of regions which belong to the so-called imitators and leaders of innovation, who are significant internationally. This is due, among other things, to the internal diversity of Mazowieckie Voivodship and developmental polarization connected to the fact that the capital of the Voivodship, Warsaw, is at the same time the capital of the country, while the remaining area is predominantly agricultural. Warsaw, together with the suburban zone, is an area of concentration of human resources, highly qualified labour force, absorptive market,

[27] Regional Innovation Scoreboard https://ec.europa.eu/growth/industry/policy/innovation/regional_en

dense communication network and developed scientific and technical infrastructure. It is also the place with the greatest innovative potential in the country, which translates to high investment attractiveness and good access to modern technologies, including ICT. Warsaw is also home to the largest number of scientific and educational institutions in the country. This results in a concentration of investment and employment in the area of research and development. Inhabitants of the capital city area also stand out in the region in terms of entrepreneurship. Extra-metropolitan centres existing in the Voivodship: Radom, Płock, Siedlce and Ostrołęka are not able to compete with Warsaw's innovative potential, but they can be an important addition to it.[28]

In 2018, the average share of innovative enterprises in the total number of enterprises in the Mazowieckie Voivodeship was 27.3% and it was the highest result in the country. In the Warsaw region of the capital this share was 29.3%, while in Mazowieckie regional - 21.2% and it was the 7th position (ex aequo with the Opolskie Voivodeship). A particularly large difference between the regions is visible in the case of the share of innovative enterprises from the service sector (Warsaw - 13.7%, Mazowiecki regional - 4.1%)[29]. In terms of total expenditure on innovative activities, the Mazowieckie Voivodeship ranks first in the country in 2018 (PLN 11.8 billion) with an almost three-fold advantage over the following voivodeships: Łódzkie (PLN 3.9 billion), Śląskie (PLN 3.9 billion) and Małopolska (PLN 3.8 billion). Service companies from the Warsaw region of the capital have the largest share in expenditure on innovative activities in Mazovia (PLN 7.6 billion - 65.1%). The share of expenditure on innovation in Mazovia in the national expenditure on innovation in 2018 amounted to 32.3% and decreased compared to the previous year by 2.2 percentage points. The value of expenditure on R&D in the Mazowieckie Voivodeship at the level of PLN 9.5 billion in 2018 gives it the first place in the country with over two and a half times advantage over the Małopolskie Voivodeship - the second in the ranking.

A disturbing phenomenon was the decline in the percentage of innovative enterprises in 2008-2017. In the case of industrial companies, the decrease was 6.3 p.p. and in the case of service companies - 7.8 p.p. At the beginning of the presented period, there were most innovative enterprises - 25.8% and 22.0% respectively. Most often, product or process innovations were introduced by entities with 250 or more employees. In 2008 they accounted for 61.9% of industrial enterprises and 52.4% of service companies, while in 2017 they

[28] https://innowacyjni.mazovia.pl/assets/uploads/Regionalna-Strategia-Innowacji-dla-Mazowsza-do-2020-roku.pdf.

[29] https://www.pruszkow.pl/wp-content/uploads/2020/09/Projekt-RIS-MAZOVIA-2030-do-konsultacji.pdf

accounted for 62.5% and 49.7% of them respectively. Both industrial and service companies were more likely to introduce process innovation than product innovation. State aid is more and more widely directed towards the development of innovative activities of enterprises. In the years 2006-2008, 18.6% of innovatively active industrial enterprises and 11.3% of service enterprises received public support, while in the years 2015-2017, 25.1% and 15.4% respectively.

4.4 R&D sector

The invariably high position of Mazowieckie Voivodship in research and development activities is a consequence of its high academic, scientific and economic potential. In the years 1999-2017 the number of research and development units increased 4 times (from 262 to 1274). In the period in question, the value of expenditures on R&D activity also increased. In 1999, expenditure calculated as per capita amounted to PLN 394, whereas in 2017 - PLN 1483. The Warsaw Capital Region stands out particularly strongly, with 95.5% of the total expenditure on R&D in the Voivodship in 2017. In Mazovia, R&D expenditure in relation to GDP in 1999-2017 was between 1.50% and 1.79%. Since 2008, this indicator has shown an upward trend and in 2017 it was 0.29 p.p. higher than in 1999. It is also worth noting the growing share of financing of R&D expenditures by the enterprise sector. In 2010, the share of funds coming from this sector was 22.7% and increased by 32.3 percentage points to 55.0% in 2017.

In the academic year 2018/2019, 233.4 thousand students studied in higher education institutions located in Mazowieckie Voivodship, which is 18.9% less than in 1999/2000. The decrease in the number of students has been observed since the academic year 2006/2007 and results, among other things, from the decrease in the population aged 19-24. More than half of the students are educated at public universities. In the academic year 2018/2019, 61% of the total number of students in the Voivodship studied there. Almost every fourth Polish university is located in Mazowieckie Voivodship. The largest academic centre in Mazovia and Poland is Warsaw - in the academic year 2018/2019, 60 universities operated here, and students accounted for 15.0% of the total number of students in the country. Favourable changes in the education and upbringing system had a clear impact on the continuous improvement of the level of education of the society. In the years 1999-2018, the share of people with higher education in the population of people aged 15 and over increased from 11.5% to 33.7%.

5. RESOURCES OF MAZOWIECKIE VOIVODSHIP AND POTENTIAL OF THE BIOECONOMY

The Mazovia region has great potential for the development of the bioeconomy, in particular for the development of rural areas by strengthening local specialisation and diversification of economic activity. Increasing the share of products with higher added value will be possible through the development of an agri-food industry using local resources. Agricultural and forestry residues and resources, wastewater and sludge treatment, municipal waste and energy crops are the main biomass resources considered in the region for the development of the bioeconomy. Improved links and symbiosis between the chemical industry and waste management and agriculture. Further details on the profile of Mazovia are summarised in the table below.

Table 4. Resources and potential of the bioeconomy in Mazovia

Population (2018)		5,391,813
Area of the region in km²		35.558
Employment	**Number of persons**	**%**
in agriculture	230,000	9.2
in forestry	-	-
Area (2018)	**ha**	**%**
agricultural land	2,410,864	67.8
forests	835.624	23.67
Main regional industry		Agriculture, Production, Storage and transport, Automotive industry
Biomass resources (2017)		
Municipal waste in t		1,776,953.12
Biodegradable municipal waste in Mg		95,228.51
Sewage sludge in Mg		75,125.17
Non-commercial biodegradable wastes in Mg		867,448.71
Energy potential	**Mote**	**GJ**
forestry	0.179	7,497,791.95
timber waste	0.008	340,766.38
hay	0.221	9,272,947.20
straw	0.027	1,132,878.40
farm biogas	0.006	257,559.34
biogas from wastewater treatment	0.028	1,190,125.80
biogas from municipal waste	0.112	4,710,462.95

Table 5. Selected indicators characterizing the bioeconomy potential of the Mazowieckie voivodship in 2019

No.	Indicator	Poland	Mazowieckie Voivodship
Human resources			
1.	Population per 1 km²	123	153
2.	Balance of internal and international migration for permanent residence (%)	0.2	3.4

3.	Natural increase per 1000 population	0.9	0.4
4.	Working people per 1000 population	411.2	498.5
5.	Occupational activity rate in %	56.2	60.3
6.	Employment rate in %	54.2	58.1
7.	Students per 10 000 population	292.2	404.7
8.	Graduates per 10 000 population	78.0	99.3
9.	Employed in research and development activities per 1000 professionally active people	8.0	16.8
Macroeconomic indicators			
10.	GDP per capita in PLN	55 230	88 626
11.	Gross value added per 1 working person in PLN	123 451	159 749
Agriculture, forestry and environmental protection			
12.	Agricultural land area per capita in ha	0.38	0.40
13.	Area of orchards per capita in ha	0.01	0.02
14.	Global agricultural production in PLN / ha of UAA	7 231	9 520
15.	Cattle per 100 ha of UAA	43.3	61.4
16.	Production of live animals for slaughter per meat in kg / ha of UAA	373.1	590.3
17.	Milk production in l / ha of UAA	959	1 658
18.	Purchase value of agricultural products - prod. plants in PLN / ha of UAA	1 304	1 460
19.	Purchase value of agricultural products - prod. livestock in PLN / ha of UAA	3 162	4 994
20.	Purchase of agricultural products per cereal units / ha of UAA	42.9	53.6
21.	Forest cover in %	29.6	23.5
22.	Stock of standing timber in m^3/ha	286	256
23.	Acquisition of timber (roughage) per 100 ha of forest area in m^3	474.7	289.6
24.	Outlays on fixed assets in environmental protection per capita in PLN	323	439
25.	Municipal waste collected per capita in kg	332	321
Entities of the national economy and innovative activity			
26.	Entities of the national economy in the REGON register per 10 thousand population	1 175	1 576
27.	Sold production of industry per capita in PLN	42 077	59 796
28.	Investment costs per capita in PLN	8 361	13 477
29.	Gross value of fixed assets per capita in PLN	111 075	167 703
30.	Enterprises that incurred expenditure on innovative activities in% of total enterprises in industry	30.7	34.8
31.	Research and development expenditure per capita in PLN	789	2 012
32.	Expenditure on research and development - relation to (GDP) in %	1.21	1.99

Source: Statistical yearbook of voivodeships 2020. Central Statistical Office (CSO), Warsaw; Statistical yearbook of forestry 2020. CSO, Warsaw; Statistical Yearbook of Agriculture 2019. CSO, Warsaw;

6. SWOT ANALYSIS

A strategic SWOT analysis allows to analyse the strengths and weaknesses of the region against the opportunities and threats created by the environment.

Internal (characteristics of bioeconomy industries)

Strengths	Weaknesses
• high position in primary agricultural production, • significant resources of renewable energy sources, in particular biomass, biogas, wind and solar, • very high potential of enterprises, • food industry equipped with modern technological lines and equipment, • strong export standing, • research facilities in the field of food biotechnology, • traditional recipes, high quality products, well-known brands, • production of food with the highest taste and nutritional parameters, • easy access to raw material. • well-educated staff, • large amounts of waste generated, • laboratory R&D facilities.	• lack of coherent competences and rules for financing research, commercialisation and innovation, • lack of initiative and professional readiness of structures to transfer knowledge, • low spending on R&D, • dispersion of research and technological development potential, • fragmentation of businesses, • lack of access to many technologies on the domestic market, • poor cooperation with scientific entities in the field of technology implementation, • waste management problems, • excessive chemical treatment of agriculture, • low quality of agricultural land, • high acidification of soils, • unfavourable area structure of farms, • low level of protection and storage of water resources and the use of RES • moderately favourable climatic conditions for agricultural production, • low productivity of land, labour and capital in agriculture.
External (ambient features)	
Opportunities	Threats
• increase in the demand for high quality products, • modernisation of agriculture, storage, trade, industry and services, • preserving biodiversity and developing the natural resource base, • enormous opportunities to open up a new market for health-oriented food, • possibility of building a market for profiled food based on nutrigenomics, • the prospect of moving to a low-carbon and zero-carbon economy, • increase in the public awareness concerning healthy eating and proper diet, • possibility of creating specialities in biodegradable polymers, • growing potential for the use of bio-	• no development strategy concerning bioeconomy. • low public awareness, • dispersed regulations, • lack of political will to move away from conventional technologies. • cost increases related to the large-scale introduction of the bioeconomy that are unacceptable to the society, • technology transfer too slow, • delayed readiness to make necessary changes to the system within the following matters: - legal, - fiscal, - financial, - administrative and organisational, • insufficiently transdisciplinary approach to new solutions,

processes, be they hybrid or cascade chemical-biological solutions as alternatives to traditional chemical methods, • possibility of evaluating today's bio-waste towards a valuable starting material for the bioeconomy, • expanding the existing range of applications of wood materials and products, creating new composites, • construction of bio-refineries to close and optimise value chains in agricultural processing, • scientific potential of universities and institutes.	• climate change, • water shortages, stepping, • difficulties in financing projects from selected industry sectors due to a fragile legal environment, • significant proportion of the constituent industries depend largely on short or medium term European policies.

Source: own study.

The quantitative approach to the components of the SWOT analysis indicates a balance between the strengths and weaknesses of the Voivodship. However, the predominance of opportunities in relation to threats confirms that Mazovia has considerable potential and development resources, which allows it to continue the beneficial trends, effectively overcoming the identified threats. The conditions outlined in the SWOT analysis and reliably conducted economic foresight will be the basis for the creation of pro-development activities that fit into the challenges of the new generation.

Bioeconomy development factors

(technological, economic, administrative, political, social)

High importance for the bioeconomy	
Result is certain (high probability)	Result is uncertain (low probability)
• Permanent access to waste. • The existence of marketable technologies for use in the bioeconomy. • Availability of funding sources. • Political will. • Convincing society that development of bioeconomy is right. • Clarity of environmental benefits. • Consistency and clarity of the legislation. • Limited soil and water resources (quantitative and qualitative). • Environmental pollution. • Rising energy demand. • Fashion and demand for eco/bioproducts.	• Requirements and needs of businesses and consumers - reluctance to make changes. • Introduction of the latest technologies that are not in the mature phase. • Innovative technological solutions on a small scale (households, SMEs). • Development of efficient energy storage technologies. • Changes in administrative procedures that would allow for a long-term direction of development, lack of stability of legal provisions. • Inconsistent and dispersed regulation of

• Growing share of bioeconomy in the structure of Polish economy. • Rising prices of energy carriers. • Rising costs of human labour. • Unpredictable political factors. • Low public awareness.	the bioeconomy. • Uncertainty of clear environmental benefits. • Development of a national bioeconomy strategy. • Providing funding for bioeconomy projects.
Low importance for bioeconomy	
(high probability)	(low probability)
• Political grouping variability. • Transport logistics. • Ageing population. • Digitisation of rural areas.	• Migration of people from rural areas. • Dependence of bioeconomy development on the political party in charge.

Source: own study.

The following challenges concerning bioeconomy were identified:

- preventing food waste,
- reducing the volume of mixed municipal waste in favour of the volume of selectively collected waste,
- reducing the weight of waste going to landfill,
- increasing the volume of recovered secondary raw materials from municipal waste and obtained in the waste recycling process,
- building new biogas plants,
- construction and extension of composting plants for green waste and other bio-waste,
- ensuring that green waste and other bio-waste is produced from green waste and other bio-waste of a product with fertilising properties or crop enhancers,
- introducing the principles of circular economy,
- water protection,
- supporting the development of green industry and eco-innovation,
- further develop of production of energy from renewable sources,
- ensuring sustainable and balanced development and preserving high environmental values,
- development of an environmentally conscious society,
- according to the RED II Directive, the so-called Winter Package, the share of energy from RES in 2030 should amount to 35% of total energy consumed, including for transport at the level of 1.5% (from RES) in 2021 and increase to 12% in 2030, and the obligation to produce advanced biofuels 3.6% by 2030. However, the share of 1st

generation biofuels should be reduced from max. 7% in 2021 to maximum. 3,6% in 2030.

Of the nine factors presented in Figure 6, biological resources, human capital and legal status are of key importance for the conditions and quality of research and activities undertaken in the bioeconomy.

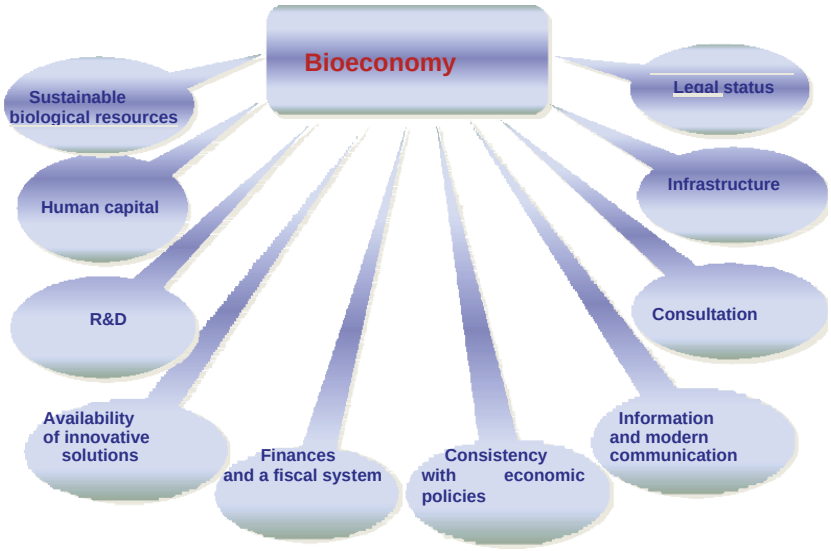


Figure 6. Factors determining activities in the area of bioeconomy
Source: Chyłek E. K., Kopiński J., Madej A., Matyka M., Ostrowski J., Piórkowski H. 2017. "Uwarunkowania i kierunki rozwoju biogospodarki w Polsce" (Conditions and directions of development of bioeconomy in Poland). Ministry of Agriculture and Rural Development, Institute of Technology and Life Sciences in Falenty, Warszawa-Falenty, p. 172.

7. MISSION, VISION AND PURPOSE

7.1 Mission

The mission of the strategy is a concise and realistic formulation of the philosophy, objectives and principles of development. Taking into account the changing situation in the environment, the growth of development opportunities and expectations of the region's inhabitants, the mission of the bioeconomy development strategy for Mazowieckie Voivodship was formulated as follows:

Mazovia as the leader of the bioeconomy in Poland

7.2 Vision

The vision is a description of the future socio-economic image of the Voivodship, which should be achieved as a result of the implemented development strategy. The vision is a model which should be followed by the Voivodship; it is a task to be fulfilled. The vision is also a definition of what the success of the region's mission is supposed to be. In other words, the vision of Mazowieckie Voivodship is a description of the aspirations of the region's development until 2030, constituting a background for the selection and assessment of the validity of the adopted strategic objectives. In the course of works on the Strategy, an attempt was made to define the vision of the Mazovia's Bioeconomy 2030, which reads as follows:

Mazovia will become a region:

- **with a significant share of the use of biomass in the development of a circular economy,**
- **developing in accordance with the principles of sustainable development,**
- **in which innovative technologies of bioeconomy and related industries will be developed, enabling increased bioeconomy efficiency,**
- **economically competitive, with an eco-conscious society.**

7.3 Objectives:

The strategic part of the document consists of a hierarchical and coherent set of development plans for the region in the field of bioeconomy, which consists of: strategic objectives, operational objectives and directions of activities allowing to achieve the assumed vision of development. The strategic objectives for the development of the Mazovia's bioeconomy guide the scope of necessary actions in the perspective of 2030 and allow for the use of the potential and reduction of development barriers, diagnosed in the SWOT analysis.

The Strategy identifies five strategic objectives:

- **Efficient resource management in line with sustainable development,**
- **Increase in the use of renewable biological resources in the sectors which create high added value,**
- **Contribution to the climate policy,**
- **Strengthening the research potential of scientific entities and development of the cooperation in the relation between business, science and environment,**

- **Shaping and promoting pro-environmental and pro-healthy consumer behaviours.**

8. GUIDELINES

8.1 Efficient resource management in line with sustainable development

8.1.1 Agriculture and fisheries

8.1.1.1 Rational use of agricultural production space and maintaining the production potential of soils and waters

Activities

- Ensuring sustainable soil fertility through: preventing soil degradation, improving the pH of acidic soils, increasing the availability of fertilisers,
- Adaptation of branches and directions of production, plant varieties and animal breeds to natural, economic and organisational conditions,
- Sustainable balance of organic matter,
- Reclamation of degraded soils and protection of agricultural land,
- Sustainable balance of nutrients (fertilizers),
- High index of soil vegetation,
- Observing the principles of proper agrotechnology and zootechnics,
- Introduction of integrated soil monitoring systems to optimise irrigation and the use of plant protection products[30],
- Construction of small water reservoirs, devices and systems for water retention and modernisation of existing devices and systems to increase the share of small-scale water retention in the water balance,
- Promotion, construction and development of already existing circular facilities (in the case of the fisheries sector, aquaculture facilities using recirculation and water retention methods in production are of particular importance; at the same time, traditional carp ponds, where fish growth depends on natural food and water management is based on the principle of water retention, which prevents this resource from being wasted, also remain important),

[30] MINROL http://www.gios.gov.pl/pl/stan-srodowiska/monitoring-jakosci-gleby-i-ziemi

- Ensuring preservation of biodiversity and elimination of monocultures,
- Stocking density adjusted to the absorption potential of the ecosystem,
- Rational farm equipping in terms of technical infrastructure,
- Adapting agriculture to the effects of climate change,
- Observing the principles of the Code of Good Agricultural Practice[31],
- Rational organisation of work and rational use of agricultural technology and skilful farm management,
- Perceiving farms in their relationship with the environment (rural areas),
- Achieving remuneration for work and development resources comparable to those gained for work performed outside the agriculture industry (investments and minimising intermediaries in the sales chain),
- Improving the standard and accessibility of information society tools.
- Promotion of organic farming based on latitude-specific crops.
- Use of agricultural biofilms, systems of recycling traditional films.
- Environmental education,
- Building hygiene awareness and promoting and supporting education related to hygiene and ecology,
- Building awareness of food respect - activities supporting the promotion of "zero waste" in the areas of food and education on minimizing the scale of food waste ("food waste").

8.1.1.2 Production of raw materials with the desired quantitative and qualitative parameters expected by consumers and the industry

Activities

- Adjustment of production structures to demand,
- Improving the quality of plant and animal raw materials (e.g. creative breeding of plants, animals and fungi of a higher value, with the possibility of using molecular and biotechnological tools, taking into account biodiversity and resistance to climate and environmental change; animal nutrition and husbandry systems that enhance the nutritional and health benefits of animal products, including those that increase productivity and reduce environmental burden, taking into account animal welfare),

[31] Authors of the Code: MINROL, FAPA Foundation of Assistance Programs for Agriculture, Institute of Soil Cultivation, Fertilization and Soil Science Puławy

- Reduction of the presence of undesirable substances in raw materials (e.g. production of high quality seed and nursery stock, with increased resistance to diseases and pests; integrated protection of plants and cultivated fungi against diseases and pests using innovative biopreparations, biotechnological methods and agrotechnical treatments),
- Development and promotion of organic farming,
- Benefiting from the possibilities of precision farming,
- Optimisation of by-product management,
- Supporting traditional forms of farming:
  - Beekeeping and apiary management,
  - Inland fishing,
  - Herbal,
  - Fibrous plants.
- Use of agricultural production space for renewable energy production.

8.1.1.3 Reduction or elimination of threats to the environment and ensuring preservation of biodiversity

Activities

- Introduction of environmentally friendly technologies and machinery and equipment for soil cultivation, sowing and fertilization, planting, plant care and protection, harvesting, conservation and storage of agricultural crops, improving agrotechnical parameters and ensuring high quality of agricultural products, RES-powered irrigation systems,
- Implementation of innovative formulations in plant protection products and biocidal products, reducing negative impacts on humans and the environment, compatible with the principles of integrated pest management,
- Protection and successive improvement of water quality through reduction of pollution and extension and modernisation of sewage treatment systems,
- Rationalising water management in plant and animal production,
- Reducing the negative impact of agriculture on ground and surface waters,
- Improving animal welfare and health protection,
- Protection of pollinating insects, including bumblebees and solitary bees,
- Counteracting the effects of threats of natural origin, including natural disasters disrupting the sustainable development of agricultural, forestry and water areas,

- Implementation and promotion of technologies minimizing the consumption of natural resources and energy carriers.

8.1.1.4 Improving the quality and availability of advisory services and measures for integration and transformation in the agricultural and processing sector, as well as the efficiency of the use of Common Agricultural Policy or European Regional Development Fund funds

Activities

- Increasing the availability, quality and use of advisory and training services for farmers, including information society tools, as well as research potential in creating product and technological innovations,
- Using intelligent systems and technologies and tools for monitoring the production process and assessing the quality of raw materials and finished products of the highest biological, health and technological quality, taking into account the latest analytical methods, e.g. remote positioning (GPS), drones for quantitative and qualitative analyses of soils and crops,
- Supporting creation and development of agricultural manufacturing groups, agricultural cooperatives and other forms of horizontal and vertical integration,
- Promoting good practices of cooperation between all shareholders in the agri-food sector, taking into account new models of organising production and trade, including the use of new (communication) technologies,
- Improving the area structure and management capacity of agricultural holdings,
- Strengthening vertical links between agricultural producers and the processing sector,
- Increasing interest in the use of EU funds targeted at innovation-related objectives,
- Implementation of research projects (national and international) aimed at innovative solutions in the agri-food sector,
- Implementing innovation in agriculture and fisheries and increasing demand for innovation among producers,
- Modernisation of agriculture and fisheries aimed at using the possibility of adaptation of the latest technologies, including: automation, digitalisation (use of satellite technologies, precision agriculture, herd management systems, decision support programs), breeding (including plant varieties less sensitive to environmental conditions, technologies enabling mechanisation of fruit and vegetable harvesting,

increasing the efficiency of feed use, use of fully automated technology - robots, use of automatic feed machines, monitoring of livestock buildings by means of cameras, use of natural biological methods for reclamation of ponds and water reservoirs).

8.1.2 Forestry

8.1.2.1. Sustainable forest management

Activities

- Increasing forest resources while maintaining their stability and biodiversity,
- Reducing soil degradation and surface runoff to increase the degree of retention,
- Adaptation of stand species composition to the habitat and increasing genetic and species diversity of forest biocenoses,
- Optimisation of forest production capacity to increase wood supply,
- Increasing the quality of stands and raw material for the wood industry,
- Acquisition, selection and implementation of planting of selected species of trees and shrubs, taking into account their genotypes, in order to select the desired utility characteristics for selected branches of the wood sector,
- Efficient and environmentally safe logging,
- Protection of stands against pests,
- Planting of woody plants with increased resistance characteristics, taking into account climatic, soil, water and biocenosis conditions,
- Development of energy crops with high mass growth, resistance and high dryness for fuel production,
- Rational hunting economy for environmental protection and agricultural development,
- Adaptation of forest management to climate change and changing environmental conditions,
- Forest and woodland management using Life Cycle Assessment (LCA) techniques,
- Monitoring as well as early warning systems (e.g. satellite observations, drones) and measures to reduce fires and their effects, e.g. use of non-environmental RES sources as a power source for fire protection systems or principles,
- Development of forest infrastructure.

8.1.2.2. Enhancing the role of forests and forest management in mitigating climate change

Activities

- Continuous expansion of forest resources and their contribution to the global carbon cycle,
- Increasing carbon accumulation in biomass and forest soils,
- Mobilisation of wood resources, also from non-forest areas,
- Wood substitution of non-renewable materials and products,
- Promoting the use of wood waste as local fuel.

8.1.2.3. Use of pro-environmental and pro-social functions of the forest

Activities

- Maintenance and improvement of environmental functions of the forest (protection of forest soil and water resources),
- Maintaining health and vitality of forest ecosystems,
- Enhancing biodiversity in forest ecosystems,
- Prevention of illegal logging and trade in forest products,
- Supporting private forest owners and their associations,
- Strengthening socio-economic functions of the forest,
- Using the potential of forests, especially forest promotion complexes, to shape the ecological awareness of society,
- Expansion of the functions of the forest gene banks.

8.1.3. Waste management

8.1.3.1 Municipal waste, including food waste and other biodegradable waste

Activities

- Raising public awareness of waste prevention and proper management of municipal waste, including food waste and other biodegradable waste,
- Reduction of the share of mixed municipal waste in the whole stream of collected waste and the amount of biodegradable municipal waste directed to landfills,

- Implementation of solutions allowing for proper monitoring and control of the handling of the municipal waste fraction sorted from the mixed municipal waste stream and not intended for storage,
- Implementation of an effective system of selective waste collection and collection at source (paper and cardboard; metals, plastics, multi-material packaging; glass, bio-waste, segregation into wet and dry waste),
- Promoting technologies for the treatment of bio-waste which result in a fully-fledged and environmentally safe material for fertiliser or reclamation,
- Promotion and implementation of activities to prepare for re-use and recycle suitable products or materials separated from the municipal waste stream,
- Stimulating the development of the market for secondary raw materials and products containing secondary raw materials by supporting cooperation between producers and the recovery organisations representing them, industry and local authorities and the consistent enforcement of the obligations for preparation for re-use and recycling,
- Promoting products made from waste materials through appropriate promotion and education measures as well as public procurement,
- Achieving a recycling and re-use preparation rate of at least 80% of the paper, metal, plastic and glass fractions from municipal waste by 2030,
- Dissemination and support of eco-design in the scope of extending the product life cycle (design focused on extending the product life cycle and allowing for maximum use of elements for reuse and recycling, creation of products with the use of raw materials recovered from waste and sewage, providing substitutes for hazardous, complex and burdensome substances in the recycling process, including the implementation of research projects in the above-mentioned scope),
- Implementation and dissemination of sustainable methods of converting municipal waste with energy recovery, including the use of segregated oversize as an energy source for the industrial sector,
- Dissemination of waste treatment technologies that reduce emissions of CO_2 and other greenhouse gases into the atmosphere,
- Development, research and support of composting facilities: introduction of an assortment of wet biodegradable waste and implementation of technology for the process of obtaining a wholesome compost.
- Supporting and implementing methods of using out-of-date food waste

8.1.3.2 Post-consumer waste

Activities

- Development of the existing system for collecting waste oils, including those from dispersed sources, and their transfer to authorised entities for management,
- Management and regeneration of refrigerants,
- Introduction of improved technologies for the use of waste in the form of fly ash, slag, ash-slag mixture, and post-reaction products from installations in the construction industry,
- Technologies for optimal production and use of alternative fuels obtained from waste, including RDF,
- Use of anthropogenic minerals in the process of reclamation of post-extractive areas,
- Application of selective technological processes to obtain highly processed chemical compounds from waste,
- Production of multi-material and composite materials based on waste for use in various industries.

8.1.3.3 Sewage sludge

Activities

- Preventing and reducing the amount of municipal sewage sludge generated in sewage treatment plants as waste and eliminating the production of municipal sewage sludge which, due to its quality, creates problems with its management in accordance with the regulations, through thermal transformation, application of overground facilities, production of fertilizers or crop-enhancing agents etc.,
- Increasing the amount of municipal sewage sludge treated before its introduction into the environment and increasing the amount of municipal sewage sludge subjected to thermal treatment,
- Aiming to maximise the use of nutrients contained in sediments while meeting all sanitary, chemical and environmental safety requirements,
- Application of solutions allowing the use of industrial wastewater streams carrying a load of organic compounds as substrates in heterotrophic wastewater treatment processes,

- Closing water and sewage circuits, using pre-treated wastewater; treatment of rinse water for municipal and industrial purposes,
- Wastewater treatment through introducing integrated treatment systems taking into account the use of RES and CO_2 binding, e.g. additional algae reactors,
- Implementation of solutions aimed at optimising energy consumption, including the use of renewable energy sources in water and sewage management,
- Development and implementation of technological solutions for the use of energy from wastewater in combined energy systems, including wastewater treatment systems integrated with water and heat recovery,
- Elimination of micro-pollution from sewage sludge (micro plastics, pharmaceuticals),
- Management and recycling of ashes from the thermal conversion of sludge in construction,
- Recovery of phosphorus and other biogens from sewage sludge,
- Introduction of successive stages of wastewater treatment, e.g. disinfection for partial use of wastewater treated as municipal water (street cleaning, equipment, refrigeration, etc.).

8.2 Increase in the use of renewable biological resources in the sectors which create high added value

8.2.1 Processing of agricultural raw materials and animal products

Activities

- Production of high-quality food:
  - reformulation of existing products to improve their quality,
  - improving existing and introducing new, innovative food production and processing technologies,
  - taking actions aimed at minimising food processing and preserving nutrients and beneficial bioactive substances as fully as possible,
  - prevention or minimisation and monitoring of additives to intensify macro-phage cultures (antibiotics, hormones),
  - taking actions to maximise the share of natural raw materials and reduce the use of food additives,
  - reduction or elimination of anti-nutritional ingredients and allergens in food;

- production of foodstuffs for particular nutritional uses and other products with designed nutritional and health characteristics adapted to different consumer groups,
- processing of animal products to increase their dietary value,
- production and distribution of high quality and innovative products, including traditional, regional and ecological ones,
- support and promotion of the quality food sector.

8.2.2 Wood sector

Activities

- Use of wood and forest biomass to produce materials to replace other non-renewable raw materials,
- Developing recycling technologies for contaminated wood materials (e.g. railway sleepers)
- Processing aimed at obtaining wood and wood-based materials with extended durability under conditions of internal and external use, increased resistance to destructive factors such as biotic, fire, weathering, photolithic ageing factors,
- Production of durable joinery, using micro-coatings, nanotechnology, mimetic,
- Use of wood as the main elements of large-size structures,
- Implementation of technologies focused on intelligent tools, methods and processes leading to the production and recycling of pulp, paper, cardboard, corrugated board and related products aimed at minimising the share of basic raw materials in order to protect forest resources (including increased share of recovered paper and other fibres, including synthetic ones), while obtaining high performance parameters,
- Development of wood-based materials for modern construction applications:
  - new generation materials that would show better properties, lower emissions, biodegradability, but also, under normal use, resistance to biological agents (fungi, insects, rodents),
  - technologies for the extraction of bioactive compounds from forests, wood industry waste, including conifer waste, for economic use,
  - modern, biodegradable, reusable and removable wood and wood-based, paper and cardboard packaging,

- products, processes and technologies for the management of industrial waste using wood, optimisation of the use of production residues from solid wood processing for products with high added value.

8.2.3 Medical sector

Activities

- Research and development of production of biological and biosimilar drugs,
- Development of new technologies for the production of innovative and generic medicinal products, biological and biosimilar drugs, medical devices and dietary supplements as well as foodstuffs for special nutritional purposes,
- Production of medicinal substances of natural origin for treatment of the following conditions:
  - pre-diabetes and prehypertension,
  - threat of destabilisation of atherosclerotic plaque (prevention of myocardial infarction and stroke),
  - related to chemical and radiotherapy and immunosuppressive treatment,
  - chronic inflammation,
  - related to chronic hepatitis, pancreatitis and digestive tract diseases - small intestine and large intestine,
- Research on the creation of new forms of herbal medicinal products - micro and nano technologies,
- Implementation and dissemination of production and use of bioactive substances with improved bioavailability and tolerability used for prevention purposes, including modern-age diseases, and to increase the effectiveness of treatment,
- Application of new technological solutions to improve the bioavailability of substances contained in food supplements and foodstuffs for particular nutritional uses and to achieve the effect of controlled administration, release or supply of substances contained in food supplements and foodstuffs for particular nutritional uses.
- Monitoring of hospital and pharmaceutical waste segregation systems and implementation of technologies allowing to recover high quality raw materials from them.
- Minimising hospital waste

8.2.4 Biotechnology, chemical and environmental sectors

8.2.1 Use of innovative biotechnological processes to produce bio-products

Activities

- Biomass and waste as a medium for the production of new tools for biotechnology (including cultures of macro- and micro-algae, bacteria, fungi and other organisms),
- Development of new sources of biocatalysts and unique metabolites, construction and modelling of effective biocatalytic tools for biosynthesis and bioconversion processes, bio-refining and biotransformation and for environmental protection processes,
- Development of bioprocesses based on the use of biomass and waste from the agro-food, forest-wood and herbal industries to obtain substrates for various industries, including chemical, cosmetic, pharmaceutical, agricultural, textile, packaging, pulp and paper and other products,
- Biorefining of renewable raw materials, including waste from the agri-food, forest-wood and herbal industries (using microorganisms, including microalgae and microscopic fungi) for their comprehensive management and use in the production of added value compounds,
- Use of renewable natural resources in synthesis and biosynthesis of specialist intermediates used in the production of biologically active substances of plant protection products, biocidal products and veterinary medicinal products**,**
- Production of bioactive materials for medical and multifunctional uses for various industries,
- Application of bionic engineering in the processes of modification and functionalisation of polymer materials (including bionics of structures, material features, biochemical processes, biological resistance, ergonomics and other phenomena).

8.2.2 Advanced processing of biomass into specialised chemical products

Activities

- Production of specialist market products from plant, animal and animal raw materials and their derivatives and by-products from biomass processing by chemical, physico-chemical or biochemical processes,

- Use of renewable raw materials in the synthesis of polymers and plastics using those polymers,
- Efficient use of biomass in thermal processes e.g. biocarbon for agriculture, industry and sewage treatment plants,
- Development and use in practice of complex technologies of processing plant, animal and waste materials from agri-food, chemical, energy, landfill sewage treatment plants, etc. for production of semi-finished products for further processing for chemical, pharmaceutical, household and other industries.

8.2.3 Bioproducts and performance chemicals

Activities

- Manufacture of dietetic and medicinal products and food additives of plant origin (including extracts of herbal, fibrous and oleaginous plants), animal and microbiological origin,
- Implementation of effective technologies for the production, processing, refining and modification of natural and renewable fibres,
- Production of polymeric composites with the use of plant raw materials (bionanocomposites, integrated multilayer and multifunctional composites),
- Production of fibrous biomaterials and innovative polymeric materials for specialised technical, hygienic, medical, agricultural and other applications,
- Development of forms of biopreparations for their application in biosynthesis, biocatalysis and biomass and waste processing,
- Production of bioagrochemicals, biopharmaceuticals and soil conditioners, slow-acting fertilizers, agrobiosorbents, root-layer preparations, microbiological vaccines, biopesticides, biosurfactants.

8.2.4 Application of innovative biotechnological methods in environmental protection

Activities

- Popularisation of methods of biological removal of fatty and oil-derived pollutants, heavy metals, biodegradation of anthropogenic organic substances in waste streams,
- Application of innovative fermentation processes for processing waste from the agri-food industry and municipal waste,

- Intensification of efforts to prevent eutrophication processes by removing phosphorus and nitrogen from aquatic ecosystems, urban and industrial wastewater,
- Development and implementation of new bio- and phyto-remediation technologies for water and ground environment,
- Integration of biological and physico-chemical processes in the treatment of industrial wastewater, enabling the closure of water and energy cycles,
- Development of biological methods of deodorizing municipal, industrial and livestock waste,
- Dissemination of biological pest control methods in agricultural and forestry crops and food storage and sanitary hygiene (pheromones, repellents, biopesticides, others),
- Application of biological methods for removal of micro-pollutants from water and wastewater and recovery of biogenes.

8.2.5 Energy sector

Activities

- Development of technologies to prepare and inject biomethane into the distribution and direct networks,
- Biomass gasification for energy purposes (including, inter alia, innovative small-scale technologies - up to 5 MW for biomass combustion, excluding co-firing),
- Degassing of biomass for energy, heating or both; combined with the production of charcoal, biocarbon as manure or activated carbon,
- Production of liquid biofuels, biocomponents, other second and next generation chemicals,
- Replacement of the technology of using natural gas as fossil fuel for the benefit of agricultural and landfill biogas from sewage treatment plants,
- Biomass thermal processing based on the capture of chemical carbon in the form of charcoal or biocarbon, combined with energy production based on volatile components, with no or minimal carbon content (BECCS - Negative CO_2Energy),
- Production of fuels, biopolymers, chemicals and fertilizers based on the release or synthesis of valuable chemicals in bio-refinery processes,
- Development of energy technology for waste management in WTE processes (including the combined system).

8.3 Contribution to climate policy

8.3.1 Reduction of greenhouse gas emissions and biosecurity of CO_2

Activities

- Taking measures to reduce greenhouse gas emissions from agriculture and the agri-food chain (e.g. rationalisation of nitrogen fertilization, proper storage and application of natural fertilizers, promotion of bean plant cultivation, use of nitrification inhibitors, extending the life span of females, slurry acidification, composting of natural fertilizers),
- Carbon sequestration in soil and biomass produced in agriculture (e.g. catch crop cultivation, conservation tillage, maintenance of permanent grassland),
- Increasing carbon accumulation in biomass and forest soils,
- Mobilisation of wood resources, also from non-forest areas,
- Restoring stands after natural disasters and increasing and rebuilding forest resources to improve the greenhouse gas balance,
- Developing and disseminating knowledge on climate-friendly practices,
- Public procurement and preference for Co_{22}reduction solutions.

8.3.2 Production of energy from renewable sources

Activities

- Biomass use in energy generation:
  - solid fuels,
  - conventional and high-tech biofuels,
  - biogas,
- Application of innovative technologies for the generation of electricity from wind energy, both onshore and offshore, aimed at increasing the efficiency of the conversion process (e.g. vertical axis wind turbines) and reducing investment costs,
- Research, development and implementation of photovoltaic cells to improve the efficiency of power generation and other performance characteristics,
- Efficient and eco-friendly energy production based on geothermal heat,
- Integration of biogas plants with the gas distribution network,

- Use of groundwater and surface water heat to generate thermal energy using high-power heat pumps (> 1 MW),
- Use of innovative technological solutions in micro-sources: photovoltaic (including new materials for photovoltaic applications), fuel cells, biological and microbiological cells, using thermoelectric, piezoelectric and other phenomena to produce electricity and heat,
- Use of energy storage devices, including mobile devices, to support energy management and to provide auxiliary services related to the improvement of power quality,
- Development of energy technology for waste management in WTE processes (including the combined system),
- Research on and implementation of technologies for the conversion of biomass or waste to fuels with parameters enabling safe use in currently produced production units,
- Creating local power islands,
- Works on the storage of energy in the form of green hydrogen,
- Increasing the capacity of power networks,
- Increasing the number of charging places for electric vehicles.

8.4 Strengthening the research potential of scientific entities and development of the cooperation in the relation between business, science and environment,

Activities

- Integration of the activities of the science, education and development sector (including, among others, research institutes, universities and scientific units),
- Intercollegiate integration, working groups consisting of experts with experience in implementation and business understanding,
- Consolidation of research issues relevant to bioeconomy priorities,
- Encouraging cooperation between the science sector and business and creating strategic business partnerships (including greater use of the potential of KIS, EIP, Smart Labs and National Key Clusters Working Groups),
- Implementation of research programmes for innovation (including through the EU Framework Programmes),

- Transfer of knowledge from the science sector on innovative solutions to reduce the negative environmental impact of bioeconomy sectors,
- Preferences for public, EU and national support for development investments in enterprises and farms, including the smart specialisation instrument,
- Reducing uncertainty in the implementation of innovations and high risk innovative projects, support for SMEs,
- Equipping rural and fishing areas with hazard warning systems and developing technical infrastructure to limit the effects of weather events.

8.5 Shaping and promoting pro-environmental and pro-healthy consumer behaviour

Activities

- Disseminating knowledge about the principles of nutrition, food traditions of the country and the region and the quality of agri-food products among the society and promoting healthy consumption patterns,
- Creating innovative communication and education tools to help consumers make informed dietary choices,
- Use of innovative technologies to create tools for better nutrition planning and assessment of nutrition at the individual and the collective level,
- Introducing innovative ways to increase the recognition of food of high quality,
- Creating innovative tools to detect food adulteration,
- Developing tools and modern research techniques and food quality markers (including bioavailability of ingredients) for assessing the impact of food products on human health,
- Developing methods of analysis and selection of dedicated food at population and individual level,
- Increasing the use of bioproducts in society, including in the public sphere,
- Campaigns concerning circular economy, bio-economy, biogas plants etc.

9. STRATEGY IMPLEMENTATION SYSTEM

The implementation of each strategy is a complex, multithreaded and cyclical process. The implementation of the Bioeconomy Development Strategy of Mazovia will be carried out

using the principles of multi-stakeholder and multi-level governance as well as multilateral coordination. Multi-level governance will be implemented by strengthening relations between the Voivodship's self-government and national government and the Voivodship self-government and local governments. The Voivodship self-government, despite being a key entity in the process of development planning, does not have fully adequate resources, competences and possibilities to achieve the visions and objectives set out in the strategy. Therefore, effective cooperation with other public stakeholders and representatives of the private and social sector, in line with the principle of multi-stakeholder governance, is essential in this respect.

Apart from the initiating, coordinating and controlling role, the self-government of the Voivodship has the task of taking actions leading to the creation of a network of various partners cooperating with each other, actively participating in the process of implementation of the objectives set out in the Strategy, which will translate into synergy of actions and implementation of positive scenarios indicated in the document.

Apart from a wide range of stakeholders involved in the development of the bioeconomy sector in Mazovia, the system of the Strategy implementation also includes the use of various instruments, among which the following should be mentioned:

- Regional Operational Programme of Mazowieckie Voivodship 2014 -2020 and 2021 - 2027. The main role of the Operational Programmes is to strengthen and effectively use the economic and social potential for sustainable and intelligent development of the Voivodship,
- National Operational Programmes - basic tools for the implementation of interventions with financial contribution from EU funds. For the implementation of the Bioeconomy Development Strategy, the programmes developed for the EU financial perspective 2021-2027 will be crucial, using the funds of the Common Strategic Framework (CSF), i.e. the European Regional Development Fund (ERDF), The Cohesion Fund (CF), the European Social Fund+ (ESF+), Just Transition Fund (JTF), the European Fund for Rural Development (EAFRD) and the European Maritime and Fisheries Fund (EMFF),
- Legal-administrative and planning instruments: studies of various forms and a wide range, i.e. Voivodship spatial development plan, spatial development conditions studies, local spatial development plans, decisions on environmental conditions of project implementation, waste management plans, etc.,

- The Mazovia Regional Innovation Strategy 2020 and the innovation support system and smart specialisation of the region play an important role in the development of the bioeconomy. For the next financial perspective, it will be necessary to develop a new generation of Regional Intelligent Specialisation compatible with the bioeconomy development strategy,
- Financial instruments: among others, multiannual financial forecasts, financial aid granted to local government units, public-private partnership, tax preferences,
- Information and promotion instruments: among others, trainings, courses, conferences, cyclical international, supra-regional and regional bio-economic forums, platforms for exchange of information and experience.

A well-developed network of institutional cooperation also serves to exchange data, develop knowledge about socio-economic processes in the region and its external environment. This is important for the process of socialising the implementation of the strategy. It should be stressed out that the possible use of the catalogue of instruments by the self-government of the Voivodship is legally conditioned, as the involvement of entities in the process depends on their own decision, and the impact is of a mainly indirect nature.

The Strategy's executors and at the same time its stakeholders will be as follows: local government units from the area of Mazowieckie Voivodship, units from the economic sector and business support institutions, economic self-governments, non-governmental organisations, units from the education and scientific-research sector, health care and social welfare institutions, universities, local governments of other Voivodships, as well as all inhabitants of the region.

Cooperation and partnership are necessary for effective implementation of the Strategy, especially in those aspects that go beyond the powers of the Voivodship self-government. The Voivodship self-government will also support activities of other entities involved in the implementation of the Strategy's objectives and integrate entities in the implementation of pro-development activities. The success of the measures undertaken depends on openness, constant search for implementation possibilities and broad cooperation with the government administration (both local and central), cooperation with other regions, mainly with neighbouring voivodships, as well as supra-regional cooperation, both at the national and the international level (cooperation with international organisations and regions of other countries).

In order to ensure the highest effectiveness of the activities carried out, it is necessary to be guided by selected principles, which define and organise the whole process of

programming and implementing the Strategy, as well as regulate the manner of conduct and the area of cooperation of all the entities / stakeholders involved in the process.

Universal principles:

- autonomy - understood as the right of the Voivodship's self-government to set the development policy objectives resulting from internal needs and specific potentials of the region,
- prevalence - the Strategy is a master document to other strategic documents at regional level and implies the need to ensure compatibility of all types of strategic documents developed at the regional level,
- cooperation and partnership - assumes strengthening the cooperation of all entities involved in the implementation of the Strategy, including local government units from the area of Mazowieckie Voivodship, local governments from other voivodships, government administration, the economic sector and business environment institutions, economic and professional self-governments, non-governmental organisations and the region's inhabitants, units from the education and research sector, international organisations and regions of other countries. Moreover, this principle aims at building a culture of partnership and cooperation, which will focus on cooperation between people, institutions and organisations, as well as establishing lasting relations between the entities implementing the Strategy. This principle is also understood as participation, co-determination and co-responsibility of entities in the creation of the development policy of the region and implementation of the Strategy's objectives. Cooperation and partnership are necessary conditions for the success of the implementation of the Strategy, because some of the activities go beyond the powers of the self-government of the Voivodship.

Development planning principles:

- cohesion - means taking into account in the process of developing the Strategy, the objectives contained in strategic documents at the European and the national level. In particular, attention was drawn up to the coherence of the Strategy with the directions set out in the Strategy for Responsible Development 2020 (with an outlook towards 2030), the National Strategy for Regional Development 2030 and the thematic objectives of the EU cohesion policy,

- demographically determined development - targeting interventions in individual public policies, taking into account demographic trends. The implementation of the development policy is to reduce the scale of negative demographic changes,
- integrated planning - consisting in a multidimensional integration of planning and implementation of the development policy of Mazowieckie Voivodship, combining social, economic and spatial dimensions, while keeping sustainable development. The planned intervention should be tailored to the specificity of the area, respond to its specific needs and be based on the internal development potential of the area. The integrated territorial approach means the need to correlate at the Voivodship level the development policy in the socio-economic area with the spatial policy, so that they constitute a coherent system of planning the region's development. It is important to take account of the territorial context when programming, implementing and monitoring measures. This principle also assumes complementarity of actions taken at different levels of administrative division,
- selectivity - means concentration of integrated and complementary activities leading to achievement of selected objectives, strategic for the development of the Voivodship, support for specific social groups and development of designated intervention areas. The selectivity principle assumes making a strategic choice in terms of directions of Voivodship development in cooperation with all partners involved in its implementation. This principle also means supporting those industries, fields, sectors and niches which, given their potential, allow for building a real competitive advantage of a given area on a regional, national or international scale and constitute a driving force for economic development.

Implementation principals:

- sustainable development - assumes implementation of measures aimed at improving the standard of living of the inhabitants, while ensuring a balance between social, economic, spatial and environmental aspects in the conditions of a developing market economy. The principle promotes development based on resource efficiency and innovative solutions taking into account climate policy challenges,
- multi-level governance and integrated undertakings - assumes undertaking coordinated actions and creation of development investments implemented by various entities (local government units, business entities and social partners) and financed from various sources to ensure their complementarity. Implementation of integrated projects

will ensure the effectiveness of financial support, synergy and greater benefits for the development of the region than in the case of individual activities. This principle takes into account the involvement of the social and economic partners in the decision-making and implementation processes.

10. STRATEGY MONITORING AND EVALUATION SYSTEM

Implementation of the Strategy requires systematic observation of changes taking place in the region, as well as responding to emerging problems and threats in achieving the results assumed by the Strategy and will be subject to constant monitoring. The thematic scope of monitoring and evaluation of the bioeconomy implementation is determined by strategic and operational objectives. The basic point of reference in monitoring the implementation of the Strategy is a set of indicators showing the expected results of the implementation of the Strategy, relating to particular strategic and operational objectives. The main document in the monitoring process will be a periodic report on the implementation of the Strategy for Bioeconomy Strategy in Mazovia, submitted for approval to the Board of Mazowieckie Voivodship. The report will be prepared at least every four years and will include a part devoted to the level of implementation of the objectives of the Strategy and the evaluation of the socio-economic and spatial situation of the Voivodship. The monitoring of the Strategy will be the basis for assessing the degree and dynamics of progress in the implementation of the adopted strategic and operational objectives. The section on the level of achievement of the strategy's objectives will be measured by means of indicators from the strategy monitoring system.

In order to ensure the effectiveness, efficiency, usefulness and sustainability of the intervention provided for in the Strategy, evaluation studies will be carried out by an external entity. The selection of evaluators should be conducted in accordance with the Act of 11 September 2019 Public procurement law (Journal o Laws, No. 2019, item 2019, as amended). Internal evaluations may also be carried out in addition to external evaluations.

Types of evaluation:

- On-going evaluation, combined with monitoring of the Strategy and evaluation of development policy in view of the next EU financial perspective, may be a premise for amendments to the Strategy,

- Ad hoc evaluation, which may be carried out in case the monitoring of the Strategy shows a significant departure from the objectives initially set and where proposals for revision of the Strategy are made,
- Ex post evaluation at the end of the strategic period, in the year 2030. This is the evaluation which will determine the effectiveness of the implementation of the Strategy and will be carried out by independent experts or institutions, including an assessment of the use of funds, the effectiveness and efficiency of the aid and its impact and impact on the development of the region.

The main objective of the evaluation will be to answer three questions:

1. Have the provisions of the Strategy remained valid after about three/five years?
2. What should be changed or supplemented during the next revision of the Strategy?
3. Has the position/situation of Mazowieckie Voivodship changed due to the implementation of the Strategy?

The coordinator of the monitoring system (the department responsible for the development of the bioeconomy of the Marshal's Office) will be responsible for the detailed definition of the scope of evaluation - study objectives and evaluation criteria.

11. FINANCIAL FRAMEWORK

The success of the implementation of the Strategy is largely dependent on the financial capacity of local government units in the Voivodship and private business entities operating on its territory. In order to effectively implement the Strategy, the self-government of Mazowieckie Voivodship will look for all available sources, tools, methods and possibilities to implement specific objectives in order to make the vision proposed in the document come true. Planning financial outlays for the implementation of the Bioeconomy development policy after 2020 (in the financial perspective 2021-2027) is hampered mainly by the ongoing work on the shape of the national development policy and the ongoing negotiations on the future shape of the EU Multiannual Financial Framework. Therefore, the financial framework of the Strategy was defined in a directional way by indicating potential sources of financing. Due to the wide scope of the planned interventions, the financing system of the Strategy will be based on the principle of assembly of financial resources from various sources using various support tools. The catalogue of public funds, including the following, is crucial for financing the Strategy:

- funds from the budget of Mazowieckie Voivodship;
- the European Union budget,
- the state budget,
- funds of local government units,
- other public funds.

An important role in financing development interventions will also be played by private funds, which can be used to co-finance projects implemented under operational programmes or in the formula of public-private partnership. Direct initiatives of the private sector, in particular of entrepreneurs, will take part in the implementation, translating into the growth of the economic potential of the region.

Funds from the budget of Mazowieckie Voivodship will finance development expenditures directly or co-finance development expenditures financed from other sources. The financial condition of all entities implementing the Strategy will also affect the possibility of absorbing funds from other sources, primarily EU funds. Some of the resources from the above catalogue will be used directly for the implementation of the Strategy, others - by using various implementation tools. Below are those tools which are of the greatest importance in terms of their potential to be used to implement the objectives of the Strategy.

Due to the ongoing process of agreeing on the shape of the cohesion policy for 2021-2027, at this stage it is not possible to definitively determine the scope of support under the individual operational programmes, nor the amount of funds that will be available to Mazowieckie Voivodship. According to the draft general regulation of 29 May 2018, it can be assumed that cohesion policy support will focus on a limited number of objectives. The most important tool for the Voivodship under the cohesion policy will be the regional operational programme, which is planned for 2021-2027. The document is developed, managed and implemented by the Board of Mazowieckie Voivodship. Other tools that Mazowieckie Voivodship will use to implement the Strategy will be national operational programmes covering the bioeconomy sectors. The scope of their intervention will result from objectives set out in EU regulations, as well as needs and investments that are significant from the point of view of the economy and development of Poland set out in strategic documents, in particular SOR, and integrated sectoral strategies, including especially KSRR 2030, while maintaining the established demarcation of support between the national and regional level. Assuming as above, the national operational programmes will support those objectives of the

Strategy that are consistent with them. The following programmes will also be used to implement the Strategy:

- those managed directly by the European Commission,
- tools using European Investment Bank resources,
- other international financial institutions,
- The Norwegian Financial Mechanism and the Financial Mechanism of the European Economic Area.

National sources of funding will be of great importance to the implementation of the Strategy for Development of the Bioeconomy in Mazovia. Regional policy will be implemented through national development programmes, including multi-annual programmes, as well as other instruments based on public funds. It will also be possible to benefit from the professional system of development institutions, by using the instruments offered by:

- the Polish Development Fund,
- Bank Gospodarstwa Krajowego [National Economy Bank],
- Polska Agencja Rozwoju Przedsiębiorczości [Polish Agency for Enterprise Development],
- Korporacja Ubezpieczeń Kredytów Eksportowych [Export Credit Insurance Corporation] S.A,
- Polska Agencja Inwestycji i Handlu [Polish Investment and Trade Agency] S.A.
- Agencja Rozwoju Przemysłu [Industrial Development Agency] S.A,
- The National Fund for Environmental Protection and Water Management,
- The National Centre for Research and Development.

ANNEX NO. 1: STRATEGY MONITORING INDICATORS

Factor	Measurement unit	Value	Year achieved	Comments/remarks
number of bioeconomy initiatives implemented at the level of local government units	number of initiatives with Q4 2020 as 1.00	1.50	2030	local self-goverment show growing interest in bioeconomy initiatives
the share of renewable energy in gross electricity production, in particular PV biomass	percentage share with Q4 2020 as 100%	PV 300% biomass 125%	2030	the increase in initiatives promoting PV (government programs such as My Electricity, etc.) and the growth of grassroots market interest allow for the assumption of a significant increase in the share of PV. In the case of biomass, moderate but stable growth to a minimum level of 125% should be expected

(co-)combustion of biomass for energy purposes in power plants and combined heat and power plants	percentage share with Q4 2020 as 100%	125%	2030	(co-)combustion of biomass for energy purposes seems to be a solution that allows to significantly reduce emissions with relatively low investment outlays. However, problems with the availability of biomass and its growing cost (mainly transport) suggest that the increase in the share of this technique will be relatively small
number of biogass plants	number of plants operating and/or under construction with Q4 2020 as 1	1.30	2030	the availability of free biomass for contracting at an acceptable price seems to be the basic factor allowing to assume an unknown increase in the share of this energy source. The increase should result mainly from small units using their own biomass
percentage of biomethane in the gas grid	percentage share	20%	2030	the legal barriers currently in force (Q1 2021) (no regulations governing the introduction of biomethane into the grid), in our opinion, will translate into a slow growth of this technique
co-combustion of non-fossil fuel originated hydrogen with	percentage share	5%	2030	very high competition in the use for transport and forecasting, the low availability of non-fossil hydrogen will translate into a small share of hydrogen co-combustion. Due to the achievable emission reduction effects and acceptable financial outlays for the implementation of this technology, they will allow it to appear on the market.

methane				
production of biofuels, including advanced biofuels (min.2G)	production volume with Q4 2020 as 1.00	0.5 for less than 2G 1.80 for 2G and higher	2030	Due to the ending of support in including 1G biofuels among emission targets, a marked decrease in the production volume should be expected, but due to the attractiveness of prices, no complete cessation of production should be expected. Biofuels 2G and above face serious economic problems (market profitability of production), while the need to demonstrate them for climate purposes and accelerated technology development suggest their increased presence on the market
production of biohydrogen (non-fossil fuel originated)	production volume with Q4 2020 as 1.00	1000	2030	at the launch time, it did not demonstrate any production of biohydrogen on a scale above the research scale in Mazovia. The launch of the first installation will translate into a significant increase in production.
production of biohydrogen (non-fossil fuel originated) with CCU/CCS techniques	production volume with Q4 2020 as 1.00	50	2030	the development of these technologies is far less advanced. A pilot or small-scale production installation for experience building/ technology adaptation is expected by 2030
production of biohydrogen from biomethane	percentage share of biohydrogen volume	60%	2030	This method should be considered as slightly dominant in relation to hydrolysis, due to the market grounding of biomethane and its local availability. The share of hydrogen production using CCU / CCS is estimated to be still a niche in 2030

pyrolysis				
share of collective transport vehicles powered by alternative fuels in the fleet, excluding classic hybrids and LPG vehicles	percentage share in fleet	Warsaw: min. 90% Rest fo Mazovia: min. 60%	2030	Warsaw has made a clear commitment to purchase only low- or zero-emission vehicles from 2015 (http://www.transport.um.warszawa.pl/sites/default/files/0198_uch_zal.pdf.pdf). Taking into account the average vehicle life time in the fleet for 12-15 years, it should be considered that min. 90% of the rolling stock will be replaced by 2030. In other parts of Mazovia, this process will be less dynamic due to the scale of operations of local carriers and less possibilities of financing more expensive vehicles and financing the construction of accompanying infrastructure
management of the municipal waste stream for: for energy purposes for other purposes, including biochemicals	percentage share in waste stream with Q4 2020 as 100%	for Energy purposes 350% for other purposes 150%	2030	an obvious increase in the management of waste streams, especially for energy purposes, is expected. Initial initiatives are emerging in this regard. The main barrier to further growth is the problems with the separation and repeatability of the waste stream (annual variability) and the reluctance to accept the additional costs associated with receiving a waste stream of acceptable quality (e.g. the cost of biodegradable waste bags that do not interfere with the operation of the installation).

bioeconomic research and application projects financed from national sources	overall budget (with at least one partner located in Mazovia region) with Q4 2020 as 1.00	1.50	2030	the growing need to implement bioeconomy initiatives is noticeable in financing units (NCN, NCBiR), the growing scientific excellence of partners located in Mazovia allows us to assume a significant increase in obtaining a financial stream from domestic sources. However, since Mazovia is treated as a developed region and thus excluded from financing in some programs, this increase should be treated with caution.
bioeconomic research and application projects financed from international sources	overall budget (with at least one partner located in Mazovia region) with Q4 2020 as 1.00	1.70	2030	There is a growing activity of consortia with partners from Mazovia (both research units and industrial partners) in applying for funds at the international level (the Horizon Europe program and its successor, multiteral programs). The growing scientific excellence of the application and the increased awareness of the need for such initiatives will translate into an increase in the volume of funds obtained
presence of green airport initiatives per commercial passenger airport (not including aeroclubs, etc.), ports marked with the IATA	presence of implemented initiatives per every category & airport (1 if implemented, 0 if not)	sustainable avation fuel WAW – 1 WMI – 1 RDO – 1 CPK – 1 sustainable ground	2030	In terms of sustainable aviation fuel, it should be expected that the dynamic development of technology and the falling price will translate into fuel certification at least until 2025, and thus the introduction of an obligation to use it before 2030. Hence, it will be present at all airports under consideration. Modernization of the airport in Radom (RDO) should result in the implementation of "sustainable airport" initiatives. However, the scale of the airport dictates to be skeptical about "sustainable ground operations". WAW airport is considered to be a pioneer in implementing initiatives. The WMI airport is characterized by (Q1 2021) instability and a difference in vision among the ownership group, and this factor requires far-reaching skepticism in introducing investments not required by legal regulations.

code (CPK as central airport under planning as Q1 2021)		operations WAW – 1 WMI – 0 RDO – 0 CPK – 1 sustainable airport WAW – 1 WMI – 0 RDO – 1 CPK - 1		
biorefinery installation	numer of plants at least under construction	1	2030	development of complex bio-refineries installations in Europe and the growing ease of obtaining funds for this type of unit allows to set up the location of at least one experimental/pilot unit (or bigger) in Mazovia
the level of R&D expenditure in relation to the national average	level with national average as 1.00	1.30	2030	Mazowsze has an established position as an innovation leader. The only factor impeding a more dynamic development is the exclusion of entities in Mazovia as a developed region from some public aid programs. We should expect a growing number of initiatives financed entirely from own resources.
the level of expenditure in the SME	level with national average as	1.20	2030	easier access to funds for small but important initiatives (e.g. PARP Innovation Voucher) will allow the SME sector to partially reduce its own expenditure by replacing it with funds from public programs, however, the growing awareness of

sector, in relation to the national average	1.00			the availability of this type of funds will translate into an overall increase in the budget of implemented initiatives
the level of outlays in the industrial sector in relation to the national average	level with national average as 1.00	1.35	2030	the growing need to reduce emissions and pro-environmental activities will translate into a comprehensive increase in implemented projects. Certain difficulties in the access to public funds, and usually a lower level of public financing than for SMEs will result in a greater increase in outlays from own funds
employment in the R&D sector, compared to the national average	level with national average as 1.00	1.20	2030	Mazovia is one of the leaders in employment in the R&D sector. The presence of leading academic centers, research institutes (Polish Academy of Sciences, Łukasiewicz Research Network) results in high availability of qualified staff and equipment necessary to complete projects at the highest level
the number of university graduates in related fields of study, in relation to the national average	level with national average as 1.00	1.10	2030	Mazovia is a perfectly recognizable center of education in these areas. The presence of universities dedicated to the sector (eg SGGW in Warsaw) is conducive to the development of the sector.
number of initiatives related to	number of buildings meeting the	300	2030	Passive construction initiatives slowly developing in Poland, including Mazovia. At the time of drafting the document (Q1 2021), these initiatives are rather individual, local and resulting from the involvement of individual investors, or a

passive housing (energy self-sufficient)	definition			very high awareness of local government units or entrepreneurs. The experience of operating this type of buildings in Polish conditions should be a catalyst stimulating the growth of initiatives and popularity of this type of solutions.
number of RHC (renewable heating & cooling) projects, particularly in the office sector	percentage share of buildings equipped with RHC solutions	min. 30%	2030	the increase in availability and decrease in prices of RHC solutions will enable their wider use in the office sector. Growing customer awareness and growing expectations of pro-environmental solutions will be an additional factor stimulating the emergence of comprehensive RHC solutions. The potential permanent change of corporate office cultures after the CoViD-19 pandemic and a partial permanent transition to Home Office work of a minimum of some employees were identified as the main barrier to potential growth, mainly due to deacreased number of offices.
share of "green" heat sources in households	percentage share of buildings equipped with "green" heat sources in households	min. 80%	2030	the availability of starting data is difficult, because currently (Q1 2021) there is no register of heat sources in households. The legal obligation enters into force and complete baseline data is expected by the end of 2022. The increase in clean air initiatives and the emerging significant subsidies for the replacement of heat sources (even more than 90% for the poorest) as well as striving to increase the energy efficiency of the households will lead to the gradual and certain elimination of non-ecological solid fuel stoves. However, in our opinion, their presence will not be completely eliminated by 2030, they will be present in some of the poorest households, especially in rural areas, where, in addition, the use of coal is somehow rooted in the culture and changing habits in this area is very difficult and it will require advanced initiatives, including education, on the effects of burning poor quality fuel. The growing system of controlling flue gas from stoves (including the use of drone technologies) allows for the elimination of the uncontrolled burning of waste in

				households by 2030.
the level of air pollutant emissions per citizen or per unit of energy produced, including: carbon dioxide, methane, solid particles,	level with Q4 2020 as 1.00	carbon dioxide 0.85 methane 0.90 solid particles 0.75	2030	The reserved difference in the pace of introducing climate changes for Poland allows for assuming a gradual decrease in total emissions, but in the not too ambitious scenario. Improvement is expected, in particular in the field of particulate matter, thanks to the anticipated elimination of combustion of coal and substandard fuels in households, as well as in industry through rising prices of carbon dioxide emission allowances.
the level of waste recycling into material (raw material)	share of recycled waste in the stream compared to that used in Q4 2020 (Q4 2020 as 1.00)	1.30	2030	an increase in recycling of plastics is expected, also due to the improvement of selective collection mechanisms (including the implementation of a deposit system for packaging), which will translate into an increase in the availability of a qualitative stream for re-development. Also in the field of glass waste, an increase in initiatives is foreseen to facilitate material re-introduction.
the level of waste recycling into energy recycling	share of recycled waste in the stream compared to	1.50	2030	An increase is expected mainly in the area of biogas/biomethane production from the municipal waste stream, but also pyrolysis or thermolysis processes of waste plastics of a quality that does not allow material recycling to be re-introduced, to e.g. liquid and solid fuel component fractions.

	that used in Q4 2020 (Q4 2020 as 1.00)			