ShapingBio

The bioeconomy of the future

D4.1 Policy and stakeholder recommendations

Submitted version

Report awaits European Commission approval

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List of Abbreviations

Abbreviation	Full name
AI	Artificial Intelligence
BE	Bioeconomy
BIC	Bio-based Industries Consortium
CBE JU	Circular Bio-based Europe Joint Undertaking
CEE countries	Central and Eastern European countries
CSA	Coordination and Support Action
CSC	cross-sectoral collaboration
ECBF	European Circular Bioeconomy Fund
EC	European Commission
EIC	European Innovation Council
EIT	European Institute of Innovation & Technology
ERRIN	European Regions Research and Innovation Network
EU	European Union
GPP	Green Public Procurement
HE	Horizon Europe
HEI	Higher Education Institution
IPCEI	Important Projects of Common European Interest
IS	Innovation System
JRC	Joint Research Centre
k€	1000 Euro
LCA	Life Cycle Assessment
Mio	Million, 10^6
MS	Member States
NCP	National Contact Point
OECD	Economic Cooperation and Development
PDI	Pilot and Demonstration Infrastructures
PPP	Public-Private Partnership
R&D, R&D&I	Research and Development, Research and Development and Innovation
SMEs	Small and Medium-sized Enterprises
TRL	Technology Readiness Level
TTO	Technology Transfer Office

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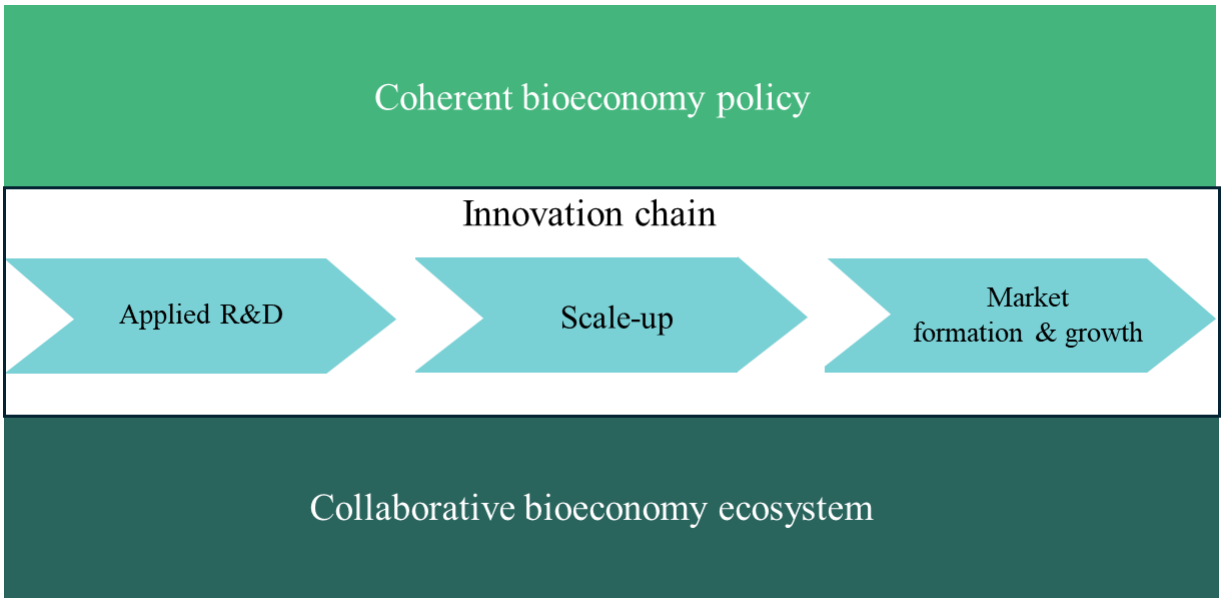
Executive Summary

The **ShapingBio project**, funded by Horizon Europe, aims to enhance the EU bioeconomy innovation ecosystem by providing recommendations for a more coherent and globally competitive bioeconomy across the European Union. It seeks to address fragmentation and encourage stakeholder engagement while promoting cross-sectoral innovation. The project identifies measures that EU institutions, EU Member States, and other stakeholders should take to strengthen innovation ecosystems within the bioeconomy.

The ShapingBio recommendations are organized into five areas, of which three cover the innovation chain of bio-based products, processes and services from the R&D to commercialization stage.



The following recommendations have been identified. They are described in more detail in the report.

Coherent Bioeconomy Policy

A coherent bioeconomy policy is essential for guiding the transition from a fossil-based economy to a sustainable bio-based circular economy. This requires:

- Convincing high-level key decision-makers in the quintuple helix of the importance and relevance of bioeconomy
- Making bioeconomy more generally known
- Developing a shared understanding of the holistic bioeconomy concept as basis for bioeconomy policy
- Developing a dedicated holistic and coherent bioeconomy policy in all EU Member States and more regions
- Shifting the focus from bioeconomy strategies to effective and efficient implementation of the policies

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- Intensifying and improving the coordination within bioeconomy policies between the relevant quintuple helix stakeholders and between bioeconomy policy and related policy fields
- Anticipating and addressing regulatory and administrative hurdles early which may later hinder progress in the scale-up and commercialisation stage

Applied Research and Development

In the EU, applied R&D activities in bioeconomy are significantly supported by public funding. However, the analysis in ShapingBio reveals that improvements in the applied R&D funding landscape are needed.. Recommendations comprise

- All Member States should have a comprehensive and coherent funding portfolio
- All Member States funding organisations should critically assess their funding conditions whether they are suitable for the target groups (e.g. academia, SMEs, primary producers, cross-sectoral or cross-border collaboration), whether they take the specificities of applied R&D in bioeconomy sufficiently into account and should eventually amend the funding conditions
- Continuing efforts to effectively provide targeted information on funding opportunities
- Continuing efforts to simplify and harmonize application processes and to reduce administrative burden for applicants and grant holders both on EU and national levels
- Encouraging collaboration between academia and industry to enhance knowledge and technology transfer and drive innovation
- Createing more favourable conditions for academics from natural and engineering sciences as well as social sciences and humanities in bioeconomy-related inter- and transdisciplinary research and for academia-industry collaboration

Scale-up and Deployment

To overcome hurdles in scaling innovations from research to market readiness (often referred to as the "valley of death"), the following recommendations are given:

- Raising awareness about the existing European scale-up infrastructure asset
- Keeping scale-up infrastructures state-of-the-art, co-fund the scale-up phase of bioeconomy innovators and support cross-border use and collaboration of pilot and demonstration infrastructures (PDIs)
- Ensuring continuous funding possibilities throughout the innovation chain
- Establishing more public-private partnerships (PPPs) activities and establish Important Projects of Common European Interest (IPCEI) activities in bioeconomy
- Enhancing tailored support for start-ups / companies along their development journey by Member States, but also private investors
- Continuing and expanding public equity schemes with relevance to the bioeconomy

Market Formation and Growth

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Demand-side policies are vital for fostering market adoption of bio-based products. The report recommends:

- Strengthening implementation of economic instruments for demand-side policies on EU and Member States levels
- Implementing a coherent policy mix for bio-based products which strengthens bio-based segments while disincentivizing fossil-based alternatives. A single instrument will not suffice
- Designing the policy mix and respective instruments based on a clear strategy which either prioritizes selected biomass use pathways or defines steering criteria (e.g. product characteristics, certain environmental impacts)
- Promoting synergies with other strategic activities (e.g. circular economy, public procurement policy)

Collaborative Bioeconomy Ecosystem

Collaboration among diverse stakeholders and across sectors is essential for unlocking the full potential of the bioeconomy. Recommendations include:

- Strengthening the role of SMEs, which are crucial for innovation and adaptability within the bioeconomy
- Promoting partnerships between research institutions, industry, and policymakers to foster cross-sectoral collaboration
- Aligning services offered by intermediaries and collaborative platforms to actors needs

1. Introduction

Global challenges such as population growth, climate change, loss of biodiversity and transgression of planetary boundaries increase the urgent need for a transition towards more sustainable production processes, products, services in all sectors of economy, as well as more sustainable consumption and lifestyles. The recent Covid-19 pandemic, the ongoing conflict in Ukraine, unstable political situations globally, and recent distortions in the global trade system through tariffs collectively exacerbated these challenges, exposed EU`s vulnerabilities and emphasized the urgent need for enhanced resilience.

It is widely recognised that the bioeconomy holds significant potential to address these challenges. This is highlighted in international initiatives such as the Global Bioeconomy Summit in 2024 in Nairobi, Kenya (IACGB 2024), the G20 Initiative on Bioeconomy which adopted 10 High-Level Principles on Bioeconomy (GIB 2024) under the Brazil's Presidency and is continued under South Africa's Presidency of the G20 and the FAO's initiative to establish a global partnership on Bioeconomy for Sustainable Food and Agriculture, supported by the Global Forum for Food and Agriculture (GFFA) 2025.

In the EU, the bioeconomy holds significant economic importance. In 2021, the bioeconomy sector comprised more than 17 million employees, representing more than 8% of the EU's workforce, showcasing its significant socioeconomic importance (Lasarte Lopez & M'barek; 2024), with the agricultural sector as

the highest employment level of employment. Although agricultural employment is likely to decline in the future, the growing variety of bio-based applications has the potential to create new employment opportunities and secure domestic value chains within the bioeconomy.

Between 2012 and 2021 the value added by bioeconomy sectors grew by 40%, driven mostly by different bio-based industries (Lasarte Lopez & M'barek; 2024). In 2021, the EU bioeconomy generated €728 billion in value added, spread across EU Member States, representing more than 5% of the EU's GDP. Including different related services, the share of bioeconomy related to Gross Domestic Product is more than 10%. Furthermore, it offers a high innovation potential for sustainable and new biobased products through biomanufacturing, as well as high income diversification and job creation potential for stakeholders (Ronzon et al. 2022).

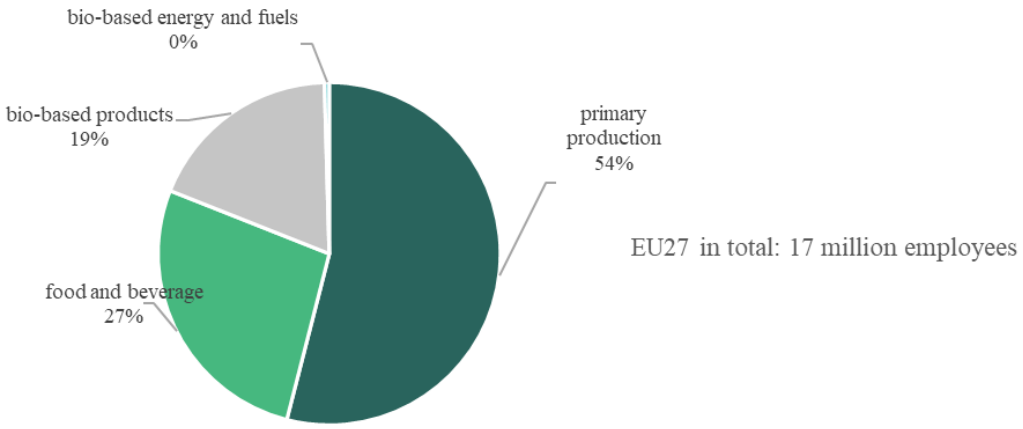

Figure 1: Employment in the EU-27 bioeconomy in 2021.

Source: JRC 2023.

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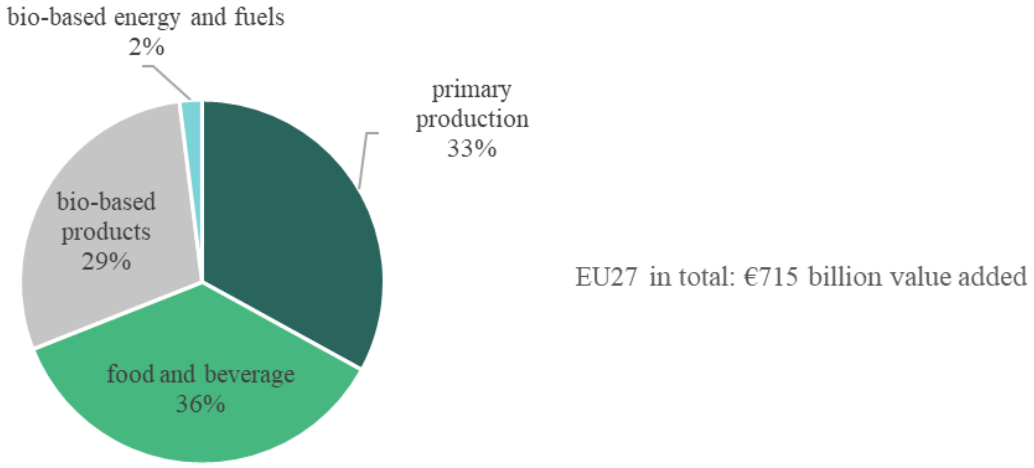

Figure 2: Value-added in the EU-27 bioeconomy in 2021.

Source: JRC 2023.

Despite its importance and potential, there is the risk that the EU bioeconomy falls behind other major economies, such as USA and China. In 2022, the Biden-Harris administration, by the Executive Order EO14081, established the National Biotechnology and Biomanufacturing Initiative to advance American biotechnology and biomanufacturing in health, climate change, energy, food security, agriculture, supply chain resilience, and national and economic security, and to build a vibrant domestic biomanufacturing ecosystem. Although this executive order was revoked in 2025 by the Trump administration, the USA remains a strong competitor for the EU. The Chinese government in its 14th Five-Year Plan for Bioeconomy Development (2021-2025) has set ambitious development goals for China's bioeconomy. For instance, by 2035, the Chinese bioeconomy should become a modern innovative ecosystem at the forefront of global bioeconomy. Furthermore, short term goals until 2025 include a focus on strategic priorities such as biomedicine, bio-agriculture, bio-manufacturing and biosecurity. On the other hand, the Indian Government approved the BioE3 policy and an implementation plan to realise India's BioEconomy vision, putting a focus on innovation-driven support for R&D, the establishment of biomanufacturing and Bio-AI hubs for biobased chemicals, functional foods, precision biotherapeutics, climate-resilient agriculture, biofuels, and marine/space research (ABLE 2025).

Accordingly, efforts are needed to ensure the EU bioeconomy stay competitive globally. This requires transitioning into more holistic and coherent frameworks and coordinated efforts to establish thriving bioeconomy landscape across the EU. Given the multi-sectoral nature of bioeconomy (e.g., agriculture, marine), frameworks should be adaptable to the diverse needs of each sector. These challenges and developments make a redefinition of priorities for the further development of the EU bioeconomy a must that has been recognised by the EC and is currently being addressed.

In line with current EU political discussions and developments such as the Draghi Competitiveness Report, the “Clean Industrial Deal,” and the Competitive Compass (EC 2025a) as well as the Vision for Agriculture and Food, the European Commission plans the elaboration of several closely related strategies, including the Update of the Bioeconomy Strategy (2025), the European Biotech Act, and the Life Sciences Strategy, the Circular Economy Act (2026) and the Start-up and Scale-up Strategy. These initiatives are all part of

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the Flagship Actions Pillar 1 of the Competitive Compass (EC 2025a). Moreover, there have already been a range of political actions and position papers from key actors related to the bioeconomy, including the EC Communication "Building the Future with Nature: Boosting Biotechnology and Biomanufacturing in the EU" (EC 2024) and the subsequent launch of the new Biotech and Biomanufacturing Hub to support innovative companies[1]. Additional actions include the "Key Actions for Bioeconomy in the EU – Summary of Non-Paper" from Estonia, Finland, Italy, Latvia, Spain, and Sweden, its follow-up that was additionally signed by France, Portugal, Lithuania as well as the conclusions on the opportunities of the bioeconomy in light of current challenges, with special emphasis on rural areas, by the Council of the European Union (Council of the European Union 2023). The launch of the "Regional Innovation Valleys for Bioeconomy and Food Systems" initiative at the EU level further underscores these efforts. Alongside EU policy, there have been a range of key activities, such as the Foundation of the Bioeconomy Cluster Alliance in 2025 and the BIC-ERRIN position paper (ERRIN / BIC 2024). Moreover, regional actors have been particularly active in launching regional or communal bioeconomy strategies.

Despite the bioeconomy's substantial value and its potential to contribute to green growth, there are still a range of questions regarding the implementation of the bioeconomy. Addressing the diverse planetary boundaries concerning land, biodiversity, and other factors is crucial. Balancing food security with energy production and industrial use presents a significant challenge. Determining the mechanisms to prioritize the use of scarce resources, such as land and public funding, is essential. Additionally, it is important to consider how different and diverse (potential) bioeconomy stakeholder groups can benefit from these developments. Establishing bioeconomy value chains across Europe in both urban and regional areas is necessary. Ensuring that certain stakeholder groups, such as farmers, are integrated and compensated is also vital. Finally, equitable distribution of the potential higher costs of bio-based products or policies, such as carbon taxes, will be necessary to ensure their competitiveness with fossil-based alternatives. All of which necessitates that the bioeconomy be implemented in a socially responsible manner.

The new Bioeconomy Strategy planned the end of 2025, aims to advance innovation and maintain the EU's leadership in the bioeconomy. It will propose actions to unlock the potential of bioeconomy innovations, so that they can reach the market, generating green jobs and growth. The strategy will also focus on reinforcing circularity and sustainability, while contributing to the decarbonisation of the EU economy. It will set the framework conditions to enable bioeconomy startups, entrepreneurs and new business models to thrive. More concretely, the EC has highlighted four areas where impact is needed and aimed to be covered in the upcoming New Bioeconomy Strategy (Tikkanen 2025):

- Creating efficient demand for more value from less resources
- From lab to fab – priorities for scaling up
- A globally competitive European bioeconomy sector
- Securing sustainably sourced biomass supply

[1] https://ec.europa.eu/commission/presscorner/api/files/document/print/en/ip_25_365/IP_25_365_EN.pdf

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2. Recommendations: topics, geographical scope and structure of the report

ShapingBio aims to accelerate the bioeconomy implementation ensuring its competitiveness. This includes recommendations on how to bring R&D efforts more effectively to industrial production and commercialisation scale and how to create markets for these products and processes. Furthermore, it also covers how to align major bioeconomy actors and enhance their collaborations throughout the EU bioeconomy ecosystem.

The findings and recommendations presented in this report are based on comprehensive desk research and intensive engagement with around 2,000 key experts and stakeholders from all over the EU. This engagement occurred through 45 events and interviews conducted between 2022 - 2025. ShapingBio recommendations will serve as an input for the ongoing update of the EU Bioeconomy Strategy 2025.

In the context of ShapingBio, the bioeconomy encompasses all sectors and associated services and investments involved in the production, usage, processing, distribution or consumption of biological resources (e.g., animals, plants, micro-organisms, including organic waste), including ecosystem services.

Due to resources constraints, the ShapingBio project is unable to consider all the determinants of innovation within the bioeconomy - such as various organizational, social, political, and economic factors, which are essential in any technological or sociocultural context. Therefore, a selection of key areas has been made throughout all the analytical work packages based on the project call text, which reflects knowledge gaps identified by the European Commission, current policy discussions, and the competencies of the consortium members.

The different topics and cross-topics addressed in ShapingBio fall under the following thematic areas (see Figure 3 below):

1) Coherent bioeconomy policy,

2) Applied R&D,

3) Scale-up and deployment,

4) Market formation and growth,

5) Creation of collaborative bioeconomy ecosystem.

The project covers these 5 areas, but it is out of the scope to cover all the *different* aspects across these topics and therefore we focus only on specific aspects. To better guide the reader, we have organized the report into chapters based on these aspects. The overall logic is the better functioning of the innovation system along the innovation journey from rather low technology scales to market commercialization supported by a coherent bioeconomy policy and an innovative ecosystem.

Therefore, five following segments are defined:

- **Coherent Bioeconomy Policy** covers the strategic approach of the EU and its Member States from strategy setting to its practical implementation. It analyses horizontal bioeconomy policy coordination and coherence between different ministries and policy fields at Member States level, and vertical coordination and coherence across different geographical governance levels (EC, Member States, regions).

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- **Applied R&D** covers the TRL 3 and 4 and deals with comprehensive and coherent funding portfolios as well as academia-industry collaboration[2].
- **Scale-up and deployment** comprises the critical phase from lab to scale TRL 5-7 and the role and financing of pilot and demonstrations plants (PDIs). It also covers private and public financing from lab to commercial biomanufacturing (TRL 8-9), including the CBE JU and current IPCEI activities. Moreover, start-up funding and support for the growth and development of SMEs (including start-ups and psin-offs) are considered, given their essential role in the bioeconomy.
- **Market formation and growth** focuses on demand-side policies to foster bio-based innovation.
- **Collaborative Bioeconomy Ecosystem** zooms in on non-financial support for bioeconomy sectors and collaboration among and between them.

For each of these segments, we will provide a brief on the status quo and remaining challenges. Please note that these snapshots include only selected argumentation points. The complete recommendations for each segment are based on the comprehensive analysis conducted in the ShapingBio project[3].

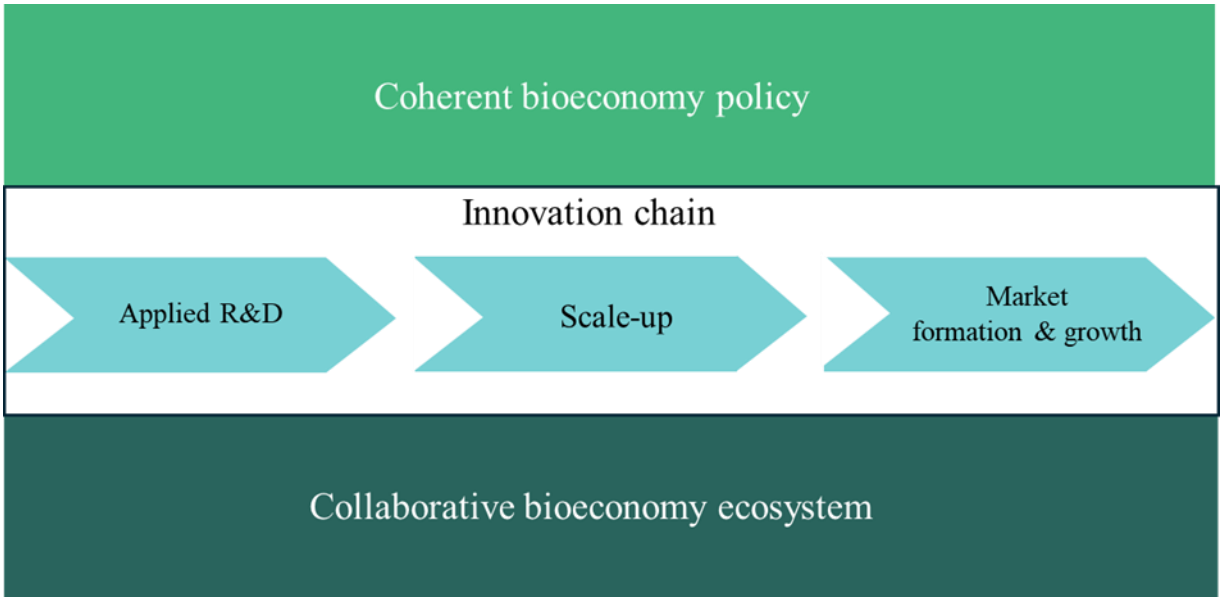

Figure 3: Schematic overview of policy recommendation categories, covered in report D4.1. Source: Fraunhofer ISI

The conceptual and methodological framework underlying our recommendations is Innovation Systems (IS) Approach. This approach encompasses all the aforementioned thematic issues and considers the

[2] Within this document we are using the term "Technology Readiness Level" (TRL) to categorize different stages of research and development. Based on this framework, a technology or innovation from a smaller-scale prototype or demonstration (lower TRL) to a larger-scale implementation (higher TRL). Key steps are the transitioning a technology from a smaller, lab-scale prototype (typically TRLs 1-3) to demonstrate the feasibility and economic viability of a technology for widespread adoption (TRLS 4-7) and then turn to larger, industrial-scale operation (TRL 8-9).

[3] All the deliverables of ShapingBio are available on www.shapingbio.eu

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varying importance of policy and governance at different levels, including regional aspects. The IS framework is well-established in innovation studies as it provides an understanding of the key factors that enable the better comprehension of various innovation processes. This framework places innovation at the centre of focus and acknowledges that the determinants of innovation in specific areas (e.g., bioeconomy) are embedded within broader societal structures (e.g., policy, collaboration, financing) rather than just within individual stakeholders.

The IS approach has a special focus on regional aspects, which is also addressed in the ShapingBio project. This emphasis is because technological innovation should not solely aim at economic growth and competitiveness but should also enhance capacities to tackle grand societal challenges such as climate change, health, and digitalization. It should also consider territorial inequalities to study transformative change in various areas, including bioeconomy (Isaksen et al. 2022). Focusing on regional aspects enables us to explore and understand why some regions (and the industries they host) are more innovative than others and how to create a policy approach that fosters favourable conditions for regional innovation and growth across the EU (Asheim et al. 2019).

Building on this, the report offers a comprehensive overview of the primary objectives, status quo, progress achieved and potential challenges ahead. On that basis it identifies and elaborates different supportive measures that influence bioeconomy ecosystem throughout the EU and its Member States. The recommendations proposed draw on the work done in previous work packages of the project, which included 46 multi-actor thematic workshops and additional one-on-one expert interviews with practitioners and experts to address existing gaps.

Regarding the **geographical scope**, given the variation in resources and capabilities in the member states, bioeconomy development is heterogenic in the EU. As a detailed quantitative and qualitative analysis of all EU Member States was beyond the scope of ShapingBio, we used classification levels of the innovation ecosystem classification defined by the European Innovation Scoreboard (2023) as basis for collecting quantitative data and highlight the differences:

- Emerging innovators (Bulgaria, Croatia, Latvia, Poland, Romania, Slovakia)
- Moderate innovators (Czechia, Estonia, Greece, Hungary, Italy, Malta, Lithuania, Portugal, Slovenia, Spain)
- Strong innovators (Austria, Cyprus, France, Germany, Ireland, Luxemburg)
- Innovation leaders (Denmark, Finland, the Netherlands, Belgium, Sweden)

As Box 1 with selected results of ShapingBio indicates, such a geographical differentiation of bioeconomy policy is partly needed, and the presented categorization is used for those ones in the following.

As ShapingBio can provide limited info on national level, the recommendations are formulated at such a level that the principal direction for the Member States is indicated and for selected recommendations we also differentiate between countries.

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Box: Status-Quo of Bioeconomy according to European Innovation Scoreboard classification

When comparing key indicators for the Bioeconomy such as value added and employment as well as innovation and financing with overall size (area, inhabitants), some patterns emerge. While the innovation leaders possess medium employment and value-added shares (e.g. 11% for employment), which are in line with their size proportion (area, inhabitants), they show their strong performance also for the bioeconomy with significant shares (e.g. 31% for patents). They are mostly only outpaced by the strong innovators, for example France and Germany perform very well especially in patents. In contrast, moderate innovator's share in employment (33%) and value added (32%) reflects their size, and while bioeconomy HE funding reaches a significant share (27%) because of Spain's strong performance, company financing and patents performance is relatively low (15% respectively 19%). For emerging innovators, bioeconomy employment share (34%) is significant, which is highly driven by the labour-intensive agri-food industries. However, emerging innovators do not participate to a significant extent in innovative European projects and receive little amounts of funding (all indicators below 5%).

Table 1 Status-Quo of Bioeconomy according to innovation categories

	Total Size		BE Innovation and Financing			BE Contribution	
	Area	Inhabi-tants	HE Funding BE	Company Financing	Patents	BE Employ-ment	BE Value Added
Emerging Innovator	20%	17%	5%	1%	2%	34%	10%
Moderate Innovator	32%	35%	27%	15%	19%	33%	32%
Strong Innovator	28%	37%	38%	47%	59%	22%	41%
Innovation Leader	20%	11%	30%	38%	31%	11%	17%
EU-27	100%	100%	100%	111%*	100%	100%	100%

Source: last available data from Eurostat, STI, Dealroom, Horizon Dashboard, JRC.

*sums up to more than 100% as some patents have applicants from several EU countries

This overall picture points out two important issues. First, there is a heterogeneity in the EU bioeconomy. While this is not necessarily a problem and not all indicators should be equal, there are clear indications from stakeholder consultation that the full potential of the EU bioeconomy is hampered by the current imbalances, especially as the lagging behind countries often have very valuable biomass resources that may be partly used for high-value-added exploitation. Second, ShapingBio analysis implies that a geographical differentiation of bioeconomy policy is needed, especially as the resource endowments in terms of biomass (type) availabilities and existing industries highly differ between the EU Member States and EU regions.

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3. Coherent bioeconomy policy

3.1 Introduction to coherent bioeconomy policy

Bioeconomy deployment requires policies that provide clear directions for the transition from a "linear fossil-based economy" to a "sustainable, just, and bio-based circular economy" which makes the best possible sustainable use of biomass and biological resources. While directionality is also a feature of other transformative policies, it is particularly complex in bioeconomy due to its specific characteristics:

- **Innovations**. Bioeconomy is knowledge-based and requires technological, organisational and social innovations to flourish.
- **Spanning several sectors and policy fields**. Bioeconomy cuts across traditional economic sectors and thus different sectoral policy fields. Decisions taken in other policy fields may have a significant impact on the bioeconomy, but this impact may not always be fully anticipated in the decision-making process. Therefore, the synergistic integration of different sectoral policies to form a coherent bioeconomy policy and subsequent coordination is required.
- **Novel value chains and actor constellations.** Bioeconomy deployment does not only take place in established value chains and actor constellations but also requires novel ones. It must therefore foster the formation of novel value chains and novel actor constellations.
- **Alignment of different stakeholder priorities.** Due to its transformative, cross-cutting nature, bioeconomy deployment must align diverse, and sometimes conflicting, stakeholder priorities and interests.
- **Place-based priorities and activities**. Bioeconomy requires a place-based policy framework to exploit the available assets, but minimizing unintended environmental, economic, or social consequences. This framework must be specifically tailored to the concrete national, regional or local contexts, and in addition be aligned with one another.
- **Alignment along geographical governance levels**. Bioeconomy is embedded in international, national and regional value chains and therefore requires alignment of policies and activities across different geographical governance levels (e.g. international, EU, national, regional levels).
- **Goal conflicts are inherent to bioeconomy**. This requires agreements on priorities and finding solutions and compromises across economic sectors, sectoral policies and stakeholder interests.
- **Regulations and administrative procedures.** With increasing maturity and scale-up to industrial production of bioeconomy innovations, their deployment requires the harmonisation of regulations and administrative procedures across economic sectors and geographical governance levels.

A coherent bioeconomy policy that adequately addresses these interconnected challenges can be characterised as follows: It is grounded in a holistic understanding of bioeconomy which takes a systems perspective and acknowledges the requirement of a systems transformation. It complies with High Level Bioeconomy Principles (GIB 2024) and contributes to achieving Sustainable Development Goals. It is based on a holistic and coherent concept, framework or strategy that guides innovation and transformation efforts across different economic sectors. It also overcomes silos of traditional policy fields. It effectively coordinates and aligns the relevant government bodies, research institutions, private sector entities, and civil society with the aim to agree on shared goals, strategic priorities, and ways to achieve these goals. It establishes procedures in policy, but also throughout the innovation ecosystem how to exploit synergies, resolve goal conflicts, and minimize unintended negative impacts. Moreover, in a coherent bioeconomy policy strategic priorities guide the consistent allocation of resources, and funds from different sources are combined synergistically and used efficiently within an adequately tailored policy instrument portfolio: It fosters the swift translation of applied R&D efforts into industrial processes and marketable products and

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services. It creates a favourable regulatory and administrative environment for bioeconomy without compromising high quality standards in the three sustainability dimensions environment, economy, and society. It thus supports the development of a robust innovation ecosystem.

Such a bioeconomy policy is needed at all geographical levels, at the EC level as well as at national Member States levels. As the strategic importance of regions in the deployment of the bioeconomy has only recently received more attention, regional – or even municipal policies – are also needed. With respect to global competitiveness and resilience, these policies should also be aligned with one another ("vertical" alignment across geographical levels). In this way, the overall EU-wide policy effort could exceed the sum of its individual member states and regional policies.

In the following, the term "holistic and coherent bioeconomy policy" will be used for a policy that fulfils these criteria outlined above.

This following chapter is structured as follows: It addresses bioeconomy policy coherence from three perspectives:

- Coherent strategic approach to bioeconomy policy on national or regional level (chapter 3.2)
- Coordination of bioeconomy policy on national level (chapter 3.3), and
- Addressing emerging regulatory and administrative hurdles for innovative bioeconomy solutions (chapter 3.4).

In each of these subchapters, a short introduction into the state of play is given, followed by recommendations.

3.2 Coherent strategic approach to bioeconomy policy on national or regional level

3.2.1 State-of-play

For the state of play of a coherent strategic approach to bioeconomy policy, we use the existence of a dedicated bioeconomy strategy as indicator[4]. The ShapingBio analysis showed that EU Member States and regions differ in the progress which they have made towards a dedicated bioeconomy strategy (Mubareka et al. 2023; Sakellaris et al. 2024; European Commission et al. 2024). Only 11 EU Member States[5] have published a dedicated bioeconomy strategy or related policy document. Information on regional bioeconomy strategies is even more patchy. In countries and regions without a dedicated bioeconomy strategy, bioeconomy-related goals and activities are fragmented and scattered over several sectoral strategies and policies (Haarich and Kirchmayr-Novak 2022). In this way, only a fraction of the bioeconomy's potential is harnessed by neglecting its systemic, cross-sectoral, and transformative nature. Moreover, it risks hindering the transition to an integrated circular bioeconomy framework and could prioritise short-term gains (such as job creation) over long-term and future-oriented competitiveness and sustainability goals.

The ShapingBio analysis (Hüsing et al. 2024) showed that countries and regions do not follow the same pattern or similar pathways towards their respective bioeconomy strategy. They progress at different speeds.

[4] We acknowledge that important bioeconomy activities and initiatives can be implemented without a dedicated bioeconomy strategy.
[5] Austria, Estonia, Finland, France, Germany, Ireland, Italy, Latvia, the Netherlands, Portugal, Spain (status in April 2025)

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The processes are not necessarily linear, and several states used windows of opportunity (e.g. EU presidency, favourable national political constellations) to advocate for bioeconomy as a political priority or published their bioeconomy strategy. Both top-down initiatives, taken by governments, as well as bottom-up initiatives, taken by stakeholder groups, or a mix of both approaches, can be observed. International policy developments legitimizing bioeconomy (e.g. Sustainable Development Goals, Paris Agreement, EU Green Deal) as well as developments in international and EU bioeconomy policy were reported to be drivers for Member States and regions to take action. Leadership taken by one or several ministries, regional authorities, or agencies along with commitment from high-level policy makers to the bioeconomy, are key success factors. In some regions, it was shown that existing networks and clusters initially not dedicated to bioeconomy (e.g. industrial networks, green development clusters) could successfully function as platforms to expand regional activities into bioeconomy (Hüsing et al. 2024).

The ShapingBio analysis (Sakellaris et al. 2024; Hüsing et al. 2024) showed that Member States and regions without a dedicated bioeconomy strategy often did not perceive the need for an additional bioeconomy approach because

- there may be a lack of knowledge and shared understanding what bioeconomy is and what the holistic bioeconomy concept entails,
- the notion prevailed that bioeconomy were already adequately covered by sectoral policies or other activities (e.g. circular economy, regional strategy),
- the benefits and added value of an additional holistic and coherent bioeconomy policy were not obvious to them. This may partly be due to a lack of "visibility" of bioeconomy. EU-wide, it is difficult to locate bioeconomy policy responsibilities in national ministries – often, not even a dedicated bioeconomy division exists. Even notable bioeconomy activities may be highly scattered across different policy fields, funding measures, data bases, or indicators. Therefore, they are not necessarily recognised as belonging to bioeconomy or assigned to bioeconomy, especially if different vocabulary and terms or classifications schemes and codes are used,
- progress could be faster in traditional policy fields,
- the holistic and coherent bioeconomy policy approach would expose diverging positions and priorities among stakeholder groups, making it very difficult and resource-consuming to develop commonly shared visions, goals, and priorities, agreement on ways how to achieve them, and solutions to goal conflicts.

3.3.2 Recommendations

Against this background, recommendations on the following topics are given in detail below:

- Convincing high-level key decision-makers of the importance of bioeconomy
- Make bioeconomy more generally known
- Development of a dedicated holistic and coherent bioeconomy policy in all EU member states and more regions
- Shifting the focus from bioeconomy strategies to effective and efficient implementation

Convincing high-level key decision-makers of the importance of bioeconomy

A prerequisite for a holistic and coherent bioeconomy policy is that high-level policy-makers and key decision-makers are aware and convinced of the importance of bioeconomy, as a basis to take respective actions. According to our analysis, **the European Commission and EU member states** should continue their efforts

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- to inform and educate high-level and key decision-makers about bioeconomy and its importance for competitiveness, economic growth and resilience, environmental protection, fighting climate change, and quality of life,
- to put bioeconomy on the agenda of international and global policy summits and activities (e.g. EU presidency, G7, G20),
- to improve the knowledge base of bioeconomy inputs, outputs, outcomes and impacts, and use it in informing key decision-makers, e.g.,
    - by developing further and harmonising the indicator-based monitoring of bioeconomy in the EU, on Member States and regional levels, and using this for an indicator-based bioeconomy benchmarking of EU Member States,
    - by commissioning and publishing regular updates on the state of play of bioeconomy in the EU and its Member States and regions,
- to make advantages, benefits, outcomes and impacts of bioeconomy more tangible, e.g.,
    - by establishing highly visible lighthouse or flagship projects and communicating impact case studies)
    - by establishing physical spaces as foci for bioeconomy activities, e.g. bioeconomy infrastructures, centres of excellence, hubs, clusters (see also chapter 7),
    - by advocating and striving for a bioeconomy Important Project of Common European Interest (IPCEI) (see also chapter 5).

Make bioeconomy more generally known

In addition to informing and educating the target group of high-level and key decision-makers, there is also the need to make the bioeconomy generally known. This may be especially relevant for fostering regional engagement in bioeconomy. Although notable efforts have already been taken, these efforts need to be continued. **All bioeconomy stakeholders from the quintuple helix should**

- build new activities on the experience and good practice already gained,
- pay specific attention to tailoring the activities specifically to the respective target groups,
- address and actively involve target groups which have been neglected so far, are difficult to reach, or become relevant as goals, priorities, and needs develop over time and new topics arise,
- experiment with innovative formats,
- ensure that platforms for exchange of good practice and mutual learning, evaluations and meta-analyses of these activities are an integral part of these efforts, so that activities achieve lasting outcomes and impacts effectively and efficiently.

Development of dedicated holistic and coherent bioeconomy policy in all EU Member States and more regions

To reach the goal of the EU as globally competitive player in bioeconomy, all EU Member States and more regions should develop a dedicated holistic and coherent bioeconomy policy and regularly revise and update it. An indicator for this can be a dedicated bioeconomy strategy.

Policy makers **in countries and regions without a dedicated bioeconomy strategy and policy** should

- continue to strive for a dedicated national or regional holistic bioeconomy policy which is tailored to the specificities of their country or region.

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- foster a climate and environment for the transformational change towards a bioeconomy, through elaborating on the opportunities available for the bioeconomy in their country or region and seek support from influential quintuple helix stakeholders.
- actively seek resources and support. Examples for resources and support are nationally or regionally funded projects, EU funded projects or Coordination and Support Actions, bioeconomy initiatives such as the BioEast Initiative, Regional Innovation Valleys (Directorate General for Research and Innovation, 2023), the intergovernmental Western Balkans initiative ("Berlin Process")[4] etc.
- learn from good practice and the experience of other countries and regions. Examples are relevant policy networks, e.g. the EU Bioeconomy Policy Forum, OECD, BioEast Initiative, CBE JU national representatives group, or national networks (e.g. in Germany TransBIB network), and EU level CSAs (e.g. CEE2Act, ROBIN).
- hold inclusive dialogues with quintuple helix stakeholders to pave the way for long-term impacts and results, shifting the focus from an initiative or project-based focus into an impactful change.

Policy makers **in countries and regions which are in the development or revision phase of bioeconomy strategies** should

- adopt good practice for the strategy development or revision phase that is available in several countries and regions and has already been collected and disseminated, e.g. in European Commission et al. (2021), as outputs from various projects which foster bioeconomy in regions (e.g. ROBIN, TransBiB, regional innovation valleys). The active participation in policy networks (e.g. the European Bioeconomy Policy Forum, OECD, BioEast Initiative, CBE JU national representatives group, G7, G20) is an excellent and highly recommended opportunity for mutual learning and exchange of experience.
- give consideration to the ministry or institution that leads this process. The ShapingBio analysis showed that the leading institutions play a crucial role in mediating between the different actors and stakeholder groups involved and are likely to influence the direction of the bioeconomy. Therefore, the choice of the leading institution should be considered in view of the present bioeconomy situation and of the anticipated future role of the country.
- carefully design the strategy development or revision process. Good practice is the active engagement of all relevant decision-makers and stakeholders (e.g. relevant high-ranking ministerial and stakeholder representatives with the competence to take strategic decisions, integration of bioeconomy-specific expertise as well as stakeholders' needs and perspectives). While consultations of experts and stakeholders are already an integral part of such processes, it is recommended to additionally carry out different interactive dialogue formats to listen to all the different voices presented in the quintuple helix framework. This contributes to a more nuanced mutual understanding, for considering different options, for consensus-building and for creating ownership of achieved results and compromises.
- foster regional engagement in bioeconomy – both at the EC and Member States levels.

Shifting the focus from bioeconomy strategies to effective and efficient implementation

An integral part of the coherent strategic approach to bioeconomy is the translation of goals and priorities into policy-induced activities and their implementation. The ShapingBio analysis (Hüsing et al. 2024) showed that not all existing bioeconomy strategies give sufficient guidance for implementation. Such guidance requires clear – and desirably quantitative – goals, strategic priorities and shared solutions to goal conflicts. Moreover, only few countries[5] have an action plan on how to implement their strategy. Action plans should entail a balanced portfolio of support activities, budget allocation to defined strategic priorities, and clearly assigned responsibilities and timelines for activities. Therefore, there is a clear need to shift the

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focus from "having a dedicated bioeconomy strategy" to its coherent implementation. One option is to have a holistic bioeconomy strategy with an action plan.

Policy makers **on all geographical governance levels** (EC, Member States, regions, municipalities) should

- strive for bioeconomy strategies with action plans which give clearer guidance for the subsequent phase of translating strategies into concrete actions. It is recommended to take inspiration from good practice examples in other countries or regions or from good practice in other policy domains than bioeconomy.
- advocate for and/or provide support at regional, national and EU or supranational level for adopting good practice how a coherent bioeconomy policy drives actions towards implementation. It is recommended to actively participate in corresponding fora and activities for mutual exchange of experience and mutual learning processes.

3.3 Improving bioeconomy policy coordination at national level

3.3.1 State-of-play

Bioeconomy cuts across economic sectors and established policy fields. This requires horizontal coordination between different national ministries and departments responsible for (parts of) bioeconomy policy. Moreover, a coordination with other policy fields, e.g. agriculture, forestry, fisheries, industry, circular economy, research and innovation, environmental and climate policies is required: decisions in these policy fields may have a significant impact on bioeconomy, and bioeconomy may contribute important solutions in these fields.

The goal of policy coordination is to harness the full potential of bioeconomy, to enhance EU competitiveness, and to exploit synergies, while avoiding unintended negative impacts, ambiguous policy signals and unaligned incentives.

Therefore, it is important to create an environment in which effective, efficient and continuous coordination of bioeconomy activities and policies across ministries, policy fields and sectors takes place, even under changing governments or shifts in political priorities. According to the ShapingBio analysis (Hüsing et al. 2024), EU member states have chosen different options to establish a coordination-supportive environment: they range from a formally established coordination body at the one end and a more network-like character of coordination at the other end of the options spectrum. Success factors in the set-up of the coordination-supportive environment are the careful selection of the institution, ministry or person which chairs the coordination process, clearly defined mandate and terms of reference, and the provision of sufficient resources in terms of budget, staff, and time for (sometimes resource-consuming) coordination processes.

Regarding the working mode, flat hierarchies within the coordination body, a collaborative, open, dialogue-oriented and trustful working climate, and the willingness and ability to align diverging interests, to find compromises in controversial issues and solutions to goal conflicts were identified as good practice (Hüsing et al. 2024). An integral part of the coordination is to maintain a continuous dialogue between key quintuple helix stakeholders. Beside setting the foundations of priorities, a key outcome of the continuous dialogue is the promotion of a collaborative culture for a sustainable, resilient, and competitive bioeconomy.

However, knowledge on how bioeconomy policy is coordinated in the different EU member states is still patchy. Therefore, there is a need to analyse further which coordination options are established in which countries, and what good coordination practice entails with respect to institutionalisation, decision power, organisation and working mode.

In addition, vertical coordination across different geographical levels (i.e. international/global – EU – Member states – regions) is also important. Vertical policy coordination between national and regional

levels may not present significant challenges in small countries with small and well-interconnected bioeconomy communities or centralised governance structures. However, it may require more attention in larger countries with a higher number of regions with diverse profiles, or in federal republics, or in countries with regions that have a high degree of autonomy. In these cases, actively aligning national and regional priorities, strategies and activities would more likely achieve synergies and avoid conflicting activities. ShapingBio analysis showed that regions gained more impact through joint positions in negotiations with the European Commission.

3.2.2 Recommendations

Policy makers **on all geographical governance levels** (EC, Member States, regions, municipalities) should

- support the establishment of coordination-supportive environment for bioeconomy policy in their country or region. The chosen coordination option should be tailored to the country and regional specificities.
- advocate for support at regional, Member State and EU or supranational level on expanding the knowledge on bioeconomy policy coordination options. The knowledge could be expanded e.g. in Coordination and Support Actions or with commissioned studies.
- proactively address the bioeconomy policy coordination topic in existing bioeconomy policy fora and activities for mutual exchange of experience and mutual learning processes.

The **EC** should

- consider the option of future oriented Bioeconomy Dialogue modelled after the Strategic Dialogue on the Future of EU Agriculture, followed by a European Board on Bioeconomy, similar to the European Board on Agriculture and Food.

Although it is primarily the responsibility of national governments to improve their bioeconomy policy coordination, the European Commission (EC) and other supranational institutions, such as the Organisation for Economic Co-operation and Development (OECD) and others, can play an important role to support such efforts.

Our recommendations **for the EC and other supranational institutions** are:

- Continue to encourage and support EU Member States and regions without a bioeconomy strategy or only a narrowly confined, sectoral ones by Cooperation and Support Actions and policy networks to develop holistic, coherent bioeconomy policies with dedicated bioeconomy strategies.
- Encourage and support all EU Member States and their regions in their efforts to improve the quality of their bioeconomy strategies. Options that could be considered are e.g. commissioning studies what good practice strategies entail, Coordination and Support Actions, exchange of good practice in suitable fora (e.g. conferences, European Bioeconomy Forum, CBE JU group of national representatives, OECD).
- Support EU Member States and their regions in their efforts to improve their bioeconomy policy coordination. Support options that could be considered are e.g. commissioning studies what good practice coordination entails, Coordination and Support Actions, and exchange of good practice in suitable fora (e.g. conferences, European Bioeconomy Forum, OECD).

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3.4 Addressing emerging regulatory and administrative hurdles for innovative bioeconomy solutions

3.4.1 State-of-play

Most bioeconomy strategies and policies have a focus on fostering R&D&I and lay the foundation for knowledge-based innovations. These innovations may be situated between traditional sectors at the interface of different policy fields, and may require the establishment of novel, often cross-sectoral value chains. When these innovations progress towards scale-up and commercialisation, the regulatory and administrative environment becomes very important. However, the ShapingBio analyses showed that the regulatory and administrative environment is a significant hurdle – among others – for the deployment of these innovations (Hüsing et al. 2024), for acquiring financing for scale-up (Garthley 2024; chapter 4.1, chapter 5), for market entry and commercialisation (chapter 6). These hurdles may be due to

- regulatory frameworks which were tailored to conventional processes, products and services, but are not fit for purpose for these innovations,
- the lack of incentives because established policy support measures do not apply to these innovations,
- the fact that authorisations, licenses, permissions and surveillance of these innovations often fall into the competency of several different regulatory or administrative authorities,
- heterogeneity across EU Member States and/or regions whether the regulatory framework and administrative environment is supportive for these innovations,
- heterogeneity across EU Member States and/or regions with respect to number and expertise of the responsible administrative authorities. This makes it difficult for innovators to navigate efficiently between administrative processes and to predict the required time and effort to obtain a decision. This is especially relevant in larger Member States, with a federal and/or decentralised administrative structure.

A holistic and coherent bioeconomy policy must anticipate such regulatory and administrative challenges and disincentives early in the innovation process, e.g. by commissioning studies and analyses, by foresight exercises, by dialogues with innovators, regulatory and administrative experts, by mapping and analysing relevant regulatory frameworks, administrative responsibilities and procedures. Anticipated challenges then need to be proactively addressed with appropriate measures.

Attention should not only be directed to the regulatory frameworks, but also to their practical implementation by administrative procedures. ShapingBio analysis showed that innovators can more efficiently navigate administrative procedures if they can easily obtain the information which authorities are responsible, and if there is transparency of the required administrative procedures. Moreover, streamlined administrative requirements could reduce administrative burden (Hüsing et al. 2024).

The following recommendations were derived from an analysis of low-trophic aquaculture, an innovative development within blue bioeconomy. However, the findings and recommendations can also be applied to other emerging sectors in the bioeconomy. It depends on the innovative emerging sector at which geographical governance level the regulatory and administrative competences, respectively, are located. Depending on the innovative emerging sector, this may be the EU, the national, regional or municipal level or combinations thereof. Whether national, regional or municipal authorities or combinations thereof are responsible, also depends on the EU member state.

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3.4.2 Recommendations

Actors **with regulatory competence** (could be located at different geographical governance levels: EU, national, regional level) should

- anticipate regulatory challenges and disincentives early in the innovation process, e.g. by mapping and analysing relevant regulatory frameworks, administrative responsibilities and procedures, by commissioning studies and analyses, by foresight exercises, by dialogues with innovators, regulatory and administrative experts.
- develop potential solutions to anticipated regulatory challenges and disincentives in dialogue with all relevant stakeholders. This process could be led by a task force or committee in a transparent process. With the aim to share good practice and to harmonise chosen approaches, international collaboration and knowledge exchange is advisable.
- invest in capacity building by training staff in the relevant institutions with regulatory competence.
- consider regulatory sandboxes, collect systematically experience with different regulatory frameworks to derive good solutions for tailoring the regulatory frameworks.
- tailor the relevant regulatory frameworks so that they fit the innovations. Ideally, they should also be harmonised across the same governance levels.

Actors **with administrative responsibility for permissions, licenses, authorisations, and surveillance** (could be located at different geographical governance levels: EU, national, regional, municipal level) should

- anticipate early potential hurdles in administrative responsibilities and procedures, as suggested above.
- clearly map responsibilities of the relevant authorities and communicate them together with designated contact points to innovators to support easy navigation in the administrative procedure. If possible, responsibilities should be (semi-centralised) in one or few authorities to establish a one-stop shop.
- invest in capacity building by training of administrative staff and establish platforms for mutual learning and good practice exchange.
- establish pre-submission consultations between applicants and authorities with the aim to reduce workload for both sides and shorten the time required from application to authorisation,
- reduce bureaucracy, e.g. by comprehensive and harmonised guidance for authorities and innovators, and by digitalisation of administrative procedures.

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4. Applied R&D

Applied R&D in bioeconomy is at the forefront of developing solutions to solve the most pressing global issues, such as food security and climate change. The advancements made through applied R&D enable the creation of high-value products, establishing new markets and hence boosting Europe's economic growth, resilience and environmental stewardship. It is the key for bridging the gap between research and scientific discoveries into practical/industrial applications. Scientific disciplines and skills required for applied R&D in bioeconomy include biotechnology (e.g. genetic engineering, genome editing, synthetic biology, microbial fermentation or enzymes optimization) as well as information technology (IT) and Artificial Intelligence (AI). However, innovations in bioeconomy are interdisciplinary by nature and often cover different fields. The majority of these innovations are at low technological readiness level emphasising the need to support research organizations and the exploitation of new applicable research and development (R&D) results to support its transition towards market-readiness. In ShapingBio, applied R&D covered TRL 3-4, comprising proof of concept (TRL 3) and extensive laboratory testing of prototype components or processes (TRL 4).

The following presentation of findings and recommendations is structured by first focussing on funding issues, while additional aspects in particular regarding technology transfer is presented afterwards.

4.1 Applied R&D funding

4.1.1 State-of-play

Public funding plays an important role in resource mobilization for applied R&D. In the EU, funding dedicated to applied R&D in the bioeconomy comprises significant policy support for "traditional fields" of the bioeconomy, such as the primary sector (e.g. agriculture, forestry and fisheries), as well as for converting industries. At the EU level, Horizon 2020 and Horizon Europe (Cluster 6), along with the CBE JU are the key funding sources for R&D activities in the bioeconomy in Europe. Recent evaluations of Cluster 6 and the CBE JU (European Commission 2024a, 2024b) confirm that they have a significant impact on fostering research & development activities in relevant topics and creating collaborations across sectors as well as between industry and research.

However, the funding for applied bioeconomy R&D is rather unevenly distributed. According to the CORDIS Dashboard[6], six Member States receive more than 60% of the bioeconomy-related funding (Cluster 6, the CBE JU and the bioeconomy related missions[7]). These countries are Spain, Germany, Italy, the Netherlands, France and Belgium (Figure 4). Particularly, Central and Eastern European Member States – as well as very small Member states – are lagging behind.

The reasons for this are manifold. Central and Eastern European countries are traditionally focused on primary production and less on R&D activities, where there are already fixed long term collaboration activities between actors, with new project partners have difficulties joining the established research

[6] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-dashboard
[7] Cluster 6 in Horizon Europe includes: food, bioeconomy, natural resources, agriculture and environment. The related missions are the restoration of ocean and waters, and soil deal for Europe.

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consortia. Another reason is of course the different size of the Member States,[8] which partly explains the differences in funding.

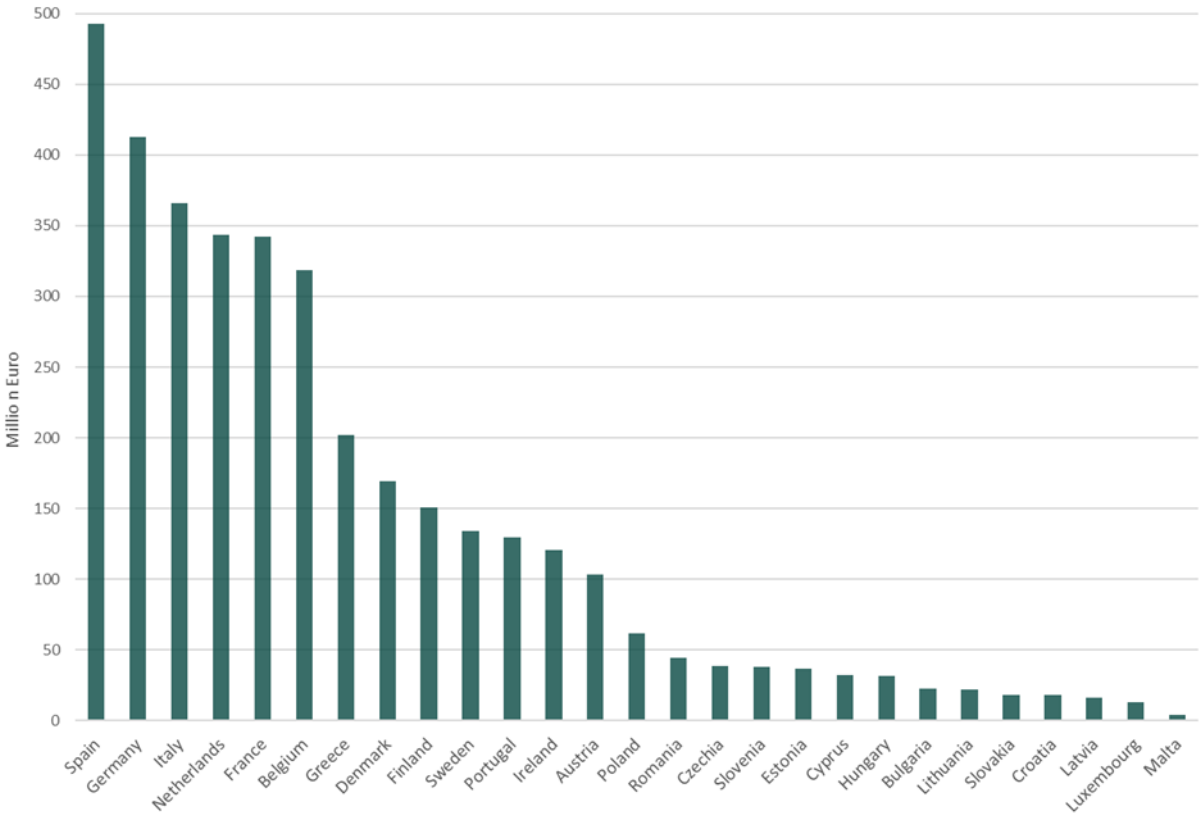

Figure 5: Horizon Europe funding per country for bioeconomy.
Source: Fraunhofer own calculation based on CORDIS database. Status: January 2025.

Beside the EU-level funding schemes, several Member States have established public funding programmes that support applied R&D activities in the bioeconomy. Most of these measures comprise grants to academia and industry and aim to support collaboration between them. Some countries (Germany, Austria, Ireland, Spain, Italy, Finland, Portugal) have established at least one funding scheme specifically dedicated[9] to bioeconomy. Large countries, such as Germany or France, have a portfolio of different support measures covering different research topics or types of collaboration. Portugal has introduced a programme, which comprises different funding modules such as basic research, R&D infrastructures, feasibility studies and industrial R&D (TRL 5-8) with a planned annual budget of €30 million.[10] However, most Member States do not have policy instruments dedicated to bioeconomy. Rather, almost all Member States have policy

[8] The ShapingBio Deliverable 1.2 also presents funding in terms of Euro per capita: Western and Northern European countries dominate.
[9] Bioeconomy policy instruments are dedicated to the bioeconomy if they can be identified in relevant bioeconomy strategies, action plans or other governmental documents that comprise goals, visions and measures for the bioeconomy. ShapingBio has collected instruments in the following database https://www.shapingbio.eu/resources/#1280.
[10] https://www.fundoambiental.pt/ficheiros/portaria-n-2622021-aprova-o-regulamento-do-sistema-de-incentivos-as-empresas-promocao-da-bioeconomia-sustentavel-pdf.aspx

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instruments in place such as programmes to foster specific sectors (e.g. agri-food) or open programmes (e.g. for R&D, regional development) that in principle can also support bioeconomy activities.

Overall, the same group of countries, which are on top of EU Horizon Europe funding appear to be more active in national and/or regional funding for the bioeconomy. While comparable indicators in terms of budget or directly comparable numbers of policy instruments are missing, there are indications from the ShapingBio assessment and from JRC repositories that many of the country's leading in EU funding have more dedicated and larger national R&D funding activities. For the majority of smaller Member States, general funds are the way to go. However, it is not clear whether the funding conditions are specifically tailored to the specificities that distinguish bioeconomy applied R&D from R&D in other fields (e.g. relatively high capital costs for equipment, rather long phase of R&D process before market entry) and to which extent they are used for bioeconomy purposes. Among others, the financing conditions may also differ between countries and may be less favourable. One example is the low funding amount per project in Czech Republic for public research institutions, which leads either to underfinanced projects or to complex project requirements due to the need for co-financing by industry. Another example is the percentage of co-funding for companies which may be prohibitive for smaller companies or in critical stages of their development.

To conclude, in the EU bioeconomy significant applied R&D activities are supported in particular by public funding. However, the analysis in ShapingBio reveals that improvements in applied R&D funding landscape are needed. These include coherent funding systems and less heterogeneity in funding-access across the EU. Moreover, some adjustments in funding structures (improved findability, less administrative burden) would raise the potential to generate innovations in the EU.

4.1.2. Recommendations

Provision of sound funding portfolio

- All Member States should have a **comprehensive and coherent funding portfolio**. This means that there should be national funding opportunities in programs that address specific needs in the bioeconomy. The portfolio should address all TRL stages of applied R&D and all relevant target groups. Redundancies or gaps should be avoided. Here, a coordination between local, regional, national and EU funding bodies is important since the goal is to create integrated funding pipelines to avoid gaps in R&D financing that hinder project completion.
- All MS funding organisations should **critically assess their funding conditions whether they are suitable for the target groups** (e.g. academia, SMEs, primary producers, cross-sectoral or cross-border collaboration), whether they take the specificities of applied R&D in bioeconomy sufficiently into account and should eventually amend the funding conditions. Experts consulted in ShapingBio emphasize the need of technology-oriented SMEs support, which should include higher co-funding (in those cases, where this is possible considering state-aid-rules), lower administrative burdens and foci on innovative activities.[11] Generally, an exchange of good practice between the MS would be desirable (e.g. a dedicated CSA or other kind of project between relevant regulatory administrative institutions). A harmonisation of funding conditions and administrative requirements across funding agencies in one country would make the navigation for fund-applicants easier.

[11] As an example, among the top 30 of private entities for bioeconomy funding only the half are technology-oriented firms, while the rest consist of consultancies, proposal-writing firms etc. While these activities are of course relevant as well, modifications in funding requirements and funded activities may lead to an increase of technology innovation measures.

- For more **advanced Member States** with structured funding schemes and R&D capabilities in the bioeconomy (e.g. Germany, Ireland, France) there is a need to continue efforts to
  - do horizon scanning and identifying cutting edge scientific advances, deep tech approaches and translating this into an ambitious R&D agenda,
  - maintain a coherent and comprehensive portfolio of funding programmes,
  - keep R&D infrastructures technologically and skills up to date,
  - foster cross-sectoral collaboration, and ensure effective inclusion of all relevant actors along (new) value chains,
  - foster regional engagement via R&D,
  - pay attention to IP support and tech transfer,
  - foster technological, organisational and social innovations,
  - also include social sciences and humanities disciplines in R&D efforts,
  - conduct ex-post evaluations of R&D programmes and use the evaluation results for further improvement of new activities.

- **Moderate and emerging innovators** should build up capacities and competencies to become an attractive partner for privately or publicly funded research projects. This requires an increase of national funding within a coherent portfolio, the adaptation of national funding conditions to the specificities of bioeconomy R&D, and stronger participation in EU funded R&D activities. Current EU-funded projects such as BEAMING[12] and Boost4BioEast[13] or BioInSouth[14] map the situation of these Member states regarding their capabilities and capacities. They highlight significant regional disparities in terms of infrastructure, access to funding and quality of human resources. The key problem is also the underused research potential and fragmentation, leading to overall underdeveloped innovation ecosystem. Therefore, measures that address the needs of the applied R&D actors have to be implemented, e.g. jointly by the EU and the respective Member States. Therefore, next to the knowledge of adequate measures the awareness and willingness of the respective policy actors must be raised.
- On a strategic level, it would be desirable to have a **better overview to which extent and how bioeconomy R&D is being funded on EU, MS national and regional levels**. If this overview exists, it will create transparency of public funding priorities and increase the visibility and accountability of bioeconomy in comparison to other research areas. A key requirement would be the agreement on common taxonomy/classification of funding activities within and across MS as well as common glossary. JRC, EU and OECD could have in role in striving for harmonisation as well as in the provision of further information, such as funding data, relation to bioeconomy (e.g. fully dedicated funding schemes).

Simplify administrative processes and provide information on funding opportunities

Public funding opportunities are widely scattered across different funding agencies and programmes. This makes finding the proper funding call challenging for actors both in academia and industry. National contact points, national and regional funding agencies and cluster organisations provide help. For example on the EU level of a one-stop shop is the Horizon Europe NCP Platform for Cluster 6: Food, Bioeconomy, Natural Resources, Agriculture and Environment. This platform provides information, material, seminars,

[12] https://beamingproject.eu/
[13] https://bioeast.eu/objectives/
[14] https://www.bioinsouth.eu/

workshops and contact information all in one place which are relevant for all matters related to proposal preparation. Perhaps, these services are not sufficiently known, as it still remains difficult to find a proper programme. While these challenges apply to all EU Member States, there are indications that some countries seem more advanced than others in terms of navigation of EU, national and regional funding.

Moreover, companies still report high administrative burdens in the application process and lack of knowledge on financing of bioeconomy. Moreover, SMEs, especially start-ups often struggle to secure the necessary funding for R&D activities or have to share budgets with proposal-writing or managing agencies to meet the high demands of reporting.

At EU level, the vast majority of beneficiaries have only one or two grants per programme – and it can be assumed that the situation is not much different on the Member State level. Many of the beneficiaries are SMEs or newcomers regarding Horizon participation. This means that they have little or no previous experience with the administrative processes and requirements, which prevent them from applying for funding. To address the administrative burden, the EC since 2018 has stepwise rolled out lump sum funding[15] as a simpler funding model for applied R&D grants – as compared to reimbursement of real costs. Starting from 2 % of the budget in 2021/2022, an increase of the share of lump sum funding to 50 % of the overall budget by 2027 is planned. A recent evaluation of this simpler funding model (EC 2025) showed that it achieved its goals, especially the reduction of financial error rates and administrative burdens for beneficiaries, is easier to use for beneficiaries with limited experience, and allows the applicants to focus more on project content than on financial management.

Recommendations

- **Funding agencies** should advocate for **additional support for platforms for mutual learning and knowledge exchange** on good practice. They should actively participate in these platforms and exchange formats. Here, among others a project between agencies, platforms etc. may be fruitful for knowledge transfer and exchange between the EU MS. Another option could be Joint calls (such as the Future Food Systems Partnership) that could be used as such a platform for exchange between funding agencies.
- **Public institutions** should provide enhanced support for **navigating the funding landscape**, such as dedicated assistance and dedicated personnel to support submissions. The findability of relevant funding programmes should be further improved (see also section 5.4 for common terminology of technologies). One step could be to increase awareness in the bioeconomy community about which information platforms exist, and which support and advice is being offered.
- **Academia and SMEs** should actively **seek the support of national contact points**, national and regional funding agencies, and cluster or sector organisations to better navigate the funding landscape. It may be advisable to dedicate personnel in-house to develop know-how on how to apply for national and European grants, if public funding is key for the respective research organisation or company.
- The **potential of artificial intelligence (AI)** and machine learning tools to optimise funding search processes should be explored.
- Efforts to simplify and **harmonize application processes and to reduce administrative burdens** for applicants and grant holders should be continued both on EU and national levels. The gradual shift from actual cost grants to an increased share of lump sum funded projects in Horizon Europe is a promising step. Other options under consideration on EC level are shortening the Horizon Europe work programme documents, 2-stage application processes for grants with a simplified first stage and making

[15] EU Funding & Tenders Portal; accessed 9.4.2025

grant contracts less prescriptive so that they allow more academic freedom (Matthews 2025). This approach as well as other cost models and options are to be optimized.

- For **lump sum projects** further improvements of this funding approach still needed on splitting work packages, making the lump sum budget table user friendly and improve the quality of the evaluation feedback. Additionally, more clarity on record-keeping and controls, upskilling of administrative staff, applicants and beneficiaries is needed. Gaining more insights whether this approach is also suitable for large grants and consortia.

Reducing the period between elaboration of EU work programmes and their implementation

A general challenge at the EU level is the time lag between the elaboration of EU work programmes and the start of EU-financed bioeconomy project implementation. The time takes more than 2 years between the first draft of the funding calls in the work programme, and its opening, the time for application, decision process and grant agreement procedures. This long timeline maybe partly due to reasonable efforts for an appropriate stakeholder involvement process as well as having an orientation function for stakeholders which foci are set in the medium-term. However, the fast-changing economic situation, the technological progress and market developments may lead to the situation that new topics should be added to the foci already set, to achieve the necessary progress.

Recommendations

- While some parts of work programmes should still be focused on highly collaborative processes to elaborate longer-term subjects and calls, some other parts may be **more adaptive to emerging trends, significant global events, or unforeseen shifts in markets and sectoral needs**. One possibility would be to adapt the practice of some of the Public-Private Partnerships (PPPs) in Horizon, such as the CBE JU, for which strategic roadmap is set for several years, while the implementation via calls is made on an annual basis and therefore, the process of elaboration and implementation of the Work Programme is faster. Another option would be to implement a fast-track procedure for the revision of calls when urgent global issues or technological advancements arise, ensuring that the program can respond more quickly to unforeseen challenges, such as the COVID-19 pandemic, which significantly shifted priorities in various sectors. Fast-tracked calls could focus on addressing immediate crises or accelerating innovations that have proven vital.

4.2 Non-funding related issues

4.2.1 State-of-play

Europe is the home of world class research performing organisations and scientific publications which play an essential role in technology breakthroughs and innovation. However, the EU often faces difficulties in transforming science into commercial activity (“European paradox”) (Ménière et al. 2024). Academic research in Europe is typically focused on longer-term objectives, driven by the pursuit of knowledge and innovation that can lead to significant societal advancements over time. In contrast, the industry often prioritizes quicker returns on investment to meet emerging market demands and business opportunities. Collaborative R&D projects, involving both academia and industry, are one option to improve knowledge exchange and technology transfer between these two groups. However, they must be designed in a way that they can be expected to produce practical results that contribute to innovation scalability.

As bioeconomy aims at transformation of the fossil-based, mainly linear economy into a more bio-based circular economy, also social and organisational innovations as well as behavioural and life style changes

are required. They are rooted in the understanding of human behavior, social relationships, human culture and expression. Therefore, in addition to natural sciences and engineering sciences, also the scientific disciplines of social sciences and humanities play a key role in applied bioeconomy R&D (Voelcker et al. 2025).

4.2.2 Recommendations

Improve knowledge exchange and collaboration between academia and industry

- **Aligning research with industry needs:** It is important to ensure that applied research and especially collaborative research is better aligned with industry needs. Target groups for the following recommended activities are policy makers, research and industry associations, clusters and collaborative platforms, and tech transfer agencies. Collaborative platforms/clusters can facilitate collaboration between scientists, engineers, and business professionals to integrate technical innovation with business feasibility. All actors mentioned above should conduct regular assessments to identify emerging industry needs and trends. This information should be utilized to guide research agendas, ensuring they remain relevant and impactful. Funding agencies can foster research-industry dedicated funding and highlight it in funding calls.

Create more favourable conditions for academics in bioeconomy-related inter-and transdisciplinary research and collaboration with industry and non-academic stakeholders

A major criterion for academic careers is a track record of highly cited peer-reviewed publications in top journals. Although researchers may be interested in inter- and transdisciplinary research and academia-industry collaborations, the results from these activities may not always lead to this kind of publications. Consequently, this may hamper the interest and priority to collaborate with other disciplines, industry partners, or non-academic stakeholders and the general public, especially for younger researchers who still have to build their academic careers.

Recommendations

- **Encourage collaborative culture in academia:** institutional culture that values and supports collaboration with industry partners alongside traditional academic achievements are necessary. University leadership and department heads should take a lead in promoting this kind of cultural shift of academic thinking and in developing corresponding skills.
- **Create conditions in academic institutions which provide incentives for academia-industry collaborations:** Academic institutions should implement policies that use a broader set of performance indicators beyond peer-reviewed publications and impact factors for career pathways and for resource allocation (e.g. personnel, budget, equipment). Such sets of indicators could comprise e.g. acquired grants, acquired grants for collaborative projects, filed patent applications and patents, being a member of industrial networks or of company advisory boards, track record of founding companies, co-publications with industry, non-academic publications. Similar criteria could be applied by national research funding bodies, e.g. when evaluating grant applications for collaborative projects.
- **Build trust and understanding:** In addition to academia, industry associations and collaborative structures should act as facilitators for establishing communication between academia and industry so that both sides understand each other's needs and interests and build trustful relationships.

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- **Encourage and support inter- and transdisciplinary research:** It is recommended to establish an institutional culture more broadly that values and supports interdisciplinary research between natural sciences and engineering disciplines on the one hand and social sciences and humanities on the other hand. Moreover, transdisciplinary research should be appreciated and supported: it integrates knowledge and perspectives from various academic fields and non-academic stakeholders to address complex, real-world issues in a socially relevant way. In several Horizon Europe cluster 6 calls, multi-actor co-creation approaches are already mandatory. This should be continued and expanded. Guidance and good practice for applicants how to prepare multi-actor projects is provided e.g. by the project PREMIERE (Preparing multi-actor projects in a co-creative way). National funding organisations should also demand such transdisciplinary multi-actor, co-creative approaches and provide sufficient incentives.

Support technology transfer capabilities

In addition to collaborative projects, consultancy and spin-out companies, patents are important instruments for technology transfer. European universities play an important role in patenting and thus as a source of innovation in Europe. Academic patent applications have increased significantly over the last years, due to reforms on Member States and Higher Education Institutions (HEIs) levels. The extent of academic patenting can therefore be taken as an indicator of knowledge diffusion and technology transfer from HEIs to industry and to markets. However, there are several shortcomings in this IP transfer pathway. In view of the debate about Europe's economic global competitiveness the translation of IP can no longer be a “nice to have”, but a “must do (faster)” because every patent that is not actively translated equates to lost added value.

Public funding of R&D mainly allows the completion of the scientific work. However, the validation of research results often cannot be accomplished in these publicly funded R&D projects. There are too few options to acquire funding for this validation work. In addition, expenses for filing patent applications and maintaining patent protection are often incurred after the end of a publicly funded project and can therefore not be accounted for in the project. This is a funding gap.

One has to distinguish between indirect and direct academic patent applications. Indirect academic patent applications are often based on academic knowledge generation (e.g. the result of joint academia-industry activities). They are typically filed and owned by companies which have expertise in the patenting process and the exploitation of the patent. These applications have a higher likelihood of meeting industry’s immediate needs. By contrast, direct academic patent applications are often more science-based, and the path to commercialization may be less obvious. For these cases, support of inventors in academic institutions or in spin-off start-up companies by Knowledge or Technology Transfer Offices (TTO) at HEIs plays an important role.

However, there is a wide variety of models across European countries and HEIs on how these TTO operate and how well their performance supports both academic inventors as well as SMEs aiming at acquiring or licensing academic knowledge or technology (Ménière et al. 2024). Many academic inventors and SMEs perceive the processes for filing patent applications or finalising licensing agreements as too complex, long and resource intensive. There may also be conflicts between the HEI and the innovators whether short- to medium term revenues (interest of the HEI) or long-term success of a spinout company (interest of inventors and founders) should be prioritized (SPRIN-D et al. 2023). The focus of TTOs on generating short- to medium term revenues from IP-transfer is often rooted in their financing model - if they need to pay their patenting fees and staff salaries from milestone payments and licensing fees.

Improving the conditions under which academic researchers can file patent applications and under which TTOs at HEI operate, rethinking priorities, and tailoring their services better to the needs of inventors and SMEs are therefore opportunities to support, speed up and intensify knowledge and technology transfer from HEI to industry.

Recommendations

- When defining technology transfer strategies and policy for a country or HEI, it is essential to be aware of the existing diversity across the EU and also within Member States. Therefore, technology transfer strategies and policy should be specifically tailored to the national frame conditions, the HEI research performance and portfolio and the TTO model and capabilities.
- Funding agencies should consider whether they could add validation modules to publicly funded projects or offer specific validation support programmes. They should also consider implementing instruments which could cover fees for filing patent applications and for maintaining patents.
- Academic institutions and their TTOs should develop clear spin-off policies which make it transparent to founding teams and investors how the respective institution deals with IP and which conditions it offers. Good examples of this are Imperial College in the UK, Columbia University in the USA and the Swiss Federal Institutes of Technology in Lausanne (EPFL) and Zurich (ETH) in Switzerland (SPRIN-D et al. 2023).
- TTOs should implement standard operating procedures and model contracts for IP cases that represent the majority of cases in the respective HEI. These model procedures and contracts can then be efficiently adapted to the individual case. Such standardisation, combined with flexible adaptation options, increases transparency, efficiency, and legal security due to reduced errors.
- TTOs should be encouraged and supported to develop and implement spin-off policies, standard operating procedures and model contracts.
- An effective and efficient support of IP transfer processes require interdisciplinary knowledge in the TTO team, in technology as well as in legal and administrative affairs. Salaries, incentives and work conditions should be attractive to recruit staff with the required expertise and experience. In-house TTO expertise could be complemented by the option to buy in services, e.g. specialised patent lawyers.

5. Scale-up and deployment

The transition from lab to fab for research results is essential to enter the market and covers different stages and activities, such as techno-economic optimization of scaling-up of batches to build up commercial plants as well as getting the capacity, resources and knowledge to enter markets in case of SMEs. The following recommendations divide between those dimensions in the sub-chapter 5.1-5.3 and focus mostly on financial needs arising in those phases, while e.g. education or identification of concrete technical hurdles was outside of the scope.

5.1 Scale-up of bioeconomy innovations

5.1.1 State-of-play

Scaling up bioeconomy innovations is crucial because it bridges the gap between promising laboratory research and commercially viable products or processes, because of following challenges:

- **"Valley of Death":** The transition from lab to market is often fraught with challenges, leading to a phenomenon dubbed the "valley of death." Many innovative biotechnologies fail to reach their full potential because they struggle to overcome the technical and financial hurdles of scaling up.
- **High Costs:** Scaling up requires significant investments in infrastructure, equipment, and expertise. Demonstrating viability at larger scales is essential for attracting investors and securing funding for further development.
- **Market Readiness:** Only by scaling up can a bioeconomy innovation be proven suitable for mass production and market adoption. This ensures its relevance and impact on the broader economy.

Essentially, scale-up transforms promising research into tangible solutions that can drive growth and sustainability in the bioeconomy sector.

To ensure successful scale-up of innovative projects to market readiness, a state-of-the infrastructure, actor capabilities and appropriate financial resources are perquisites. To bring research ideas to the markets and consider the different roles of actors in the value chain (e.g. technology developer, material supplier, service provider) a range of public and/or private infrastructure and funding support is needed for de-risking.

Therefore, we consider:

- The critical phase from lab to scale TRL 4-7 and the role and financing of pilot and demonstrations plants (PDIs).
- Private and public financing from lab to commercial biomanufacturing (TRL 8-9), including the CBE JU and current IPCEI activities.
- The start-up funding and supporting their growth and development, considering the key role of SMEs in the bioeconomy.

5.1.2 Recommendations

Raise awareness about the existing European scale-up infrastructure asset

The transition phase from smaller lab-scale prototype to industrial scale operation is crucial because it demonstrates the feasibility and economic viability of technology for widespread adoption. Scale-up is vital for several reasons. First, for validation purposes as it confirms that a technology can perform as expected at larger volumes. Also, for commercialization as it paves the way for commercial production and market entry. Lastly, for the economic impact as it unlocks the potential for significant economic growth and job creation in the bioeconomy sector.

Scaling up the bioeconomy in Europe's innovation strengths requires greater attention to lead to adequate impact, both in terms of sustainability and economic impact.

Open access, multipurpose, shared pilot and demo facilities play an **important role** in supporting innovation from the lab towards industrial scale. They enable faster, cheaper and better scale-up of innovative bioprocesses and thus de-risk the innovation trajectory of start-ups and SMEs.

Europe has a great asset in this respect more than 120 already existing open-access pilot and demo facilities, enabling the scale-up of all innovative bio-based processes including microbial proteins, functional food ingredients, dyes, biosurfactants, bioplastics, biopesticides, biochemicals, biomaterials, biofuels. They open their doors to bioeconomy innovators to use their existing infrastructure, without additional time and resources for purchasing ab equipment needed. We therefore call it shared infrastructure. It was not invested for a one-off specific scale-up exercise but serves to scale-up multiple bioprocesses. The infrastructure is to be shared with multiple users. Consequently, this is a cheaper solution, for both the innovative companies

and society. For the innovators, as they do not need to invest in expensive scale-up equipment themselves, they can just access a pilot facility and pay a service fee. For the society, not spending regional or EU money to build single-use pilot lines, but a fewer number lines with shared capacities. In addition, the pilot and demo facilities have specifically trained staff (bioprocess engineers, bioprocess technicians) who are adept at dealing with the challenges involved in scaling up innovative bioprocesses. Since it is about innovation (tested for the first time in the world), being able to deal with failures is important in this respect. Individuals working at a PDI view these as challenges and enable higher-quality in scale-up activities.

Those advantages contribute to EU competitiveness in the bioeconomy by being faster, cheaper and better than in individual activities. The strong and broad European network of Pilot and Demonstration Infrastructures (PDIs) can be used as an **asset to accelerate** the deployment of large-scale biomanufacturing.

ShapingBio's assessment addressed bioeconomy scale-up infrastructure network Pilots4U[16], which grew out of a BBI JU project (2017-2019). This network currently relies on persistent efforts of a few PDIs to support the European ecosystem.

To support the bioeconomy in Europe, it is advisable to provide structural support for the Pilots4U platform, establishing it as a reference for technology infrastructures in this sector. Currently the Pilots4U database includes all PDIs and their equipment across Europe and is currently undergoing a transformation. A new version of the platform is scheduled for launch in June 2025 as part of the CBE JU project Copilot.

Pilots4U serves as a vital operational tool for biotechnology companies, who are seeking support for scaling up their innovations. Its integration within the EU Biotech Hub positions it well, yet there remains an opportunity for it to assume an even more pronounced role in the bioeconomy scale-up efforts.

Pilots4U network could be more actively involved in EU, Member State, and regional activities. An example of this engagement is the CBE JU's initiative to give more visibility European pilot and demo facilities through the organization of a PDI Fair, which has been positively received. These kinds of initiatives can further strengthen the role of Pilots4U in enabling innovation and collaboration across the bioeconomy landscape in Europe.

Keep scale-up infrastructures state-of-the-art instead of duplicating capabilities

PDIs have undergone significant expansion since 2022, driven by increased demand (2021) from start-ups and SMEs. According to the Pilots4EU database, the network included **262 Pilot & Demonstration Infrastructures (PDIs)** across **86 organisations in 14 European countries.** This expansion ensures ample capacity and availability to handle current and future scale-up needs[17].

A comprehensive survey conducted within ShapingBio (see Deliverable D2.2) showed that there is currently sufficient capacity (89%) and availability (94%) of these open access bioeconomy pilot and demo infrastructures. In the meantime, they cover 11 technology areas and 50+ different technologies and provide innovators (spin-offs, start-ups, scale-ups, SMEs, corporates) (Figure 6) a broad support for process development, for scale-up and for custom manufacturing.

[16] https://biopilots4u.eu/
[17] https://www.bbeu.org/projects/pilots4u-powered-by-copilot/

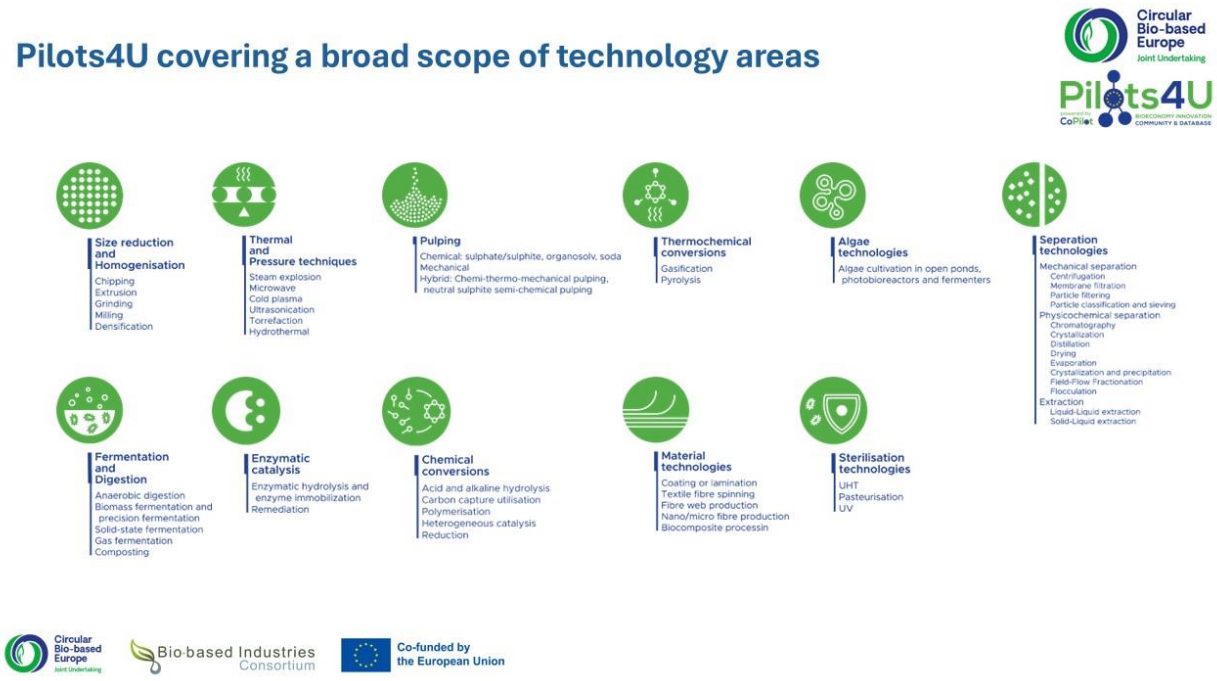

Figure 7: Overview of Technology Scope of Pilots4U database (2024).
Source: Author's explanation.

A large proportion of the surveyed PDIs (59%) still had short-term expansion plans in 2024. This goes hand in hand with PDIs' inherent drive to keep their infrastructures state-of-the-art (91%).

In the last period (2024-2025) a slowdown in the biotech sector is observed, with private investors becoming more reluctant to invest in bioeconomy innovation due to the higher interest rates and slow return on investment related to investing in bioeconomy innovations. This results in significantly lower scale-up demand at the existing PDIs, slowing down the scaling of innovation in Europe. At the same time, we see plans emerging in several regions within Europe to build additional pilot and demo capacity for scale-up of the regional bioeconomy[18].These development result in a need of support and coordination for PDIs.

Recommendations

- **Support the 120+ existing infrastructures in keeping them state-of-the-art**, investing in new equipment rather than further duplication within Europe. Support the users of PDIs by providing them with a scale-up voucher scheme instead of duplicating pilot and demo facilities everywhere and being left behind with many sub-optimal facilities with high CAPEX and OPEX demands, that are not viable in the long run.
- **Raise awareness among regional authorities** about the existence of a strong European pilot and demo infrastructure network open to all European bioeconomy innovators for a service fee and able to support and accelerate the deployment of regional bioeconomy innovations and provide mobility of regional

[18] https://www.emra.ie/two-midlands-bioeconomy-projects-awarded-e10-million-in-eu-jtf-funding/

scale-up co-funding. Regional funding should allow spending activities of funded organizations in other regions with a state-of-the-art pilot or demo facilities.

- **Use the Pilots4U platform to analyse the European scale-up capacity** and to detect specific pilot and demo infrastructure gaps. Support demand driven investments, based on these insights.

De-risk investments for private investors by co-funding the scale-up phase of bioeconomy innovators

For bioeconomy innovators, collaboration in an early stage of technology development with open access pilot and demo infrastructures, can substantially reduce costs, risks and development time/time-to-market and reinforces the chance to successful market entry. Scaling up bioeconomy innovations is and remains a lengthy and risky process compared to scaling up IT innovations, for instance. The capital requirements are of a different magnitude and the lead time of scale-up iterations is longer. As a result, private investors today are rather reluctant to close financial deals.

While there is significant support in Europe for supporting low TRL research, limited adequate financial support is available for the scale-up and demonstration phase of bioeconomy innovations. Therefore, the following measures should be taken into account.

Recommendations

- **Amplify derisking the scale-up phase of innovators**, by providing co-funding support and removing constraints to efficiently use open access pilot and demo facilities, hereby lowering the technological risk of bioeconomy innovations and increasing private investor's appetite.
- Create an **easily accessible and "fast application" voucher system for scale-up** (e.g. 50% co-funded, 100 -250 k€ for scale-up of biobased processes). Involve finance actors in the development of co-funding support schemes. Regional funding should allow spending in other regions with a state-of-the-art pilot or demo facility.
- **Increase budgets for higher TRL or later stage innovation support**, adapted to the higher capital requirements involved.

Support of cross-border use and collaboration of PDIs

The European wide operational PDIs cover a broad scope of various technology areas in the bioeconomy and provide process development and custom manufacturing in addition to scale-up support. The knowledge and expertise of the people working within the PDIs plays an important role. They help lowering the technological risk that an innovation has in a lab phase to stimulate the appetite of investors to invest capital in the large-scale deployment of bioeconomy innovations.

For innovators in the scale-up phase, it is important to find the open access pilot and demo infrastructure that best suits their process (using a specific technology out of 50 different bioeconomy technologies). However, these demo-sites are often located in another region or country.

Recommendations

- Provide bioeconomy innovators the **opportunity and support to leverage the capacity and manpower of existing PDIs,** anywhere within Europe. As a result, accelerate their scale-up phase, with the regional development of large-scale biomanufacturing as the main driving force.
- **Facilitate collaboration between PDIs across European regions**, enabling SMEs to access the most suitable infrastructure regardless of location.

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- **Provide mobility for regional/national funding schemes** so that regional SMEs can tap into the performing and widely available scale-up facilities in Europe that best fit their scale-up needs. Existing pilot and demo infrastructures already have the bioprocess expertise and, through cross-border collaboration, can provide (1) engineering support in designing large-scale manufacturing sites and (2) provide and train the personnel that will be deployed in these manufacturing sites.

5.2 Financing for scaling-up to commercial level production

5.2.1 State-of-play

In the following the broader perspective of innovation financing to scale-up throughout higher TRL-stages (also e.g. including private demonstration plants) of public funding in combination with private financing is taken. According to the majority of stakeholders approached in ShapingBio. a well-designed public support is important to de-risk private sector investments and build up biomanufacturing capabilities and capacities. However, companies should avoid becoming fully dependent on public funding. There have been advances in recent years for funding of pilot and demonstration on the EU level with few Member States, taking actions to combine public and private investment models (table 2).

Table 2 Example for funding of pilot and demonstration activities on EU level and by their Member States

Geographical Area			
Name of Instrument	**Industrial Bioeconomy**	**Shared Island Bioeconomy Demonstration Initiative**	**Circular Bio-based Europe (CBE)**
Funded activities	use of existing demonstration plants build of private demonstration plants and, new model in end 2025: support for build-ups of commercial plants	Development of Biorefineries (TRL 6-8)	Demonstration projects (DEMOs): TRL (6-7) Flagship projects (FLAGs) for projects – first-of their kind large-scale production facilities in Europe (TRL 8)
Time Period	2021-	01.03.2024 - 31.12.2026	Since 2014: (prior BBI)
Volume	n.a.	Annual Budget 20 Mio €	2014-2023 DEMOs: 405 Mio € FLAGs: 339 Mio €

Source: BMWK (2025), CBE JU (2025), DFAM (2024).

In addition, some other countries have either broader bioeconomy funding programmes (e.g. Portugal) or more general industrial related programmes (e.g. France) which provide funding possibilities for bio-based demonstration or commercial plants. However, beyond those mentioned examples, coherent funding along the innovation chain is missing. While public funds support early-stage research, they often fall short in later stages, where substantial investments are required for infrastructure and market entry. In addition, for innovative collaboration projects, actors across the whole value chains and across sectors are of high importance. But those collaborations in innovation activities often only existent in earlier TRL-stages, as finance for later stage is missing. Moreover, despite the progress in funding described above, even in strong

innovating countries like Germany and Finland, companies and investors report challenges in securing sufficient financing for large-scale projects.

A more comprehensive funding landscape in the bioeconomy is needed that covers the needs of the actors in their progress in the innovation development chain for scaling-up. The following recommendations are complementary to cover the different financing needs and to booster the landscape.

5.2.2 Recommendations

Provide continuous and target-group adequate funding along the innovation and value chains

- **Ensure continuous funding possibilities throughout the innovation chain:** Funding frameworks that allow projects to apply for support at different stages of their lifecycle, from scale-up to commercialization, ensuring that critical long-term projects receive continuous investment and the changing needs during that journeys, are needed. This could be either provided by consistent funding landscape of closely interacting funding agencies with highly harmonized funding procedures. Another option are funding schemes (e.g. on EU level related to EIC or EIT) that are milestone-bounded. This approach aligns funding calls with specific developmental, market, or technological achievements, promoting strategic and measurable progress and could be combined with an increasing request for private contributions (e.g. from investors). For the details to elaborate a well-functioning instrument, which may not be solely elaborated for the bioeconomy and should avoid overarching bureaucracy, it would be needed to elaborate in an extra study. [19] Another related option is a high flexibility of funding agencies, e.g. following the example of the German SPRIN-D (Federal Agency for Breakthrough Innovation), which customizes its financing timelines to align with the specific development stages and needs of each project. Moreover, it acts via calls for market and societal challenges, such as the circular biomanufacturing challenge.[20]
- **Secure continuity by dedicated CSC (cross-sectoral collaboration) funding programmes** in higher TRL stages. Activities to fund those CSCs are needed and maybe linked to flexible multi-stage funding or coherent funding landscape but could also be larger programmes covering funding across the innovation chain. Hubs/networks (e.g. Clusters, Industry associations) can play a crucial role by acting as matchmakers in finding the right business partner for funding and long-term investments.

Enhance Public-Private Partnerships (PPPs)

Institutionalized PPPs can address the access-to-market challenge by combining public funding with private expertise and networks to navigate market entry and support de-risking investments, particularly in less mature bioeconomy ecosystems. PPPs offer joint funding mechanisms where public funds match private investments, particularly in scaling stages. By fostering cross-border collaboration, especially between regions with different innovation capacities, PPPs can enable knowledge sharing, harmonize market access strategies, and support the development of transnational value chains, ultimately reducing market risks and aligning public and private investment goals. Currently, the EIT Food and CBE JU are the only PPPs in the bioeconomy on EU-Level and hardly any comparable structures on national level in Member States. The CBE JU is highly valued by the stakeholders, and a recent evaluation points out its creations of many novel cross-sector interconnections within the bio-based sector as well as highly active participation of a diverse

[19] An important difference e.g. compared to the discontinued SME Instruments from Horizon 2020 would be that in each of the phase innovation activities in already higher scales would be funded (in difference to a differentiation between e.g. feasibility study and scale-up such exited for the SME instrument).
[20] https://www.sprind.org/en/actions/challenges/biomanufacturing

range of entities (SMEs, public research, etc.) (European Commission 2024b). Currently the CBE puts stronger emphasis on approaching those and includes farmers and encourages in some calls the participation of additional stakeholder groups in its CBE JU Widening Strategy, but not judgeable to which extent such activities have an impact.[21]

Recommendations

- **Establish more public-private partnerships (PPPs) activities** aimed at bioeconomy sectors using CBE-JU as a good example. These PPPs should focus on de-risking mechanisms, such as access to market and infrastructure support, to lower the entry barriers for private investors and increase cross-border collaboration. Important features of such PPPs should be appropriate inclusion of countries with moderate innovation capacities, but high biomass feedstock potentials, as well as a focus on cross-sectoral projects to overcome the CSC issues described above. For more details, it still would have to be explored in an extra study, where/how such (e.g. on EU-level or cross-border initiatives supported by EU) PPPs would be linked or even part of CBE.

Advance in IPCEI (Important Projects of Common European Interest) activities to booster the bioeconomy

However, the reconfiguration and partly completion of existing funding instruments may not be sufficient to boost the bioeconomy and to enter the stage of wide deployment. By spring 2025 there are activities towards the establishment of an IPCEI for biotechnology and biomanufacturing pushed forward by European countries.[22] An IPCEI is a transnational project of common European interest that makes an important contribution to economic growth, employment, competitiveness and resilience of the European industry and the economy through state funding. IPCEIs are special projects with rules enabling Member States to cover up to 100% of a project's funding gap with public funding for eligible activities (research and development and first industrial deployment). Hence, funding would not come from EU budgets, but a certain number of Member States. The number of Member States involved, and level of funding differ between the 10 approved IPCEIs in the range of €1-8 billion.[23] Prospectively, IPCEI could complement existing funding structures especially at TRL 9: CBE Flagships can provide funding up to TRL9, but only for first-of-its-kind commercial plants or products. By contrast, IPCEI funding could also support the construction of additional production plants or products. They would therefore offer broader opportunities for building-up of commercial plants.

Recommendations

- The **implementation of an IPCEI related to the bioeconomy** is encouraged, as it is a powerful cross-national tool to address finance needs for implementation of the bioeconomy. However, it is recommended that ICPEI should be aligned to the EU (Horizon Europe, CBE JU) and national funding landscape to complement thematically and to the needed innovation phases. Moreover, from EU perspective the participation of many Member States and ideally wide range of stakeholder types from different geographical areas would help to foster collaboration across the countries.

[21] https://www.cbe.europa.eu/system/files/2023-09/CBE-JU-widening-strategy.pdf
[22] Formally, the Joint European Forum for IPCEI decided a pre-assessment of biotechnology for 2025 under the lead of Germany, Estonia and Finland. See https://competition-policy.ec.europa.eu/state-aid/ipcei/joint-european-forum-ipcei_en#adopted-by-the-jef-ipcei
[23] https://competition-policy.ec.europa.eu/state-aid/ipcei/approved-ipceis_en

5.3 Start-up financing

5.3.1 State-of-play

Direct company financing is of key importance to support growth of companies and to cover expenses until commercialisation, other than applied R&D and process scale-up.

ShapingBio analysed private financing for bioeconomy companies, focusing on type, origin, extent and distribution of private investments across the EU bioeconomy innovation ecosystems via Dealroom database for the period 01.1.2021- 08.08.2024.

Regarding origin of investors, companies across all bioeconomy ecosystems in the EU secure funding from private investors situated both domestically and internationally, including global investors. Close to three-quarters of the sum of investment amounts come from investors' HQ that are located outside Europe. This is because the rest of the world takes part in mature deals are fewer but secure higher individual deals. Considering the classification of the European Innovation Scoreboard investments from investors with HQ in the EU come predominantly from strong innovators (9% of the total sum of investments), such as Germany or France and lead innovators (5,7%). Moderate and emerging innovators hold together less than 1%.

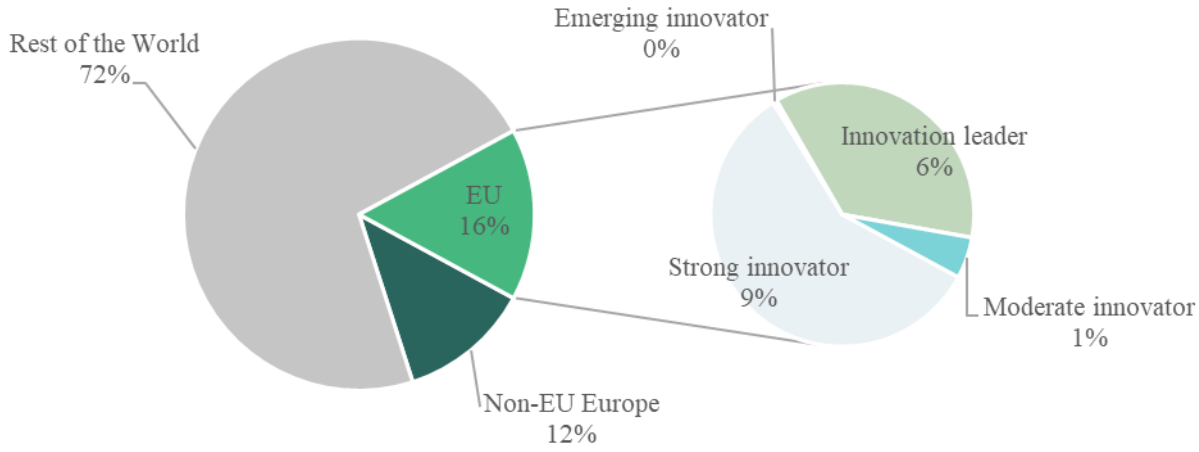

Figure 8: Investors in the EU bioeconomy by sum of investment amounts.
Source: Dealroom.co.

Regarding the geographical distribution of the financed companies, a similar picture emerges, with mainly the lead and strong innovators participating in deals.

ShapingBio analysis shows that there is a lack of sufficient financing for SMEs, particularly in moderate or emerging innovative countries moderate or emerging innovators. Regarding public support, a significant number of Member States have start-up and early-stage financing (but mostly not bioeconomy-dedicated) instruments, but similar possibilities do not exist in all Member-States. From private investors perspective, bioeconomy investments are high-risk with long time for ROI due to technological and market challenges. Moreover, the public-private efforts are insufficient from the investor's perspective regarding the number of activities and details of procedures. In addition, according to stakeholder opinions, bureaucratic processes

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required to secure public funds are often too complex and time-consuming, deterring smaller startups from accessing essential financing. This misalignment between public and private capital can lead to insufficient co-investment in bioeconomy ventures, limiting growth and innovation.

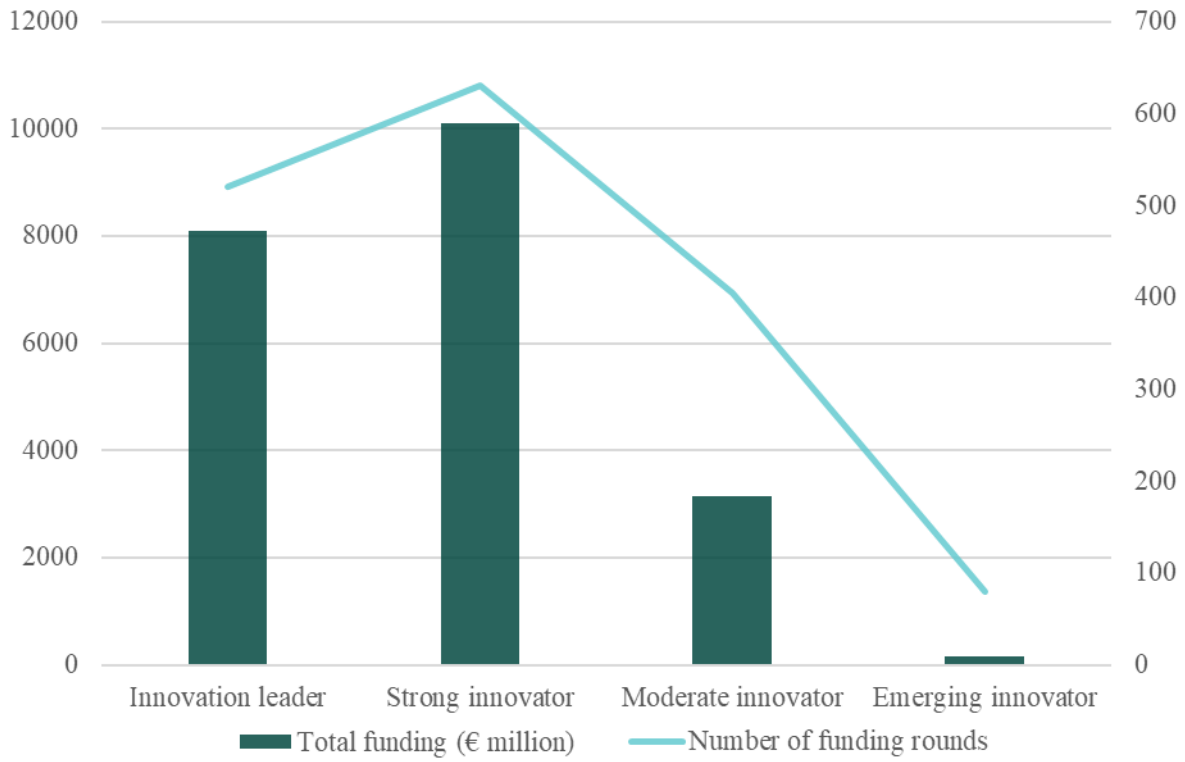

Figure 9: Total amounts and number rounds raised per innovator category.
Source: Dealroom.co.

5.3.2 Recommendations

Start-up funding addressing the needs of bioeconomy SMEs

- Regarding start-up funding, EU and the majority of the EU Member States **should streamline the pathway to commercialisation by creating specialised funding schemes** that provide early-stage capital to bioeconomy startups, particularly for spin-offs emerging from universities and research institutions. By offering pre-seed and seed funding, as well as tailored mentorship and business development support, these programs can address the gap in technology transfer and help scale the number of companies that reach investment-readiness.
- In a similar vein, **private investors should better address the full growth journey of bioeconomy companies** by providing tailored financial and business support across all stages. In addition, many bio-based segments are not yet established areas with clear investment modes and success stories, more investors should gain expertise in the bioeconomy and diversify investment portfolios by including deep tech and sustainability-focused innovations, which may have slower returns but significant societal impact.

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- To **reduce risk and to facilitate awareness and understand standardization of bioeconomy terminology** (technology nomenclature) across the EU for regulatory and funding frameworks is needed. This refined nomenclature could then be incorporated into funding calls at the EU, national, and regional levels, integrated into regulatory frameworks, and adopted in private market assessments, studies, and other relevant analyses. Such alignment is crucial to creating a cohesive environment for the bioeconomy, simplifying public financing application process, mitigating investment risks, and supporting the growth of bio-based innovations throughout Europe.

Further develop public equity investment schemes

Equity investment schemes, particularly those piloted by public organisations, play an essential role in supporting riskier bioeconomy projects by providing a critical buffer for private investors. By offering equity investments alongside private sector capital (co-investments), public institutions can help mitigate the perceived risks associated with bioeconomy projects. Public equity investors usually co-invest with private investors, enabling the later ones to diversify their portfolio by being able to join more investments with significant high investment rounds. Furthermore, these schemes are often structured to offer favourable conditions, such as longer investment horizons or lower return expectations, allowing bioeconomy projects the time and flexibility needed to reach commercialisation and market entry.

On the EU level already a range of instruments exist. The European Circular Bioeconomy Fund (ECBF) has a raised more than €300 million and has invested in 16 circular bioeconomy start-ups with activities in TRL 6-9 as of between 2019-June 2024 (Technopolis 2024). The fund has a market share of investment in the European bioeconomy of around 15% and has been successful to addressing the funding gap for bio-based innovation, as for every € of public investment, €12.30 of private capital has been leveraged. (Technopolis 2024). However, it is also constituted that the overall bioeconomy VC market in Europe remains relatively small compared to US. In addition to ECBF, at least some countries have public equity funds with significant investments in the bioeconomy, and according to a ShapingBio survey they are quite known among the answering companies. Regarding the functioning of public-private co-investments, unsurprisingly the issue of co-public investment was discussed diverse with stakeholders, as the investors and companies are not all focused on such financing approach.

Recommendations

- The **existing public equity schemes with relevance to the bioeconomy should be continued and ideally expanded** to match the potential need regarding the innovation pipeline in the bioeconomy. It should be ensured that these funds are - especially if they are not dedicated to bioeconomy- have specific expertise in the various fields of the bioeconomy. Moreover, information should be provided on the role and characteristics of public equity schemes to mitigate unjustified concerns which prevent some companies from even considering this option. In addition, hubs/networks (e.g. Clusters, Industry associations) can play a crucial role by acting as matchmakers in finding the right business partner, funding and long-term investments from smart investors. Regarding the ECBF, the recommendations of the evaluation (Technopolis 2024), e.g. regarding the expansion of sectoral focus and blended instruments to fulfil partially high financing needs, are well in line with ShapingBio findings of needs, and strongly supported.

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6. Market formation and growth

6.1 State-of-play

Market development in the bioeconomy is essential for driving innovation, generating economic growth, and potentially to address environmental challenges, as it enables the translation of scientific advancements into commercially viable products. The bioeconomy is advancing in Europe, with increasing investments and policy support aimed at enhancing market opportunities. Collaborative efforts among stakeholders are essential to accelerate the development of new markets and to enable the EU to achieve a sustainable and resilient future. Bio-based solutions have demonstrated significant market development in different related sectors. Examples of these include:

- The adoption of bio-based plastics in consumer goods, Novamont is an Italian company (founded in 1990) that specializes in the development, production, and commercialization of biodegradable and bio-based plastics. Novamont biodegradable and compostable bioplastics Mater-Bi® is a starch-based family of bioplastics and is suitable for injection moulding, sheet and film applications. It is manufactured in the Novamont Integrated Biorefinery, which has a production capacity of 120.000 ton/year for compounding, and 60.000 ton for polyesters.
- In the food industry there is an increased uptake of bio-based packaging solutions. For example, Sulapac[24] is a Finnish start-up specializing in biodegradable, compostable materials made from wood and plant-based ingredients, to replace plastic packaging. The company Sulapac was founded in 2016 with the mission of reducing plastic pollution by developing innovative alternatives to traditional plastic. Sulapac's core product is made from renewable materials, such as wood fibres and plant-based biopolymers. The company has partnerships with global players in their field, such as Nestle, L'Oréal and Stora Enso.
- Another example is the biofuels sector, where advanced biofuels are developed from different waste materials. Novozymes is known for its development of wide range of enzymes that facilitate the production of different products, including biofuels, particularly ethanol. Bioenergy sales for the full year 2023 increased 23% compared to 2022. [25]

These examples showcase the potential for significant adoption of bio-based products, highlighting both established successes and emerging projects that could further contribute to market growth. However, the potential of success stories is manifold higher than already realized today. Typically, bio-based products face higher production costs compared to conventional industries and bio-based products face regulations, infrastructure, user practices and preferences that are only aligned with the needs of existing (usually fossil-based) technologies. Hence, there are several justifications and reasoning for demand-side policies in the bioeconomy:

- **Market Development and Adoption**: Bio-based products often face higher production costs compared to traditional fossil-based materials. Moreover, there are (potentially inefficient) path dependencies to existing facilities and the already highly optimized traditional chemical processes. Demand-side policies, such as subsidies, tax incentives, or public procurement policies, can help create a market for bio-based products. By increasing demand, these policies encourage businesses to invest in and scale up the production of bio-based goods, making them more competitive in the market.

24 https://www.sulapac.com/
25 https://ethanolproducer.com/articles/novozymes-bioenergy-sales-up-23-in-2023

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- **Innovation and Technological Advancements**: Demand-side policies help to create a stable market environment that encourages innovation. When there is consistent demand for bio-based products, companies are more likely to invest in research and development to improve product performance, reduce costs, and expand applications. This can lead to breakthroughs in bio-based materials, making them more viable for a wider range of industries.
- **Environmental and Economic Benefits**: By fostering demand for bio-based products, demand-side policies help reduce reliance on fossil fuels and lower carbon emissions. This shift supports the transition to a more sustainable economy. Additionally, a growing bio-based industry can create green jobs, stimulate local economies, and reduce environmental pollution, contributing to a broader societal benefit.

The importance of market formation via demand side policies has been already recognized by the EU policy makers. The current EU Bioeconomy Strategy has already highlighted the importance of demand-side measures for bioeconomy. The strategy calls for policies that create market incentives for different bio-based products, especially in terms of labelling, sustainability measurement and standards, Action 1.4 will promote and further develop existing standards and labels and the development of public procurement guidelines for biobased products. For example, to increase consumer acceptance of new products, reliable and comparable information on the environmental performance of products should be available to consumers (e.g. using the Product Environmental Footprint (PEF) method). Moreover, the Bioeconomy Strategy highlights the importance of public procurement policies for bioeconomy to increase the integration of biobased products and services into consumption patterns. On a general level, the EU has already introduced the Green Public Procurement (GPP) as a voluntary measure, designed to promote green products and services. The basic concept of GPP relies on having clear, verifiable, justifiable, and ambitious environmental criteria for products and services, based on a life-cycle approach and scientific evidence base[26]. The European Commission (EC) has already been developing voluntary GPP criteria for several product groups. Furthermore, following the adoption of the 2020 Circular Economy Action Plan, the Commission is proposing minimum mandatory GPP criteria and targets in sectoral legislation and phase in compulsory reporting to monitor its uptake.

Moreover, 8 of the 11 EU Member States with bioeconomy strategies have at least some elements of demand-side policies included in their planned policy actions, such as consideration of bio-based products in public procurement (e.g. Finland, Portugal) market incentives for bio-based production/consumption (e.g. creation of predictable and stable tax policy for the bioeconomy sector in Latvia). Regarding actual implemented demand-side policies in the bioeconomy there is a wide of range of potential instruments, see Figure 10 for potential instruments and some examples in Figure 9.

26 https://green-business.ec.europa.eu/green-public-procurement_en

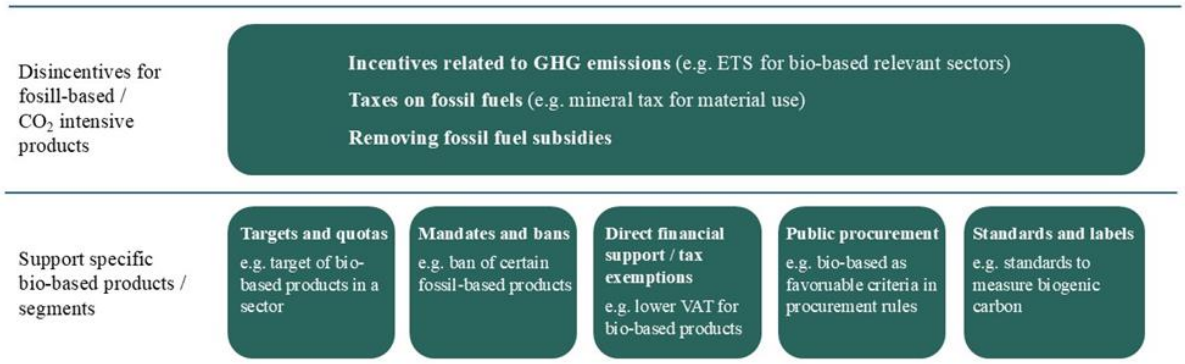

Figure 11: Demand-side policy instruments.
Source: Fraunhofer ISI

Table 3 Selection of Demand-Side Policies in the EU and its Member States

Member State	Type of Instrument	Measure	Footnote to Link
	Incentives Related to GHG Emissions	The EU Emissions Trading System (EU ETS) increases the cost of carbon emissions, making biofuels more attractive as a sustainable alternative to conventional fuels and thus incentivizes a shift to bio-based alternatives.	27
	Targets and Quotas	The EU sets targets for biofuel use in transportation, heating, or power generation. The EU MS follows the EU Renewable Energy Directive (RED III), setting a target for at least 5 % of advanced biofuels in transport fuels by 2030.	28
	Targets and Quotas	Italy establishes quotas, e.g. 60% minimum share of bio- based content in plastic bags in the Italian market from 01/01/2021.	29
	Target and Quotas	From 2030, the use of bio-sourced or low-carbon materials in France will represent at least 25% of major renovations and constructions covered by public procurement.	30
	Mandates and Bans	EU aims to minimize deforestation and forest degradation by banning products linked to such practices and requiring that wood and other raw materials supplied to the EU market meet strict sustainability standards.	31
	Mandates and Bans	Italy enforces the mandatory use of compostable plastics in supermarkets with increasing share of renewable materials.	32

27 https://ec.europa.eu/clima/policies/ets_en
28 https://joint-research-centre.ec.europa.eu/welcome-jec-website/reference-regulatory-framework/renewable-energy-recast-2030-red-ii_en
29 https://www.gazzettaufficiale.it/eli/Id/2017/08/12/17G00139/sg
30 https://www.ecologie.gouv.fr/
31 https://eur-lex.europa.eu/legal-content/DE/TXT/PDF/?uri=CELEX:32023R1115
32 https://www.gazzettaufficiale.it/eli/id/2021/11/30/21G00210/sg

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	Mandates and Bans	Austrian legislation prohibiting certain lubricant additives and chainsaw oils components that are harmful to the environment.	33
	Direct financial support/ Tax incentives	Finnish tax breaks or discounts encourage businesses and consumers to shift to clean technology (e.g. bioenergy, biofuels, equipment key technologies for climate-neutral economy)	34
	Public Procurement	Dutch National Biobased Products Procurement Database (BBPD) provides guidance for public procurement	35
	Standards and labels	Germany's Blue Angel eco-label certifies bio-based products like furniture and cleaning agents as environmentally friendly. Labels like this highlight the environmental and social benefits of bio-based products, helping consumers make informed choices.	36

Source: Fraunhofer ISI

Despite these examples of supportive policies, demand-side policy instruments are highly scattered in terms of geographical areas in the EU covered, segments of bio-based products addressed, and instruments used. According to stakeholders consulted in ShapingBio the strongest reason for this stagnation is the lack of political will to implement such measures. Moreover, lobby interests and potential unintended effects may hamper implementation. Regarding the latter, specific measures may favour certain biomass uses over others, bringing discussions about priorities and hierarchies of biomass use into consideration. In addition, some instruments may have an impact on market structure, e.g. certain measures may force also small companies to conduct LCA or certified biogenic carbon etc., which may be very costly for them.

Another characteristic for implementation is that all instruments have close links to other policy fields and activities. There are close links to circularity, e.g. to which extent also recycled non-biomass products, waste or certain uses are included. Another example is the revision of Public Procurement Directive which may present an opportunity for emphasising the strong role of bio-based products.

Currently a range of these policy instruments are discussed at EU-level and few Member-States, focusing on quotas, modification or adding of additional emissions-trading systems that favour biogenic carbon or better GHG-emission performance of bio-based products.[37] However, each of these instruments have its potential and drawbacks with most of them cover only some segments of bio-based products.

6.2 Recommendations

- With the transition of the bioeconomy towards implementation, the EU and its Member States should **put stronger emphasis on economic instruments for demand-side policy** for bio-based products and services. A **coherent policy mix** ideally consists of several measures, ideally disincentivizing use of fossil products (e.g. by higher taxes or reduced subventions) and supporting bio-based products. For the design of instruments which focus on bio-based products, a **clear strategy and common understanding** is needed. Such a strategy must either prioritize selected biomass use pathways or define criteria which must be fulfilled by the respective product (e.g. certain environmental impacts).

33 https://www.ris.bka.gv.at/GeltendeFassung/Bundesnormen/10010629/Verbot%20bestimmter%20Schmiermittelzus%c3%a4tze%20und%20Verwendung%20von%20Kettens%c3%a4gen%c3%b6len%2c%20Fassung%20vom%2010.12.2021.pdf
34 https://www.twobirds.com/en/insights/2024/finland/government-proposal-for-a-law-on-tax-credits-for-clean-technology-investments
35 https://www.agro-chemistry.com/articles/new-bio-based-products-are-added-every-day/
36 https://www.blauer-engel.de/en
37 See e.g. for Germany https://biooekonomie.vdi-tz.de/-lp/vXLXr29363/6Xsbw120, on EU-level the EC ..

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Moreover, such strategies should comprise the use of CO_2 and recycling to address the broader goal of a net zero economy. Synergies and coherence to other Strategic activities (e.g. circular economy, public procurement, energy policy) should be ensured as well as potential effects on market structures considered in implementation. Moreover, measures should be **closely connected to sustainability goals and derived environmental standards**.

- **National and regional activities** are especially important to implement green bio-based public procurement to address specificities of regional and national value chains. Therefore, demand-side policies could be linked geopolitical considerations, favouring local value chains, but still with a level-playing field inside the EU.

7. Collaborative bioeconomy ecosystem

7.1 State-of-play

Bioeconomy encompasses a wide range of different domains and sectors, such as primary production sectors (e.g., agriculture, forestry, fisheries), but also processing sectors, such as biotechnology, food, cosmetics or waste management. Each of these areas possesses specialized knowledge, techniques, resources and stakeholder groups. Ongoing global challenges related to climate change, increasing market demand for more sustainable products and services, are impacting the operating environment of all these bioeconomy sectors involved (Guerrero & Hansen, 2021).

Engaging in collaboration allows stakeholders from different sectors to bring together their unique and complementary perspectives and expertise, as well as resources, and presents a significant opportunity for established bioeconomy sectors to develop new technologies and production processes. The importance of collaboration in bioeconomy has already been recognized by the community due to its many-fold significance. By engaging in collaborative activities, different stakeholder groups can share resources and gain better access to funding. Furthermore, the exchange of knowledge and information, risk mitigation and improved communication between different stakeholder groups, to identify emerging problems and develop solutions (Fischer et al. 2024). Therefore, involving diverse stakeholders in collaboration throughout the bioeconomy innovation chain is of high importance.

The data gathered on the EU in the ShapingBio project shows that, over the past decade, the number of transnational collaborative structures in the bioeconomy has grown significantly (see Figure 12 below).

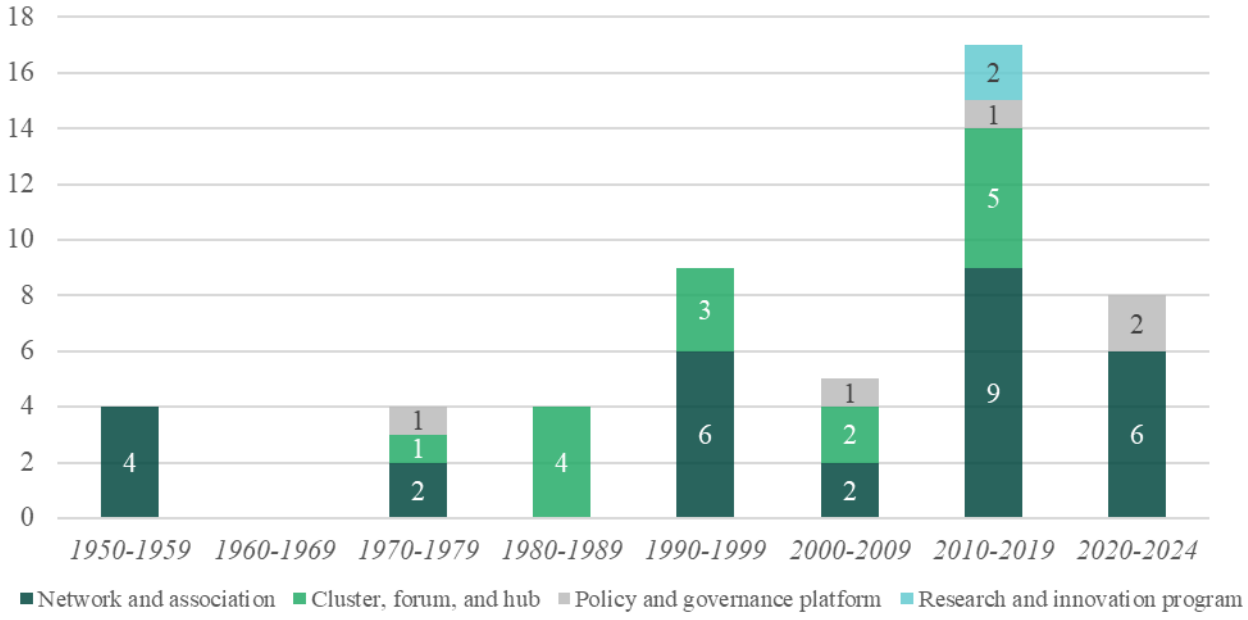

Figure 13: Development of collaborative structures in the bioeconomy.
Source: Fraunhofer ISI

Since 2010, the EU has witnessed a rapid growth of collaborative structures in bioeconomy. It indicates an increased awareness of bioeconomy in terms of increased sustainability and the need for a circular economy. Also, the rapid advancement of different digital technologies has supported setting up new collaboration by

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enabling cross-border collaboration. Most bioeconomy collaborations occur through the formation of associations, clusters, funding programs, and academia-industry partnerships. This allows for leveraging knowledge and resources from various sectors to comprehensively tackle the challenges and opportunities of the bioeconomy (Sakellaris et al. 2023).

SMEs are one of the key stakeholder groups in bioeconomy and play an important role in it. For example, the blue bioeconomy sector is predominantly comprised only of SMEs and the same way the agriculture sector, SMEs account for almost 80% of the activities across the value chain. The EU food and drink industry comprises 290,000 SMEs, which generate 39,1 % and 40,7 %, respectively, of the industry's turnover and provide more than half of the jobs in the sector (Food Drink Europe, 2023). These figures highlight the critical role of SMEs in bioeconomy development and the need for supportive framework conditions. In bioeconomy, it is therefore crucial to offer ongoing support for the creation of SMEs and their growth, as they are one of the key innovative stakeholders in bioeconomy that contribute significantly to the sector by fostering innovation and building resilience in a competitive market. Policy makers and research institutions increasingly recognize the valuable contributions SMEs bring to bioeconomy. Due to their smaller size, SMEs can make quicker decisions and adapt more readily to new ideas – an advantage that sets them apart from larger firms in collaborative settings. Additionally, SMEs often have a deep understanding of the specific challenges and opportunities within their sector and geographical location. Their focus on innovation and growth makes them more open and inclined to participate in collaborative initiatives, further enhancing their role in collaborative projects. (Fischer et al. 2024).

According to the data collected in the ShapingBio project, different EU funding programs, such as Horizon 2020 and Horizon Europe, have supported and incentivized partnerships by providing financial support for collaborative activities to all the stakeholders, including SMEs. These programs, especially the Bio-Based Industries Joint Undertaking and later Circular Bioeconomy Initiative (CBE-JU), play a very strong role in establishing cross-sectoral new value chains. Several KPIs (e.g. number of participating sectors and collaborative projects initiated, stakeholder engagement level, patent applications, innovation outputs and impact on employment) reflect the collaborative nature by either involving actors from different sectors or establishing VCs that require stakeholders from various sectors to come together and work on innovative solutions. For example, the strategic participation of (bio)waste managers are encouraged in the CBE JU projects, focusing on recycling and large-scale valorisation of sustainable biomass. Additionally, new bio-based value chains must introduce at least one new or innovative element. This may involve a novel feedstock, new markets for bio-based solutions and/or innovative technologies for converting sustainable feedstock into bio-based products. Moreover, the CBE JU acts as a catalyst for collaboration, encouraging actors to consider the entire value chain and seek optimal cooperation partners on an international scale[38].

Furthermore, the Strategic Research and Innovation Agenda of CBE JU[39] calls for further integration of bio-based research and innovation throughout industrial bio-based systems and increased the involvement of R&I actors including feedstock providers in the bio-based value chains. This will enable new forms of collaboration among key actors in bio-based systems to better involve primary producers, including in new bio-based value chains.

Also, the MSs have implemented a range of policy instruments and funding mechanisms to enhance cross-sectoral collaboration. These include R&D programs, public-private technological platforms, tax incentives, financial support for innovation projects, and European programmes aimed at fostering international cooperation in the bioeconomy (Fischer et. al. 2024; Sakellaris et. al. 2023).

[38] See more details: https://www.cbe.europa.eu/?utm_source=chatgpt.com
[39] See more details: https://www.cbe.europa.eu/system/files?file=2022-06/cbeju-sria.pdf

According to the information gathered in the ShapingBio, in the Baltic and Scandinavian countries, the complexities of cross-sectoral collaboration in the bioeconomy are characterized by varying degrees of cooperation among biomass producers and other stakeholders. While countries like Lithuania, Latvia, and Estonia exhibit relatively low levels of collaboration among biomass producers, preferring internal efficiency improvements, Sweden and Finland boast a rich tradition of collaboration, especially in the forest industry. This variation in collaboration can be attributed to different regional characteristics and specific local contexts. A positive case in the northern region is Denmark, where a strong tradition of dialogue and cooperation between public and private sectors is deeply embedded, fostering partnerships that yield innovative solutions for mutual benefit. This approach is particularly evident in value chains that derive from agriculture and the food industry, where agriculture is a significant supplier to the Danish biogas industry and the fishing industry provides raw materials to industries like pet food and fish-meal production.

In the Central and Eastern European countries, despite possessing valuable resources, collaboration often remains theoretical, with actual cooperation occurring primarily for securing financial grants. The BIOEAST initiative plays a crucial role in facilitating this interaction, aiding in identifying opportunities and challenges, and supporting innovative solutions for example in Bulgaria, where agriculture and forestry play significant roles in the bioeconomy. Initiatives by BIOEAST in the region support collaboration and include knowledge sharing, policy coordination, research and development collaborations, and capacity-building programs.

In most of the Western and Southern-European countries collaboration in the bioeconomy is focussed on aligning national strategies, fostering innovative research, and encouraging multi-level partnerships. The bioeconomy policies, often steered by ministries of agriculture, forestry, enterprise or economics, still require further collaborative efforts across sectors to harness the bioeconomy's full potential. To stimulate collaboration various policies have been implemented, which aim to foster an environment where diverse stakeholders can collectively address challenges and drive innovation. Some examples of strategies include Ireland's Food Vision 2030, the Netherlands' Top Sectors approach, and Belgium's National Energy and Climate Plan, each targeting specific sectors and challenges to optimize collaboration and resource flow (Fischer et.al. 2024; Sakellaris et.al. 2023).

Nevertheless, despite a supportive collaborative environment, certain specific aspects still hinder the full realization of the opportunities presented by bioeconomy. First, increased support from governmental agencies, industry associations and academic institutions is necessary to promote the creation of SMEs. A general lack of assistance in creating spinouts, spin-offs and start-ups leads to a limited number of new companies, resulting in fewer investments, jobs, and innovations. This issue is particularly pronounced in countries with low innovation index, where the culture and mindset of entrepreneurship in R&D institutions is basically missing[40].

7.2 Recommendations

Support of Spin-outs

- Increasing support for the **development of spin-outs from universities** to strengthen ties between research and industry is needed. A good practice is for example the **Flemish Institute of Technological Research (VITO)**[41] in Belgium receives funding from the Flemish Government based on the number of spin-offs generated annually, highlighting the potential for increased funding and innovation through

[40] https://research-and-innovation.ec.europa.eu/statistics/performance-indicators/european-innovation-scoreboard_en
[41] https://vito.be/en

this model. University administrations, policy makers, and industry stakeholders should take coordinated action to reform IP policies, enhance support to stimulate the creation of new companies.

- To effectively foster the growth of spinouts and spin-offs within the bioeconomy, it is essential to implement **targeted support programs**. These programs should include mentorship initiatives that can connect aspiring academics and entrepreneurs with experienced industry leaders, providing valuable guidance and insights throughout the business development process. Access to research and development (R&D) resources is also critical, enabling SMEs to innovate and develop competitive products. This could involve partnerships with universities and research institutions, allowing SMEs to leverage cutting-edge research and technology. A good practice example is **BioInnovate Ireland**, which is a collaborative initiative aimed at fostering the growth of spinouts and spin-offs in the health sector[42]. University administrations, policy makers, and industry stakeholders should take coordinated action on national level in creating targeted support programs.
- It is vital to establish **incubators and accelerators** that offer tailored assistance services to new companies. These programs should provide specialized resources, including mentorship, networking opportunities, and access to funding, specifically designed to meet the unique challenges faced by bioeconomy startups. An example of a national-level accelerator focused on the bioeconomy is the **Bioeconomy Innovation Platform** in **Sweden**[43]. University administrations, policy makers, and industry stakeholders should take coordinated action in creating incubators and accelerators.

Support bioeconomy SMEs capacities in technology transfer

In bioeconomy, SMEs are facing significant additional challenges compared to bigger companies. They struggle with long and expensive research and development processes, which require expensive equipment, expertise, and specialized facilities, which strain furthermore already limited SMEs resources. Additionally, the time needed to move from laboratory research to market-ready products can be lengthy, making it challenging for SMEs to generate immediate returns, which highlights the need for specific and improved support measures for the SMEs in the EU bioeconomy sector.

Recommendations

- **Outsourcing and Technology Licensing**: SMEs could consider strategically outsourcing some R&D activities to specialized research laboratories or universities, which may have the necessary infrastructure, cutting-edge technology and expertise, that may not be available in house. University administrations, industry associations, governmental agencies and technology transfer offices within academic institutions should take action in creating an ecosystem that supports SMEs in outsourcing and technology licensing.
  Technology licencing is another viable option for SMEs looking to accelerate their product development. By licensing technologies, SMEs can speed up the R&D process and reduce upfront investment costs associated with creating new technologies from scratch. This approach enables them to capitalize on innovations that have already been validated, enabling them to bring products to market more efficiently with reduced costs. Next to licensing in, also licensing out of the SMEs developments is an important option. University administrations, industry associations, governmental agencies and technology transfer offices within academic institutions should act in supporting SMEs in technology licensing strategies development. For more information on technology transfer between academia and

[42] http://www.bioinnovate.ie/
[43] https://www.ri.se/en/expertise-areas/projects/bioeconomy-innovation-platform

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industry, particularly regarding improving Technology Transfer Office (TTO) performance, see Chapter 4.3 above.

Support of cross-sectoral collaboration in the bioeconomy

It is essential to involve a greater diversity of stakeholder groups along the bioeconomy value chains, particularly in terms of collaborative activities. It is often challenging to involve primary producers, such as those in the agricultural sector, as they often are not up to date with potential opportunities arising from collaborative initiatives and have different culturally influencing factors (i.e. dominance of very traditional non-collaborative practices). This can therefore hinder the overall potential of bioeconomy. The integration of feedstock and primary producers into the entire value chain has been addressed at the EU level, as CBE JU encourages primary producers to get involved in its funded projects either as project beneficiaries or within the project's value chains. Certain segments are increasingly merging, reflecting a convergence of interests and practices of stakeholders. The data collected in the ShapingBio project indicates that a significant portion of primary producers, including agriculture, are increasingly integrating with other sectors. For example, waste collectors and recycling industries are becoming more interconnected with primary production, fostering a circular economy approach. In contrast, other construction and textiles sectors, are only beginning to be incorporated into this collaborative landscape.

This trend generally indicates a growing recognition of the interconnectedness of various sectors within the bioeconomy, although further efforts are necessary to fully integrate all relevant segments.

Recommendations

- **Enhancing legitimacy of bioeconomy:** Increase awareness of the bioeconomy concept among stakeholders and the wider public outside the bioeconomy community. Policy makers should drive efforts to boost the visibility and accessibility of bioeconomy inputs, outputs, outcomes, and impacts throughout the EU and across all stages of innovation.
- **Multi-actor approach:** EU policy makers should establish and sustain a multi-actor approach in bioeconomy that fosters dialogue among policy makers, experts, and stakeholders from academia, industry, civil society, and government. A primary objective of this approach is to cultivate a culture of engagement, collaboration and co-creation, ultimately enhancing the commitment to collaboratively advance a sustainable, resilient, and competitive bioeconomy.
- **Connecting primary producers to the value chain:** National level policy makers and industry clusters should set up an intermediate structure (e.g. cooperatives) that connect stakeholders to the next step in the value chain, such as different cooperatives. These connections are important for improving collaboration and ensuring that primary producers can access resources and support. Also, it is important to promote market access to help primary producers to gain access to new bio-based markets, which in turn motivates the stakeholders to participate in innovative value chains. Target groups for this initiative include associations and industry clusters that can facilitate these connections and support the formulation of cooperatives.
- **Establishing regional Innovation Hubs:** It is important to stimulate the creation of regional hubs, which could be also virtual, that focus the support of different bioeconomy-related industries and stakeholders. The hubs can serve as focal point for information exchange, networking, resources sharing to foster a supportive and collaborative environment for bioeconomy. As a second step, virtual hubs to physical investment, facilities activities in low-innovation countries (e.g. PDIs).
- **Developing and communicating case studies:** To increase the involvement of stakeholders, it is necessary to develop case studies that highlight the benefits of collaboration in the bioeconomy. These case studies should be effectively communicated to different stakeholder's groups, illustrating

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opportunities for bioeconomy and emphasise the cost-saving potential of CSC through circularity and resource optimization & identify and communicate cross-sectoral benefits and market opportunities. By presenting real-life evidence examples of success, stakeholders can better understand the potential advantages of collaboration in bioeconomy. Target groups for this initiative include associations and industry clusters that can disseminate this information.

Aligning services offered by intermediaries and collaborative platforms to actors needs

The services offered by intermediaries and collaborative platforms face the challenge of not adequately aligning with the evolving needs of their members in a rapidly changing environment. Additionally, in EU regions where the bioeconomy concept has not yet been fully implemented, there is often a scarcity of physical spaces for stakeholders to facilitate the exchange of ideas. These physical spaces, such as innovation hubs, research centres, and networking environments, have been shown in the ShapingBio project to be effective practices for fostering partnerships and exchanging ideas among various stakeholders. However, not all EU Member States are equally equipped with such facilities. In particular, regions of the EU where the bioeconomy concept has not yet been fully implemented, such as Central and Eastern European (CEE) countries, often experience a scarcity of physical spaces for stakeholders to engage in idea exchange. This issue is particularly pronounced in CEE countries, where infrastructure and resources are limited compared to more advanced regions like Northern and Western Europe. The absence of established venues for collaboration can hinder the development of innovative solutions and slow down the progress of bioeconomy initiatives.

Recommendations

- **Support collaborative structures:** targeted support is necessary to make sure that their services are well aligned with the needs of their members and users. This includes regular assessments of needs and dedicated funding to develop custom-made services for the members (e.g. networking, training, resource sharing, administrative support). Leaders and managers of collaborative structures should regularly assess the needs of their members and users through surveys, feedback sessions, and consultations. There is a need to proactively adapt their services based on this feedback.
- **Build partnerships with international and cross-border stakeholders** to broaden perspectives and access resources that support growth. Industry associations, governmental agencies and trade promotion agencies should take coordinated action in creating an ecosystem that supports bioeconomy stakeholders to build further partnerships.
- **Organize study visits** to expose members to current best practices to support active engagement and knowledge exchange. Collaborative structures leaders, industry associations and bioeconomy companies and other stakeholders should take coordinated action in organizing study visits that enhance knowledge exchange and building new partnerships.

To enhance cross-sectoral collaboration in the bioeconomy, it is essential to increase support for SMEs, fostering their growth through targeted programs and mentorship initiatives. Also, establishing regional innovation hubs and incubators can provide the necessary resources and networking opportunities for bioeconomy stakeholders. Policymakers should promote dialogue among stakeholders and make dedicated efforts to integrate primary producers into the value chain. Additionally, raising awareness of the bioeconomy concept will encourage wider participation and is essential for wider legitimation to unlock the full potential of bioeconomy and drive sustainable innovation across Europe.

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