Project title	**Supporting the establishment of the innovative governance models to achieve better-informed decision-making processes, social engagement and innovation in the bio-based economy**		
Project acronym	BIOMODEL4REGIONS		
Grant Agreement	101060476		
Project start date	01/07/2022	**Duration**	36 months

SIX REGIONAL BIO-BASED ECONOMY STRATEGY BLUEPRINTS, ONE BY EACH PILOT REGION

Due date	**December 2024**	**Delivery date**	**December 2024**
Work package	5		
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Version	1		

Dissemination level

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Version and amendments history

Version	Date	Created/Amended by	Changes
1.0	20 December 2024	Grizans, Jurijs (ICLEI)	–

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement N° 101060476

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This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement N° 101060476

Executive Summary

This report is entitled “Six Regional Bio-Based Economy Strategy Blueprints, One by Each Pilot Region” and represents intellectual outcome of the European Union's (EU) Horizon 2020 research and innovation program funded project: “Supporting the establishment of the innovative governance models to achieve better-informed decision-making processes, social engagement and innovation in the bio-based economy" (BIOMODEL4REGIONS).

By building on knowledge and experiences from years of research and studies within the field of bioeconomy the project BIOMODEL4REGIONS strives to put proven best practices and successful initiatives to action. This is done thanks to a methodology based on the set-up of a governance structure demonstrated in six pilot regions: Delta Region (Netherlands), Nitra Region (Slovakia), Normandy Region (France), Northern Sweden (Sweden), Tuscany Region (Italy), and Western Macedonia Region (Greece), considering their conditions and assets and different primary sectors: forestry, agri-food, aquatic biomass and organic fraction of municipal solid waste.

To foster continuation of BIOMODEL4REGIONS approach to set-up of a governance structure among bioeconomy clusters beyond the project timeline, BIOMODEL4REGIONS pilot regions developed six Regional Bio-Based Economy Strategy Blueprints. This report presents a comprehensive collection of these six blueprints developed by the BIOMODEL4REGIONS pilot regions.

This document establishes the strategic knowledge and practical experiences foundation for scalability planning of the BIOMODEL4REGIONS approach in the pilot regions beyond the project timeline, as well as for planning the replication of the BIOMODEL4REGIONS innovative governance models in other regions across Europe, and beyond, to enable the progress of the bioeconomy development.

This report can be relevant and helpful for regional and local authorities, public administrations, industry, primary producers, small and medium-sized enterprises, civil society organisations including non-governmental organisations, knowledge providers, citizens, consumers, etc.

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1. Introduction

1.1. BIOMODEL4REGIONS Project Overview

The European Commission Joint Research Centre report "Trends in the EU bioeconomy – update 2024" highlights the need for policy actions for improving the sustainability of the bioeconomy, including reducing consumption, fostering innovation, and improving biomass circularity. Coordination and cooperation among Member States is important to ensure a coherent EU bioeconomy policy framework and to share knowledge advances in a fast-changing policy area.

The BIOMODEL4REGIONS **aims** to support the establishment of the innovative governance models at regional/local level to achieve better-informed decision-making processes, social engagement, and innovation to support and strengthen EU and international science-policy interfaces to achieve the Sustainable Development Goals by delivering the following **tasks (TA):**

- **TA-01:** Supporting the development of regional/local strategies, aiming at exploiting the local potentials and innovations by integrating the opportunities created by the local bio-based economy thus contributing to the broader bioeconomy transition.
- **TA-02:** Developing novel business models to enable consumers, industry/producers, and public bodies to a societal switch towards environmentally responsible behaviour by means of biobased products and services.
- **TA-03:** Developing best practice guidelines for local operators and innovation developers, supporting climate-neutrality and low environmental footprint improvements of bio-based products and services.

The BIOMODEL4REGIONS represents an organised transnational networking initiative of bio-based economy clusters, namely EU clusters actively involved in the bio-based economy at regional or national level. Project **methodology** is based on the set-up of a governance structure among bioeconomy clusters that are leveraging previous successful projects, initiatives, and best practices to capitalise on work performed through several years of research and studies in the field of bioeconomy. These results are demonstrated within the project to support six pilot regions chosen in clusters' networks.

1.2. Purpose of the Regional Bio-Based Economy Strategy Blueprint

During the project timeline with the support of the project partners, BIOMODEL4REGIONS pilot regions worked on developing regional bio-based economy strategy blueprints, **bringing together stakeholders from the whole value chains** (including local, regional authorities and researchers), and integrating project research and innovation results.

The regional bio-based economy strategy blueprint serves as **a guide for co-development and co-creation bio-based economy strategy at the regional level.** It is a strategic tool for outlining the connection between regional economy, society, and the environment.

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BIOMODEL4REGIONS provides **action-focused strategies** to exploit the potential of the bio-based value chains and promote the adoption of innovative and sustainable governance models in Europe. Regional bio-based economy strategy blueprints are aiming **to exploit the different local potentials** e.g., in terms of feedstocks (forestry, agri-food, aquatic biomass and organic fraction of municipal solid waste), infrastructures, production, and investment.

The regional bio-based economy strategy blueprints development methodology is inspired by the ICLEI – Local Government for Sustainability (ICLEI) Green Climate Cities (GCC) programme. To assess governance models in the six pilot regions it is based **on a three-tiered framework,** starting off with basic sustainability governance functions derived from climate governance and becoming more bio-based economy specific in following tiers. A set of **70+ indicators** has been aggregated from literature and developed by the BIOMODEL4REGIONS consortium experts to evaluate the criteria set forth in the developed framework.

To streamline the development of the regional bio-based economy strategy blueprints, ICLEI has created a template with the annotations, instructional guidance, and recommendations for each of the sections. The template has a flexible structure, **allowing sufficient localisation and adaptability** given the differing framework, context, and scope of each of the bio-based economy strategy blueprints to be developed. The structure of the template is presented in the figure below.

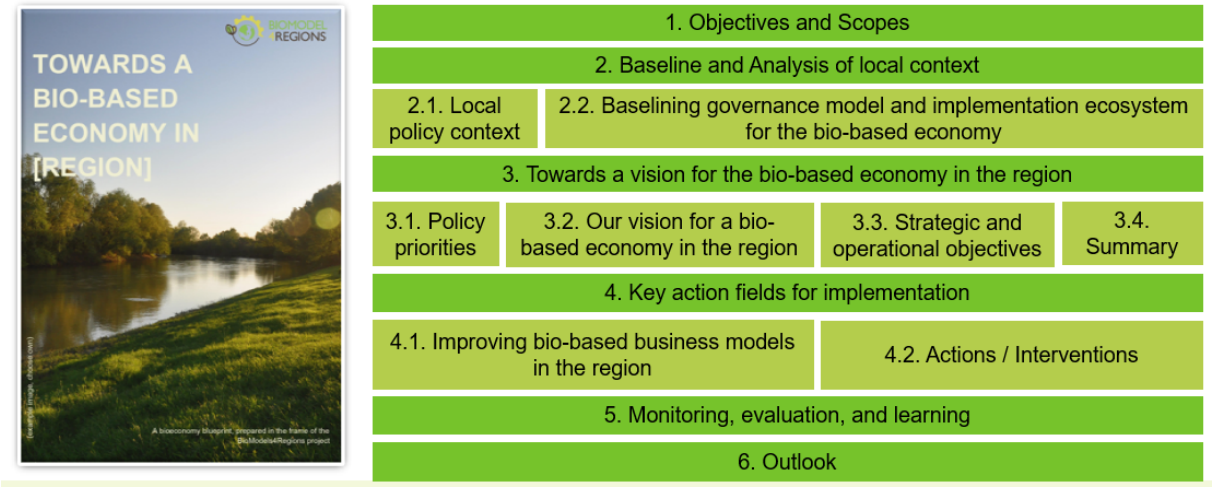

Figure 1: The structure of the bio-based economy strategy blueprint template (Source: ICLEI)

To ensure that the pilot regions develop the regional bio-based economy strategy blueprints in a co-designing manner, ICLEI with the engagement of all BIOMODEL4REGIONS Partners supported pilot regions in organising and implementing co-creation workshops in each pilot region with relevant stakeholders, in particular regional authorities, and consortium partners. The participatory workshops were designed to help project pilots **co-think, co-discuss, co-develop,** and **co-validate** the bio-based economy strategy blueprints. Results from the development of the regional bio-based economy governance models and analysis carried out in the BIOMODEL4REGIONS project were presented during the workshops. Based on previous findings and on their knowledge of regional conditions and assets, participants were asked to define a long-term vision for the bio-based economy in pilot regions and derived medium-term goals from this vision within the framework of local development and investment

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as well as environmental protection plans. During the period from June to November 2024 all regional co-creation workshops have been successfully implemented in each of the six pilot regions.

Regional bio-based economy strategy blueprints can act as a strategic intellectual and practical guide for the region practitioners for development of the bio-based economy strategies further according to the regional characteristics, needs, and capacities.

1.3. Comparative Overview of Regional Competences in Pilot Regions

Regional bio-based economy strategy blueprints are a unique composition of knowledge, experiences, courage, and enthusiasm for stronger development of the bio-based economy in the pilot regions. Six BIOMODEL4REGIONS pilot regions developed the regional bio-based economy strategy blueprints with consideration of their mandates and responsibilities within the respective national administration and governance framework. Table 1 briefly presents the comparative overview of regional competences in the BIOMODEL4REGIONS pilot regions.

Table 1: Comparative Overview of Regional Competences in Pilot Regions

Pilot Region	NUTS (EU Nomenclature of territorial units for statistics)	Competences
Delta Region (Netherlands) [More information]	NUTS Level 3 - 4	• Dutch municipalities enjoy many competences which they exercise in the different sectors of governmental action (environment, housing, social programs, traffic, buildings, culture and leisure facilities, social services, etc.) as provided for by the relevant sectoral laws and regulations enacted by the central powers. • Apart from adjudicatory powers, municipalities are also endowed with certain planning powers, for instance in the domain of urban development and planning (although the municipal plans must respect and fit in the provincial plans).
Nitra Region (Slovakia) [More information]	NUTS Level 3	• Regions (superordinate territorial units) form the second governance system level in Slovakia. • The self-governing regions hold original competences in several areas as well as competences delegated by the central government covering various areas relevant for spatial development, e.g.: (1) the social, economic, and cultural development of the self-governing regions; (2) management of the self-governing regions' own budget, investment, and public contracts; (3) regional planning; (4) etc.

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Pilot Region	NUTS (EU Nomenclature of territorial units for statistics)	Competences
Normandy Region (France) [More information]	NUTS Level 1	• France is divided into 18 regions, of which 13 are on the mainland and five are overseas. Regions are managed by a regional council made up of representatives voted into office in regional elections every five years. The councillors elect their own president who heads the Regional Executive. • Regions deal with (1) economic development; (2) regional planning; (3) vocational training; (4) the construction and (5) maintenance of high schools and (6) intercity transport. They have considerable budgets, but they lack separate legislative authority and therefore cannot draft their own statutory laws.
Northern Sweden (Sweden) [More information]	NUTS Level 3	• Sweden can be characterised as a unitary and decentralised state in which the central government delegates authority within a three-tier governmental structure: central, regional, and municipal. Regions and municipalities do not hold legislative powers, but they do have executive powers in taxation and administration at their respective levels. • The regions have responsibilities for public health and cultural institutions, as well as public transport. Since 2017, all regions in Sweden have overseen regional development and are supposed to develop regional development strategies.
Tuscany Region (Italy) [More information]	NUTS Level 2	• Regions are recognised as autonomous entities provided with their own statutes, powers, and functions in accordance with the principles of the Constitution. The regions have legislative powers in all matters not expressly covered by state legislation. • Moreover, they take part in the preparatory decision-making processes for EU legislative acts in the areas that fall within their responsibilities and are also responsible for the implementation of international agreements and European measures within the limits established by the law.
Western Macedonia Region (Greece) [More information]	NUTS Level 2	• Regions are self-governing territorial legal entities which form the second level of Local Government. The Regions are responsible for

Pilot Region	NUTS (EU Nomenclature of territorial units for statistics)	Competences
		planning and implementing regional policies regarding their responsibilities according to the principles of sustainable development and social cohesion, and in consideration of both national and European policies. • Regions exercise their competences within the framework of the relevant laws and administrative regulations, in the fields of: (1) planning, development; (2) agriculture, livestock, fishery; (3) natural resources, energy-industry; (4) spatial planning, environment; (5) etc.

Annex-01

Towards a Bio-Based Economy in Delta Region (Netherlands)

BIOMODEL 4REGIONS

TOWARDS A BIO-BASED ECONOMY IN THE DELTA REGION

A bio-based economy strategy blueprint, prepared in the frame of the BioModel4Regions project

This document has been prepared in the framework of the European project "BIOMODEL4REGIONS – Supporting the establishment of the innovative governance models to achieve better-informed decision-making processes, social engagement, and innovation in the bio-based economy".

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 101060476.

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December 2024

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List of Abbreviations

Abbreviation	Definition
BBPs	Bio-based products
BIC	Bio-based Industries Consortium
CBBD	Circular Biobased Delta
CBE JU	Circular Bio-based Europe Joint Undertaking
GCNE	Green Chemistry New Economy
HCH	Holland Circular Hotspot
JTF	Just Transition Fund
KIA	Knowledge and Innovation Agenda *(translation from Dutch)*
KPI	Key performance indicator
RIV	Regional Innovation Valley
ROM	Regional Development Agency *(translation from Dutch)*
RVO	Netherlands Enterprise Agency *(translation from Dutch)*
SME	Small and Medium-sized Enterprise

Glossary

Keyword	Definition
Bioeconomy	The bioeconomy covers all sectors and systems that rely on biological resources (animals, plants, micro-organisms and derived biomass, organic waste), their functions and principles. It encompasses all sectors and associated services and investments that produce, use, process, distribute or consume biological resources, including ecosystem services (agriculture, forestry, fisheries, food industry, pulp and paper, textiles, environmental technology, energy, and industrial sectors such as the chemical and biotechnology sector and finally the user and the consumer). *The EU Bioeconomy Strategy*
Bio-based economy	Use of renewable biological resources, including plant, animal, and microbial materials, to produce materials, chemicals, energy, and other products, thereby reducing dependence on fossil resources. Part of the bioeconomy where bio-based products are produced. It can be about bio-based activities in chemistry, textile industry, pharmaceutical industry, wood processing industry construction, among other ones. *European Commission*
Bio-based products	bio-based materials and bio-based chemicals
Plant-based products	term increasingly used beyond the agri-food domain and for bio industrial topics (here understood as synonym to the term bio-based products)
Triple helix	industry, government, and research institutions

1 OBJECTIVES & SCOPE

The Rhine-Scheldt Delta Region (Delta Region), encompassing Southwest Netherlands and part of Belgian Flanders, is a strategically vital area characterised by its dynamic industries, major ports, and strong potential for driving the bio-based economy transition. This region hosts some of Europe's largest and busiest ports, including the Port of Rotterdam, the Port of Antwerp, and the North Sea Port[1] (which combines the Ports Vlissingen, Terneuzen, and Ghent). The presence of ports represents a series of unique characteristics for the areas where those are located. It attracts multiple industries given strategic transportation routes; it incentivizes the developments of the logistics sectors as well as investments in infra-structure given that ports are key gateways for global trade. These ports not only facilitate international commerce but also play a crucial role in the supply chains of various industries, including chemicals, petrochemicals, food processing, and logistics.

The region's industrial landscape is diverse, with a strong presence of traditional sectors such as manufacturing, energy, and agriculture, alongside emerging bio-based industries that leverage its robust infrastructure and innovation capacity. Still, there is a particular set of companies for which direct access to deep waters, congestion-free connections to the hinterland, reliable energy supply, an underground pipeline network combined with the space for production and storage is even more interesting: the chemical industry. The presence of ARRRA[2], one of the world's largest chemical clusters, frontrunner in the field of sustainability, and covering a large part of this region's territory, brings a strong influence into the region's economy.[3] In the bio-based economy context, this means that green chemicals find a unique context in which to develop. Beyond the chemical industry, another top sector in the region is agrifood, composed of agriculture, horticulture, and fisheries, with emphasis on innovative agriculture and food production. In this industry there is rapidly increasing attention and resources to bio-based solutions[4] for applications from construction to packaging. Here, it is worth noting that the Delta region is strategically positioned in providing the ARRRA region with security of feedstock via regional access, due to the presence of the highly efficient and large-scale sugar beet producing industry.[5]

Considering its well-established industries and port facilities, the Delta Region has a unique setting to integrate circular practices, develop new bio-based value chains, and reduce environmental impact, positioning the region as a key player in Europe's green transition. This is strengthened by clear incentives signalled by the (provincial) public sector. Guiding these efforts in the Delta region are, to mention a few, the 'Implementation Agenda for the Economy,

[1] The economic added value of the chemical industrial clusters is of great importance to the region. The cross-border port North Sea Port alone has an added value of approximately €14.5 billion and direct and indirect employment of 100,000. Source www.vnci.nl/over-de-chemie.

[2] The Antwerp- Rotterdam- Rhine- Ruhr Area (ARRRA).

[3] The chemical industry in the Netherlands is the fourth largest in Europe and is essential for the Dutch economy, representing 16 percent of the total export of goods with 45,000 employees and a turnover of €67 billion in 2023. See https://www.vnci.nl/chemie-in-cijfers, www.zeeland.com/nl-nl/live-work/zeeuwse-topsectoren, www.brabant.nl/onderwerpen/economie/innovatie-technologie/ondersteuning-topsectoren/.

[4] Several innovation and collaboration networks are being launched. Most recently, 'The Plant-based Network' (HPN) launched in October 2024. Source https://hetplantbasednetwerk.nl/.

[5] 'The Bio-based Delta: Where agro meets chemistry. A globally competitive region for developing bio-based business' (2015) www.greenchemistrycampus.com/images/uploads/The_Bio-based_Delta_online_3.pdf.

Knowledge & Talent Development 2024-2027' of North Brabant[6], both the 'Economic Agenda - Implementation Programme for the Economy 2024-2027'[7] and the 'Environmental Vision' (Ambition 3 - A sustainable and innovative agenda)[8] of Zeeland, and the updated Circular Strategy 2024-2037 – 'Building a Circular South Holland Together'[9] of South Holland provinces. These key guiding instruments are further detailed in section 3.1. The public sector in the region also supports the development of the bio-based economy ecosystem via attractive tax regime and multiple incentives. These have special focus on facilitating research, development, and innovation, and fostering collaboration on cutting-edge technological advancements to ensure talented human capital is involved. Academic institutions present in the region, such as Wageningen University and Research, Delft University, Eindhoven University and Ghent University and Universities of Applied Sciences are some of the institutions often involved in such joint projects and initiatives.

In the context of the Biomodel4Regions Horizon Europe project, the efforts to develop this blueprint for the Delta Region has been led by two different organisations throughout the project's timeline. From the beginning of the project until January 2023, the leading organisation was the Circular Bio-based Delta (CBBD), a long-term initiative in the region that for 10 years acted as a key player to connect the triple-helix and advance conversations in the following topics and projects: valorisation of carbohydrates (Sugar Delta), biorefining of lignocellulosic ('Redefinery'), lignin valorisation into binders for asphalt (CHAPLIN), and development of bio-aromatics ('Biorizon').[10] In 2023, Holland Circular Hotspot (HCH) entered the consortium to continue the work of CBBD. Holland Circular Hotspot is a private foundation that aims to accelerate the international transition to a circular economy by connecting companies, knowledge institutes and (local) authorities, and support international collaboration and knowledge exchange on the Dutch circular economy. Both organisations' network, knowledge, and efforts in coordination have been crucial for the process, nonetheless, it is important to highlight that the purpose and relevance of this blueprint could only be achieved by a joint effort of the community of stakeholders in the bio-based space in this region. This blueprint therefore is the result of multiple interactions and contributions from over forty stakeholders who represent the triple helix: public sector, private sector, and knowledge institutions. Several moments have enabled specific and updated insights that were translated into this tool. Various workshops, meetings, and interviews have allowed for furthering the content and providing specific and relevant contributions to this blueprint.

It is important to clarify that although the Delta Region includes both the Netherlands and Belgium, and, the extensive data for the multiple governance key performance indicators (KPIs) used for the baseline context and analysis for recommendations is drawn from the provinces of North Brabant and Zeeland, based in the Netherlands. Although not involved in this project to the same extent as the above-mentioned provinces, both East Flanders (Belgium) and South Holland (the Netherlands) were consulted in different moments and have several economical commonalities to the former provinces. Later in this document, this is reflected in the recommendations for strategic objectives and activities for increased and targeted collaboration across the provinces in the Delta. Extensive cross border interactions,

[6] See https://www.brabant.nl/actueel/nieuws/provincie-presenteert-plannen/.
[7] See https://www.zeeland.nl/digitaal-archief/ZLD2024-6563.
[8] See https://www.zeeland.nl/actueel/ambitie-3-een-duurzame-en-innovatieve-economie.
[9] See https://circulair.zuid-holland.nl/.
[10] Both projects, CHAPLIN (now called CIRCUROAD) and Biorizon, continue with their activities.

complementing value-chains, expanding models, and building on local-knowledge for achieving scale-up and increased European Funding are a strong conclusion drawn from the multiple conversations leading to this blueprint.

The blueprint has therefore focused on key regional common challenges, solutions, and lessons learned. Beyond identifying key common priorities and, when available, sharing on existing solutions to the development of the bio-based economy in the region, the blueprint brings attention to the collaboration opportunity brought by strengthening initiatives between the Netherlands and Belgium. Ultimately, it aims to serve as guidance for creating a bio-based economy for the Delta Region by translating the current needs and hopes from its stakeholders into a clear common vision, strategic objectives, and activities to serve as relevant and practical next steps for the bio-based economy across the provinces in this geography.

2 BASELINE AND ANALYSIS OF LOCAL CONTEXT

2.1 LOCAL POLICY CONTEXT

The Netherlands has been at the forefront of circular economy efforts including the bio-based economy since the launch of its government-wide programme, 'A Circular Economy in the Netherlands by 2050', in 2016, setting the 2050 ambition for a fully circular economy. This foundational plan evolving from the Memorandum on Bio-based Economy[11] published in 2012 was supported by the National Raw Materials Agreement in 2017, followed by another relevant document, the 'Report on Sustainable biomass and bioenergy in the Netherlands for 2030' (2016)[12]. In 2018, the first Circular Economy Implementation Programme (2020-2023) originated five 'Transition Agendas' bringing specific actions for the sectors of Consumer Goods, Plastics, Construction, Manufacturing, and Biomass & Food.[13] The second phase, the National Circular Economy Programme (2023-2030), builds on these efforts by incorporating more compulsory measures to drive sustainable practices, including targeted actions in sectors such as bio-based construction and green chemicals. The bio-based economy is featured within the Transition Agendas and is prominent in the Agendas for Biomass and Food, Construction, and Plastics. It is worth mentioning that a key objective in the National Programme for Circular Economy (NPCE) is sustainable biomass valorisation ('value pyramid') or production of bio-based materials and use of residues for biofuels and heat ('co-production').

In the Netherlands, there is not yet a law specifically dedicated to the Circular Economy. Nevertheless, for years these strong strategies for the Circular (and Bio-based) Economy transition have led to strong advancements within the country and the targets for specific industries brought by such strategies have played a key role. When observing beyond policies and into the legal field, currently, the approach to CE takes place in a perspective of handling waste within the Environmental Act. For example, it is possible to request waste prevention

[11] See https://open.overheid.nl/repository/ronl-archief-8a090fbf-b1f6-4f71-8c9a-fe680d19c08f/1/pdf/hoofdlijnennotitie-bio-based-economy.pdf.
[12] See https://platformduurzamebiobrandstoffen.nl/wp-content/uploads/2020/04/2016_Min-EZ_Biomassa-2030_strategische-visie-op-inzet-biomassa.pdf.
[13] See www.government.nl/topics/circular-economy/accelerating-the-transition-to-a-circular-economy.

plans in Environmental Permits and regulations can also be included regarding the use of (secondary) raw materials. However, this is not yet mandatory and obligated for companies.

The guideline for waste or raw materials is also an important piece. When a company uses waste from another company as raw material, they are considered a waste treatment plant, which means more technical requirements to prevent environmental and public health risks. It is possible to get a declaration that a specific waste stream is not anymore to be qualified as waste, but as raw material. This 'end-of-waste' status given by the public authority (province or municipality) that has issued the environmental permit is, however, a judgement of the material used. It does not have a legal status that provides legal certainty for the company that processes the end-of-waste material into a product. To improve this process, a national platform is being set up by the Interprovincial Consultation and its Environmental Services for permitting surveillance and maintenance of companies to provide validated and uniform 'Waste or raw material declarations'.

Looking at provincial level, in Zeeland, the bio-based economy is seen as integral to the circular economy. This means that policies and regulation include both topics. When it comes to agricultural policies, the region supports the development of the bio-based economy by stimulating knowledge and research on bio-based cultivations. Additionally, there is the support to the establishment of new value chains for agricultural development (to provide farmers with new opportunities). This is stated in the agriculture policy, chapter 3.1.4. With subsidy programmes (European and provincial) where the development of a bio-based economy and cultivation, through innovation projects and investments in machinery is stimulated (GLB - NSP)[14]. Further, the municipalities in the province of Zeeland are currently developing a joint CE policy, which should include the bio-based economy. In the concept policy plan, goals are SMART formulated regarding circular house construction, infrastructure, public space, area development, purchase, consumption, waste, and raw materials. The administrative determination is expected for the beginning of 2025.

North Brabant has since its 2021-2023 Implementation agenda for Circular Economy taken a strong role of responsibility in the raw material transition, including a strategy for biomass and food (under 'bio raw materials'). The most recent policy framework, Implementation Agenda Economy, Knowledge & Talent Development[15] brings next steps in the strategy for the bio-based economy between 2024 and 2030. This aims to lead to CO2 reduction, increasing security of supply and strategic autonomy, combating biodiversity loss and pollution of water, air and soil through less waste and emissions, and water and soil quality.

2.2 BASELINING GOVERNANCE MODEL AND IMPLEMENTATION ECOSYSTEM FOR THE BIO-BASED ECONOMY

National governmental bodies of relevance in the governance structure of the bio-based economy in the Netherlands are the Ministry of Infrastructure and Water Management, the Ministry of Economic Affairs and the Ministry of Climate Policy and Green Growth, the Ministry of Agriculture, Fisheries, Food Security and Nature, and the Netherlands Enterprise Agency. In addition, created in 2011 by the Ministry of Economic Affairs in response to economic

[14] See www.zeeland.nl/subsidie-aanvragen/nationaal-strategisch-plan-gemeenschappelijk-landbouwbeleid-2023-2027.
[15] See www.brabant.nl/onderwerpen/omgevingsbeleid/beleidskaders.

challenges and the need to boost innovation across industries are the Top Sectors[16]. These promote innovation, collaboration, and international competitiveness in key economic areas through public-private partnerships. To arrive at the best solutions, businesses, universities, research centres and government work together on knowledge and innovation. Each top sector defines its Knowledge and Innovation Agenda (KIA)[17] which outlines the strategic research and innovation priorities for the sector based on societal challenges, missions, and opportunities for growth. Within each top sector, the parties are united in the Top Consortium for Knowledge and Innovation (TKI). The TKIs implement the KIAs by drawing up research agendas and objectives and managing specific projects and public-private partnerships for the coming years.[18] Also relevant to the bio-based economy is the cluster organisation Green Chemistry, New Economy (GCNE),[19] which was implemented in 2022 through a collaboration of multiple stakeholders. GCNE acts as a coordinator and enabler in the ecosystem of green chemistry in the Netherlands. It facilitates public-private collaborations and connects various projects and initiatives under the shared goal of advancing sustainable chemical practices. Another initiative, Green Chemistry Accelerator, supports start-ups by removing barriers, 'massaging' the market, and attracting the right investors and already bears fruits, such as the Paques Biomaterials' new demonstration plant.[20]

Briefly mentioned above, in support of Research, Development, and Innovation, the Netherlands has the National Growth Fund[21] which invests in projects that contribute to the sustainable earning capacity of the Netherlands. One of the themes defined is Key Technologies and Valorisation, to which the 'Biobased Circular' project, an initiative of among others, led by Green Chemistry, New Economy, paves the way for the Netherlands to switch to the use of climate-neutral materials and is being implemented in 2024. Invest NL is another funding source, providing financing as participation or as (subordinated) loan. One of their focuses is the bio-based and circular economy solutions. There are also PPPs in R&D programmes across borders (Netherlands and Belgium), such as between TNO and VITO, located at the Green Chemistry Campus, the Biorizon Project.[22] Subsidies and fiscal instruments are used as well (MIA/Vamil for market introduction (subsidy) and WBSO (fiscal), although not specific for bioeconomy). An additional national financing instrument is the Just Transition Fund (JTF)[23], designed to aid in economic diversification and the creation of sustainable jobs is especially relevant for sectors like green chemistry and bio-based industries, where there is potential to transform traditional industries into low-carbon, sustainable operations. Given their industrial heritage and the need to transition away from fossil-fuel-based industries, Zeeland and West-Brabant in the Netherlands are key beneficiaries of this fund.

Looking specifically at the Delta region within the Dutch border, which includes the provinces of Zeeland, North Brabant, and South Holland, their provincial governments work in synergy with multiple organisations to develop and implement their strategies. The Regional

[16] For instance, ChemistryNL is the name of the Top Sector Chemistry. It executes the mission-driven top sector innovation policy (*MTIB*) of the Ministry of Economic Affairs.
[17] *Kennis en Innovatieagenda's.* https://www.topsectoren.nl/missiesvoordetoekomst.
[18] TKI-BBE (Bio-based Economy): The Top Sectors Chemistry, Energy and Agri & Food provide direction to the research agenda through TKI-BBE and offer companies financial support for research projects. More details can be found at www.biobasedeconomy.nl/tki-bbe/.
[19] *Groen Chemie, Nieuwe Economie*. https://groenechemie.nl/over.
[20] https://www.paquesbiomaterials.nl/.
[21] *Nationaal Groeifond*. https://nationaalgroeifonds.nl/hoe-werkt-het-nationaal-groeifonds.
[22] https://www.biorizon.eu/biorizon/initiators/.
[23] See https://www.uitvoeringvanbeleidszw.nl/subsidies-en-regelingen/just-transition-fund-jtf.

Development Agencies (ROMs) are an important part of this ecosystem. ROMs invest mainly in innovative and fast-growing, regional companies and help restructure business parks. These provide venture capital to entrepreneurs and may even become shareholders in these companies. They also guide entrepreneurs in their business operations and encourage them to establish themselves in the region. In the province of North Brabant, there are two development agencies, BOM[24] (Brabant) and REWIN[25] (West Brabant), in Zeeland, there is Impuls Zeeland[26] and in South Holland, Innovation Quarter[27] is the ROM. All ROMs have the bio-based economy represented in their themes and activities.

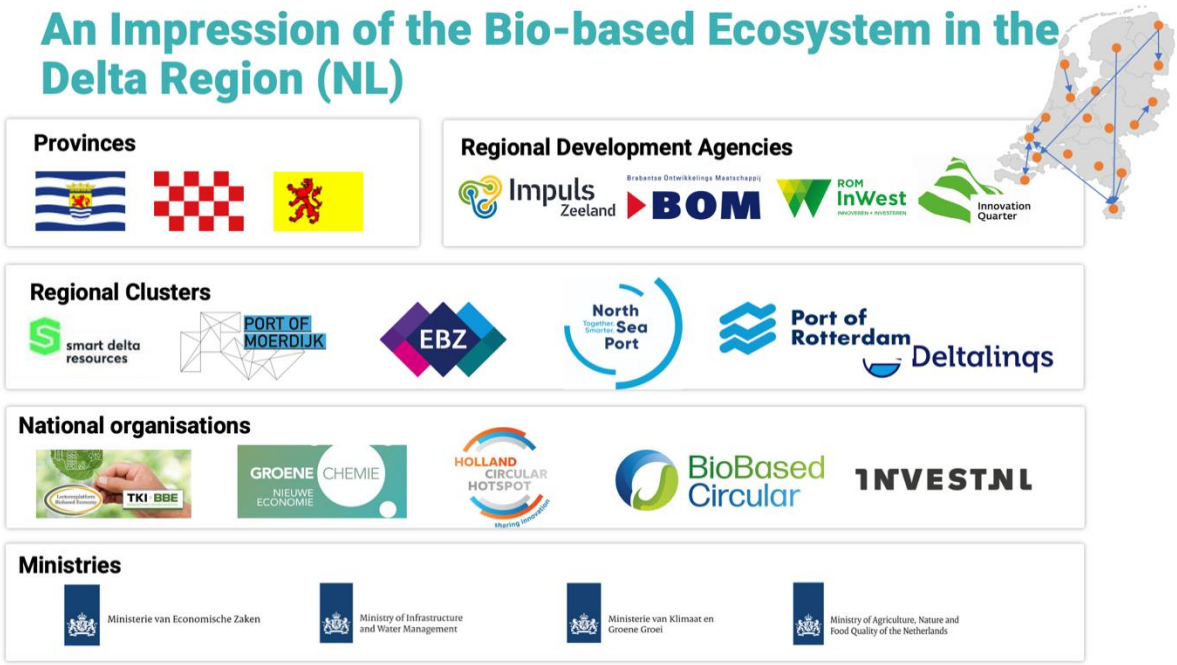

Figure 1: Bio-based Ecosystem in the Delta Region (The Netherlands), adapted from GCNE 2024

It is worth mentioning that the spatial distance between provinces brings substantial challenges in terms of coordination and collaboration. Collaboration often occurs between the regional clusters and development agencies but not as much between municipalities. An organic solution for strategic decision-making that emerged between the provinces and private sector regionally was to set up the cluster Circular Biobased Delta. It was first established as an informal collaboration of the provinces of Zeeland and North Brabant in 2010 and became a foundation in 2013 (the province of South Holland joined in 2014). Its Supervisory Board included representation of the multiple entities working at the bio-based space at the provinces in the region, industry, research, and public stakeholders. A 10-year plan was formulated and discussed at the supervisory board – again consisting of industry, research institutions, and government (triple helix). Biobased Delta's vision was set to drive the transition towards a net-zero and circularity in the Delta region, more specifically, in CBBD's vision and ambition plan the target was set to achieve a 10 megaton CO2 reduction and 50% circularity in the Delta Region by 2030. These targets were inspired by the National Plan but were adjusted to reflect the regional needs and possibilities. The targets were decided and approved by the triple helix in the region, represented in the Board of the CBBD. The cluster used different national

[24] See www.bom.nl/.
[25] See www.rewin.nl/en/.
[26] See www.impulszeeland.nl/.
[27] See www.innovationquarter.nl/en/.

formats and events for networking and communication (e.g. the Dutch Design Week) and it worked closely with European countries and collaborated for instance, with Circular Biobased Europe (via its membership of BIC) and other European cluster organisations (e.g. SPRING and Bioeconomy4Change).

When looking at financial investments for the development of the bio-based economy in the Netherlands, as can be inferred from the paragraphs above on national organisations promoting innovation and green growth, those are available mainly through public channels or R&D investments of companies and a few blended funding options. There are a few additional options besides European programmes (e.g. CBE, EFRO) and national programmes (Dutch National Growth Fund). Some municipalities, e.g. Bergen op Zoom in the region of Brabant, issues vouchers to stimulate the bio-based economy. The 19.000 EUR vouchers are available to small bio-based economy businesses. The fund is made available through the provincial government, focusing on green chemistry. Other regions have similar voucher systems.

In the Netherlands, education programmes on the bio-based economy largely focus on tertiary education (university programs). Universities, schools, and research institutes are the primary source for bio-based innovations in the Delta Region. Spin-offs from universities, when successful and attractive, are usually embraced and widely supported by industry. Regionally, there are cooperations such Avans University of Applied Sciences and HZ University of Applied Sciences creating MNEXT[28], a centre of expertise. Centres of Expertise have been appointed by the Ministry of Education, Culture and Science to strengthen the connection between higher education and regional economic cooperation in the Netherlands. Those are action-orientated partnerships between companies, higher education, government and other public organisations to foster innovation, experimentation and investment that is focused on future-directed vocational education and professional practice. They form highly trained professionals who can implement and transform the transition towards a bio-based society. Another example connecting education and practice can be found at Curio, in Western Brabant, with the 'Teacher-team (*practoraat*) Agrofood & Bio-based'[29]. These are specialized applied research groups embedded within Dutch vocational education (MBO) with focus on practical, hands-on research topics seek to solve challenges faced by industries and society. The methods of practice-based professional learning both support entrepreneurs with new knowledge and introduce students to current practical issues.

In summary, the governance structure for the bio-based economy in the Delta Region is characterised by triple-helix participation (public, private, and knowledge institutions), and a predominant top-down, centralist approach with a strong regional identity. This reflects the existing public financing and regulation as the provinces implement in regional accents and in developing triple helix ecosystems. The national and regional bioeconomy strategies respectively link strongly with the focus areas of the EU Bioeconomy Strategy. There is a strong horizontal governance scheme both at national and regional level, involving numerous ministries and cross-ministerial steering boards and committees fostering exchange on the topic and enabling trans-regional and national partnerships. The presence of regional organisations, such as CBBD, with focus on a particular sector (the bio-based industry) and coordinating local stakeholders' interests and needs with national and European agendas and funding strongly contributes to this ecosystem.

[28] See www.mnext.nl/.
[29] See www.curio.nl/over-ons/onderwijsinnovatie/practoraten/agrofood-en-biobased.

Governance Framework Analysis for the Delta Region

An analysis of the Delta Region Governance framework was performed by Wageningen University and Research. In this section are results of the analysis according to the governance framework developed by Jacobi, Hayder and Connolly (2023), outlining a three-tiered framework consisting of basic governance functions (1st tier), specific bio-based governance functions (2nd tier) and assessment criteria (3rd tier). A set of around 50 indicators was evaluated and benchmarked, following an intensive data collection process by the six Biomodel4Regions pilot regions and their cluster organisations. The data was then processed, cleaning-up errors and filling gaps with reasonable assumptions, to visualise results in the BERST Dashboard.[30]

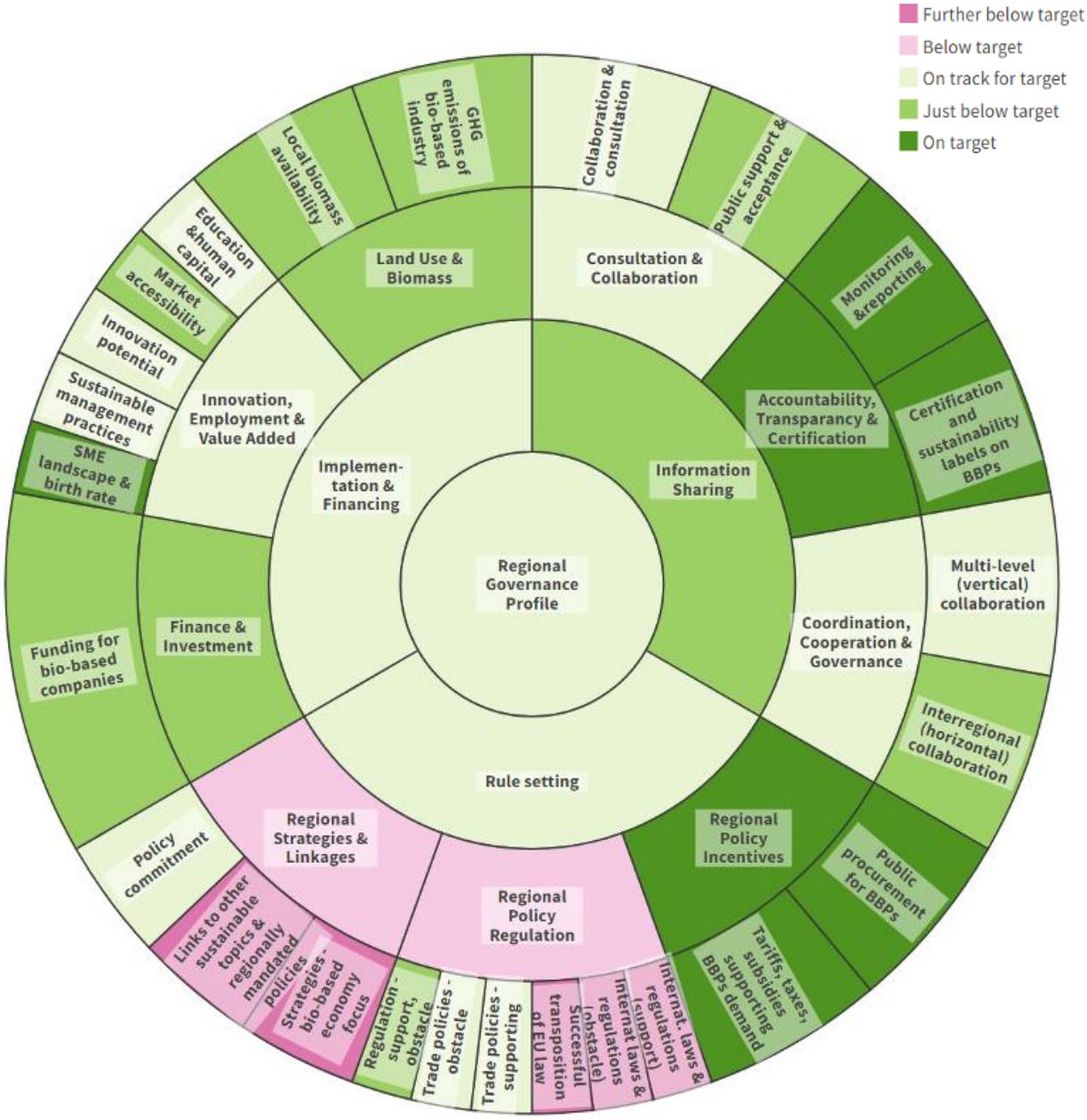

Figure 2: Regional Governance Profile 'the Delta Region', The Netherlands, BERST Dashboard 2023

[30] https://beta-berst.databank.nl/jive

Figure 3: Overview of the assessment criteria (tier 3) including scores, BERST Dashboard 2023

A summary, according to the figure above, the highest scoring criteria include:

- Monitoring & reporting (information-sharing)
- Certification and sustainability labels on BBPs (information-sharing)
- SME landscape & birthrate (implementation & finance)
- Tariffs, taxes, and subsidies (rule-setting)
- Public procurement for BBPs (rule-setting)

Assessment criteria, scored just below benchmark include:

- Local biomass availability (implementation & finance)
- Regulation for the bb economy (rule-setting)
- Public support & acceptance (information-sharing)
- Interregional (horizontal) collaboration (information-sharing)
- Funding for bio-based companies (implementation & finance)
- Market accessibility (implementation & finance)

Criteria scoring low, but with view ('on-track') towards benchmark include:

- Education & human capital (implementation & finance)
- Policy commitment (rule-setting)
- Innovation potential (implementation & finance)
- Coping with trade policies as obstacle (rule-setting)
- Using trade policies for the bb economy (rule-setting)
- Multi-level (vertical) collaboration (information-sharing)
- Collaboration & consultation (information-sharing)
- Sustainable management practices (implementation & finance)

Least scoring areas and therefore biggest challenges according to the evaluation done, include:

- Links to other regional (sustainability strategies) (rule-setting)
- Strategies/policies with bioeconomy focus (rule-setting)
- Successful transposition of EU law (rule-setting)
- Dealing with international/EU laws – in support and as obstacle/challenge (rule-setting)

The regional bio-based economy in the Delta Region has been found to have well established structures for information sharing both vertically (between governance fields/government levels) and horizontally (between actor groups at regional level), including with the public. See in image above, on the 1st tier "basic governance structure", how the Delta Region scores highest on information-sharing. There is a high degree of bio-based industry collaboration. Furthermore, labels for bio-based products (BBPs) are effectively used and applied and certification mechanisms are in place to stimulate and regulate bio-based markets. Additionally, the regional government and its institutions and agencies have been reporting schemes in place to verify progress along a circular bio-based economy transition as for examples to the national monitoring of the Bio-based Economy by the Netherlands Enterprise Agency (RVO) since 2015[31] making *accountability, transparency & certification* the strongest evaluation criteria within this 1st tier governance function (see figure above). From 2020, RVO broadened the earlier focus on the Bio-based Economy to the circular economy.

In terms of *implementation & finance*, the results suggest that the regional bio-based economy is characterised by very robust value chains, strongly developed and partly diversified bio-based market structures. It has high value added, and a workforce employed in well-paid jobs. Although innovation potential and sustainability practices (i.e. share of companies with sustainability credentials) have been evaluated as the lowest KPI in this 1st tier function, the small and medium-sized enterprise (SME) landscape and birth rate appears to be very promising compared to the threshold. Factors that lead to this interpretation are the prospective land and water ecosystems in place to derive feedstock for the bio-based economy and land-use and sector conflicts are minimised; the fact that emissions from bio-based industries are low, only slightly lower than the benchmark; the dedicated public funding available for strategic bio-based economy development; and the framework conditions and

[31] https://www.rvo.nl/onderwerpen/bio-based-economy/feiten-cijfers-circulaire-economie accessed on 21 October 2024.

bio-based technology readiness levels are favourable for private investments. In relative terms, the biggest challenges within the area of implementation & finance appears to be the sustainable management practices of companies involved in the bio-based economy, the innovation potential, and the education and build-up of human capital (see figure above).

In the *rule-setting* space, results based on its dedicated and fairly integrated bio-based economy policy framework suggest that the bio-based economy in the region uses and advocates for using a large variety of incentivising mechanisms available to stimulate production and consumption of BBPs, especially in the area of procurement for BBPs and in terms of taxes and subsidies supporting BBP demand, making *regional policy incentives* the by far the most promising criteria within the 1st tier function of *rule-setting*. Much less pronounced appears to be the area of *regional policy regulation*, where results suggest that the region is hindered by EU and national law and regulation on the bio-based economy, e.g. on waste and its focus on environmental and public health risks which is one of the region's key focus areas in terms of valorisation. Overall, a favourable transposition of EU law in the bio-based economy context is lagging compared to the threshold. The most significant challenges in this governance area appear to be on the degree of integration of bio-based economy policies, regulations and strategies with other policy priorities, or regional mandates. Here, a missing systemic link and harmonisation of the regional bio-based strategic framework with other sustainability targets (e.g. climate resilience, sustainable development goals - SDGs, etc.) as well as the absence or too scarce bio-based content of related regional frameworks, are noteworthy

3 TOWARDS A VISION FOR THE BIO-BASED ECONOMY IN THE DELTA REGION

3.1 POLICY PRIORITIES

Climate change adds pressure on our fossil-based economy. The need to reduce greenhouse gas emissions, the finiteness of fossil resources and the high import dependency for raw materials make a change of course inevitable. To make our economy carbon neutral, the transition to alternative sources and renewable raw materials - such as biomass for materials and chemicals - is of priority importance.

The bio-based economy is one of the elements of the Dutch ambitions to realise CO2 emissions reduction and circularity.[32] Given its focus on agriculture, horticulture, chemical industry, ports, construction and innovation, the Delta region has great potential to play a strong role in the Netherlands regarding bio-based activities and in contributing to CO2 emissions reduction.

The current economic system in the region largely consists of linear chains. The linear economy produces a large part of global CO2 emissions and therefore contributes significantly to climate change. It also leads to loss of value of materials and depletion of finite raw materials. The provinces in the region want to contribute to the transition to a circular economy that increases broad prosperity in the area and enables higher-value products while using fewer raw materials. Additionally, circularity provides a strong positive economic effect for these provinces. It increases the strategic autonomy of the provinces by reducing dependence on raw materials from outside the province and or the region. It gives local companies a competitive advantage because the impending need for a future-proof economy pushes the global economy to transition into a circular economy in the coming decades.

South Holland's policy priorities are structured around eight foundational building blocks as part of its Circular South Holland 2024-2027 strategy[33], aiming to accelerate the transition towards a circular economy. Among these, key building blocks include Circular Innovation and Coalition and Networks, which focus on fostering collaborative efforts and innovative approaches. By 2030, the province envisions that half of the organisations with significant raw material flows will visibly progress towards circularity, collectively achieving a 50% reduction in the use of new metals, minerals, and fossil raw materials compared to 2015 levels. The province plays a facilitative role in supporting networks centred on bio-based construction, circular solar panels, reusable packaging, and the optimal valorisation of natural residual flows. South Holland actively engages in sectors like sustainable agriculture, green ports, smart industry, the port industrial complex, energy, and digitalization by providing subsidies and investments, exchanging knowledge, adapting regulations, and fostering further partnerships.

Moreover, South Holland is driving the transformation of four circular market chains within the sectors of port and industry, construction, agriculture, and maritime due to their significant potential for circular impact, new earning opportunities, and the existing enthusiasm among

[32] Nova institute (2021) indicates that the estimate is that 20% of embedded carbon demanded in 2050 will be supplied via the bio-based track www.renewable-carbon.eu/graphics
[33] See https://magazine.zuid-holland.nl/samen-bouwen-aan-een-circulair-zuid-holland/

stakeholders. This transformation involves creating shared visions with partners, knowledge institutions, and financiers, and developing joint agendas and EU-oriented propositions. The province aims to support at least 15 breakthrough projects that reshape these circular market chains, ranging from circular energy transitions to bio-based crops.

One of Zeeland's primary policy priorities is to maintain and strengthen its diverse economic structure to ensure a robust and sustainable regional economy. The province's economic foundation is built on strong ports, a versatile tourism and recreation sector, diverse retail trade, a traditionally innovative agricultural and fishing sector, and a solid industrial cluster. To address these priorities and overcome challenges, Zeeland's policy spearheads focus on enhancing the business climate and regional image, fostering innovation and development capacity through targeted SME support and funding, and transitioning to a sustainable and climate-neutral economy by embracing the circular economy, promoting sustainability, and integrating nuclear energy into the regional energy mix. Zeeland also aligns these priorities with national and European agendas to reinforce its regional efforts.

The Province of Zeeland supports the national and regional target of 50% reduction of use of primary abiotic raw materials in 2030 and towards 100% reduction in 2050 and has selected three priority sectors to direct their focus on implementing such targets: ports and (Chemical) Industry, construction, and SMEs. With additional priorities in types of raw materials to be set soon after the results from the monitoring report become available (expected for Q4, 2024).

The province of North Brabant promotes the use of green raw materials and the multiple value in using all parts of plant materials with as little energy or waste across as possible. For years the province has been developing chains for bio-based building materials and aims to have 4,000 hectares of fibre cultivation in the province by 2027. In combination with this strategy, North Brabant develops an innovation coalition for having fibres cultivated and to be processed and used in buildings construction, such as housing and factories. Together with partners, the innovation coalition is to promote supportive legislation, to stimulate public-private partnerships of market demand. This innovation coalition is aligned with Building Balance and the EN Zuid program that focuses on using as much as possible substances from plants. North Brabant continuously looks for financial support in European funds. The BioBuild project with partners from Finland, Poland, Greece, and Moldova has been submitted in Interreg Europe's third call.

Recently North Brabant joined forces to take a leading position in the transition into sustainable food systems. The focus is on scaling up ingredients that make plant-based food tasty, nutritious, and affordable. The ambition of the Province of North Brabant, the Brabant Development Company (BOM), and REWIN (West Brabant) is to make Brabant the scaling-up hotspot of Europe. North Brabant is ideally located between the food innovation hotspots Ghent, Delft and Wageningen and has almost the entire chain in-house to produce plant-based food innovations. It will facilitate a network of accessible pilot, demo and full-scale facilities. In addition, long-term sector-specific support is being set up for start-ups in the scale-up phase. Existing companies can also join the initiative and, for example, use part of their capacity to collaborate with start-ups. In addition, the collaborating partners will work on international positioning, acquisition, and entering collaborations with international start-ups. Where possible, the BOM will invest in participating food start-ups.

3.2 OUR VISION FOR A BIO-BASED ECONOMY IN THE DELTA REGION

The vision for a bio-based economy in the Delta Region defined here below is a result of a process of multiple engagement moments with over 50 stakeholders representing the triple helix on the Delta.[34] This effort was coordinated in the scope of the Biomodel4Regions Horizon Europe project, however it builds on ongoing work from the multiple stakeholders, and it seeks to align with recommendations from the knowledge sector as well as with provincial policies and strategies defined by the public sector and goals set by the bio-based industry in the region. It is the group's understanding that a vision statement describes the long-term goals, dreams, and aspirations for the region and its communities. The vision statement sets the bar high in terms of how the region wants to be perceived by the world in the future.

The vision for the bio-based economy in the Delta Region answers the following guiding questions:

- What should be the purpose of the region regarding the bioeconomy transformation by 2050?
- What are the social, environmental, and economic impacts that the region wants to achieve through this vision?
- How does the region want to position itself? and why?

The vision states, therefore, that:

By 2050, the economy in the Delta region will be sustainable and climate neutral. This means use of primary fossil resources and CO2 emissions approaching zero. The necessary knowledge is present in the area, being developed or accessed. This makes the Delta region a thriving and future-proof economy that operates within the carrying capacity of the area. This makes it an area attractive to live, work and learn. The transition to renewable bio-based raw materials is part of achieving this ambition for the region. In fact, the 1st step is the transition to circular which fits into existing process technology. The 2nd step is the transition to bio-based for which new bio-based process technology must be developed and should be started now. This document by B4R is particularly focused on elaborating the transition to renewable bio-based feedstocks and associated process technology.

[34] Central discussion on the vision initiated in June 2024 on the workshop day delivered in Middelburg with the presence of main stakeholders of the triple helix interested and affected by this vision. Continued by online workshops, interviews, and separate meetings for development, clarification, and common agreement to be achieved. Representation from the provinces of Zeeland, North Brabant and East Flanders, local development agencies, bio-based business and knowledge and research institutions. The full-day workshop focused on identifying the elements for a regional vision, discussion of common challenges and suggestions for collaboration for solutions that would benefit the goals beyond one same province. The workshop included a few presentations from ongoing work that is developing the bio-based economy in the different provinces and (Dutch) national and European targets and possibilities for funding. In combination with presentations, the workshop enabled several moments for group discussions, reconvening at the end of each session to share different perspectives and align those further. Key findings led to the initial drafting of this blueprint, which continued to be developed further in consultation and involvement of several of the attendees of this key workshop.

While the transition to renewable bio-based feedstocks is a critical step toward a sustainable Delta region, this vision for the region's future encompasses much more than only a bio-based approach. A truly sustainable and climate-neutral economy will require a comprehensive transformation across all industrial activities, ensuring they operate within the environmental carrying capacity of the area. This entails a robust shift not only toward bio-based raw materials but also toward circularity, efficient energy use, waste minimization, and responsible resource management. The goal here is to foster an overarching sustainable industry that incorporates bio-based principles as a key component, yet remains committed to an inclusive, adaptable framework that addresses broader economic, ecological, and social challenges. By establishing this inclusive vision, the stakeholders create a resilient and attractive region for current and future generations to live, work, and learn.

3.3 Strategic & operational objectives

The regional circular bio-based economy revolves on developing viable solutions - from technical, to economic, environmental, (socially)responsible, and transparent, learning how to work together (creating new value chains, involving new players and know-how) and then growing together (scale-up, multiplication, awareness).

Based on the learnings from existing efforts across the pilot region and their results achieved, the core elements to the vision for the Delta Region can be organised into the following three strategic objectives.

3.3.1 Develop Regional Collaboration

Guiding stakeholders' statements linked to the vision

"*…the Delta region a thriving and future-proof economy that operates within the carrying capacity of the area.*"

"*… ensuring strategic autonomy and resilience for the region and its communities.*"

The Delta is unique in the sense that it has so much in common and is interlinked beyond the borders of the Netherlands and Belgium. There is great potential and regional interest in looking into possibilities in the Delta Region that are not solely for Belgian or Dutch stakeholders. A cross-border collaboration brings extra potential if it builds onto the several common aspects. It would build on on-going activities, knowledge, and goals shared and channel resources and efforts into building faster and better technologies and models.

However, it is still the perception of several stakeholders in the region that currently there is not a structure or clear overview of all active parts in the space for the Delta region. The conclusion of the quadruple helix organization Circular Biobased Delta has left a gap that remains only partially addressed. Several initiatives exist within each of the provinces in the region, however, there is difficulty in keeping an oversight of latest developments, hindering optimization of efforts, plans, and investments. This collaboration strategy can solve this

challenge. All the different parts (the triple helix) are necessary to be included and actively involved/ in collaboration to move the vision into strategies, targets, and activities to results. It is a similar situation to leaping frogs, reaching multiple directions. It is necessary to get them to choose the same direction. For this, it is needed to know who they are, get them involved and in agreement to collaborate and act.

To translate this in practical terms, it would be necessary, as a next step, to identify among existing institutions (or a network of institutions) a coordinator(s) which would lead the support to industries and academia in sharing non-competitive knowledge, assist with identification of missing actors in the value chain for new opportunities, and therefore enable consortia to be formed and can apply and obtain investment to reach much needed advancements. Such a leadership to keep focus and ensure involvement of the multiple actors necessary to achieve systemic change has been agreed to pose as a key element to achieve the vision for the region. This could be per sector and on demand from companies. There, knowledge and experience would be exchanged, per sector, and from which consortia could emerge that formulate project applications for innovations that contribute to accelerating the transition.

The coordinating institution could serve as a platform to showcase bio-based projects from various stakeholders leading to potential 'strategic autonomy' or 'regional hub'. Quarterly/bi-annual meetings would help identify common barriers and solutions by ensuring the triple helix stakeholders continuously engage and learn from each other.

It is important to mention that such a coordinating institution would ideally be made financially viable by financing obtained from joint projects developed by the stakeholders in the region and overseen by the coordinating institution. This would ensure a clear framework, and development of topics and activities according to shared regional interests agreed for the projects. An example would be European funding via e.g., Regional Innovation Valleys to finance these coordination activities in (potential) collaboration with the public and private sector.

Proposed operational objectives for the region:

1- Establish a model for a regional coordinating organisation to oversee regional efforts and goals into creating joint opportunities of financing and development of technology and business models in the bio-based economy space. This coordinating organisation model could potentially translate into improving already existing structures, such as the regional Knowledge and Innovation Chain Networks by ensuring cooperation and exchange with stakeholders of the triple helix.

2- Increase the growth of the network alignment via strategic meetings focused on companies, facilitated by public sector and academia, to inform topics and partners of common interest for cross-border and/or cross-province collaboration. Ensure that the data being produced by national agencies is flowing/informing (e.g. via Bio-based accelerating days) the Knowledge & Innovation Networks existing for the different sectors (it is key that specific information reaches the right companies and businesses)

3- Aim for a growth in the number of joint-proposal submissions for EU opportunities (Regional Innovation Valleys for Bioeconomy and Food, Horizon Europe, Interreg, IPCEI). Jointly set an objective to facilitate an increase in collaborative proposal development for EU opportunities, aiming for new cross-border and multi-province submissions annually.

Examples of initiatives contributing to regional collaboration:

Regional Innovation Valleys (RIVs)

One of the 25 actions of the New European Innovation Agenda (NEIA). It aims to harness the full innovation potential across Europe, connecting less and more innovative regions and addressing social challenges through cutting edge technology. Involved regions identify their competitive advantages to bridge innovation divide, using their complementary strengths for an improved Research & Innovation (R&I) ecosystem. The R&I ecosystem can be a regional cross-border instrument to find opportunities of innovation at different levels: between regions, in the use of technologies, on investments, through skills development. Bioeconomy-related Regional Innovation Valley ecosystems can strengthen place-based strategic policymaking and exploit funding synergies. A key step in this topic is aligning the region and identifying common topics of interest.

Stakeholders in this project, representative of the triple helix, identify competitive advantages to bridge innovation divides, using their complementary strengths for an improved R&I ecosystem and are interested in applying for receiving a RIV label in future calls. Using as guidance topics the CBE-JU calls for 2024, preliminary conversations during our workshops already indicated clear common interests. The Delta region could propose a route and steps to establish a regional coordination mechanism to create an innovation and upscaling valley for replacing fossil with green raw materials. This could cover all applications of green raw material replacements in products. The target set should be to reduce fossil in the life cycle of specific products, for instance, having 50% replacement with green raw materials by 2030.

Circular Biobased Delta (CBBD)

The Circular Biobased Delta was for 10 years active in the Delta region. Its focus was to bring together organisations that could take steps to deal with raw materials and emissions more intelligently. Financed by some of the provinces and larger companies in the Delta, the CBBD created a regional ecosystem for the bio-based economy and developed a portfolio of projects, ranging from production of new biomass-based chemicals to plastics recycling routes aimed at CO2 emissions reduction. Funding for the CBBD was concluded in December 2023 and from conversations with regional stakeholders during workshops and interviews CBBD contributed to advancing and accelerating the bio-based industries. The stakeholders see the value and importance in identifying the next possible coordination organism to be taking over and expanding the role of CBBD to fulfil the need for a regional collaboration effort, learning from its lessons. *A coordination* mechanism that can promote supportive legislation, stimulate public-private partnerships of market demand, and attract European funding is an effective way of establishing regional collaboration. It would ensure the network is known, visible, and connected. Equally important, it would bring coordination of investment, a key element of the innovation system. For example, the Regional Innovation Valleys initiative.

However, there are a few main lessons learned from CBBD which bring rich insights for future developments in collaboration and information-sharing in the region. Lesson 1: a coordinating organisation needs to ensure to be closely interwoven with existing relevant regional organisations. It was difficult for CBBD to interweave with larger stakeholders in the space of the regional bio-based economy (e.g. Smart Delta Resources). Potentially another route could be via organisations such as Vitaal Sloegebied Kanaalzone (VSK) and BioPark Terneuzen

(BPT), which represent multiple entities interested in developing bio-based solutions in the area. A coalition of the willing. Lesson 2: the focus on higher technology readiness levels (TRLs) projects help prove the case of successful bio-based business models by showing concrete results. Lesson 3: calculate the potential reduction in CO2 emissions and use of raw materials. This provides crucial information for decision-makers to identify where to prioritise to achieve transition to a circular bio-based economy.

3.3.2 Facilitate Innovation and Scale-Up

Guiding stakeholders' statements linked to the vision

"We will encourage that the necessary feedstock for the bio-based raw materials is available to enable the reduction of virgin fossil extraction by providing a more sustainable replacement."[35]

"We will promote a high-quality knowledge cluster" with the objective of innovation to grow regionally, among others.

There are considerable challenges in ensuring feedstock for bio-based products, quantities produced, and optimizations. When looking at solutions to these issues, knowledge exchange, data collection, and testing of new technologies are clear priorities. There is an urgent need for further investigation on crucial data and understanding regarding the regional figures pertinent to the bio-based economy. How much land in the provinces and the flows originating from biomass? How much materials need to replace fossil ones? Estimations of how much to produce, harvest and convert to be replaced. Should the province import the biomass to have enough feedstock for bio-based, would cooperating with (specific) parts of Europe for import be better or worse than increasing local production and therefore consider where new crops would fit, and best be placed? near industry or elsewhere? Should low value high volume biomass be produced near where feedstock is grown?

A lesson learned from CBBD in the Delta region is the need to make an inventory of the potential existing in the region. At an early stage, have an independent engineering firm to globally calculate the potential reduction in CO2 emissions and use of raw materials. This calculation is important for the knowledge & Innovation networks, policy makers and other organisations. This provides insight into which projects/activities should be prioritised (for investments, for adjustments of industrial processes, among other key decisions with long-term impact) to accelerate the transition and increase the impact in terms of reduction.[36]

In addition, it is essential to test new technologies and solutions to determine their viability for large-scale application. While there are already well-known bio-based materials, many other

[35] The publication "Brightsite Transition Outlook 2023" indicates that an entire transition to bio-based ethylene and bio-based ammonia requires 25,000 km2 of cropland (or 90,000 km2 of forest accretion). 1 km2 = 100 hectares. 25,000 km2 = 2.5 million hectares. Assuming the Nova Institute that by 2050 20% of raw materials will be bio-based, then 20% of 2.5 million hectares is 500,000 hectares. The Netherlands had a total of 535,000 hectares of cropland used for food and feed production in 2022. Available at https://brightsitecenter.com/bto-download/.
[36] https://cedelft.eu/publications/co2-reduction-with-the-circular-bio-based-delta/

natural materials may also be suitable but require thorough investigation to confirm their suitability and reliability.[37] This should be complemented and enhanced through the educational system. Facilitating innovative solutions and ability for skilful assessments would benefit from better-trained working population able to adapt quickly to technological developments and new forms of work organisation. Educational institutions play a crucial role in this context by equipping the workforce with the adaptability to keep pace with technological advancements and new organizational methods.[38] This shift requires that current skills be updated and refined, rather than entirely new training standards being created. Increasing the emphasis on green economy training programs is a powerful lever to enhance employee capabilities, ensuring a workforce that is prepared to step into the sustainable jobs of the future.

Provinces in the region have and continue to play a key role in this strategic objective of facilitating innovation and scale up. They are in a strategic position to consolidate and further develop the ecosystem by understanding how to support the coordinating organisations, as it was the case with the Circular Bio-based Delta, and the Green Chemistry Campus, and networks for the different value chains (Knowledge & Innovation Networks) [39]. Additionally, they can support in creating market impulse for bio-based products, as the local examples of BioVoice (SMEs are challenged by large company to come up with innovative solutions) and Symbioses for growth program (residue streams are identified and neglected chains are formed), as well as seek exploration of opportunities for EU funding/investments and instruments and, supporting feasibility studies and realisation of scaling up production facilities (e.g. Biogate Europe feasibility study biorefinery plant).

Proposed operational objectives for the region:

1- Triple helix regional organisations to increase efforts in identifying common technical barriers and play a role in facilitating interactions of the network (industry-academia dialogues) to find solutions to overcome these.

2- Triple helix regional organisations to grow the use rate of Application Centres where entrepreneurs can test their innovative ideas in an accessible way are other much needed actions.

3- Knowledge and Innovation Networks and Knowledge Institutions (supported by the public and private sectors) identify (and collect) relevant data to inform key decision-making such as for the process of selecting areas for industrial settlement.

4- Expand educational and vocational training programs within regional educational institutions to adapt and update skills for emerging bio-based sectors. Target relevant technical and vocational programs in the region to incorporate specialized modules on bio-based innovation, sustainable materials testing, and circular production processes contributing to workforce readiness for the bio-based economy.

[37] See for example TNO *Bouwinnovatie* Lab https://www.tno.nl/nl/technologie-wetenschap/laboratoria/bouwinnovatie-lab/.
[38] For more details see Skills in Transition – The way to 2035, CEDEFOP, 2023 available at https://www.cedefop.europa.eu/files/4213_en.pdf
[39] https://campuszeeland.nl/kennis-en-innovatienetwerken/

Examples of initiatives contributing to innovation and scale-up:

Bio Base Europe Pilot Plant

The Bio Base Europe Pilot Plant is a flexible and diversified pilot plant for the development, scale-up and custom manufacturing of bio-based processes and products and aims at closing the critical gap between scientific feasibility and industrial application of new biotechnological processes. Infrastructure that enables new products and processes to be tested at the right scale and within reasonable costs is key. The INTERREG Flanders-Netherlands project kicked-off in 2008, on the Flemish side, the project was co-financed by Flanders, the Province of East-Flanders and the City of Ghent. On the Dutch side, the project was co-financed by the Dutch Ministry of Economic Affairs, the Province of Zeeland, Zeeland Seaports, ROC Westerschelde and Delta NV. The Pilot Plant is situated in the Port of Ghent in Belgium and is equipped with state-of-the-art equipment to perform biomass pretreatment, biocatalysis, fermentation, up- and downstream purification and green chemistry. It focuses on conversion of biomass (a.o. agricultural crops and by-products, industrial side streams) into biochemicals, biomaterials, biofuels and other bioproducts.

Application Centres and Knowledge and Innovation Networks

It is important for companies to be able to participate in innovation projects and to learn from other companies and knowledge institutions. It is important for knowledge institutions and governments to be well informed about the questions that exist within companies. This comes together in a K&I network. The provinces in the region have facilitated several Knowledge and Innovation Networks as this allows them to award grants to organisations involved. An example is the Knowledge & Innovation Network Circular Building. This is a public-private initiative that stimulates and organises knowledge exchange and development by bringing together supply and demand in the field of circular construction in Zeeland. The work is based on three pillars: (1) knowledge sharing, (2) networking and (3) initiating. (1) In order to share extensive knowledge and experience, the network regularly organises (theme) meetings on circular topics with excursions to circular construction projects and/or companies. (2) The goal of networking is to strengthen each other, learn together and collaborate in reducing CO2 emissions. (3) The parties involved determine together which themes are addressed. The network guides the development into projects and connects the right participants to ensure that everyone can get started quickly.

Application Centres are part of the R&I ecosystem by providing a space for entrepreneurs to test their innovations at a low cost, facilitating the transition from concept to marketable product. In Zeeland[40], an example is the Bio-based Innovation Garden Rusthoeve[41] which specialises in growing various potential bio-based crops, and supports the testing of small-scale biorefining technologies, helping to bridge the gap between lab research and practical agricultural applications. It serves as a collaborative hub where farmers, researchers, and businesses from sectors like agriculture, construction, and chemistry come together to explore

[40] Also in Zeeland is the Natural Fiber Application Center (NAC), Raamsdonksveer, which for over 10 years fills in the gap between laboratory and pilot, working towards industrial production within the scope of lignocellulosic fibres.
[41] www.impulszeeland.nl/projecten/biobased-innovation-garden-rusthoeve

and develop new applications for green raw materials. In North Brabant[42], an example is the Green Chemistry, an incubator focused on technologies, chemical building blocks and products that enable significant impact: pyrolysis, bio-aromatics, and applications with superior characteristics. At Green Chemistry Campus businesses, governments and knowledge and educational institutions join forces to lead intermediate circular biobased organization in West Brabant that have an economic impact to strengthen the regional circular bio-based ecosystem.

3.3.3. Enhance Market Demand

Guiding stakeholders' statements linked to the vision

"Improved understanding of bio-based economy's key relevance and urgency to increase societal understanding, institutional support, and market demand."

Despite efforts from multiple stakeholders, the positive economic impacts that the bio-based economy can bring are not clear to the market. Purchasers from companies and governmental institutions especially have the power to choose to use bio-based molecules, materials, or products as input for their products, processes, and operations.

Procurement by governmental institutions and companies acts as a powerful lever to drive innovation by creating immediate demand for bio-based solutions, products, and materials, which in turn signals strong market potential. This demand gives innovators a clear incentive to develop competitive, sustainable alternatives to conventional products, knowing there is a committed buyer base. For bio-based industries, this market pull is essential not only to stimulate production at scale but also to justify continued R&D investment. Strong procurement practices also help establish supply chain stability, encourage economies of scale, and build buyer-supplier networks' key factors that reduce costs and promote broader adoption of bio-based innovations. Additionally, when public and corporate buyers commit to sustainable procurement policies, they foster long-term market confidence, helping bio-based sectors attract further private and public funding needed to scale up and compete with established fossil-based solutions.

However, to drive bio-based economy solutions forward, procurement finds it difficult to assess viable options for their needs when it comes to choosing bio-based instead of fossil-based. It is necessary, therefore, to create more opportunities to showcase bio-based solutions using new technologies that are both already available and in the making. Initiatives that create the space for both offer and demand to meet, be informed, ask questions, understand options available for them, agree on needs and possibilities are vital.

The increase of the bio-based economy can allow for new jobs to be created, the development of new technologies, and other potential benefits in addition to environmental ones need to be specifically addressed with different potential targets. From engaging primary producers to understand how to valorise unexploited resources that could enable them to increase their incomes to explaining to the young generations the potential that investing in educational and

[42] Also in North Brabant is KATC (Kunststoffen (Polymer) Application and Training Center), at the Curio (Bergen op Zoom).

career paths to develop their skills for future jobs in the sector represent. It is essential to engage with local communities, raise awareness about the benefits of a bio-based economy, and address potential concerns related to land use, food security, and environmental impacts.

Companies' philosophies also need to change. The bio-based story is a good one. People can understand it once it is presented. The reasoning behind why bio-based is viable, necessary, and how it can grow should be better explained to lead to increased understanding and, consequently, adoption.

Proposed operational objectives for the region:

1- Increase participation of small, middle, and large companies at bio-based events promoting existing businesses and solutions regionally to engage value chains and identify alternatives to fossil-based materials and molecules used in their products.

2- Strengthen focus of bio-based innovation projects communication and dissemination tasks to include more detailed exchanges with potential markets. This would contribute to early-stage identification of specific (technical or other) needs that at a later stage would prevent the adoption by a contracting company.

3- Create a comprehensive, easily accessible platform that connects procurement teams within companies and government bodies to verified suppliers and developers of bio-based solutions. This aims to facilitate targeted buyer-supplier engagement, streamline sourcing processes, and promote visibility of bio-based options aligned with business procurement needs.

Examples of initiatives contributing to the Enhancement of Market Demand:

Bio-based Circular (BBC)

This initiative aims to establish a new sector in the Netherlands focused on bio-based plastics and products. Among its strategies, the one highlighted in the context of enhancement of market demand is the focus brought by BBC to boost the use of carbohydrate-based building blocks for bio-based materials, enhancing economic activity and reducing greenhouse gas emissions. BBC promotes collaboration among SMEs, the agricultural sector, and the chemical industry to create and scale circular value chains. The initiative focuses on setting up five fully circular value chains and expects significant economic growth and job creation by 2050.

3.4 SUMMARY

Vision	Strategic objectives	Operational objectives
By 2050, the economy in the Delta region will be sustainable and climate neutral. This means use of primary fossil resources and CO2 emissions approaching zero. The necessary knowledge is present in the area, being developed or accessed. This makes the Delta region a thriving and future-proof economy that operates within the carrying capacity of the area. This makes it an area attractive to live, work and learn. The transition to renewable bio-based raw materials is part of achieving this ambition for the region. In fact, the1st step is the transition to circular which fits into existing process technology. The 2nd step is the transition to bio-based for which new bio-based process technology must be developed and should be started now	Develop Regional Collaboration	Establish a model for a regional coordinating organisation to oversee regional efforts and goals
		Increase the growth of the network alignment to inform topics and partners of common interest for cross-border and/or cross-province collaboration
		Aim for a growth in the number of joint-proposal submissions for EU opportunities
	Facilitate Innovation and Scale-Up	Triple helix regional organisations to increase efforts in identifying common technical barriers and play a role in facilitating industry-academia dialogues to find solutions to overcome these
		Triple helix regional organisations to grow the use rate of Application Centres where entrepreneurs can test their innovative ideas in an accessible way are other much needed actions
		Knowledge and Innovation Networks and Knowledge Institutions identify and collect relevant data to inform key decision-making processes
		Expand educational and vocational training programs within regional educational institutions to adapt and update skills for emerging bio-based sectors
	Enhance Market Demand	Increase participation of small, middle and large companies at bio-based events promoting existing businesses and solutions regionally
		Strengthen focus of bio-based innovation projects communication and dissemination tasks to include more detailed exchanges with potential markets
		Create a comprehensive, easily accessible platform that connects procurement teams within companies and government bodies to verified suppliers and developers of bio-based solutions

4 KEY ACTION FIELDS FOR IMPLEMENTATION

Developing the bio-based economy within the Delta Region requires addressing several common barriers that hinder collaboration and growth. One of the primary challenges is the high cost and relative slow pace of innovation in the bio-based sector. To create affordable, high-performing bio-based products, it is essential to accelerate innovation and find solutions to mitigate the financial risks associated with the bio-based economy. SMEs in particular need support in multiple fronts to have the right tools and knowledge to overcome access to funding and achieve a level of development of its innovation that is market ready.

A critical barrier to this goal is the regulatory framework for the bio-based sector. The lack of policies supporting bio-based product development, added to limiting regulations on various aspects, such as product environmental footprints and waste, nitrogen emissions, impede the growth of the bio-based economy. Policymakers in the Delta Region must collaborate to develop a supportive regulatory environment for the sector and to find short-term solutions while legislation needs time to adjust to most recent developments in societal needs.

As highlighted by Franc Bogovic, Member of the European Parliament, in Brussels the sustainability debate often has a sole focus on nature preservation and technology. However, it should not be forgotten that sustainability includes a social and economic component to which often little attention is given.[43]

To have politicians (*gedeputeerde en provinciale staten*) and companies/businesses (private sector) fully aware of the possibilities for and potential from the bio-based economy also pose a significant challenge. Enhancing the understanding from these groups regarding the benefits and implications of the bio-based economy is vital for setting the urgency which will lead to the level of support needed to achieve the transition from traditional, fossil-based products.

Lastly, infrastructure constraints and limited resources, such as space and energy, hinder the development of the bio-based economy in the Delta Region. Improving infrastructure and efficiently managing resources are crucial to promote growth and collaboration in the sector.

Addressing these barriers requires concerted efforts from policymakers, industry leaders, researchers, and the public to develop strategies and initiatives that drive innovation, strengthen the regulatory environment, increase public awareness, and enhance infrastructure within the Delta Region. By working together, the region can create a conducive environment for the growth and development of the bio-based economy.

4.1 IMPROVING BIO-BASED BUSINESS MODELS IN THE DELTA REGION

In recent years, the provinces in the region have been investing in a strong economic bio-based ecosystem at the interface of agriculture and chemistry, often, they have worked together on projects. In this way, they feel to have contributed in a programmatic way to innovation in plant-based material and product development, and scaling of activities in green chemistry. Their work has contributed to a market impulse for bio-based products, but future

[43] See www.agro-chemistry.com/articles/sugar-as-the-ideal-bio-feedstock-for-the-chemical-industry/.

steps are needed, and the following have been considered below, to strengthen and improve the strategy, based on learnings during the process.

The development of new bio-based economy value chains must incorporate service provider actors (cluster, government etc.) and value-chain actors (SMEs, start-ups). Governance should consider availability of support instruments as subsidies for the different development levels. Good governance should develop a clear long-term vision for a bio-based economy as well as advancing and joint development of a common agenda, joint projects, and common communication. The common elements should target actors from the triple helix. Good governance untangles the complex policy and regulations landscape for better product development and market entry. Including policies that allow multi-dimensional use of material and products (awareness raising and policy support) and prevent greenwashing. Accountability is supported by clear and transparent labelling on the different products which raise better awareness in the retail sector and consumers.

4.1.1 Level the playing field: supportive regulation and access to finance

Developing viable business models that attract investors is crucial for the growth of the bio-based economy. It is essential to educate investors about the unique benefits and long-term profitability of bio-based products compared to fossil fuels. Establishing dedicated funding channels, such as green bonds or sustainability-linked loans, can provide the necessary financial support. Moreover, lobbying for governmental subsidies and incentives specifically for bio-based initiatives can level the playing field against fossil fuel competitors.

A fair playing field includes regulations that recognize the unique attributes of bio-based products and offer them fair treatment compared to fossil-based products. Lobbying for changes in the status of bio-based products to move away from 'waste' categorization will also help in reducing regulatory hurdles

Activities proposed here below contribute to the operational objective of increasing regional collaboration with the aim to accelerate learning and building on knowledge already available, establish new partnerships, and achieve faster and better results.

1. Establish a coordinating organisation with representatives from all stakeholders of the triple helix. This organisation's operations could be (partially) funded via successful regional collaboration project proposals.[44]
2. Map the ecosystem in the region (full mapping of stakeholders, currently multiple fragmented initiatives and out of date).
3. Ensure information flow to and from the region on what regards priority topics and opportunities for its stakeholders.

[44] For instance, by successfully securing CBE-JU funding through collaborative regional project proposals that align with CBE-JU objectives, the coordinating organisation can drive unified regional action in bio-based innovation. This will play a pivotal role in advancing the regional strategic objectives and bringing its vision to fruition.

4. Actively engage in the Bio-based Industries Consortium (BIC)[45]. BIC's core activities are supporting the alignment of funding with local needs, enabling impactful partnerships, and ensuring that regional concerns help shape funding calls to address local challenges via the CBE-JU work programming.

4.1.2 Addressing Technical Barriers through Accelerated Innovation and Education

Accelerating the development of innovations from concept to commercial product is paramount. Traditional steps, such as bender, pilot, and demo stages, must be streamlined or bypassed through integrated development programs that allow simultaneous advancements in various stages. This can be achieved by fostering closer collaborations between research institutions, universities, and industry players to facilitate faster prototype development and testing. Collection and sharing of data on a sufficient scale is paramount. Additionally, enhancing educational programs to focus on the complexities of scale-up processes will prepare a workforce adept at managing these challenges, thus ensuring smoother transitions from laboratory-scale to industrial-scale operations.

Activities proposed here below contribute to the operational objective of facilitating innovation and scale up.

1. Regional organisations such Impuls Zeeland, KIK|MPI (*Kennis en innovatiecentrum Maintenance Procesindustrie*), Smart Delta Resources, Bio-based Innovation Garden bring in their accumulated knowledge to facilitate industry-academia dialogues to overcome technical barriers.

2. Regional organisations such as CO3 Campus in Terneuzen and MNEXT, to propose measures to grow the use rate of Application Centres.

3. Map and perform strategic analysis on regional biomass demand and supply.

4. Collect sufficient data on feedstocks and secondary biomass for better industrial symbiosis and urban planning.

5. Identify relevant factors and trade-offs to define a process to select new industrial areas for scaling-up of the bio-based industry. There is a pressing need for such industrial areas to be created in the region, a challenging task given several consequences in multiple levels that it brings.

[45] The Bio-based Industries Consortium (BIC) is a non-profit organisation which represents the private sector in a Public-Private Partnership (PPP) with the European Commission. BIC's core mission is to support the shift from fossil-based to bio-based, renewable solutions by connecting businesses, innovators, and policymakers, creating opportunities for sustainable development and commercialization in the bio-based sector. Key activities and contributions of BIC include: (1) Facilitating knowledge sharing and networking among members to drive innovation and growth in the bio-based economy. (2) Advocating for favourable policies, regulations, and investment frameworks to support the development and competitiveness of the bio-based industries in Europe. (3) Supporting the Bio-based Industries Joint Undertaking (BBI JU), a €3.7 billion partnership between the European Commission and BIC, which funds research and innovation projects in the bio-based industries.

6. For each project proposal under development conduct an early-phase assessment of the project's potential impact, specifically evaluating expected reductions in CO2 emissions and decreases in reliance on abiotic raw materials.

7. Collaborate with regional educational institutions and vocational training centres to develop targeted programs on bio-based scale-up processes. Aim for each major institution in the region to offer specialized courses or certifications focusing on bio-based production, pilot-to-scale transition management, and sustainable materials testing.

4.1.3 Supporting SMEs

Providing targeted support for SMEs in the bio-based sector through access to funding and markets pose as a main lever to support their growth and success. Establishing networks that connect SMEs with larger industry players, research institutions, and investors can create synergistic opportunities. Giving the stage for visibility and increased familiarity with bio-based innovation improves understanding, which improves acceptance and reflects on market demand.

Additionally, focusing on flagship projects, such as First-of-a-Kind (FOAK) initiatives, and providing them with the necessary resources and support can demonstrate the viability and benefits of bio-based technologies, thus attracting further investment and interest in the sector. An example of a flagship cross-border initiative is the Biorizon Shared Research Center [46](North Brabant). The focus was on converting biomass and residual streams into bio-based aromatics (chemical industry). The project has also developed a community for both global leaders and SMEs providing access to knowledge through a platform.

Activities proposed here below contribute to the combined operational objectives of increasing regional collaboration and enhancement of market demand:

1. Small, medium, and large companies working together in Supply Chain Integration: focus on working with SMEs to integrate them into the supply chains of large bio-based projects or products. This would offer a practical route to market for innovative products.
2. Participate in cross-border consortia that focus on flagship initiatives, such as FOAK projects, to pool resources and share knowledge while accessing new markets and regulatory environments.
3. Define topic of common regional interest for innovation valley: green chemistry or materials (e.g. application on products for construction industry: insulation, coatings). European funding key to support provincial work for the development of the bio-based economy.
4. Establish quarterly sector-specific bio-based webinars to connect bio-based innovators with companies looking to replace fossil-based materials, focusing on case studies that demonstrate successful transitions to bio-based inputs.

[46] For more details visit www.biorizon.eu/biorizon/vision/.

5. Develop and distribute a ‘Market Needs Checklist’ template for bio-based projects. This checklist would guide teams in identifying critical specifications, standards, and regulatory requirements during the research phase to avoid adoption barriers later.
6. Establish partnerships with bio-based industry associations, certification bodies, and regional suppliers to define a vetted list of bio-based suppliers, products, and solutions. Such a continuously updated directory of suppliers who meet industry standards and sustainability certifications, giving procurement teams confidence in their sourcing choices would populate the platform that connects procurement teams with bio-based suppliers.
7. Supplier Spotlight Webinars and Demo Days to showcase bio-based products and allow direct engagement to ask questions and see real-world applications to encourage procurement teams to consider and adopt bio-based solutions, creating a more active and engaged buyer community.

By addressing these priority areas, the Delta region can enhance its business models to better utilise the bio-based potential, can remove barriers and create opportunities. These activities, clustered in the topics listed above contribute to the regional vision of optimal valorisation of residual streams and by-products into higher-value applications.

A first next step from these strategies, suggested by the discussions leading to this blueprint, would be to focus on developing a regional innovation valley proposal jointly developed by stakeholders in the Delta.

4.2 ACTIONS / INTERVENTIONS

At this point it has not been possible to agree on numeric operational targets across provinces and stakeholders. Nonetheless, there is agreement on the importance of those defined operational focus to be increased.

In next steps, as mentioned in chapter 6 'Outlook', this is something to be defined.

Vision	Strategic objectives	Operational objectives	Activities
By 2050, the economy in the Delta region will be sustainable and climate neutral. This means use of primary fossil resources and CO2 emissions approaching zero. The necessary knowledge is present in the area, being developed or accessed. This makes the Delta region a thriving and future-proof economy that operates within the carrying capacity of the area. This makes it an area attractive to live, work and learn. The transition to renewable bio-based raw materials is part of achieving this ambition for the region. Indeed, the1st step is the transition to circular which fits into existing process technology. The 2nd step is the transition to bio-based for which new bio-based	Develop Regional Collaboration	Establish a model for a regional coordinating organisation to oversee regional efforts and goals	Establish a coordinating organisation with representatives from all stakeholders of the triple helix
		Increase the growth of the network alignment to inform topics and partners of common interest for cross-border and/or cross-province collaboration	Ensure information flow to and from the region on what regards priority topics and opportunities for its stakeholders
			Small, medium, and large companies working together in Supply Chain Integration
		Aim for a growth in the number of joint-proposal submissions for EU opportunities	Map the ecosystem in the region
			Actively engage in the Bio-based Industries Consortium (BIC)
			Define topic of common regional interest for an Innovation Valley proposal
	Facilitate Innovation and Scale-Up	Triple helix regional organisations to increase efforts in identifying common technical barriers and play a role in facilitating industry-academia dialogues to find solutions to overcome these	Regional organisations bring in their accumulated knowledge to facilitate industry-academia dialogues to overcome technical barriers
		Triple helix regional organisations to grow the use rate of Application Centres where entrepreneurs can test their innovative ideas in an accessible way are other much needed actions	Regional organisations to propose measures to grow the use rate of Application Centres
		Knowledge and Innovation Networks and Knowledge Institutions identify and collect relevant data to inform key decision-making processes	Map and perform strategic analysis on regional biomass demand and supply
			Collect sufficient data on feedstocks and secondary biomass for better industrial symbiosis and urban planning
			Identify relevant factors and trade-offs to establish a process to select new industrial areas for scaling-up of the bio-based industry

Vision	Strategic objectives	Operational objectives	Activities
process technology must be developed and should be started now			For each project proposal under development conduct an early-phase assessment of the project's potential impact, specifically evaluating expected reductions in CO2 emissions and decreases in reliance on abiotic raw materials
		Expand educational and vocational training programs within regional educational institutions to adapt and update skills for emerging bio-based sectors	Collaborate with regional educational institutions and vocational training centres to develop targeted programs on bio-based scale-up processes
	Enhance Market Demand	Increase participation of small, middle and large companies at bio-based events promoting existing businesses and solutions regionally	Establish quarterly sector-specific bio-based webinars to connect bio-based innovators with companies looking to replace fossil-based materials, focusing on case studies that demonstrate successful transitions to bio-based inputs
		Strengthen focus of bio-based innovation projects communication and dissemination tasks to include more detailed exchanges with potential markets	Develop and distribute a 'Market Needs Checklist' template for bio-based projects to guide teams in identifying critical specifications, standards, and regulatory requirements during the research phase to avoid adoption barriers later
			Supplier Spotlight Webinars and Demo Days to showcase bio-based products and allow direct engagement to ask questions and see real-world applications to encourage procurement teams to consider and adopt bio-based solutions, creating a more active and engaged buyer community
		Create a comprehensive, easily accessible platform that connects procurement teams within companies and government bodies to verified suppliers and developers of bio-based solutions	Establish partnerships with bio-based industry associations, certification bodies, and regional suppliers to define a vetted list of bio-based suppliers, products, and solutions to populate a platform that connects procurement teams with bio-based suppliers

5 MONITORING, EVALUATION AND LEARNING

In the Delta Region, a critical initial step toward advancing the bio-based economy is to clearly define a strategy for collaboration. This includes identifying an effective coordination mechanism and a central coordinating organisation that represents all stakeholders. As outlined in Chapter 3, various options are available, each leading to different strategic outcomes. Once this foundational step is in place, it will guide the development of tailored approaches to monitoring, evaluation, and learning (MEL) that align with the region's unique goals and resources.

Reflecting on insights gained from the Circular Bio-Based Delta (CBBD) initiative, the Delta Region can benefit from implementing streamlined, targeted MEL processes that focus on specific priority areas within the bio-based economy. Lessons from CBBD underscore the importance of selecting KPIs that are SMART (Specific, Measurable, Achievable, Relevant, and Time-bound). Overloading the MEL framework with excessive or unreliable indicators risks diluting their impact and undermining strategic clarity.

Clear and accessible communication is also essential for MEL success. CBBD's experience highlights the value of specialised communication resources to convey complex topics effectively, as "a picture is worth a thousand words". Investments in professional reporting and presentation can help stakeholders understand and engage with MEL insights, fostering broader support for bio-based initiatives.

Additionally, clear alignment between investment and measurable outcomes is crucial for building confidence among funders and partners. Investors and partners need to see how their contributions are translated into tangible results. However, it can be challenging for the coordinating organisation to directly correlate financial inputs with specific impacts. Establishing an agreed reporting structure among funders, investors, and other partners can help synchronise expectations and reinforce accountability. When full institutional organisation is not feasible, a temporary coordination model, such as adopting a European funding structure, may offer valuable frameworks for transparent, multi-year monitoring and reporting practices.

A possible outline of an evaluation framework for the Delta Region, for discussion and decision for its adoption by the stakeholders could prioritize the areas and include the categories below.

1. Governance and Stakeholder Engagement
    - Establishment of the Coordinating Organization: Evaluate the setup and efficiency of the proposed coordinating organization, including its success in involving the triple helix stakeholders (public, private, research sectors).
    - Stakeholder Collaboration Metrics:
        - Number and type of partnerships formed.
        - Frequency of stakeholder meetings and engagement activities.
        - Degree of alignment among stakeholders on priorities, with special focus on policy alignment, including the roles of Technology Readiness Levels (TRL) in bio-based innovation.

2. Funding and Financial Leverage
   - Monitoring CBE-JU and Other Funding Streams: Track funding secured from CBE-JU and other relevant EU and national funds, assessing their alignment with regional project objectives.
   - Financial Metrics:
     - Total funds secured from CBE-JU and other sources.
     - Proportion of funds supporting the coordinating organization and project implementation.
     - Level of private sector co-funding attracted.

3. Innovation and Technology Readiness
   - Bio-based Project Development and Maturity: Assess the number and maturity of bio-based projects in the Delta Region, with a focus on Technology Readiness Levels (TRL 1-8) and their scalability.
   - Innovation Metrics:
     - Number of projects advancing through TRLs.
     - Types and scale of bio-based innovations developed (e.g., materials, molecules, products).
     - Number of patents, products commercialized, or new technologies adopted by SMEs and large companies.

4. Environmental and Economic Impact Assessment
   - Carbon Reduction and Resource Efficiency: Track measurable outcomes in CO2 emission reductions, reductions in the use of abiotic raw materials, and the degree to which projects promote resource circularity.
   - Impact Metrics:
     - Annual and cumulative CO2 emissions reductions.
     - Decrease in abiotic resource usage and increases in renewable feedstock use.
     - Job creation and economic growth within the bio-based sector (quantified by jobs, revenue growth, or exports).

5. Policy and Regulatory Advancement
   - Alignment with EU and National Policies: Monitor alignment with relevant EU and Dutch policies, assessing any policy barriers encountered and the success of policy advocacy by the Delta Region's coordinating body.
   - Policy Metrics:
     - Number of new policies or adjustments that support bio-based initiatives.
     - Success in addressing regulatory barriers, including those related to bio-feedstock eligibility.
     - Degree of integration with broader Dutch national policies on bio-based economy and sustainability.

6. Market Development and Demand Stimulation
   - Market Signal and Procurement Success: Evaluate demand generated for bio-based products and materials through regional public procurement policies and private sector adoption.
   - Market Development Metrics:

- Volume of bio-based products purchased by public sector institutions and private firms.
- Adoption rate of bio-based solutions by local businesses and consumers.
- Number and scale of local procurement initiatives supporting bio-based solutions.

7. Public Awareness and Knowledge Transfer
   - Communication and Outreach: Assess the success of efforts to raise public awareness and transfer knowledge about bio-based solutions, such as events, workshops, and educational campaigns.
   - Awareness Metrics:
     - Number of outreach events and attendees.
     - Public knowledge and acceptance rates of bio-based products (e.g., through surveys).
     - Engagement with educational institutions to integrate bio-based topics into curricula.
     -
8. Periodic Review and Adaptive Management
   - Regular Evaluation and Reporting Cycles: Set specific intervals (e.g., annual, biennial) for reporting progress against these metrics, enabling adaptive management and recalibration of objectives as necessary.
   - Adaptive Metrics:
     - Frequency and quality of evaluation reports.
     - Responsiveness to challenges identified in previous cycles.
     - Adjustments made to project selection or strategic focus based on evolving needs.

6 OUTLOOK

The provinces in the Delta region, particularly North Brabant and Zeeland have the Bio-based Economy as a strong priority and clearly integrated in their Circular Economy strategies and implementation agendas. Other provinces in the Delta, including in the Belgium Flanders, have equally dedicated attention to the circular bio-based economy and are interested in exploring regional collaboration to reach larger and better results.

As a result of the multiple triple-helix stakeholders exchanges for the development of this blueprint, the next step is to have the regional stakeholders leading the way to develop a joint proposal to apply for one or more European funding programs. Opportunities preliminarily identified are the Regional Innovation Valleys (RIVs) Initiative, part of the New European Innovation Agenda (NEIA),[47] and CBE-JU calls under Horizon Europe,[48] for funding projects developing innovative and sustainable bio-based solutions.

The group formed during this work can be a starting point to proceed with guided discussions in defining specific topics and targets for the RIVs and or deciding the CBE-JU call in which to apply. The group would also benefit from identifying an existing organisation acting in the regional circular bio-based space to host and coordinate these efforts.

Additional activities, as identified above, should occur in parallel to supporting the process of expanding the knowledge over what already is happening in the provinces and the region. This is necessary to overcome technical challenges as well as to raise awareness of the private sector on the true potential that bio-based products, materials, and solutions have to offer to their businesses. Including defining numeric operational targets for the region, which, at the conclusion of this blueprint was not possible to be defined across provinces and stakeholders given the need to, first, identify a collaboration mechanism (funding, whether via European, national, or other projects or public-private partnerships).

Regarding obtaining extensive and comparable data from the region to bring trends to light, inform discussions, evidence gaps and lacking elements, this would be guided by the process of working together in developing a regional joint proposal.[49] Examples of data of increased relevance are **bio-based market trends** (growth of bio-based industries, including agriculture, chemical recycling, and circularity), **sustainability impacts** (data on CO2 reductions, green chemistry developments, and renewable resource usage), **economic data** (analyses of how the bio-based economy is contributing to regional employment, innovation, and investments), **policy and regulatory impacts** (how current policies are supporting or hindering bio-based

[47] See https://research-and-innovation.ec.europa.eu/strategy/support-policy-making/shaping-eu-research-and-innovation-policy/new-european-innovation-agenda_en

[48] See www.cbe.europa.eu/open-calls-proposals

[49] Key organisations actively gathering and analysing data to drive bio-based economy development, providing valuable insights for policymakers and businesses in the region are, BOM (Brabant development agency), REWIN (regional development agency), Green Chemistry Campus (hub for innovation and market research), MNEXT (practice-oriented research powered by Avans Hogeschool and HZ University of Applied Sciences), K&I netwerk Circulair Bouwen at Campus Zeeland and Campus Zeeland more broadly (knowledge and innovation networks), Impuls Zeeland (regional development agency), POM Oost-Vlaanderen (provincial development agency), CAPTURE initiative (research platform for disruptive innovation), ILVO (Institute of Agricultural, Fisheries & Food Research).

initiatives), and **technological advancements** (information on innovations in bio-based technologies, including pilot projects and emerging breakthroughs)[50].

By leveraging the existing momentum and collaborations within the Delta region, the stakeholders involved, representing the triple helix, are bound to enhance cross-border synergies and further solidify the region's leadership in the circular bio-based economy. The blueprint here created with active involvement of several stakeholders of the Delta region serves as a practical and relevant instrument for any initiatives looking into creating measurable impact in the advancement of opportunities in the bio-based economy space and solutions to overcome the bottlenecks faced by the region.

The proposed coordinated efforts will not only strengthen regional stakeholders' capacities to access European funding but also lay a foundation for continuous knowledge-sharing and strategic alignment. In pursuing this vision, the region can collectively drive impactful innovations, foster sustainable economic growth, and position itself as a model for the European Green Deal and beyond.

[50] This is an indication of relevant categories, not a final listing. This needs to be informed and agreed upon by the regional stakeholders involved in the next steps for the regional collaboration activities.

Annex-02

Towards a Bio-Based Economy in Nitra Region (Slovakia)

TOWARDS A BIO-BASED ECONOMY IN NITRA REGION – From Waste to Value Approach

A bioeconomy strategy blueprint, prepared in the frame of the BioModel4Regions project

This document has been prepared in the framework of the European project "BIOMODEL4REGIONS – Supporting the establishment of the innovative governance models to achieve better-informed decision-making processes, social engagement, and innovation in the bio-based economy".

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 101060476.

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December 2024

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List of Abbreviations

Abbreviations	Definition
BEC	Bioeconomy Cluster
DON	District Office Nitra
EU	European Union
INCIEN	Institute for Circular Economy
MARD	Ministry of Agriculture and Rural Development of Slovak Republic
MBT	Mechanical-biological treatment of municipal waste
MoE	Ministry of Environment of Slovak Republic
NGO	Non-governmental organization
NSK	Nitra self-governing region
R&D	Research and development
UKSUP	Central Control and Testing Institute in Agriculture
VAIA	Research and Innovation Authority

INTRODUCTION

The Nitra region of Slovakia is at a critical crossroads in its journey toward establishing a sustainable bioeconomy, particularly through effective waste management practices. This blueprint outlines a comprehensive strategy focused on transforming waste management in the region. It aims to address the pressing challenges of excessive waste generation, low recycling rates, and the sustainable processing of organic waste. By leveraging the region's rich agricultural heritage and industrial capabilities, the blueprint envisions a circular economy that minimizes waste and maximizes resource recovery. Key components include enhancing waste separation practices, improving collection systems for biodegradable waste, and promoting the use of compost and bioenergy derived from waste.

Collaboration among stakeholders, including local municipalities, the Bioeconomy Cluster (BEC), and the Association of Municipalities for Waste Management in Nitra (PZO), is essential to successfully implement these strategies. The blueprint emphasizes community engagement and educational initiatives to foster responsible waste practices and stimulate local participation.

Ultimately, by focusing on sustainable waste management and resource efficiency, this blueprint aims to enhance the Nitra region’s environmental resilience, boost economic growth, and contribute to broader European sustainability goals, laying the groundwork for a more prosperous and sustainable future.

1 OBJECTIVES AND SCOPE

Slovakia does not have a dedicated strategy for bioeconomy on national nor on regional level. Even though the term bioeconomy is rising on importance over the course of last few years, the concept of bioeconomy in Slovakia seems to be very difficult to grasp at the policy level. However, the Ministry of Agriculture and Rural Development of the Slovak Republic (MARD) has recently developed a Roadmap for Circular Bioeconomy, which serves as a concept for the establishment of circular bioeconomy in the conditions of Slovakia. By promoting of the roadmap, MARD has drafted the pathways for carbon farming, renewable energy sources, biomass and biowaste, biogas and biomethane, organic fertilizers, treatment of municipal wastewater in small municipalities and operations, circular bioeconomy, sustainable insulation systems, construction, and packaging materials, technological (artificial) captures and recycling of CO2 at the source with subsequent energy and raw material utilization. This is the first step leading to comprehensive approach to sustainable development that brings benefits for the economy, the environment, and society.

However, regions are struggling to adapt their own strategies due to insufficient top-down communication. Regions should be the driving force in establishing such strategies, mainly because they have access to stakeholders in the bioeconomy. The bioeconomy is characterized by being largely dependent on regional local actors who can best respond to the needs and demands of the local population. The regional blueprint is one of the tools to bring national strategies to the regions and to start mobilizing regional actors in the bioeconomy (who often do not even realize what bioeconomy is). It is important to point out though, a broad regional strategy in the bioeconomy would be insignificant if we do not take into account the specifics of individual regions, as the strategy must reflect these specifics. In accordance with the principles of the quadruple helix, each region should reflect the needs of society by connecting regional authorities, science, and industry. Nitra is one of the pilot regions within the Biomodel4Regions project.

The Nitra region is a dynamically developing area that focuses on strengthening innovation, supporting entrepreneurship, improving the quality of the environment, and promoting the transition to a low-carbon economy. Key economic sectors with high added value include the automotive, electrical, and machinery industries. Due to its soil and climatic conditions, the region has the best prerequisites for a broadly diversified agricultural production. Historically Nitra region has a significance in agrifood industry supported by the presence of only agricultural university in Slovakia – Slovak University of Agriculture in Nitra (SUA), National Agricultural and Food Centre (NPPC) and agricultural research infrastructure.

In addition to agriculture, significant development potential exists in the food industry, plastics industry, and tertiary sectors. The Nitra region is predominantly rural, comprising 339 rural municipalities (95.8%) and having the lowest urbanization rate at the regional level in Slovakia (45.6%). The regional economy is primarily supported by two key pillars: the high agricultural production as well as the presence of the automotive industry. Given the rural nature of the region, the regional bioeconomy strategy needs to be specifically targeted to reflect current needs of municipalities.

Therefore, the Bioeconomy Cluster (BEC) proposes a regional bioeconomy strategy focused on a functional waste management system due to the unsustainable nature of the current

system, characterized by excessive mixed waste production, rising fees, and an inability to meet EU recycling targets. Transitioning to a functional system will yield economic savings, create jobs, and significantly improve the environment by reducing carbon footprints and methane generation. As Slovakia's most productive agricultural region, Nitra Region possesses significant bioeconomy potential, which can be maximized through efficient waste processing and the return of organic matter to the soil as an added value. This strategy is therefore crucial for the region's sustainable development and the fulfilment of European environmental goals.

1.1 STAKEHOLDERS INVOLVED IN THE BLUEPRINT AND THEIR ROLE

The stakeholders involved in creating this blueprint are primarily those with whom the BEC established close contact during project activities and who see great potential in addressing specific waste management challenges as a springboard for the Nitra region's bioeconomy sector. This blueprint highlights the need for regional collaboration among local governments and demonstrates a participatory approach to developing strategic documents. The BEC, as the document's developer, is responsible for the strategy's content.

As part of the Biomodel4Regions project, the BEC engaged stakeholders from 2022 to map the Nitra region's bioeconomy. The BEC identified significant biomass potential in municipal solid waste, specifically its organic fraction. Although Nitra is a major agricultural region, existing practices largely see agricultural biomass processed within the agricultural or food processing sectors. However, Nitra is also a rural region with lower urbanization, where local governments – as executors of delegated state authority – face numerous challenges. Waste management is one such challenge, marked by an inefficient system and a lack of systemic communication between the state and local governments. Starting January 1, 2025, changes in waste legislation led by the Ministry of the Environment (MoE) indicate that local governments will incur higher costs due to new requirements for the mechanical-biological treatment of waste (MBT). The ministry is also expected to raise landfill fees. These changes significantly impact local waste management, prompting the development of this bioeconomy strategy focused on waste management.

The Nitra region has a unique association – Association of municipalities for waste management in Nitra region (PZO), currently uniting 57 municipalities. PZO focuses on long-term, comprehensive, and efficient waste management within its member municipalities, reducing landfill waste, and addressing problematic waste management issues. PZO represents a best practice model replicable across Slovakia. PZO was identified as a key actor serving as a best practice example for our blueprint. PZO is a public nonprofit organization established in 2005. It consists of 57 member municipalities in the Nitra region, representing nearly 84,000 residents across more than 25,000 households. As a unique institutional model of municipal cooperation, PZO excels in waste management innovation. They digitalize waste data using precise weighing and tracking systems to effectively monitor and optimize waste collection processes. Operating a composting facility that processes about 15,000 tons of bio-waste annually, PZO handles materials such as grass, plant residues, and plant-based kitchen waste from various sources. They are also investigating the production of biomethane from organic waste to fuel their waste collection fleet, aiming to lower their carbon footprint. PZO converts bio-waste into high-quality compost, improving soil quality, and fostering research

through collaborations with universities and educational institutions. Through innovative waste management solutions, they minimize landfill reliance, allowing for the redirection of waste towards energy recovery. The PZO model provides environmental benefits like high-quality compost production, economic gains through revenue generation and cost savings, and social advantages including enhanced waste services and job creation. This model serves as a replicable template for sustainable waste management, achieving environmental, economic, and social goals.

As part of a collaborative initiative between BEC and PZO, the initial goal was to explore options for piloting and expanding dry fermentation technology. However, these intentions were temporarily halted due to veterinary restrictions imposed by the Central Control and Testing Institute in Agriculture (UKSUP). In response, BEC proactively engaged with the Nitra Self-Governing Region (NSK), responsible for implementing Integrated Regional Strategy and managing a reservoir of strategic investments, which includes PZO's project to establish a Nitra Region Circular Economy Centre. This regional strategy is designed to support local development by aligning investments with community and environmental needs.

Several meetings were held with NSK's leadership and strategic planning department to investigate potential support for the project, particularly in identifying suitable land for the Nitra Region Circular Economy Centre. Through these discussions, it became apparent that NSK currently lacks a formal strategy or mandate for regional waste management. Nonetheless, NSK was identified as a stakeholder which could potentially assist municipalities in implementing effective waste management models. NSK also showed a potential in fostering education initiatives to promote waste separation awareness among residents, which inspires to adopt a more grassroots, community-centred approach.

Recognizing that a successful waste management model relies on community engagement and widespread awareness, BEC and PZO decided to initiate an educational campaign focused on the importance of waste separation. Waste composition analyses was conducted in three villages – Vinodol, Ivanka pri Nitre, and Mojmírovce – by examining the contents of mixed municipal waste containers to better understand local separation. In close collaboration with the mayors of these municipalities, the community members were involved in these analyses to reinforce a community-focused approach. This approach emphasized active stakeholder engagement and continuous education to foster responsible waste management practices (detailed information available in Chapter 3). Each of the three events was filmed, and an educational video was produced to support a broad outreach campaign throughout the Nitra Region.

In September 2024, BEC and PZO co-organized a co-creation workshop attended by over 50 key stakeholders. The main idea of the workshop was to outline the regional bioeconomy strategy with focus on waste management. The workshop featured speakers from BEC, PZO, NSK, the Ministry of Environment (MoE), the Nitra District Office's Department of Environment (DON), the Institute for Circular Economy (INCIEN), and PedaVita NGO. Important attendees included representatives from the Ministry of Agriculture and Rural Development (MARD), mayors from the Nitra region, representatives of academia, business sector, NGOs.

The workshop's discussions centred on the primary regional waste management framework, the "Waste Management Program for Nitra Region 2021-2025," developed by the Nitra District Office's Department of Environment (DON). This program, which was introduced in alignment with the NSK's Integrated Regional Strategy, aims to address regional waste management challenges and offer areas for support. The workshop also addressed upcoming legislative

changes presented by the MoE that will significantly impact municipal waste management, potentially affecting the region's economy and the daily lives of its residents.

Following the policy overview, the CEO of PZO introduced the proposed Nitra Circular Economy Centre, grounded in the following principles:

- Reduced frequency of mixed municipal waste collection,
- Increased frequency of separated waste collection,
- Digitalization of waste management data,
- A motivational fee system for municipalities,
- Ongoing education for residents,
- Emphasis on biodegradable waste,
- Expansion of composting facilities to produce high-quality compost for agriculture, and
- Enhancement of composting with dry fermentation technology to produce bio-methane.

Building on this theme, a representative from PedaVita NGO addressed the challenges posed by municipal waste and illegal landfilling, particularly its impact on agricultural land and farmer livelihoods. The speaker highlighted the role of compost in recycling biodegradable waste, transforming it into valuable soil nutrients that benefit agriculture while reducing mixed waste content, as demonstrated in the analyses conducted in the three municipalities.

INCIEN's presentation underscored the importance of municipal-level circular economy strategies focused on waste prevention and material consumption analysis. They advocated for a bottom-up approach, from households to municipal offices, enabling communities to align their practices with a hierarchy of waste priorities, prioritizing prevention, and sustainability.

A significant portion of the workshop allowed for open discussion with mayors regarding their primary challenges in waste management. Mayors expressed concerns about limited communication from higher policy levels, including MoE and NSK, and the difficulties they face in implementing effective systems locally. Their feedback identified several key obstacles in adopting bioeconomy-aligned waste management strategies:

- Limited expertise,
- Fragmented institutional strategies and lack of coherence,
- Insufficient local capacity for strategy development,
- Inadequate communication from policymakers to municipalities,
- Absence of a quadruple helix approach,
- Shortage of relevant data and best practice knowledge sharing,
- Insufficient involvement of bio-based businesses in local governance,
- Lack of a regional framework that integrates competencies across water, soil, waste, and environmental management,
- Need for a functional waste management model,

- Limited end-processing infrastructure for separated waste commodities (e.g., plastics, paper, glass),
- Need for better coordination at the regional level, especially given Nitra's role as an agricultural hub, and
- Recognition of waste as a valuable commodity with further processing potential.

This event highlighted both the opportunities and the pressing needs for improved communication, strategic alignment, and community engagement and put the base for blueprint document.

1.2 KEY AREAS COVERED BY THE BIOECONOMY BLUEPRINT

Waste Management

Sustainable waste management is a cornerstone of the Nitra region's bioeconomy strategy. This blueprint envisions a regional waste economy model that transforms municipal solid waste into valuable resources while minimizing waste generation and maximizing resource recovery. A primary focus is on the organic fraction of municipal waste, which can be converted into compost, bioenergy, and bioplastics. This transformation reduces landfill dependence and mitigates environmental pollution by lowering greenhouse gas emissions and groundwater contamination. The blueprint promotes the development of local composting facilities, along with dry fermentation technology, to produce bio-methane from organic waste. This approach not only reduces the region's carbon footprint but also creates new economic opportunities in bio-based industries. By improving waste management practices and promoting waste separation education, the blueprint seeks to stimulate a regional culture of sustainability, where waste is valued as a resource. In doing so, the region can foster economic growth, expand green jobs, and advance overall resource efficiency, making Nitra a leader in circular economy practices.

Agriculture

The Nitra region's rich agricultural heritage is central to its bioeconomy strategy, with agriculture positioned as both a contributor to and beneficiary of circular economy initiatives. This blueprint prioritizes the strategic use of compost produced from organic waste to improve soil fertility, support sustainable crop production, and reduce reliance on synthetic fertilizers. Compost derived from municipal organic waste is rich in essential nutrients and organic matter, which enhances soil structure, retains moisture, and reduces erosion. By integrating this sustainable fertilizer into farming practices, local farmers can improve crop yields, decrease production costs, and build resilience against soil degradation. Additionally, bio-based products like bioenergy and bioplastics created from organic waste offer farmers new revenue streams and support a shift toward bio-based agricultural practices. This approach aligns with the region's goals for a sustainable bioeconomy and offers environmental benefits, improved food security, and long-term economic sustainability in agriculture.

Municipalities

Municipalities play a vital role in driving rural development and implementing bioeconomy strategies at the local level. This blueprint highlights the importance of community involvement and education as essential elements for successful waste management and sustainable practices. By engaging residents in large-scale educational campaigns, municipalities can

promote the benefits of waste separation, resource conservation, and circular economy principles. Community-focused initiatives, such as workshops and hands-on programs in schools and local organizations, aim to empower residents to adopt responsible waste practices. Additionally, municipalities can promote community gardening projects that utilize compost derived from organic waste, encouraging local food production, strengthening community ties, and supporting environmental sustainability. This grassroots approach fosters a culture of stewardship and responsibility, positioning municipalities as catalysts for change and sustainability within the Nitra region's bioeconomy framework. Through these efforts, municipalities can achieve more efficient waste management, enhance local resilience, and contribute to the region's transition toward a sustainable, circular economy.

1.3 ROLE OF THE BIOECONOMY BLUEPRINT WITHIN THE REGIONAL GOVERNANCE MODEL

This blueprint is intended to propose the design of integrating sustainable, circular economy principles within the governance model of the Nitra region, aligning public policy, public sector initiatives, and community-driven efforts toward shared goals in waste management, agriculture, and rural development. By providing a strategic framework for resource efficiency, environmental sustainability, and economic resilience, the blueprint has a potential to serve as a guiding document to streamline regional collaboration and foster cross-sector alignment.

At its core, the blueprint functions as both a guide and a practical toolkit, enabling policymakers and stakeholders to navigate the complex challenges of regional bioeconomy development. It emphasizes a cooperative governance model that actively involves municipal governments, local businesses, community organizations, and citizens. This collaborative approach promotes efficient resource allocation, informed decision-making, and shared accountability across multiple governance levels.

Strategic policy alignment

The blueprint aligns with existing strategic documents, namely the Waste Management Program for Nitra Region 2021-2025 (DON) and the Integrated Regional Strategy created by NSK. By dovetailing with these foundational policies, the blueprint ensures that bioeconomy initiatives are not isolated efforts but part of a cohesive, overarching strategy. It complements and reinforces the objectives of these policies, particularly by prioritizing waste reduction, recycling, and resource valorisation. Additionally, it might serve as a catalyst for policy innovation, offering municipalities potential roadmap for integrating circular economy principles into their local frameworks.

Empowering municipalities and local stakeholders

The blueprint underscores the importance of municipal-level action, positioning local governments as primary actors in implementing bioeconomy practices. Recognizing the unique needs and capacities of municipalities and its governance, the blueprint provides guidance on developing tailored waste management strategies, promoting community engagement, and fostering local economic opportunities in bio-based sectors. Through capacity-building initiatives, knowledge-sharing platforms, and support for pilot projects, the blueprint outlines how can municipalities adopt circular practices, adapt policies to local

conditions, and inspire grassroots initiatives such as biodegradable waste composting to add the value to agricultural supply chain.

Cross-sector collaboration and stakeholder engagement

Taking into consideration that effective bioeconomy implementation requires a multi-stakeholder approach, the blueprint facilitates partnerships among regional institutions, private companies, and community organizations. By establishing a structured framework for collaboration, it promotes a “quadruple helix” model that involves public entities, private businesses, academia, and civil society in a continuous feedback loop. This model enhances communication across sectors, ensuring that local authorities, waste management companies, farmers, and residents work in sync toward common objectives. The blueprint also supports the involvement of bio-based businesses, particularly in composting, bioenergy production, and biodegradable materials, fostering innovation and entrepreneurship within the region.

Data-driven decision making and transparency

Effective governance requires robust data and transparent processes, and the blueprint emphasizes the need for accurate, accessible data on waste generation, material flows, and resource recovery across municipalities. By integrating digital tools for data collection and sharing, the regional authorities and municipalities can track the progress, assessing performance, and making informed adjustments to strategies. This data-driven approach enhances accountability, supports evidence-based policy adjustments, and ensures transparency at all levels of governance.

Fostering a culture of sustainability and awareness

Recognizing that behavioural change is crucial for long-term sustainability, the blueprint promotes educational initiatives aimed at increasing public awareness of waste separation, recycling, and the environmental benefits of circular economy practices. Municipal governments are encouraged to lead regional educational campaigns that inform citizens about the importance of reducing, reusing, and recycling. By promoting environmental literacy and community involvement, the blueprint cultivates a culture of sustainability that empowers residents to actively participate in bioeconomy initiatives and reinforces their role as stewards of local resources.

Economic and environmental resilience

The blueprint’s role within the regional governance model extends to bolstering economic resilience and environmental sustainability. By promoting circular economy practices, the blueprint supports the creation of jobs on local level and potentially might attract the bio-based investments. It aims to balance economic growth with ecological stewardship, fostering resilience against external disruptions such as legislative changes in waste management, environmental degradation, and climate change.

1.3.1 Co-creation workshop for stakeholders

The co-creation workshop, which was organized on September 24th, 2024, to reveal the regional needs of stakeholders involved in the development of blueprint, attracted over 50 participants, including 15 mayors from regional municipalities, 15 policy maker representatives, the BEC pilot actor, NGOs, farmers, local initiatives, and businesses. The event featured six dynamic presentations of DON, MoE, PZO, INCIEN, PedaVita and NSK with a highlight being the Regional Model of Waste Management presented by the PZO. Feedback indicated that attendees particularly appreciated this enlightening session. Overall, this workshop served as a vital platform for knowledge sharing and collaboration, aiming to strengthen regional waste management efforts and promote sustainable practices across municipalities.

A significant outcome of the workshop was the identification of cooperation and communication as essential components for effective regional waste management. Participants expressed keen interest in insights shared by representatives of the MoE and regional authorities, who provided valuable information on waste management statistics, new legislation, funding opportunities, and forthcoming project proposals.

Engagement was high, with active discussions taking place throughout the event.

Key outcomes from the workshop revealed several critical points:

- There is a pressing lack of both quantity and quality data regarding municipal waste management.
- Regional leaders, particularly mayors, identified a significant challenge in the lack of effective communication both top-down and bottom-up.
- Participants learned about various EU-level initiatives that could support their transition towards circular economy models.
- Increased cooperation among municipalities could lead to optimized waste management practices.
- A need for an improved two-way flow of information between policymakers and municipalities was highlighted.
- The replicability of the PZO model could help retain revenues within the region, allowing waste collection businesses to invest in innovative technological solutions for waste validation, including composting plants and bio-methane production, which adds value for farmers and contributes to sustainable energy solutions.
- Based on the outcomes, it is evident that there is an urgent need to link strategies and policies on both regional and national levels, emphasizing the importance of effective communication across all stakeholders involved.

2 BASELINE AND ANALYSIS OF LOCAL CONTEXT

In this chapter the BEC build upon the report on governance and policy regime for the bioeconomy and bioeconomy potential in the pilot region Nitra, which is a part of D3.3. Report itself provides insights into the effectiveness of current bioeconomy governance and identifies opportunities and strategies for improvement. In Nitra region's section it examines the region's socioeconomic profile, bioeconomy-related policies and initiatives, and performance across three key governance areas: implementation and financing, rule-setting, and information sharing. Using a standardized assessment framework, the report evaluates governance indicators and highlights regional strengths and challenges in developing and enhancing their bioeconomy. The findings of this quantitative assessment were validated through qualitative interviews with local experts and stakeholders in Nitra region.

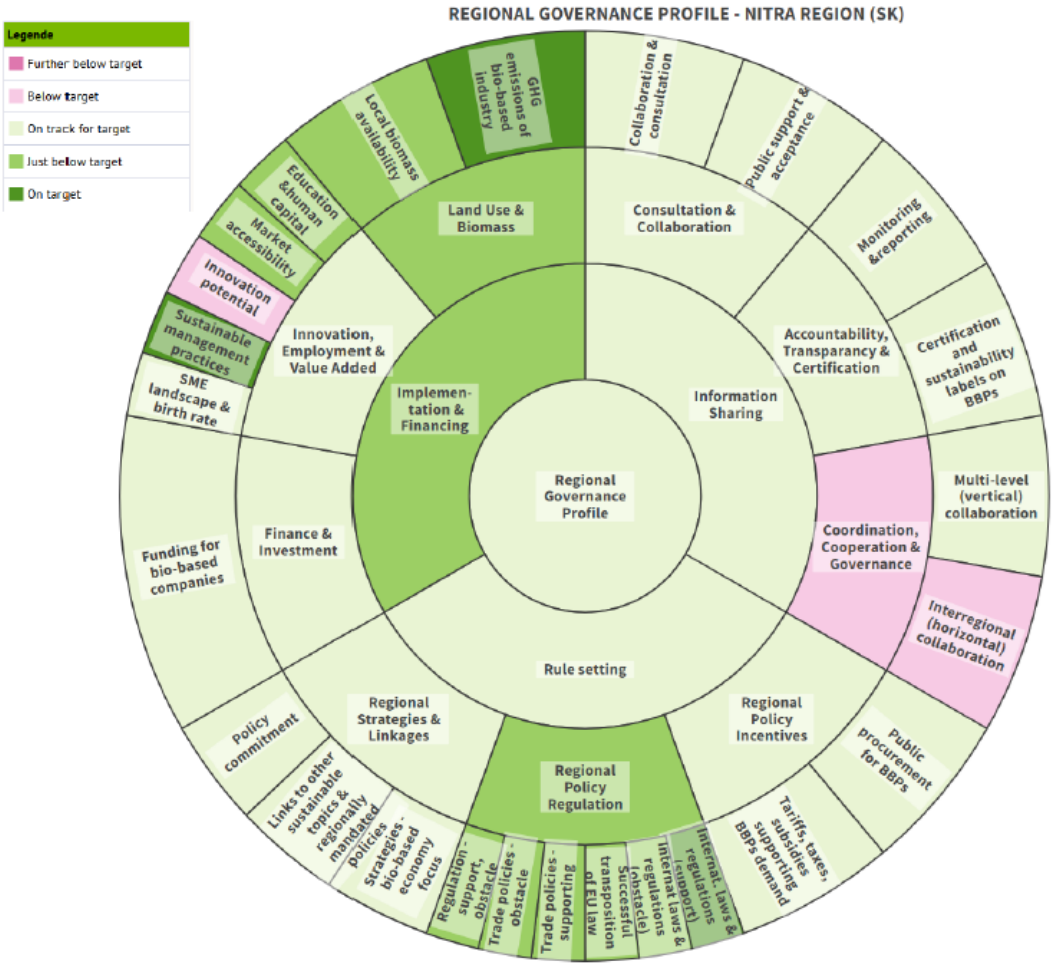
2.1 BIOECONOMY GOVERNANCE IN NITRA REGION

The analysis of bioeconomy governance model in Nitra region is based on the bioeconomy governance framework developed by Jacobi, Connolly, and Hayder (2023) – developed in the BIOMODELS4REGIONS project. This framework categorizes governance functions into three tiers of increasing specificity: basic governance functions (1st-tier), specific bioeconomy governance functions (2nd tier) and assessment criteria (3rd-tier) – which were assessed using an indicator as a set of 50 indicators. For each governance function in each tier the region was scored on a five-part Likert-type (ordinal) scale, which consisted of:

- Further from target
- Below target
- On track for target
- Just below target
- On target

Of the three first-tier basic governance functions (Implementation & Financing, Rule Setting and Information Sharing), Nitra received the middle score of "On track" in Information-sharing and Rule-setting, and the higher score of "Just below target" in Finance and Implementation. This is within a similar range to other regions in the Biomodel4Regions project, most of which scored better in Finance and Implementation than the other categories. Figure 1 visualizes the results organized into the three tiers of governance functions.

Figure 1: Regional governance profile of Nitra Region based on the bioeconomy governance framework developed by Jacobi, Connolly, and Hayder (2023)



Source: Deliverable 3.3 Reports on governance and policy regime for the bioeconomy and bioeconomy potential in the pilot regions

Drilling down to the second tier of nine bio-based governance functions, most indicators were determined to be “On track for target.” The highest scores were primarily found in Regional Policy and Regulations, Land Use & Biomass, and Innovation, Employment & Value Added. The following section lists and contextualizes the specific assessment criteria that received the best scores (on target and just below target) in these three categories of second-tier bio-based governance functions.

Regional Policy and Regulation

- International laws and regulation (support)
- International laws and regulation (obstacle)
- Successful transposition of EU law
- Trade policies – supporting

- Trade policies – obstacle
- Regulations – support, obstacle

Most of the assessment criteria under Regional Policy and Regulation focus on the implementation of EU-level laws, policies and regulators, or the presence of corresponding national policies. Thus, the high scores in this category track with other sources' descriptions of the Slovak Republic's bioeconomy sectors (agriculture and forestry) as being highly influenced by EU policies, regulations, and certification schemes. However, despite the name of this category, laws, regulations, and policies related to bioeconomy at the regional level – namely, from the government of Nitra – do not appear extensive or well-developed. That said, given the relatively small size of Slovakian regions, most policymaking happens at the national level, so it is unclear how much regional-level policymaking, regulations or laws could be expected or desired.

Land Use & Biomass

- GHG emissions of bio-based industry
- Local biomass availability

Given the strong influence of EU policy in Slovakian bioeconomy sectors, the high scores in Sustainable management practices and Greenhouse gas emissions may be partially attributed by the increasing focus on sustainability within EU frameworks and concomitant support. Local biomass availability reflects the well-established agricultural industry in Nitra.

Innovation, Employment and Value Added

- Sustainable management practices
- Market accessibility
- Education and human capital

Education and human capital is exemplified by the presence of the Slovak University of Agriculture in Nitra. However, the expert interviewees noted a lack of capacity and knowledge related to bioeconomy across stakeholder types. The high score in market accessibility raises additional questions, because other sources indicated that Slovak agricultural products could struggle to complete economically in EU markets, due in part to producers' relatively lower levels of modernization and efficiency, which may be connected the fragmented ownership structure and small plot sizes. In the context of this analysis, the market accessibility assessment criteria mainly reflect the relatively straightforward permitting practices for infrastructure that might enable bioeconomy businesses, such as a processing facility or biogas plant.

The area with the most challenges, described as "Further below target," are Innovation potential and Interregional (horizontal) collaboration. In this governance analysis, Innovation potential reflects the relatively low levels of R&D expenditures, but the expert interviews expand on these challenges to include complex bureaucratic processes and difficulties in small and medium enterprises (SMEs) accessing funding and private financing. The challenges with Interregional (horizontal) collaboration are borne out in the expert interviews.

During working groups held with Slovakian cluster members early in the project, participants expressed the views that good governance on the bioeconomy means successful development of multi-stakeholder dialogue (including local and regional governments, industry, and research), and improved targeting of existing supporting schemes, funding and subsidies that promote the roll-out of technology in bio-based industries. Other key aspects of good governance include increasing public awareness of the social and environmental benefits of the bioeconomy, making sure regulations are supportive at the national and EU levels, allowing circularity in bio-waste processing in specific areas and bringing innovation to market.

To validate the results of the governance analysis, interviews were conducted with four experts Nitra from March to May 2024. These experts represented the Slovak University of Agriculture, NSK and MARD. A primary obstacle highlighted by interviewees was a lack of capacity and knowledge related to the bioeconomy. Interviewees said that the concept of bioeconomy was poorly understood and sometimes conflated with circular economy, with relevant expertise missing among most stakeholders including government officers and producers of bio-based products. (The exception to this seems to be the Slovak University of Agriculture, which was frequently referenced as an asset at the region's bioeconomy governance). The other most widely cited obstacle was the lack of bioeconomy strategies at the national and regional level. Interviewees saw this to be linked to the lack of prioritization of bioeconomy at the national level and the lack of expertise, coordination, and funding on bioeconomy-related areas. Interviewees described a lack of proper structures for communication and organizational collaboration. Particularly, despite numerous initiatives and projects related to bioeconomy at the national level and in Nitra, these efforts were fragmented and uncoordinated, meaning that the learnings or results of these initiatives were not effectively captured disseminated.

Nitra already has an established agricultural sector, with a good availability of biomass and multiple existing organizations that are active in this space. There are opportunities to enhance and build on it by increasing the horizonal networking, coordination and cooperation between the many existing stakeholders and producers in the region. Interviewees emphasized the value of the presence of the Slovak University of Agriculture in Nitra, which can be leveraged for knowledge transfer and R&D. Interviewees foresaw future business and economic opportunities from new and diversified value-added bio-based products, especially ones that made use of current waste streams, which would build on the current output of both the agriculture and forestry sectors. Support from the EU was described positively, with sufficient availability of funding, technical solutions, and training.

The expert interviews largely confirmed the findings from the governance analysis. They agree on the need for improvement in coordination and cooperation, to better integrate the fragmentation among current bioeconomy-related initiatives and connect stakeholders to each other, and that the existing agricultural sector and current biomass availability are assets that ca be built on. The main area of disagreement was the analysis' high scoring of "education and human capital" in Nitra, which differed from the experts' assessment of a lack of capacity and expertise related to bioeconomy. A possible explanation is the grouping of education and human capital into one category – educational opportunities may be a strength given the nearby agricultural university, but this doesn't necessarily mean that the average level of expertise among stakeholders is high. Additionally, there was disagreement related to

Innovation potential. The analysis rated Nitra as “below target” in this area, whereas interviewees saw opportunities for existing SMEs to benefit from new business opportunities by expanding into new, value-added bio-based products. This may be attributed to the presence of both high theoretical potential for innovation, and lack of current government structures or policies that would bolster that innovation. The governance analysis also scored Nitra highly in the category of (Regional) Policy Regulation, which includes policies, regulations, and laws at all levels of government, including the EU. The experts confirmed that EU support was available and relevant policies were being implemented but did not speak directly to trade regulations.

2.2 PATHWAY TOWARDS A COMPREHENSIVE BIOECONOMY STRATEGY

When discussing legislation that specifically targets the bio-based sectors of the economy, one can identify fragments within various strategic documents. At the national level, the Slovak Strategic Plan for the Common Agricultural Policy for 2023-2027, developed by the Ministry of Agriculture and Rural Development (MARD), emphasizes fostering regional bioeconomy development through the LEADER program. This initiative enhances sustainability by promoting local development and diversification of economic activities such as short value chains and local food production, while also addressing environmental and climate change initiatives. By building social capital and improving local governance, the program mobilizes communities, encourages stakeholder cooperation, and boosts local capacities, ultimately driving comprehensive regional growth in the bioeconomy sector. Furthermore, the recent Roadmap for Circular Bioeconomy outlines critical areas for development within the bioeconomy, including carbon farming, renewables, biogas and biomethane, and organic fertilizers. Waste management, particularly concerning biodegradable materials, is addressed specifically in the biogas and biomethane chapter, as well as in sections related to composting within organic fertilizers.

The Smart Specialization Strategy SK RIS3, overseen by the Research and Innovation Authority (VAIA), complements these efforts by promoting innovation policies that focus on national and regional strengths, thereby providing potential sources of financing through partnerships among businesses, public entities, and knowledge institutions.

At the regional level, the Ministry of Environment (MoE) plays a crucial role in waste management legislation, dictating how waste should be handled, its categorization, associated fees, and extended producer responsibility for designated products. The MoE's Environmental Policy Strategy for the Slovak Republic until 2030 identifies waste management, air quality, and conservation of habitats and species as major environmental challenges, with a vision aimed at achieving better environmental quality and sustainable economic circulation.

In the Nitra Self-Governing Region (NSK), which supports regional development and environmental protection, the Integrated Regional Strategy has been developed to focus on sustainable development. In the area of the environment, it includes a range of measures and objectives that focus on protection of natural resources- promoting sustainable management of natural resources such as water, soil, and biodiversity. Second environmental measure is an air and water quality addressing pollution issues related to air and water, monitoring quality, and protecting water sources. Waste management measure is aimed on supporting recycling,

minimizing waste, and improving waste management systems. Two remaining environmental measure are green spaces and biodiversity and climate change adaption to mitigate the impacts of climate change and increasing the resilience of the region to climate risks.

Figure 2: Overview of regional and national Strategies related to bioeconomy and waste management

Source: composition by authors

The Waste Management Program of the Nitra Region for the years 2021-2025 focuses on effective and sustainable waste management in the region. The goal of this program is to improve the quality of the environment in the Nitra Region, contribute to sustainable development, and ensure healthy living conditions for the residents of the region. The main objectives and elements of the program include:

- Waste minimization – supporting measures to reduce the volume of waste produced and its prevention.
- Recycling and reuse – increasing the rates of recycling and reuse of materials, which helps conserve natural resources and decrease the amount of waste sent to landfills.

- Improvement of waste collection and sorting systems - implementing efficient collection and sorting systems to encourage citizens to manage waste correctly and ensure effective infrastructure.
- Education and awareness raising and increasing public awareness of the importance of waste sorting and environmental – through educational campaigns.
- Safe and ecological waste management – ensuring eco-friendly methods for the disposal of hazardous and problematic waste.

To create clear links among these various strategies and legislation, it is essential to ensure that the objectives outlined in the MARD's strategic documents align with the waste management initiatives of the MoE and the regional goals set by NSK. Integrating the Roadmap for Circular Bioeconomy within the frameworks of waste management at both the national and regional levels can foster a coherent approach that maximizes resource efficiency. Additionally, establishing feedback loops between various stakeholders – such as local governments, businesses, and citizens – will facilitate the sharing of best practices and innovative solutions, ultimately enhancing the effectiveness of bioeconomy and waste management efforts across the Slovak Republic. Engaging communities in decision-making processes can further improve social capital and ensure that the initiatives are locally relevant and impactful.

3 WASTE MANAGEMENT STARTEGY OF NITRA REGION

Considering ongoing economic development and the pervasive adoption of consumer lifestyles, among other contributing factors, the production of waste continues to escalate. In contemporary society, methods of indiscriminate waste disposal, such as incineration in communal pits, are neither feasible nor acceptable. Likewise, the accumulation of waste in landfills poses significant challenges to both societal welfare and environmental integrity, necessitating the pursuit of innovative solutions for responsible and sustainable waste management.

Given its status as Slovakia's agricultural epicentre, the Nitra Region bears a heightened responsibility to adopt comprehensive waste management strategies that prioritize the restoration and enhancement of soil quality and environmental health. The implementation of environmentally considerate models that bolster, rather than burden, ecological systems is of paramount importance. The compost produced from the processing of biodegradable municipal waste (organic waste) can serve as a valuable source of organic fertilization, offsetting the negative impacts associated with the decline in livestock production and the subsequent reduction in manure availability.

This document outlines a proposed model for waste management in the Nitra Self Governing Region (NSK), drawing from established best practices. The model is meticulously crafted to contribute positively to the region, its inhabitants, and the natural environment. To address the pressing necessity for an effective waste processing model, it is critical to recognize that the current waste management system is unsustainable due to several key factors:

1. The excessive generation of mixed municipal waste, predominantly disposed of in landfills,
2. Approximately 80% of this mixed municipal waste comprises materials that could be sorted for recycling, such as glass, paper, plastics, and organic waste,
3. Organic waste alone constitutes 40-60% of the mixed waste stream.

By enhancing waste separation processes and implementing an optimized system, the production of mixed municipal waste could decrease from approximately 200 kg to less than 50 kg per person. The diverse composition and challenging disposal of mixed municipal waste make it particularly problematic, with current handling options – incineration and, most critically, landfilling – occupying the lowest tiers of the waste management hierarchy. Currently, up to 55% of waste ends up in landfills.

Significantly, the current waste fee for citizens is €42 per person per year in Nitra. Starting in 2025, Slovakia will introduce mandatory mechanical-biological treatment (MBT) of waste before landfilling, escalating the handling costs of mixed waste significantly, potentially exceeding €120 per tonne (excluding VAT), which will impact citizen fees. The first phase of mandatory MBT – stabilization of the organic fraction – will begin on January 1st 2025 (on the voluntary basis until January 1st 2027), with estimated costs between €50 and €100 per person per year. By January 1, 2027, there will be a requirement to divert the calorific fraction of waste from landfills, with expected costs rising to €120 or more.

Furthermore, the waste management sector aims to achieve two pivotal targets by 2035: reducing landfill waste to a maximum of 10% of total municipal waste and recycling at least 65% of municipal waste. In addition, in March 2020, the European Parliament adopted the EU Circular Economy Action Plan, setting out goals for climate neutrality by 2050. This plan positions the circular economy as a cornerstone of production, aiming to decouple economic growth from the use of natural resources and double the rate of circular material use.

Therefore, the BEC see the necessity for drafting a bioeconomy blueprint that not only addresses waste management challenges but also aligns with regional governance models to support sustainable development and ecological enhancement.

3.1 LOCAL CONTEXT OF WASTE MANAGEMENT IN NITRA REGION

According to data from the Statistical Office of the Slovak Republic in 2022, the Nitra Self-Governing Region (NSK) had a population of 673,547, generating nearly 389,000 tons of municipal waste. This translates to an average of 577 kg of municipal waste per capita annually. While comparing this to waste generation in developed EU countries (e.g., Denmark: 786 kg; Belgium: 759 kg; Germany: 646 kg; Finland: 609 kg per capita in 2021), NSK's figures aren't the worst. However, the significant difference lies in the waste management system and, particularly, how we handle the mixed municipal waste. In these other EU countries, less than 5% of waste ends up in landfills.

Table 1: Quantities of selected types of municipal waste produced in the NSK in the year 2022.

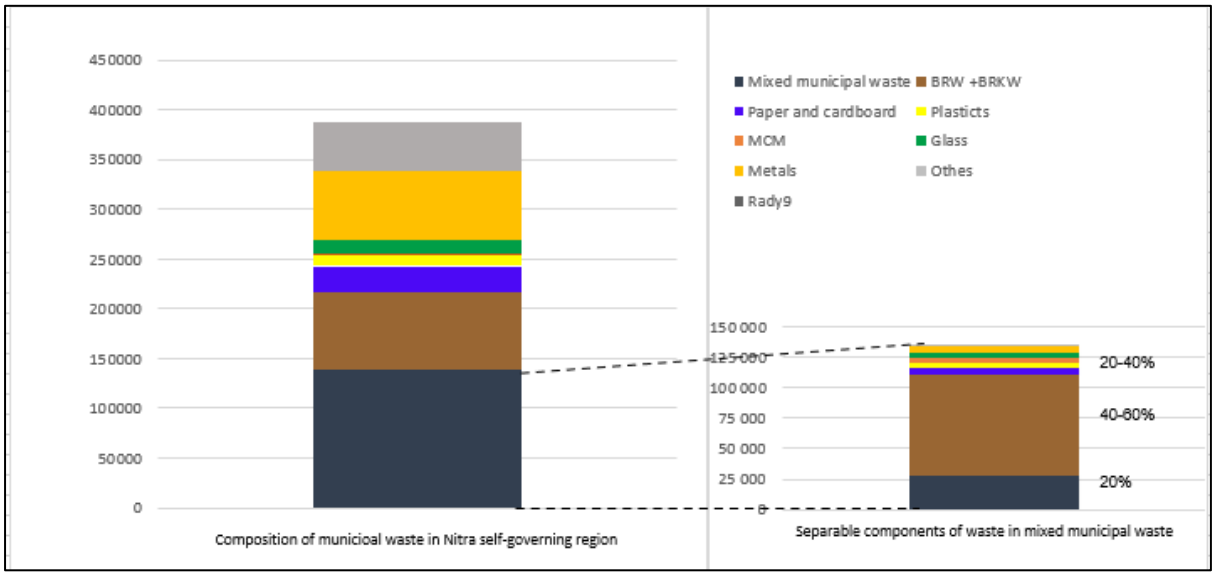
Quantities of selected types of municipal waste (in tons) produced in the Nitra Self-Governing Region (NSK) in the year 2022	
Mixed municipal waste	138 732 t
Biodegradable waste	71 039 t
Biodegradable kitchen and restaurant waste	7 034 t
Paper and cardboard + packaging from paper and cardboard	26 295 t
Plastics and packaging from plastic	11 816 t
Multilayer composite materials based on cardboard (cardboard-based composites)	346 t
Metals and packaging from metal	954 t
Glass and packaging from glass	14 898 t
Metals	69 074 t
Others	48 617 t
SUM	388 805 t

Source: Statistical Office of Slovak Republic

Numerous analyses of mixed municipal waste reveal that despite current sorting and collection systems, up to 80% of the material in mixed waste is still recyclable. Specifically, in 2022, the NSK generated almost 139,000 tons of mixed municipal waste, meaning the average resident produced 205 kg of this type of waste annually. Of this, over 150 kg consisted of plastics, paper, glass, metals, WEEE (Waste Electrical and Electronic Equipment), and organic waste

(biodegradable municipal waste). The challenge is clear: we must significantly improve waste separation by citizens and enhance the efficiency of the waste management system.

Figure 3: Composition of the municipal waste in NSK (2022)



Source: authors´ composition based on the data from Statistical Office of Slovak Republic

The primary goal is to create a sustainable waste management system for the Nitra region. This proposed regional solution is designed to boost regional competitiveness by generating production, employment, and financial opportunities. All waste generated within the region has the potential to be managed locally, ensuring that revenue remains within the region and can be reinvested in further waste management development, including innovation and research. This system is largely based on the successful and internationally recognized model of the PZO for separate waste collection and management. This model, run by a municipal association, prioritizes environmentally responsible waste management, and reinvests profits into community development.

Simultaneously, the goal is to create a system that doesn't excessively increase waste disposal fees for citizens, maintaining reasonable costs.

3.2 BASELINING GOVERNANCE MODEL AND IMPLEMENTATION OF WASTE MANAGEMENT MODEL

The core philosophy of the waste management strategy model is to divert recyclable and otherwise processable waste components from mixed waste streams at their point of origin – households – effectively reducing the amount of waste ending up in landfill bins – black bins for mixed municipal waste. The proposed solutions align with the Waste Management Program for 2021-2025. This waste management model prioritizes a long-term, environmentally sound approach encompassing waste reduction, reuse, recycling, and responsible disposal. It leverages regional collaboration, as exemplified by the regional centre of circular economy, to optimize resource allocation and efficiency. Furthermore, it actively

engages citizens through public awareness campaigns and financially incentivizes responsible waste sorting and reduced mixed waste via fair and transparent fees. Crucially, the model emphasizes the importance of continuous technological improvements to further enhance efficiency and sustainability.

The proposed model also has several environmental goals:

- Reducing the amount of mixed municipal waste ending up in landfills.
- Utilizing and recycling materials to benefit from the circular economy, thus reducing the carbon footprint.
- Returning organic matter to the soil (in the form of compost) – compost application improves soil water retention, mitigating the negative impacts of climate change.

Furthermore, this model could offer additional benefits to the region, such as:

- Creating new jobs and boosting regional employment.
- Improving citizen well-being through cleaner environments.
- Generating resources to fund innovative initiatives and regional projects (financing through NSK, VAIA).

Waste collection and separation

1. **Intensifying/Improving separated waste collection in the Nitra Region** – increasing separation rates and improving separated waste collection isn't easy and requires a phased approach to build a functional waste management system that citizens accept and adapt to. We have identified these key steps to improve waste separation:

   Door-to-door collection – collection system will be implemented, using color-coded, chipped bins for efficient waste separation (organic waste, paper, plastic, mixed municipal waste). The frequency of collection can be adjusted based on the volume of generated waste for each fraction. The goal is to reduce the frequency of mixed municipal waste collection while increasing the frequency of separated waste collection.
2. **Improved collection infrastructure** – the initiative involves building or municipal collection points ("zberné dvory") in communities and improving their accessibility. Established of these points allow residents of the municipalities to dispose various types of waste that cannot be separated through typical household sorting (textiles, electronic waste, hazardous waste, cooking oil, etc.). Citizens need convenient access to disposal services for bulky and hazardous waste, ideally at no cost. This requires establishing and/or supporting municipal collection points or recycling yards offering free services.
3. **Collection frequency and methods** – to ensure system efficiency, collection methods for all waste types must be adapted. Curb side collection for plastics, paper, and organic waste is a significant convenience for citizens and encourages participation. Requiring citizens to transport sorted waste to designated collection points would hinder participation. Collection frequency should be tailored to individual waste types to maximize citizen convenience and encourage thorough separation. The frequency should reflect the volume of waste generated (frequent collection for high-volume waste types). This optimization of the waste collection and frequency will actively reduce the amount of mixed

municipal waste ("zmesový komunálny odpad") by focusing on increasing the frequency of the collection of the fractions that can be separated.

Example: weekly biodegradable /organic waste collection; 3-weekly collection for plastics, Tetra Pak, and metals; monthly collection for mixed municipal waste and paper.

4. **Incentive-based waste fee system + weighing of all municipal waste** – a key incentive to improve waste separation is an incentive-based fee system for mixed municipal waste. This essentially means citizens only pay for the mixed municipal waste they generate, motivating them to produce less mixed municipal waste and separate more effectively. Introducing fees based on waste volume is complex and should be implemented gradually to avoid encouraging illegal dumping. A proven method (from PZO) is to replace lump sum waste fees with fees based on the number and size of mixed municipal waste bins used by each household. This encourages households to monitor their waste output. To prevent citizens from illegally dumping waste in nature, weighing all types of municipal waste is essential to ensure accurate waste collection data and fair fees. Introducing weighed waste collection will not change the total waste volume, only how citizens handle their waste and incentivize increased sorting.
5. **Public awareness and education** – improving sorted waste collection hinges on increased citizen participation in waste separation. However, current waste separation guidelines (what goes into which bin) remain confusing and inconsistent for Slovaks. Frequent changes in technology and regulations over recent years have further fuelled public confusion and mistrust. While nearly all waste can now be separated, minimizing waste sent to landfill bins, citizens need proper training on correct waste separation techniques. Targeted public awareness campaigns can educate and motivate citizens to separate their waste. However, even the most effective campaigns may not be successful as some people only respond to financial incentives, as described above.

   Before implementing this new waste management model, it's crucial to focus on reducing overall waste generation. Therefore, PZO, in collaboration with the Bioeconomy Cluster, created an educational video campaign. This campaign incorporates data from mixed municipal waste analyses to produce an educational video for residents of the Nitra region. BEC and PZO decided to initiate an educational campaign focused on the importance of waste separation.

Picture 1: Photo from filming the awareness campaign

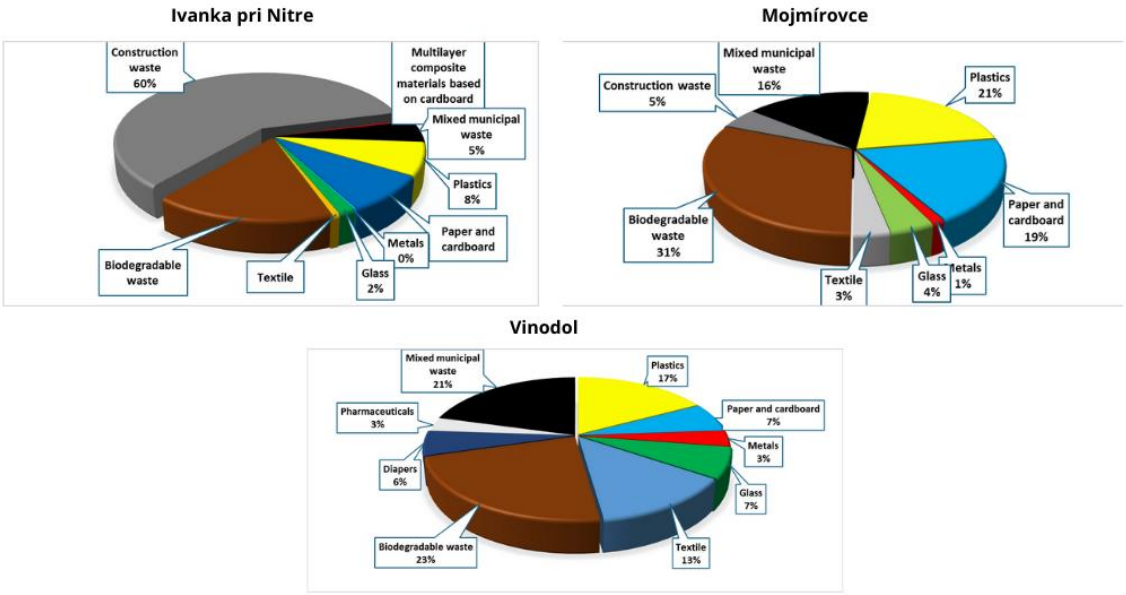
Source: authors´ picture

Waste composition analyses was conducted in three villages – Vinodol, Ivanka pri Nitre, and Mojmírovce – by examining the contents of mixed municipal waste containers to better understand local separation. In close collaboration with the mayors of these municipalities, the community members were involved in these analyses to reinforce a community-focused approach. The methodology for conducting the analysis was same in each village. The sample – on average 20 containers for mixed municipal waste (120 l each) was dumped into one large pile, and the task of the volunteers from the local community was to separate the individual components of the waste.

This approach emphasized active stakeholder engagement and continuous education to foster responsible waste management practices. Each of the three events was filmed, and an educational video was produced to support a broad outreach campaign throughout the Nitra Region.

Figure 4 shows the results of analyses in three villages, showing the obvious fact, one of the biggest components of the mixed municipal waste is the biodegradable waste (organic). The results also showed that, on average, only about 14% of the total volume of containers for mixed municipal waste was truly non-separable mixed municipal waste.

Figure 4: Composition of mixed municipal waste containers during the awareness campaign



Source: authors' composition based on the data from PZO

The final video from campaign is accessible here:

https://www.dropbox.com/scl/fi/djkjn24evr8aw3hd49r4s/AZKO_final.mp4?rlkey=zeb18wiw08xl0lpk1qmyzmpm6&st=fmi2fv35&dl=0

Technical solutions

Building a network of composting facilities – since January 2021, Slovakia has mandated curb side collection of household biodegradable organic waste. Municipalities must either compost or use biodigesters. However, compost from many facilities is of poor quality, containing microplastics and other contaminants, making its use more harmful than beneficial. The type of technology employed by the composting facility and how it processes the biodegradable waste are crucial factors.

This model proposes creating municipal associations (covering 50,000-70,000 residents) to share composting facilities. This improves efficiency and provides direct community involvement in waste management. These associations would be responsible for managing waste in their "micro-regions." Membership provides direct access to community members to facilitate change and allows access to better technology for sorting, grinding, and sieving biowaste, enhancing compost quality. These facilities could also incorporate anaerobic digesters for biogas production, using the biogas as fuel for waste collection vehicles, reducing costs for the association, or using it for community building heating, lowering municipal costs. The resulting digestate would also be composted and returned to the soil.

Biomethane production units – composting plants could also process biological waste that cannot go directly into the composting process: biological waste with an animal component. Before this waste is processed in a biomethane station, it undergoes hygienization to eliminate pathogens, often using the container method, where waste is sealed and heated to a specific temperature for a set duration to ensure safe conditions. Among the various methods for extracting energy from municipal solid waste, biomethane production stands out as the most promising option. This process allows to produce methane gas from any waste stream by applying suitable conversion technologies. After hygienization, the waste is processed in the biomethane station, enabling to obtain biomethane efficiently.

Creating a centralized logistics centre – Optical sorting line for separated waste from the entire Nitra region – a central optical sorting line would streamline separated waste processing. This would involve establishing a regional facility to process all collected waste. The sorting line would separate separated waste based on their usability:

1. Materials recycling – materials suitable for reprocessing into new plastic products.
2. Energy recovery – unsuitable for materials recycling but usable as solid recovered fuel (e.g., in cement production where the ash is also a valuable product).
3. Landfilling – non-recyclable and non-recoverable materials.

This system ensures high-quality and precise sorting, maximizing materials recycling, using energy recovery for other materials and minimizing landfilling.

Establishing a "Reuse" centre – A Second-Hand goods collection point – the EU promotes reuse centres. These facilities accept unwanted but usable items from citizens, offering them free disposal and reselling the items at nominal cost. The profits fund the centre's operation. This reduces waste volume and is environmentally friendly. Several similar facilities already exist in Slovakia (e.g., Back2life in Trnava, KOLO in Bratislava), serving as examples for Nitra.

3.3 EXAMPLES OF BEST PRACTICE

Biograda Zdroje Zeme

Biograda Zdroje Zeme is an innovative environmental project dedicated to addressing the challenges associated with the management of biodegradable waste, green energy production, and soil degradation. The project focuses on the effective recovery of biodegradable waste in compliance with Slovak legislation and EU regulations, with a target processing capacity of up to 100,000 tons of biodegradable kitchen waste and 30,000 tons of animal manure annually. By leveraging these inputs, it produces 20,000 tons of patented regenerative biochar substrate enriched with nutritional components. Project prioritizes the sorting of bio-waste to determine its suitability for immediate use or the need for sanitization. This process includes assessing the waste for future applications, whether for dry or wet fermentation, carbonization, or as part of their regenerative substrate. Through its comprehensive strategies and innovative solutions, Biograda Zdroje Zeme promotes environmental sustainability by reducing reliance on landfills, producing high-quality compost, and fostering economic growth through efficient waste management. This model not only addresses environmental challenges but also enhances social conditions by providing

improved waste services and creating job opportunities. As a replicable framework for sustainable waste management, it aims to achieve significant environmental, economic, and social outcomes.

Regional approach:

- Biograda's success depends on actively involving local communities, farmers, and businesses in all stages – from initial needs assessment and process design to ongoing monitoring and feedback. This participatory approach ensures the solution is relevant and accepted.
- Processing waste locally and producing locally needed products reduces reliance on external resources and creates local jobs.
- Customized solutions are tailored to meet specific needs of different communities, soil types, waste streams and resource requirement.
- By creating local jobs and supporting local business communities, it enhances the economic viability and resilience of the region.

Key factors for achieving success:

- Process based on original research and development, protected by patents. This innovative technology allows for the conversion of waste into valuable resources, creating a sustainable and circular economy model.
- Active collaboration with strategic partners and participates in various programs (e.g., Horizon Europe) to leverage expertise and resources.
- This approach aims to demonstrate economic feasibility by measuring the process's effectiveness and cost benefits for clients. This ensures sustainability and encourages wider adoption.
- By converting waste and creating soil improvers, Biograda contributes to a greener environment.

Živá Záhrada ltd. and PedaVita NGO

Živá záhrada s.r.o. and PedaVita NGO are non-profit organizations established in Slovakia, focusing on soil health and biodiversity. Živá záhrada, a registered social enterprise, operates a composting facility processing approximately 2,000 tons of biomass annually, utilizing materials such as grass clippings, plant residues, and food waste from various sources. This compost is then used to improve soil quality, and they also produce compost teas. The organization actively engages with the community, educating residents and professionals alike on composting best practices. PedaVita NGO, a research and development organization, supports Živá záhrada's efforts by conducting research on soil life, providing laboratory services for soil and compost analysis, and offering consultancy on soil health and agricultural practices. They collaborate with universities and educational institutions to further enhance knowledge and innovation in sustainable waste management. The combined model of Živá záhrada and PedaVita NGO improves recycling rates, generates high-quality compost, promotes soil health, and contributes to both environmental and economic well-being of the region. The model is demonstrably replicable for other communities aiming to achieve

environmental, economic, and social sustainability through innovative waste management practices.

Their combined model emphasizes:

- Collaboration with farmers, municipalities, and the community to foster support and participation.
- Investment in composting facilities and laboratory capabilities.
- Adherence to local, national, and EU waste management regulations.
- Ongoing educational programs and outreach to promote responsible waste management practices.

Key factors contributing to their success include:

- Outlining collection, processing, and end-use of materials.
- Streamlined processes to minimize costs and maximize resource recovery.
- Maintaining high standards for compost and other outputs.
- Active community participation in decision-making and regular communication.

PZO

Association of municipalities for waste management in Nitra region (PZO) is a public nonprofit organization established in 2005. It consists of 57 member municipalities in the Nitra region, representing nearly 84,000 residents across more than 25,000 households. As a unique institutional model of municipal cooperation, PZO excels in waste management innovation. They digitalize waste data using precise weighing and tracking systems to effectively monitor and optimize waste collection processes. Operating a composting facility that processes about 15,000 tons of bio-waste annually, PZO handles materials such as grass, plant residues, and plant-based kitchen waste from various sources. They are also investigating the production of biomethane from organic waste to fuel their waste collection fleet, aiming to lower their carbon footprint. PZO converts bio-waste into high-quality compost, improving soil quality, and fostering research through collaborations with universities and educational institutions. Through innovative waste management solutions, they minimize landfill reliance, allowing for the redirection of waste towards energy recovery. The PZO model provides environmental benefits like high-quality compost production, economic gains through revenue generation and cost savings, and social advantages including enhanced waste services and job creation. This model serves as a replicable template for sustainable waste management, achieving environmental, economic, and social goals.

Regional approach of PZO is based on:

- Early-stage stakeholders engagement, including municipalities, residents, and businesses, to ensure support.
- Developed robust infrastructure for composting, recycling, and waste processing.
- Ensure compliance with local, national, and EU waste management regulations.
- Conduct continuous education programs for residents on waste separation.

Key factors for achieving success:

- Create a detailed waste management plan covering collection, processing, and end-use.
- Promote community involvement through regular communication and decision-making participation.
- Streamline operations for efficiency, reducing costs, and maximizing resource recovery.
- Maintain high standards for compost quality and recycled materials.
- Secure funding and develop a financial model for long-term sustainability.

The PZO model's standout feature is its community-centric approach, where active stakeholder engagement and continuous education foster a culture of responsible waste management, drastically reducing landfill waste and improving recycling rates, benefiting both the environment and the local economy.

4 TOWARDS A VISION FOR THE BIO-BASED ECONOMY IN NITRA REGION

The Nitra region stands at the precipice of an opportunity to cultivate a robust bio-based economy, driven by the pressing need for sustainable practices in waste management, agriculture, and community engagement. As a fundamental principle, this vision must prioritize the following policy objectives:

a) **Integration of national and regional strategies**

Align the strategies developed by the MARD with regional initiatives, ensuring that local policies are reflective of both national goals and the unique characteristics of the Nitra region.

b) **Enhanced communication channels**

Develop effective communication mechanisms between policymakers and local governments, ensuring that vital information flows efficiently in both directions. This approach will empower municipalities to adopt innovative waste management practices aligned with bioeconomy principles.

c) **Support for local stakeholder engagement**

Emphasize the importance of grassroots initiatives in the bioeconomy development process. Engaging local stakeholders – such as farmers, businesses, NGOs, and residents – will foster a sense of ownership and commitment to sustainable practices.

d) **Investment in infrastructure and technology**

Prioritize investments in green technologies and waste processing infrastructures, such as composting facilities and anaerobic digesters, to ensure efficient processing of bio-waste and the production of value-added products.

e) **Education and awareness programs**

Launch comprehensive educational campaigns aimed at informing residents about the benefits of waste separation, recycling, and sustainable agricultural practices, thereby nurturing a culture of responsibility within the community.

4.1 VISION FOR THE BIO-BASED ECONOMY IN NITRA REGION

The vision for the bio-based economy in the Nitra region is to establish a thriving, circular economy that harnesses local resources, minimizes waste, and integrates sustainable practices into everyday life.

Sustainable resource management represents a multifaceted and dynamic approach to managing both agricultural and municipal solid waste, transforming these materials into valuable resources such as compost and bioenergy (possibly in the form of bio-methane). This transformation not only enhances soil health but also significantly contributes to carbon farming initiatives, which are crucial for mitigating climate change effects and promoting environmental stability. By turning waste into a resource, sustainable resource management effectively closes the loop in material life cycles, reducing landfill use and promoting a circular economy.

Economic resilience is another vital component of this approach, as it fosters the development of a local bioeconomy. This fast-developing sector is very important in creating new job opportunities and supporting small businesses, while simultaneously stimulating investments in green technologies. By doing so, it fosters economic stability at both the local and regional levels, reducing reliance on imported materials and enhancing self-sufficiency. Furthermore, a strong emphasis on environmental stewardship is evident in this approach, which aims to preserve the natural environment through strategies such as reduced waste generation, recycling practices, and the implementation of organic farming methods. These practices not only enhance biodiversity but also improve soil quality, contributing to the overall health of ecosystems.

A crucial element in realizing these goals is the emphasis on collaboration and innovation. This involves creating a cooperative framework that brings together key stakeholders, including local governments, businesses, research institutions, and communities. By fostering innovation and facilitating the sharing of best practices, such collaborations are instrumental in overcoming the challenges associated with transitioning to a bio-based economy, paving the way for a sustainable and resilient future. This holistic approach aligns economic, environmental, and social objectives, illustrating how interconnected systems can work together to achieve sustainability goals.

4.1.1 Strategic and Operational Objectives

Strategic Objectives

1. **Optimize waste management systems**

Establish a comprehensive waste management framework that promotes waste separation, recycling, and composting as core practices in the Nitra region, thereby reducing landfill reliance and achieving EU recycling targets. By implementation of regional waste management model proposed in the chapter 3, Nitra region on the level of municipalities can optimize waste strategies, establish data collection systems for waste management, set fair fees for local governments, move towards circular solutions, and significantly increase the sorting rate of municipal waste.

2. **Enhance agricultural practices**

Integrate bio-based products, such as compost and organic fertilizers, into agricultural practices to improve soil fertility and promote sustainable farming techniques that reduce dependency on synthetic inputs. This is closely related to the development of livestock production in Slovak Republic in past two decades. Livestock numbers have drastically fallen over the past 30 years (cattle -30%, pigs -80%), leading to a significant decrease in manure, a vital organic fertilizer for maintaining soil fertility. Despite livestock's importance to food security, plant production receives disproportionately more support than animal agriculture. Compost produced from the organic fraction of municipal waste can serve as a viable alternative to declining manure supplies. However, the quality of the compost is paramount. It is essential to invest in research and technology that ensures high-quality compost production, with a key focus on preventing the presence of microplastics.

3. **Promote bio-based industries**

Encourage the development of local bio-based industries, including bioenergy production and biogas facilities, that utilize organic waste, thereby enhancing regional value chains and providing renewable energy solutions.

Operational Objectives

a. **Implement educational programs** – launch targeted educational campaigns that engage local communities in sustainable practices and promote awareness of the importance of the bioeconomy in achieving environmental and economic goals (similar as the educational campaign described in chapter 3).

b. **Develop collaborative networks** – foster partnerships between local governments, universities, businesses, and NGOs to facilitate knowledge sharing, resource pooling, and the development of innovative solutions tailored to local needs.

c. **Monitor and evaluate progress** – establish indicators to track the effectiveness of implemented strategies, ensuring continuous improvement and adaptation of policies to meet the evolving needs of the Nitra region (more in chapter 6).

d. **Secure funding and investment** – identify and leverage funding opportunities from national and EU sources to support the implementation of bioeconomy initiatives, maximizing available resources for infrastructure development, research, and community projects.

5 KEY ACTION FIELDS FOR IMPLEMENTATION

5.1 IMPROVING BIO-BASED BUSINESS MODELS

In line with the findings of WP4.2 Research on bio-based business models, Slovakia's bio-based economy is still developing, with significant potential driven by the country's agricultural resources, emerging technological advancements, and increasing market demand for sustainable products. However, the sector faces numerous challenges, including regulatory hurdles, economic barriers, and a lack of awareness among farmers and consumers. Slovakian companies are pioneering efforts in their respective fields, focusing on sustainable products that contribute positively to both the environment and society. In the period between May and July 2024, BEC has conducted 4 interviews with local bio-based businesses to analyse adaption factors and impact. 4 interviewees were 2 food-oriented bio businesses and 2 producers of organic fertilizers and compost.

Among the identified key drivers of these businesses there is a growing demand among consumers for organic and sustainable products, which is seen as a significant driver for the bio-based economy in Slovakia. It has been observed that increased awareness of health and environmental issues among consumers contributes to rising interest in organic nutritional supplements. The ability to focus on quality and obtain certifications, opens new market opportunities beyond Slovakia. Furthermore, technological advancements play a crucial role as well. Innovating within the agricultural sector through research and development is critical for creating effective organic fertilizers. Enhanced product technology has been noted as beneficial in improving soil fertility while maintaining environmental sustainability. Organizational strength and commitment to sustainability are recognized as key factors in the sector's development. Additionally, effective business-to-business (B2B) and business-to-farmer (B2F) sales strategies have facilitated strong client relationships, leading to expanded market reach.

On the other hand, barriers and challenges were recognized despite these positive factors. Several barriers hinder the growth of the bio-based sector. Economic challenges, especially price sensitivity and intense competition from conventional products, are significant obstacles. Many consumers continue to prioritize cost over sustainability, making it difficult for organic products to compete effectively in a price-driven market. Higher costs associated with organic ingredients are seen as a barrier to scaling operations and entering new markets. Political and institutional challenges also pose considerable difficulties. Inconsistent regulations and bureaucratic hurdles complicate the production and distribution of organic fertilizers. While some government funding exists for research and innovation, the lack of clear, supportive policies for organic farming creates uncertainty that hampers business growth. Social barriers, particularly low awareness among farmers about the benefits of organic soil conditioners, further limit market growth. Many farmers are unfamiliar with the advantages of using organic products, which restricts market penetration for these solutions. Overcoming the inertia of traditional farming practices and convincing farmers to switch from chemical fertilizers to organic options remains a challenge.

Social impact

The bio-based sector significantly influences social outcomes, particularly in job creation and educational opportunities. It provides stable job options in regions where employment is limited and engages in collaborations with local vocational schools, thereby offering students practical experience in organic food production. Internships and employment of local individuals are also contributing positively to community engagement and well-being.

Environmental impact

Products in the bio-based sector contribute to environmental sustainability by enhancing soil fertility and reducing toxicity, making them valuable for sustainable agriculture. However, the environmental benefits are sometimes overshadowed by the carbon footprint associated with the transportation of raw materials and finished products. While the products themselves present significant benefits, the logistics involved can create challenges that need addressing. Additionally, the need to import certain bio ingredients from other continents leads to increased CO2 emissions related to transportation.

Economic impact

Expanding product offerings in the bio-based sector holds economic promise. Diversification and innovation are viewed as critical components for maintaining competitiveness amid fluctuating demand and strong competition. Opportunities exist to enhance agricultural yields through the adoption of organic fertilizers, which not only improve soil quality but also offer compelling economic incentives for farmers. Nevertheless, the barriers of low demand and price sensitivity must be overcome to fully realize these opportunities.

Furthermore, there are prospects for growth through expansion into new markets. Efforts to explore export opportunities to different regions indicate a positive outlook for market development, supported by organizational infrastructure that ensures product consistency and quality.

Two strategies for improvement of business models in local bio-based sectors might be:

1. **Facilitate market access by establishing the platforms for local bio-based businesses** to connect with potential customers, investors, and larger supply chains.
2. **Incentivize innovations by creating financial incentives and support mechanisms** for businesses adopting sustainable practices and innovative technologies in waste management and bioeconomy. Here there is a space for the regional governance (NSK) to facilitate the support mechanisms for these incentives.

5.2 ACTIONS / INTERVENTIONS

The proposed key action fields aim to advance the bioeconomy strategy's goals by prioritizing effective waste management, fostering community engagement, and promoting the development of local bio-based industries in the Nitra region.

Actions:

Enhancement of waste separation and collection

To enhance the waste separation and collection the local municipalities should start with implementation of color-coded, smart waste bins for better waste sorting at the source. Another key action is designed door-to-door collection systems tailored to the local waste composition, increasing the frequency of organic waste collection.

Awareness raising and community engagement

As mentioned above one of the key problems in building the bio-based market in Slovakia is the low awareness among the consumers. On the other hand, consumers with low awareness on bio-based products do not perceive the hierarchy of waste management where the most important level is the waste prevention by conscious consumer. Comprehensive educational initiatives targeting waste separation, composting, and the benefits of bio-based products can empower communities to adopt sustainable practices, increase awareness of environmental issues, and foster a culture of responsibility towards resource management, ultimately leading to enhanced waste reduction and improved environmental outcomes. Also, engaging local schools in education programs about waste management and sustainable practices, fostering a culture of responsibility among future generations.

Developed infrastructure for waste management

Investing in robust waste management infrastructure is critical to advancing the bioeconomy in the Nitra region, involving the establishment of accessible composting facilities and biomethane production units that meet quality standards. These composting facilities will effectively process biodegradable waste – such as food scraps, yard waste, and agricultural residues – transforming them into high-quality compost that enhances local soil fertility and reduces reliance on chemical fertilizers. Biomethane production units will convert organic waste into renewable energy, providing an alternative energy source that reduces the amount of waste sent to landfills and lowers the carbon footprint of waste collection operations. Additionally, creating dedicated collection points for hazardous waste and recyclables will ensure proper disposal and promote environmental safety, encouraging community participation in waste separation initiatives. Integrating these infrastructures with comprehensive educational programs will further amplify their effectiveness by informing residents about the importance of waste separation and the benefits of composting.

Encourage circular economy practices

According to INCIEN, municipalities must play a central role in addressing the climate crisis by implementing circular economy solutions to maximize their impact. The way we produce, use, and dispose of or valorise products and food accounts for nearly half of global greenhouse gas emissions and at least 90% of biodiversity loss and freshwater scarcity. The circular economy is not merely waste management; it is about resource management. The first phase involves preparation and planning, which includes steps such as fostering collaboration among stakeholders, analysing local contexts and resource flows to identify untapped assets, gathering successful circular examples, and considering circular opportunities for priority sectors and urban services. Creating a circular vision and strategy with clear goals follows. The second phase focuses on assistance and action, which entails training and educating to mobilize individuals, businesses, and civil society, creating a favourable environment for circular enterprises, advocating for and procuring circular assets

and services, nurturing circular businesses, and catalysing circular innovations for practical implementation. The third phase emphasizes investment and implementation, which includes connecting producers and potential users of surplus resources, extending the lifespan and utility of assets, building circular infrastructure, directing financing toward circular projects, and reporting on progress in the circular economy through continuous monitoring. Small steps toward the circular solutions could include promoting the community-centred initiatives such as “Reuse Centres” where residents can donate or buy second-hand items, minimizing waste and encouraging resource recovery. Support local farmers in integrating organic fertilizers (produced from municipal waste) into their agricultural practices to enhance soil health is another solution which is vital given the agricultural focus of the region Nitra.

Strengthen stakeholder collaboration

Establishing a regional bioeconomy stakeholders’ network is essential for bringing together regional governance, municipalities, businesses, NGOs, and the agricultural sector to facilitate knowledge sharing and resource pooling. This collaborative network can serve as a platform for organizing regular forums and workshops, ensuring continuous dialogue and collaboration among all stakeholders. Additionally, by partnering with local universities, the network can explore joint funding propositions for innovative waste management projects, further enhancing the region's capacity to effectively address bioeconomic challenges and implement sustainable practices. Through these combined efforts, stakeholders can not only strengthen their individual initiatives but also create a cohesive and supportive community focused on advancing the bioeconomy in the region.

Leverage funding opportunities

Identify and pursue funding from national and EU sources for bioeconomy initiatives, including investments in infrastructure and research can significantly enhance the development and implementation of regional bioeconomy strategies, particularly in areas like waste management and sustainability. The Nitra region, recognized for its agricultural production, has substantial potential to leverage funding from EU initiatives, national programs, and local partnerships to establish a robust circular economy. Also using initiatives InvestEU Advisory Hub The Circular City Centre - C3 (https://advisory.eib.org/about/circular-city-centre.htm) can support municipalities in developing and funding bioeconomy oriented projects. By aligning with the Roadmap for Circular Bioeconomy recently developed by the MARD, local governments and stakeholders can tap into financial resources dedicated to projects that promote innovation in waste processing, renewable energy, and sustainable agriculture, also utilizing VAIA as an information source (Výzvy z Plánu obnovy – Výskumná a inovačná autorita). Engaging in collaborative efforts through initiatives like the Biomodel4Regions project can also facilitate access to grants and expertise, enabling the Nitra region to implement effective waste management systems that not only reduce landfill dependency but also enhance local economic resilience. Developing comprehensive, region-specific strategies that focus on stakeholder education and community involvement in bioeconomy practices will be vital in unlocking these funding opportunities and ensuring long-term sustainability.

6 MONITORING, EVALUATION AND LEARNING

Effective monitoring, evaluation, and learning (MEL) are essential components of the bioeconomy strategy implementation focused on the waste management within the Nitra region. MEL outlines a comprehensive framework for assessing the performance of bioeconomy initiatives, enabling stakeholders to adapt to challenges, optimize resource use, and continuously improve strategies over time.

I. Monitoring

Data collection will be crucial, utilizing sources such as the RISO information system, waste generation reports, landfill records, and data from the Slovak Statistical Office. This will track key indicators:

1. **Waste generation** – monitoring of the generation of municipal, industrial, and hazardous waste, disaggregated by type. Historical data comparison and establishment of benchmarks will identify trends and potential issues.
2. **Waste diversion** – tracking of the success of waste diversion efforts. Key indicators include the percentage of waste recycled, composted, and landfilled, with specific targets per the "Binding Part of the Waste Management Program for Nitra 2021-2025“ section regarding municipal waste.
3. **Separate collection** – monitoring the tonnage and percentage of separated waste collected, including paper, plastic, metal, glass, biowaste, and other materials. The current aim is to achieve a 60% separation rate by 2025.
4. **Waste treatment capacity** – tracking the capacity utilization of waste treatment and disposal facilities (landfills, composting plants, incineration plants) to identify potential capacity constraints.
5. **Financial performance** – monitoring the budget expenditures against planned allocations, highlighting any variances and potential cost overruns.
6. **Frequency** – data collection frequency. Data will be collected annually, with quarterly reporting on key indicators to enable timely intervention when necessary.
7. **Reporting** – compiled reports submitted to relevant stakeholders, including the DON and other responsible parties.

II. Evaluation

The effectiveness of the program will be evaluated using a combination of quantitative and qualitative methods. Quantitative analysis will assess progress toward program goals through the examination of collected data from monitoring activities, while qualitative data will be gathered from stakeholders – including municipalities, waste management operators, and citizens – through surveys, interviews, and focus groups. Comprehensive evaluations will take place annually, aimed at determining overall success and extracting valuable lessons learned. Additionally, the program may consider an independent external evaluation to provide unbiased feedback, thereby enhancing its credibility.

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III. Learning

Findings and lessons learned from monitoring and evaluation activities will be shared among stakeholders to promote continuous improvement, while feedback from these processes will guide adjustments to program strategies and implementation plans, ensuring responsiveness to evolving needs. Additionally, all monitoring, evaluation, and learning activities will be meticulously documented, encompassing methodologies, data, analyses, and recommendations for future enhancements, thereby fostering a systematic approach to knowledge sharing and adaptive management.

IV. Reporting

Regular internal and external reports will be vital for tracking progress and communicating successes and challenges. These reports will be formatted to ensure accessibility and understanding for various stakeholders.

By focusing on data-driven decision-making and stakeholder involvement, the region can effectively harness its potential, driving toward a sustainable and resilient circular economy. Regular assessments will not only help in identifying areas for improvement but also foster a culture of continuous learning and adaptation within the region's bioeconomy initiatives.

7 OUTLOOK

The Nitra region stands at a pivotal moment in developing its bioeconomy strategy, particularly in waste management. As Slovakia lacks a dedicated national strategy for bioeconomy, regional efforts must align with the recent "Roadmap for Circular Bioeconomy" released by the MARD. This roadmap outlines crucial pathways needed to drive sustainable practices across various sectors, including agriculture, renewable energy, and waste management. Collaboration among regional stakeholders, including the BEC, PZO, the NSK, and local communities, is essential. Their engagement in the process will be key to addressing the challenges that have historically hindered sustainable waste management practices, such as the need for community awareness, effective legislation, and appropriate technological solutions for waste processing.

Key areas of focus

The key areas for future emphasize enhancing waste separation systems, implementing educational initiatives, and creating robust infrastructures for better waste management. Upcoming discussions among the stakeholders involved in this blueprint will focus on best practices for improving recycling rates, promoting composting, and developing biomethane production facilities. Furthermore, with the expected legislative changes on waste management fees and adherence to EU recycling targets nearing, the urgency for a well-defined strategy intensifies.

Planned next steps

Through the implementation of the BIOMODEL4REGIONS project, we had the opportunity to engage with a diverse array of stakeholders pivotal to the development of a comprehensive strategy for the Nitra region. Their insights are invaluable not only for crafting the bioeconomy strategy but also for implementing concrete steps that will advance waste management initiatives. One of the key players in this process is the NSK. Currently, NSK does not possess designated competencies regarding waste management; however, our findings indicate that their involvement would be immensely beneficial in promoting and facilitating the successful implementation of the bioeconomy blueprint. The engagement of NSK in this blueprint represents a significant opportunity to bridge the existing gap in regional waste management capabilities. By encouraging NSK to adopt a more active role, we believe we can lay the groundwork for their future participation in addressing waste-related challenges. Their current mandate includes securing investments through their Integrated Regional Strategy, which could be leveraged to support waste management initiatives. However, this is just the starting point; ongoing collaboration and commitment from NSK will be essential to enhance their capabilities and response to regional waste management needs.

Furthermore, it is imperative to reconsider the region's strategic priorities concerning bioeconomy. Observing the neighbouring Banská Bystrica region, which has clearly established bioeconomy as a top priority, it becomes evident that the Nitra region has the potential to similarly prioritize its bioeconomy strategy, particularly with a strong emphasis on waste management. As the most rural area in Slovakia, the Nitra region is well-positioned to address its municipal waste issues, especially considering the upcoming changes introduced by the MoE legislation, which will significantly reform the waste management system. A major

challenge confronting municipalities is the currently low levels of waste separation, which leads to significant volumes of recyclable materials being mixed. Notably, the organic fraction constitutes the largest segment of mixed municipal waste. This organic waste is not only a major contributor to landfill methane emissions but also represents a lost opportunity for resource recovery. The mandated implementation of mechanical-biological treatment (MBT) necessitates the segregation of organic materials prior to landfilling, creating an urgent need for improved waste separation practices among residents.

Effective separation can mitigate the financial burden imposed on municipalities and their inhabitants; especially as higher waste management fees are anticipated due to the new legislation. A key focus of these separation efforts should be on biodegradable waste, which can be converted into valuable products such as compost and bioenergy in the form of biomethane. The successful valorisation of biodegradable waste hinges on effective separation, collection, and advanced technological treatment strategies. Recognizing the rapid technological advancements in waste management, BEC and PZO have explored various solutions for processing not only plant-based biodegradable waste but also the animal component. PZO's existing composting facility has provided a substantial foundation for this exploration, where we examined the feasibility of utilizing the container method for waste hygienization. This technique allows for biological treatment that effectively reduces waste mass and eliminates pathogenic microorganisms, thereby enhancing waste processing capabilities. However, guidance from the Central Control and Testing Institute in Agriculture (UKSUP) indicated that to test the hygienization process adequately, the entire composting facility would need to be temporarily closed. Despite this setback, we are committed to pursuing these developments further, as integrating the processing of animal waste into PZO's operations would significantly enhance compost production and contribute to biomethane generation. The production of biomethane is crucial, as it possesses the potential to power PZO's waste collection vehicles, thereby reducing operational costs and contributing to the region's sustainability goals. Considering these considerations, our strategic plan will focus on the following key areas:

Enhancing waste separation practices – focused on development of targeted community awareness programs emphasizing the importance of waste separation, with specific campaigns tailored to biodegradable waste.

Searching for opportunities to invest in advanced waste processing technologies – promoting the adoption of innovative treatment solutions for both plant and animal-based waste, ensuring that PZO can effectively operate and comply with new regulations.

Collaboration with NSK for investment and support – we will continue our lobbing activities closely with NSK to channel regional investments towards bioeconomy initiatives, ensuring that financial resources are allocated to critical projects in waste management.

Develop the potential for establishing pilot programs for composting and biomethane production – utilizing existing infrastructure within PZO to launch pilot programs that demonstrate best practices in composting and biomethane production, serving as models for replication across the region.

Sustaining long-term engagement with stakeholders – maintain an ongoing dialogue with stakeholders, including local communities, municipalities, and businesses, to foster collaboration and shared responsibility for achieving the bioeconomy goals.

7.1 KEY ACTIONS

Collaborative workshops – the BEC plan to schedule additional workshops with stakeholders to further refine the bioeconomy strategy, focusing on community needs and available resources.

Pilot projects – under the responsibility of establishments like PZO is to implement pilot initiatives for waste separation and composting in selected municipalities to serve as models for broader implementation.

Funding opportunities – exploring not only national but also EU funding sources to support the development of infrastructure for composting, recycling, and waste processing units.

Key open questions

How can the BEC effectively engage the community in the waste management process to ensure high participation rates?

What specific technologies can be employed to enhance the quality of compost produced from organic waste?

How will the BEC measure the success of implemented strategies in meeting EU recycling targets?

SUMMARY

Slovakia currently lacks a coherent national or regional strategy for bioeconomy. Although the concept is gaining traction, it remains complex and poorly understood at the policy level. Recently, the MARD introduced a "Roadmap for Circular Bioeconomy," which provides a framework for fostering sustainable practices across various sectors, including carbon farming, renewable energy, biomass utilization, biogas, organic fertilizers, and wastewater treatment.

Despite the roadmap, implementing effective bioeconomy strategies at the regional level faces significant challenges due to inadequate communication and cooperation. Local actors are essential to driving the bioeconomy forward, as they can better address the needs of their communities. The Nitra region, recognized as a pilot area within the Biomodel4Regions project, is uniquely positioned to develop a tailored bioeconomy strategy focused on sustainable waste management.

Nitra's economy benefits from diverse agricultural production, alongside strong industrial sectors such as automotive and machinery. The predominantly rural nature of the region, comprising 339 municipalities, necessitates a strategy that reflects local specificities and fosters innovation, entrepreneurship, and environmental sustainability. The proposed bioeconomy strategy prioritizes a functional waste management system to address the pressing issues of excessive waste generation, rising disposal fees, and failure to meet EU recycling targets.

Key stakeholders involved in the development of this blueprint include local governments, the BEC, and the PZO. The PZO has established itself as a best practice model in waste management innovation, focusing on efficient waste processing and community engagement. The blueprint emphasizes collaboration among these stakeholders to optimize waste management practices, enhance resource recovery, and promote educational initiatives for residents.

Following stakeholder engagement and analysis, the blueprint identifies critical areas of action, including improving separation and collection systems for biodegradable waste, investing in advanced waste processing technologies, bolstering collaboration with regional authorities like NSK, and implementing pilot programs for composting and biomethane production. Community involvement and awareness campaigns are essential to fostering responsible waste practices.

Overall, the blueprint outlines a pathway for the Nitra region to capitalize on its bioeconomic potential. By integrating effective waste management strategies that prioritize biodegradable waste recovery and converting it into compost and bioenergy, the region can achieve significant environmental, economic, and social benefits, positioning itself as a leader in circular economy practices. Continuous dialogue among stakeholders is crucial to ensure the successful implementation of these strategies, with a focus on achieving local and European sustainability goals.

Annex-03

Towards a Bio-Based Economy in Normandy Region (France)

A BIO-BASED ECONOMY IN Normandy

A bioeconomy strategy blueprint, prepared in the frame of the BioModels4Regions project

This document has been prepared in the framework of the European project "BIOMODEL4REGIONS – Supporting the establishment of the innovative governance models to achieve better-informed decision-making processes, social engagement, and innovation in the bio-based economy".

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 101060476.

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December 2024

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List of Abbreviations

Abbreviations	Signification in French	Explanation in English
MONKEY	Appel à projet	Call for proposals
ADEME	Agence de la transition écologique	The French Agency for Ecological Transition
Aquimer	–	A French competitiveness cluster specializing in adding value to aquatic products
AREA	Association Régionale des Entreprises Alimentaires de Normandie	Organization that supports the development and promotes the agri-food sector
BCIB	AAP Biomasse Chaleur pour l'Industrie du Bois	Call for proposals of Biomass Heating for the Wood Industry
Carnot I2C	Innovation Chimie Carnot	A major player in French partnership research in chemistry
ChemTech	communauté des startups de la Chimie.	Chemistry startups network
Cosmetic Valley	–	An organization that brings together, coordinates and supports companies, research centres, universities and schools in the French perfumery-cosmetics sector
CPIER	Contrat de Plan interrégional Etat-Région	Plan contract between French State and a Region
GRIT	Chambre d'Agriculture de Normandie	Regional Chamber of Agriculture, Normandy
ECOMER	Club Mer Economie Circulaire	Circle promoting the circular economy for seafood professionals
FULL DELIVERY	Festival de l'Excellence NOrmande	Annual event for excellence in Normandy
France Chemistry Normandy	–	A trade organization dedicated to chemical companies
IDCosm	Plateforme d'innovation pour l'industrie cosmétique	Platform for cosmetic innovation
Polyvia	–	A major professional organisation in France, representing the interests of plastics and composites manufacturers.
SNOTRA	Sargasses de NOrmandie : valorisaTion d'une Ressource Algale	NOrmandy's Sargassum: developing an algal resource
Valorial	–	An agri-food competitiveness cluster catering for north-west France and brings together 390 industrial firms, research centres and higher education establishments, to focus on developing smarter food.
SRADDET	Schéma régional d'Aménagement, de Développement Durable et d'Egalité des Territoire	Regional blueprint for planning, sustainable development and territorial equality

1 INTRODUCTION

The Normandy Region published the Normandy bioeconomy strategy for the period 2023-2025 in March 2023 and presented it at the Salon International de l'Agriculture (International Agricultural Show), a key annual event for discovering the world of French agriculture.

This document sets out the successive steps that led to Normandy's ambition for a bioeconomy strategy. In collaboration with the stakeholders involved in Normandy's bioeconomy, the priorities were defined based on the biomass resources available in Normandy. Finally, a critical analysis of the 2023-2025 bioeconomy strategy in Normandy was carried out by the stakeholders, showing the additional actions to be put in place to achieve the objectives defined in the Normandy bioeconomy strategy. New proposals and recommendations to be included in the next programming of the Normandy bioeconomy strategy are suggested to develop new areas of development for the bioeconomy and consider some new bioeconomy themes.

2 OBJECTIVES & SCOPE

Normandy's bioeconomy strategy aims to position the region as a key player at national and European level in this field. It is part of an overall approach to ecological and economic transition, making the most of Normandy's specific assets. It has been defined different main objectives:

- **Accelerate the development of the bioeconomy**: By encouraging the creation of new sectors, supporting innovation, and strengthening the competitiveness of Normandy businesses.
- **Develop a circular economy**: By making the most of local resources, reducing waste and minimising environmental impact.
- **Creating added value and jobs**: By stimulating investment, developing new products and services, and strengthening the skills of local stakeholders.
- **Enhance the attractiveness of the region:** By positioning Normandy as an innovative and dynamic region in the field of bioeconomy.

Normandy's bioeconomy strategy is already defined in the last 18 months. So, the document scope is to set out how bio bioeconomy strategy In Normandy has been defined and what the foundations of this strategy are. The current strategy is then presented. And finally, the stakeholders evaluated the strategy after 18 months during a workshop. The results of the discussions identify the barriers and opportunities for this bioeconomy strategy in Normandy, as well as the priorities that could be added to the strategy in its next scheduling.

3 BASELINE AND ANALYSIS OF LOCAL CONTEXT

3.1 NATIONAL POLICY CONTEXT

Figure 1. Regions in France with regional strategies
Source: Haarich et al., 2022

In 2015, France initiated work to develop a national strategy for the bioeconomy with the aim of developing biomass resources, making better use of them, and improving knowledge of what is already known. In 2016, France defined its national strategy for mobilizing biomass. In 2017, the National Strategy for the Bioeconomy was launched, showing France's willingness to define a framework for the use of bioresources. This was followed by an action plan for the period 2018-2020 which deliberately focused on the non-food uses of the bioeconomy.

The objective of these different national strategies is to promote the development of regional plans and strategies that the French regions must initiate, considering their regional specificities.

In 2018, the Normandy Region relied on national strategies to develop its first regional biomass plan, which aims to:

- draw up an inventory of the Normandy situation of biomass production, mobilisation, and consumption, considering on how public policies have an impact on biomass management.
- determine the quantitative objectives of development and mobilization with the modalities of evaluation and monitoring.

This regional plan was drawn up by the State and the Normandy Region with the support of the territory's stakeholders (local authorities, economic stakeholders, environmental protection associations, etc.).

As a reminder, the Normandy Region is particularly marked by a strong presence of the agricultural sector and with its 640 km of coastline, the fishing and aquaculture sectors are also very present with all the stakeholders in the marine sector represented.

In 2022, the Normandy Region initiated work with all stakeholders to develop the Normandy bioeconomy strategy. Work has been undertaken with the various stakeholders (institutions, companies, technical centres, clusters, etc.). A complete territorial diagnosis has been carried out on the five sectors of the Normandy bioeconomy: plant proteins, blue bioeconomy, natural fibres for use as materials, bioenergy, and bio-based chemistry. General assemblies have been created to find out the needs of the territory's stakeholders. Following this, in 2023, the

Normandy region established its 2023-2025 regional bioeconomy strategy in which operational objectives were defined for each priority sector.

In parallel with this work, cooperation between the Normandy Region and the Grand Est and Haut de France Regions has been initiated. They have taken collective action to join forces on common issues such as plant proteins and plant fibres. These levers will make it possible to develop Research and Development and innovation and facilitate the acceleration of transitions.

These regions have jointly launched calls for expressions of interest to find out what companies need

3.2 BASELINING GOVERNANCE MODEL AND IMPLEMENTATION ECOSYSTEM FOR THE BIO-BASED ECONOMY

3.2.1 Methodology for bioeconomy governance assessment

The analysis of bioeconomy governance model in Normandy is based on the governance framework developed in the BIOMODEL4REGIONS project. This framework (image below) represents different governance functions into three tiers of increasing: basic governance functions (Tier 1), specific governance functions (Tier 2) and assessment criteria (Tier 3). 50 indicators assess theses governance functions.

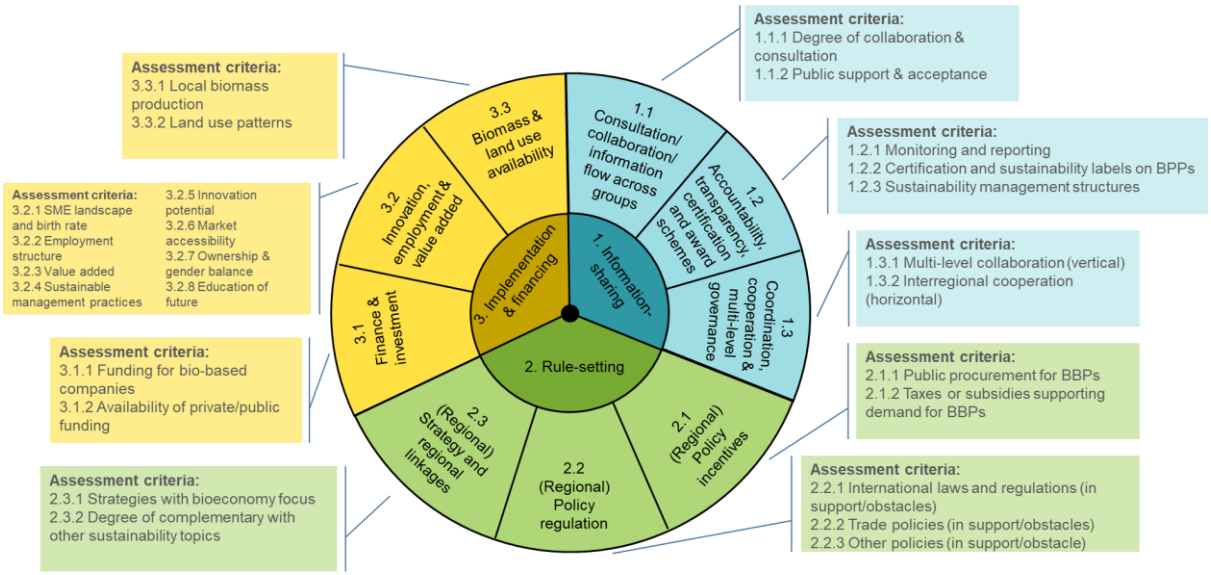

Figure 2. Governance framework (three tiers) to address the bioeconomy governance state of arts in Pilot Regions

Tier-1: Primary governance functions

Primary governance functions are established to denote the most basic purpose of governance, derived from Andonova et al. for the climate governance context. Basic governance functions include:

- **Information-sharing** – including all types of information flow (e.g., information, consultation, co-creation etc.) both vertically between different levels of e.g., governments and horizontally between different actors (or actor groups) within the governance system.
- **Rule-setting** – denoting the basic function of governance to set the framework conditions, rules and norms for the interaction and transaction of actors within the governance system.
- **Implementation and finance** – covering all aspects of the macro-economic sphere both monetary and *biophysical* (see Pauliuk et al., 2017) that are related to implementation and realisation of the transition from a linear, fossil-based economy to a more circular, bio-based one.

Tier-2: Functional fields of bio-based economy governance

The second tier includes functional governance fields for the bio-based economy (in principle also applicable to other areas), breaking down the three primary governance functions identified in Tier-1. These functional governance fields are not exclusively focused on regional level actors, but mostly span across multiple governance levels.

- **Consultation, collaboration, and information flow across actors** – including all types of information flow for all types of purposes and between all actor groups.
- **Accountability, transparency, certification, and award schemes** – covering any types of practices between actor groups that are designed to promote transparency and accountability in production and consumption (industrial sphere) or monitoring and reporting (public sphere).
- **Coordination, collaboration, and multi-level governance** – including any practices or formalised mechanisms for collaboration and coordination in place, both horizontally and vertically (multi-level governance & multi-level collaboration).
- **Policy incentives** – comprising all types of policy-induced incentives to stimulate and favour bio-based production and consumption such as taxes, subsidies, bans or other ways of *internalising externalities* (see Bithas, 2011).
- **Policy regulation** – including all types of regulations along the bio-based value chain and across multiple government levels (including EU level), e.g., relevant trade, agriculture and health regulations, EU By-product Criteria, EU End-of-Waste Criteria, Food Packaging and Clean Energy, etc.
- **Regional strategy and regional linkages** – refer to the kind of regional bio-based economy strategy and vision setting by the regional government (and its related institutions) as well as to the depth of integration and linkages with other regionally mandated tasks as well as economic and sustainability strategies (e.g., climate change, circular economy, resilience etc.).
- **Finance and investment** – referring to the different types of public and private financing and investment and its availability in the national or regional context.
- **Innovation, employment, and value added** – involving the structure of the regional and local bio-based markets and its interlinkages with the national level. It also involves innovation potential, sustainable management practices and the employment structure

(e.g. agriculture vs. high-tech sectors) within those markets as well as the gross value added per bio-based sector.

- **Local biomass production and land use** – including the types and quantities of bio-based feedstock materials circulated in the bio-based economy as well as a stock-taking of the prevalent regional land-use patterns.

Tier-3: Assessment Criteria and Key Performance Indicators (KPIs)

Assessment (or evaluation) criteria have been developed to provide the means to evaluate the results of the application of the analysis model. The initial set of indicators (developed by Wageningen and complemented by ICLEI in the BIOMODEL4REGIONS project) should be used to verify the performance of a given criteria. The evaluation of assessment criteria in turn through KPIs (both qualitative and quantitative indicators), help identify challenges and opportunities.

3.2.2 Bioeconomy governance assessment results

The analysis of Normandy's governance highlights several strengths, but some weaknesses still exist despite the strategy. The graph below shows these levels of indicators: the scoring is 0 (further below the target), 1 (below target), 2 (in track for target), 3 (on target).

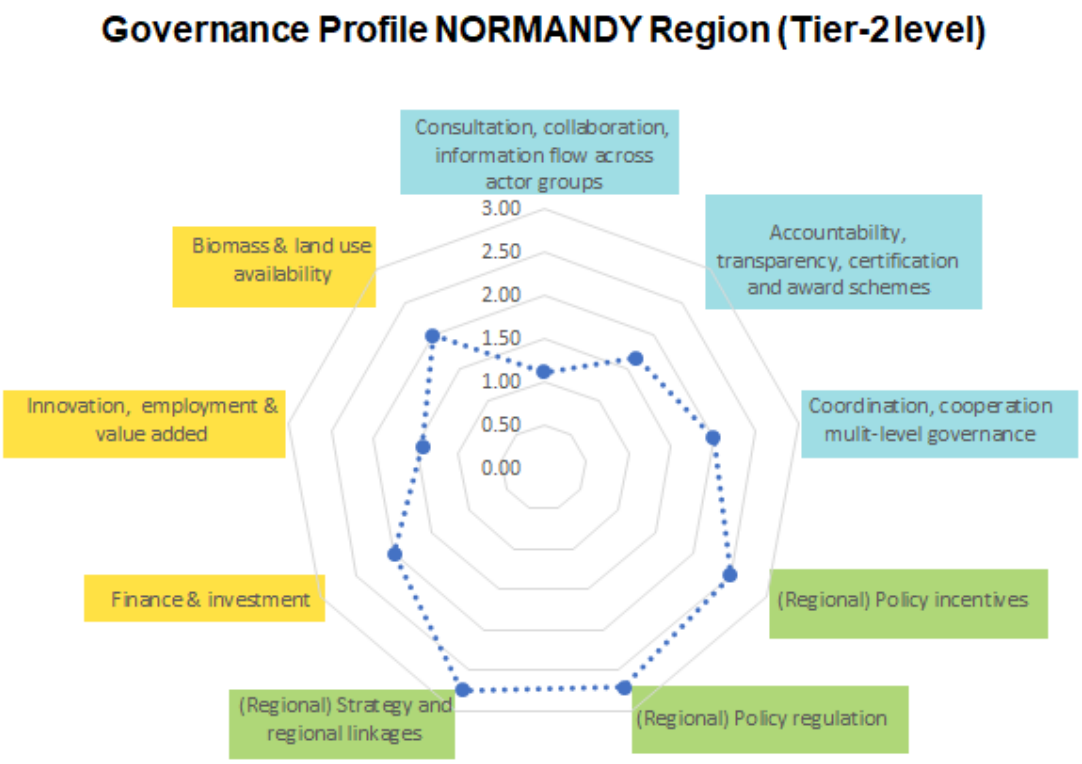

Figure 3. Governance Profile Normandy spider graph base on Tier-2 level

The **Rule Setting** area (in green) is the most strength in Normandy's bioeconomy governance. Normandy has defined a bioeconomy strategy, and these indicators shows that it has almost hit the target. The current regulations and incentives are so very developed. The three indicators level are very characteristic of a strategy recently in place but there is still some way to go to reach the target. Regional policies and regulations are effectively employed to incentivize the adoption of bio-based products and technologies, demonstrating a clear commitment to sustainability and innovation.

The **information-sharing** area (in blue) shows a disparity of results indicators. The coordination and multi-level governance is at a middle target showing good exchanges between local, regional, and national governance level but it can be improved. The collaboration between stakeholders is very insufficient and is the most significant weakness of all governance indicators. Many of actors would like a better cooperation however there is no regional coordinator to federate the stakeholders to improve joint efforts.

The **Implementation and financing** area (in orange) is identified as the weakest area within Normandy's governance profile, due to challenges with Consultation and Collaboration, within which Public Support & Acceptance was shown to be a particular issue. The region has room for improvement in fostering awareness of and appreciation for the region's bioeconomy activities. Under-developed structures for collaboration and consultation between stakeholders and the public may limit the region's ability to foster a cohesive and integrated bio-based economy.

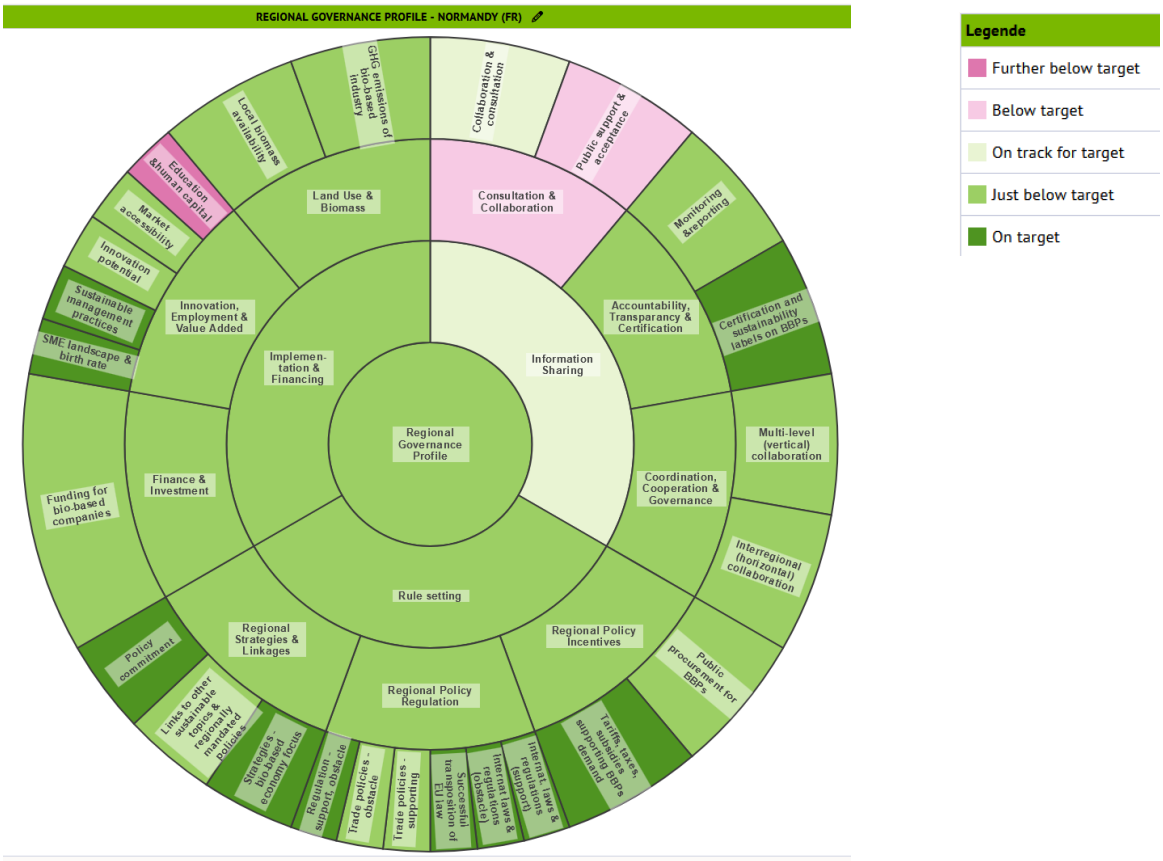

Figure 4. Governance Profile Normandy presented through a sunburst chart and based on three tier levels. The colours indicate how far is the KPI from the target

Overall, the governance profile of Normandy highlights a region that is has a strong ecosystem of bio-based SMEs, sustainable production practices, and a supportive, committed policy and regulatory framework with effective linkages between relevant strategies. It found that addressing the challenges in consultation, collaboration and public awareness and support will be crucial for Normandy to further develop a more robust and sustainable bio-based economy.

Normandy must address the challenges in consultation, collaboration and public awareness and support will be crucial to further develop a more robust and sustainable bio-based economy. The following priority actions have been identified:

1. **Review and rationalize regulations to promote innovation and alignment.** Simplify regional and national regulations, while aligning them more closely with EU standards, could reduce administrative burdens and increase the competitiveness of local bioeconomy enterprises.
2. **Develop structures to promote collaboration among stakeholders**. Build strong collaborations could benefit from including partners from the public and private sectors, universities, research centres, and civil society.
3. **Raise awareness among the public, government officials and SMEs.** Inform the public about the existence and benefits of the bioeconomy in Normandy, government officials could improve their understanding of the landscape of bioeconomy stakeholders and tools.
4. **Increase SME's access to existing funding, and seek new funding sources for bioeconomy initiatives, such as EU funding for research and development.** Facilitate SME access to existing funding requires streamlining the application processes and providing tailored guidance to bio-based SMEs.
5. **Promote an inclusive transition to an equitable bioeconomy.** Ensure that processes that engage and consult stakeholders are accessible to people from all backgrounds.

The results obtained from the bioeconomy governance framework explained in this paragraph have been crosschecked with some interviews with stakeholder experts in Normandy.

4 A VISION FOR THE BIO-BASED ECONOMY IN NORMANDY

4.1 NATIONAL POLICY PRIORITIES

The **Normandy bioeconomy strategy** aims to develop a sustainable economic model, based on the use of renewable biological resources. It is part of a context of ecological and energy transition, and meets several major objectives:

- **Developing sustainable agriculture:** This involves promoting more environmentally friendly agricultural practices, such as agroecology, to reduce the use of pesticides and chemical fertilisers, preserve biodiversity and promote carbon sequestration in soils.
- **Recover biomass:** Biomass, from agriculture, forestry, and waste, must be optimally recovered to produce renewable energy (biofuels, biogas), bio-based materials (wood, textiles, biodegradable plastics) and chemicals from biomass.
- **Developing bio-based sectors:** The creation of bio-based sectors is essential to ensure the sustainability of the bioeconomy. This means supporting research and innovation, facilitating access to finance, and developing partnerships between the different actors in the value chain.
- **Supporting innovation:** Innovation is a key driver of the bioeconomy. The aim is to develop new technologies to improve the efficiency of production processes, create new products and find new applications for biomass.
- **Foster the energy transition:** The bioeconomy can contribute to the energy transition by providing renewable energy and reducing dependence on fossil fuels.
- **Preserving biodiversity:** The bioeconomy must be developed in a way that preserves biodiversity and ecosystems. It is therefore essential to put in place measures to protect the environment and promote sustainable agricultural and forestry practices.

To achieve these objectives, several levers are mobilized:

- **Financial support:** Financial aid schemes have been set up to support research, innovation, and development projects in bio-based sectors.
- **Regulation:** Regulation plays an important role in encouraging economic actors to adopt more sustainable practices and in promoting the development of the bioeconomy.
- **Awareness:** Raising awareness among the public and economic stakeholders about the challenges of the bioeconomy is essential to promote its development.

In summary, France's bioeconomy strategy aims to build a more sustainable, resilient, and competitive economy, based on the natural resources of its territories.

4.2 REGIONAL BIOECONOMY PRIORITIES IN NORMANDY

In 2022, The Normandy Region decided to be supported in developing the implementation of the Normandy Bioeconomy Strategy and has entrusted the Bioeconomy for Change (B4C) cluster with the carrying out of preparatory work to define its strategy.

B4C has drawn up **territorial diagnostic studies of the bioeconomy** on the above-mentioned themes. These diagnoses made it possible to establish the biomass present in the territory, the strengths, and opportunities for each of the priority axes as well as the actors present in the Normandy territory. In May 2022, the **General Assembly of the Bioeconomy in Normandy** was organised to identify the needs of the territory's stakeholders. This event brought together around 150 stakeholders to reflect on the issues, needs and challenges for the coming years in the field of the bioeconomy in Normandy. Various thematic workshops were held to help determine the action programme for the future Normandy bioeconomy strategy.

These various works are the basis for establishing the 2023-2025 bioeconomy strategy in Normandy. The Normandy Region aims to become a reference in the bioeconomy in France and Europe, thus promoting its leadership in this field.

The bioeconomy in Normandy involves a multitude of stakeholders, each of whom plays an essential role in the development of this sector. These stakeholders interact in complex ways to transform biological resources into sustainable products:

- **Farmers and foresters:** They are at the heart of the production of biomass, the primary resource of the bioeconomy. They play a crucial role in the sustainable management of agricultural and forest land, by adopting environmentally friendly practices.
- **Fishermen and fish farmers**: Marine biomass is very fragile, and its resources are not inexhaustible. These players therefore have an essential role to play in the preservation and sustainable management of fish, crustaceans, seaweed, etc.
- **Industrials:** They transform biomass into finished products such as biofuels, bio-based materials, and chemicals. They invest in new technologies and develop new markets.
- **Researchers and universities**: They carry out fundamental and applied research to improve production processes, develop new products and find solutions to environmental challenges.
- **Public authorities:** At local, regional, and national level, public authorities define the policies and regulations that govern the development of the bioeconomy. They provide financial support for projects, set up support systems and facilitate collaboration between the various players.

In cooperation with all stakeholders and regional policy actors, 5 key priority sectors have been defined, as follows:

- **Plant-based proteins and new sectors**: To position itself as one of the leaders in this sector by making the most of the results of various projects, by strengthening the support of the 5 protein sectors and by identifying new market needs.
- **Blue Bioeconomy:** Ensuring a favourable framework for the development of seafood by-products (fish, undersized mussels, shells, etc.), algae (macroalgae and microalgae) and emerging aquaculture (aquaponics, frogs farming, lobster hatchery, etc.).

- **Natural fibres for material and textile use:** Strengthening the structuring of the natural fibre sector by developing knowledge of bio-based solutions and raising awareness of the use of bio-based materials.
- **Bioenergy:** Continue to support the bioenergy sector, with a view to reducing energy CO2 emissions, and develop the anaerobic digestion sector.
- **Bio-based chemistry:** federating and structuring the bio-based chemistry sector by mobilising biomass such as wheat, rapeseed, straw, etc.

4.3 GENERAL OBJECTIVES OF A BIO-BASED ECONOMY IN NORMANDY

Normandy 's bioeconomy strategy aims to accelerate and support the structuring of the territory's five key sectors, while strengthening a common base to raise awareness of the bioeconomy among economic and research stakeholders and to support structuring projects in the region's key sectors.

The overall objectives of this strategy include:

- **Strengthening a common base:** Raising awareness among the public and economic stakeholder of the challenges of the bioeconomy, creation of an observatory to better understand biomass deposits.
- **The development of key sectors:** We support the structuring of five sectors (plant proteins, blue bioeconomy, natural fibres, bioenergy, bio-based chemistry) by promoting innovation, research, and collaboration between stakeholders. The bioeconomy can create new jobs, stimulate innovation, and strengthen the competitiveness of Normandy companies.
- **Enhancement of local resources:** We encourage the use of local biomass (plant, marine, etc.) to develop high value-added products and services, by creating short circuits and reducing transport costs.
- **A more diversified agriculture:** By developing new sectors, such as vegetable proteins or natural fibres, the Normandy Region can offer new opportunities to farmers and diversify their incomes.
- **Sustainable development:** Integration of the principles of the circular economy, reduction of the environmental footprint, preservation of biodiversity. The aim is to reduce dependence on fossil resources and minimise environmental impact.
- **A response to societal challenges:** The bioeconomy can contribute to meeting major challenges such as food security, the energy transition, and the fight against climate change.
- **Awareness and training:** We set up awareness-raising actions to make the challenges of the bioeconomy known to the public and economic actors. We are also developing training courses to support companies and local authorities in their transition to the bioeconomy.
- **Research and innovation:** We support basic and applied research to develop new technologies and products from biomass.

4.4 STRATEGIC & OPERATIONAL OBJECTIVES IN BLUE BIOECONOMY

The Normandy Region has defined two major fields for the development of the **blue bioeconomy**. The ambitious goals require the mobilisation of all stakeholders to develop structuring projects.

Normandy wants to continue the structuring of new future sectors for its territory. That's why it defines operational actions to develop micro/macro algae and emerging of aquaponics. these strategic actions defined in the blueprint are:

- **Federate the actors of the algae sector**: Facilitate the structuring of the different algae sectors (micro and macro) by creating a shared space for exchanges and collaborations. As a result, a Normandy Algae Sector association was created in May 2024 bringing together all the stakeholders in the macroalgae sector: institutions, representatives of the aquaculture sector, industrialists, technical centres, competitiveness clusters, local authorities, etc.
- **Promote the emergence of new projects**: initiate regional events to identify and connect aquaculture project leaders with the existing ecosystem. To bring out projects between the blue bioeconomy and the cosmetics industry by communicating via the innovation platform dedicated to project leaders.
- **Facilitate the structuring of emerging aquaculture sectors**: To help the economic development of aquaponics stakeholders by supporting them in the structuring of their activities and by promoting the emergence of new aquaponics farms in Normandy.
- **Promote the Normandy seaweed sector to the cosmetics industry**: Communicate with the stakeholders in the ingredients and finished cosmetic products by participating in trade fairs dedicated to this industry.

Normandy Region and ADEME are supporting these different lines of development by a financial participation and an active collaboration with all stakeholders. They also facilitate the implementation of companies and start-ups. The Normandy Region and ADEME provide a dynamic stimulus for local players.

4.4.1 Structuring by-product sector from fishing and aquaculture

Normandy is the second largest fishing region in France and the first region for shellfish especially for oysters and scallops. It is also the most diversified region for aquaculture. These productions generate by-products waste that need to be valorised. The valorisations are various, they can be used in food, feed, bioplastics, construction, etc. That's why Normandy Region wanted to integrate by-products valorisation in its bioeconomy strategy blueprint to develop a new local recycling industry. This strategy is focused on two main defined actions:

- **Raise awareness among all stakeholders about the territory's projects and promote the sharing of good practices:** Organize meetings between blue bioeconomy stakeholders, via the ECOMER club, to show the projects, initiatives, and actions underway in Normandy as well as to bring out new projects related to the blue bioeconomy strategy and the issues of the marine sector. The main goal of this action is to help maritime professionals people discover the possibilities for recycling the waste or by-products they produce.

- **Structure the co-product sector:** Assess the volume of deposits present in the territory, identify possible sources of recovery, and set up a value chain for the recovery of co-products. This structuration requires to develop all value chain, and particularly the implementation of the supply chain.

In summary, Normandy's bioeconomy strategy aims to make Normandy a reference region in terms of the blue bioeconomy, an opportunity to transform our economic model by developing innovative, more sustainable, and more resilient sectors, while enhancing local resources and creating added value.

4.5 SUMMARY

Vision	Strategic objectives	Operational objectives
1. Plant proteins 	1.1 Structuring plant protein sectors	1.1.1 Continue to develop 5 plant protein sectors in Normandy (CV soya, organic soya, peas, faba beans, edamame) for human consumption, considering environmental impact and climate change.
		1.1.2 Raise farmers'and livestock breeders' awareness of the challenges of producing plant proteins in a changing environmental context. Provide them with technical and financial support.
	1.2 Position Normandy as a leading protein region at national and European level	1.2.1 Facilitate exchanges between the various links in the value chain (from upstream agriculture to downstream processing) through visits to technical centres (IMPROVE, Extractis, etc.) at national level.
		1.2.2 Continue the inter-regional partnership (Normandy, Hauts de France, Grand-Est)
	1.3 Increase the promotion of plant proteins grown in Normandy	1.3.1 Raise awareness of plant proteins among catering professionals so that they can be incorporated into menus
		1.3.2 Promote Normandy protein crops at the Salon de lAgriculture and FENO.
	1.4 Identify market needs to guide research and innovation work	1.4.1 Organise exchanges between all the links in the chain to clearly identify needs and, consequently, the organisation of upstream activities and the distribution of value.
		1.4.2 Organise a major event based on the main results of market studies (details reserved for members) - Elements of the value chain / contractualization - Testimonials from members - A demonstrator (visit or video)
	1.5 Communicate the results of regional stakeholders' projects	1.5.1 Promoting the results of projects at events bringing together industry stakeholders

Vision	Strategic objectives	Operational objectives
2. Blue bioeconomy 	2.1 Unite the stakeholders in the algae industry	2.1.1 Support initiatives to structure the micro- and macro-algae sectors in Normandy to provide a forum for the exchange and sharing of best practice between all the stakeholders involved.
	2.2 Encouraging the emergence of new projects	2.2.1 Put existing aquaculture stakeholders in touch with potential project developers
		2.2.2 Promote the IDCosm platform to list and inform the cosmetics industry of potential projects with which to partner.
	2.3 Facilitate the structuring of emerging aquaculture sectors	2.3.1 Monitor work to define the existing 'derogation framework': conditions for which authorisations do not need to be obtained, etc.
		2.3.2 Support the economic development of stakeholders in aquaponics, and the development of the sector via projects (SMART AQUAPONICS, etc.).
	2.4 Promote Normandy's seaweed sector within the cosmetics industry	2.4.1 Promote cosmetic ingredients and finished products to stakeholders through OPEN INNOVATION and the COSMETIC 360 exhibition.
	2.5 Raise awareness among all stakeholders of the projects underway in the region, encourage the sharing of best practice, and compile a list of stakeholders' projects and initiatives.	2.5.1 Organise meetings between stakeholders (including ports and conurbations), create a forum for exchanging information on current projects and best practices.
3. Natural fibres 	3.1 Pursue the inter-regional dynamic (Normandy, Grand Est and Hauts-de-France)	3.1.1 Support projects involving natural fibres for reindustrialisation and national sovereignty
		3.1.2 Enrich, update, and make available a common map of natural fibre stakeholders throughout the value chain, including training stakeholders.
	3.2 Develop the Normandy hemp textile industry	3.2.1 Work on the hemp textile charter announced and signed in June 2022 and promote the downstream sector.

Vision	Strategic objectives	Operational objectives
	3.3 Develop the construction sector	3.3.1 Organise a 'straw' event in conjunction with the construction and farming industries.
		3.3.2 Bring together straw-producing craftsmen and farmers
		3.3.3 Train farmers to produce straw bales in accordance with the professional rules of the construction industry.
		3.3.4 Raise awareness and identify and monitor the needs of those involved in the construction industry to set up structuring projects such as prefabrication.
	3.4 Raise awareness among stakeholders downstream in the industry	3.4.1 Raise awareness of the use of biobased products in end-user training courses for the construction industry.
		3.4.2 Increase awareness of the use of biobased products in polymer and/or textile end-user training courses
		3.4.3 Organise workshops in conjunction with other end-user clusters to identify the interests of application sectors for natural fibres.
		3.4.4 Organise a conference at the Consumer Environment & Safety conference.
		3.4.5 Coordinate the IMPROVE-PACK project on packaging innovations (CPIER Vallée de Seine project)
	3.5 Promoting Normandy's sectors within the cosmetics industry	3.5.1 Promote cosmetic ingredients and finished products to key stakeholders through OPEN INNOVATION and exhibition at COSMETIC 360
	3.6 Provide visibility on regulations and environmental impacts	3.6.1 Making information available to stakeholders through events
	3.7 Communicating results of regional stakeholders	3.7.1 Promote the results of the projects at events bringing together all the industry stakeholders

Vision	Strategic objectives	Operational objectives
	3.8 Structuring collaborative innovation on organic sourcing	3.8.1 Deploying and promoting the IDCosm platform
	3.9 Understanding environmental performance of natural fibres	3.9.1 Carry out life cycle analyses of the main natural fibres grown in Normandy
4. Bioenergy 	4.1 Accelerate the development of the mechanisation sector in Normandy	4.1.1 Promote the MethaNormandy plan: organise events for the industry, support and raise awareness among farmers and local authorities, monitor units and projects, etc.
	4.2 Accelerate the development of the wood-energy sector for collective / tertiary buildings	4.2.1 Manage the wood energy programme
	4.3 Decarbonising industry	4.3.1 Disseminate the BCIB calls for projects and other France 2030 schemes
	4.4 Helping the forestry and wood industry to become more structured	4.4.1 Support biomass-producing infrastructures, finance forestry equipment and storage platforms (FC). Promoting France 2030 schemes to promote forest renewal
	4.5 Developing the agricultural sector	4.5.1 Increase the number of self-consumption agricultural wood-fired heating systems and make better use of woodland products.
5. bio-based chemistry 	5.1 Bringing together stakeholders, raising awareness, and developing momentum around bio-based chemistry	5.1.1 Organise a workshop in conjunction with the ChemTech network
	5.2 Develop teaching on the bioeconomy in chemistry courses	5.2.1 Offer tailor-made courses on bio-based chemistry
	5.3 Think tank	5.3.1 Organise meetings for France Chimie Normandie members to define a bioeconomy action plan.
	5.4 Structure collaborative innovation projects on biological sourcing	5.4.1 Deploy and promote the IDCosm platform

Vision	Strategic objectives	Operational objectives
	5.5 Promote Normandy's supply chains within the cosmetics industry	5.5.1 Promote cosmetic ingredients and finished products to stakeholders through OPEN INNOVATION and the COSMETIC 360 exhibition.
	5.6 Raise awareness among stakeholders in the cosmetics industry	5.6.1 Organise the Consumer Environment & Safety conference
	5.7 Communicate and promote the results of collaborative projects between regional stakeholders	5.7.1 Publish project results in innovation notebooks
		5.7.2 Promote project results to industry stakeholders

5 KEY ACTION FIELDS FOR IMPLEMENTATION

Since 2021, the Normandy Region has set itself the goal of becoming a national and European reference in the bioeconomy. And to achieve its objectives, it has set up an ambitious strategy for the Normandy bioeconomy. It wants to respond to the challenges:

- **Environmental initiatives** that are facing it by drastically reducing carbon emissions and decarbonizing its industries to achieve carbon neutrality by 2050.
- **By developing new ecosystems** based on the circular economy, local bioresources and by attracting new investments in research, the establishment of new industries and new technologies. It is also a way to develop new local jobs.
- **Societal initiatives** to meet the needs of all, guarantee our food, energy and industrial independence by developing sustainable models. The bioeconomy can help strengthen food security, the development of local activities and meet a growing demand for healthy and quality products.

The Normandy Region has a significant forest, agricultural, fish and aquaculture biomass available on its territory with significant industrial development potential for various applications. Many prospects are available to it because it has a rich ecosystem:

- **Local stakeholders** are very committed to the development of the bioeconomy. Awareness-raising is carried out for all stakeholders (institutional, industrial and individual) to demonstrate the potential of the bioeconomy.
- **Technical centres and specialised laboratories** invest in research projects related to the bioeconomy to promote the emergence of technology transfer.
- **An agricultural and maritime heritage** anchored throughout Normandy is a solid basis for the development of bioeconomic sectors.
- **A diversified industrial infrastructure** with the presence of large agri-food groups that drive innovation with intermediary companies that value co-products. Agriculture, fisheries and aquaculture professionals involved in
- **A desire to develop new sectors**: agrofuels, bioplastics, cosmetic products, bio-based materials, etc.
- **A presence of professional organizations and unions** support the development of the activities of their professionals and to accompany them in the appropriation of new activities in the bioeconomy.

However, to achieve the defined objectives, the structuring of several sectors is necessary (co-products, anaerobic digestion, etc.).

5.1 ACTIONS / INTERVENTIONS

Vision	Strategic objectives	Operational objectives	Activity
1. Plant proteins	1.1 Structuring plant protein sectors	1.1.1 Continue to develop 5 plant protein sectors in Normandy (CV soya, organic soya, peas, faba beans, edamame) for human consumption, considering environmental impact and climate change.	1.1.1.1 Increase in plant protein areas and the number of contracts signed
		1.1.2 Raise farmers'and livestock breeders' awareness of the challenges of producing plant proteins in a changing environmental context. Provide them with technical and financial support.	1.1.2.1 Raising farmers' awareness
	1.2 Position Normandy as a leading protein region at national and European level	1.2.1 Facilitate exchanges between the various links in the value chain (from upstream agriculture to downstream processing) through visits to technical centres (IMPROVE, Extractis, etc.) at national level.	1.2.1.1 1 to 2 meetings
		1.2.2 Continue the inter-regional partnership (Normandy, Hauts de France, Grand-Est)	1.2.2.1 3 joint protein events (Grand Est, Hauts-de-France and Normandy) a joint call for proposals for 3 regions
	1.3 Increase the promotion of plant proteins grown in Normandy	1.3.1 Raise awareness of plant proteins among catering professionals so that they can be incorporated into menus	1.3.1.1 organisation of 1 event
		1.3.2 Promote Normandy protein crops at the Salon de lAgriculture and FENO.	1.3.2.1 1 prepared vegetarian meal
	1.4 Identify market needs to guide research and innovation work	1.4.1 Organise exchanges between all the links in the chain to clearly identify needs and, consequently, the organisation of upstream activities and the distribution of value.	1.4.1.1 Organisation of 1 event
		1.4.2 Organise a major event in 2023 based on: - The main results of market studies (details reserved for members) - Elements of the value chain / contractualization - Testimonials from members - A demonstrator (visit or video)	1.4.2.1 organisation of 1 event

Vision	Strategic objectives	Operational objectives	Activity
	1.5 Communicate the results of regional stakeholders' projects	1.5.1 Promoting the results of projects at events bringing together industry stakeholders	1.5.1.1 Organisation of a hemp application market food meeting (proteins)
2. Blue bioeconomy	2.1 Unite the stakeholders in the algae industry	2.1.1 Support initiatives to structure the micro- and macro-algae sectors in Normandy to provide a forum for the exchange and sharing of best practice between all the stakeholders involved.	2.1.1.1 support the structure
	2.2 Encouraging the emergence of new projects	2.2.1 Put existing aquaculture stakeholders in touch with potential project developers	2.2.1.1 Organisation of 1 to 3 networking events
		2.2.2 Promote the IDCosm platform to list and inform the cosmetics industry of potential projects with which to partner.	2.2.2.1 1 communication campaign
	2.3 Facilitate the structuring of emerging aquaculture sectors	2.3.1 Monitor work to define the existing 'derogation framework': conditions for which authorisations do not need to be obtained, etc.	2.3.1.1 –
		2.3.2 Support the economic development of stakeholders in aquaponics, and the development of the sector via projects (SMART AQUAPONICS, etc.).	2.3.2.1 7 aquaponic farms in the Norman territory (2025)
	2.4 Promote Normandy's seaweed sector within the cosmetics industry	2.4.1 Promote cosmetic ingredients and finished products to stakeholders through OPEN INNOVATION and the COSMETIC 360 exhibition.	2.4.1.1 1 communication campaign
	2.5 Raise awareness among all stakeholders of the projects underway in the region, encourage the sharing of best practice, and compile a list of stakeholders' projects and initiatives.	2.5.1 Organise meetings between stakeholders (including ports and conurbations), create a forum for exchanging information on current projects and best practices.	2.5.1.1 annual meetings via Ecomer
3. Natural fibres	3.1 Pursue the inter-regional dynamic (Normandy, Grand Est and Hauts-de-France)	3.1.1 Support projects involving natural fibres for reindustrialisation and national sovereignty	3.1.1.1 support interregional projects

Vision	Strategic objectives	Operational objectives	Activity
		3.1.2 Enrich, update, and make available a common map of natural fibre stakeholders throughout the value chain, including training stakeholders.	3.1.2.1 online interregional mapping
	3.2 Develop the Normandy hemp textile industry	3.2.1 Work on the hemp textile charter announced and signed in June 2022 and promote the downstream sector.	3.2.1.1 develop a local brand
	3.3 Develop the construction sector	3.3.1 Organise a 'straw' event in conjunction with the construction and farming industries.	3.3.1.1 organisation of 1 event
		3.3.2 Bring together straw-producing craftsmen and farmers	3.3.2.1 organisation of 1 event in 2024
		3.3.3 Train farmers to produce straw bales in accordance with the professional rules of the construction industry.	3.3.3.1 1 training course
		3.3.4 Raise awareness and identify and monitor the needs of those involved in the construction industry to set up structuring projects such as prefabrication.	3.3.4.1 awareness campaigns
	3.4 Raise awareness among stakeholders downstream in the industry	3.4.1 Raise awareness of the use of biobased products in end-user training courses for the construction industry.	3.4.1.1 Training craftsmen in the use of bio-sourced building materials
		3.4.2 Increase awareness of the use of biobased products in polymer and/or textile end-user training courses	3.4.2.1 organisation of 1 to 3 workshops
		3.4.3 Organise workshops in conjunction with other end-user clusters to identify the interests of application sectors for natural fibres.	3.4.3.1 organisation of 1 to 2 workshops
		3.4.4 Organise a conference at the Consumer Environment & Safety conference.	3.4.4.1 1 conference
		3.4.5 Coordinate the IMPROVE-PACK project on packaging innovations (CPIER Vallée de Seine project)	3.4.5.1 organisation of 3 workshops
	3.5 Promoting Normandy's sectors within the cosmetics industry	3.5.1 Promote cosmetic ingredients and finished products to key stakeholders through OPEN INNOVATION and exhibition at COSMETIC 360	3.5.1.1 communication campaign

Vision	Strategic objectives	Operational objectives	Activity
	3.6 Provide visibility on regulations and environmental impacts	3.6.1 Making information available to stakeholders through events	3.6.1.1 Organisation of hemp event and other meetings. Publication of articles in the agricultural and stakeholders' newsletters
	3.7 Communicating results of regional stakeholders	3.7.1 Promote the results of the projects at events bringing together all the industry stakeholders	3.7.1.1 Organisation oh hemp event and other events about projects. Promotion of results in innovation notebooks
	3.8 Structuring collaborative innovation on organic sourcing	3.8.1 Deploying and promoting the IDCosm platform	3.8.1.1 communication campaign
	3.9 Understanding environmental performance of natural fibres	3.9.1 Carry out life cycle analyses of the main natural fibres grown in Normandy	3.9.1.1 5 life cycle assessments (hemp, miscanthus, flax, nettle, and straw)
4. Bioenergy	4.1 Accelerate the development of the mechanisation sector in Normandy	4.1.1 Promote the MethaNormandy plan: organise events for the industry, support and raise awareness among farmers and local authorities, monitor units and projects, etc.	4.1.1.1 production of 4750 gwh (2030)
	4.2 Accelerate the development of the wood-energy sector for collective / tertiary buildings	4.2.1 Manage the wood energy programme	4.2.1.1 Develop collective heaters in towns and in the countryside
	4.3 Decarbonising industry	4.3.1 Disseminate the BCIB calls for projects and other France 2030 schemes	4.3.1.1 Develop wood-fired industrial heating systems
	4.4 Helping the forestry and wood industry to become more structured	4.4.1 Support biomass-producing infrastructures, finance forestry equipment and storage platforms (FC). Promoting France 2030 schemes to promote forest renewal	4.4.1.1 Developing businesses to increase the biomass mobility
	4.5 Developing the agricultural sector	4.5.1 Increase the number of self-consumption agricultural wood-fired heating systems and make better use of woodland products.	4.5.1.1 Increase the use of wood chips
5. bio-based chemistry	5.1 Bringing together stakeholders, raising awareness and developing	5.1.1 Organise a workshop in conjunction with the ChemTech network	5.1.1.1 1 workshop in reverse pitch format (industrial needs)

Vision	Strategic objectives	Operational objectives	Activity
	momentum around bio-based chemistry		
	5.2 Develop teaching on the bioeconomy in chemistry courses	5.2.1 Offer tailor-made courses on bio-based chemistry	5.2.1.1 develop training courses: carbon cycle, bio-sourced solvents, plant materials, etc.
	5.3 Think tank	5.3.1 Organise meetings for France Chimie Normandie members to define a bioeconomy action plan.	5.3.1.1
	5.4 Structure collaborative innovation projects on biological sourcing	5.4.1 Deploy and promote the IDCosm platform	5.4.1.1 communication campaign
	5.5 Promote Normandy's supply chains within the cosmetics industry	5.5.1 Promote cosmetic ingredients and finished products to stakeholders through OPEN INNOVATION and the COSMETIC 360 exhibition.	5.5.1.1 communication campaign
	5.6 Raise awareness among stakeholders in the cosmetics industry	5.6.1 Organise the Consumer Environment & Safety conference	5.6.1.1 1 to 2 meetings
	5.7 Communicate and promote the results of collaborative projects between regional stakeholders	5.7.1 Publish project results in innovation notebooks	5.7.1.1 Distribution of the innovation booklet and communication campaigns
		5.7.2 Promote project results to industry stakeholders	5.7.2.1 Meetings about hemp to cosmetics market applications

6 FEEDBACK ON IMPLEMENTATION STRATEGY

This chapter is dedicated to taking stock of Normandy's bioeconomy strategy after 18 months of implementation. To do this, a dedicated workshop was organised with stakeholders in the bioeconomy: local institutions, industrial representatives, researchers, and associations representing the marine industries, as well as companies working in the bioeconomy. During the workshop, stakeholders were able to give their feedback on the bioeconomy strategy, which has been in place since March 2023.

6.1 UNLOCK BARRIERS AND BRAKES IN BLUE BIOECONOMY

Since the implementation of the bioeconomy strategy in Normandy, there are still several obstacles to be overcome that are slowing down the development of the bioeconomy. Stakeholders have highlighted these obstacles:

- **Regulations** need to evolve to facilitate the development of the industry. For example, it is not permitted to set up a seaweed farming business in Normandy, and the same applies to seaweed harvesting, although regulations are beginning to change for the better.
- **Administrative barriers** should make it easier for new stakeholders to set up in the region
- **The structuring of the sector** needs to be led by a local stakeholder to facilitate its development, and it needs to be supported by institutions such as the Normandy Region and certain government departments.
- **The supply chain** is an obstacle to the structuring of the sector, which does not facilitate its development. Consideration needs to be given to the massification of deposits to keep transport costs under control.
- **The cost of innovation** is high when it comes to initiating projects. How can they be financially supported?
- **Funding sources** such as calls for projects do not match the pace of companies. The opening periods for these calls for projects are too short to allow companies to submit projects.
- **All the stakeholders** in the blue bioeconomy ecosystem need to be identified to facilitate collaboration.
- **Synergies** between regions need to be developed to boost the bioeconomy.
- Not enough is known about the volumes of biomass available.
- **The co-products/waste** from the blue bioeconomy are very little exploited, and there is a need to structure these sectors to enable marine professionals to diversify their financial resources.
- **Today, climate change** and rising energy prices are additional factors slowing down the development of the blue bioeconomy.

6.2 OPPORTUNITIES OFFERED BY BLUE BIOECONOMY STRATEGY

The stakeholder workshop also highlighted some tremendous opportunities for the development of the bioeconomy. The stakeholders identified several themes in the blue bioeconomy strategy that would facilitate development:

- The **diversity and volume of the biomass** present on the Normandy coast are factors in the development of new industries.
- Under-utilised **research and development** are a fantastic lever for development. Projects could emerge in collaboration with private sector stakeholders
- The **stakeholders in the blue bioeconomy eco-system** are all present in Normandy. From producers to processors, their presence is a key factor in the successful development of the sector.
- **Changes in regulations** will help to remove obstacles and encourage the emergence of projects, collaborations, and initiatives.
- **Influencing policies** to encourage the emergence of projects
- **Broadening the eligibility criteria** for financial aid and calls for projects/applications would facilitate the development of the blue bioeconomy in Normandy.
- **Setting up network heads** to boost the development of the sector, with the support of local authorities.

6.3 NEW NEEDS OF THE BLUE BIOECONOMY STRATEGY

The Normandy Bioeconomy Strategy 2023-2025 has focused on several specific themes. The workshop identified new topics that could help to develop the bioeconomy more rapidly. Stakeholders expressed several wishes for integration, focusing on the structuring of new sectors of the future, such as algae and aquaculture, as well as the development of sectors for the valorisation of by-products from fishing and aquaculture.

Here are a few ways in which the bioeconomy strategy could evolve from 2026 onwards:

- **Adaptation to climate change** is not addressed in the current strategy. Taking this into account would make it possible to anticipate changes in biomass and species migration (new species, disappearance of species, etc.). Warmer waters will accelerate these changes, which will inevitably have an impact on the activities of the blue bioeconomy sectors.
- The **involvement of research** in projects to exploit co-products and waste from fishing and aquaculture, both upstream and downstream of the sectors.
- **certain species** from fishing and aquaculture are currently little consumed by consumers. Actions to raise public awareness could be envisaged through tastings, communication campaigns or, for example, cookery workshops.
- The **development of new innovative projects** for the food, pharmaceuticals and cosmetics markets, taking into account the different project leaders.
- **Better support for start-ups** in innovation linked to the blue bioeconomy

- The development of **bioenergy production** in the blue bioeconomy in association with research laboratories
- The **biomass volumes** present in Normandy are still not fully understood. An observatory would enable all the stakeholders in the eco-system to become involved in new projects and programmes.

7 SOURCES

1. France Stratégie. Biomasse agricole: quelles ressources pour quel potentiel? https://www.strategie.gouv.fr/sites/strategie.gouv.fr/files/atoms/files/fs-ns_-_biomasse_agricole_-_quelles_ressources_pour_quel_potentiel_-_29-07-21.pdf
2. Rapport SRADDET: https://www.prefectures-regions.gouv.fr/normandie/irecontenu/telechargement/117230/874009/file/2024-03-29%20(DT)%20-%20Rapport%20SRADDET.pdf
3. Regional Forest and Wood Plan 2016-2026, https://draaf.normandie.agriculture.gouv.fr/le-programme-regional-de-la-foret-et-du-bois-de-normandie-a2402.html
4. Regional Waste Prevention and Management Plan, https://www.normandie.developpement-durable.gouv.fr/plan-regional-de-prevention-et-de-gestion-des-a2075.html

Annex-04

Towards a Bio-Based Economy in Northern Sweden (Sweden)

BIOMODEL 4REGIONS

TOWARDS A BIOBASED ECONOMY IN NORTHERN SWEDEN

Eleonora Borén

A bioeconomy blueprint, prepared in the frame of the BioModels4Regions project

This document has been prepared in the framework of the European project "BIOMODEL4REGIONS – Supporting the establishment of the innovative governance models to achieve better-informed decision-making processes, social engagement, and innovation in the bio-based economy".

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 101060476.

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15th of December 2024

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1 OBJECTIVES & SCOPE

The Bioeconomy Blueprint for northern Sweden is a strategic framework aimed at guiding the region's transition into a competitive, sustainable, and resilient bioeconomy. This document seeks to integrate the bioeconomy related strategies of the four northern regions, while also aligning with broader national policies and the proposed national bioeconomy strategy (currently under referral revision), as well as European policies and legislation.

The blueprint provides a common vision for northern Sweden, also in line with the proposed national bioeconomy vision and objectives as well as other national strategies that include bioeconomy. This alignment ensures that regional policies are coherent with national and European bioeconomy strategies, facilitating coordinated policy implementation and fostering synergy across different governance levels.

This document serves as a means for strategically coordinating efforts, across the regions in northern Sweden, but the document holds no political mandated bearing. The document can be used as a foundation for the four northern politically steered regions in their work to revise and update strategies and policies pertinent to the bioeconomy sector. The blueprint can also be used by all those involved in the development of the bioeconomy to start implementing the recommended actions herein without delay. As the core of the bioeconomy in northern Sweden, the scope of this Blueprint focuses on the forestry bioeconomy. The key areas and recommendations can be applied to the other bioeconomy sectors.

Today, Northern Sweden is one of the most forest dense areas in Europe. The region has been built by felling one tree at the time to give way for small agricultural patches and roads through the deep forests. Yet, to this day, 97% of the productive land remains covered in forest and about 1% is agricultural land. The economy of northern Sweden has been partly built of the iron ore taken out of the mines, but also of the billions of trees cut down, firstly hand sawn and pulled out by timber horses out of the deep forests and thereafter transported along the rivers by brave timber men down the coast for further valorisation.

Nowadays, modern machines take down the trees and cut their tops and branches, the logging residues, in one swift operation before they are transported on trucks and trains. However, local processing industries, such as pulp mills which produce cellulose-based products of the wood, the majority of forest biomass (about 80%) is exported in minimally processed forms, primarily as raw timber sawn at sawmills, meaning there is still a large untapped potential for further valorisation of the timber, both within the region and for export.

Over the past 150 years, huge investments have been made into industries processing forest biomass. Sawmills, pulp and papermills and CHPs are continuously investing in more innovative and effective processes to stay competitive. This is the main driver for innovations and growth in the forest bioeconomy but is not the focus of this blueprint. Over time, strong synergies as well as competition have developed between these industry segments and forest owners.

1.1 INVOLVEMENT IN THE DEVELOPMENT OF THE BLUEPRINT

The foundation of the Bioeconomy Blueprint has been laid out during work performed during the preparation of the Swedish national Bioeconomy strategy that started during 2022, in which partner organizations of the blueprint held an active role.

In the work, a task has been carried out of coordinating the regions in the national bioeconomy strategy. In addition to workshops with the Government Offices, interviews with regional strategists on behalf of the Government Offices were conducted and a survey performed for them to answer the investigators' questions. This material is now part of the annexes to the report on the new bioeconomy strategy that was completed in December 2023.

In parallel to discussing a strategy from a regional perspective, the national network has also developed the indicators for a new regional bioeconomy statistic, together with Statistics Sweden, which will be published in January 2025. This will be an excellent tool for all regions to track developments in different areas of the bioeconomy, which can also be linked to carbon emissions.

The Bioeconomy Blueprint has been developed together with three main stakeholder groups: regional administration, business (from biobased start-ups to large scale companies), academia and research institutes. in addition, cluster organisations, innovation hubs, politicians, industry associations and national authorities have had input in different forums.

The initial blueprint was drafted during a workshop conducted during the referral process of the National Bioeconomy Strategy, where stakeholders from northbound regions contributed with their input on what is important for Northern Sweden in the Bioeconomy Strategy. Also, input has been provided in a joint workshop with the EU-project MainstreamBio, providing input from biobased start-ups within the region and innovation hubs. Finally, the blueprint has been tested with input from the RISE Processum Biorefinery Cluster, composed of some 20s companies ranging from SMEs to large scale enterprises, all active within the bioeconomy of the region.

A Swedish national bioeconomy strategy is still pending approval, awaiting a final proposal from the referral process that was completed the end of summer of 2024. Sweden has parts of the bioeconomy sector already incorporated into national and regional regulated strategies. Once the national strategy is approved, a cascade of alignment work will follow suit to the regionally regulated strategies. We hope this document can be a tool for inspiration in this work for the northern counties of Sweden, in coordinating efforts, aligning vision and goals for different parts of the bioeconomy (food, climate, self-sufficiency, economic growth) to achieve a strong, sustainable, and resilient north.

2 BASELINE AND ANALYSIS OF LOCAL CONTEXT

2.1 BIOECONOMY HISTORY IN NORTHERN SWEDEN

Biomass has always been essential in Northern Swedish’s society, initially used for food, energy, clothing, tools, and construction. Northern Sweden's agriculture, forestry, aquaculture,

and fisheries have been vital for the country's economic and cultural development. Over the last century, industrialization and access to fossil resources replaced the bio-based economy with a fossil-based one, shaping societal norms and consumption patterns. Post-World War II industrial growth led to economic progress but also severe environmental issues, including pollution of air, water, and land due to a lack of regulations and purification technology. With growing awareness of climate and environmental challenges, improved purification methods have significantly reduced industrial emissions since the 60's and 70's.

Since the late 1970s, the bioeconomy has expanded in Sweden's energy sector, transitioning from fossil fuels to bioenergy, now widely used for heating buildings and power generation. Policies like the carbon tax (1991) and the EU emissions trading system (2005) have further promoted biofuels, reducing Sweden's carbon emissions by about 33% since 1990. In the last 20 years, biofuels usage has increased, primarily through imported liquid biofuels and domestic production of renewable fuels like biogas. Additionally, production of paper packaging materials and sawn timber for construction has grown significantly over the past 15 years.

2.1.1 Agriculture

Throughout the history of Northern Sweden, agriculture has provided food through crop cultivation and livestock production, as well as materials like flax for textiles, linseed oil, and paints. The textile industry expanded in the 18th century with the import of cheaper flax and cotton, reducing domestic flax production. Historically, Sweden maintained a high degree of self-sufficiency in food, with crop cultivation and livestock mutually supporting nutrient cycles. However, global trade and imports have significantly reduced domestic agricultural production, leading to smaller areas dedicated to crops and livestock.

Over the past 70 years, agriculture has undergone significant modernization. Advances in technology, infrastructure, and fossil-based fertilizers like nitrogen and imported feed have enabled more efficient food production. Despite this intensification, greenhouse gas emissions from agriculture have decreased by over 10% since 1990. Today, there are solutions to produce low-emission fertilizers and domestic feed with reduced climate impacts. However, increased global trade has made agriculture more efficient but also exposed its vulnerabilities, as recent geopolitical tensions and disrupted trade routes have highlighted risks to food security.

Agriculture's primary contribution to the bioeconomy is within food production. Additionally, it supports biobased industries by providing biomass for other products and residual streams that can be transformed into new goods. The sector also contributes to biogas production. While only a small share of agriculture biomass is used for energy, grain and rapeseed are utilized for chemicals and fuels, while straw and willow serve other energy purposes.

Currently, 85% of Sweden's agricultural land is arable, with the remainder used for pasture. Of the arable land, 94% is actively used for producing feed and food raw materials the remaining 6% (162,500 hectares) is fallow. This unused land presents opportunities for increased production for various purposes.

2.1.2 Blue economy

Fishing and aquaculture have historically played an important role in Northern Swedish's food supply and are deeply embedded in Swedish culture and history. Maritime trade and a robust fishing industry have been vital for the Swedish economy and food supply. Today, the contribution of these blue industries to the bioeconomy mainly involves the use of renewable aquatic biomass from marine and freshwater systems, including catches from commercial fishing, aquaculture of animals and plants, and the harvesting of seaweed and algae. Aquatic biomass primarily consists of proteins, fats, and oils. By-products from the fishery supply chain can be used to extract high-value proteins and omega-3 oils.

Environmental issues and overfishing in lakes and seas, have led to reduced fishing activity. Today, fish supply relies heavily on imported fish, mainly from Norway. In 2022, the total catch weight from commercial sea fishing was a mere 121,000 tons of which over 80,000 tons was exported to Denmark and used as ingredients in fish feed. The aquaculture and the fishing industry hold the greatest potential for increased efficiency and added value within the Swedish bioeconomy.

2.1.3 Forestry

Northern Sweden is characterized by vast forest resources, a cold climate, and sparsely populated areas. Bioeconomy is almost totally dominated by forest bioeconomy as 97% of the productive land is covered with forest. Agriculture and fishery make a very small contribution to the economy. The total land area for Northern Sweden is 221 800 km^2 of which 67 % is forest land (148 920 km^2). The total growing forest stock is 1 314 million m^3 and the annual growth is 45 million m^3. The protected forest area amounts to 42 990 km^2 or approx. 20 % of the productive forest land. Additional to this there are voluntarily set aside areas made by private forest owners. The annual harvest in the region is on an average 31 million m^3. In addition to domestic wood, imported round wood can also contribute to the regional market.

The forest and its industry have been vital to northern Sweden for centuries. Early forest-based products included ships and tar, but major industrial development began in the 19th century with sawmills, followed by technology enabling the conversion of forest biomass into pulp, paper, and packaging, and later into fuels, chemicals, and textiles.

Since 1903, Swedish law has required replanting of trees, so called reforestation, after felling and logging, a principle that is still central to forest management today. Along with improved forestry methods, this law has doubled Sweden's forest biomass since 1923, despite nearly doubled annual harvesting. Sweden now has a vast forest biomass supply compared to many industrialized nations and is the world's fifth-largest exporter of forest products.

A key to competitiveness is the efficient use of the entire tree. Larger logs are processed into sawn timber, while smaller parts and by-products go to pulp and paper production. Residues from pulp mills are used for chemicals, plastics, adhesives, food additives, batteries, and energy. In addition, many homes in cities are heated via district heating from the power plants. Sawn timber is critical to the bioeconomy, providing most of the forest owner's income, making efficient sawmills essential for the entire value chain. Around 80% of Swedish forest products are exported.

In recent years, industrial wooden construction has grown significantly, increasing the share of multi-family homes built with wooden frames. Simultaneously, the paper industry has shifted focus due to digitalization and changing consumption patterns. Since the late 1990s, production of packaging and tissue paper has increased, while graphic paper production has nearly halved. Swedish forest industries were early to transition to high-value-added products, a trend that continues. Many pulp mills have evolved into advanced biorefineries, fractionating raw materials for diverse uses. As efficiency improves, more residues are expected to be refined into new paper materials, plastics, chemicals, fuels, textiles, and other innovations.

2.1.3.1 Is there enough biomass for new users?

Sawn timber products and pulp and paper products have dominated the use over a long time but the use of forest biomass for energy purposes has grown rapidly over the past decades. In the near future, the use of forest biomass in biorefineries is expected to increase and will claim additional supply of biomass. This arises the question if there is enough biomass available for both new and existing users of biomass.

Suppliers of forest biomass in northern Sweden declare an increasing difficulty to increase felling volumes in the future and plans to decrease felling volumes has been declared by the major forest owner in northern Sweden (Sveaskog). As a result of the ongoing war in Ukraine, import of biomass from Russia, Belarus and Baltic states are not more available. As a result of the upcoming EU policies, harvesting volumes may decrease even more. This has resulted in that existing users of biomass (sawmills, pulp mills and heating plants) face increasing difficulties to supply their existing industries and prices for pulpwood and especially for wood fuels has increased significantly. As a result of harvesting operations, large volumes of logging residues (tops and branches) are available in the region.

These residues have hardly been utilized at all since they have a low commercial value due to their location far away from most existing end consumers and the costs of harvesting, transport and storing has been too high compared to the market price of forest industry by products. Recent increases in prices for wood fuels has increased the interest in logging residue extraction. For future expansion of biorefineries, it is important that future polices will focus more on biomass availability and mobilisation. It is likely that new production of bioproducts and biofuels will benefit from finding synergies with existing biomass consuming industries as illustrated in the map below (Figure 1).

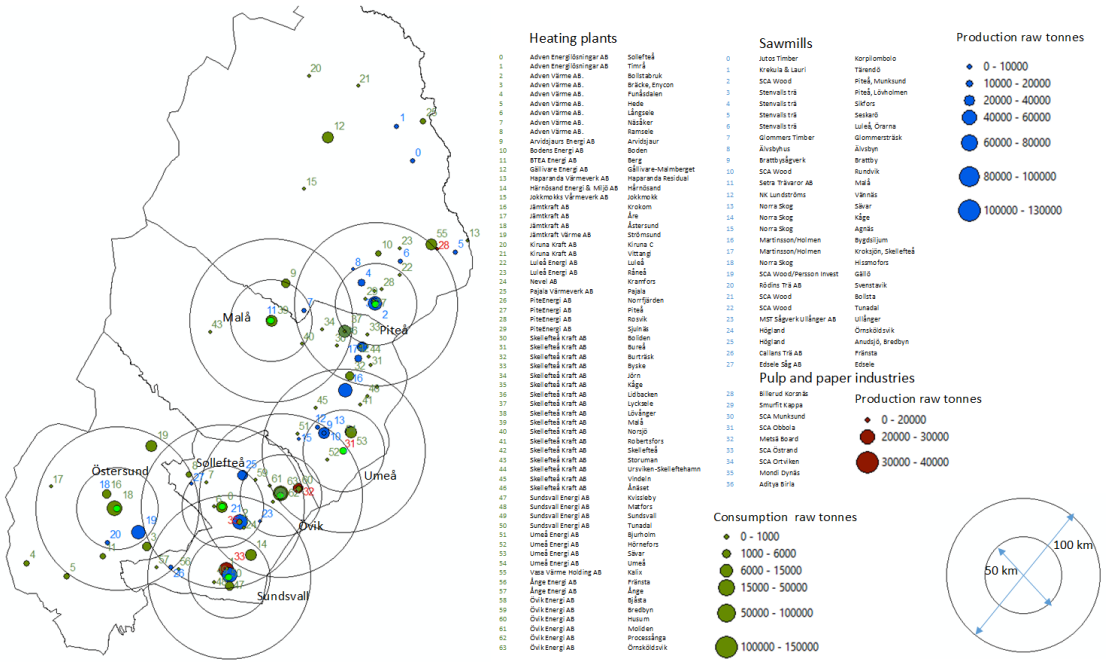

Figure 1 Map of northern Sweden with major industries consuming woody biomass. Raw material supply areas for potential biorefineries.

2.1.4 Status-quo of Bioeconomy Sectors in Northern Sweden

While forestry remains a cornerstone of Northern Sweden's bioeconomy, several other bioeconomy sectors are predicated to also driving sustainable growth and resilience, blurring the traditional sectoral boundaries as an integrated circular biobased economy develops.

Within the region there are several identified areas that are included within the scope of bioeconomy. Some of them are in themselves broader than bioeconomy but enablers for carrying out a bioeconomy. Below, a status quo for the different areas are provided.

Bioenergy

In Sweden and especially in northern Sweden, bioenergy plays a significant role in the energy and electricity supply, contributing to both heat and power production. Bioenergy is generated from various sources of forest industry by products like bark and sawdust to a much smaller extent from agricultural waste, and from anaerobic digestion to biogas.

Bioenergy accounts for about 37% of Sweden's total energy supply, making it the largest single source of energy in the country. When it comes to electricity generation, bioenergy contributes roughly 10-12% of the national electricity mix. This is achieved mainly through combined heat and power (CHP) plants and within forest industries, where biomass combustion generates both electricity and heat. The CHP plants are highly efficient and serve as an important part of providing heat especially during colder months to citizens via the district heating systems installed connected to the CHP and the adjacent cities.

The future potential for bioenergy, particularly from forest residues (the logging residues left behind after felling), is expected to grow in Northern Sweden. The practice of harvesting

logging residues declined in 2014, especially in northern of Sweden as the output of forest industry by products until now been sufficient for the regional demand. Collection of logging residues is still more common in southern based Götaland and Svealand than in northern Sweden. In southern based regions Götaland, during the period 2018–2022, logging residues was extracted on 64 % of the final felled area and in Svealand on 44 % of the area. In Southern Norrland and Northern Norrland (of which half of south Norrland and the whole of Northern Norrland make up the northern Sweden region herein), the corresponding proportions were 19 and 7 %, respectively.

In northern of Sweden there is today a surplus of logging residues. The surplus amounts to nearly 14 TWh per year, while sustainably harvesting around 21 TWh of logging residues annually is feasible. Through to mild winters the early 10' the market declined in the northern and with that the logistic system disappeared. What needs to be managed today is rebuilding the capacity for machinery and logistics systems in the region. The later has found a new interest in recent years following increase in energy prices and a predicted higher demand of electricity in the northern of Sweden.

The Swedish Energy Agency projects a moderate increase in bioenergy's contribution to the electricity mix over the next few decades, driven by enhanced utilization of forest residues and advancements in technology for biomass conversion. By 2035, it is expected that the share of bioenergy in electricity generation could rise to 15-18%, depending on the rate of increase in logging residues utilization and the implementation of new bioenergy technologies.

In Northern Sweden most forest biomass resources are today fully utilized, and established forest industries are competing for the available resources. It the near future, it is not likely that harvesting levels can increase but it is more likely that because of upcoming EU policies, harvesting levels may decrease. Forest Industry by products are today almost fully utilized. Only outputs with high water content like fibre sludge and green liquor (biomass residual streams from pulp mills) etc. are difficult to use. This situation makes it hard for new users to secure long-term and cost-effective raw material supply needed for investments.

There is a potential for growth in bioenergy production and for investments in biorefineries, but the increase in biomass demand must be balanced with sustainability concerns. As new users of biomass most likely will demand biomass assortments of a well-defined quality, like sawdust, today used for combustion. CHPs can compensate for the shortage of sawdust by burning more logging residues. or other more complex biomass assortments not suitable for upgrading. CHP technology is robust and designed to handle more complex fuels. In this way undesirable market distortion can be avoided. If we don't extract the logging residues from the forest they will decompose (5-10 years) in the forest releasing CO_2 to atmosphere anyway. Environmental impact of LR extraction is small and well known and regulated by the national forestry act. The extraction of logging residues needs to be carefully managed to protect soil quality and biodiversity.

Several initiatives for production of biofuels from lignocellulosic biomass have been proven on a demonstration scale (e.g. production of DME, dimethyl ether from black liquor, via gasification) but failed to reach industrial production scale. Northern Sweden has several ongoing projects within carbon capture and utilization (CCU) both applied to heavy industry and to combined heat and power plants at municipal level.

Liquid Wind is advancing its FlagshipTHREE project in partnership with Umeå Energi at the Dåva cogeneration plant in Umeå, Sweden (the largest city in the Northern Sweden region). This facility is part of Liquid Wind's mission to develop green electro fuels to decarbonize sectors like maritime shipping, which relies heavily on fossil fuels. Once operational, the plant aims to reduce CO2 emissions by 271,000 tons annually.

The project plans to produce approximately 130,000 tons of eMethanol per year. This will be achieved by capturing biogenic CO_2 emissions from the CHP Dåva plant and combining it with green hydrogen derived from renewable electricity, such as wind power. Construction is scheduled to begin in 2024, with the facility expected to be operational by 2027.

In addition to its environmental goals, the project supports Umeå's commitment to becoming climate-neutral by 2030 and aims to stimulate regional economic growth by creating green jobs. This collaboration between Liquid Wind and Umeå Energi exemplifies a symbiotic approach to sustainable energy production, leveraging local resources to drive impactful change.

Biofuels and e-fuels for transportation

Sweden has been a leader in biofuel adoption, with biofuels accounting for a significant portion of its transport fuel mix.

The status of biofuels for transport in Sweden, particularly in northern regions, reflects a dynamic and evolving landscape. Sweden has been a leader in biofuel adoption, with biofuels accounting for a significant portion of its transport fuel mix. Hydrotreated Vegetable Oil (HVO) is a major component, with imports playing a crucial role. In 2022, HVO blending in diesel accounted for 24.7% of the total diesel pool, equivalent to 1.2 million cubic meters, and this trend continued into 2023 (1).

HVO is by far the largest used biofuel in Sweden, accounting for 16 TWh of the 22 TWh (**Error! Reference source not found.**). However, the majority of HVO used in Sweden is imported, with only a small fraction produced domestically. In 2018, for example, only about 5% of the 14 TWh of HVO consumed was produced from Swedish raw materials. 2021, the number had increased to 11% of the 16 TWh of HVO (Table 1). The primary sources of HVO imports include countries like Finland and the United States, with feedstocks ranging from crude tall oil to slaughterhouse waste.

Table 1 Share of renewable fuels in Sweden in 2021 and share of production from Swedish raw materials

Product	Quantity used, TWH	Share from Swedish raw materials, %
HVO	16,0	11
FAME	3,0	4
Ethanol	1,3	25
Biogas	1,6	65

Source: Swedish Energy Agency, 2022a.

In the proposed national bioeconomy strategy, a large investment for liquid biofuels is suggested with high set targets of having a domestic transport fleet operating to 90% on liquid

biofuels, ideally predominantly of national biomass, by 2045, see section Part I Overview of the interim report ‘Fossil free transports” (SOU 2023:15)

Bioproducts and Bioplastics

The advancement of high value biochemicals, bioplastics, and biomaterials represents a pivotal objective in the development of the bioeconomy. Forest residual biomass and agricultural residues can be employed in the production of bioplastics, which can assist in reducing reliance on fossil-based plastics and creating new market opportunities. It is of paramount importance to ensure the availability of materials that are capable of undergoing degradation to facilitate the transition towards a circular economy. Areas of innovation include the development of lignin-based materials, cellulose nanofibers, and bio-based packaging solutions.

Traditional and innovative food products from agriculture and forest

Northern Sweden offers unique opportunities for both traditional and innovative food products derived from agriculture and the forest – often described as "the pantry of the forest." Traditional practices such as reindeer herding, hunting for game and small game, and foraging for berries and mushrooms play a vital role in preserving cultural heritage and sustaining livelihoods. These activities provide underutilized resources, including high-quality proteins like smoked reindeer meat and game, which hold potential for higher-value products. The rich forests also offer functional berries such as lingonberries and cloudberries, renowned for their nutritional and health-promoting properties. Innovation in food production focuses on increasing the valorisation of these natural resources, particularly through advanced methods to develop higher-value products.

Opportunities lie in protein extraction technologies for alternative proteins, both for food and feed, as well as the development of fermented plant-based foods and novel functional food products. By combining traditional knowledge with innovative food processing, Northern Sweden can unlock the potential of its natural resources, offering sustainable and high-quality products while maintaining cultural traditions and promoting bioeconomic growth.

Northern Sweden's rich forestry sector also provides opportunities for innovation in sustainable food and feed production, particularly through the development of Single Cell Protein (SCP). SCP involves producing high-quality protein derived from microorganisms such as bacteria, yeast, fungi, or algae. These microorganisms can be cultivated using forestry by-products, including residual biomass like sawdust, wood chips, and lignocellulosic waste, which are abundant in the region's forestry industry. The process of producing SCP begins with breaking down forestry residues into simple sugars or other feedstock through enzymatic or chemical processes. These feedstocks then serve as a substrate for microbial growth in controlled bioreactors. The microorganisms efficiently convert the biomass into protein-rich biomass, which can be harvested, processed, and used as an alternative protein source for food, feed, or functional products.

This innovative approach not only adds value to underutilized forestry by-products but also aligns with circular bioeconomic principles by reducing waste and creating sustainable protein solutions. By integrating SCP production with Northern Sweden's forestry sector, the region

can further enhance its role in developing sustainable, high-value bio-based products, supporting both food security and industrial innovation.

Aquaculture and Blue Bioeconomy

The blue bioeconomy in northern Sweden is growing, particularly through innovative projects like the Big Akwa, which exemplifies industrial symbiosis with the paper industry. The blue bioeconomy focuses on utilizing renewable aquatic biomass from marine and freshwater systems, including fish, shellfish, seaweed, and algae. This sector is crucial for sustainable development, offering high-value products such as dietary supplements, pharmaceuticals, and bio-based materials.

Recirculating Aquaculture Systems (RAS) are a key technology in this region, enabling efficient and sustainable fish farming by recycling water within the system. RAS minimizes environmental impact and allows for the cultivation of fish in controlled environments, enhancing productivity and reducing the need for antibiotics. The Big Akwa building in northern Sweden is a prime example of how RAS can be integrated with other industries. Located near a paper mill, this facility utilizes waste heat and carbon dioxide from the mill to optimize the conditions for aquaculture, creating a symbiotic relationship that benefits both industries.

This integration not only improves the sustainability of fish farming but also enhances the overall efficiency of resource use in the region. By leveraging the by-products of the paper industry, like the Big Akwa project reduces waste and lowers the carbon footprint of both sectors. This model of industrial symbiosis is a promising approach for the future of the blue bioeconomy in northern Sweden, demonstrating how innovative technologies and collaborative efforts can drive sustainable growth and create new economic opportunities.

The blue bioeconomy has significant potential in Northern Sweden due to its vast water resources and growing expertise in aquaculture and innovative technologies. Traditionally, the region has relied on small-scale fisheries and coastal activities, but recent developments have expanded the role of the blue bioeconomy to include sustainable aquaculture, advanced water-based technologies, and industrial synergies.

One of the key players in this development is Big Akwa, a company pioneering land-based aquaculture systems in Northern Sweden. They specialize in Recirculating Aquaculture Systems (RAS), an advanced method that recycles and purifies water within fish farming facilities. RAS minimizes water use, reduces environmental impacts, and allows year-round fish farming, even in the challenging northern climate. This technology not only enhances production efficiency but also aligns with sustainable practices critical for the region's bioeconomy.

Big Akwa is also a strong advocate for industrial symbiosis, where waste and by-products from one industry are used as inputs for another. For instance, excess heat from nearby industrial processes can be utilized to regulate water temperature in aquaculture facilities, while nutrient-rich wastewater from fish farming can be treated and repurposed as fertilizer in agriculture or energy production. This integrated approach reduces resource waste, promotes circularity, and strengthens local economies.

The blue bioeconomy in Northern Sweden is positioned to grow further through collaboration between aquaculture, forestry, agriculture, and energy sectors. With innovative solutions like RAS and industrial symbiosis, companies such as Big Akwa are demonstrating how sustainable aquatic production can thrive in colder climates while contributing to regional economic development and the national bioeconomy agenda.

An example of innovative cross-sectorial work between blue bioeconomy and agriculture is Agtira in Härnösand. Agtira operates Europe's largest circular aquaponic system, combining fish farming with tomato cultivation. Nutrients from rainbow trout farming fertilize the tomatoes, while the plants clean the water, creating a closed-loop, sustainable system. Founded on Pecka Nygård's innovative idea, the company produces around 500 tons of tomatoes and 60 tons of fish annually, meeting demand for Swedish-grown produce year-round. With further expansion, Agtira aims to revolutionize sustainable food production both locally and internationally.

Textiles and Fiber Innovation

Northern Sweden is at the forefront of textile and fibre innovation, leveraging its strong forestry sector to develop bio-based alternatives to cotton and synthetic fibres. Companies like Domsjö Fabriker play a key role by producing dissolved cellulose from wood, a crucial raw material for sustainable textiles. Meanwhile, Renewcell in Sundsvall, now branded as Circulose, pioneers textile recycling, transforming discarded textiles into high-quality recycled cellulose for new garments. Innovation areas include cellulosic yarns, biodegradable fabrics, and non-woven materials, offering solutions for a circular, low-carbon textile industry.

Sustainable agriculture

Agriculture in northern Sweden faces unique challenges due to its colder climate, shorter growing season, and limited arable land compared to the southern regions. Historically, the region relied heavily on hardy crops such as barley, oats, and potatoes, as well as livestock farming, particularly dairy and beef cattle. In recent years, there has been growing interest in expanding sustainable agriculture in the north, focusing on resilient crops and innovative techniques to overcome the climatic challenges.

The proportion of productive land in the four northernmost regions, comprising agricultural land (arable land and pasture), is considerably lower than in other Swedish regions. In the most northern country, Norrbotten, it accounts for less than 1 % of the total area, while in Västerbotten it is 1.4 percent, in Västernorrland it is 2 %, and in Jämtland-Härjedalen it is 1 %. In general, over 90% of the utilised arable land in northern Sweden is used to grow grassland and fodder crops. The harvests from these crops form the basis of the milk and meat production that constitutes the backbone of northern agriculture.

Despite the limitations, northern Sweden holds significant potential for bioeconomy development. Livestock farming provides manure for biogas production, and unused land can be utilized for energy crops like willow or for cultivating legumes and grasses to reduce dependency on imported feed. Additionally, cold-resistant crops and greenhouse technologies are being explored to extend the growing season and diversify agricultural output. Forestry and agriculture often overlap in northern Sweden, providing opportunities to integrate biomass production for biofuels, bioenergy, and other bio-based products. With increased investment

and research into climate-adapted farming, northern agriculture can play a greater role in Sweden's bioeconomy.

Eco-Tourism

Northern Sweden offers significant opportunities for eco-tourism, combining its natural beauty and sustainable practices to promote the bioeconomy. Leveraging the region’s forests, farmlands, and waterways, activities such as forest-based wellness tourism, and nature-based experiences allow visitors to engage with sustainable lifestyles while boosting local economies. Innovation in bio-based infrastructure and zero-waste tourism models ensures minimal environmental impact. Additionally, sustainable transport options, like electric vehicles and cycling trails, further reduce the carbon footprint, making Northern Sweden a leader in eco-friendly, immersive tourism experiences.

2.2 LOCAL POLICY CONTEXT

The Swedish bioeconomy strategy is under its last processing, with the 2012 *Research and Innovation Strategy for a Bio-based Economy* serving as its foundation. Sweden’s focus on bioeconomy aligns with broader macro-regional initiatives, such as the *Nordic Bio-based Economy* and *Baltic Bio-based Economy*, which impact rural development.

While there is no national strategy, bioeconomy has for a long time been integrated into various regional strategies, particularly in forestry, where the focus is on wood, wood-based products, and biomass such as the Regional Development Strategy, Smart Specialization, Forestry Strategy, Food Strategy, and Circular Strategy. It also intersects with other policy areas, such as sustainable growth, cities, materials, bio marine industries, and circular bio-based industries. Key objectives include sustainable natural resource management, growth, and employment. Biofuels also play a significant role in regional development strategies. Other bioeconomy sectors, such as construction, biomaterials, and research and innovation, are addressed depending on regional economic profiles. Challenges in legislation include transitioning from demonstration to operation, particularly regarding waste legislation. Advocates highlight the need to include hunting, foraging, tourism, and minority group traditions in strategies.

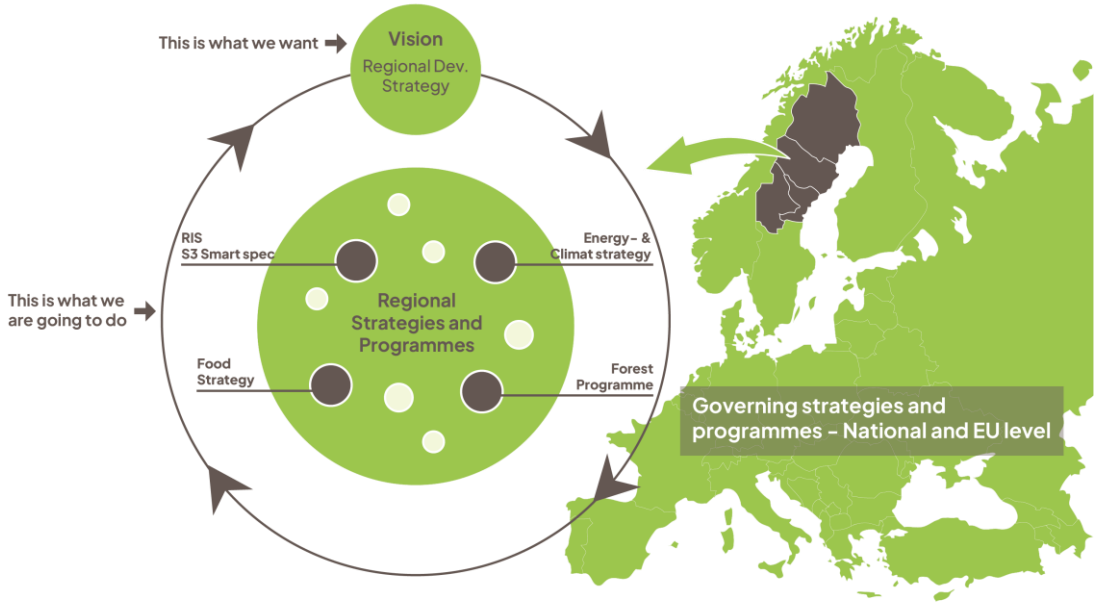

Figure 2 Overview of the policy landscape of Northern Sweden.

At the national level, various ministries collaborate on bioeconomy strategy development, supported by policies like the Carbon Tax, Circular Economy Strategy, and national climate plans. The countries in Northern Sweden, characterized by forestry, agriculture, and sparse rural populations, participates in *S3 programmes*, prioritizing forest-based bioeconomy for 2021–2027. Governance responsibilities for the bioeconomy vary across counties and municipalities, with differing levels of authority and collaboration on topics like food strategies, forestry programs, and energy and climate strategies.

A bioeconomy blueprint for northern Sweden must have good understanding and relate to the existing an upcoming policy landscape on national, and regional levels but the highest ruling Eois U-level. The northern Swedish region operates within the framework and polices of the four northernmost counties (county of Norrbotten, Västerbotten, Västernorrland, and Jämtland-Härjedalen) (Figure 2).

2.2.1 EU governance on forest-based industries and primary forest producers

The forest was not part of the treaty when Sweden joined the EU but was seen as a national competence. But recent legislations i.e. Fit-for-55**,** the restoration directive, and the EU Deforestation directive, EUDR, have a major impact on forest related industries and primary producers.

Even though Sweden historically had the highest carbon sequestering, in EU reported in LULUCF, an additional burden was decided, leading to lower potential of harvest of forest biomass. Before the revised LULUCF Sweden had 27,9 million hectares of forest of which 18,9 million hectares are available for wood supply and 9 million hectares not available, for various reasons (e.g. formally protected, voluntarily set aside, low production forest land). The

discussion regarding what counts as renewable when it comes to forest biomass has led to uncertainties for users of biomass and entrepreneurs harvesting the same.

The EUDR reveals a mistrust towards the National Forest Inventory and the Swedish Forestry Act, and the certification Schemes used in Sweden (FSC, Forest stewardship council and PEFC). The new legislation will add considerable administrative burdens and costs both for National authorities, forest industries and private forest owners.

The Biodiversity Strategy and the following legislations creates conflicts between nature and man by, to a larger extent than earlier, depriving private forest owners the right to decide how to manage their forests and instead by law forces them to leave them for biodiversity reasons.

Several of the existing strategies on a regional and a national level have been developed before the Fit for 55 package that will be implemented in Swedish law the coming years. Uncertainty about the upcoming regulations and directives from EU poses a big risk for both existing and new investments. Policies are complex, difficult to predict and not coherent and pose a significant risk, both financially and juridical, for future growth and investments in the forest bioeconomy. A challenge for the future is to harmonize bioeconomy related policies on a regional level with national and especially with polices on an EU level (Figure 3).

Wood-based products and bioenergy	Forest increment	Multi-purpose forestry	Increased carbon sink	Biodiversity
RED II-III BioEconomy Strategy LULUCF BAUHAUS	Bioeconomy Strategy	Agricultural policy Rural dev. programmes Forest Program	LULUCF Fit for 55 Bioeconomy Strategy	Biodiversity strategy Nature Restoration Regulation The Habitats Directive Deforestation directive, EUDR
Increased wood utilization	⟷		Decreased wood utilization	

Figure 3 Overview of EU policy, divided by five sectors of ranging from production of biobased products and bioenergy to nature preservation of carbon sinks and biodiversity.

2.2.2 National level

Sweden's Climate Act and Climate Policy Framework: In 2017, Sweden adopted a climate policy framework. (Came into effect in 2018) The framework consists of a climate law, climate targets and a climate policy council. The purpose of the framework is to create a clear and coherent climate policy to ensure long term signals to the market and other actors. The long-term goal is for Sweden to have no net emissions of greenhouse gases into the atmosphere by 2045, and to achieve negative emissions thereafter. The emissions from domestic transport, except domestic flights, are to be reduced by at least 70 per cent by 2030, compared to 2010. the long-term goal includes emissions covered by the EU's Effort Sharing Regulation (ESR). Emissions covered by the EU Emissions Trading System (EU ETS) are not included.

Policies for decarbonising the heating and the transport sector: Bioenergy is the leading energy source in Sweden today. The Swedish energy system has gone through a major transformation. In the 1970s oil was totally dominating. Today, oil is almost entirely a transport

fuel, whereas bioenergy has taken over in district heating, and plays a major role in industry and in electricity production.

Sweden has the highest share of renewable energy in EU. The overall share of renewable energy (bio, hydro and wind) in Sweden is today 66%. The use of bioenergy in Sweden has increased from 40 TWh/year in the 1970s to around 140 TWh/ year today. Biomass has a dominant position in the Swedish heat market as a fuel for CHP for district heating. Very little fossil fuels are today used for heating. Biomass is also the main energy source for energy intense forest industries. Increased use of bioenergy is the main reason that Sweden has managed to decrease greenhouse gas emissions by 25% between 1990 and 2014. During the same time the total growing volume of forest has increased storing more and more carbon in the forest every year. The main reason for this development is a broad political support for long term and stable energy policies starting with the introduction of carbon tax in 1991 and further developed with green electricity certificates introduced in in 2003. However, the transport sector is still dependent on fossil resources.

In Sweden, the parliament has decided that the vehicle fleet should be fossil independent by 2030. In connection with the decision on the climate policy framework 2017, the parliament decided that greenhouse gas emissions from domestic transport should decrease by at least 70 percent by 2030 compared to 2010. De carbonizing the transport sector is a more complex and difficult task than the heating sector and policies has neither been stable nor long term. In 2018, Sweden had the largest share of renewable fuels for transport in the EU with a 23 % share. The main driver for this development has been the tax exemption that was introduced in 2007. However, the tax exemption has been questioned by EU as state subsidy and permission to extend it has been granted during this period 7 times. This has not created the long term and stable energy policy landscape required for investments in domestic production of biofuels.

In 2018, 85 % of the biofuels used in Sweden were imported and a reduction quota was introduced. The quota stipulates that the distributers of transport fuels are obliged to reduce the carbon footprint from the volumes sold by 19.3 % for diesel and by 2.6 % for gasoline. The reduction quota will step by step be increased until 2030 reaching 28% for petrol and 66% for diesel in 2030. However, these policies were unpopular as the made the diesel fuel more expensive. The new government promised to reduce the price for diesel fuel and drastically lowered the reduction quota to EUs minimum level. In the future, polices for decarbonising the transport sector must harmonise with EU polices as the transport sector will be part of EU ETS in 2017.

National Circular strategy: The national strategy for circular economy from 2020 points out the direction for the transition to circular production, consumption and business models as well as non-toxic and circular material cycles. A circular economy is a tool for reducing society's use of resources and the environmental and climate impact that follows from this. The bioeconomy reinforces and interacts with the circular economy through renewable production and resource-efficient use of organic residual streams. The bioeconomy also focuses on aspects that are not directly covered by the circular economy, such as creating new chemical building blocks, functionality and properties of products that are based on the biological cycle.

National food strategy: In 2017, the overall goal of the food strategy was adopted is a competitive food chain where total food production increases while relevant national

environmental goals are reached, and sustainable growth and employment are created throughout the country. The increase in production, both conventional and organic, should respond to consumer demand. An increase in production could contribute to an increased degree of food self-sufficiency. Vulnerability in the food chain must be reduced.

National Forest program: The forest program is a platform for dialogue between forest stakeholders, authorities and the government. The strategy for the forest program was adopted in 2018.

The five focus areas will contribute to achieving the program's vision, work, and organization. The vision for the forest program is that "The forest, the green gold, should contribute to jobs and sustainable growth throughout the country as well as to the development of a growing bioeconomy.

Fossil Free Sweden: Fossil Free Sweden is an initiative by the Swedish Government to increase the pace of the climate transition. The goal is to build a strong industrial sector and to create more jobs and export opportunities by going fossil free. By working together with companies, industries, municipalities and regions, Fossil Free Sweden is identifying obstacles and opportunities to accelerate developments.

As part of Fossil Free Sweden, 22 different industries have produced their own roadmaps to show how they can enhance their competitiveness by going fossil free or climate neutral. The roadmaps show the opportunities, identify obstacles, and contain proposals for solutions both through the industries own commitments and through political proposals. Taken together, they show what a fossil free business sector will be like. The roadmaps have been presented to the Government and now form a basis for continued work by Fossil Free Sweden and the industries participating.

The 22 roadmaps for fossil free competitiveness produced by the various industries in the business sector show what is required to make industry fossil free or climate neutral. This “jigsaw puzzle of Sweden” cannot be pieced together if all the roadmaps are implemented at the same time. Fossil Free Sweden is therefore developing strategies that show how the challenges can be managed and how the transition can be pressed ahead and benefit Swedish competitiveness in international markets. The strategies containing proposals of measures are produced by Fossil Free Sweden, with support from several companies and universities that essentially back the strategies and are then presented to the Government

All these national ambitions are anchored in the work needed to drive the bioeconomy forward in the regions, but the focus should be based on the regional conditions and needs.

2.2.2.1 The proposal of the Swedish national Bioeconomy Strategy

On 29 March 2023, the interim report fossil free transports (SOU 2023:15) was published, analysing, and proposing measures to promote the efficient production of liquid biofuels based on domestic raw materials in Sweden.

On 1 December 2023, the committee submitted its final report ‘SOU 2023:84 A sustainable bioeconomy strategy - for a prosperous fossil-free society’. The assignment was to develop proposals for a national strategy including follow-up goals and measures for a sustainable, competitive, and growing bioeconomy. The final report proposes quantitative goals and

indicator systems, follow-up and evaluation, new statistical assignments and a number of measures that, according to the final report, need to be done within the framework of a strategy.

These two reports undergone a referral process during the summer of 2024, and is currently undergoing a summary of the referrals.

Part I Overview of the interim report 'Fossil free transports" (SOU 2023:15)

The focus is on promoting domestic production of renewable transport fuels using raw materials like biomass, carbon dioxide, and electricity. This is seen as part of a broader strategy to enhance the national bioeconomy and green industry. While the primary aim is renewable fuels and intermediate products, the scope also includes value chains that produce other renewable products (e.g., plastics and chemicals) traditionally made from fossil resources. The shift towards renewable fuels aligns with national climate and energy policies, economic growth, and improved supply security. The transport sector, to reduce greenhouse gas emissions, is expected to rely on three main strategies: electrification, efficiency improvements, and renewable fuels. Electrification is progressing, but due to slow changes in the vehicle fleet, especially heavy transport, renewable fuels will remain crucial. In sectors like aviation and maritime transport, the demand for renewable fuels is expected to persist long-term.

Increasing domestic production of renewable fuels could support economic goals by generating jobs and stimulating economic activities throughout the value chain, especially when using domestic raw materials. It also enhances supply security by reducing dependency on imported fuels and raw materials. In scenarios like energy blockades or global raw material shortages, having a domestic supply of renewable fuels would be advantageous for both civilian use and national defence. Overall, the investigation emphasizes the importance of scaling up domestic production of renewable fuels to meet climate targets, enhance economic growth, and improve national supply security.

The proposal has the vision that by 2040 Sweden will have a domestic production of liquid renewable fuels and intermediate products that is at least of the same order of magnitude as the country's needs. The production should be based on a high proportion of domestic raw materials. The increased domestic production of renewable fuels and intermediate products has contributed to sustainable growth, increased employment, and strengthened security of supply of fuels throughout the country. It has also contributed to new biorefineries and the production of other biobased products that replace fossil-based products.

To that end, the investigation concludes that new policy instruments are necessary to increase the domestic production of renewable liquid fuels and intermediates from local raw materials. The current incentives help reduce capital costs for new production investments but do not address revenue risks, particularly for non-established, innovative production technologies. As a result, future production capacity is likely to rely on existing technologies, continuing dependency on imported raw materials.

The investigation highlights the need for new policy measures to improve domestic production of renewable liquid fuels and intermediates from local raw materials. Existing incentives mainly reduce investment costs but do not address revenue risks, especially for new, non-established

technologies. As a result, future production may rely heavily on existing methods, leading to continued import dependency. To address this, the investigation proposes a flexible, long-term revenue guarantee system that would cover the difference between a market reference price and a bid price, thus providing financial stability for producers. Companies could apply for these guarantees through a competitive bidding process, focusing on renewable fuels and intermediates produced in Sweden using specified raw materials like those listed in the EU Renewable Energy Directive, as well as carbon dioxide and electricity.

The revenue guarantee would be granted for a ten-year period, with payments based on production volume and the price differential and is planned to be active from 2024 to 2048, with the first payouts expected in 2029. Regular evaluations would ensure the policy's effectiveness, focusing on improving bidding processes and reference pricing. The policy does not limit the end use of the products, allowing flexibility for various sectors to benefit. This measure aims to stimulate domestic innovation, reduce import reliance, and support economic growth while aligning with climate and energy objectives.

Overall, the proposal aims to encourage domestic innovation in renewable fuel production, reduce dependency on imports, and support economic growth while aligning with climate and energy goals.

Part II - Overview of the proposed Bioeconomy strategy (2023:84)

The aim of "A sustainable bioeconomy strategy – for a prosperous fossil-free society", SOU 2023:84, is to promote sustainable growth, renewal, and employment across the country, contribute to environmental and climate benefits, and enhance supply capacity while reducing vulnerability in society. This is based on biomass from the forestry, agriculture, and fisheries sectors, as well as by-products from food processing.

The strategy outlines the following tasks: measure the development of the bioeconomy over time, both in individual sectors and assess its climate benefits while suggesting improvements to methodologies if needed. It also includes analysing the socioeconomic impacts of various options, proposing measures to enhance cooperation and dialogue among stakeholders, identifying opportunities to increase access to sustainably produced biomass, and addressing barriers like regulations that limit competitive production and processing. Additionally, it highlights the need to evaluate current education, research, and innovation efforts in the bioeconomy and analyse further actions required for growth, including skills development.

The strategy does not cover all areas of bioeconomy but acknowledges that the strategy needs to be aligned and coherent to other existing strategies that also regulate parts of the Swedish Bionomy:

- The Bioeconomy Strategy
- The Circular Economy Strategy
- A Food Strategy for Sweden
- The National Forest Programme
- The Strategy for Swedish Fisheries and Aquaculture
- The Strategy for Sustainable Tourism and the Growing Visitor Industry
- National Strategy for Sustainable Regional Development 2021–2030
- Ongoing Investigation of National Forest Policy, including EU policy.

Notable is that the ensuring a sustainable primary production of biomass is not in scope of the proposed Bioeconomy strategy but suggested to be continued to be managed within the framework of each relevant policy area, as well as within the National Forest Programme, the Food Strategy, and the Strategy for Swedish Fisheries and Aquaculture, that today already regulate the primary production.

The proposed national strategy rests on three pillars (Figure 4), 1) Promote Sustainable Growth, 2) Climate Benefits of the Bioeconomy, and 3) Enhancing national resilience and reducing vulnerability. No pillar is given more weight than another pillar.

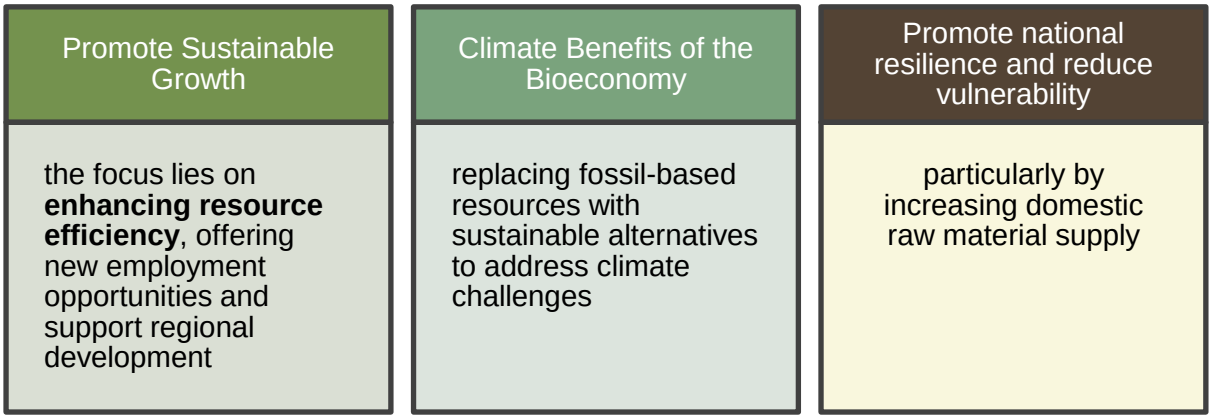

Figure 4 The three pillars of the Swedish national Bioeconomy strategy.

The first pillar of Sweden's national bioeconomy strategy, *"Främja hållbar tillväxt"* (Promote Sustainable Growth), highlights the role of bioeconomy in driving long-term competitiveness, exports, and sustainable job creation across the country. With Sweden's abundant biomass, innovative industries, and expertise in efficient processes, the focus lies on enhancing resource efficiency, increasing recycling, and utilizing rest streams across sectors.

A growing bioeconomy can revitalize rural areas, offering new employment opportunities and supporting regional development through biorefineries, industrial symbioses, and clusters. Collaboration among regions and digital advancements are key to maximizing resource use and fostering innovation nationally and globally.

The second pillar of Sweden's bioeconomy strategy, *"Bioekonomins klimatnytta"* (Climate Benefits of the Bioeconomy), emphasizes the bioeconomy's role in replacing fossil-based resources with sustainable alternatives to address climate challenges. The substitution effect – where bio-based products replace fossil-intensive materials – plays a central role, though its calculation remains complex and depends on geography, market dynamics, and production methods.

In agriculture, climate benefits can be achieved by optimizing processes to reduce emissions, enhancing soil carbon sequestration, and utilizing residues for biorefineries that produce biogas, protein, and biomaterials. Efforts in livestock management, like methane reduction through feed additives and mixed milk-meat production, further contribute to climate goals.

In forestry, Sweden's sustainably managed forests act as a carbon sink, provided growth exceeds harvest rates. Climate-smart forestry, balancing carbon storage and resource use, strengthens resilience against threats like fires and storms. The role of forests sparks ongoing debate, requiring open dialogue to reconcile economic use and preservation goals.

Aquaculture innovations, including land-based fish farming and algae production, reduce emissions and resource use, offering alternatives to fishmeal and fossil-based nutrients. Together, these bio-based solutions demonstrate significant climate potential through resource efficiency, circularity, and substitution of high-emission products, contributing to Sweden's broader climate and sustainability targets.

The third section of the Swedish national bioeconomy strategy, "Stärkt försörjningsförmåga," emphasizes the role of a growing bioeconomy in enhancing national resilience and reducing vulnerability, particularly by increasing domestic raw material supply. Following the geopolitical shifts caused by the COVID-19 pandemic and Russia's invasion of Ukraine, there is a heightened understanding of the need for more robust supply systems.

Goal and vision of the proposed strategy

The vision of the proposed strategy is to: "*We contribute to a prosperous, fossil-free society, through a sustainable bioeconomy."*

The vision describes a future where biobased raw materials, biobased solutions, and systems, together with a high degree of electrification and circular business models, have replaced fossil-based alternatives.

And the goal is that: "*By 2040, Sweden will have a more resource-efficient, resilient, and competitive bioeconomy throughout the country."*

The overall goal consists of three parts: resource efficiency, resilience, and competitiveness. It entails that raw materials and residual streams are taken care of effectively, that there is a high degree of self-sufficiency in critical goods, and that the bioeconomy grows throughout the whole country

As a measure to achieve the set goal, several quantitative indicators and target levels have been set that should measure the inflation-adjusted progress of the change of the Bioeconomy until the year 2040 as compared to 2021:

- The value added of the bioeconomy has increased by 60 percent.
- The substitution effect of the bioeconomy has increased by 50 percent.
- The export value of the bioeconomy has increased by 100 percent.
- Domestic production of renewable fuels as share of fuel demand in the transport sector, excluding electricity, amounts to 90 percent.
- At least 50 percent of the regions have increased the number of employees in the bioeconomy by at least two percent.
- At least 85 percent of the regions have increased the added value within the bioeconomy by at least 60 percent.

The investigation proposes that the overarching goal of the national bioeconomy strategy is that by 2040, Sweden will have a more resource-efficient, resilient, and competitive bioeconomy throughout the country. More specifically, this means that:

- In a more resource-efficient bioeconomy, all bio-based raw materials and residual streams are managed in an efficient and sustainable manner, creating climate benefits and more value from fewer inputs. Bio-based solutions are designed to be reusable and recyclable, and waste becomes a valuable raw material where it arises, or it is distributed and further processed by another actor. A high degree of circularity is the norm.
- In a more resilient bioeconomy, there is a high degree of self-sufficiency in supply-critical goods and services, and thus a greater supply capacity in terms of production, domestic raw materials, and labor.
- In a more competitive bioeconomy, the bioeconomy grows at the expense of the fossil-based economy, contributing to significant climate benefits and good working conditions. The Swedish bioeconomy is also internationally competitive, leading to extensive export of goods, technology, expertise, and solutions.
- In a more resource-efficient, resilient, and competitive bioeconomy throughout the country, there is strong regional cooperation and collaboration based on local and regional conditions for the bioeconomy.

To obtain the above three focus areas have been suggested: (1) More resource-efficient, biobased solutions, (2) Increased regional, national, and international cooperation, (3) A developed knowledge base.

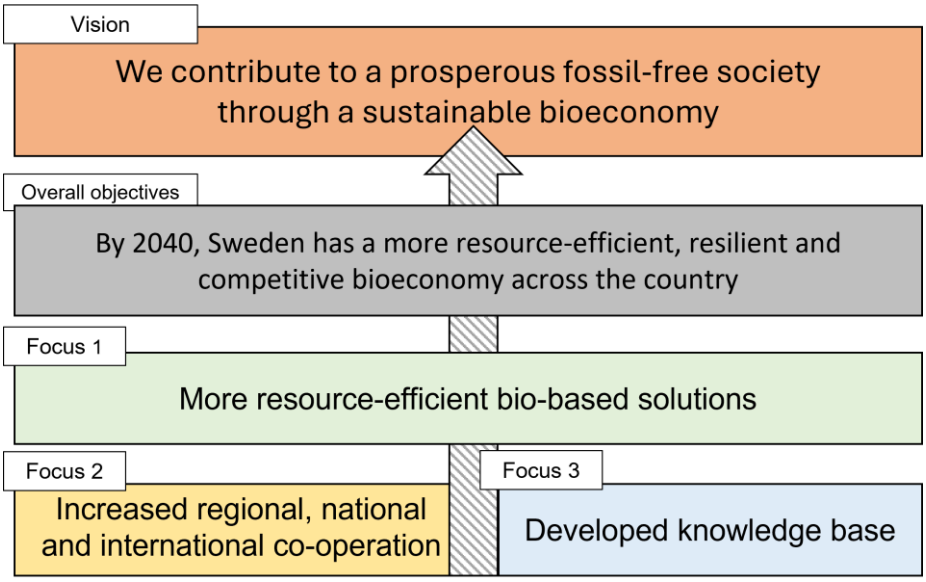

Figure 5 The proposed vision, goal and focus areas of the national Bioeconomy strategy.

The first focus area can be considered the primary focus area, whereas the other two areas are enablers. In other words, measures within these two focus areas contribute to, and create better conditions for, a more resource-efficient, bio-based solutions (Figure 5).

Within these three focus areas, in total 17 actions have been proposed.

1. Revenue guarantees for domestic production of liquid renewable fuels and intermediates.
2. Plan for industrial wood construction and increased wood utilization.
3. Policy instruments to promote bio-based solutions.
4. Data sharing on bio-based residual streams
5. Supply analysis of Sweden's overall need for supply-critical bio-based goods and services.
6. Increase support for procurement of socially critical bio-based solutions.
7. Extend and develop Klimatklivet for a strengthened supply capacity.
8. Include bioeconomy results in regional conditionality decisions.
9. Promote regional bioeconomy networks.
10. Expand risk and vulnerability analyses.
11. Involve the relevant authorities in the work on the bioeconomy strategy.
12. More Swedish bioeconomy experts in EU institutions
13. Establish co-operation between national strategies.
14. Establish bioeconomy networks within the EU.
15. Support for test and demonstration environments for bio-based solutions.
16. Increased investment in interdisciplinary science and cross-sectoral knowledge-building.
17. Establish a national interdisciplinary graduate school.

2.2.3 REGIONAL GOVERNANCE MODEL

Regions in Sweden are governed by directly elected political assemblies known as regional councils, every four years. In addition to their healthcare responsibilities, all regions are also accountable for regional development. It is a statutory requirement for the regions to devise a strategy for the county's development and to oversee the implementation of this strategy. It is about aligning the county's stakeholders to work towards common goals, fostering collective growth and development based on the county's unique circumstances.

Regional Development Strategy (RDS): The leading policy document in regional development work is the RDS**,** together with the Regional Plan. This strategic Plan is a statement of intent for the Regional Council. The RDS acts as a steering document to coordinate and guide regional development efforts. The strategy is a mandate from the government and is considered by government authorities. It guides and influences the allocation of regional and European project funding. It is the foundation for regional work and the basis for national and international lobbying. The strategy, which is adopted by the regional council, sets out the county's common ambitions and is intended to be a guide for actors in all sectors. It aims to create a comprehensive plan to promote the development of a region through co-operation between municipalities, businesses, and other stakeholders.

Regional Innovation Strategy (RIS): The strategy is based on the directions and priorities of the Regional Development Strategy (RDS) Regional Innovation System (RIS) is a concept that describes the networks and institutions within a region that work together to promote innovation. It can include universities, research institutes, companies, cluster organizations, incubators, and regional authorities. The purpose is to promote innovation by creating synergies between different actors in the region and strengthening knowledge flows. The aim is to create a dynamic environment where new ideas and technologies can be developed and commercialised.

Bioeconomy has been integrated into a variety of regional strategies in Sweden in recent years (Table 2). It has been the focus in all regional forestry strategies, focusing primarily on wood, wood-based products, and forestry biomass. The bioeconomy strategists in northern Sweden have also identified the following strategies that include the bioeconomy. Smart specialization identifies priority areas, a food strategy with action plans and every region also has a strategy to realise the government's policy for energy transition and reduced climate impact. This work is described in an Energy- and Climate strategy.

Table 2 Overview of regional strategies connected to bioeconomy.

REGIONAL DEVELOPMENT STRATEGY	
Norrbotten	2020-2030 Sweden's most welcoming and innovative county
Västerbotten	2020-2030 An attractive region where differences create development power
Västernorrland	2020-2030 Strategic plan
Jämtland/ Härjedalen	2024-2050 An innovative and sustainable region to live, work and develop in
REGIONAL FOREST PROGRAM BASED ON THE NATIONAL STRATEGY	
Norrbotten	2020-2030 Focus areas 1-5: 1: Sustainable forestry with increased climate benefits 2: Multiple use of forests for more jobs and sustainable growth throughout the country 3: World-class innovations and processed forest raw materials 4: Forests to be included as a profile issue in Swedish international co-operation 5: A knowledge leap for sustainable forest management and conservation
Västerbotten	2020-2030 Work for a growing bioeconomy and strengthen the role of forests in a sustainable society. Focus areas 1-5: See above
Västernorrland	2020-2030 The forest as a resource for jobs, sustainable growth, utilisation and conservation in Västernorrland Focus areas 1-5: See above
Jämtland/ Härjedalen	2020-2030 Jämtland County forests for a growing bioeconomy and a sustainable future. Focus areas 1-5: See above
SMART SPECIALIZATION	
Norrbotten	**NATURE BASED ECONOMY** Areas of development Tourism and hospitality Culture and creative industries Space Arctic testing Energy technology

	Smart Society
Västerbotten	**INNOVATIONS STRATEGY** 3 focus areas Natural resources Forest bioeconomy Mining & Minerals Sustainable energy systems Manufacturing industry Knowledge resources: Life Science Digitalisation Natural, cultural and knowledge resources: Hospitality Food and beverages Cultural and creative industries
Västernorrland	Forest bioeconomy Manufacturing metal, machinery, vehicles Renewable energy, solar, wind, hydro and bioenergy Govtech Production and business systems Areas of development: FoodTech Autonomous mobility Crisis and rescue Smart Caring
Jämtland/ Härjedalen	Forest, soil, water Sustainable energy Tourism Digital solutions

REGIONAL FOOD STRATEGY BASED ON THE NATIONAL STRATEGY

Norrbotten	2022-2025 CLOSE TO FOOD Increased production, value and food security. Sustainable and local consumption, food more important in strategies and development
Västernorrland	2021-2030 Increased demand and sustainable production of food
Jämtland/ Härjedalen	Increased trust between authorities, business and consumers, More food in private and public meals, increased collaboration for skills supply and product development.
Västerbotten	Sustainable entrepreneurship, Knowledge and innovation, Conscious consumption.

ENERGY & CLIMAT STRATEGY

Norrbotten	Fossil-free transport World-class production Future consumption and trade Resource efficient buildings Flexible and robust energy system
Västerbotten	Energy Forest carbon sequestration and a growing bioeconomy The future of forestry and agriculture
Västernorrland	Transport-efficient society and fossil-free transport Strong and sustainable bioeconomy A sustainable construction and property sector Sustainable consumption The electricity system of the future

Jämtland/ Härjedalen	**Fossil fuel free 2030 Jämtland County** Fossil fuel-free transport and machinery Forest as a resource and carbon sink Renewable energy Climate-smart food Sustainable consumption

Summary

Many of the above priorities can be directly classified as bioeconomy. Most of them belong to the forest bioeconomy. Food strategies also focus on consumer behavior to strengthen the region's self-sufficiency. Renewable energy and climate-friendly solutions, as well as digitalization, require cross-sectoral innovation to boost competitiveness and sustainability. Tourism is linked to natural resources and regional attractiveness. In addition to the regional strategies presented above, two of our regions address reindeer husbandry as part of the bioeconomy. There is currently no overall strategy for the bioeconomy at regional level in the northernmost parts of Sweden. However, strategic bioeconomy development work is included in several of the existing strategies that govern the regions' activities.

2.3 BASELINING GOVERNANCE MODEL AND IMPLEMENTATION ECOSYSTEM FOR THE BIO-BASED ECONOMY

The baseline of the Northern Sweden's bioeconomy governance can be divided into three governance areas, 1) Information and finance, 2) Rule-setting, and 3) information sharing (Table 3). In Implementation & Finance, Northern Sweden's bioeconomy benefits from robust value chains, favorable funding conditions, and a promising SME landscape. However, challenges persist in innovation potential and market accessibility, especially for new actors. For Rule-Setting, the region has a comprehensive policy framework that integrates EU laws, tariffs, however, challenges include fragmented integration with other sustainability strategies, and obstacles from EU laws and policies. Within Information-Sharing, reporting mechanisms are in place but collaboration across levels of governance and public acceptance need work, indicating significant room for improvement stakeholder engagement across regions.

Table 3 Baseline bioeconomy governance of Northern Sweden

Governance Area	Key Strengths	Moderate Scoring Areas	Challenges
Implementation & Finance	• Robust value chains and diversified biobased markets. • Strong SME landscape and birthrate. • Public funding for bioeconomy development. • Favourable conditions for private investments. • Sustainably managed land and water ecosystems.	• Education & human capital development. • Local biomass availability. • Market accessibility (not logistically)	• Innovation potential remains underdeveloped. • Market accessibility for new actors can be limited, with large established players on the market.

Governance Area	Key Strengths	Moderate Scoring Areas	Challenges
Rule-Setting	• Integrated bioeconomy policy framework. • Full transposition of EU laws. • Supportive tariffs, taxes, and subsidies.	• Integration of regulations with other policy priorities. • Policy regulations for bioeconomy.	• EU laws create obstacles. • Policy is inconsistent. • Public procurement for bio-based products (BBPs). • Use of trade policies for bioeconomy development.
Information-Sharing	• Monitoring and reporting mechanisms are in place. • Certification and sustainability labels.	• Multi-level collaboration • Collaboration between actor groups.	• Public support and acceptance. • Limited interregional collaboration.

Out of the three areas, Implementation & Finance and Rule-Setting are the strongest while information-sharing is the most challenging area. Strengthening information sharing and collaboration as mechanisms are key to advance the bioeconomy transition in the region.

3 TOWARDS A VISION FOR THE BIO-BASED ECONOMY IN NORTHERN SWEDEN

3.1 POLICY PRIORITIES

The three key priorities of the Northern Swedish region align with the three pillars that the proposed national strategy rests on 1) promoting sustainable growth, 2) climate benefits of the bioeconomy, and 3) enhancing national resilience and reducing vulnerability (Figure 6).

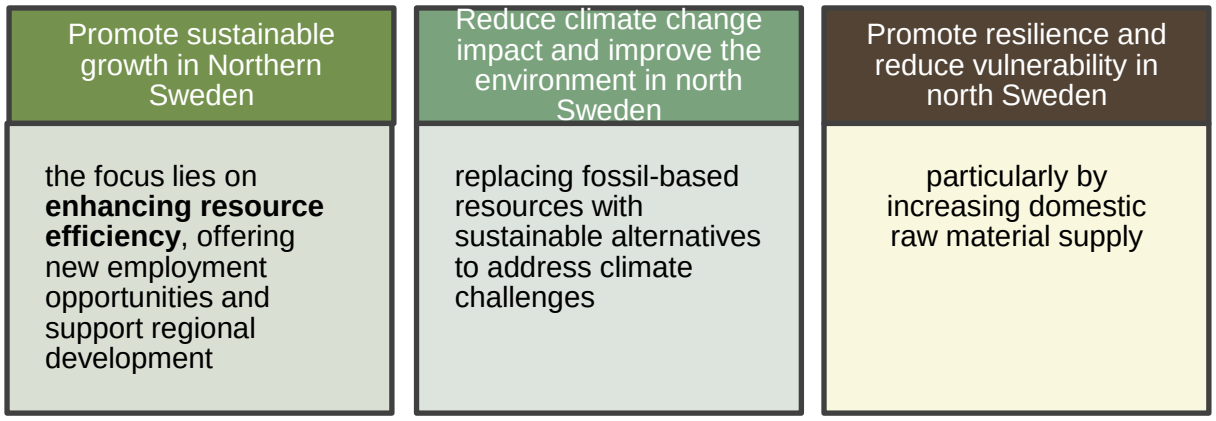

Figure 6 The three pillars of the Northern Swedish Bioeconomy blueprint.

Reducing Climate Change

A clear priority for Northern Sweden's bioeconomy strategy is reducing climate change through the substitution of fossil-based products with biobased alternatives across the full value chain. This includes everything from compounds and chemicals in the production to the final product. Additionally, technologies such as Carbon Capture and Utilization (CCU) and Carbon Capture and Storage (CCS) are emphasized to mitigate CO_2 emissions effectively. Assessing the entire lifecycle of biobased products, including feedstock production,

transportation, and processing, is crucial to fully understand the climate benefits of these substitutions.

Within forestry, climate-smart management plays a pivotal role, as sustainably managed forests act as carbon sinks, provided growth rates exceed harvest levels. This balance strengthens the region's resilience to environmental threats like wildfires and storms while addressing the ongoing debate on economic forest use versus preservation goals. Innovations in aquaculture, such as land-based fish farming, algae production, and sustainable alternatives to fishmeal, further support emissions reductions and resource efficiency.

Promoting Resource Efficiency and Sustainable Growth

Resource efficiency and sustainable bioeconomic growth form the second priority, focusing on regional development and employment generation in Northern Sweden, particularly in rural areas. By advancing bioeconomy sectors, e.g., forestry, agriculture, and aquaculture, there are opportunities to increase jobs and economic growth in a sustainable manner. However, this growth must align with broader social development goals, ensuring equitable access to healthcare, elderly care, education, and transport services across the region. Within agriculture, resource efficiency is enhanced by optimizing processes to reduce emissions and improve soil carbon sequestration. Innovative circular BioSolutions and industrial symbioses are essential for creating new business models that benefit both the local economy and the environment.

Enhancing National Resilience and Resource Security

The third priority highlights the importance of bioeconomy development in strengthening the regions resilience and reducing vulnerability. Northern Sweden has a large potential to increasing the supply of domestic raw materials and advancing self-sufficiency. Utilizing abundant regional biomass ensures that biobased industries can meet national and global demands while reducing dependence on imported resources.

Collaboration across regions, advancements in digital technologies, and the development of industrial clusters are key strategies for optimizing resource use and promoting innovation. By enhancing recycling practices and utilizing residual streams across sectors, Northern Sweden contributes to both climate goals and national resilience, ensuring long-term economic and environmental stability.

3.2 Our vision for a bio-based economy in Northern Sweden

By 2040, the vision of Northern Sweden is to have a more resource-efficient, resilient, and competitive bioeconomy. This vision is directly in line with the proposed national Bioeconomy vision, but herein with a vision that this that northern Sweden also in itself shall reach the vision having transitioned to a sustainable bioeconomy.

Vision
By 2040, Northern Sweden has a more resource-efficient, resilient, and competitive bioeconomy that contributes to a nationally prosperous fossil-free society.

The vision rests on the three pillars of the key priority areas: resource efficiency, resilience, and competitiveness. It entails that raw materials and residual streams are taken care of effectively, that there is a high degree of self-sufficiency in critical goods, and that the bioeconomy grows throughout the whole region.

3.3 STRATEGIC & OPERATIONAL OBJECTIVES

To effectively utilize the biobased potential in Northern Sweden several priority areas for action has been identified, that are actions to strengthen weaknesses identified in the governance areas of Implementation & Finance: Rule-Setting, Information-Sharing (Table 4).

Table 4 The three primary bioeconomy governance dimensions: Implementation & Finance, Rule-Setting, and Information-Sharing with identified strategic objections areas

	Key Strengths	Moderate Scoring	Challenges	Strategic Objectives
Implementation & Finance	Robust value chains and diversified biobased markets.	Education & human capital development.	Innovation potential remains underdeveloped.	**Enhancing Access to Funding** – Improve funding mechanisms for SMEs and innovation actors to unlock potential.
	Strong SME landscape and birthrate.	Local biomass availability.	Market accessibility for new actors can be limited.	**Developing Infrastructure for Biobased Products** - Enhance logistics, processing, and infrastructure for bio-based solutions.
	Public funding for bioeconomy development.	Market accessibility (not logistically).		**Promoting Education and Skills Development** – Build a skilled workforce to drive growth and innovation.
	Favourable conditions for private investments.			**Leveraging Natural Resources Sustainably** – Ensure sustainable land, water, and resource management practices.
	Sustainably managed land and water ecosystems.			
Rule-Setting	Integrated bioeconomy policy framework.	Integration of regulations with other policy priorities.	EU laws create obstacles.	**Advocating for Supportive Policies and Regulations** – Work towards policies that promote bioeconomy development and resolve conflicts with EU laws.
	Full transposition of EU laws.	Policy regulations for bioeconomy.	Policy is inconsistent.	
	Supportive tariffs, taxes, and subsidies.		Public procurement for bio-based products (BBPs).	
			Use of trade policies for bioeconomy development.	
Information sharing	Monitoring and reporting mechanisms are in place.	Multi-level collaboration.	Public support and acceptance.	**Strengthening Collaboration Across Sectors** – Improve multi-level and cross-actor collaboration to accelerate knowledge sharing and transparency.
	Certification and sustainability labels.	Collaboration between actor groups.	Limited interregional collaboration.	**Fostering Product Development and Market Credibility** – Enhance certification, sustainability labels, and public awareness for bio-based products.

Each of the identified strategic objectives are below detailed:

1. Strengthening Collaboration Across Sectors

Strengthening collaboration across sectors is essential for advancing the bioeconomy in Northern Sweden. Aligning strategies at regional, municipal, and national levels creates

coherence and amplifies long-term societal impacts while ensuring the fulfilment of national bioeconomy indicators. By fostering partnerships between academia, industry, and policymakers, a favourable policy and investment landscape can be established, allowing for the integration of proven knowledge and new biobased solutions, particularly in established industries like pulp mills, sawmills, and energy companies. Enhanced knowledge sharing, including data on biobased residual streams and project outcomes, supports matchmaking along the value chain and drives innovation through stronger joint ventures. Collaboration through innovation hubs and incubators further accelerates start-ups' access to funding and expertise, fostering a dynamic ecosystem that leverages regional strengths to create sustainable growth, employment, and rural development.

2. Enhancing Access to Funding

Enhancing access to funding is crucial for accelerating bioeconomy growth in Northern Sweden, particularly for biobased innovation and investment. Strengthening cooperation with traditional industries like pulp mills, sawmills, and energy companies will enable the integration of biobased solutions across established sectors. Developing multi-actor partnerships, involving both academic and non-academic stakeholders, is key to breaking down silos and building strong consortiums that can successfully apply for funding. Simplifying the application process, especially for start-ups and small enterprises, is essential to ease administrative burdens and make it easier for these businesses to participate in larger collaborative projects. Providing targeted support to SMEs and making funding available for early-stage companies to demonstrate new technologies will help bridge the “Valley of Death” – the critical gap between innovation and full-scale commercialization. Ultimately, streamlined access to funding will help foster sustainable growth, ensure a higher success rate for start-ups, and drive the transition to a thriving bioeconomy in Northern Sweden.

3. Developing Infrastructure for Biobased Products

Developing infrastructure to produce biobased commodities is essential to unlock the full potential of the bioeconomy in Northern Sweden. In total, four areas of infrastructure have been identified, 1) energy supply, 2) transport and logistics, 3) digitalization and AI, and 4) research and development infrastructure.

Energy Supply: Ensuring a stable, resilient, and cost-effective renewable energy supply is critical for biobased commodity production. Additionally, strengthening of the power grids is important for enhancing the transmission capacity of renewable energy, supporting investments and societal needs. Supporting the more efficient use of low-value heat sources from industries will further improve energy efficiency and reduce costs.

Transport and Logistics: Investing in infrastructure that supports the logistics and distribution of biobased products is essential. There are vast logistical challenges intraregional through to the share distances but also a congested cargo system and forest industry by products being scattered across large distances at sawmills. Establishing processing facilities needs careful consideration to establish them close enough to raw material sources, yet not too far of reach the market. Local governments can play a pivotal role in creating a conducive environment for these developments in advocating for a viable train infrastructure in the region, in road maintenance and in keeping smaller harbours open (and possible investing in deepening them for larger freight ships). It is also important to mobilize underutilized biomass

resources, such as logging residues, to optimize the biomass supply for Combined Heat and Power (CHP) plants.

Digitalization and AI: The use of digital technologies and AI is increasingly important for driving circularity within the bioeconomy. Developing applications for reuse, recycling, and traceability will improve the management of bio-based products throughout their life cycle. These technologies can streamline processes, enhance efficiency, and enable better decision-making by providing real-time data on material flows, product quality, and environmental impact.

Research and Development Infrastructure: Establishing robust, accessible state of the art R&D infrastructure is essential for advancing biobased technologies and solutions. Access to testbed and demonstration facilities will help to faster bridge the gap between research and commercial-scale production, making new technologies more accessible. Supporting research into more efficient and environmentally friendly biomass utilization and logistics will reduce costs and environmental impacts while improving sustainability. Creating arenas for networking and information sharing among industry stakeholders, policymakers, and researchers will foster collaboration and innovation, increasing competitiveness and enabling knowledge transfer across the bioeconomy sector.

4. Fostering Product Development and Market Credibility

By anticipating market needs and collaborating with customers from the early stages, businesses can align product development with demand and ensure that bio-based products meet market requirements. Also, strengthening the region's resilience and self-sufficiency in critical sectors such as agriculture, transport fuels, and process chemistry is fundamental for securing long-term sustainability.

One of the key strategies for building market credibility is the adoption of certifications and product declarations. Increasing access to sustainability reports, digital product passes, and environmental declarations enables consumers and partners to better understand the environmental benefits of biobased products. This transparency builds trust and demonstrates the positive impact of these products, further driving their adoption. The use of certifications will help companies differentiate themselves in the market, ensuring their products meet both regulatory standards and consumer expectations for sustainability.

5. Promoting Education and Skills Development

Addressing the skills gap in the region is critical for the growth of biobased businesses. Investing in education and training programs focused on bioeconomy and sustainable practices can help attract and retain talent. A clear commitment to gender equality can be a tool. Collaborations among industry, universities and vocational schools can ensure that the workforce is equipped with the necessary skills. Creating attractive communities is important to attract and retain skilled citizens. An additional adjacent area closely connected to this is to improve civil services and living conditions across the whole region of Northern Sweden, to ensure the same level of service, health care, schools for families.

6. Advocating for Supportive Policies and Regulations

Active participation in European bioeconomy networks is important for increasing the knowledge base of Nordic European forestry management within the broader European context. Engaging more proactively in these networks enables the region to elevate its bioeconomy initiatives, ensuring that its unique circumstances, such as its reliance on Nordic forestry, are well-represented. By contributing expertise and experiences to these networks, Northern Sweden can increase understanding of its bioeconomy context in the EU and strengthen its influence on European policy decisions.

One important focus is advocating for a regulatory environment that supports bioeconomy initiatives, with policies that incentivize investments and procurement. Through increased visibility and representation, Northern Sweden can help shape a regulatory framework that fosters growth, reduces barriers to investments, and secures the region's supply chains.

The goal is a regulatory system that supports bioeconomy initiatives and enabling investments and procurement also to increase the degree of self-sufficiency. Focus on measures in the national bioeconomy strategy to get budget for investments.

7. Leveraging Natural Resources Sustainably

At the heart of sustainable bioeconomy development lies the efficient and responsible use of natural resources. With 97% of productive land in Northern Sweden covered by forest, the region has a vast, renewable resource base that must be managed with long-term sustainability in mind. Resource efficiency is crucial in enhancing the value derived from forestry, sawmilling, and pulp and paper industries, ensuring that by-products are fully utilized to their highest potential. Investments in energy-efficient processes, as well as the upgrading of forest industry by-products, can contribute to both the growth of the bioeconomy and the increase in its added value. At the same time, encouraging carbon-efficient practices within forest management, such as increasing forest increment and carbon uptake, will provide significant climate benefits while ensuring that forests continue to act as carbon sinks. A focus on circularity is also vital for sustainable bioeconomy practices. Supporting the reuse of materials such as wood, paper fibres, and other bioproducts will help reduce waste, conserve resources, and contribute to a circular economy. This requires modernizing waste legislation to make it easier to recycle and repurpose biobased products, thereby minimizing environmental impacts.

Operational objectives

Within the proposed national bioeconomy strategy indicators and target levels have been set up (Table 5 & 6). Among the targets set up by the proposed national bioeconomy strategy they all highly apply to the priorities of Northern Sweden, and as follow-up of these indicators and target levels will be conducted by regional authorities as part of evaluating the progress of the bioeconomic strategy on a national level the same indicators will be applicable for northern Sweden. The indicators 1-4, are for on a national level, inflation adjusted for the years 2021-2040. The target levels a-b, relate to the regional advancement across Sweden, where the operational objective for the four northbound counties would be to be among the positively contributing countries.

Table 5 Operational objectives

No.	Objective
1	The value added of the bioeconomy has increased by 60 percent.
2	The substitution effect of the bioeconomy has increased by 50 percent.
3	The export value of the bioeconomy has increased by 100 percent.
4	Domestic production of renewable fuels as share of fuel demand in the transport sector (excluding electricity) amounts to 90 percent.
a	At least 50 percent of the regions have increased the number of employees in the bioeconomy by at least two percent.
b	At least 85 percent of the regions have increased the added value within the bioeconomy by at least 60 percent.

Table 6 The strategic and operational objective

Strategic objectives	Operational objectives
1. Strengthening Collaboration Across Sectors	1- 4, a+b
2. Enhancing Access to Funding	1-4, a+b
3. Developing Infrastructure for Biobased Products	1-4, a+b
4. Fostering Product Development and Market Credibility	1-4, a+b
5. Promoting Education and Skills Development	1-4, a+b
6. Advocating for Supportive Policies and Regulations	1-3, a
7. Leveraging Natural Resources Sustainably	1,3 b

3.4 SUMMARY

In summary, the strategic objectives for advancing the bioeconomy in Northern Sweden focus on strengthening cross-sector collaboration, enhancing access to funding, developing key infrastructure, fostering product development and market credibility, promoting education and skills, advocating for supportive policies, and ensuring the sustainable use of natural resources (Figure 7). These efforts aim to align regional, municipal, and national strategies, integrate biobased solutions across industries, and build a dynamic ecosystem for innovation.

Sustainable forest management and circular economy practices will ensure long-term environmental and economic benefits, while increased collaboration will enhance Northern Sweden's role in the broader European bioeconomy, which the progress thereof can be evaluated through the operational objectives.

Figure 7 Identified strategic priority areas.

4 KEY ACTION FIELDS FOR IMPLEMENTATION

The strengths and challenges outlined emphasize the need for a resilient, integrated, and collaborative ecosystem to effectively implement biobased solutions. Northern Sweden's vast forest resources and existing industries, such as pulp, sawmills, and energy production, provide a solid foundation for a bioeconomy ecosystem.

The biobased implementation must leverage these strengths while addressing regional challenges. Through an analysis of in-depth interviews with biobased SMEs in the region, several key adoption factors have emerged, detailed as key-pathways for enhancing biobased business models creating long-term growth, innovation, and sustainability.

4.1 CHALLENGES AND BARRIERS FOR A BIOBASED IMPLEMENTATION ECO-SYSTEM

4.1.1 Infrastructure and land use

A lack of reliable electricity production, grid capacity, and other infrastructure, such as railways, roads, and ports, poses significant challenges growth of the bioeconomy. Now this is not a problem, but with several large investments and projects planned for northern of Sweden, this will become a bottle neck. The ongoing green industrial transition will sharply increase electricity demand, and infrastructure gaps risk delaying investments, forcing operations to relocate domestically or internationally.

Conflicts over land use and resources are highlighted by several regions. Traditionally, the focus on timber has been the most apparent contribution of the forest to national interests. However, due to competing land use the identification of the wider role of forests has been recognised. Watersheds and biodiversity together with cultural and social activities related to forests are increasingly included as potential demands on forests in competition with timber production.

One such hindrance to companies' development in the bioeconomy is conflicts over land use and resources, such as reindeer grazing. This issue is specific to the northern region and is a two-sided coin, as reindeer herding is also part of the regional bioeconomy. The Sami, an indigenous people in northern Sweden, have used the land for centuries but do not own it, leading to recurring conflicts with other stakeholders like forestry and mining. Reindeer herding is central to Sami culture but often competes with other land uses such as forestry, tourism, and construction. Another significant conflict is the ongoing mining dispute in northern Sweden, where the Sami oppose mining due to its impact on reindeer migration and environmental risks. Despite having land use rights, these are often insufficiently protected by legislation, making the Sami vulnerable to such challenges. Regions call for a holistic perspective to serve the many landowners in Sweden who have both land and forest in the same company.

4.1.2 Workforce and Skills Shortage

Many stakeholders highlight that insufficient skills development poses a challenge to business competitiveness. There is a need for new knowledge and expertise across academia, the public sector, and industries, especially in digitalization, automation, and energy. Competence gaps exist at all educational levels, from process engineers and operators to researchers and professionals requiring retraining through higher education or short vocational courses.

The Climate Policy Council (Swe: Klimatpolitiska rådet) stresses the necessity for education system reforms to meet workforce needs for the green transition. These reforms must include further training for professionals and improved vocational and secondary education to address skills gaps. Additionally, public agencies need sufficient capacity and knowledge to support businesses in their transition. Enhanced dialogue between government, industries, and academic institutions is critical to meet the growing knowledge demands, ensuring both climate goals and supply security are achieved.

4.1.3 Regulatory Hurdles

Inefficient, unpredictable, and lengthy permitting processes are viewed as significant obstacles to new investments, particularly for the green transition. Many analyses highlight the need for streamlined processes to ensure success in this area. Several government reviews have examined these issues, emphasizing the need to shorten approval times and make processes more effective and predictable. In June 2023, the government launched another review to improve environmental permitting, following earlier findings that current processes require significant reform to support the green transition.

Uncertainty about current rules and future policies discourages investments and hinders technological development, as well as the use of raw materials for production processes. Existing sector-specific incentives, like tax exemptions and investment support, largely focus on bioenergy and biofuels, leaving other biobased solutions underfunded. A broader approach utilizing multiple technologies is necessary to meet climate goals and enhance supply security.

Sweden’s bioeconomy growth relies on alignment between national and EU regulations. Strict national requirements beyond EU laws can reduce competitiveness, limit technological development, and hinder efficient raw material use. Swedish representation in EU legislative processes is limited, making it harder to address country-specific concerns.

Current waste laws, designed for linear systems, hinder circular bioeconomy development. Municipal monopolies on waste management can prevent recycling and reuse. Definitions of waste often include valuable materials, complicating their recovery and reuse. Harmonized EU regulations are needed to enable efficient international material flows.

Increased availability of sustainably produced raw materials from forestry, agriculture, and fisheries is essential. Demand for renewable raw materials is growing, but EU regulations may limit their use. This creates concerns about meeting supply needs for a circular, biobased economy.

Additionally, trade policy regulations pose another layer of complexity. The current regulatory environment can be restrictive, making it difficult for biobased products to compete effectively. Compounding this issue is the fact that fossil-based products are often significantly cheaper to produce, creating a challenging competitive landscape for biobased alternatives. This price disparity makes it hard for new entrants to gain a foothold in the market.

4.1.4 Market Development

The journey towards establishing new biobased businesses in Northern Sweden is hampered with several barriers. One of the primary challenges is the dominance of established players in the market, which creates a landscape resistant to change. These traditional industries often maintain a mindset that prioritizes existing practices over innovation, leading to a reluctance among major companies to embrace new biobased solutions. In many cases, these large players actively seek to use established rules and standards, such as ISO standards for mass balance, to slow down the transition, thereby perpetuating the status quo.

Higher costs and risks associated with biobased solutions challenge their competitiveness. Fossil-based alternatives benefit from subsidies, creating price imbalances. Existing government measures target specific bioeconomy sectors, primarily for reducing greenhouse gases, rather than supporting broader growth or resource security.

Regions highlight barriers of complex regulations, and conflicting policies on resource use. Fragmented responsibilities between regional growth and agricultural policies limit holistic approaches. Differing interpretations of project benefits by authorities further hinder support. Regions also struggle to integrate bioeconomy solutions into preparedness for emergencies, such as energy supply issues.

The financing landscape further complicates matters, as the market has cooled off, making it increasingly difficult to secure funding for deep tech ventures. The Swedish government's expectation for businesses to provide parallel equity, for certain calls, when seeking financial support adds another hurdle, as many start-ups struggle to meet these requirements. One of the most pressing issues is the "Valley of Death," a critical phase where companies struggle to secure the necessary funding to bridge the gap between initial development and commercial viability. This dilemma is often compounded by the need for contracts to justify investments in production facilities and raw materials, creating a classic "chicken and egg" scenario. Without contracts, companies hesitate to invest, yet without investment, securing contracts becomes increasingly difficult.

Cross-sectoral collaboration is critical for biobased innovation but often hindered by uncoordinated access to raw materials and expertise. State funding for research, innovation, and test environments helps mitigate risks, but better cooperation across industries is needed to create new value chains.

4.1.5 Strengths and possibilities for a biobased implementation eco-system

4.1.5.1 Abundant Natural Resources

Northern Sweden's vast forest landscapes, covering 97% of its productive land, provide a renewable and sustainable foundation for the bioeconomy. The region's Nordic forestry practices ensure long-term forest management, balancing environmental goals with economic productivity. This renewable resource base offers significant potential for producing biobased products such as pulp and paper, biomaterials, wood products, and biochemicals. Additionally, forestry by-products like sawdust, bark, and logging residues can be utilized to generate value-added outputs, driving resource efficiency, and contributing to a circular economy. By leveraging its natural resource wealth, Northern Sweden can address climate goals while creating opportunities for innovation and industrial growth.

4.1.5.2 Strong Industrial Foundation

Northern Sweden has an established industrial base, including pulp and paper mills, sawmills, and energy companies, which serves as a strong platform for scaling biobased solutions. These industries are equipped with infrastructure, workforce expertise, and logistics networks that can be leveraged to integrate innovative technologies into existing production systems. By upgrading industrial by-products into high-value applications such as bioenergy, biofuels, and advanced biomaterials, the region can maximize resource utilization and reduce waste. Additionally, opportunities for industrial symbiosis – where one industry's by-products are inputs for another – further enhance efficiency and sustainability, positioning the region as a leader in industrial bioeconomy implementation.

4.1.5.3 Collaboration and Innovation Ecosystem

Collaboration among industry, academia, and policymakers is a key strength of Northern Sweden's bioeconomy. This interconnected ecosystem fosters innovation through joint research, knowledge transfer, and cross-sector partnerships. Universities and research institutes contribute cutting-edge expertise in sustainable forestry, biomass utilization, and circular solutions, while testbeds and demonstration facilities accelerate the validation and commercialization of biobased technologies. By supporting innovation hubs and start-ups, the region can drive advancements in biobased products and processes, creating a dynamic environment where businesses and researchers collaborate to solve societal challenges and unlock new market opportunities.

4.1.5.4 R&D as a Catalyst for Innovation

Research and development (R&D) play a crucial role in driving innovation across Northern Sweden's bioeconomy. By providing access to state-of-the-art testbeds and demonstration facilities, the region can bridge the gap between research and commercial-scale production, accelerating the adoption of new technologies. Supporting collaborative R&D projects will

enhance biomass logistics, energy efficiency, and environmental performance while reducing costs. Universities, research centres, and industries can work together to develop solutions that improve resource utilization, create sustainable processes, and drive competitiveness. By prioritizing innovation, Northern Sweden can emerge as a global leader in biobased technology development.

4.1.5.5 Commitment to Sustainability and Circularity

A strong focus on sustainability and circularity underpins Northern Sweden's bioeconomy vision. Sustainable biomass management practices, such as increasing forest increment and carbon uptake, align resource use with climate goals while enhancing the carbon sink capacity of forests. Encouraging the use of long-lasting wood products in construction further contributes to carbon sequestration and reduces reliance on carbon-intensive materials. At the same time, circular practices that emphasize reuse, recycling, and recovery of wood fibers, paper, and bioproducts minimize waste and conserve resources. By modernizing waste systems and legislation, the region can maximize circularity, serving as a model for sustainable resource management.

4.1.6 Key pathways for improving biobased business models

Over the past 150 years, huge investments have been made into industries processing forest biomass. Sawmills, pulp and papermills and CHPs are continuously investing in more innovative and effective processes to stay competitive. Industry driven investments are the main driver for innovations and growth in the forest bioeconomy. Over time, strong synergies as well as competition have developed between these industry segments and forest owners. A few big companies are dominating the market and defending their investments hampering new businesses to enter the market. However, there are several key-pathways for establishing new biobased businesses.

In Sweden, start-ups have access to a variety of funding opportunities that cater to different stages of development and investment needs. For those seeking funding in the early stages of business development there are several call e.g hypothesis testing, which is designed to support early-stage research and development projects. This program typically provides funding to validate innovative ideas and concepts, making it an excellent choice for start-ups looking to test their business models or technologies before scaling up. Another significant initiative for large scale projects is the so called "The Industry Leap" which focuses on promoting sustainable industrial development. This program offers financial support for projects that aim to reduce carbon emissions and enhance resource efficiency.

Start-ups engaged in biobased innovations can particularly benefit from this funding, as it aligns with Sweden's broader goals of transitioning to a greener economy. Additionally, Vinnova, Sweden's innovation agency, provides various funding opportunities for start-ups, including grants and innovation vouchers. These can be utilized for product development, market entry, and collaboration with research institutions, making them highly valuable for new businesses.

The EU regulatory landscape plays a significant role in shaping biobased businesses. Key drivers include emission rights regulations, which compel businesses to adhere to strict emission standards, pushing them towards more sustainable practices. Additionally, the

upcoming deforestation regulation, set to take effect on December 30, 2025, aims to curb deforestation and could impact sourcing strategies for biobased materials. The Corporate Sustainability Reporting Directive (CSRD) and the Carbon Border Adjustment Mechanism (CBAM) introduce additional compliance requirements, which can be both a challenge and a motivator for businesses to adopt sustainable practices.

There are common strengths among the SMEs striving to succeed in this sector. A robust demand for biobased products exists, driven by customers' sustainability goals. Additionally, having a skilled and experienced workforce is crucial, as these employees are essential for driving innovation and product development. Moreover, strong engagement between industry, academia, and incubators, e.g Örnsköldsvik municipality, fosters innovation and collaboration.

Externally, the potential for biobased businesses is supported by a growing global emphasis on environmental sustainability and supportive political climates. Regulations aimed at boosting biobased initiatives present opportunities for growth. However, threats loom from shifting global politics, such as changes in U.S. leadership and the implications of the ongoing conflict involving Russia, which can affect resource availability and market stability. Furthermore, restrictions imposed by the EU on forest management and the potential for increased customs fees could hinder progress.

4.2 ACTIONS / INTERVENTIONS

The blueprint developed in Northern Sweden is comprised of seven strategic objectives (Table 7). Inspired by the Proposal for a Swedish Bioeconomy these objectives will contribute to the national indicators and targets, which also serve as the operational objectives. Furthermore, the Proposal comprises 17 measures, and an indication (*) is provided as to which national goal our actions are aligned with the strategic objective.

Table 7 Overview of strategic objectives, actions and expected results for 2040.

Strategic objective	Action	*	Expected result
1. Strengthen collaboration across sectors			
	Strengthen cooperation and coherence between strategies in Northern Sweden	9	Synchronized bioeconomy strategies that align efforts and provide long term effects on society.
	Strengthen cooperation and exchange of best practices between Swedish regions	9	Fulfilment of the national bioeconomy indicators for all regions
	Strengthen collaboration between academy, industry, and policy makers for a favorably policy and investments landscape	11	Multi-stakeholder interaction will ensure that relevant and critical issues for the whole bio-economy sector are included.
	Strengthening cooperation with established bioeconomy industries like pulp mills and sawmills or energy companies to introduce and integrate new biobased solutions.		Increased use of proven knowledge and experiences

Strategic objective	Action	*	Expected result
	Share information about on-going and completed bioeconomy projects, find gaps and future possibilities for cooperation.		Joint project applications and funding to support regional bioeconomy development.
	Share data on biobased residual streams, with a complete view of flows, traceability, volumes, and characteristics. Identify and address barriers utilization.	4	Matchmaking along the biobased value chain to support stronger joint venture for biobased business cases.
2. Enhance access to funding for biobased innovation and investment			
	Develop multi-actor partnerships to avoid silos and build strong consortiums also involving actors outside the academy when applying for funding		More funding and greater impact on prioritized areas,
	Support to SMEs to apply for funding. Simplify the application process for start-ups/small enterprises to take part in larger joint projects. and ease their administrative hurdles.		Start-ups can earlier take part in larger projects, meaning
	Support and make funding available for start-ups/small enterprises to reach demonstration of new technologies and innovations and to overcome the valley of death to reach full scale production.		Greater success rate for startups to reach commercial scale.
3. Develop infrastructure for production of biobased commodities			
3.1 Energy supply	Support investments in resilient production of renewable electricity in Northern Sweden that harmonizes weather dependent electricity supply (wind, solar and bio) with adjustable power supply (hydro) and base power supply. Support investments in power grids for increased and resilient transmission of electricity.		Secure long term and resilient supply of renewable electricity at a stable and attractive price for investments and for the society
	Support more efficient use of low value heat sources from industry		Increased energy efficiency
3.2 Transport & logistics	Support development and investments in cost effective, resilient, and fossil free road and		Costs and CO2 savings in the supply chain.

Strategic objective	Action	*	Expected result
	train transports including biomass terminals.		
	Support initiatives for mobilizing underutilized and complex biomass resources such as logging residues available le for CHPs.		Make larger volumes of well-defined biomass resources economically available for production of biobased commodities without causing negative market distortions
3.3 Digitalization and AI	Develop applications for reuse and recycling, streamlining, visualization, traceability		Increased circularity
3.4 Research and technology infrastructure	Spread knowledge about entire value chains and understanding of the value of test beds. Make test and demo facilities visible. Study visits and meeting places for awareness, new ideas and cooperation	15	Increased availability and utilization rate of test and demo facilities, test beds reduce the costumer
	Support research and development of more effective and environmentally friendly biomass use and logistics.		Costs and CO2 savings in the supply chain. Reduced environmental impact.
	Create arenas for information sharing and networking involving industry and policy makers.		Raised awareness of gaps and opportunities in available research infrastructure
	Increase sales of technology knowledge and technology infrastructure.		Increased competitiveness and contributes to knowledge transfer of best-practice technologies.
	Support sustainable and cost-effective infrastructures for energy, water and waste management.		Cost savings and reduced environmental impact. Increased circularity.
4. Foster product development and market credibility			
	Expand risk and vulnerability analyses of Northern Sweden	10	Increased self-sufficiency in critical areas: agriculture (including fertilizers), heat and power, transport fuels/electricity, process chemistry.
Certificates and product declaration	Increase access to sustainability reports, digital product passes, environmental declaration, Central Securities Depository Regulation (CSDR)		Better understanding of the environmental benefits of goods and services
5. Promote education and skills development			
	Analyze and suggest improvements for the use of bioeconomy and related		Bioeconomy – a well-known and well-defined term. Increased

Strategic objective	Action	*	Expected result
	terminology in the school's/ universities and governing documents		public and political awareness and understanding
	Establish a national interdisciplinary graduate school	17	Skilled workforce/competence supply
	Enhance collaboration between academia, research institute and industry	16	Necessary subject and transversal. Skilled workforce/competence supply
	Promote education by making job opportunities and education visible		Skilled workforce/competence supply
	Increase society's attractiveness to facilitate recruitment (diversity and equality)		Skilled workforce/competence supply
6. Advocating for supportive policies and regulations			
	Mobilize and be more active in bioeconomy networks within the EU	14	Increased understanding of the northern Sweden bioeconomy context in the EU and strengthened influence on EU policy
	Involve more experts from Northern Sweden in EU institutions	12	Increased understanding of the northern Sweden bioeconomy context in the EU and strengthened influence on EU policy
	Increase understanding of the Nordic forestry model and the importance of active and sustainable forest management		More drivers and less barriers for investments and growth in the bioeconomy. Increased security of supply
	Promote policy instruments for increased investments in biobased solutions	3	Increased investments in biobased solutions
	Develop a plan for innovations and new business models, as well as increased biomass usage that promotes a circular approach, including enhanced reuse.		Increased incentives to support circular business models
	Increased support for procurement of biobased solutions critical for security of supply	6	Increased market for biobased products and reduced risk for new biobased solutions
	Support for the actions proposed in the national bioeconomy strategy and make budget available when necessary		Increased impact of the bioeconomy strategy
7. Natural resources sustainably			
Resource efficiency	Support investments in processes for energy efficiency and for increased upgrading and adding value to sawn goods, pulp		Increased growth and added value in the bioeconomy

Strategic objective	Action	*	Expected result
	and paper and forest industry by products		
Carbon efficiency cycle	Encourage best practice biomass management practices for increased forest increment and carbon uptake. Support use of long-lasting wood products and biomaterials in construction and in the society	2	Increased climate benefit
Circularity	Encourage and support the reuse of wood, paper fibers and other bioproducts. Modernize waste legislation for increased circularity		Increased circularity

5 MONITORING, EVALUATION AND LEARNING

Regional Statistics Bioeconomy

In many bioeconomy strategies and blueprints ambitious goals are set up for the bioeconomy. In the proposal for a national bioeconomy strategy, clear goals are set up for indicators such as added value and employment (Table 7). However, tools to follow up goal achievement are often missing, especially on a regional level as statistics are often presented on a national level. A growing number of regions need to regularly measure the economic impact of the bioeconomy and how it affects regional development. Target levels for 2040 in the national strategy that are suggested to be followed up is that at least 50% of regions have increased the number of people employed in the bioeconomy by at least 2% and that at least 85% of regions have increased the value added in the bioeconomy by at least 60%. These targets are suggested to be monitored by the regional authorities at six-year intervals.

A network for regions collaborating on the bioeconomy has produced basic information for carrying out regional analyses on the bioeconomy in Sweden. Within Bio4Model4Regions project, a working group has been active with the overall goal to improve, update and to make the national and the regional bioeconomy statistics part of the Swedish official statistics with annual updates.

Statistics Sweden has on commission from BioFuel Region financed from BioModels4Region project developed new and updated regional statistics for industries within the bioeconomy for all 21 Swedish regions. It covers industries that are fully or partly producing goods and services that connects to the use of biomass. In this case biomass refers to plants, forestry, animals and fish. Many industries belong to 100 percent to the bioeconomy. This means that everything these industries do, directly or indirectly, contributes to production or biomass value added. These industries comprise agriculture, forestry, fishing, food and tobacco, wood, paper and paper pulp, accounted for 45 percent of bioeconomy value added in 2015, and the regional level statistics are quality assured. Other industries' regional contributions should be viewed with caution in this pioneer project on regional statistics.

Regional perspective

Identifying a subset of the economy, that is, bioeconomy employment and value added, can be done at national level with an analysis of each industry. Identifying the regional perspective requires more data and detailed analysis of the activities in a specific region.

Specific regional statistics is used, but the share of bioeconomy per industry is the same regardless of region. This means that the regional bioeconomic feature is not as clearly visible as in a regional assessment made by county, in industries that are not completely classified as bioeconomic. For example, the chemical industry may produce bio-based goods in some regions, but this is not visible in the statistics that have been produced. All industries have the same share, regardless of region. Industries identified as fully bioeconomic do not have this effect, and the production in the region can be fully identified (Table 8).

Table 8 Bioeconomy shares by industry (SNI 2007) Activity (SNI 2007)	Bio share, %
A01 – Agriculture	100
A02 – Forestry	100
A03 – Fishing	100
C10-12 Manufacture of food products, manufacture of beverages, manufacture of tobacco products	100
C13-15 – Manufacture of textiles, Manufacture of wearing apparel, Manufacture of leather and related products	48
C16-17 – Manufacture of wood, Manufacture of paper and paper products	100
C18 – Printing and reproduction of recorded media	92
C20-21 – Manufacture of chemicals and chemical products, Manufacture of basic pharmaceutical products and pharmaceutical preparations	15
C22 – Manufacture of rubber and plastic products	7
C28 – Manufacture of machinery and equipment n.e.c.	11
C31-32 – Manufacture of furniture, Other manufacturing	33
D35 – Electricity, gas, steam and air conditioning supply	24
36-39 Water supply; sewerage, waste management and remediation activities	30
F41-43- Construction of buildings, Civil engineering, Specialised construction activities	17
I55-56 – Accommodation, Food and beverage service activities	2
M69-72 – Legal and accounting activities, Activities of head offices; management consultancy activities, Architectural and engineering activities; technical testing and analysis, Scientific research and development	0.3
N78-82 – Employment activities, Travel agency, tour operator and other reservation service and related activities. Security and investigation activities, Services to buildings and landscape activities.	3
R90-93 – Arts, entertainment and recreation	2

The statistics is today available (in Swedish) as an interactive web based tool here.

The methodology is available (in English) here.

6 OUTLOOK

Northern Sweden has great potential for bioeconomic development and growth. We have very good access to biomass based primarily on sustainable forestry. Here is one of the world's strongest forest and processing industries and world-leading research in the field. We are well ahead in the green transition with planning of large investments and conscious consumers and politicians. All in all, we are in a golden position to take a leadership role when the new bioeconomy is now emerging. However, in daily life in both politics and business but also civil society, there is a lack of knowledge and different perceptions of what the bioeconomy is and what significance it can have for our society.

In 2012, the EU developed a strategy for the bioeconomy. It highlights that bioeconomic growth must be based largely on the specific regional conditions. Through a sustainable use

of bioresources, Northern Sweden can help to solve the global challenges such as a growing population, overuse of resources, environmental destruction, and climate change, but our conditions for contributing to the bioeconomy must be highlighted better. For this to happen, however, there are several obstacles that must be removed and a number of strategic investments that must be implemented.

For decisions that promote bio-economic development to take place, knowledge about the conditions of forestry in this area must be significantly strengthened at both EU level and national level. The forest has a key role, and we have a tradition of active forestry that needs to be highlighted both nationally and within the EU. The EU is developing a policy for climate and bioeconomy that affects Sweden, and there is often a lack of understanding of the positive importance of forestry for both the economy and the climate. Forestry is often criticized for a lack of environmental consideration and that prevailing forestry methods lead to an increased extinction of species. It is urgent to gain good acceptance for our forestry, if its potential to contribute to bioeconomic growth is to be fully utilized for the strong and rapid change in society's direction that the climate demands.

For all actors active in bioeconomic development, the blueprint can serve as toolbox for inspiration. Our ambition has been to describe and relate to existing strategies and initiatives on a regional and national level. In Sweden, many such initiatives and strategies exist. This adds complexity to this blueprint but not to describe and consider existing strategies would make the blueprint a document for very few to be inspired by. For greater impact of this blueprint, it has been essential to use the actions and targets set up in the proposal for a Swedish a bioeconomy strategy and find ways how Northen Sweden can contribute as much as possible. This has also been a successful strategy for mobilizing key stakeholders in workshops and to give input into the referral process (Figure 8).

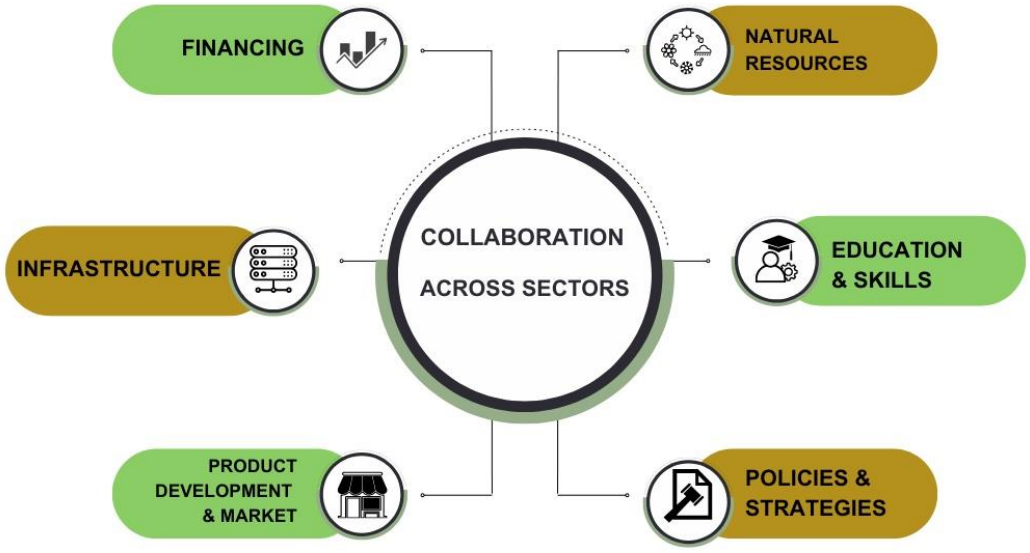

Figure 8 The key actions areas of the Bioeconomy Blueprint of Northern Sweden

For the future, we will continue our work to mobilize stakeholders with workshops and webinars supported by the blueprint, the national bioeconomy strategy and the regional statistics for bioeconomy that will be published in January. With this strategy we believe we

will mobilize a lot more stakeholders and that we can inspire them to further boost the bioeconomy in northern Sweden with the proposed actions in this blueprint.

The proposed national bioeconomy strategy is still pending. Goals and indicators may be subject to change. When the strategy is well approved there will be a synchronized work to update existing strategies to align with the new bioeconomy strategy. There will also be a huge and complex task to harmonize EU policies with policies on national and regional level. To achieve this, strong support and collaboration with North Sweden European Office is crucial. North Sweden European Office is the Brussels representation of Norrbotten, Västerbotten, Jämtland-Härjedalen and Västernorrland, the four northernmost counties of Sweden. In Northern Sweden, several industries, clusters, regions and municipalities, institutes and academies are active in boosting the bioeconomy. We encourage all bioeconomy stakeholders in Northen Sweden to integrate suggested actions in this blueprint, and other related strategies, into their future priorities.

7 APPENDIX STAKEHOLDERS

Organisation/company	Category	F/M	Region
Bio4Energy	academia	M	Northern Sweden
Swedish Univ. of Agricultural Sciences	academia	M	Northern Sweden
Swedish Univ. of Agricultural Sciences	academia	M	Northern Sweden
Umeå University	academia	M	Northern Sweden
North Sweden European Office	Brussels representation of the four northernmost counties of Sweden	F	Brussel
Biocompost	business	M	Northern Sweden
Domsjö Fabriker	business	M	Northern Sweden
Energifabriken i Sverige AB	business	M	Northern Sweden
Envigas	business	M	Northern Sweden
Eurocon	business	M	Northern Sweden
Biobased business	business	M	Northern Sweden
Jämtkraft	business	M	Northern Sweden
Kyl- och Frysexpressen	business	M	Northern Sweden
Metsä Board Sverige	business	F	Northern Sweden
Mondi Dynäs	business	F	Northern Sweden
PulpEye	business	M	Northern Sweden
Ragn-Sells	business	M	Northern Sweden
SCA	business	F	Northern Sweden
Sekab	business	F	Northern Sweden
Sekab	business	F	Northern Sweden
Sekab	business	M	Northern Sweden
Skellefteå Kraft	business	M	Northern Sweden
Valmet AB	business	M	Northern Sweden
Vattenfall	business	M	Northern Sweden
WSP Sweden	business	F	Northern Sweden
Övik Energi AB	business	M	Northern Sweden
Övik Energi AB	business	F	Northern Sweden
BioFuel Region	cluster	F	Northern Sweden
BioFuel Region	cluster	F	Northern Sweden
BioFuel Region	cluster	M	Northern Sweden
BioFuel Region	cluster	F	Northern Sweden
Leader Höga Kusten	cluster	M	Northern Sweden
Piteå Science Park	cluster	M	Northern Sweden
The Cluster of Forest Technology	cluster	F	Northern Sweden
BioFuel Region	cluster	F	Northern Sweden
BioFuel Region	cluster	M	Northern Sweden

Organisation/company	Category	F/M	Region
Statistics Sweden	government institute	M	Sweden
Statistics Sweden	government institute	F	Sweden
Bizmaker	innovation hub	M	Northern Sweden
Bioinnovation	Innovation hub	F	Sweden
Bioinnovation	innovation hub	M	Sweden
Bizmaker	innovation hub	M	Northern Sweden
Dalarna Science Park	innovation hub	F	Sweden
Innovarum	innovation hub	F	Northern Sweden
Örnsköldsviks kommun	local government	F	Northern Sweden
Örnsköldsviks kommun	local government	M	Northern Sweden
Forestral Catalana	MainBIO, Spain	F	Northern Sweden
Government office	national government	F	Sweden
Regeringskansliet	national government	F	Sweden
Regeringskansliet	national government	M	Sweden
Härnösand Municipality	politician	F	Northern Sweden
Sollefteå Municipality	politician	M	Northern Sweden
Storuman Municipality	politician	F	Northern Sweden
Umeå Municipality	politician	F	Northern Sweden
Vännäs Municipality	politician	M	Northern Sweden
Region Dalarna	regional government	F	Sweden
Region Gävleborg	regional government	F	Northern Sweden
Region Gävleborg	regional government	M	Sweden
Region Halland	regional government	M	Sweden
Region Jämtland/Härjedalen	regional government	F	Northern Sweden
Region Kalmar län	regional government	F	Sweden
Region Kalmar län	regional government	M	Sweden
Region Norrbotten	regional government	F	Northern Sweden
Region Norrbotten	regional government	M	Northern Sweden
Region Skåne	regional government	F	Sweden
Region Uppsala	regional government	M	Sweden
Region Värmland	regional government	M	Sweden
Region Västerbotten	regional government	F	Northern Sweden
Region Västernorrland	regional government	F	Northern Sweden
Region Västra Götaland	regional government	F	Sweden
Region Örebro	regional government	F	Sweden
Region Örebro	regional government	F	Sweden
Region Östergötland	regional government	M	Sweden
RISE Processum	research institute	F	Northern Sweden
RISE Processum AB	research institute	F	Northern Sweden

Organisation/company	Category	F/M	Region
RISE Processum AB	research institute	F	Northern Sweden
RISE Processum AB	research institute	F	Northern Sweden
RISE Processum AB	research institute	F	Northern Sweden
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RISE Processum AB	research institute	M	Northern Sweden
RISE Processum	research institute	F	Northern Sweden
RISE Processum AB	research institute	F	Northern Sweden
RISE Processum AB	research institute	M	Northern Sweden
Biobased business	start-up	F	Northern Sweden
Biobased business	start-up	M	Northern Sweden
Biobased business	start-up	M	Northern Sweden
RESELO	start-up	F	Northern Sweden
Biobased business	start-up	F	Northern Sweden
Biobased business	start-up	M	Northern Sweden
Biobased business	start-up	M	Northern Sweden
Farmer Association North	trade association	F	Northern Sweden
Farmer Association North	trade association	F	Northern Sweden
Farmer Association North	trade association	F	Northern Sweden
Skogsindustrierna	trade association	M	Sweden

Annex-05

Towards a Bio-Based Economy in Tuscany (Italy)

BIOMODEL 4REGIONS

TOWARDS A BIO-BASED ECONOMY IN TUSCANY

A bioeconomy strategy blueprint, prepared within the Biomodel4Regions project

SPRING – *Sustainable Processes and Resources for Innovation and National Growth*
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December 2024

This document has been prepared in the framework of the European project "BIOMODEL4REGIONS – Supporting the establishment of the innovative governance models to achieve better-informed decision-making processes, social engagement, and innovation in the bio-based economy".

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 101060476.

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List of Abbreviations

AKIS	Agricultural Knowledge and Innovation Systems
ARRR	Regional Resource Recovery Agency
ATECO	ATtività ECOnomica (“Economic Activity”)
BIT	Strategia Italiana per la Bioeconomia (Italian Bioeconomy Strategy)
CAP	Common Agricultural Policy
DG RTD	Directorate-General for Research and Innovation
EAFRD	European Agricoltural Fund for Regional Development
EC	European Commission
EIP-AGRI	European Innovation Partnership Agriculture
ERDF	European Regional Development Fund
ERIAFF	European Regions for Innovation in Agriculture, Food and Forestry
ESF	European Social Fund
ICT	Information and communications technology
ISTAT	National Statistical Institute
KPI	Key Performance Indicator
LEADER	Liaisons Entre Action de dévelopement de l'Économie Rurale
NGO	Non-Governmental Organization
POC	Proof Of Concept
RDC	Rural Development Complement
RDP	Rural Development Programme
RP	Regional Programme
RTTO	Regional Technology Transfer Office
S3	Smart Specialisation Strategy
SDG	Sustainable Development Goal
SME	Small Medium Enterprise

EXECUTIVE SUMMARY

The B4R Strategy Blueprint provides a strategic framework to advance the bioeconomy in Tuscany, focusing on sustainable resource management and economic diversification while aligning with national and European goals. It envisions the bioeconomy as a catalyst for regional transformation, emphasizing the importance of engaging stakeholders from regional authorities, businesses, research institutions, and civil society to achieve policy coherence and maximize impact.

The blueprint highlights key milestones, such as the 2017 Study Day on Bioeconomy, the 2019 European Bioeconomy Scene conference, and the enactment of Regional Law No. 34/2020, which have shaped the region's bioeconomic direction. It identifies strategic sectors, including advanced materials, sustainable agri-food production, forestry and biomass, and waste management, as central to Tuscany's bioeconomy development.

To realize the blueprint's vision, several recommendations are outlined. Strengthening partnerships among stakeholders through formal networks is essential. Investments in research and innovation are necessary to develop new technologies in bio-based industries. Public awareness campaigns should be launched to highlight the benefits of the bioeconomy, while educational programs must align with the evolving needs of industries. Progress should be tracked through robust monitoring frameworks, and sustainable practices should be encouraged across sectors through targeted incentives.

The B4R Strategy Blueprint serves as a vital tool for fostering a sustainable bioeconomy in Tuscany. By engaging stakeholders, focusing on strategic sectors, and implementing its recommendations, the region aims to balance environmental conservation with economic growth, creating a resilient and sustainable future.

1 OBJECTIVES & SCOPE

1.1 ROLE OF THE BIOECONOMY BLUEPRINT WITHIN TUSCANY REGION

The Bioeconomy is configured as an aggregate that transcends the typically sectoral boundaries of economic activities. Within the Bioeconomy, different activities and sectors are interconnected, materials and technologies are exchanged along supply chains, and production processes are interrelated. Classifications of sectoral economic activities therefore only partially capture the specificities and points of contact of the different components of the meta-sector. In 2023, the set of activities related to the Bioeconomy in Italy, defined on the basis of the perimeter indicated in the previous paragraph, generated an estimated output of 437.5 billion euros, 9.3 billion more than in 2022 (Figure 1) and employing about two million people. The Bioeconomy thus represents 10% in terms of production value and 7.6% considering employment out of the total Italian economy which positioned Italy as the third-largest bioeconomy in Europe[1].

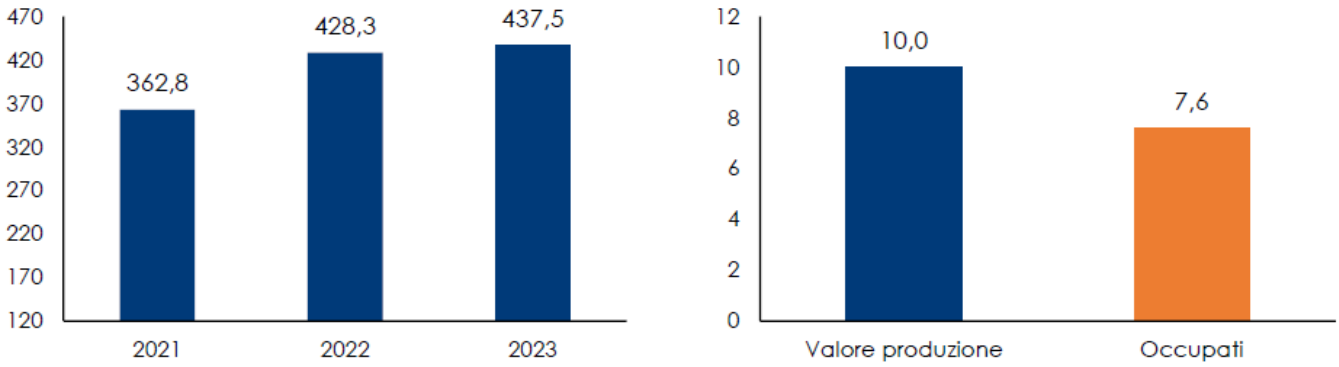


Figure 1: On the left, the evolution of the Bioeconomy in Italy (billion euro); On the right, the weight of the Bioeconomy in Italy on the total economy, in terms of production value and employment (%).

The European Commission and the bioeconomy sector advocate for stronger involvement of regional authorities, recognizing their unique capacity to identify and respond to local needs and opportunities. Regions can promote investments that mobilize European resources effectively, tailored to the specific strengths and challenges of their local economies. In this context, a bioeconomy strategy blueprint is particularly advantageous, as it provides a structured framework for local stakeholders to engage with existing and emerging policies, coordinate funding sources – including EU programs and private investments – and support bioeconomy initiatives that reflect regional goals.

The bioeconomy blueprint is a strategic tool aimed at fostering sustainable resource management and regional development, with a specific focus on Tuscany. By emphasizing the sustainable use of biological resources, the blueprint seeks to balance environmental conservation and economic growth through circular economy principles. For Tuscany, the blueprint highlights the bioeconomy as a catalyst for regional transformation. The region has demonstrated leadership in some initiatives. However, the limited scope of current

[1] https://group.intesasanpaolo.com/it/research/research-in-primo-piano/ricerche-tematiche/2024/10--rapporto-la-bioeconomia-in-europa

bioeconomy initiatives and low public awareness reveal an urgent need for a comprehensive strategy to fully harness the potential of the bioeconomy.

A key objective of the blueprint is to diversify Tuscany's economy by supporting bio-based industries and creating opportunities in emerging sectors such as biobased materials, sustainable agriculture, and renewable resources. This diversification strengthens economic resilience and aligns regional efforts with national and European goals. It fosters cross-regional collaboration, ensuring policy coherence and maximizing the impact of bioeconomic activities. The blueprint also emphasizes education and skills development, recognizing that the transition to a bio-based economy requires a workforce equipped with specialized expertise. Initiatives tailored to emerging bio-based industries not only enhance employability but also ensure the broad sharing of benefits, contributing to social stability and inclusivity.
Stakeholder engagement and governance are pivotal in Tuscany's bioeconomic transition. The blueprint provides a framework for inclusive decision-making, actively involving local communities, businesses, research institutions, and non-governmental organizations. This participatory approach enhances transparency, accountability, and the legitimacy of policy decisions, ensuring that diverse perspectives shape the region's bioeconomic policies.

Finally, the blueprint underscores the importance of securing funding and investment to scale up bioeconomy activities. By leveraging sources such as European Union programs, national funds, and private investments, Tuscany can accelerate its transition towards a bio-based, circular economy. This adaptive approach ensures that Tuscany remains on course to achieve its bioeconomy objectives, paving the way for sustainable and resilient regional growth.

1.2 KEY STAKEHOLDERS FOR THE DEVELOPMENT OF THE BIOECONOMY STRATEGY BLUEPRINT

All the above goals can be reached if the Bioeconomy blueprint is deemed as a useful tool for policy makers, that would consider the input provided by a variety of stakeholders, in particular the so-called "Quadruple Helix stakeholders" - meaning local institutions representatives, academia, industry and civil society (i.e. local communities and citizens)[2]. The are listed as follow:

- Regional authorities - play a key role in shaping strategies and implementing policies at the local level, aimed at supporting bioeconomy growth. At the same time, they allow to secure funds from national and EU bodies, by aligning with their strategies.
- Businesses and industry leaders - significant stakeholders, particularly in crucial sectors for Tuscan bioeconomy like advanced materials, agri-food, forestry and agricultural biomass, urban and industrial waste, energy.
- Research and academic institutions - crucial stakeholder in advancing bioeconomy technologies towards the scale up and training the future workforce,
- Civil society - directly affected by the bioeconomy transition, and it is encouraged to participate in public consultations to ensure that its needs are heard.

[2] Carayannis, Elias G., and David FJ Campbell. "Triple Helix, Quadruple Helix and Quintuple Helix and how do knowledge, innovation and the environment relate to each other: a proposed framework for a trans-disciplinary analysis of sustainable development and social ecology." International Journal of Social Ecology and Sustainable Development (IJSESD) 1.1 (2010): 41-69

Workforce, labour organisations, investors and financial institutions do not apply to the Quadruple helix definition; however, they play a strategic role in the bioeconomy sector. Workforce and labour organizations play an important role by identifying skill gaps and providing necessary training. They advocate for fair labour practices, ensuring a socially inclusive transition to bio-based sectors, which contributes to economic resilience and stability. On the other hand, investors and financial institutions are key to funding bioeconomy projects. By assessing the viability of investments in bio-based industries, they ensure that projects are economically sound and environmentally sustainable, crucial for scaling up activities and driving regional growth.

A pivotal role in coordinating the stakeholders above is played by Cluster SPRING – The Italian Circular Bioeconomy Cluster. It aims at stimulating the development of bioindustries in Italy through a holistic approach to innovation, with the goal to relaunch Italian industry under the banner of environmental, social and economic sustainability. It promotes research and investments in new technologies in the bioeconomy sector, in constant dialogue with local stakeholders.

1.3 PATHWAY TOWARDS A COMPREHENSIVE BIOECONOMY STRATEGY – PAST ACTIVITIES AND REGIONAL LAWS

The bioeconomy in Tuscany has already been extensively explored through initiatives and actions at various levels. The bioeconomy blueprint of Tuscany does not represent the very first step towards a dedicated bioeconomy strategy; rather, it builds upon positive experiences that can be consolidated and expanded. This document establishes itself as a strategic reference point, aiming to strengthen the actions already undertaken and provide a clear and coordinated direction for the regional development of the bioeconomy.

- **Study Day on Bioeconomy in Tuscany** (2017) – it was promoted by the Presidency of the Tuscany Region and organized as a discussion working groups among operators and experts in the bioeconomy sectors. The aim was to identify potential, excellence cases, strengths, and development opportunities of the bioeconomy in Tuscany, in line with the national strategy. The goal was also to define a regional action plan and to start initiatives to attract investments in the identified sectors. Key topics included the integration of renewable biological resources into various sectors such as agriculture, forestry, food production, and biotechnology. Speakers and experts discussed how bioeconomy can foster innovation, promote circular economy models, and contribute to environmental sustainability.
- **European Bioeconomy Scene conference** (2019) – Tuscany was present at the event, with other 400 participants from 42 countries, to discuss the state of art and the future of the bioeconomy in Europe. During the conference, Tuscany participated in the European Bioeconomy Stakeholder Panel, organized by the European Commission's DG Research for the first time in collaboration with the ERIAFF Network (an initiative coordinated by the Tuscany Region). Significant attention was focused on the implementation of the European bioeconomy strategy and on the knowledge and support tools for both national and local policies, as well as for mobilizing investments[3].

[3] https://www.regione.toscana.it/-/la-bioeconomia-in-toscana

Overall, in Tuscany, bioeconomy is integrated into various regional strategies and policies aimed at promoting sustainability and economic innovation. Two main strategic directions might be appointed to promote sustainability within the Tuscan production system.

The first one focuses on extensive strengthening of the vital components of the system, to ensure continuous attention to the needs of the society, supported by institutions and social organizations, aiming at creating a favourable environment for both social and economic sustainability. The second direction involves an intensive revision of production mechanisms through innovation. This includes enhancing the skills of the workforce, increasing the digitalization of processes, and transitioning towards ecological practices that utilize renewable energy and reduce the use of unsustainable resources. The goal is to emerge from a phase of stagnation and promote economic growth that is both inclusive and environmentally sustainable.

Starting from the guidelines of the European institutions, Tuscany has already intervened with numerous acts to support the regional circular economy.

- **Regional Statutory Law No. 4/2019** marked a significant step by incorporating the promotion of the circular economy among the priority objectives in Tuscany's Statute. Earlier, **Regional Law No. 48/2018** had already explicitly recognized the circular economy as a key priority in the region's economic and financial planning initiatives.
- **Regional Law n.34/2020,** named "Law for the promotion of the bioeconomy and sustainable development" is a key legislative framework aimed at fostering the bioeconomy and ensuring sustainable development in Tuscany. It marks a significant step in Tuscany’s commitment to fostering a green, circular, and sustainable economy that integrates ecological, economic, and social goals, supporting the transition to a more sustainable and circular economy. It foresees new provisions relating to specific measures for the prevention of waste production, also encouraging donation and reuse.

In alignment with international, European, and national decarbonization policies, Tuscany has established its own strategy, Tuscany Carbon Neutral 2050. This initiative, in place for several years, outlines a comprehensive framework of actions and interventions designed to transform the energy system, agriculture, and land use. It also focuses on modernizing the industrial sector, transport infrastructure, and urban areas, with significant impacts across all societal activities.

2 BASELINE AND ANALYSIS OF LOCAL CONTEXT

2.1 PRODUCTION SECTORS FOR THE BIOECONOMY IN TUSCANY

The Tuscany bioeconomy strategy blueprint include a variety of sectors that are strategic for the regional economy, such as advanced materials (leather and tanning, paper sector), agri-food, forestry and agricultural biomass, urban and industrial waste, energy.

2.1.1 Leather and Tanning

The manufacturing system remains one of the main drivers of regional development and the textile, leather and tanning sector is among the traditional ones in Tuscany. It is characterized by a high number of employees and the small average dimension of its enterprises. The sector also produces most of the special industrial waste (together with the paper and stone sectors) and has a consolidated tradition in the application of robotics and automation systems.

The tanning cluster along the Arno River, employing nearly 6,000 people out of a total of around 18,000 in Italy, generated a production value of approximately 1.2 billion euros in 2021, reflecting a growth of +24.7%. This contributed to Italy's overall national production value of 4.2 billion euros, which saw an increase of +17.5%. Exports from the sector reached 2.9 billion euros, up by +18.3%. In terms of businesses, Tuscany is home to 506 tanning companies, nearly half of the 1,154 companies nationwide.

Between 2019 and 2022, employment in the sector decreased by 7%. However, from 2022 to 2023, the number of employees remained largely stable, showing a slight increase of 1%. For 2024, current forecasts suggest that employment will likely hold steady, as 67% of businesses expect to maintain their current workforce levels[4].

The Fashion Technological District has long been committed to circularity initiatives, recognizing the fashion sector as a key driver of the region's economy. A standout example is the ongoing Textile Hub project in the Prato district. This project involves the creation of a comprehensive collection centre that handles pre-consumer textile waste, production waste from technical textile industries, as well as post-consumer clothing waste.

Beyond serving as a facility for textile waste collection and treatment, the Textile Hub is primarily envisioned as a research and development centre. Its main focus is on developing innovative technologies for recovering and producing secondary raw materials. These materials are intended to be reintegrated not only into the textile market but also into other sectors such as construction, geotextiles, packaging, and furniture. By doing so, the Textile Hub aims to enhance sustainability across multiple industries and strengthen the regional bioeconomy.

[4] https://www.cnatoscana.it/crisi-pelletteria-da-congiunturale-a-strutturale-presentata-oggi-la-ricerca-di-cna-toscana-e-fondazione-cna-opera/

2.1.2 Paper

The paper sector is a key pillar of Tuscany's manufacturing industry, boasting a long-standing tradition in robotics and automation. However, it also generates a significant share of the region's special industrial waste. In areas like the Capannori paper district, a major challenge is the structural shortage of facilities with sufficient capacity and technical capabilities to manage the sector's specific waste treatment needs. As a result, a substantial portion of the waste is exported outside the region for processing. The Paper District covers an area of approximately 750 km² across the provinces of Lucca and Pistoia, including 12 municipalities, and accounts for around 80% of the national tissue paper production and nearly 40% of the country's corrugated cardboard production.

Main products are tissue paper for hygienic and domestic use (including products such as toilet paper, kitchen rolls, tissues, napkins, medical sheets, industrial rolls, and tablecloths), paper to produce corrugated cardboard (both in sheets and boxes), but also machinery for the paper and cardboard industry. The sector counts 332 companies (2021) and 10,857 employees (2021), with a turnover of €5.9 billion (2021) and export of about €2 billion (2023).[5]

2.1.3 Agri-food and bio-based industries

The agri-food sector is a crucial industry in Tuscany, recognized for its high-quality products and raw materials, as well as its strong presence in international markets. It consists of nearly 30,000 businesses and provides employment for approximately 56,000 people, generating total revenue of over €11 billion, with €2.5 billion allocated to exports.[6] Tuscany plays a leading role in Italy's agri-food landscape, accounting for over 6% of the nation's exports in this sector and ranking first for wine export value. The region's international engagement is further highlighted by the presence of multinational companies that invest heavily in the wine industry.

A significant strength of the sector lies in its collaboration with research and educational institutions. Leading regional universities offer a wide range of master's degree programs in fields such as natural sciences (including Botany, Biochemistry, and Climatology), agribusiness (covering Plant Biology, Biodiversity and Environmental Sustainability, and Agricultural Production), as well as viticulture and enology (such as Winemaking, Viticulture, and Wine Microbiology).

Significant opportunities also arise in the biobased industry, which utilizes biological resources and systems (such as microbial, animal, or plant cells, and enzymes) to produce commercially important molecules for use in the chemical, energy, pharmaceutical, materials, food, and agricultural industries. Overall, key environmental technologies that have emerged include those focused on decarbonization, green propulsion, circular economy, and enhancement of renewable energy sources, particularly geothermal energy.

[5] https://www.confindustriatoscananord.it/media/UFFICIO_STUDI/2024_09_24_Distretto_cartario_LUPT_pillole_v1.pdf
[6] KPMG - Invest in Tuscany, Agribusiness, facts and figures.

2.1.4 Forestry and Agricultural biomass

Regarding the structure of the production systems, according to the latest official data available[7], there are approximately 45,000 agricultural enterprises in Tuscany. Despite the continuous contraction in both total agricultural area (SAT) and utilized agricultural area (SAU), the loss of cultivated land has been smaller than the decrease in the number of agricultural enterprises, leading to an increase in the concentration and size of farms. In terms of employment, according to the ISTAT Territorial Accounts, the agricultural sector in Tuscany employs about 51,000 people, most of whom are involved in plant and animal production, hunting, and related services, with a smaller proportion working in forestry and fishing.

Tuscan agriculture is primarily focused on producing high-quality products with added value, typically through small- to medium-sized enterprises. To drive local development, the bioeconomy should enhance sustainability, with a key strategic goal being to ensure that circular economies offer farmers fair compensation.

For non-food-based agricultural biomass supply chains to succeed, they must provide a significant income supplement for farmers. Their success depends on several factors:

- **Managing feedstock costs**: This can be achieved by consolidating biomass sources and establishing efficient logistics systems.
- **Developing multi-feedstock, multi-product, and 'cascade' systems**: These approaches involve extracting value from biomass in multiple phases, maximizing the bio value potential.
- **Creating complementary supply chains**: This includes integrating food and non-food production, high-value and ancillary products, both at the farm level and within the broader territory.

The efficiency of forest-based biomass supply chains is also critical, particularly in terms of logistics and forestry infrastructure, including access roads.

Leveraging forest biomass for regional economic development supports sustainable natural resource management, reduces reliance on non-renewable energy, mitigates climate change impacts, creates employment opportunities, and enhances competitiveness at both the national and European levels.

2.1.5 Urban and Industrial Waste

According to the National Report on Circular Economy in Italy (2020), produced by the CEN-Circular Economy Network, Italy ranks among the top five European countries in this sector. In 2018, the per capita waste production was 499 kg, slightly above the European average of 488 kg. The recycling rate of urban waste is increasing, Italy ranks second after Germany, with a recycling percentage of 68%, exceeding the European average of 57%. However, 22% of waste still ends up in landfills, although reliance on this disposal method is decreasing.

[7] http://dati.istat.it/Index.aspx?DataSetCode=DCSP_SPA

Regarding the market for secondary raw materials, Italy is second only to France. In 2017, the circular material use rate was 17.7%, a decline from previous years and lower than that of many other European countries. Furthermore, the import of secondary raw materials is double that of exports, indicating that while the production system can valorise recycled materials, it cannot fully meet the demand with locally sourced secondary raw materials.

In 2018, Tuscany accounted for 7.5% of Italy's urban waste and 6.8% of special waste, reflecting one of the highest per capita waste generation rates in the country. This trend has been consistent over previous years and cannot be attributed solely to tourism. While the overall quantity of urban waste has remained stable in recent years, challenges persist concerning per capita waste production and the effectiveness of waste separation efforts.

Regarding the type of disposal used, the percentage of urban waste in landfill in 2018 it was 32% higher than the national average (24.9%). At the same time as the production of municipal waste, there was a decrease in the production of special waste in the last available year. (2018). In 2018, according to the "Circular Economy in Tuscany" report (ARRR, 2020), Tuscany generated approximately 7.39 million tonnes of special waste, including around 392,000 tonnes of hazardous waste and 7 million tonnes of non-hazardous waste.

An important initiative in the region is the production of 20,000 tonnes of compost annually, derived from organic waste separately collected in urban areas. This waste is processed at three industrial composting plants. The resulting compost is used by industrial sectors (30%), and by farmers (70%) in the provinces of Florence, Pistoia, and Pisa to improve soil quality for various agricultural crops.

2.1.6 Energy

The energy system in Tuscany still heavily relies on fossil fuels, although the region benefits from a significant renewable source in the form of geothermal energy, which covers about 7.5% of the final energy demand. While greenhouse gas emissions have been decreasing in recent years, energy consumption and CO_2 emissions remain high, with the energy industrial sector (26.1%) and transport (24.5%) being the main contributors. Despite a strong position in terms of renewable energy use, Tuscany has not yet achieved significant performance in energy efficiency compared to the European goals for 2030 and 2050.

The region is investing in advanced technologies, such as the production of green hydrogen from renewable sources. A notable example is the Hydrogen Industrial District in San Zeno, Arezzo, which has been a pioneer in creating an energy self-sufficient hydrogen-based community. Regional initiatives are also underway for the use of hydrogen in public transportation, such as the renewal of bus fleets and the introduction of hydrogen-powered trains. The Biopower project [8]in Tuscany faced the challenge of producing energy using renewable resources through a widespread network of small plants. The project involves 7 companies, has reduced environmental pressure by saving 1 000 000 Tonnes of Oil Equivalent (TOE) and, at the same time, created 17 new jobs.

[8] https://corporate.enel.it/media/esplora-notizie/notizie/2015/04/biopower-in-tuscany-filiera-corta-per-lenergia-del-territorio

Additionally, several research and development projects are present in the territory, along with key innovation stakeholders like GE Baker Hughes and ENEL Green Power, who are focusing on technologies for CO_2 liquefaction and decarbonization. In the future, energy-intensive industries, such as steel production, may benefit from the adoption of hydrogen and other renewable solutions to reduce their carbon footprint.

2.1.7 Technological districts

Tuscany is home to several technological districts, which are specialized areas or clusters where research, innovation, and businesses, in key productive sectors, collaborate to drive technological development and economic growth.

The enabling law for technological districts in Tuscany is Regional Law 16/2011, which provides the legal framework for the creation and operation of technological and productive districts within the region. This law aims to foster innovation, research, and economic growth by establishing technological clusters that promote collaboration between businesses, universities, research centres, and public institutions.

- **Regional Technological District of Advanced Manufacturing:** The Advanced Manufacturing 4.0 Technological District – GATE focuses on advancing the digital transformation of production processes in Tuscany's SMEs by leveraging Industry 4.0 technologies like robotics, AI, big data, IoT, additive manufacturing, and cybersecurity. The district targets key sectors such as automotive, ICT, aerospace, photonics, and robotics. Managed by Gate 4.0, a network including Gate SpA, Erre Quadro, and the Unione Industriali Pisana, it is supported by over 140 companies, 3 universities (Pisa, Florence, Siena), and 20 research centres. GATE aims to boost innovation, enhance digital capabilities, and improve the competitiveness of regional industries.
- **Regional Technological Fashion District: The OTIR2020** – The Tuscany Fashion Cluster (OTIR2020 – TFC) Technological District focuses on driving innovation within the fashion industry, with particular emphasis on the renowned Tuscan sectors of textile and apparel, footwear, and tanning. Its main objectives are to meet the innovation needs of businesses in these areas, guide them toward high-value specialized services, and provide access to scientific and technological knowledge, research networks, and resources. Additionally, the district encourages collaboration in the use of research facilities, testing labs, and certification processes. OTIR2020-TFC works to strengthen the competitiveness of companies by focusing on several key strategic trends, such as product functionalization, environmental sustainability in processes and products, Industry 4.0, marketing, distribution, logistics, and ensuring international product compliance. The district is overseen by the Prato-based research centre, Next Technology Tecnotessile, which collaborates with innovation and technology transfer centres, trade associations, and universities, including the Universities of Florence, Pisa, Siena, and the Scuola Superiore Sant'Anna.
- **Regional Technological Paper District:** The Paper Technological District – INNOPAPER fosters innovation and technology transfer across the paper supply chain, assisting companies with strategic research and development projects focused on product innovation, process optimization, and market expansion. Lucense, a research organization and service provider with a specific focus on the paper industry, is the managing entity of

the district. Lucense supports a network that connects over 150 companies and 22 research centres. The district's strategic objectives include promoting environmental sustainability, advancing the circular economy, implementing Smart Manufacturing and Industry 4.0, driving product and process innovation, and providing technical training. The overarching goal is to bridge the gap between research and industry, transferring innovative solutions to businesses in the paper sector to enhance their competitiveness and foster sustainable growth.

- **Regional Technological District of Life Sciences:** The Life Sciences Technological District is a collaborative network that links public and private stakeholders across key sectors such as biotechnology, pharmaceuticals, medical devices, ICT for health, and nutraceuticals. Established in 2011 and managed by Fondazione Toscana Life Sciences (TLS), the district primary goal is to enhance the competitiveness, market potential, and research capabilities of the region by providing support and facilitating technology transfer. The district is composed of over 190 member companies, generating a total turnover of more than 6 billion euros, and includes 32 research infrastructures, 14 research organizations, and 6 service centres dedicated to supporting the region's life sciences ecosystem.
- **Regional Technological District of New Materials – MATE:** MATE (Materiali Avanzati e Tecnologie per l'Innovazione) began its operations in the fall of 2016, bringing together 90 companies, 18 research organizations, 10 service centres, and 29 technology transfer infrastructures. Managed by the Agenzia di Sviluppo dell'Empolese-Valdelsa (ASEV), MATE is a structured network designed to promote collaborative research and innovation activities focused on developing new products and processes. This is achieved through the integration of advanced and innovative materials and technological solutions. The district's core activities include disseminating technology, producing and sharing strategic information, fostering collaborative partnerships between businesses, and offering complementary services to support companies in their innovation journeys. MATE plays a vital role in connecting businesses with the latest technological advancements, driving collaboration and enhancing the regional innovation ecosystem.
- **Regional Technological District for Energy and Green Economy.** The Energy-Environment Technological District (DTE²V) is managed by Co. Svi.G. Scrl, a consortium of public local entities, and serves as a regional cluster for the energy and green economy sectors in Tuscany. Its goal is to foster innovation, promote renewable energy research, and facilitate the exchange of knowledge and expertise through a public-private governance model. Key activities include technological forecasting, business matching, and supporting skills development and access to funding. The district also promotes the efficient coordination of smart networks across energy generators, operators, and users. Currently, it includes over 150 entities from both the research and business communities in the region.

2.2 LOCAL POLICY CONTEXT

The bioeconomy is an integral component of Italy's regional strategies for sustainable development, forming a significant part of the Smart Specialisation Strategies (S3) implemented across various regions. Furthermore, bioeconomy often intersects with broader initiatives, such as the circular economy and the green transition, highlighting its importance

in contemporary policy frameworks. Following the update of Italy's national bioeconomy strategy in 2019, regions have been encouraged to prioritize bioeconomy, leading to the establishment of frameworks in 21 regions.

Among these, Tuscany is recognized as a region with a strong focus on bioeconomy, as indicated by Haarich et al. (2022). The bioeconomy is embedded within the Regional Strategy for Sustainable Development in Tuscany[9], but it is crucial to note that there is no dedicated regional bioeconomy strategy currently in place. Instead, the topic has been incorporated into various regional programs and regulations, resulting in a fragmented approach to bioeconomy initiatives. This fragmentation raises concerns regarding the clarity and recognition of bioeconomy within the regional context.

Consequently, there is a noticeable absence of an institutionalized governance structure for the bioeconomy in Tuscany. This situation underscores the urgency for policy and governance interventions that can effectively restore and enhance the interaction necessary for fostering a positive impact on the bioeconomy sector.

Below are some key initiatives where bioeconomy principles are integrated.

❖ **European Funds (ERDF and ESF+)**

European Green Deal and Structural Fund

The 2021-2027 ERDF Regional Programme of Tuscany (RP)[10] supports the European Union's objectives for a climate-neutral economy and an inclusive and cohesive society, in line with the directives of the European Green Deal, the Sustainable Growth Strategy and the Sustainable Development Goals of the UN 2030 Agenda. The programme is closely linked to the Intelligent Specialisation Strategy (S3) of the Tuscany Region, adopting its priorities and promoting the principles of interregional participation and cooperation.

The RP Toscana ERDF 2021-2027, approved on October 3, 2022, has a budget of €1.228 billion and focuses on the following priorities:

1. **Research, innovation, digitalization, and competitiveness** (48% of resources). This priority focuses on enhancing the region's research and innovation capabilities, particularly by supporting digital transformation in both the public and private sectors. Public administration digitalization will improve service efficiency and accessibility, while small and medium-sized enterprises (SMEs) will receive support to boost competitiveness, integrate advanced technologies, and adopt sustainable business practices. All efforts align with the Smart Specialisation Strategy (S3), which promotes economic resilience and sustainable growth through innovative and technology-driven development models.

9 https://www.regione.toscana.it/documents/10180/25834939/ALLA_documento+di+strategia.pdf/ec0fd922-067f-4132-b451-760912049735?t=1614585655469
10 https://www301.regione.toscana.it/bancadati/atti/Contenuto.xml?id=5418058&nomeFile=Delibera_n.515_del_06-05-2024-Allegato-A

2. **Ecological transition, resilience, and biodiversity** (30% of resources). With a forward-looking approach to environmental and energy challenges, this priority targets comprehensive actions to decrease energy consumption and promote renewable energy production, aligning with the Region's climate goals. Projects will focus on climate adaptation, risk prevention, and resilience-building in the face of climate change. Additionally, resource efficiency through circular economy practices and efforts to protect biodiversity and green infrastructure are essential components. This priority aligns with regional frameworks like the Climate Change White Paper and the Toscana Carbon Neutral 2050 Strategy, providing strategic guidelines for sustainability.

3. **Sustainable urban mobility** (10% of resources). This priority seeks to promote eco-friendly, accessible, and efficient urban mobility options to reduce traffic congestion and pollution in cities. Investments will support the development of tram systems, bicycle paths, buses, and train services, fostering low-carbon urban transportation networks. These initiatives aim to reduce vehicle emissions, enhance urban air quality, and make commuting more sustainable and user-friendly, encouraging shifts away from car dependency.

4. **Territorial cohesion and local development** (8% of resources). This priority addresses regional disparities, especially between urban centres and less-developed rural or remote areas. Through integrated territorial strategies, the goal is to stimulate balanced regional growth by fostering social and economic inclusion, enhancing access to essential services, and promoting sustainable tourism and cultural heritage initiatives. Infrastructure improvements will also aim to increase connectivity and safety, supporting cohesive territorial development across the region.

5. **Technical Assistance (4%)**: Ensures effective program management and evaluation.

European Social Fund

The Tuscany Region will allocate 1,083.6 million euros through its European Social Fund Regional Programme (ESF+), an increase of 350 million compared to the 2014-2020 programming period (+48%). This funding will support employment and employability, foster an equitable and inclusive society, and develop a skilled and resilient workforce prepared for the transition to a green and digital economy. The fund is structured around four key thematic priorities:

1. **Inclusion (37.6%)**: Supports active inclusion, early childhood education, and welfare services for disadvantaged groups, reducing social exclusion and promoting equal opportunities.

2. **Education and Training (23.7%)**: Aligns education with labour market needs through training, dropout prevention, and partnerships between academia and industry.

3. **Employment (18.8%)**: Enhances employability and professional transitions, addressing skills gaps and promoting gender equality in the workforce.

4. **Youth Employment (15.9%)**: Provides apprenticeships, dual training, and advanced skills programs to prepare young people for the labour market.

5. **Technical Assistance (4%)**: Ensures effective program management and evaluation

Another relevant topic is the challenge of developing skills that enable people to cope with the complexities and changes in the labour market, and more generally in society, associated with the dual green and digital transition. In this perspective, it is of particular importance Tuscany Region is promoting training courses oriented towards job placement and reintegration in strategic regional sectors, and business creation, while at the same time leveraging on system actions aimed at strengthening the supply and further qualification of the network of employment services.

❖ **Smart Specialization Strategy: Work plan 2024-2025**

This document is part of Tuscany's Smart Specialisation Strategy (S3) 2021-2027[11], which promotes the territory's smart and sustainable growth by exploiting its strengths and unexpressed potential. The strategy addresses three main challenges: digital transition, ecological transition and generational transition. S3 integrates policies and funds (e.g. ERDF) to support research and innovation, with a focus on the circular economy and sustainability.

In Tuscany the key application areas of the strategy where the circular bioeconomy has been included, with few mentions, are the Environment and Energy, and the Smart Agrifood Scopes. The former includes crucial missions such as “Towards a Circular Tuscany” and “Towards Carbon Neutrality in Tuscany”. The latter focuses on “Sustainable and intelligent agricultural-forestry systems” and “High-quality agrifood production”, in line with sustainability and innovation in the agrifood sector. Finally, the Smart and Sustainable Enterprise Domain promotes the digital transition of enterprises and sustainable production, supporting an evolution towards greener and more innovative business models.

In the workplan 2024-2025 sub-articles targeting the circular bioeconomy have been reported as follow.

Advanced Manufacturing sub-articles

- Industrial biotechnology: Industrial technologies based on the use and transformation of biological material to make or modify products or processes.

Advanced Materials and Nanotechnology sub-articles

- High-performance and sustainable composite materials: Development and applications of high-performance composite, sensor and/or nanostructured materials capable of responding to environmental stimuli.
- Biomaterials, biosensors, bio actuators and bio activators: development of systems, materials, devices consisting of biologically active sensing elements.

Technologies for life and the environment sub-articles

11 https://www301.regione.toscana.it/bancadati/atti/Contenuto.xml?id=5351828&nomeFile=Delibera_n.1321_del_28-11-2022-Allegato-A

- Nutraceutics: Technologies for sustainable and competitive food cultivation, processing and transformation for the health of the individual and food safety.
- Technologies for the circular economy and bioeconomy: Technological solutions for the valorisation of multi-life, secondary and/or waste products, also of agri-food origin, for the strengthening of the circular economy.
- Technologies for decarbonisation: Technological solutions for the energy efficiency of systems and components, the development of innovative systems and new opportunities for CO_2 reduction, with a view to greater network efficiency and diversification of energy carriers.
- Green propulsion technologies: Technologies and applications for green propulsion.
- Environmental resilience and pollution: Technological solutions for resilience against extreme weather conditions and for combating hydrogeological instability and environmental pollution (water, air, soil).

In Table 1 the notices and selection procedures that compete directly with S3 are listed. They are expected to be released over the two-year period 2024-2025.

Table 1: Notices and selection procedures included in the S3 with reference to the Directorate, the regional program supporting the action and the estimated resources. All these identified Notices are related to the development of bioeconomy field in Tuscany.

Directorate	Regional Program	Call/Notice/Procedure Name	Estimated Resources	Publication Semester
Territorial Competitiveness of Tuscany and Managing Authority	PR ERDF 2021-2027 - Action 1.1.2	Research, development, and innovation for investment attraction	€7M	2nd semester 2023
Productive Activities	PR ERDF 2021-2027 - Action 1.1.3	Intelligent and sustainable territories	€13M	1st semester 2024
Productive Activities	PR ERDF 2021-2027 - Action 1.1.4	Strategic Research and Development Projects	€39M	1st semester 2024
Productive Activities	PR ERDF 2021-2027 - Action 1.1.4	Research and Development for SMEs and Mid-cap Companies	€91M	1st semester 2024
Productive Activities	PR ERDF 2021-2027 - Action 1.1.5	Support for the creation and consolidation of innovative start-ups	€2.8M	1st semester 2024
Productive Activities	PR ERDF 2021-2027 - Action 1.1.5	Support for the creation and consolidation of innovative start-ups – Risk Capital Fund	€20M	2nd semester 2024
Productive Activities	PR ERDF 2021-2027 - Action 1.1.6	Calls for Technology Transfer Centers, Competence Centers, Research Bodies, and Technology Districts	€3.5M	1st semester 2024
Education, Training, Research, and Employment	Regional Program ESF+ 2021-2027 - Action 1.d.1	Call for training projects for employees for digital and ecological transition	€2.5M	1st semester 2024
Education, Training, Research, and Employment	Regional Program ESF+ 2021-2027 - Action 4.f.2	Public notice addressed to ITS Foundations for ITS courses A.Y. 2024/2025	€10.4M	Already published
Education, Training, Research, and Employment	Regional Program ESF+ 2021-2027 - Action 4.f.2	Public notice addressed to ITS Foundations for ITS courses A.Y. 2025/2026 and 2026/2027	€14.7M	2nd semester 2024 / 1st semester 2025
Education, Training, Research, and Employment	Regional Program ESF+ 2021-2027 - Action 2.f.2	Call for funding "Pegaso Doctoral Scholarships" for the year 2024	€4.5M	1st semester 2024 and 1st semester 2025
Education, Training, Research, and Employment	Regional Program ESF+ 2021-2027 - Action 4.a.5	Call for funding fixed-term research contracts and/or research grants	€3M	1st semester 2024
Education, Training, Research, and Employment	Regional Program ESF+ 2021-2027 - Action 2.f.3	Advanced Training and Research-Action (AFR) Pathways	€1.5M	1st semester 2024
Regional Agency for the Right to University Study	Regional Program ESF+ 2021-2027 - Action 2.f.5	Higher education vouchers for postgraduate courses	€0.5M	2nd semester 2023 (2023/24), 2nd semester 2024 (2024/25)

The S3 framework also emphasizes interregional cooperation, which presents valuable opportunities for creating synergies that support Tuscany's bioeconomy strategy. This collaboration fosters shared knowledge and best practices across regions, allowing for more efficient resource use and fostering innovation. By participating in interregional networks, Tuscany can align its bioeconomy goals with broader European initiatives, enhancing competitiveness and contributing to sustainable development. This coordinated effort can help Tuscany address specific regional challenges while benefiting from the strengths and insights of other regions engaged in similar efforts. Active collaborative activities include some of interest such as:

- **ERIAFF** (Network of European Regions for Innovation in Agriculture, Food and Forestry)[12]: coordinating body set up to facilitate the flow of information between the actors involved in the management of agricultural policies within the European Union.
- **FOREST4EU Project (European Innovation Partnership Network Promoting Operational Groups Dedicated to Forestry and Agroforestry)[13]:** A European partnership network for innovation aimed at establishing 5 international hubs for the transfer of innovations in the following areas: wood mobilization; adaptation of forests to climate change; sustainable forest management and provision of ecosystem services; non-wood forest products; agroforestry.
- **STRATUS Project (AdviSors neTwork foR OptimAl ferTilisers Use)[14]**: the project aims to connect consultants across Europe to accelerate the creation and sharing of knowledge on Integrated Fertiliser Management, supporting farmers to put this knowledge into practice to achieve the objectives of the 'Farm to Fork' and Biodiversity Strategies, thus reducing nutrient losses to the environment while maintaining soil fertility. Tuscany Region will be in charge of promoting the involvement of Demo Farms and will participate in the project by creating a network to connect consultants across Europe to accelerate co-creation and knowledge sharing.

❖ **Regional Strategy for Sustainable Development**

The strategy focuses on sustainable and equitable development objectives, with particular attention to climate change and environmental protection. It also includes a commitment to carbon neutrality by 2050 (Tuscany Carbon Neutral 2050). Furthermore, the strategy has been revised to address the challenges arising from the COVID-19 pandemic, integrating international and national objectives. Bioeconomy, which encompasses sectors such as sustainable agriculture, reforestation, and the use of biological resources, is at the heart of policies for ecological transition.

The development of the Regional Strategy for Sustainable Development has been closely aligned with the guidelines outlined in the Tuscany Carbon Neutral 2050 (TCN2050), from the initial positioning phase to the final strategy. The strategy is structured, in coherence with the National Strategy for Sustainable Development, according to the five Ps of sustainability: People, Planet, Prosperity, Peace, and Partnership. For each priority, Tuscany's regional

12 https://www.regione.toscana.it/-/la-rete-eriaff
13 https://www.forest4eu.eu/
14 https://stratusproject.eu/

strategies related to the bioeconomy, aligned with the National Sustainable Development Strategy and the SDGs, are detailed below.

People

The "People" area aims to reduce poverty, enhance social inclusion, and promote well-being by expanding job opportunities, supporting innovation through training, adopting new technologies, and strengthening labour market services. It emphasizes internships, apprenticeships, and entrepreneurial training to align workforce skills with market demands.

Planet

The key themes in the "Planet" area emphasize the need to create resilient communities and territories by reducing and eventually halting biodiversity loss, managing natural resources sustainably, and preserving landscapes and cultural heritage.

- Promote building reuse projects and processes.
- Enhance urban green spaces through afforestation initiatives and neighbourhood redevelopment in a sustainable framework to reduce or offset urban emissions.
- Implement actions to reduce methane emissions related to livestock activities by ensuring proper management of livestock effluents.
- Support the transition from a linear to a circular economy, linking waste reduction to a decrease in greenhouse gas emissions.
- Strengthen forestry, agriculture, and the forest-wood-energy supply chain through investment incentives, technological innovation, and cooperation.
- Address the abandonment of agricultural land by reinforcing the socio-economic fabric of rural areas and enhancing green infrastructure.
- Promote public hubs to facilitate daily digital routines.
- Expand the availability of online services to reduce physical travel and paperwork.

Prosperity

The key themes in the "Prosperity" area include funding and promoting sustainable research and innovation, ensuring full employment and quality education, fostering sustainable production and consumption models, and decarbonizing the economy.

- Encourage innovative business models.
- Promote the development of cultural, natural, and ecotourism heritage.
- Reintegrate new sustainability-oriented professional profiles.
- Maximize the use of secondary raw materials derived from production systems to expand the productive base.

- Reduce internal economic disparities by strengthening the productive system.
- Promote circular economic models to maximize resource use in current and future production cycles.
- Implement reward systems to support interventions that close life cycles or valorize waste.
- Invest in biotechnologies and environmental technologies for waste and water treatment.
- Develop new waste treatment strategies that integrate the needs of the production sector to encourage the use of secondary raw materials.
- Increase public demand for recycled products at the regional level.

Partnership

Unlike the other areas, "Partnership" encompasses objectives with diverse goals, such as improving the socio-economic living conditions of the population, protecting human rights and equal opportunities under democratic principles, and preventing violence and conflicts on the path toward strong and democratic institutions.

1. Improve and expand digital connectivity.
2. Invest in infrastructure, access to services, SME productive activities, equipment, software, and intangible resources.
3. Enhance both physical and digital connectivity.
4. Promote collaboration and participation processes between public-private entities and public-citizen initiatives.
5. Develop and promote mechanisms for local governance.

For the priority “Peace” no strategies have been identified that align with the bioeconomy.

❖ **Rural Development Program 2014-2022**

The Tuscany RDP supports projects related to innovation in agriculture, forestry and biomass production. The bioeconomy is strongly promoted in this context, with the aim of increasing agricultural competitiveness and the efficient use of natural resources.

For the 2023-2027 period, there is an investment of nearly 749 million euros aimed at agriculture, forestry, and rural development, activating 50 specific interventions. The launch of this new programming in 2023 coincides with the final phase of the previous cycle (2014-2022), which will formally conclude on December 31, 2025.

For this reason, the "Rural Development Complement 2023-2027" campaign has been launched. The main objective of this initiative is to make the program accessible and understandable to everyone, emphasizing the importance of agriculture in all its dimensions.

The campaign aims to highlight fundamental aspects such as land management, environmental sustainability, product quality, landscape preservation, and support for farmers' incomes, thus contributing to improving their competitiveness.

❖ **Rural Development Complement 2023-2027**

The RDC Toscana 2023-2027 adapts the National Strategic Plan of the CAP 2023-2027 (approved by the European Commission with decision C (2022) 8645 of December 2, 2022, and subsequently modified by decision C (2023) 6990 of October 23, 2023, also known as PSP Italia 2023-2027) at the regional level, aiming to address regional needs more effectively and efficiently in implementing the planned interventions.

The financial allocation for the RDC Toscana 2023-2027 amounts to nearly 749 million euros, with the following co-financing percentages from regional, national, and European sources:

- 17.79% of regional funds
- 41.51% of national funds
- 40.70% of European funds, specifically from the European Agricultural Fund for Rural Development (EAFRD)

In Tuscany, out of 76 planned interventions within the CAP Italy framework, 50 have been implemented. These 50 rural development interventions in Tuscany focus on four main themes: i) Environment, ii) Investments, iii) Cooperation, iv) Knowledge.

The interventions include measures such as per capita or per surface interventions, which provide compensatory payments or premiums. There are also investments aimed at supporting projects and initiatives to enhance rural development. Cooperation initiatives focus on fostering collaboration among stakeholders in the agricultural sector. Additionally, there is a focus on the knowledge and innovation system in agriculture (AKIS - Agricultural Knowledge and Innovation System), which promotes advancements and knowledge-sharing in the agricultural domain.

Among the priorities identified by the Tuscany Region for the use of funds under the new 2023/2027 agricultural policy is bioeconomy, identified with the CAP Italy framework code E3.4 "Promote innovation for sustainable and circular bioeconomy." However, this priority has been classified as "Specific" rather than "Strategic" or "Qualifying," and therefore does not fall within the 50 interventions planned for development within the RDC[15].

Another strategic direction addressed by the RDC Tuscany 2023-2027 is the strategy for rural areas so as to have a sustainable territory and stimulate the physical, economic, social, environmental and cultural regeneration of rural communities. This requires integrated development strategies that emerge from below, mobilising and involving local actors. The Tuscany Region identified the LEADER method as the main tool for the participative local

15 *Strategic*: they are load-bearing and imply both specific actions and overall approaches that also affect other needs in a synergic manner; *Qualifying*: they concern enabling areas of intervention, to make the responses to other needs effective, in particular strategic ones; *Complementary*: they refer to more specific areas of intervention that synergistically complete the strategic needs; *Specific*: of limited relevance with respect to the National Strategic Plan.

development of rural areas, whose added value lies in the development of the potential of each rural territory that emerges from processes of territorial animation, integrated programming (the local development strategies - LDS), bottom-up planning and collective action that is consolidated in public-private partnerships: the Local Action Groups (LAGs), which, in Tuscany, over the course of programming have been able to develop and implement development strategies consistent with local needs.

❖ **AKIS - Agricultural Knowledge and Innovation System (che include la presenza di Gruppi operativi)**

AKIS, defined by Regulation (EU) No 2021/2115, represents the organisation and flow of knowledge between individuals, organisations and institutions that produce and use knowledge for agriculture and related sectors. It involves a diverse network of actors, such as farmers, advisors, researchers, NGOs and public authorities, working together to generate innovation on topics such as environment, climate, biodiversity and food systems. The innovation model is interactive and multi-actor, focused on farmers' needs, with the objective of integrating different types of knowledge and proposing specific solutions in local and institutional contexts.

The Region of Tuscany has identified three specific objectives that constitute the principles of the Akis Charter to accompany Tuscan agriculture into the future:

- **Being closer to the agricultural enterprise**: To get closer to agricultural enterprises, it will be essential to map and continuously update their needs, wishes and fears. This constant activity will make it possible to better respond to the demand for innovation, improve knowledge of the company profile and strengthen trust in institutions. Interventions such as back-office services and innovation support will be activated, with special attention to the Leaders of integrated projects, strategic representatives of the regional socio-economic system. Consultants, the core of the AKIS system, will be valorised as promoters of change, with specific initiatives such as an interregional Summer School at the Demofarms to foster the exchange of good practices. The research system (universities, public and private organisations, start-ups, etc.), trade organisations and service and technical equipment providers will also be given space for continuous discussion to stimulate collaboration and innovation.
- **Simplifying**: The aim is to simplify and innovate through smarter solutions, favouring the use of simplified cost options, structuring and improving evaluation processes. The introduction of Audit Tracks will ensure monitoring, transparency, efficiency and quality of expenditure. This approach is crucial to ensure credibility and effectiveness of public investment in research and innovation.
- **Being more competent and connected**: Communicating, analysing and sharing information on open innovation in agriculture, at interregional, national and European level, is a strategic activity. This makes it possible to reconstruct the current scenario and identify the main areas of innovation by consulting specialised portals on precision agriculture and smart agrifood. In addition, it makes it possible to collect data on the public and private actors involved, analysing projects financed in previous programming and European research cycles for the development of competitive and sustainable agricultural technologies. It also facilitates dialogue with other funds, such as the ESF and ERDF, and

territorial excellence, as well as analysing the experiences of national and European research centres.

The Tuscany Region will support with a horizontal intervention logic to which 4.03% of the RDC public allocation is allocated (30.250.00 euro). The main action sustained, with more than 40% of allocated fund, is related to EIP-AGRI Operational Groups (SRG01). This action is related to the prioritisation process developed for the RDC Tuscany 2023-2027, where nine strategic needs and nine qualifying needs were identified at regional level. The needs related to AKIS are the following one:

- EA.3 Improve information and training provision (STRATEGIC)
- EA.4 Promote the training and consultancy system (public and private) (QUALIFYING)
- EA.6 Stimulating the participation of enterprises in the development of innovations (QUALIFYING)

2.3 BASELINING GOVERNANCE MODEL AND IMPLEMENTATION ECOSYSTEM FOR THE BIO-BASED ECONOMY

2.3.1 Methodology for bioeconomy governance assessment

The analysis of bioeconomy governance models in Tuscany is based on the bioeconomy governance framework developed in the BIOMODEL4REGIONS project. This framework (Figure 2) categorizes governance functions into three tiers of increasing specificity: basic governance functions (1st-tier), specific bioeconomy governance functions (2nd tier) and assessment criteria (3rd-tier) – which were assessed using an indicator set of 50 indicators.

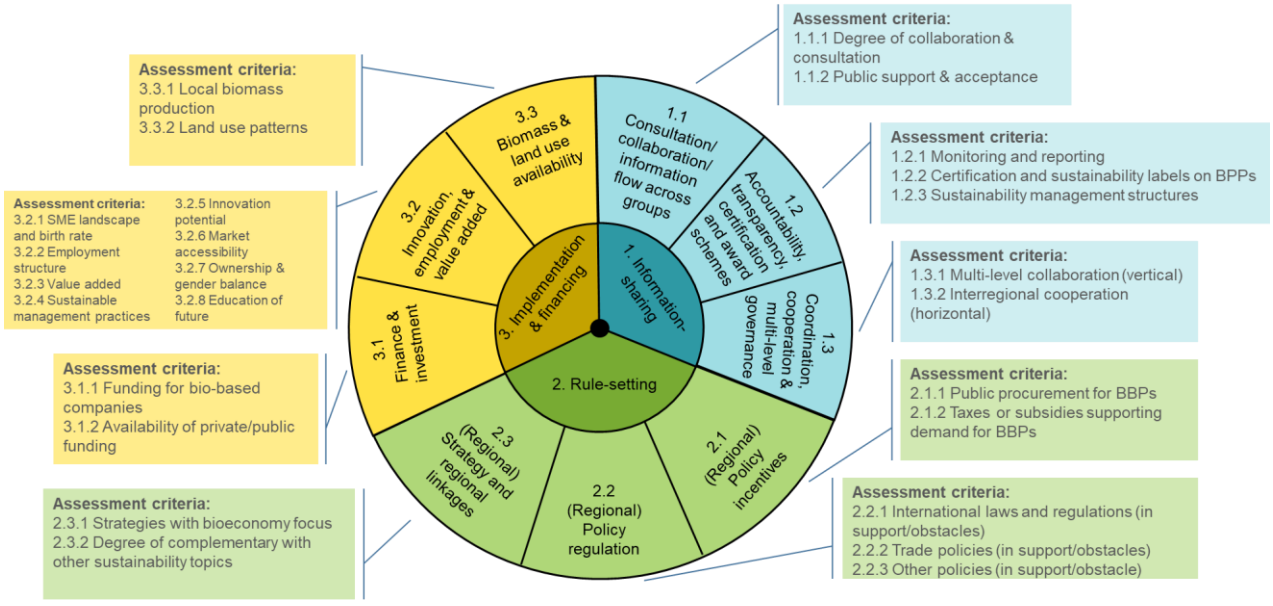


Figure 2: Governance Framework (three tiers) to address the bioeconomy governance state of arts in Pilot Regions

Definition of governance indicators:

TIER 1 - Primary governance functions

- **Information sharing** - includes all types of information flow (e.g. information, consultation, co-creation, etc.) both vertically between different levels, e.g. governments, and horizontally between different actors (or groups of actors) within the governance system.
- **Rule-making** - indicates the fundamental function of governance to establish the conditions, rules and norms for the interaction and transactions of actors within the system.
- **Implementation and finance** - encompasses all aspects of the macroeconomic sphere, both monetary and biophysical (cf. Pauliuk et al., 2017), related to the implementation and realisation of the transition from a linear fossil fuel-based economy to a more circular and biophysical economy

TIER 2 - Functional fields of bioeconomy governance

The second tier comprises the functional governance fields for the bioeconomy (in principle also applicable to other areas), subdividing the three primary governance functions identified in tier 1. These functional governance fields do not focus exclusively on actors at the regional level but extend to multiple levels of governance.

1. Information sharing
   1.1. Consultation/collaboration/information flow between actors - Indicates consultations or other collaborative processes as well as formalised information flows on bioeconomy topics (e.g. between regional governments, cluster organisations, knowledge providers and consumers/public).
   1.2. Accountability/transparency, certification and award schemes - Includes monitoring and reporting practices (e.g. between government agencies) and certification/award schemes to label or otherwise incentivise biobased products (e.g. biobased content labelling, carbon footprint printing, etc.).
   1.3. Coordination, cooperation and multi-level governance - Indicates formalised coordination mechanisms and horizontal (internal or interdepartmental governance) and vertical (multi-level governance) cooperation.

2. Definition of rules
   2.1. Policy incentives (regional) - Includes any public instrument to incentivise the production of biobased products, such as taxes, subsidies or Green Public Procurement (GPP).
   2.2. Policy regulation (regional) - Includes regional regulatory policies or the adoption/implementation of related national or EU policies, e.g. on waste, agriculture, forestry or trade.
   2.3. Horizontal (regional) strategy and linkages - Refers to governance instruments related to the creation of a vision, defining the main directions of development, e.g. circular bio-economy strategies.

3. Implementation and finance
   3.1. Finance and investment - Focuses on the availability of public or private finance for bioeconomy innovations, project development and their scalability/commercialisation.
   3.2. Innovation, employment and added value - Includes assessment of the status quo regarding innovation mechanisms, employment and added value in bioeconomy sectors.

3.3. Biomass and land use availability - Includes status quo assessment on biomass availability (material flows material flows) and land use patterns.

For each governance function in each tier the region was scored on a five-part Likert-type (ordinal) scale, which consisted of:

- Further from target
- Below target
- On track for target
- Just below target
- On target

The target varies by assessment criteria but indicates the benchmarks found in European best practice strategies (Haarich et al, 2022)[16] and in scientific literature. The data has been gathered by cluster SPRING during the course of the project. The data was then processed by ICLEI Europe, including cleaning up errors and filling gaps with reasonable assumptions, and a score was assigned to each indicator value, based on benchmarks from best practice studies, scientific literature and authors judgement (e.g. in case of qualitative indicators).

2.3.2 Bioeconomy governance assessment results

The analysis of Tuscany's governance reveals a complex profile, showcasing some notable strengths but also weaknesses that hinder the full development of the regional bioeconomy. In the Table 2 an overview of the indicators, on Tier based division, with the relevant score (from 1 to 3) have been show.

Table 2: Governance Profile Tuscany results based on Tier 2 level, with a scoring system of 0 (further below the target), 1 (below target), 2 (on track for target) and 3 (on target).

Tier 1	Tier 2	Score
Information sharing	Consultation/collaboration/information flow between actors	1,04
	Accountability/transparency, certification and award schemes	1,50
	Coordination, cooperation and multi-level governance	1,00
Rule setting	Policy incentives (regional)	1,00
	Policy regulation (regional)	0,92
	Strategy and horizontal linkages (regional)	1,17
Implementation & Financing	Financing and investment	1,50
	Innovation, employment and added value	2,17
	Biomass availability and land use	2,00

Below is a detailed description of the three main areas (Tier 1), with particular attention to the most relevant indicators (Tier 2). A visual presentation of the data is reported in Figure 3.

16 Haarich, Silke, and Stephanie Kirchmayr-Novak. 'Bioeconomy Strategy Development in EU Regions'. JRC Publications Repository, 12 May 2022. https://doi.org/10.2760/065902.

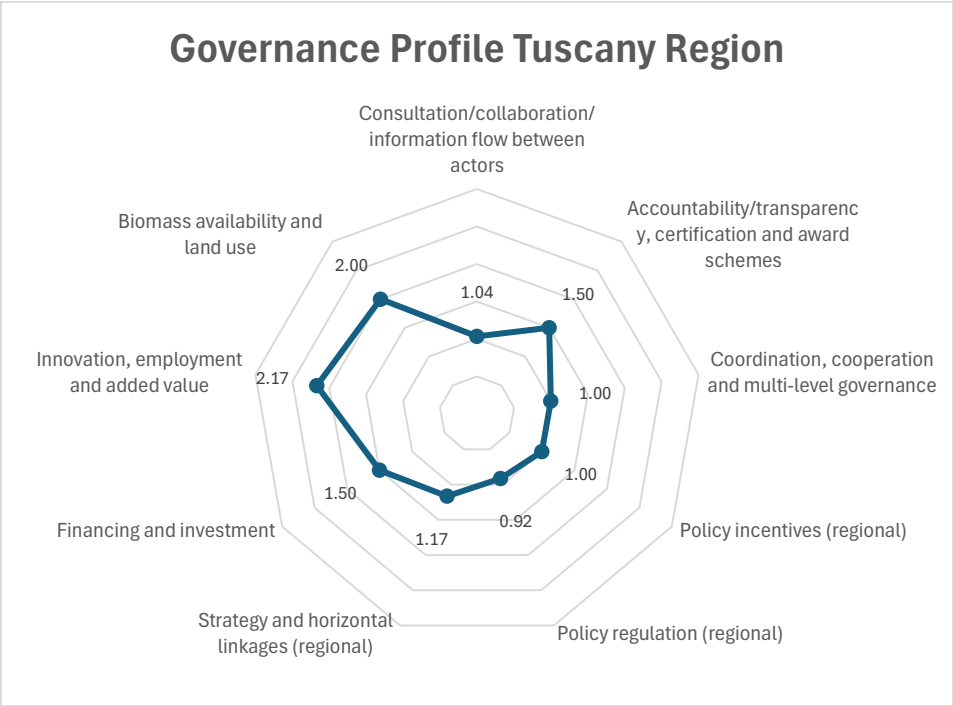


Figure 3: Governance Profile Tuscany spider graph based on Tier 2 level.

<u>Implementation and Financing</u> - *Highest average score*

The **Implementation & Financing** area is the main strength of Tuscany's bioeconomy governance. The associated indicators show that the region has a solid capacity to implement and financially support bioeconomy initiatives.

Strengths

- **Innovation, employment, and added value (2.17):** The high score reflects a robust ability to foster innovation and generate economic value. Tuscany stands out as a favourable environment for developing bio-based products and integrating businesses into the global market.
- **Biomass availability and land use (2.00):** The local availability of natural resources and relatively sustainable land management represent a strategic advantage for the regional bioeconomy.

Challenges

- **Human capital and training:** The lack of specialized skills hampers the sector's innovative potential. Targeted training and education programs are essential to bridge this gap.
- **Financing for bio-based companies:** Despite good overall results, there is a lack of dedicated tools to finance bioeconomy SMEs, limiting their ability to grow and innovate.

<u>Information Sharing</u> - *Low average score*

The **Information Sharing** area includes critical indicators such as information flow, transparency, and multi-level coordination. This area highlights significant difficulties in communication and collaboration among stakeholders.

Strengths

- **Certifications and transparency:** Progress in certification initiatives and awards for sustainable practices can incentivize the bio-based sector and improve public perception of the bioeconomy.

Challenges

- **Insufficient collaboration among actors (1.04):** Tuscany struggles to build effective networks of collaboration among SMEs, local governments, and stakeholders. This limits strategic alignment and the co-creation of regional policies.
- **Coordination and multi-level governance (1.00):** Coordination among regional, local, and national governance levels is fragmented, reducing the overall effectiveness of policies. The absence of a clear cooperation strategy among various levels of government creates operational gaps and inefficiencies.
- **Limited information flow:** Information about bioeconomy projects is not systematically shared among key stakeholders. This lack of transparency undermines public consensus and the adoption of new initiatives.
- **Consultation and participation:** Local stakeholders, such as SMEs and communities, are not sufficiently involved in decision-making processes. This reduces the relevance of policies to local needs and limits their impact.

Rule Setting - *Lowest average score*

The **Rule Setting** area is the most significant weakness in Tuscany's bioeconomy governance. The challenges in creating regulatory policies aligned with European objectives hinder the sector's long-term development.

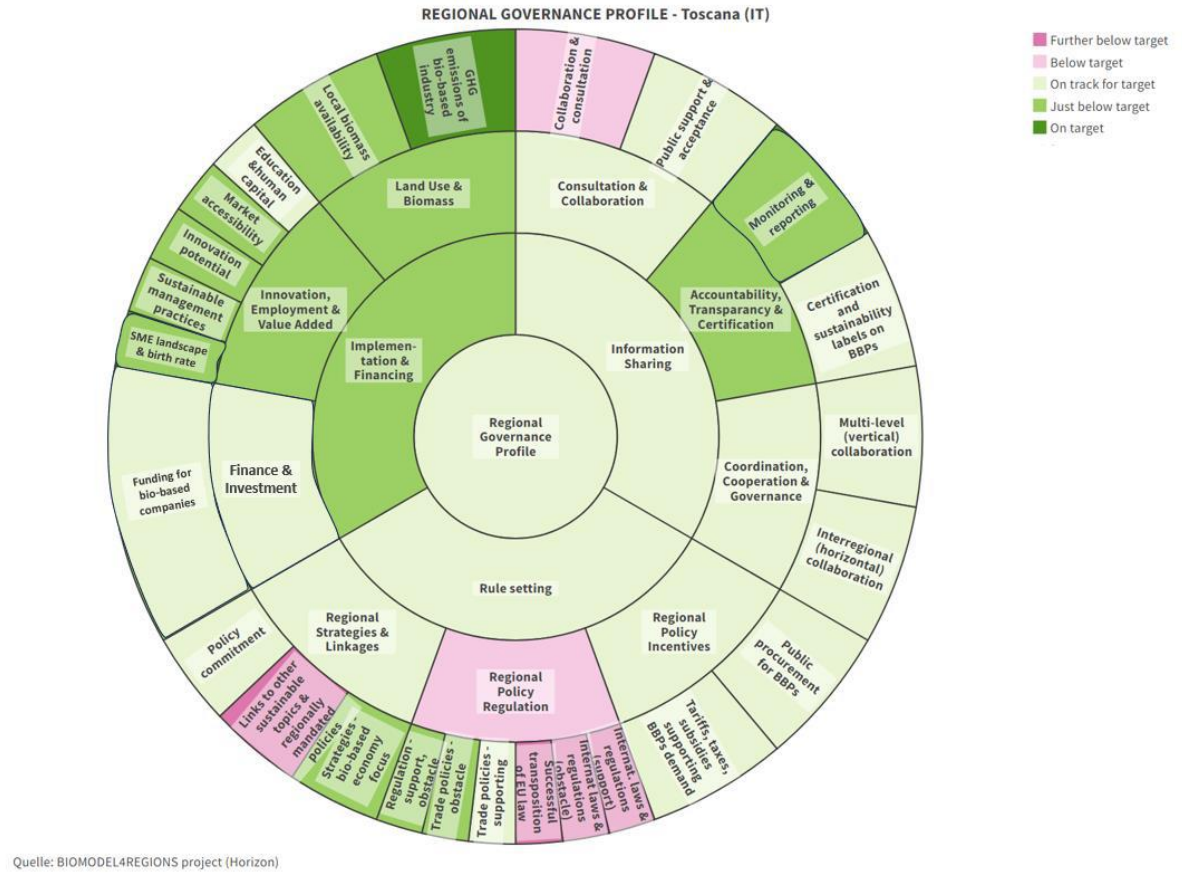
Strengths

- **Bioeconomy strategies:** Despite the challenges, Tuscany has regional strategies with a bioeconomy focus evaluated as “Just below target.” This demonstrates a political commitment to the sector, which could serve as a foundation for future improvements.

Challenges

- **Regional policy regulations (0.92):** Current regional regulations are underdeveloped or not sufficiently targeted to support the bioeconomy. The transposition of EU regulations is particularly weak, creating misalignments between regional and European policies.
- **Limited incentives:** Economic incentives, such as subsidies or favourable tax policies, are not fully implemented or are insufficient to stimulate investment and innovation.

For a detailed zoom-in in the Tuscany governance a Sunburst chart (Figure 4) has been created from Biomodel4regions project in order to showcase also tier 3 indicators.



Quelle: BIOMODEL4REGIONS project (Horizon)

Figure 4: Governance Profile Tuscany presented through a sunburst chart and based on three tier levels. The colours indicate how far is the KPI from the target (legend).

Overall, Tuscany's governance profile shows a region with some clear strengths in sustainability and innovation support, but significant areas for improvement in policy and regulation, collaboration and consultation, and funding. While the region shows potential, addressing the gaps in policy and regulation and improving collaboration across governance levels will be essential for advancing Tuscany's bioeconomy. The following priority actions have been identified:

1. **Improve multi-level coordination and information flow:** Strengthen collaboration between governance levels and stakeholders to increase the effectiveness of bioeconomy policies.
2. **Align regulations with European standards:** Create a clearer and more coherent regulatory framework to foster the growth of the bio-based sector.
3. **Enhance human capital:** Invest in training and education to develop advanced technical skills and attract talent.
4. **Strengthen stakeholder involvement:** Actively involve SMEs, local communities, and other actors to ensure the adoption of shared and locally relevant policies.

The quantitative results obtained from the bioeconomy governance framework explained in this paragraph have been crosschecked with a dedicated work through policies interviews. This qualitative check has been performed by interviewing policy experts active in Tuscany region with high degree of knowledge about the topic of bioeconomy. The robustness/alignment check shown that Tuscany had a high overall level of alignment between the governance assessment and the expert interviews.

3 TOWARDS A VISION FOR THE BIO-BASED ECONOMY IN TUSCANY

The bioeconomy represents one of the main levers for the transition towards more sustainable and circular economic models. In Tuscany, the potential to develop an innovative and resilient bioeconomy system is significant, but to fully exploit it, the current structural, operational and governance gaps must be addressed.

This chapter aims to outline a strategic vision for the bioeconomy in Tuscany, with a particular focus on the identification and definition of strategic priority areas. These areas were identified by analysing the results of the governance bioeconomy framework and using a participatory approach through a dedicated workshop.

3.1 DEFINITION OF THE STRATEGIC AREAS

The workshop actively involved the main regional stakeholders, representatives of the quadruple helix (institutions, industry, research and civil society), with the aim of ensuring an integrated and inclusive vision. The methodology adopted included an initial open discussion phase to identify priorities, followed by work in groups to formulate specific strategic actions. This process made it possible to define interventions that take into account existing barriers, facilitating factors and the operational actions needed to overcome them.

The strategic areas identified include the following:

1) **Governance and Policy**

Tuscany has significant regional instruments to support the circular bioeconomy, such as the Regional Programme (RP ERDF), which finances innovative projects and interventions for the training of farmers and the sustainable digitalisation of enterprises. However, it turned out that these instruments, although available, are difficult to use due to the fragmentation of information and the complexity of regulations governing them. Many operators, in particular SMEs, find it difficult to access calls for proposals, due to both the lack of clarity and the overly bureaucratic structure of the application processes. This situation often leads to a high drop-out rate for projects, which fail to reach the implementation stages.

During the workshop, stakeholders provided a concrete example of these difficulties. The *Green Grow project*, despite being promising in terms of innovation and sustainability, could not be completed due to insufficient financial resources. Moreover, many regional projects, despite having innovative objectives, lack an integrated vision involving the entire supply chain, from agriculture to industry, to maximise the impact of circularity. More coordination is needed between institutional actors and production sectors, with the aim of building a systemic approach.

Virtuous examples include realities such as the Tenuta di Cesa-Alberese, a technological experimentation centre that serves as a laboratory for the application of good practices, contributing to the objectives of the European Green Deal. Similarly, projects such as the AKIS (Agricultural Knowledge and Innovation System) aim to create platforms for the exchange of knowledge and innovations, although wider integration with other economic and industrial sectors is currently lacking.

From a regulatory point of view, the delay in the implementation of the National Bioeconomy Strategy in Tuscany is attributed to a lack of political strength and a fragmentation of administrative processes. The difficulty of coordination between divisions and departments reduces the ability to create a unified strategic vision. The situation is aggravated by the suspension of working tables dedicated to the circular economy, which in the past represented an important opportunity for inter-sectoral dialogue and confrontation.

2) Funding for the Circular Bioeconomy

A crucial problem is the lack of specific financial instruments for the circular bioeconomy. Although there is public (European Regional Development Fund – ERDF) and private funds (venture capital managed by Cassa Depositi e Prestiti (CDP)) that involve some topic related to it, these are not specifically oriented towards the bioeconomy and are little known. For instance, the CDP fund, although having significant investment potential, does not provide specific funding lines for projects promoting circularity, thus reducing the possibility of supporting cross-sectoral collaborations.

Moreover, the RDP (Rural Development Plan) and RDC (Rural Development Complement) only cover technology transfer, but do not finance research and development. This condition limit companies wishing to invest in innovation, forcing them to look elsewhere for resources for experimentation and design.

3) Technology, Innovation and Training

From the technological point of view, Tuscany presents a rich landscape of infrastructures and skills. For example, advanced technologies for the valorisation of agricultural by-products and energy production are already present in the area. The technological pole of Cecina and the academic programmes offered by the universities of Siena, Pisa, Florence and Scuola Superiore Sant'Anna represent regional excellences capable of supporting the circular bioeconomy. However, these technological and academic resources are often little known and poorly connected to the local production system.

In addition, a key element concerns the redevelopment of disused industrial sites present in Tuscany region. The region hosts numerous disused industrial areas, such as Piombino and Greve in Chianti, which could be regenerated through the application of circular bio-economy principles. A virtuous example is represented by the actions already undertaken on the Piombino industrial site, which serve as a model for further projects. In this direction, it is crucial to consider the old Testi cement plant in Greve in Chianti, which ceased operations in 2021. In support of this initiative, a memorandum of understanding was signed between the Region of Tuscany, the municipalities of Greve and San Casciano, and the company Buzzi Unicem, outlining a joint commitment towards the recovery and sustainable development of this area.

Tuscan academic training is recognised for its high quality, guaranteeing a workforce with advanced technical skills. However, there is a lack of adequate integration between universities and companies, which could facilitate the development of a truly circular innovation ecosystem. Moreover, even within universities there is fragmentation between departments, which limits the interdisciplinary collaboration needed to tackle the complex challenges of the bioeconomy. Another critical point is the low visibility of already available advanced technologies that could be used to promote circularity in various sectors.

3.2 STRATEGIC ACTIONS

The strategic actions presented in this chapter are the result of a co-creation process that actively involved all relevant stakeholders in the bioeconomy sector. This participatory approach made it possible to identify and outline solutions aimed at responding to the needs expressed by the stakeholders, ensuring that the proposals are realistic, effective and shared. The actions outlined were designed with the aim of addressing the main challenges limiting the sector's development and strengthening opportunities for growth and innovation.

Targeted primarily at policy makers, these actions aim to guide public policies and regional strategies to support the adoption and expansion of the bioeconomy. The intention is to create an enabling environment that stimulates the integration of research, industry and the public, promoting innovation and sustainability through concrete policies and targeted interventions.

The following strategic actions present an initial description and include:

i) Barriers: Indicates the obstacles (regulatory, technical, communication, training, etc.) that limit the development of the action.
ii) Facilitators: Identifies the people, digital and technological tools, processes and methodologies, infrastructures, organizations, and networks that can facilitate the achievement of the actions.
iii) Operational Actions: Specifies the concrete activities required to put the strategic actions into practice.

Strategic Action 1: Creation of a technopole for bioeconomy and integrated support network

Establish a Technopole dedicated to bioeconomy that functions as an integrated ecosystem, involving leading companies, universities, industry associations, and other stakeholders. This Technopole will serve as a central point for connection and collaboration, overcoming the lack of networks between various sectors and facilitating innovation.

Barriers

- Lack of networks between sectors: The absence of connections hinders innovation and reduces synergies among actors.
- Poor communication: Challenges in sharing key information slow down collaboration and the effectiveness of projects.
- Impermeability of the Tuscan system: The lack of openness to external collaborations makes it difficult to build innovation networks.

Facilitators

- Regional bioeconomy clusters: Strengthening sector activities through a local cluster that fosters collaboration.

- Industry associations and intermediaries: Act as connectors between various stakeholders, facilitating coordination and communication.
- Universities and research institutions: Linking academic expertise with industrial needs to support innovation.
- Rural districts and recycling consortia: Local structures promote the integration of economic models linked to bioeconomy.
- Regional Offices: The Regional Technology Transfer Office (RTTO) supports companies by identifying academic expertise for innovation and promotes funding, advanced training, and foreign investments in collaboration with the Tuscany Region.

Operational Actions

- Creation of an integrated bioeconomy ecosystem: Promote the Technopole as a point of reference for bioeconomy, linking universities, industries, and other key actors.
- Organizing networking events: Facilitate connections between universities and businesses to promote knowledge transfer.
- Mapping corporate academies: Identify and promote local expertise to foster collaboration between universities and companies.

Strategic Action 2: Governance and Regulatory simplification

Create a regional agency to coordinate and simplify regulations and bureaucracy in the sector, improving communication between the public and private sectors and facilitating access to funds and technologies.

Barriers

- Complexity of procedures: Bureaucratic procedures hinder participation and the success of initiatives.
- Lack of regional regulation: The absence of specific regulations makes it difficult to regulate and coordinate the sector.
- Closed university system: Limited interaction between universities, industry, and the territory limit knowledge transfer.

Facilitators

- Bottom-up operational groups: Encourage a participatory approach that allows for greater adaptability of initiatives.
- Consulting services: Promote the consultation of European regulations to align local policies.
- Industry associations: Foster coordination between public and private entities for defining common regulations.
- Regional Directorates: It is necessary to include decision-makers with specialized figures from Agricultural, Rural Development, Environment and Energy, and Productive Activities Directorates.
- National Clusters: Lobbying and support from impartial entities to mediate legislative needs.

Operational Actions

- Creation of a common table between the region and industry: Establish continuous dialogue to define shared regulations and promote common goals.
- Preventive control body: Create an entity to facilitate the regulatory process and simplify project compatibility.
- Regional agency: Create an agency to simplify procedures and coordinate initiatives effectively.
- Recognition of regulatory systems: Assign respective ATECO[17] codes and End of Waste status to facilitate the classification of bioeconomy projects.

Strategic Action 3: Development of a targeted funding programme and specific incentives

Allocate funds for bioeconomy projects, with financing for Proof of Concept (POC) and logistics incentives, implementing a stronger regional co-financing system.

Barriers

- Limited financial capacity of calls: Funding does not always cover the necessary investments.
- Low regional co-financing: Limited regional economic support reduces participation in funding opportunities.
- Lack of merit recognition: The lack of recognition for contributions limits motivation among involved actors.

Facilitators

- Funding for Proof of Concept (POC): Allocate funds for the validation phase of projects to increase their effectiveness.
- Leading bioeconomy companies: Supporting successful companies promotes faster sector growth.
- Two-phase projects: A two-phase project approach allows for more effective project management and increases success.

Operational Actions

- Modernization of regional portals: Streamline and simplify the Artea portal to facilitate the management of calls.
- Creation of a simplified incentive system: Develop incentives with clear goals and adequate financial capacity.
- Specific funding for logistics and bioeconomy: Provide targeted resources to support bioeconomy and improve regional logistics.

Strategic Action 4: Training and communication to support the bioeconomy ecosystem

[17] The acronym ATECO derives from (Attività ECOnomiche, "Economic Activity") and represents the national transposition of the European classification of economic activities, known as NACE. These codes are assigned by the National Institute of Statistics (ISTAT) and are essential for numerous statistical and administrative functions.

Implement a targeted communication program to improve the skills and awareness of stakeholders involved in the bioeconomy, with a focus on training sector operators.

Barriers

- Insufficient specific training: Inadequate training limits effectiveness and innovation.
- Lack of specialized professional figures: There is a shortage of specific sector expertise among operators.

Facilitators

- Industry organizations: Industry organizations facilitate the dissemination of knowledge among stakeholders.
- Regional and European operational tools: Use the AKIS tool to promote knowledge transfer.

Operational Actions

- Communication and training programs: Develop training pathways to improve operators' competence and awareness, including awareness-raising initiatives.
- Targeted dissemination of ERDF funds: Provide clear and detailed communication about available funds to make the financing process more transparent and accessible.
- Training in sector associations: Integrate training into associations to spread knowledge widely.

Strategic Action 5: Creation of an integrated support system for innovation and new supply chains

Facilitate access to funding and stimulate participation in innovative projects by using intuitive digital platforms, venture capital, and strengthening sector skills.

Barriers

- Complexity of bureaucratic procedures: Procedures hinder access to funding and the management of collaborations.
- Low recognition of academic and entrepreneurial contributions: The lack of value recognition can limit participation in innovative projects.
- Absence of an innovation supply chain: The lack of a structured network connecting stakeholders limits collaboration opportunities and the development of sustainable supply chains.
- Technical and environmental constraints: High costs and complexities associated with land reclamation or infrastructure conversion.

Facilitators

- Smart digital platforms: Intuitive platforms simplify access to funding opportunities.
- Electronic signatures: Electronic signatures reduce the need for paper documentation and speed up bureaucratic processes.
- Support infrastructures: Incubators and accelerators can promote startup growth and facilitate entry into new supply chains.

- Rural districts and recycling consortia: Local structures can promote the integration of new economic models related to bioeconomy.
- Past experiences: The success of the Piombino intervention offers a replicable and adaptable model.
- Community involvement: Effective communication with citizens and trade unions can help speed up the project.

Operational Actions

- Replacing calls for proposals with venture capital: Encourage the use of venture capital to fund innovative projects.
- Creation of private funding opportunities: Involve private actors in financing research, training, and the development of supply chains.
- Recognition of academic value: Implement a system of economic and public recognition to give value to academic contributions, encouraging their participation in innovative projects.
- Educational credits for the business world: Offer recognized advanced training opportunities for professionals and young people.
- Reconversion of disused industrial sites: Valorisation of disused industrial sites as territorial and economic regeneration of inland areas.

The Table 3 summarizes the main strategic actions identified.

Table 3: Main outcomes from the co-creation workshop, where for each strategic action, barriers, facilitators, operational actions have been indicated.

Strategic Actions	Barriers	Facilitators	Operational actions
1. Creation of a technopole for bioeconomy and integrated support network	• Lack of networks between sectors • Poor communication • Impermeability of the Tuscan system	• Regional bioeconomy clusters • Industry associations and intermediaries • Universities and research institutions • Rural districts and recycling consortia • Regional Offices	1.1 Creation of an integrated bioeconomy ecosystem 1.2 Organizing networking events 1.3 Mapping corporate academies
2. Governance and Regulatory simplification	• Complexity of procedures • Lack of regional regulation. • Closed university system	• Bottom-up operational groups • Consulting services • Industry associations • Regional Directorates • National Clusters	2.1 Creation of a common table between the region and industry 2.2 Preventive control body 2.3 Regional agency 2.4 Recognition of regulatory systems
3. Development of a targeted funding programme and specific incentives	• Limited financial capacity of calls • Low regional co-financing • Lack of merit recognition	• Funding for Proof of Concept (POC) • Leading bioeconomy companies • Two-phase projects	3.1 Modernization of regional portals 3.2 Creation of a simplified incentive system 3.3 Specific funding for logistics and bioeconomy
4. Training and communication to support the bioeconomy ecosystem	• Insufficient specific training effectiveness and innovation. • Lack of specialized professional figures	• Industry organizations • Regional and European operational tools	4.1 Communication and training programs 4.2 Targeted dissemination of ERDF funds 4.3 Training in sector associations
5. Creation of a support system for innovation and new supply chains	• Complexity of bureaucratic procedures • Low recognition of academic and entrepreneurial contributions • Absence of an innovation supply chain • Technical and environmental constraints	• Smart digital platforms • Electronic signatures • Support infrastructures • Rural districts and recycling consortia • Past experiences • Community involvement	5.1 Replacing calls for proposals with venture capital 5.2 Creation of private funding opportunities 5.3 Recognition of academic value 5.4 Educational credits for the business world 5.5 Reconversion of disused industrial sites

3.3 SUMMARY AND RECOMMENDATIONS

The recommendations below have been developed to provide policy makers with practical and targeted guidance aimed at transforming the identified strategic actions into concrete interventions. These suggestions aim to address the needs of bioeconomy stakeholders by tackling current barriers and making the most of facilitating factors. The aim is to foster the creation of an integrated ecosystem, capable of stimulating innovation, strengthening existing supply chains and promoting a sustainable development model at regional level. Implementing these recommendations requires a coordinated effort between public institutions, businesses, universities, trade associations and national clusters to ensure a lasting and positive impact on the sector.

The five identified strategic actions represent a clear and actionable pathway to strengthen the bioeconomy sector and address existing challenges. Below, concrete recommendations aiming to translate these strategies into effective interventions, are provided.

1. **Creation of a bioeconomy technopole**

A Bioeconomy Technopole can serve as a central hub for coordination and collaboration among key stakeholders in the sector, including businesses, universities, and trade associations. This structure would not only foster synergies but also provide a reference point for shared innovation and supply chain integration.

Recommendations:

- Identify a strategic location for the Technopole, ideally near existing clusters and academic hubs.
- Allocate dedicated funding for the construction and operation of the facility, including shared spaces for research and innovation.
- Introduce tax incentives and benefits for companies actively participating in the Technopole to encourage engagement.
- Develop digital tools to facilitate networking and communication among stakeholders, promoting a culture of knowledge sharing.

2. **Improving governance and the regulatory system**

Effective governance and a clear regulatory framework are essential to stimulate the development of the bioeconomy. A lack of coordination and bureaucratic complexities are significant barriers that reduce stakeholder participation and the success of initiatives.

Recommendations:

- Establish a Regional Agency for the Bioeconomy tasked with coordinating projects, simplifying bureaucratic procedures, and providing regulatory support.
- Set up a permanent dialogue platform between institutions and business representatives to ensure that regulations align with the sector's needs.
- Promote training for public officials to enhance their ability to manage bioeconomy projects and apply complex regulations.

- Integrate European regulations into the local context to facilitate access to funding and ensure project compliance with EU directives.

3. Developing a targeted financing program and specific incentives

Facilitated access to financing is crucial to fostering innovation and supporting businesses in implementing bioeconomy projects. However, current financial limitations and the complexity of funding calls pose significant challenges.

Recommendations:

- Introduce a two-stage funding system with an initial phase for the "Proof of Concept" and a second phase for development and commercialization.
- Simplify regional portals for managing funding calls by integrating digital tools to reduce bureaucracy.
- Encourage private sector involvement through the use of venture capital and public-private partnerships, ensuring transparency and measurable returns.
- Provide financial incentives to support the logistics of bioeconomy supply chains, with a particular focus on agricultural enterprises and SMEs.

4. Training and communication to support the bioeconomy ecosystem

To ensure the sustainable and innovative growth of the bioeconomy, it is essential to enhance skills and raise awareness among operators and the public. Improved training and effective communication can better prepare stakeholders to address the sector’s challenges.

Recommendations:

- Develop a structured regional training plan, including specific courses for sector operators, young professionals, and public officials.
- Promote the recognition of training credits for participants, offering incentives such as free access to master’s programs or discounts on advanced courses.
- Launch a communication campaign to raise public awareness of the importance of the bioeconomy and its applications.
- Collaborate with trade associations to integrate training directly into their programs, ensuring widespread dissemination of skills.

5. Building a structured network between universities and enterprises

The lack of dialogue and collaboration between universities and businesses limits knowledge transfer and the development of innovative solutions. A structured network could bridge this gap, integrating research and industry to address the sector's challenges.

Recommendations:

- Organize regular networking events between universities and businesses, such as thematic workshops and sector fairs, to foster knowledge transfer.
- Map corporate academies and local expertise to identify synergies and promote joint projects between research and industry.
- Support the creation of regional consortia that include universities, rural districts, and innovative enterprises to facilitate collaboration along the entire value chain.

- Integrate regional clusters into a national network, encouraging participation in European and international initiatives to strengthen the territory's strategic position.
- Support stakeholders in valorizing disused industrial sites through streamlined bureaucracy, business model development, incentive programs, and recognition systems showcasing supply chain contributions and success stories.

4 KEY ACTION FIELDS FOR IMPLEMENTATION

4.1 IMPROVING BIO-BASED BUSINESS MODELS IN TUSCANY THROUGH ACTIONS

The operational actions outlined in Chapter 3 are designed to concretely support the accomplishment of the strategic actions. Simultaneously, practical activities must be planned to facilitate the implementation, monitoring, and successful attainment of the operational objectives. The Table 4 presents the strategic actions related to the specific activities required to achieve them.

Table 4: List of specific activities identified for each strategic action.

Strategic Action	Topic	Activity
Action 1: Creation of a technopole for bioeconomy and integrated support network	Building the technopole infrastructure	• Establish a physical and digital space for the Technopole to serve as a hub for collaboration. • Develop state-of-the-art facilities for research, innovation, and meetings for stakeholders in bioeconomy.
	Ecosystem integration and stakeholder engagement	• Map existing stakeholders (universities, companies, rural districts, consortia, etc.) and their expertise. • Set up an advisory board including representatives from universities, industry associations, and rural districts to guide Technopole activities. • Coordinate with regional offices like the RTTO to align academic expertise with industrial needs.
	Networking events and knowledge exchange	• Map existing stakeholders (universities, companies, rural districts, consortia, etc.) and their expertise. • Set up an advisory board including representatives from universities, industry associations, and rural districts to guide Technopole activities. • Coordinate with regional offices like the RTTO to align academic expertise with industrial needs.
	Communication and collaboration tools	• Develop a digital platform for stakeholders to exchange information, submit project ideas, and access resources. • Launch a dedicated communication campaign to promote the Technopole and its benefits. • Create an open-access library of bioeconomy research, policies, and best practices.
	Training and capacity building	• Partner with universities to offer customized training programs in bioeconomy-related fields. • Establish mentorship schemes pairing startups with industry leaders and academic experts.
	Local and global collaboration	• Establish partnerships with international bioeconomy hubs to encourage knowledge sharing and innovation transfer. • Develop joint projects with regional clusters and rural districts to foster bottom-up collaboration.
	Policy advocacy and regulatory alignment	• Collaborate with regional and national agencies to advocate for policies that support bioeconomy innovation and simplify procedures for Technopole stakeholders.

Strategic Action	Topic	Activity
	Monitoring and evaluation	• Set up a dashboard to track collaborations, project outcomes, and stakeholder feedback. • Conduct annual reviews to refine Technopole activities and address barriers effectively.
Action 2: Governance and regulatory simplification	Establish a regional agency for coordination	• Form a dedicated regional agency with experts in bioeconomy-related fields to streamline processes and act as a mediator between public and private sectors. • Recruit representatives from industry associations, academia, and rural districts to ensure broad sector representation.
	Simplify bureaucratic procedures	• Implement electronic documentation systems with user-friendly interfaces to reduce paperwork and speed up applications. • Set up a Preventive Control Body to review project compliance with regional and national regulations, reducing delays in approvals.
	Foster public-private dialogue	• Organize regular forums and working groups between regional authorities and industry stakeholders to align on goals and share feedback. • Develop communication channels for bottom-up initiatives, allowing rural and smaller entities to voice their needs.
	Promote clear regulations	• Collaborate with national clusters and consulting services to align regional policies with European bioeconomy standards. • Assign specific ATECO codes and End of Waste status to bioeconomy projects to facilitate regulatory clarity.
	Monitor and adjust regulatory frameworks	• Use pilot projects to test the impact of simplified procedures before broad implementation. • Establish a feedback mechanism where stakeholders can report inefficiencies in the regulatory process.
Action 3: Development of a targeted funding programme and specific incentives	Strengthen regional co-financing	• Design a dedicated bioeconomy fund with increased co-financing rates to support small and medium-sized enterprises (SMEs). • Introduce two-phase project funding, covering Proof of Concept (POC) validation and subsequent scaling stages.
	Create targeted incentives	• Develop logistics incentives to enhance supply chain efficiency and support sustainable practices. • Provide tax breaks or grants for companies investing in innovative bioeconomy technologies.
	Modernize regional portals	• Upgrade the Artea portal to streamline application processes for funding and incentives, including real-time status updates for applicants. • Integrate AI-driven recommendation tools to match applicants with the most relevant funding opportunities.
	Recognize contributions and merit	• Launch a bioeconomy excellence awards program to recognize outstanding projects and individuals. • Introduce economic rewards or public recognition for academic and entrepreneurial contributions to innovation.

Strategic Action	Topic	Activity
	Attract private investment	• Partner with venture capital firms and private investors to create hybrid funding models for innovative projects. • Establish investment roundtables to showcase bioeconomy projects to potential backers.
Action 4: Training and communication to support the bioeconomy ecosystem	Develop sector-specific training programs	• Partner with universities and industry associations to create certified training programs tailored to bioeconomy operators. • Establish apprenticeship schemes where students can gain practical experience in bioeconomy businesses
	Launch communication campaigns	• Use digital and traditional media to raise awareness of the bioeconomy's potential, targeting policymakers, investors, and the general public. • Publish success stories of regional projects to inspire and attract stakeholders.
	Promote knowledge transfer	• Organize training workshops using the AKIS (Agricultural Knowledge and Innovation Systems) tool to bridge academic and practical expertise. • Develop an open-access knowledge platform where operators can access research, funding information, and best practices.
	Enhance accessibility of funds	• Provide webinars and guides to explain the funding application process, especially targeting underrepresented rural areas. • Collaborate with industry associations to run information sessions on available European Regional Development Fund (ERDF) opportunities.
	Build capacity in sector associations	• Integrate bioeconomy modules into existing sector association programs to spread knowledge widely. • Host regional conferences to connect stakeholders and promote continuous learning.
Action 5: Creation of a support system for innovation and new supply chains	Build a digital ecosystem for innovation	• Design and implement user-friendly platforms to connect stakeholders, facilitate funding applications, and simplify bureaucratic procedures. • Incorporate electronic signatures to simplify documentation processes for collaborative projects.
	Promote private and venture capital funding	• Complement traditional calls for proposals with venture capital-driven funding models to support high-potential startups and incentivize projects which includes reconversion of disused sites. • Establish bioeconomy accelerators to mentor and fund early-stage companies.
	Reconversion of Disused Industrial Sites	• Develop incentive programs for private-sector stakeholders to invest in site reconversion for bioeconomy purposes. • Collaborate with regional planning authorities to streamline permissions and support infrastructure upgrades.
	Strengthen local supply chains	• Work with rural districts and recycling consortia to integrate circular economy models into new supply chains.

Strategic Action	Topic	Activity
		• Map regional supply chain gaps and prioritize funding for projects addressing these gaps. • Establish collaborations among startups, research institutions, and industries to utilize reconverted sites as innovation hubs. • Encourage circular economy practices by linking supply chains with available resources and infrastructure at reconverted sites.
	Incentivize academic and entrepreneurial contributions	• Create economic recognition programs to reward impactful research and entrepreneurial innovation. • Offer educational credits and certifications for professionals working on bioeconomy projects to enhance their career prospects. • Publicly showcase successful initiatives in reconverted sites to inspire further stakeholder engagement.
	Leverage support infrastructures	• Partner with incubators and accelerators to help startups scale and connect to new supply chains. • Establish regional innovation hubs in partnership with the Technopole to coordinate activities and resources.
	Strengthen international collaboration and training	• Facilitate participation in EU-funded programs such as Horizon Europe to integrate regional projects into global supply chains. • Host international summits to attract global attention to regional bioeconomy initiatives. • Provide specialized training and mentorship programs focused on managing innovation in reconverted industrial zones.

5 OUTLOOK

5.1 PLANNED NEXT STEPS

The document will remain a *living document*, evolving through continuous updates and contributions. Its implementation will be supported by several key actions:

- Incorporating feedback from the stakeholder workshop to refine and enhance its content.
- Organizing a workshop in February, open to stakeholders who did not initially participate, to delve further into practical aspects and foster broader engagement.
- Hosting an in-person event with policymakers to present the strategic document developed and initiate discussions aimed at establishing a direct line of collaboration. This event will bring together key sector representatives around a working table to streamline efforts and build a cohesive strategy.

5.2 KEY OPEN QUESTIONS AND ISSUES

Effectively implementing the proposed strategic actions for the bioeconomy ecosystem requires addressing key uncertainties and challenges that may influence their success. The following questions have been formulated to identify critical gaps, guide stakeholder discussions, and refine the strategies for achieving the desired outcomes. These questions are structured to encourage deep reflection and collaborative problem-solving among policymakers, industry leaders, academia, and other stakeholders, ensuring that the bioeconomy initiatives are both practical and impactful.

Strategic Action 1: Creation of a technopole for bioeconomy

Integration and collaboration:

- How can the Technopole ensure equal participation from diverse stakeholders (e.g., small enterprises, rural communities, and large corporations)?
- What mechanisms can be implemented to maintain active and long-term stakeholder engagement?
- How can global partnerships be established while retaining a strong regional focus?

Sustainability and scalability:

- What are the funding and operational models for the Technopole to ensure financial and operational sustainability?
- How will the Technopole scale its activities beyond initial pilot regions or projects?

Impact measurement:

- What metrics should be used to evaluate the success of the Technopole in fostering innovation and collaboration?
- How can the performance of networking events and training programs be effectively assessed?

Strategic Action 2: Governance and regulatory simplification

Policy alignment:

- How can regional policies be effectively aligned with European frameworks (e.g., ATECO codes) without introducing additional complexity?
- What are the most common bureaucratic obstacles faced by bioeconomy projects, and how can these be systematically eliminated to accelerate project implementation?

Stakeholder dynamics:

- How can local stakeholders, such as industry associations and small companies, be engaged in a bottom-up approach to influence the creation of bioeconomy-specific regulations?
- How can the interaction between regional decision-makers (e.g., agricultural, environment, energy departments) and bioeconomy stakeholders be structured to ensure regulations are both practical and effective?
- How can the Preventive Control Body be structured to avoid bureaucracy while ensuring regulatory compliance?

Implementation challenges:

- What are the risks of resistance to simplified procedures from traditional systems or stakeholders, and how can these be mitigated?
- How can transparency in regulatory adjustments be maintained?

Strategic Action 3: Development of targeted funding programme & specific incentives

Equity and accessibility:

- How can regional co-financing be enhanced to provide more equal opportunities for small businesses and startups to access bioeconomy funding?
- What measures can ensure fair evaluation of contributions in funding rounds and merit-based recognition?

Resource allocation:

- What types of financial instruments or grants can be developed to better support Proof of Concept (POC) stages, considering the high-risk nature of early-stage bioeconomy projects?
- What criteria will guide the allocation of logistics incentives to avoid overlap or inefficiency?

Private Investment:

- What incentives or assurances can attract private venture capital to co-invest in bioeconomy projects?
- How can public-private partnerships be structured to maximize innovation while minimizing risk?

Strategic Action 4: Training and communication to support the bioeconomy ecosystem

Skill development:

- What specific competencies are most needed in the bioeconomy sector, and how can training programs address these gaps effectively?
- How can training programs balance theoretical knowledge with practical, hands-on experiences?

Awareness and outreach:

- How can communication campaigns be tailored to reach diverse audiences, including non-specialists and rural stakeholders?
- What innovative dissemination strategies can increase awareness about funding opportunities and success stories?

Resource constraints:

- What resources (financial, technological, and human) are required to sustain long-term communication and training initiatives?
- How can sector-specific training be integrated into existing education systems without overburdening institutions?

<u>Strategic Action 5: Integrated support system for innovation</u>

Platform design and use:

- How can smart digital platforms be designed to ensure user-friendliness, scalability, and data security? What specific features should be included?
- What measures can prevent exclusion of stakeholders with limited digital literacy?

Supply chain development:

- What criteria should guide the identification and funding of supply chain gaps to maximize sector-wide benefits?
- How can rural districts and consortia be effectively integrated into new supply chains?
- What regulatory or financial mechanisms can ensure sustainable redevelopment of industrial sites while promoting innovation?

Incentivizing innovation:

- How can academic and entrepreneurial contributions be evaluated and rewarded to sustain innovation momentum?
- What role should incubators and accelerators play in fostering startups, and how can their effectiveness be tracked? What role should regional governments and international stakeholders play in promoting site reconversion as a core strategy for bioeconomy growth?

Ensuring Effective Use of Reconverted Sites:

- What benchmarks can be established to evaluate the success of reconverted industrial sites in fostering innovation and collaboration?
- How can reconverted sites become long-term assets for regional and national bioeconomy supply chains?

Cross-Cutting Issues

Monitoring and evaluation:

- What overarching framework can track the outcomes and impacts of all five strategic actions cohesively?
- How can continuous feedback be gathered from stakeholders to refine strategies?

Long-term vision:

- What are the potential risks (e.g. political shifts, funding cuts) that might derail long-term goals, and how can these be mitigated?

5.3 TIMELINE

The

Table 5 provides a detailed breakdown of the timeframe for implementing the proposed activities across the five strategic actions. Each action is categorized based on its expected implementation timeline, allowing for clear prioritization and efficient resource allocation. This structured approach ensures that short-term initiatives lay the foundation for mid-term and long-term goals, driving sustainable progress within the bioeconomy ecosystem.

Legend:

- **Short-term:** 0–12 months
- **Mid-term:** 1–3 years
- **Long-term:** Beyond 3 years

Table 5: Timeframe to develop the specific activities identified, in relation to operational and strategic actions.

Strategic Action	Operational Actions	Activities	Timeframe
1. Creation of a technopole for bioeconomy and integrated support network	1.1 Creation of an integrated bioeconomy ecosystem 1.2 Organizing networking events 1.3 Mapping corporate academies	- Build Technopole infrastructure (physical & digital) - Map stakeholders and form advisory boards - Organize networking events & bioeconomy fairs - Develop a digital collaboration platform - Provide training programs and mentorships	Short to Mid-term
		- Partner with global bioeconomy hubs for knowledge transfer - Collaborate with regional offices and clusters - Advocate for supportive bioeconomy policies - Monitor Technopole performance	Mid to Long-term
2. Governance and Regulatory simplification	2.1 Creation of a common table between the region and industry 2.2 Preventive control body 2.3 Regional agency 2.4 Recognition of regulatory systems	- Create a regional agency for coordination - Implement electronic documentation systems - Establish a Preventive Control Body for compliance review - Organize forums for public-private dialogue	Short-term
		- Align regional policies with European standards (eg. ATECO codes) - Test simplified procedures via pilot projects - Develop feedback mechanisms for regulatory adjustments	Mid to Long-term
3. Development of a targeted funding programme and specific incentives	3.1 Modernization of regional portals 3.2 Creation of a simplified incentive system 3.3 Specific funding for logistics and bioeconomy	- Increase regional co-financing rates - Introduce two-phase funding (POC and scaling) - Create logistics incentives and tax breaks for bioeconomy companies - Modernize the Artea portal	Short to Mid-term

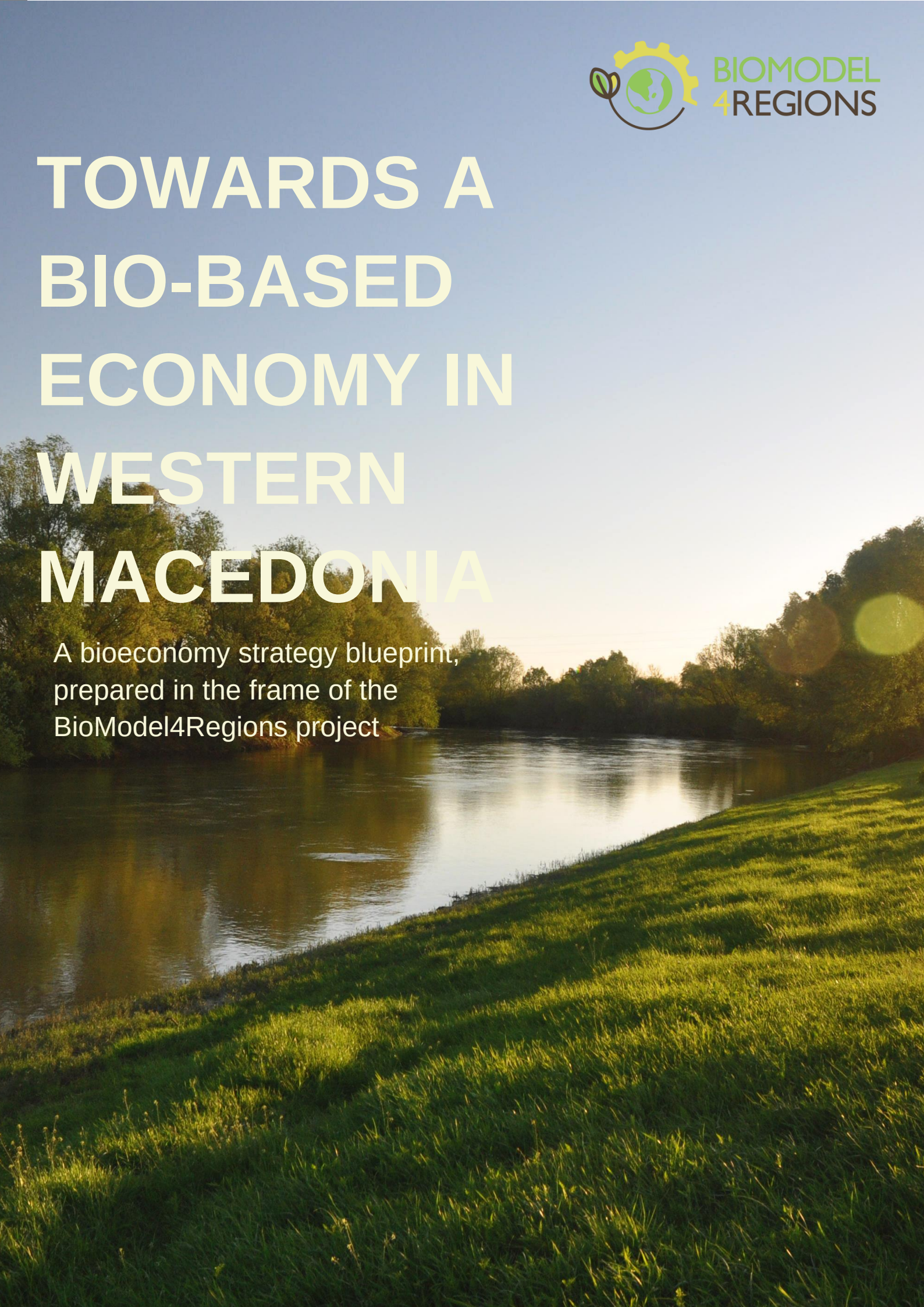
Strategic Action	Operational Actions	Activities	Timeframe
		- Attract private investment via venture capital partnerships - Recognize contributions through awards and economic incentives - Establish investment roundtables for private funding opportunities	Mid to Long-term
4. Training and communication to support the bioeconomy ecosystem	4.1 Communication and training programs 4.2 Targeted dissemination of ERDF funds 4.3 Training in sector associations	- Develop sector-specific training programs with universities - Launch targeted communication campaigns - Use AKIS tools for knowledge transfer - Organize training workshops and webinars on funding processes	Short-term
		- Integrate bioeconomy modules into association programs - Establish regional conferences and open-access knowledge platforms - Highlight success stories to inspire collaboration and participation	Mid to Long-term
5. Creation of a support system for innovation and new supply chains	5.1 Replacing calls for proposals with venture capital 5.2 Creation of private funding opportunities 5.3 Recognition of academic value 5.4 Educational credits for the business world 5.5 Reconversion of disused industrial sites	- Create smart digital platforms for project and stakeholder matchmaking - Partner with venture capital firms for funding - Map supply chain gaps and fund targeted projects with incentives programme for site redevelopment - Establish collaborations between startups, research institutions, and industries to utilize reconverted sites as innovation hubs	Short to Mid-term

Strategic Action	Operational Actions	Activities	Timeframe
		- Provide economic recognition for academic and entrepreneurial contributions to supply chains and showcase success stories from reconverted sites. - Support startups through incubators and accelerators - Provide specialized training and mentorship programs focused on managing innovation in reconverted industrial zones.	Mid to Long-term

6 ACKNOWLEDGEMENTS

Annex-06

Towards a Bio-Based Economy in Western Macedonia (Greece)



BIOMODEL 4REGIONS

TOWARDS A BIO-BASED ECONOMY IN WESTERN MACEDONIA

A bioeconomy strategy blueprint, prepared in the frame of the BioModel4Regions project

This document has been prepared in the framework of the European project "BIOMODEL4REGIONS – Supporting the establishment of the innovative governance models to achieve better-informed decision-making processes, social engagement, and innovation in the bio-based economy".

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 101060476.

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December 2024

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List of Abbreviations

Abbreviations	Definition
EU	European Union
ERDF	European Regional Development Fund
NGOs	Non-governmental organizations
ESIF	European Structural and Investment Funds
EIB	European Investment Bank
NSRF	National Strategic Reference Framework
SMEs	Small and medium-sized enterprises
MEL	Monitoring, evaluation, and learning
R&D	Research and Development

Glossary

Keywords	Definition
Bioeconomy	The bioeconomy means using renewable biological resources from land and sea, like crops, forests, fish, animals, and micro-organisms to produce food, materials, and energy.
Bio-based economy	The biobased economy takes into consideration the production of non-food goods, whilst bioeconomy covers both bio-based economy and the production and use of food and feed.
Circular economy	A circular economy is a system which maintains the value of products, materials, and resources in the economy for as long as possible and minimises the generation of waste. This means a system where products are reused, repaired, remanufactured, or recycled.

1 OBJECTIVES AND SCOPE

1.1 ROLE OF THE BIO-BASED ECONOMY STRATEGY BLUEPRINT WITHIN THE REGIONAL GOVERNANCE MODEL

The Bio-based economy strategy blueprint (Blueprint) is a pivotal document within the governance model of the Western Macedonia region (Greece), driving the transformation towards a sustainable and resilient economy. This strategic framework not only aligns local initiatives with broader national and European bio-based economy policies but also fosters a holistic approach to economic development, environmental stewardship, and social inclusivity.

At its core, the Blueprint serves as a strategic planning and policy development tool. It articulates a clear vision and sets four specific goals and priorities for harnessing bio-based resources effectively. It ensures that regional policies are in harmony with national and European bio-based economy strategies, promoting coherence and synergy in policy implementation. This alignment is crucial for leveraging funding opportunities and maximizing the impact of bio-based economy initiatives.

One of the fundamental functions of the Blueprint is to advocate for sustainable resource management. Western Macedonia, a region historically dependent on lignite mining, is transitioning towards more sustainable economic activities. The Blueprint underscores the importance of using biological resources sustainably, emphasizing practices that support environmental conservation while driving economic growth. By promoting circular economy principles, the Blueprint encourages the minimization and reuse of waste and by-products, thereby reducing the ecological footprint of regional industries. For example, one approach could be to support local industries in Western Macedonia to reuse agricultural by-products or convert organic waste into bioenergy or compost, thereby closing resource loops and reducing dependence on external inputs.

Economic diversification and innovation are central themes of the Blueprint. It aims to reduce the region's reliance on traditional sectors by fostering the development of bio-based industries. This diversification is vital for economic resilience, providing new opportunities in fields such as bioenergy, bioproducts, and sustainable agriculture. The Blueprint also serves as a catalyst for innovation, encouraging research and development in bio-based technologies. By supporting startups and facilitating collaborations between academia, industry, and government, the blueprint nurtures an ecosystem conducive to technological advancement and entrepreneurship. For example, the Blueprint could help to encourage partnerships with local agricultural cooperatives to produce bio-based products, such as biodegradable packaging materials made from agricultural residues. Furthermore, to stimulate innovation, the Blueprint could help to support incubator programs that help bio-based startups to develop and scale their technologies, fostering collaboration among universities, research institutions, and regional businesses.

The Blueprint also plays a crucial role in job creation and skills development. As the region pivots away from lignite mining, there is a growing need for new skills and training programs tailored to emerging bio-based sectors. The Blueprint outlines initiatives aimed at equipping the workforce with the necessary skills to thrive in these new industries. This focus on education and training not only enhances employability but also ensures that the benefits of

the bio-based economy transition are widely shared, contributing to social stability and economic inclusion.

To clarify how the Blueprint supports job creation and skills development, we can provide concrete examples of its initiatives. For instance, the Blueprint could help to outline training programs in collaboration with local technical schools and universities to provide certifications in bio-based fields, such as bioprocess engineering and sustainable agriculture practices. Additionally, partnerships with bio-based companies could offer apprenticeships or internships, giving workers hands-on experience in bioenergy production or bioproduct manufacturing. These targeted programs ensure that as Western Macedonia transitions from lignite mining, the local workforce is prepared for new roles, supporting economic inclusion and social stability across the region.

Stakeholder engagement is another key function of the Blueprint. Effective governance in the bioeconomy transition requires the active participation of various stakeholders, including local communities, businesses, research institutions, and non-governmental organizations. The Blueprint provides a framework for inclusive decision-making, ensuring that diverse perspectives are considered in shaping bioeconomy policies. For example, it could help to organise regular stakeholder forums where representatives of local communities, businesses, research institutions and NGOs work together on bioeconomy policy proposals. They could also establish advisory committees that include these stakeholders to provide ongoing input and feedback on key decisions. This framework not only ensures that a variety of perspectives are incorporated into policymaking, but also builds trust and accountability by making stakeholders feel directly involved in the region's bioeconomy transition.

Funding and investment attraction are critical components of the Blueprint. It identifies potential funding sources, such as European Union (EU) programs, national funds, and private investments, to support bioeconomy projects. For instance, it refers to the EU programs such as Horizon Europe and the European Regional Development Fund (ERDF) as potential sources to support bioeconomy projects. Additionally, it highlights national funds aimed at green transition initiatives and outline strategies for attracting private investments, like establishing tax incentives for bio-based startups. By showcasing the region’s commitment to sustainable development and highlighting its strategic advantages for bio-based industries, the blueprint helps attract investments that are essential for scaling up bioeconomy activities. To underscore the region's commitment, the Blueprint refers to the Western Macedonia’s sustainable development plans, such as the Just Transition Development Plan, which outlines a roadmap for transitioning away from lignite dependency while prioritizing the bioeconomy. This alignment with both regional and European strategies demonstrate a proactive stance on sustainable development, which can be appealing to investors looking to support green industries.

Finally, the bioeconomy blueprint includes mechanisms for monitoring and evaluation. It sets benchmarks and indicators to measure the progress and impact of bioeconomy initiatives on economic growth, environmental sustainability, and social well-being. Continuous monitoring and evaluation allow for the adjustment of strategies and actions, ensuring that the region remains on track to achieve its bioeconomy goals.

1.2 PRIMARY INVOLVED STAKEHOLDERS OF THE BIO-BASED ECONOMY STRATEGY BLUEPRINT

The Blueprint of Western Macedonia is a pivotal strategic document designed to guide the region through a transformative journey towards sustainable economic development. This Blueprint is meticulously crafted to serve a broad spectrum of stakeholders, each playing a critical role in the successful implementation of bioeconomy principles. By addressing the needs and roles of these diverse stakeholders, the Blueprint ensures a comprehensive and inclusive approach to regional development, presented in a Figure 1.1 below.

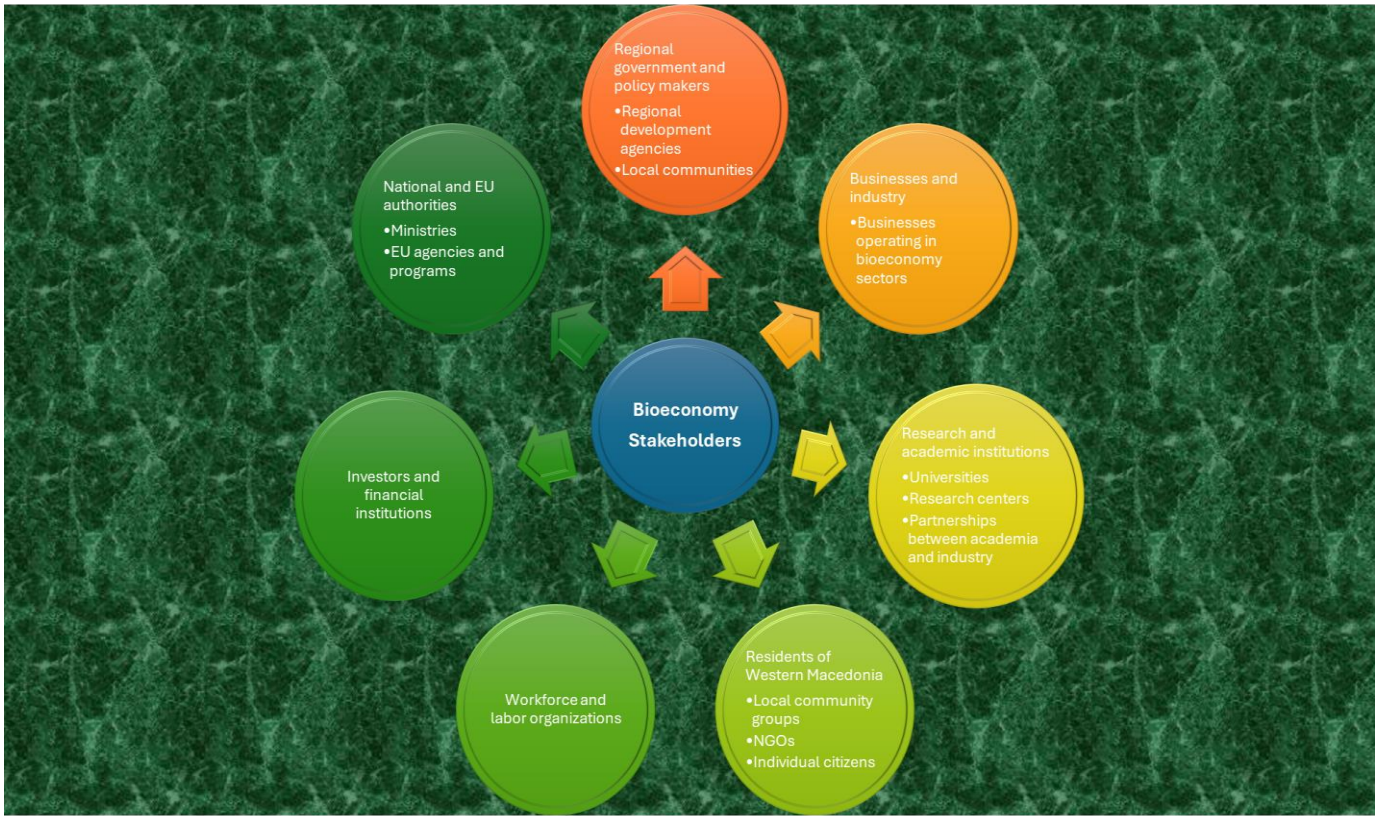


Figure 1.1 Involved stakeholders of the bio-based economy strategy blueprint (Source: author's elaboration)

Primarily, the Blueprint targets the regional government and policymakers. These entities are at the helm of setting strategic directions and implementing policies that foster the growth of the bioeconomy. The regional development agencies, local municipalities, and elected officials are deeply involved in this process. Their responsibilities include developing and enforcing policies that encourage sustainable practices, coordinating with national and EU bodies to secure necessary funding, and continuously monitoring and evaluating the impact of bioeconomy initiatives. This alignment with broader national and EU strategies is crucial for leveraging funding opportunities and maximizing the effectiveness of bioeconomy projects.

Businesses and industry leaders are also primary audiences of the Blueprint. These stakeholders are key players in adopting and scaling bio-based technologies and practices. Companies operating in sectors such as agriculture, forestry, bioenergy, food processing, and waste management are particularly significant. By investing in and adopting bio-based innovations, these industries contribute to economic diversification and resilience. Their collaboration with research institutions facilitates the development of new products and technologies, driving forward the region's bioeconomy. Moreover, businesses provide

valuable insights during policy development, ensuring that regulations support economic growth and innovation.

Research and academic institutions form another crucial group targeted by the Blueprint. Universities, research centers, and academic bodies are instrumental in fostering innovation and advancing bioeconomy technologies. Researchers, professors, and students engaged in bioeconomy-related studies contribute through cutting-edge research and development. These institutions also play a vital role in training the future workforce, offering educational programs that equip students with the skills needed in bio-based industries. Partnerships between academia and industry ensure the transfer and commercialization of new technologies, enhancing the region's competitive edge.

The Blueprint is also designed with the local communities and citizens in mind. The residents of Western Macedonia are directly impacted by the economic and environmental changes brought about by the bioeconomy transition. Local community groups, non-governmental organizations (NGOs), and individual citizens are encouraged to participate in public consultations, providing feedback on bioeconomy projects and ensuring that the initiatives meet their needs and aspirations. By engaging in sustainable practices and supporting local bio-based businesses, communities play a vital role in the region's transition. They also stand to benefit from new job opportunities and improved quality of life resulting from sustainable economic growth.

Workforce and labor organizations are essential stakeholders in the Blueprint. As Western Macedonia shifts away from lignite mining, there is a pressing need for new skills and training programs tailored to bio-based sectors. Vocational training centers, labor unions, and employment agencies are involved in identifying skill gaps and providing the necessary training. These organizations advocate for fair labor practices and good working conditions, ensuring that the bioeconomy transition is socially inclusive. By helping workers transition from traditional industries to new bio-based sectors, they contribute to the region's economic resilience and social stability.

Investors and financial institutions are also key audiences for the Blueprint. Banks, venture capitalists, and public and private investment funds are crucial in providing the capital needed to support bioeconomy projects. By assessing the viability and sustainability of investments in bio-based industries, these financial entities help ensure that projects are economically sound and environmentally sustainable. Their involvement is critical for scaling up bioeconomy activities and attracting further investments, thereby driving regional economic growth.

Finally, national and EU authorities are vital stakeholders in the Blueprint. National government bodies and EU institutions provide regulatory frameworks, funding, and support for regional bioeconomy initiatives. Ministries related to agriculture, environment, and economic development, as well as EU agencies and programs, play significant roles in setting standards and offering incentives. Their support ensures that regional activities are aligned with national and EU sustainability goals, facilitating a cohesive and coordinated approach to bioeconomy development.

1.3 PATHWAY TOWARDS A COMPREHENSIVE BIOECONOMY STRATEGY

The bioeconomy blueprint of Western Macedonia is a foundational guide for the region’s transition to a sustainable and resilient economic model. Rather than being the final goal, it

provides a structured design that can be followed to create a comprehensive bioeconomy strategy. This blueprint outlines the initial steps needed to ensure Western Macedonia can effectively leverage its bio-based resources, supporting sustainable growth and regional development.

1. Detailed Planning and Vision Refinement

The initial step following the establishment of the bioeconomy blueprint involves refining the vision and engaging in detailed planning. This phase is critical for setting specific, measurable, achievable, relevant, and time-bound (SMART) goals that guide the region's bioeconomy initiatives. It requires a comprehensive assessment of the region's bio-based resources, identifying key areas for development, and outlining clear objectives and milestones. Additionally, a thorough analysis of current economic, environmental, and social conditions is necessary to tailor the bioeconomy strategy to Western Macedonia's unique context. This detailed planning ensures that the strategy is both realistic and ambitious, providing a clear roadmap for future actions.

Action	The first step involves refining the bioeconomy vision and conducting a comprehensive resource assessment.
Key Activities:	Resource Mapping: Identify bio-based resources in the region (e.g., agricultural residues, forest biomass, renewable energy potential).
	SWOT Analysis: Conduct a more detailed SWOT analysis of key sectors (agriculture, forestry, waste management) in consultation with regional experts and stakeholders.
	Goal Setting: Establish SMART goals (Specific, Measurable, Achievable, Relevant, and Time-bound) for bioeconomy sectors, such as reducing carbon emissions by 15% within five years or increasing the share of bio-based industries in the regional GDP by 20% by 2030.
Roles	Regional development agencies, local government, universities, and research institutions will play a critical role in conducting the assessments and defining goals.
Funding Sources	EU Horizon Europe funding, National Development Plans, local government budget allocations.

2. Enhanced Stakeholder Engagement

Building on the initial engagement facilitated by the blueprint, the next step focuses on deepening collaboration with a broader range of stakeholders. Effective stakeholder engagement is essential for ensuring that diverse perspectives are incorporated into the bioeconomy strategy. This involves organizing workshops, public consultations, and collaborative platforms where local communities, industry leaders, academic institutions, and civil society organizations can contribute their insights. Such a participatory approach enhances the legitimacy and effectiveness of the bioeconomy strategy, fostering a sense of ownership and commitment among all stakeholders.

Action	Deepen collaboration with a broader range of stakeholders to ensure inclusivity and build long-term partnerships.
Key Activities:	Stakeholder Mapping: Create a stakeholder map that includes local farmers, business leaders, academics, policymakers, and NGOs.

Action	Deepen collaboration with a broader range of stakeholders to ensure inclusivity and build long-term partnerships.
	Workshops & Public Consultations: Organize at least 4 workshops per year to discuss bioeconomy challenges and opportunities, encouraging local input into the strategy.
	Advisory Committees: Establish advisory committees with representatives from industry, academia, and civil society to provide ongoing input
Roles	Regional authorities, university departments, local chambers of commerce, and community leaders.
Funding Sources	Local authorities, EU Social Fund Plus for community engagement, public-private partnerships.

3. Policy Development and Integration

Developing specific policies and regulations is a crucial step towards a dedicated bioeconomy strategy. Creating an enabling regulatory framework that supports bio-based industries, promotes sustainable practices, and incentivizes innovation is essential. Policies must address key areas such as land use, resource management, waste reduction, and environmental protection. Integrating bioeconomy principles into existing regional policies and planning documents ensures a cohesive approach to sustainable development. This policy integration aligns regional efforts with national and EU strategies, facilitating coordinated and effective implementation.

Action	Develop policies and regulations that enable bio-based industries and integrate them into existing regional development plans.
Key Activities:	Policy Mapping: Identify gaps in existing policies related to bioeconomy sectors, such as land use, waste management, and renewable energy.
	Drafting New Policies: Create new regulations, including tax incentives for bio-based industries, grants for green startups, and bio-certification schemes.
	Integration into Regional Development Plans: Ensure that bioeconomy principles are incorporated into the broader regional development and urban planning strategies.
Roles	Regional government, Ministry of Agriculture and Rural Development, environmental agencies, and legal experts.
Funding Sources	European Structural and Investment Funds (ESIF), national funding programs, public-private partnerships.

4. Capacity Building and Skills Development

Transitioning to a bioeconomy requires a skilled workforce equipped with the necessary knowledge and expertise. Investing in education and training programs to develop these skills is vital. Collaborations with universities, vocational training centers, and industry partners are essential to design and implement effective training initiatives. Building local capacity ensures that the workforce is prepared to meet the demands of the emerging bioeconomy, contributing to economic resilience and social stability. Such capacity building not only enhances employability but also drives innovation and productivity within bio-based sectors.

Action	Build the capacity of the workforce by designing education and training programs that address specific bioeconomy skills gaps.
Key Activities:	Skills Gap Analysis: Conduct a skills gap analysis in bio-based sectors, identifying key areas such as sustainable farming, bioenergy, and green chemistry.
	Curriculum Development: Collaborate with universities and vocational training centers to develop specialized training programs and degrees in bioeconomy-related fields.
	Internships and Apprenticeships: Launch internship programs in partnership with local bioeconomy businesses to ensure practical, hands-on experience.
Roles	Universities, industry leaders, local employment offices, and training institutions.
Funding Sources	EU Erasmus+ program, private sector co-investment

5. Funding Acquisition and Investment Attraction

Securing adequate funding and attracting investments are crucial for implementing a comprehensive bioeconomy strategy. Identifying and accessing various funding sources, including EU programs, national funds, private investments, and public-private partnerships, is necessary. Developing attractive investment propositions and promoting the region's commitment to sustainability can help attract investors. Ensuring financial support for bioeconomy projects is essential for their successful implementation and scalability, driving economic development and job creation.

Action	Secure funding and attract investment to support bioeconomy projects and initiatives.
Key Activities:	Investment Readiness Program: Develop a program to help local bioeconomy projects prepare attractive business plans and feasibility studies to attract investment.
	EU Funding Applications: Identify and apply for relevant EU funding programs, including Horizon Europe, LIFE Program, and the European Investment Bank (EIB) funding for green innovation.
	Private Sector Investment: Organize investment roadshows and bioeconomy summits to attract private investors and venture capitalists.
Roles	Regional development agencies, local government, business incubators, financial institutions, and private investors.
Funding Sources	EU Horizon Europe, National Development Funds, EIB, private venture capital.

6. Monitoring, Evaluation, and Continuous Improvement

Establishing mechanisms for monitoring and evaluation is vital to track progress and assess the impact of bioeconomy initiatives. Setting up a robust system to collect data, measure outcomes, and evaluate the effectiveness of policies and projects allows for continuous improvement. Regular monitoring and evaluation enable adjustments and refinements to be made, ensuring that the bioeconomy strategy remains dynamic and responsive to changing conditions. This continuous learning and adaptation are essential for achieving long-term sustainability goals.

Action	Establish mechanisms for ongoing monitoring and evaluation to ensure that the bioeconomy strategy adapts and evolves.
Key Activities:	Data Collection and Reporting: Set up systems to collect data on bioeconomy outcomes, including job creation, carbon footprint reduction, and economic growth in bio-based industries.
	Evaluation Framework: Develop an evaluation framework that includes annual progress reports, mid-term reviews, and long-term assessments.
	Feedback Loops: Create feedback mechanisms that allow stakeholders to contribute insights and suggest improvements during the strategy's implementation.
Roles	Regional authorities, statistical agencies, monitoring bodies, and independent evaluators.
Funding Sources	National funding for monitoring projects, private sector contributions for specific project evaluations.

7. Public Awareness and Communication

Raising public awareness and effectively communicating the benefits and opportunities of the bioeconomy are important for gaining public support and participation. Developing communication strategies to inform and educate the public about bioeconomy initiatives is crucial. Utilizing various media channels, organizing awareness campaigns, and highlighting success stories can help build a positive perception of the bioeconomy. Encouraging community involvement and support is vital for the successful implementation of bioeconomy projects.

Action	Raise public awareness and ensure effective communication of the bioeconomy's benefits to increase public participation and support.
Key Activities:	Public Awareness Campaigns: Launch a multi-channel awareness campaign to inform citizens about the benefits of the bioeconomy, using social media, TV, and community events.
	Showcase Success Stories: Highlight successful bioeconomy projects in the region to build confidence and inspire further action (e.g., local bioenergy plants, sustainable farming initiatives).
	Engage Local Media: Partner with local media outlets to create engaging content about the bioeconomy, including interviews with entrepreneurs, success stories, and educational material.
Roles	Regional government, local media, public relations firms, community organizations, and educational institutions.
Funding Sources	National media partnerships, private sponsorship for specific campaigns.

1.4 SECTORS COVERED BY THE BIOECONOMY BLUEPRINT IN WESTERN MACEDONIA

The Blueprint for Western Macedonia is a detailed strategic plan aimed at guiding the region towards sustainable economic growth by utilizing its biological resources. This plan encompasses a variety of sectors, each vital to the bioeconomy transition. These sectors include agriculture, forestry, food processing, and waste management. By targeting these diverse areas, the blueprint seeks to encourage innovation, sustainability, and economic stability.

Agriculture

Agriculture forms the backbone of the bioeconomy blueprint. This sector is essential for producing bio-based raw materials, which are fundamental to various bioeconomy activities. The blueprint also promotes the diversification of crops to include those suitable for bio-based industries, such as biomass crops and high oil content plants for biofuels.

- Current State: Western Macedonia has a significant agricultural sector, although it is traditionally focused on staple crops. There are efforts underway to transition towards crops suited for bioeconomy applications.
- Opportunities and Importance: Expanding crop diversification in this sector is crucial for enhancing the supply of raw materials for bio-based products. For example, crops like biomass grasses, oilseeds for biofuels, and fiber crops for bioplastics could be particularly beneficial for local industries.
- Actions: The blueprint can focus on identifying and incentivizing specific crops that align with bio-based industries. It may also outline steps to support farmers with training and subsidies for crop diversification.

Forestry

Forestry is another crucial sector highlighted in the blueprint. The forests of Western Macedonia are significant sources of biomass and other forest products. The blueprint advocates for sustainable forest management practices that balance economic use with conservation. This includes responsible timber harvesting, using forest residues for bioenergy, and cultivating non-timber forest products. Promoting sustainable forestry aims to support biodiversity, prevent deforestation, and supply raw materials for bio-based industries.

- Current State: Western Macedonia's forestry resources are relatively untapped, with some forest management practices in place but limited integration into bio-based markets.
- Opportunities and Importance: Sustainable forest management in the region could contribute not only to bio-based products but also to environmental preservation and biodiversity. The blueprint could identify specific forest areas and types of residues that could serve as biomass sources.
- Actions: To foster responsible forestry, the blueprint should include targeted actions for developing local supply chains for biomass. Training programs and certifications for sustainable harvesting practices might also be highlighted to enhance the sector's growth potential.

Food Processing

The food processing sector is essential to the bioeconomy, adding value to agricultural products and generating by-products usable in other bio-based industries. The blueprint stresses the adoption of sustainable practices in food processing. It also encourages the development of new bio-based food products and ingredients, which can create new markets and enhance food security.

- Current State: Food processing is a well-established industry, but the use of by-products and waste in bio-based applications is not yet fully realized.

- Opportunities and Importance: By optimizing the use of agricultural by-products, such as leftover biomass, the sector could create valuable inputs for bio-based products like bioplastics and biofertilizers, adding economic value while reducing waste.
- Actions: The blueprint could propose incentives for companies to adopt circular economy practices, turning food processing by-products into new resources for bio-based industries. It could also outline collaboration with local businesses and startups for developing bio-based food products.

Waste Management

Waste management is a key sector for the bioeconomy, involving the transformation of organic waste into valuable products. The blueprint promotes the implementation of circular economy principles, where waste is minimized and recycled into bioenergy, bioplastics, compost, and other bio-based products. Improving waste management practices in Western Macedonia can reduce environmental pollution, create new economic opportunities, and enhance resource efficiency.

- Current State: Waste management in Western Macedonia is evolving, with some recycling and waste processing facilities in place, but these efforts are limited in scope for bio-based transformations.
- Opportunities and Importance: With a circular economy approach, Western Macedonia could turn organic waste from agriculture, food processing, and households into valuable products like bioenergy, bioplastics, and compost.
- Actions: The blueprint should prioritize establishing infrastructure for biowaste collection, sorting, and processing, focusing on scalable technologies. Additionally, it could advocate for policies that encourage local industries to use bio-based products and support community-level composting initiatives.

1.5 CONTRIBUTORS TO THE DEVELOPMENT OF THE BIOECONOMY BLUEPRINT IN WESTERN MACEDONIA

In the framework of the BIOMODEL4REGIONS project (Grant Agreement ID: 101060476), CluBE - Bioeconomy and Environment Cluster of Western Macedonia played an important role in the development of blueprint for the bioeconomy in the region of Western Macedonia. CluBE has been centrally involved in the elaboration and formulation of strategies and guidelines related to the bioeconomy with the aim of enhancing sustainability and innovation in the region. CluBE developed tailored guidelines for key bio-based sectors (agriculture, forestry, waste management, etc.) to facilitate sustainable practices and ensure each sector's alignment with bioeconomy goals. For instance, guidelines for agriculture might emphasize crop diversification towards bio-based applications, while forestry guidelines focus on sustainable harvesting and residue management. CluBE also provided recommendations to local policymakers, aiming to establish supportive regulations for the bioeconomy. This includes incentives for sustainable practices and tax benefits for companies adopting bio-based processes, ensuring a conducive environment for bioeconomy growth.

In addition, the contribution of representatives from the university, local bio-based companies and regional and local authorities was crucial for the success of the project. Through their participation in the workshop held, the representatives provided valuable insights and suggestions that were incorporated into the development of the blueprints. In addition, the

interviews they conducted helped to understand local needs and perspectives, thus strengthening the overall project strategy.

The involvement of these stakeholders demonstrates the effectiveness of the collaborative approach and highlights the importance of involving all stakeholders in promoting the bioeconomy in the region.

2 BASELINE AND ANALYSIS OF LOCAL CONTEXT

2.1 LOCAL POLICY CONTEXT

Greece has no national bio-based economy strategy in place. The attempts to for the development of a dedicated strategy is linked to European programmes and projects (e.g. Horizon Europe). Greece will be developing a national strategy. The just transition and the just energy transition are important frameworks for Greece's bio-based economy. The National Renewable Action Plan (2010), and the National Energy and Climate Action Plan 2021-2030 do, however, link to the circular economy. Additionally, the Law 4414/2016 as the support scheme for renewable electricity in Greece outlining feed-in tariffs and market participation, plays a big role in the pilot region.

The main governmental body implementing bio-based economy policies is the Ministry of Environment and Energy (YPEN), which launched the 1st National Strategy for the Circular Economy in 2018 for public consultation. In addition, the Strategic Plan for the Development of Research, Technology, and Innovation under the National Strategic Reference Framework (NSRF) 2007-13 aims to restructure the Greek economy, gearing it towards high-value-added products and services, and achieve the transition to a knowledge-based economy and society. Bio-based economy in the Research & Innovation Strategy for Smart Specialization (RIS3) and Smart Specialisation Strategies (S3), is not clearly mentioned.

Western Macedonia is one of the Greek pioneers in developing the bio-based economy and has the chance to drive the discourse at the national level. Central Macedonia and Crete are the only Greek regions which have dedicated bio-based economy strategies in place. Moreover, Western Macedonia is co-leading the Smart Specialisation Strategies (S3) industrial modernisation partnership BERRY+ which identified the circular economy as a driver for economic development. Key sectors in Western Macedonia that are concerned with bio-based economy are at present forestry (managed by the Directorate of Forest), industry (Department of Industry), agriculture and livestock farming (Directorate of Rural Economy), urban waste (managed by municipalities and DIADYMA S.A.) and energy (Ministry of Energy and Environment). Therefore, strong cross-cutting dialogue and cooperation is necessary. At present, neither at national nor regional exist strategic decision-making initiatives on the bio-based economy, which means there is no structured governance on the bio-based economy in place, yet. However, CLuBE as a platform includes a steering committee. CLuBE as a cluster is fostering collaboration, e.g. fostering the transition to green hydrogen. B2B collaboration brings together a circular economy, a just green energy transition and bio-based economy. The B2B cooperation is in place and strong in specific sectors such as waste heat recovery and usage from biogas power plants. Biomass residues from biogas plants are used by farmers as fertilisers/soil amelioration. Bio-economy and Sustainable Growth Laboratory promote and support academic knowledge. They develop synergies with public and private companies, international organisations, multinational corporations, and consultancy firms involved in the bio-based economy sector

So far businesses drive the discourse around regional bio-based economies in Greece. While the bio-based economy could prove to be a growth motor for the regional economy, it also provides an opportunity to address the environmental challenges prevailing in the country, counteracting environmental degradation and health issues. Western Macedonia seeks to use the bio-based economy as one of the decisive factors and major pillars of the post-lignite era,

exhibiting major regional lignite deposits. The post-lignite strategy includes the re-skilling or reallocation of workforce (6 000 staff re-employment), with a focus on younger cohorts, among which the unemployment rate is already high. The main barrier to innovation is seen in limited funding opportunities, as well as a high level of bureaucracy and regulatory framework conditions that limit the regional roll-out of the bio-based economy.

Furthermore, the region of Western-Macedonia is one of the more active regions on biomass valorisation in Greece. Closing material loops for a more circular economy in the region, will make available more biomass waste for cascadic uses, including the residues from agricultural crops and livestock as an excellent feedstock for fuels and chemical production. However, there is a lack of awareness on the level of (national) political decision-makers and consumers concerning the environmental and societal potential of bio-based economy for the region

Regional universities are the main source of innovation. However, despite this, the start-up scene on bio-based is still weak in the region. The Regional Innovation Scoreboard labels Western Macedonia as an ‘emerging innovator’.

2.2 BASELINING GOVERNANCE MODEL AND IMPLEMENTATION ECOSYSTEM FOR THE BIO-BASED ECONOMY

The following chapter presents the results of analysis according to the governance framework developed by Jacobi, Hayder, and Connolly (2023), outlining a three-tiered framework consisting of basic governance functions (1st-tier), specific bio-based governance functions (2nd tier) and assessment criteria (3rd-tier). An indicator set of around 50 indicators was evaluated and benchmarked, following an intensive data collection process by the six Biomodel4Regions pilot regions and their cluster organizations. The data was then processed, cleaning-up errors and filling gaps with reasonable assumptions, to visualize results in the BERST Dashboard, developed by Wageningen Research.

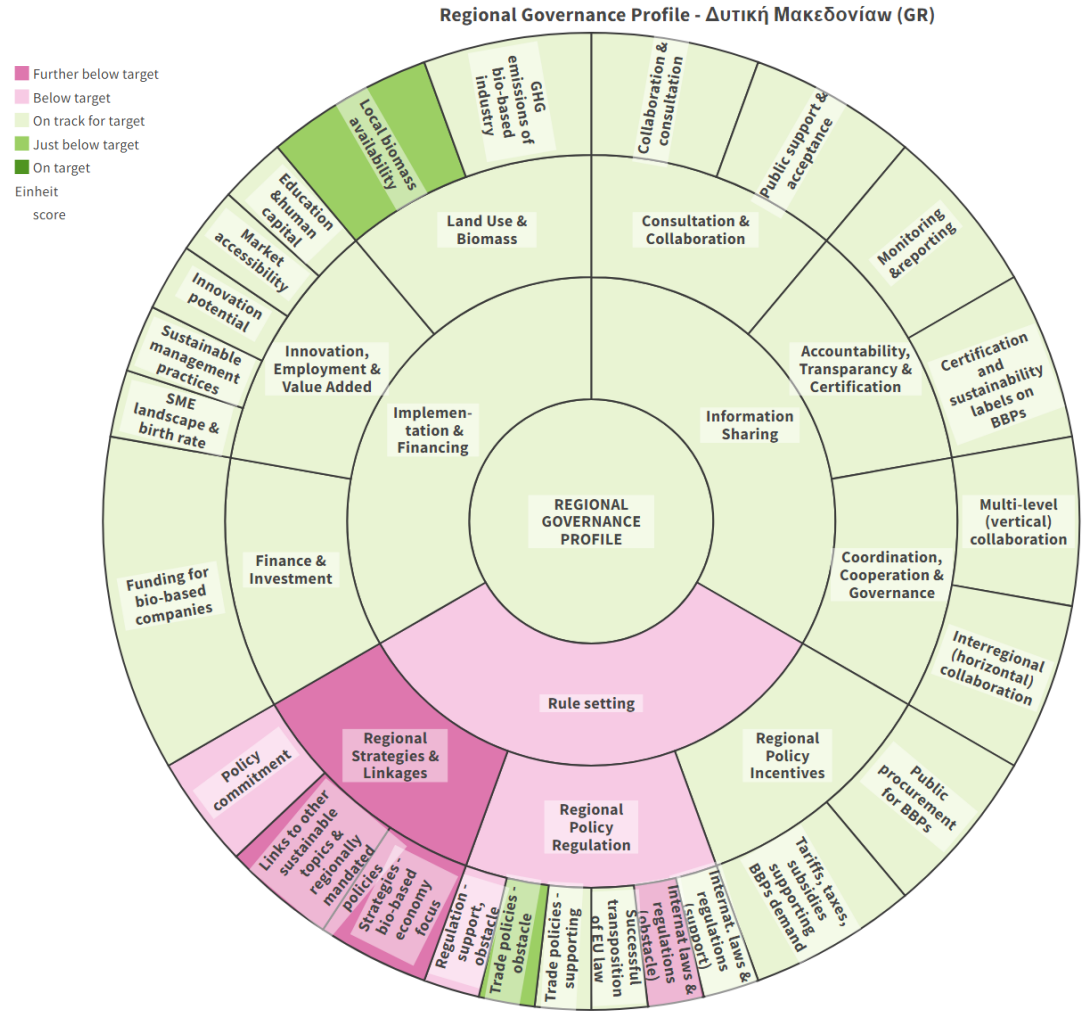


Figure 2.1: All-tier overview on assessment results for Western Macedonia (Source: BERST Dashboard)

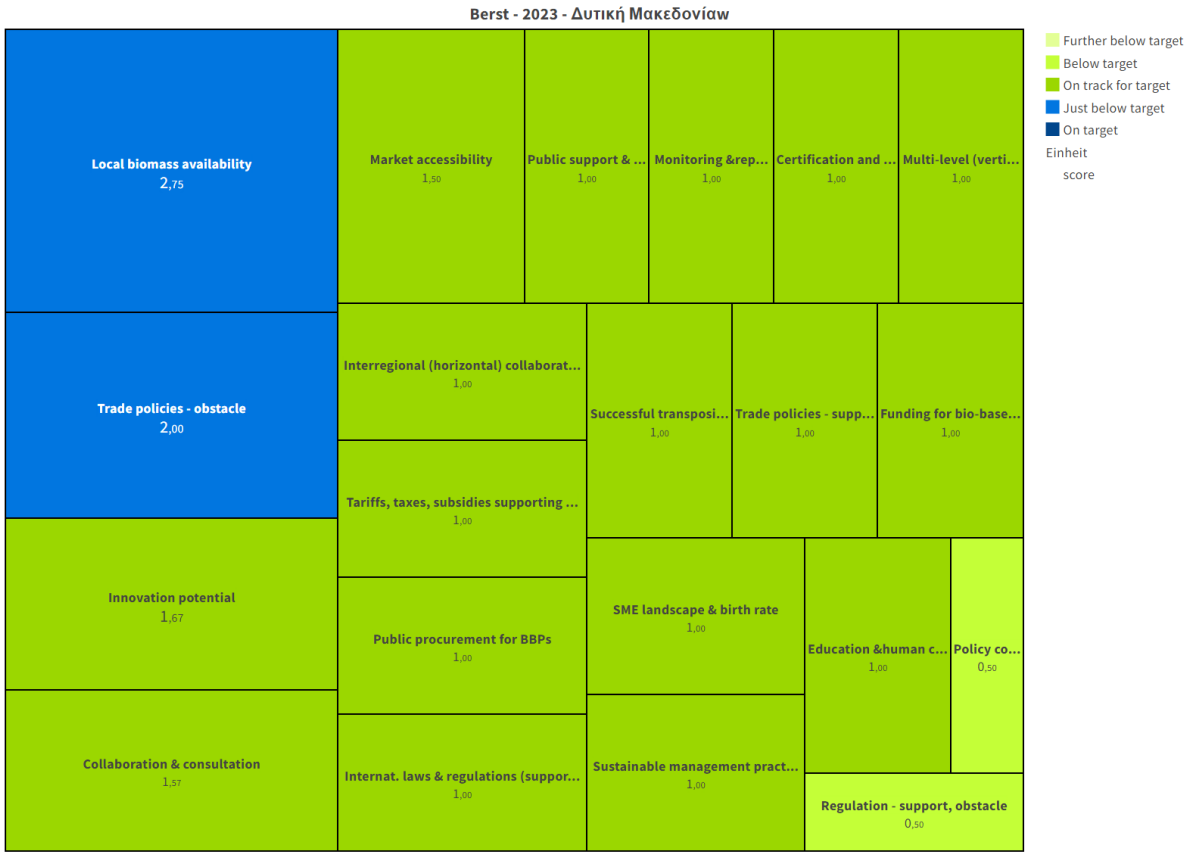
At an aggregate, 1st-tier level, the results reveal the strongest performance on implementation & finance followed by information-sharing. A lower performance can be observed in rule-setting, where also the biggest challenges for the bio-based governance in the Greek pilot regions appear to be grounded. In terms of implementation & finance, the assessment results suggest that the regional bio-based economy is characterised by robust value chains as well as developed and partly diversified bio-based market structures and substantial sectoral high-value added with an increasing workforce. Although funding and financing of bio-based economy appears to be non-sufficient, innovation potential and SME birthrate are on an upward trend. Similarly, market accessibility (i.e. level playing field for involved market actors) as well as sustainability practices (i.e. share of companies with sustainability credentials) have been evaluated at a medium/lower level, but still with view to the benchmark. There are prospective and sustainably managed land and water ecosystems in place to derive feedstock for the bio-based economy and land-use and sector conflicts are minimised (see Figure 2.1).

In the area of information-sharing, the assessment results suggest that the regional bio-based economy has some established structures for information sharing both vertically (between governance fields/government levels) and horizontally (between actor groups at regional level), including with the public – however exhibiting room for improvement on all criteria compared to the threshold. There is some bio-based industry collaboration. Furthermore,

labels for BBPs are used and applied for selected products and certification mechanisms are in place for some selected processes to stimulate and regulate bio-based markets. The regional government (and its institutions and agencies) have started on or are planning to develop reporting schemes to verify progress along a circular bio-based economy transition. None of the criteria in this field sticks out, suggesting a major challenge or a good practice, thus indicating a medium performance with room for improvement across all criteria.

Most challenges in terms of governance performance according to the assessment results can be found in rule-setting. Here, results for the 2nd tier criteria of regional policy incentives, suggest that public procurement is being used in some instances as lever to boost the bio-based development in the region. Furthermore, fiscal instruments such as tariffs, taxes and subsidies are being utilized in some instances, e.g. to favour the valorisation of biowaste. More challenging appears to be the area of regional policy regulation, where international (EU) regulation constitutes and obstacle to the successful roll-out of the bioeconomy in the region. Exceptions appear to be the transposition of EU law (as a bureaucratic process) and trade laws, which are perceived to work more in favour of bioeconomy deployment. The biggest challenge appears to be in regional strategies and linkages, where bioeconomy strategies with dedicated focus on the bioeconomy are the exception and where links between bioeconomy policy and other regionally mandated policy areas (e.g. climate change mitigation, regional economic development, education etc.) are missing, or are very weak. Likewise, there appears to be a lack in policy commitment, i.e. a lack leadership and continuity for the further development of the bioeconomy in the region.

Another, more detailed view on the assessment criteria of the evaluation (represented by tier 3) is provided by Figure 2.2 below.



Quelle: BIOMODEL4REGIONS project (Horizon)

Figure 2.2: overview on assessment criteria (tier 3) structured by scores for the Greek pilot (Source BERST Dashboard)

According to figure 3, the highest scoring criteria include:

- Local biomass availability (implementation & finance)
- Trade policies (rule-setting)
- Innovation potential (implementation & finance)

Assessment criteria, scoring slightly lower but still high enough not to be characterized as challenge, include:

- Innovation potential (implementation & finance)
- Collaboration and consultation (information-sharing)
- Market accessibility (implementation & finance)

Criteria scoring low, but with view towards benchmark include:

- Public support and acceptance (information-sharing)
- Monitoring and reporting schemes (information-sharing)
- Certification and sustainability labels (information-sharing)
- Multi-level governance (vertical) (information-sharing)
- Interregional (horizontal) collaboration (information-sharing)
- Policy commitment (rule-setting)
- Transposition of EU law (rule-setting)

- Funding for bio-based economy (implementation & finance)
- Tariffs, taxes, and subsidies supporting the bio-based economy (rule-setting)
- Public procurement for BBPs (rule-setting)
- Biobased SME rate and birthrate (implementation & finance)
- Education and human capital (implementation & finance)
- International laws and regulations supporting the biobased economy (rule-setting)
- Sustainable management practices (implementation & finance)

Least scoring areas and therefore biggest challenges according to the evaluation done, include:

- Policy commitment (rule-setting)
- Regulation (EU) (rule-setting)

3 TOWARDS A VISION FOR THE BIO-BASED ECONOMY IN WESTERN MACEDONIA

3.1 POLICY PRIORITIES

To develop a bioeconomy strategy for Western Macedonia, it's essential to emphasize several priorities. First and foremost, educating both producers and consumers on the benefits of the bio-based economy is crucial. This involves implementing robust communication strategies to enhance awareness and understanding of how bio-based products and practices contribute to sustainability and economic growth.

Improving green labelling systems is another critical priority. Establishing clear, reliable labels will help consumers easily identify and choose bio-based products. This not only promotes environmentally friendly choices but also encourages producers to adopt sustainable practices.

The strategy should incorporate comprehensive and measurable targets, particularly focusing on economic and environmental impacts. These targets should specify clear, quantifiable goals to monitor progress and ensure accountability. By emphasizing measurable outcomes, the strategy can drive significant improvements in both economic performance and environmental sustainability.

Introducing a governance model for the region's bio-based economy is also essential. This model should aim to streamline processes and minimize bureaucracy, facilitating easier engagement for businesses and stakeholders in bioeconomy activities. Simplifying administrative procedures will foster innovation and greater participation in the bioeconomy sector.

A key focus of the strategy should be on waste management and innovative valorisation options. This involves creating systems for effective waste collection, recycling, and conversion of waste into valuable products such as compost, bioenergy, and bio-based materials. Prioritizing waste management will not only reduce environmental impact but also generate new economic opportunities.

In summary, Western Macedonia's bioeconomy strategy should prioritize raising awareness about the bio-based economy, enhancing green labelling, setting comprehensive and measurable targets with an emphasis on economic and environmental impacts, proposing a governance model that reduces bureaucracy, and focusing on waste management and innovative valorisation options.

3.2 OUR VISION FOR A BIO-BASED ECONOMY IN WESTERN MACEDONIA

Western Macedonia envisions a sustainable bioeconomy driven by transparency, inclusivity, and innovation. A user-friendly governmental monitor will track eco-friendly production, supported by clear reward schemes. Long-term commitment and collaboration among all stakeholders are essential. Special IT education programs will empower the elderly to participate fully. This holistic approach ensures a prosperous and environmentally responsible future for all.

3.3 STRATEGIC & OPERATIONAL OBJECTIVES

The vision of Western Macedonia includes several key elements, each with specific strategic objectives and operational targets to ensure its successful implementation.

Transparency is a cornerstone of this vision. The region aims to establish open data platforms for real-time monitoring of eco-friendly production and ensure public access to environmental impact reports. Additionally, transparent communication channels between the government, businesses, and citizens will be developed. To achieve these objectives, an online governmental monitor will be launched by Q2 2030, bi-annual environmental impact assessments will be published, and a citizen feedback mechanism will be implemented by Q3 2029.

Inclusivity is another crucial element, promoting active involvement of all societal groups in the bioeconomy. The region aims to ensure equitable access to resources and benefits from eco-friendly initiatives, developing tailored programs to include marginalized communities. Operational targets include rolling out community engagement campaigns in all districts by Q1 2030, achieving 50% participation from underrepresented groups in bioeconomy projects by 2031, and launching specific support programs for women, youth, and the elderly by Q4 2029.

Innovation will be fostered through research and development in sustainable technologies, encouraging public-private partnerships, and providing incentives for startups and SMEs in the bioeconomy sector. An innovation hub will be established in Western Macedonia by Q3 2030, with funding for R&D projects increased by 30% annually over the next five years, and support extended to 100 new eco-friendly startups by 2031.

Promoting eco-friendly production is essential, with goals to implement sustainable agricultural and industrial practices, incentivize green production methods, and support the adoption of circular economy principles. By 2033, 40% of local farms will be converted to organic practices, industrial waste will be reduced by 50% by 2035, and key industries will achieve 75% recycling rates by 2032.

Clear and accessible reward schemes for eco-friendly practices will be designed, including tax benefits and grants for green initiatives, and recognition of eco-friendly achievements. A comprehensive reward program will be launched by Q2 2029, 500 grants will be awarded to eco-friendly projects by 2031, and tax incentives for green businesses will be implemented by Q1 2030.

Long-term commitment and collaboration among stakeholders will be built through strong partnerships among government, industry, academia, and civil society. Sustained funding and policy support for bioeconomy initiatives will be ensured, promoting a culture of continuous improvement and adaptation. Collaboration agreements with key stakeholders will be formalized by Q4 2029, multi-year funding commitments for major projects will be secured by 2030, and an annual bioeconomy summit will be established starting in 2029.

Finally, special IT education programs for the elderly will be developed to empower them to participate fully in the bioeconomy. These programs will facilitate access to technology and digital tools, encouraging the elderly to engage through digital platforms. IT education programs will be launched in community centres by Q1 2029, equipping 80% of elderly

participants with basic digital skills by 2030, and creating online platforms for elderly engagement in bioeconomy projects by Q3 2029.

By focusing on these strategic objectives and operational targets, Western Macedonia aims to build a sustainable bioeconomy that is transparent, inclusive, innovative, and environmentally responsible, ensuring long-term prosperity and engagement from all community members.

3.4 SUMMARY

The information in Subchapter 3.4 is primarily derived from the summaries discussed in the preceding sections.

Vision	Strategic objectives	Operational objectives
Transparency	Establish open data platforms for real-time monitoring of eco-friendly production.	Launch an online governmental monitor by Q2 2030.
	Develop transparent communication channels between government, businesses, and citizens.	Publish bi-annual (environmental) impact assessments.
		Implement a citizen feedback mechanism by Q3 2029.
Inclusivity	Promote active involvement of all societal groups in the bioeconomy.	Roll out community engagement campaigns in all districts by Q1 2030.
		Achieve 50% participation from underrepresented groups in bioeconomy projects by 2031.
		Launch specific support programs for women, youth, and elderly by Q4 2029.
Innovation	Provide incentives for startups and SMEs in the bioeconomy sector.	Establish an innovation hub in Western Macedonia by Q3 2028.
		Increase funding for R&D projects by 30% annually over the next five years.
		Support 100 new eco-friendly spin-offs by 2031.
Eco-Friendly Production	Support the adoption of circular economy principles.	Convert 40% of local farms to organic practices by 2033.
		Reduce domestic waste by 50% by 2030.
		Achieve 75% recycling rates in key industries by 2032.
Reward Schemes	Design clear and accessible reward schemes for eco-friendly practices.	Launch a comprehensive reward program by Q2 2029 Award 500 grants to eco-friendly projects by 2031.
		Implement tax incentives for green businesses by Q1 2030.
Long-Term Commitment and Collaboration	Build strong partnerships among government, industry, academia, and civil society.	Formalize collaboration agreements with key stakeholders by Q4 2029.

Vision	Strategic objectives	Operational objectives
	Ensure sustained funding and policy support for bioeconomy initiatives.	Secure multi-year funding commitments for major projects by 2030.
		Establish an annual bioeconomy summit starting in 2029.
IT Education Programs for the Elderly	Facilitate access to technology and digital tools.	Launch IT education programs in community centers by Q1 2029.
		Equip 80% of elderly participants with basic digital skills by 2030.
		Create online platforms for elderly engagement in bioeconomy projects by Q3 2029.

4 KEY ACTION FIELDS FOR IMPLEMENTATION

4.1 IMPROVING BIO-BASED BUSINESS MODELS IN WESTERN MACEDONIA

Western Macedonia's bio-based economy is gradually evolving, driven by the need for sustainable practices in agriculture, waste management, and various industrial sectors. The country's favourable climate and rising public awareness about environmental issues create a supportive foundation for growth in bio-based industries. However, significant challenges remain, including economic constraints, technological gaps, and regulatory complexities. A range of organizations are actively working to overcome these barriers through initiatives in sustainable forestry, organic farming, and waste management. Table one outlines the main drivers and barriers for adoption, which are further discussed in detail.

Adoption factors		
	Barriers	Drivers
Political/ institutional	-	Increased public awareness recycling
Economic	Lack of financial resources	Subsidies from EU
Social	Fluctuations in demand	Increased demand organic products
Technological	Lack of appropriate tech solutions	-
Legal	Lack of clear legislations	Promoting recycling
Environmental	Lengthy procedures	Favorable climate
Supply chain		New market openness
Organisational	Lack of strong market for recycled products	Certifications

Key Drivers

One key driver is the increasing public awareness of recycling and environmental sustainability, which is encouraging community participation in bio-based initiatives. Public engagement through educational outreach has notably boosted interest in recycling programs, opening markets for recycled products, although this market remains relatively underdeveloped.

Economic factors, particularly EU subsidies, play a crucial role in supporting bio-based activities. These financial supports help sustain cooperative models, particularly in agriculture, by funding initiatives in organic farming and enabling investments in new technologies and infrastructure. Additionally, these subsidies support training programs that educate farmers in modern and sustainable practices, which can help improve productivity.

Greece’s favorable climate also serves as a key environmental driver, supporting the production of high-quality organic and sustainable products. This climate advantage is particularly beneficial for forestry and agriculture, helping meet both domestic and international demand for sustainable materials, such as biomass, which aligns with the global focus on renewable energy.

Barriers and Challenges

Despite these drivers, Western Macedonia's bio-based sector faces several substantial obstacles. Economic challenges, especially limited financial resources, constrain the ability of organizations to invest in modernizing facilities and adopting new technologies. Although subsidies provide some relief, they are often insufficient to cover all necessary investments, limiting the scale and impact of bio-based initiatives.

Technological barriers also limit growth, as organizations struggle with access to advanced, locally adapted technologies. This technological lag reduces operational efficiency and affects the sector's ability to expand and meet growing demand for sustainable solutions.

Legal and regulatory hurdles further complicate the landscape, as companies often face lengthy and costly procedures to obtain necessary permits and certifications. This creates uncertainty, making it difficult for companies to plan and invest in long-term growth, especially when competing with larger international players who may have easier access to global markets.

	Positive consequences	Negative consequences
Social	Educational outreach and supporting local events/initiatives	Working conditions and health effects
Environmental	Enriching/valorizing soil and reduced dependence on fossil fuels	Energy consumption in sourcing process
Financial	Cooperation with local businesses for supplies, guaranteed market for farmers	Small business may exit the market, dependence on local communities for jobs.

Social Impact

The bio-based sector in Western Macedonia significantly impacts communities, especially in terms of educational outreach and job creation. Initiatives promoting recycling and sustainable practices help raise public awareness about environmental protection. Additionally, bio-based cooperatives contribute to local economies by providing stable employment opportunities, particularly in rural areas with limited job options. However, there are challenges related to working conditions, particularly during peak seasons when workloads and associated health risks increase. Educational programs and sustainability policies further enhance community engagement, though there remain environmental risks, such as air quality impacts, associated with certain bio-based processes.

Environmental Impact

The bio-based sector in Western Macedonia offers both environmental benefits and challenges. Organizations that source materials sustainably help preserve biodiversity and contribute to the long-term viability of natural resources. Sustainable forestry practices, for example, support circular economy goals and reduce reliance on non-renewable resources. However, challenges such as high energy consumption in production processes add to the sector's carbon footprint, underscoring the need for energy-efficient innovations.

Waste management initiatives within the sector have shown success in producing high-quality compost and generating renewable energy from organic waste, which enriches soil and reduces dependence on fossil fuels. Nonetheless, energy demands for these processes remain high, suggesting room for improvement in energy efficiency.

Economic Impact

The economic potential of Western Macedonia's bio-based sector is promising, especially with growing global demand for sustainable products. Organic and sustainable food markets are benefiting from increased consumer awareness, creating new opportunities for growth. Access to EU funding helps underpin cooperative stability and growth, while training programs boost productivity through sustainable farming practices. However, financial, and technological barriers still limit the sector's capacity to scale.

In terms of export potential, there is significant opportunity for expanding markets, particularly for sustainable materials where demand is rising. Certification and adherence to environmental standards enhance competitiveness but also add regulatory and logistical challenges. Expanding waste management and sustainability initiatives can attract investment and improve market reach, although technological and regulatory barriers still need to be addressed.

Overall, these drivers and barriers shape the development of Western Macedonia's bio-based economy, impacting its social, environmental, and economic contributions to the region.

4.2 ACTIONS / INTERVENTIONS

The actions presented to achieve the operational objectives include a detailed extension of the logical framework (log-frame) initially outlined in Chapter 3. This extension encompasses several critical components: the identification of the necessary activities required to meet the objectives, the assignment of specific responsibilities to relevant team members or departments, and the setting of precise timetables and milestones. These elements are essential to ensure the effective implementation and continuous monitoring of the objectives, thereby facilitating the achievement of the desired outcomes within the stipulated timeframes and resource constraints.

Vision	Strategic objectives	Operational objectives	Activity
Transparency	Establish open data platforms for real-time monitoring of eco-friendly production.	Launch an online governmental monitor by Q2 2030.	Create a control group in an authority (municipality or region) to set up the platform.
			Conduct a comprehensive needs assessment to determine the requirements for the open data platform.
			Develop a detailed project plan outlining key milestones, timelines, and resource allocation.
			Implement robust security measures to

Vision	Strategic objectives	Operational objectives	Activity
			protect data integrity and privacy.
			Organize a launch event to showcase the platform's features and benefits.
			Develop training materials and conduct training sessions for government staff and other users of the platform.
	Develop transparent communication channels between government, businesses, and citizens.	Publish bi-annual (environmental, economic) impact assessments.	Establish protocols for collecting (environmental, economic) data from various sources, including government agencies, businesses, and environmental monitoring systems.
			Analyse the collected data to assess (environmental, economic) impact, focusing on key indicators
			Conduct internal reviews and validation processes to ensure the accuracy and reliability of the reports.
		Implement a citizen feedback mechanism by Q3 2029.	Design a user-friendly feedback system that allows citizens to submit comments, suggestions, and concerns about environmental issues.
			Implement a comprehensive communication strategy to inform citizens about the new feedback system and how to use it.
			Regularly report on the feedback received and actions taken in response to citizen input, fostering transparency and accountability.
			An annual consultation for information and participation of citizens will be organised by

Vision	Strategic objectives	Operational objectives	Activity
			the Regional Union of Municipalities of Western Macedonia.
Inclusivity	Promote active involvement of all societal groups in the bioeconomy.	Roll out community engagement campaigns in all districts by Q1 2030.	Develop multilingual and culturally sensitive communication materials to reach diverse audiences effectively.
			Develop an engagement strategy tailored to each group's needs and preferences, ensuring inclusivity in campaign planning.
			Organize community workshops, seminars, and town hall meetings to educate and involve local residents in bioeconomy initiatives.
			Collaborate with local leaders, community organizations, and influencers to maximize participation and engagement.
		Achieve 50% participation from underrepresented groups in bioeconomy projects by 2031.	Implement training programs and workshops aimed at enhancing the skills and knowledge of underrepresented groups in bioeconomy-related fields.
		Launch specific support programs for women, youth, and elderly by Q4 2029.	Organize launch events, workshops, and informational sessions to introduce the programs to the target groups and stakeholders.
Innovation	Provide incentives for startups and SMEs in the bioeconomy sector.	Establish an innovation hub in Western Macedonia by Q3 2028.	Develop a detailed plan for the innovation hub, outlining its objectives, target audience, services offered, and operational structure.
			Determine the physical location for the hub, considering accessibility, infrastructure, and proximity to relevant stakeholders.

Vision	Strategic objectives	Operational objectives	Activity
			Develop mentorship programs, business development support, and access to funding opportunities to nurture growth and sustainability.
		Increase funding for R&D projects by 30% annually over the next five years.	Develop new policies or revise existing ones to streamline the application process and enhance accessibility to funding.
			Collaborate with University of Western Macedonia and industry partners to identify priority areas for investment and collaboration.
		Support 100 new eco-friendly spin offs by 2031.	Provide tailored support services such as business development assistance, access to specialized facilities, and mentorship to facilitate the establishment and growth of eco-friendly spin-offs.
Eco-Friendly Production	Support the adoption of circular economy principles.	Convert 40% of local farms to organic practices by 2033.	Launch educational programs and awareness campaigns targeting local farmers about the benefits of organic farming practices.
			Provide training workshops, webinars, and field demonstrations on organic farming techniques and sustainable agriculture.
			Recognize and reward farmers who successfully transition to organic practices and demonstrate leadership in sustainable agriculture.
		Reduce domestic waste by 50% by 2030.	Launch public awareness campaigns with DIADYMA SA to

Vision	Strategic objectives	Operational objectives	Activity
			educate households about waste reduction, segregation, and recycling practices.
			Invest in waste management infrastructure, including recycling facilities, composting plants, and material recovery facilities (MRFs), to support waste reduction and recycling initiatives.
		Achieve 75% recycling rates in key industries by 2032.	Establish baseline recycling rates and identify priority sectors for intervention.
			Provide technical assistance, training programs, and workshops to industry stakeholders on best practices for waste segregation, collection, and recycling.
Reward Schemes	Design clear and accessible reward schemes for eco-friendly practices.	Launch a comprehensive reward program by Q2 2029 Award 500 grants to eco-friendly projects by 2031.	Launch a promotional campaign to raise awareness about the reward program and encourage participation from target audiences.
			Utilize various communication channels including social media, press releases, and outreach events to reach a wide audience.
		Implement tax incentives for green businesses by Q1 2030.	Draft legislation or amendments to existing tax laws to incorporate incentives for eco-friendly practices and investments.
Long-Term Commitment and Collaboration	Build strong partnerships among government, industry, academia, and civil society.	Formalize collaboration agreements with key stakeholders by Q4 2029.	Identify and map key stakeholders from government agencies, industry associations, academic institutions, and civil society organizations involved in or impacted by initiatives related to the strategic objective.

Vision	Strategic objectives	Operational objectives	Activity
			Conduct initial meetings and discussions to understand their roles, interests, and potential contributions to collaborative efforts.
			Foster a shared understanding of sustainability principles, innovation strategies, and best practices through workshops, seminars, and knowledge-sharing sessions.
	Ensure sustained funding and policy support for bioeconomy initiatives.	Secure multi-year funding commitments for major projects by 2030.	Prioritize projects based on their potential impact, alignment with strategic goals, and feasibility.
			Draft funding agreements or memoranda of understanding (MoUs) that outline terms, conditions, and mutual commitments.
		Establish an annual bioeconomy summit starting in 2029.	Engage with potential sponsors, partners, and supporting organizations to secure financial and in-kind support for the summit.
			Invite renowned experts, thought leaders, and practitioners to contribute their insights and expertise to the summit.
IT Education Programs for the Elderly	Facilitate access to technology and digital tools.	Launch IT education programs in community centres by Q1 2029.	Develop comprehensive curriculum modules and training materials that are age-appropriate, user-friendly, and accessible for elderly learners.
			Recruit skilled instructors or volunteers with experience in teaching digital literacy to seniors.

Vision	Strategic objectives	Operational objectives	Activity
			Conduct periodic assessments and feedback sessions to evaluate the effectiveness of teaching methods, curriculum content, and overall program satisfaction among elderly learners.
		Equip 80% of elderly participants with basic digital skills by 2030.	Track the digital skills development of elderly participants through regular assessments and skills-based evaluations.
			Provide incentives such as certificates of completion, digital badges, or participation awards to motivate continued learning and skill development.
			Conduct outreach activities and promotional campaigns to raise awareness about the benefits of digital literacy and encourage more elderly individuals to participate in the programs.
			Collaborate with healthcare providers, tech companies, and community organizations to deliver specialized training sessions tailored to the needs and interests of elderly learners.
		Create online platforms for elderly engagement in bioeconomy projects by Q3 2029.	Incorporate accessibility features such as larger fonts, intuitive navigation, and audiovisual aids to enhance usability for elderly participants.
			Offer ongoing technical support and assistance to address any challenges or questions elderly participants may

Vision	Strategic objectives	Operational objectives	Activity
			encounter while using the platforms.

5 MONITORING, EVALUATION AND LEARNING

Effective monitoring, evaluation, and learning (MEL) are essential components of the strategy to implement and promote the bio-based economy in the Western Macedonia region. This chapter outlines the framework and methods used to assess progress, measure impact, and continuously improve our initiatives.

MEL framework integrates quantitative and qualitative methods to provide a comprehensive assessment of bio-based economy initiatives. It defines Key Performance Indicators (KPIs) aligned to each operational objective to measure progress and results. Regular data collection processes are implemented through surveys, interviews, data analysis and performance reporting. Rigorous data analysis is conducted to interpret trends, identify challenges, and capitalise on opportunities for improvement. Findings and recommendations are communicated to stakeholders, policy makers and the public through structured reports, dashboards, and presentations. Evidence from evaluations is used to refine strategies, adapt interventions, and optimise resource allocation for greater impact and sustainability.

Through careful monitoring, rigorous evaluation and continuous learning, the Blueprints are committed to achieving the vision of a thriving bio-based economy. Leveraging insights from the MEL framework, they aim to foster innovation, promote sustainable practices, and drive inclusive growth for current and future generations.

6 OUTLOOK

For the development and implementation of the bio-economy strategy in the Western Macedonia region, several planned steps will guide efforts to ensure sustainable development and innovation. This section outlines the next steps, key open questions, issues, and research needs that will shape the future of the bio-based economy in the region.

6.1 PLANNED NEXT STEPS

Expansion of Stakeholder Engagement: CluBE will broaden engagement efforts to include more stakeholders from various sectors, including industry, academia, and civil society. This will involve organizing additional workshops, focus groups, and public consultations to gather diverse perspectives and foster collaborative partnerships. CluBE's approach will focus on seven core areas, each with targeted goals, specific activities, and set timelines to ensure cohesive execution and inclusive stakeholder involvement. These areas include enhancing inclusivity, fostering innovation, promoting eco-friendly practices, establishing reward programs, strengthening partnerships, and improving digital literacy, particularly for elderly participants. The detailed plan will designate clear tasks, assign roles and responsibilities, and outline resource needs – ranging from technical support and funding allocations to timeline management – to guarantee a structured and transparent implementation process. By integrating these structured activities with practical operational goals, we will cultivate a bioeconomy that is sustainable, inclusive, and responsive to the evolving needs of Western Macedonia's communities and industries.

Strengthening Research and Development (R&D): To strengthen R&D in the bioeconomy sector of Western Macedonia, a strategic, multi-faceted approach will be implemented. The strategy emphasizes a substantial increase in funding to encourage innovation, as well as the establishment of dedicated support structures like innovation hubs, which will act as incubators for startups and SMEs. These efforts will be underpinned by collaborative partnerships with key institutions, particularly the University of Western Macedonia and CERTH, which will play a critical role in fostering research and facilitating knowledge exchange.

The initiative will establish clear objectives and deliverables across core areas, including transparency, inclusivity, eco-friendly production practices, reward schemes, long-term partnerships, and digital literacy programs tailored for elderly community members. The implementation plan will detail tasks, assign roles and responsibilities, set deadlines, and outline resource requirements to ensure efficient execution.

For each objective, practical tasks will be clearly outlined, specifying responsibilities such as research and policy planning, operational oversight, stakeholder coordination, and monitoring. Each task will have a set timeline to guide the project phases and ensure accountability. Resources required for each task, including funding allocations, personnel, technological infrastructure, and any necessary logistical support, will be itemized to support structured implementation and track progress effectively. This detailed approach will be crucial for building a sustainable bioeconomy that aligns with regional goals, engages diverse stakeholders, and supports continuous R&D growth in Western Macedonia.

Policy and Regulatory Framework Development: Local authorities will work on refining and expanding the policy and regulatory framework to support the bio-based economy. This includes developing new regulations that incentivize sustainable practices, as well as reviewing existing policies to ensure they align with our strategic objectives.

The development of a robust policy and regulatory framework for the bio-based economy in Western Macedonia will proceed through a structured approach to ensure actionable steps, clear responsibilities, deadlines, and the necessary resources. The main objective of this framework is to create a policy environment that incentivizes sustainable bio-based practices and aligns with long-term bioeconomy goals. To begin, a Policy Development Task Force will be established to oversee the entire process, comprising representatives from government, industry, academia, and civil society. This team will include a project leader responsible for regulatory oversight, legal experts to manage drafting and reviews, and industry representatives who will contribute insights into practical needs. The deadline for setting up this task force is the first quarter of 2026, with resources allocated for consulting fees, meeting logistics, and administrative support. Following the task force setup, a comprehensive needs assessment and policy gap analysis will be conducted. This analysis will identify existing gaps and regulatory barriers that may hinder bio-based initiatives. To accomplish this, input will be gathered from stakeholders through surveys and workshops, while benchmarking will be done against policies in leading bioeconomy regions. This task, expected to conclude by the second quarter of 2026, will require a dedicated research budget, resources for stakeholder engagement, and access to policy databases.

Infrastructure Development: Investments will be made in the necessary infrastructure to support bio-based industries. Investments will be made in the necessary infrastructure to support bio-based industries. Infrastructure development is central to supporting the growth of bio-based industries in Western Macedonia. By investing in logistics, waste management, and renewable energy facilities, the strategy ensures that bio-based businesses will have the essential resources required for sustainable growth and long-term resilience.

The approach will prioritize upgrades in logistics networks to facilitate efficient material transport and distribution for bio-based enterprises, minimizing both time and cost. Waste management systems will be enhanced to support circular economy principles, including the establishment of specialized facilities for recycling and waste-to-energy processes. Renewable energy infrastructure, such as biomass, solar, and wind energy, will be expanded to reduce reliance on non-renewable sources and promote eco-friendly power solutions across the region.

This infrastructure development plan will include detailed tasks, clear roles and responsibilities, timelines, and resource allocation to guide the process effectively. Specific activities will involve forming partnerships with regional authorities and industry experts to oversee logistics improvements, creating a task force responsible for the waste management enhancements, and collaborating with energy companies to secure renewable energy solutions. The plan will also incorporate performance milestones, regular assessments, and adjustments based on stakeholder feedback to keep development aligned with the needs of the bioeconomy sector. By establishing a robust infrastructure foundation, this initiative will

enable bio-based industries to flourish sustainably and contribute to the region's overall economic and environmental goals.

Monitoring and Evaluation System Enhancement: Enhancing the monitoring and evaluation (M&E) system is essential for tracking the bioeconomy strategy's progress in Western Macedonia and ensuring accountability and adaptability. To achieve this, the refined M&E framework will introduce advanced data collection tools, data analysis mechanisms, and stronger feedback loops between evaluation findings and strategic planning adjustments. These enhancements will provide clear, actionable insights, allowing for timely updates to the strategy as needed.

Key tasks will involve selecting and implementing advanced digital tools for data collection, which will enable real-time tracking of key performance indicators (KPIs) across bio-based projects. This will include integrating software that captures both qualitative and quantitative data from various sources, such as environmental metrics, project milestones, and stakeholder feedback. Additionally, local and regional authorities will establish a comprehensive database that allows for easy analysis, reporting, and visualization of progress data. Dedicated teams will be assigned to manage different aspects of the M&E process: data specialists will handle data collection and entry, analysts will interpret findings, and project managers will oversee the regular reporting and feedback mechanisms.

Roles and responsibilities will be clearly defined, with project managers accountable for progress reviews and data specialists for data integrity audits. Deadlines will be structured to align with major strategic milestones, ensuring that the M&E framework consistently informs decision-making and allows for course corrections as necessary. Resources needed for this enhancement include the procurement of data software, training sessions for team members on data collection tools, and dedicated funds for hiring external evaluation experts to support system optimization periodically.

Regular feedback sessions will involve all relevant stakeholders, from local government officials and project leaders to community representatives, creating a dynamic evaluation ecosystem. This continuous improvement approach will ensure that M&E not only tracks performance effectively but also remains responsive to emerging challenges and opportunities in the bioeconomy strategy's implementation, fostering long-term success and resilience.

6.2 KEY OPEN QUESTIONS AND ISSUES

1. **Balancing Economic Growth with Environmental Sustainability**: How can we ensure that the bio-based economy contributes to economic growth without compromising environmental sustainability? This question will require ongoing research and the development of best practices.

2. **Ensuring Inclusivity in the Bioeconomy**: What measures can be taken to ensure that all societal groups, particularly underrepresented communities, benefit from the bio-based economy? This issue will be a focus of our stakeholder engagement and policy development efforts.

3. **Adapting to Technological Changes**: How can we stay ahead of rapid technological advancements in the bioeconomy sector? This will require continuous investment in R&D and a commitment to adopting new technologies as they emerge.

4. **Long-Term Funding and Investment**: How can we secure sustained funding and attract long-term investment in bio-based initiatives? This remains a critical issue that will need to be addressed through both public and private sector collaboration.

5. **Public Awareness and Education**: How can we effectively raise public awareness and understanding of the bio-based economy? Ensuring that citizens are informed and engaged will be crucial for the success of our strategy.

7 Research Needs

1. **Sustainable Agricultural Practices**: Further research is needed to optimize sustainable agricultural practices that align with bio-based production, particularly in the context of local climate conditions and soil types in Western Macedonia.

2. **Lifecycle Analysis of Bio-Based Products**: Comprehensive lifecycle analyses of bio-based products are necessary to fully understand their environmental impacts and benefits compared to traditional products.

3. **Economic Impact Studies**: Studies that quantify the economic impacts of bio-based initiatives on regional economies will be important for justifying continued investment and support.

4. **Social Impacts of Bio-Based Economy**: Research is needed to understand the social implications of the bio-based economy, including job creation, skill requirements, and community benefits.

5. **Circular Economy Models**: Investigating effective circular economy models that can be adapted to the specific needs and conditions of the Western Macedonia region will be a key area of focus.

6.3 TIMELINE

The timeline will guide Western Macedonia's development of a transparent, inclusive, and innovative bioeconomy, leveraging technology, fostering collaboration, and driving eco-friendly production practices for long-term sustainability.

2027 - 2029: Expansion of stakeholder engagement, strengthening of R&D efforts, and the initial development of new policies and regulations.

- Launch of IT education programs in community centers, focusing on empowering elderly participants with digital skills.
- Rollout of community engagement campaigns across all districts, fostering inclusivity and awareness.
- Launch a comprehensive reward program with grants and incentives for eco-friendly practices, supporting sustainable projects and innovations.

- Establish a citizen feedback mechanism, promoting transparent communication and active public involvement in bioeconomy initiatives.
- Create accessible online platforms for elderly engagement in bioeconomy projects.
- Formalize collaboration agreements with key stakeholders, including government, industry, academia, and civil society.
- Launch specific support programs for women, youth, and the elderly, ensuring equitable participation in the bioeconomy sector.

2029 onwards:

Annual bioeconomy summit, starting in 2029, fostering ongoing stakeholder collaboration and knowledge-sharing.

2030 – 2032: Focus on infrastructure development, continued policy refinement, and the implementation of new monitoring and evaluation tools.

- Implement tax incentives for green businesses, encouraging eco-friendly investments and practices.
- Establish an online governmental monitoring platform for real-time tracking of eco-friendly production and public access to environmental impact data.
- Set up an innovation hub to support bioeconomy startups and SMEs, encouraging research and development in sustainable technologies.
- Achieve 50% participation from underrepresented groups in bioeconomy projects, ensuring broad inclusivity across societal groups.
- Reach a 75% recycling rate in key industries, integrating circular economy principles into industrial practices.

2033 – 2035: Further research initiatives, refinement of sustainable practices, and the scaling of successful bio-based models across the region.

- Convert 40% of local farms to organic practices, advancing sustainable agriculture within the region.
- Industrial waste will be reduced by 50% by 2035.