

# MACRO-REGIONAL STRATEGIC PLAN

TO SUPPORT THE IMPLEMENTATION OF THE CIRCULAR  
BIOBASED EUROPE JOINT UNDERTAKING'S STRATEGIC  
RESEARCH AND INNOVATION AGENDA

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## Executive Summary

The BIOEAST Initiative aims to prepare a document, a so-called *Strategic Plan*, to contribute to the implementation of the Circular Bio-based Europe Joint Undertaking's (CBE JU) Strategic Research and Innovation Agenda (SRIA) and harmonize the efforts of the two organizations. The genre of the document is linked to the concept of the Strategic Plans used in the context of Horizon Europe priority setting and biannual work program preparations. The role of the strategic plan is to guide and orient the developers of annual or bi-annual work programmes. The main objective is to validate key pathways, needs, and region-specific topics that could be considered by the decision makers.

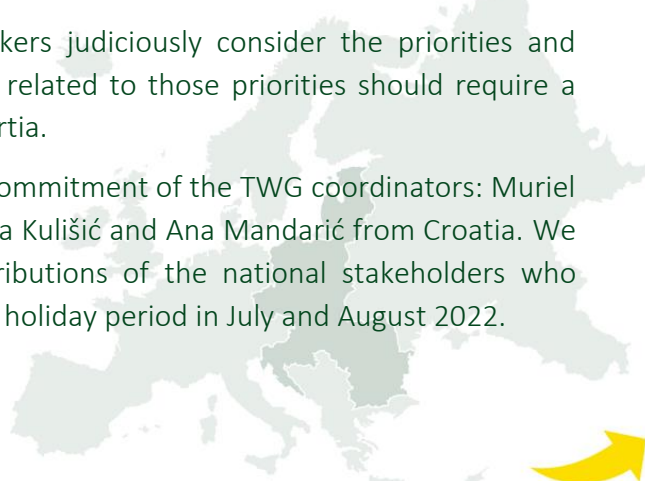
The BIOEAST Strategic Plan is based on the CBE JU's SRIA, published in May 2022. It considers the three general and six specific objectives set by the EU Council in the Single Basic Act, concerning the establishment of Joint Undertakings under Horizon Europe. The SRIA of the CBE JU defines strategic priorities for each specific objective. The aim was not to discuss needs and possible priorities of the Central and Eastern European (CEE) countries' bioeconomies in general, but to focus on the already defined strategic priorities and identify key aspects important for the BIOEAST macro-region.

The results of the exercise are well grounded, and participants of the validation workshop confirmed that this exercise could be repeated in 2-3 years. The methodology of validating the priorities is well established, and wider stakeholder engagement seems achievable, assuming the growing interest in BIOEAST countries. One should, however, consider the limitations of the exercise: there was a time limit, as well as constrained financial capacities. The aim was to deliver results as soon as possible, to be considered already during the autumn of 2022. Between June and September, two BIOEAST Thematic Working Groups were coordinating the exercise with the financial help of the Horizon Europe CSA project BIOEASTsUP. Most of the work, however, was done without financial support, thanks to the commitment and engagement of the members of the thematic working groups, the CBE JU State Representative Group members, a few Program Committee members, and external stakeholders who participated in the national validation and one central validation workshops.

A survey was conducted among bioeconomy stakeholders from the 11 BIOEAST countries to assess their needs and ideas. The results were processed according to a predefined methodology; weighted pairwise analysis was employed using an analytical hierarchical process, as a well-established multiple-criteria decision tool, to assess the needs and select the most relevant priorities in the macro-region. The expected impact of specific actions was assessed using action priority matrices. The coordinators identified 9 priorities and 9 actions to be considered during the preparation of the CBE JU's future working programmes. Moreover, these priorities could serve national level programming and action plan setting, aiding national decision makers in developing national level operational programmes.

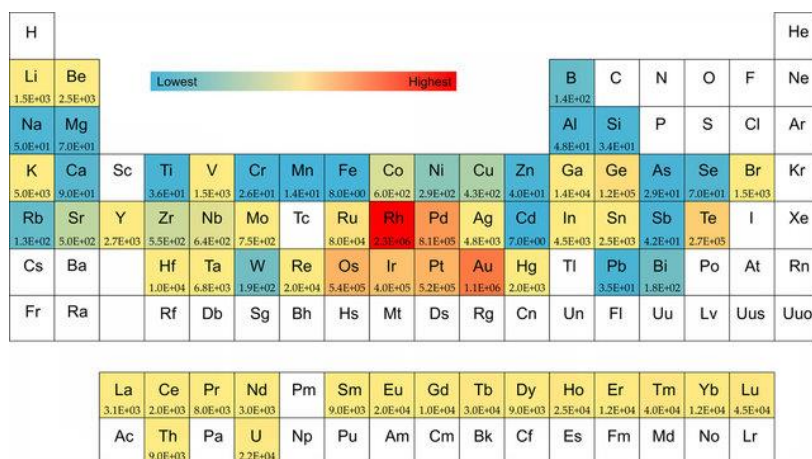
The BIOEAST Initiative recommends that decision makers judiciously consider the priorities and specific actions identified by this exercise. Future calls related to those priorities should require a significant participation of CEE countries in future consortia.

The strategic plan could not be developed without the commitment of the TWG coordinators: Muriel Jozó, Balázs Imre and Rita Soós from Hungary and Biljana Kulišić and Ana Mandarić from Croatia. We thank and greatly appreciate all the effort and contributions of the national stakeholders who participated in the survey and the workshops during the holiday period in July and August 2022.



## 1. Introduction

Currently, we are consuming Earth's resources much faster than they can be replaced<sup>1</sup>. The extraction and use of raw materials have major impacts on the environment. As the world's population and the global economy expand, consumptions of biomass, fossil fuels, metals, and minerals are expected to double in the next forty years<sup>2</sup>, while annual waste generation is projected to increase by 70% by 2050<sup>3</sup>. For the **European Union (EU)**, the finite supplies of crucial materials also mean that Member States (MS) are to a great extent dependent on imports from other countries.



**Figure 1** Total material requirement intensity of each mineral at the global level for 2015<sup>4</sup>.

Clearly, a substantial change is a must in our mainstream way of thinking to move away from the traditional, **linear economic model** that relies on large quantities of affordable, easily accessible materials and energy.

Prompted by these challenges at the global level, reflected in the UN's Agenda 2030 and the 17 sustainable development goals (SDGs), the EU launched the **European Green Deal**<sup>5</sup> (2019), a concerted strategy for growth achieving a climate-neutral, resource-efficient, socially just, and competitive economy. **Circularity** is an essential part of this wider transformation, being a model of production and consumption that stops wasteful practices by extending the life cycle of materials and products, creating cascading supply chains linking the output of one process to the input of another, and reducing waste to a minimum. This would reduce the dependency on virgin raw materials as well as the environmental pressures associated with material use, resulting in economic and environmental co-benefits. The **Circular Economy Action Plan**<sup>6</sup> of the EU provides a future-oriented agenda to implement and accelerate the changes required by the European Green Deal, mobilising economic actors, consumers, citizens, and civil society organisations.

In response to concerns about the long-term viability of the prevailing resource-intensive economic model, along with circularity, the concept of a **circular and sustainable bioeconomy (CSBE)** has been introduced in the EU, defined as the production of renewable biological resources and their conversion

<sup>1</sup> <https://www.un.org/sustainabledevelopment/sustainable-consumption-production/>

<sup>2</sup> OECD (2018), Global Material Resources Outlook to 2060.

<sup>3</sup> World Bank (2018), What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050.

<sup>4</sup> Watari et al. Total material requirement for the global energy transition to 2050: A focus on transport and electricity. Resources, Conservation & Recycling 148 (2019) 91-103 DOI: 10.1016/j.resconrec.2019.05.015

<sup>5</sup> COM(2019) 640 final.

<sup>6</sup> COM(2020) 98 final



into food, feed, bio-based products, and bioenergy. It covers various sectors, such as agriculture, forestry, fisheries, food, and pulp and paper production, as well as parts of the chemical, biotechnological and energy industries.

With more than 80% of its land covered by farms or forests, and maritime areas supporting fisheries of global significance, the EU is largely self-sufficient for most agri-food, forest, and some sea products. Based on available data it is estimated that the **European bioeconomy** has an annual turnover of about €2 trillion and employs more than 22 million people, approximately 9% of the total EU workforce<sup>7</sup>. Its sectors have a strong innovation potential due to their connection with a wide range of sciences and technologies, as well as local and tacit knowledge. **Biorefineries** that sustainably transform biomass into a spectrum of marketable food and feed ingredients, bio-based products (chemicals, materials), and bioenergy (biofuels, power and/or heat) are at the core of the bioeconomy.

As shifting from non-renewable to renewable resources is an important innovation aspect of both the circular economy and the bioeconomy agenda, the two concepts are closely linked, while **synergies** between them must be exploited to ensure that resources are used more productively and efficiently. According to an EEA Report (2018)<sup>8</sup>, both policy agendas converge with respect to economic and environmental concerns, as well as research, innovation, and societal transition towards sustainability. Yet, synergies could improve in areas such as eco-design, waste management and recycling, or innovative business models.

In 2012, the **European Commission** (EC) launched its first **Bioeconomy Strategy**<sup>9</sup>, a research and innovation agenda aimed at enhancing the sustainable exploitation of biomaterials. The strategy was envisioned to act through existing policies, while also calling on Member States, public, and private stakeholders to work more closely together to develop markets and competitiveness in bioeconomy sectors along the following main objectives:

- 1) Ensure food and nutrition security
- 2) Manage natural resources sustainably
- 3) Reduce dependence on non-renewable resources
- 4) Mitigate and adapt to climate change
- 5) Strengthen European competitiveness and create jobs

A **comprehensive review**<sup>10</sup> of the 2012 European Bioeconomy Strategy concluded that it has been a success, in particular at mobilising research and innovation, boosting private investments, developing new value chains, promoting the uptake of national bioeconomy strategies, and involving stakeholders. On the other hand, the review also recommended to adapt the initial five objectives and the related actions to better use the potential of the bioeconomy to meet current and future EU priorities.

<sup>7</sup> BECOTEPS (2011) The European Bioeconomy in 2030: Delivering Sustainable Growth by addressing the Grand Societal Challenges

<sup>8</sup> EEA Report No 8/2018. The circular economy and the bioeconomy – Partners in sustainability

<sup>9</sup> European Commission, Directorate-General for Research and Innovation, Innovating for sustainable growth: a bioeconomy for Europe, Publications Office, 2012, <https://data.europa.eu/doi/10.2777/6462>

<sup>10</sup> European Commission, Directorate-General for Research and Innovation, Review of the 2012 European Bioeconomy Strategy, Publications Office, 2018, <https://data.europa.eu/doi/10.2777/086770>





An updated **EU Bioeconomy Strategy**<sup>11</sup> was introduced in 2018, proposing a detailed **Action Plan** to support rural and coastal development, including remote areas, and facilitate a more proportionate sharing of the benefits of a competitive and sustainable bioeconomy across European territories and value chains. To ensure the effective delivery of the proposed policy goals, the Commission envisioned regular reporting on the progress of the Action Plan. The first such **Progress Report**<sup>12</sup>, published in 2022, concluded that the actions are on track towards achieving the main objectives of the Bioeconomy Strategy. In particular, the report praised the increasing number of national and regional bioeconomy strategies, as well as progress on bioeconomy deployment in Central and Eastern European countries, aided by EU funding and the establishment of new fora and networks.

The **CBE Joint Undertaking (CBE JU)** is a €2 billion public-private partnership between the EU, represented by the **European Commission (EC)**, and the **Bio-based Industries Consortium (BIC)**. It was established under **Horizon Europe**, the EU's research and innovation programme, for the period 2021-2031. While **CBE JU** is not a direct continuation of the **Bio-Based Industries Joint Undertaking (BBI JU)**, it builds on the achievements of the previous partnership and aims to address its shortcomings.

The scope of the **CBE JU** is underpinned by the updated EU Bioeconomy Strategy (2018), in line with the objectives of the European Green Deal. It aims to facilitate major contributions to the EU climate targets by delivering innovative bio-based solutions and paving the way for Europe to become the first climate neutral continent by 2050; protecting and enhancing biodiversity; combating pollution; reducing fossil resource dependence; and deploying a just transition. The partnership **funds projects of great excellence** that promote the mutual efforts of actors from different sections of the biobased value chain, while lowering the risk of such cooperations.

The **BIOEAST Initiative**, comprising policy makers and research institutes from 11 **Central and Eastern European (CEE)** Member States, aims to unlock the bioeconomy potential of the macro-region. At present, there is an uneven distribution of activities associated with the development of sustainable, circular bioeconomies across the EU MSs, impacting the potential to deliver both on the European Green Deal and national objectives<sup>13</sup>. This has direct, tangible impacts for citizens on turnover, jobs, welfare, prosperity, access to innovation, and labour productivity amongst numerous important factors<sup>14</sup>. One specific indicator is the uneven distribution of industrial processing and biorefining facilities<sup>15</sup> that create high added value throughout bio-based value chains. Statistics show that **CEE stakeholders are not taking full advantage of the opportunities** offered by the EU funding sources, in particular by CBE JU. A game-changing element could be the assessment and articulation of the needs of actors across the region. Therefore, in accordance with its agenda, BIOEAST conducted a **survey among CEE bioeconomy stakeholders** to assess their needs and ideas, providing feedback to the CBE JU and support the partnership in realising its goals.

<sup>11</sup> European Commission, Directorate-General for Research and Innovation, A sustainable bioeconomy for Europe: strengthening the connection between economy, society and the environment: updated bioeconomy strategy, Publications Office, 2018, <https://data.europa.eu/doi/10.2777/792130>

<sup>12</sup> European Commission, Directorate-General for Research and Innovation, European bioeconomy policy: stocktaking and future developments: report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Publications Office of the European Union, 2022, <https://data.europa.eu/doi/10.2777/997651>

<sup>13</sup> European Commission, Directorate-General for Research and Innovation, Deploying the bioeconomy in the EU: a framework approach for bioeconomy strategy development : 10 policy recommendations for building national bioeconomies toward a fair and just climate neutral Europe, Dupont-Ingilis, J.(editor), Maes, D.(editor), Barrett, P.(editor), Kulišić, B.(editor), Vehviläinen, A.(editor), Publications Office, 2021, <https://data.europa.eu/doi/10.2777/443131>

<sup>14</sup> Bio-based industry and biorefineries in the EU. [https://knowledge4policy.ec.europa.eu/visualisation/bio-based-industrybiorefineries-eu\\_en](https://knowledge4policy.ec.europa.eu/visualisation/bio-based-industrybiorefineries-eu_en)

<sup>15</sup> Chemical and material biorefineries in the EU [https://knowledge4policy.ec.europa.eu/visualisation/chemical-materialbiorefineries-eu\\_en](https://knowledge4policy.ec.europa.eu/visualisation/chemical-materialbiorefineries-eu_en)



To accurately **represent the interests of regional actors**, we reached out to various entities: producers, manufacturers, decision makers, and knowledge holders involved in agriculture, the food and feed industries, biorefineries, advisory services, or research and innovation. The main question we aimed to answer was:

**What types of region-specific actions and cooperations would aid the successful realization of a biobased economy in CEE?**

The survey was conducted through an **online questionnaire** aiming to explore i) which of the **priorities** expressed in the Strategic Research and Innovation Program of the CBE JU<sup>16</sup> resonate best with regional interests, and ii) what **specific actions** would aid regional actors the most. To complement and support the online survey, a **national workshop** in Hungary was also organized where actors from all sections of the biobased value chain attended to brainstorm, analysing the most pressing challenges, and looking for potential solutions through a series of **presentations**, a **panel discussion**, and **thematic workshop sessions**. The following sections exhibit the outcome of the survey, opening with a summary of the current state of the bioeconomy in the BIOEAST countries, followed by a detailed description of our methods, and finally the analysis and discussion of the results.

<sup>16</sup> CBE JU, Strategic Research and Innovation Agenda, 2022, <https://www.cbe.europa.eu/strategic-research-and-innovation-agenda-sria>

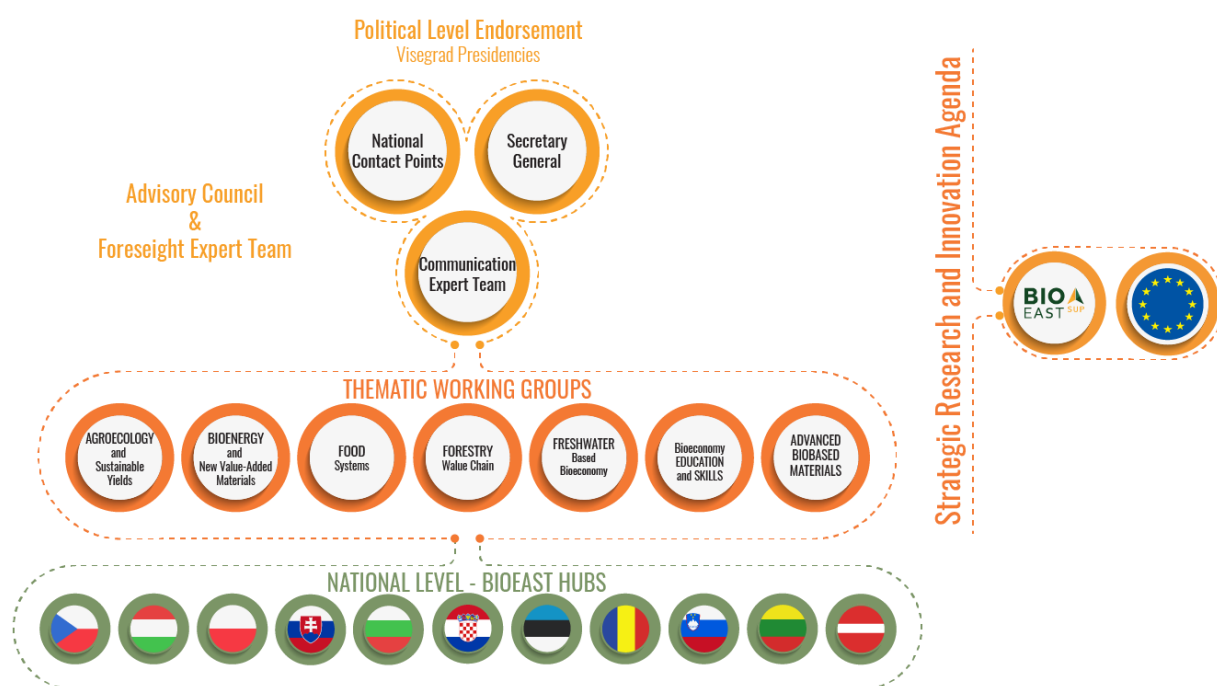




## 2. The BIOEAST Initiative and the current state of the CEE macroregion

### The vision of the BIOEAST Initiative

The BIOEAST Initiative was founded in 2016; currently, the ministries of agriculture from 11 countries in the CEE macro-region<sup>17</sup> participate in the Initiative's day-to-day work. **BIOEAST's mission** is to assist its member countries in establishing their own bioeconomy strategies. To achieve this goal, the organization focuses on enabling science-based policy making through its **Thematic Working Groups** (TWG), covering different aspects and areas of the bioeconomy, bringing together policy makers and representatives of the R&D sector. The organizational structure of BIOEAST is presented in **Figure 2**.



*Figure 2 The organizational structure of the BIOEAST Initiative.*

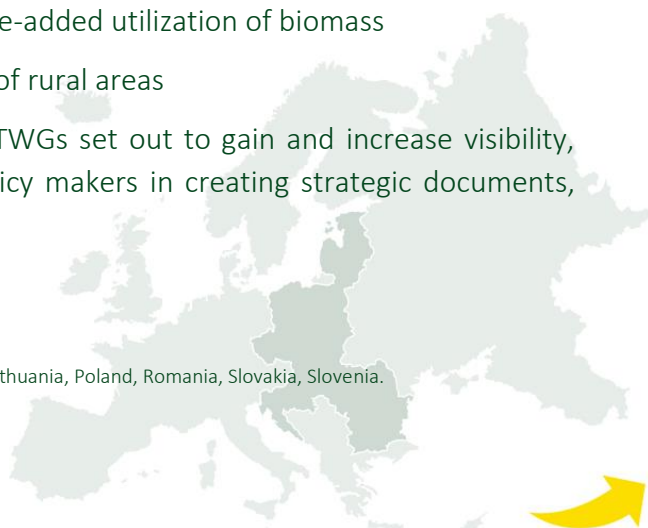
In its **BIOEAST Vision<sup>18</sup> to 2030**, the Initiative set out four long-term goals:

- 1) Productivity: increase the sustainable production of biomass
- 2) Sustainability: develop biodiversity and biosecurity
- 3) Resource efficiency: establish the circular and value-added utilization of biomass
- 4) Rural development: increase the competitiveness of rural areas

To achieve these goals, the BIOEAST Initiative and its TWGs set out to gain and increase visibility, provide evidence base, develop strategies, and aid policy makers in creating strategic documents, improving their skills, and identifying challenges.

<sup>17</sup> BIOEAST Initiative Members: Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia.

<sup>18</sup> BIOEAST Vision Paper <https://bioeast.eu/vision/>



The above goals are pursued also in the field of bio-based technologies and products, with the creation of **high-value products** being considered as a specific priority. Two dedicated TWGs address this area within BIOEAST: the Advanced Bio-based Chemicals and Materials and the Bioenergy and New Value-Added Materials Thematic Working Groups.

## Challenges and opportunities in the BIOEAST macroregion

### *Natural resources and their utilization*

The BIOEAST macro-region is recognised with a **high but unrealised biomass potential**, having a large amount of biomass on their hands. The EU13 Member States<sup>19</sup> were estimated to produce almost half (160 622 340 t out of 566 071 343 t fresh matter) of the agricultural crops in the EU in 2014.<sup>20</sup> Although agriculture and forestry are strong sectors in all BIOEAST countries, the focus varies across different subsectors due to geographical differences<sup>21</sup>. Northern countries show a higher specialization in forestry and grass-type plants, while the central region has a significant production of potato and sugar beet. The southern countries within BIOEAST focus typically on fruits and oil crops. These differences lead to **different priorities** in national and regional strategies as well. While 7.02 million people are employed in bio-based sectors in CEE, the **added value per person is very low**, only 13 000 EUR compared to the EU average of 38 000 EUR. The difference is even larger if we consider turnover values (47 000 EUR compared to the EU average of 135 000 EUR)<sup>22</sup>. Within the bioeconomy, agriculture employs the most people, followed by the food sector, which is consistent with the value added in these sectors (**Figure 3**).

### *Bioeconomy strategies*

Among BIOEAST countries, currently only Latvia has implemented a **national bioeconomy strategy**. In other countries, such a policy is either under development<sup>23</sup>, initiated by the **BIOEASTsUP** Horizon2020 project<sup>23</sup>, or is not at all considered for the time being<sup>24</sup>. In Hungary and Lithuania, work towards a dedicated bioeconomy strategy was launched before the updated EU Bioeconomy Strategy (2018) but has not yet been concluded. Since 2018, the development of national strategies has also begun in Croatia, Czechia, Poland, and Slovakia, supported by the BIOEAST Initiative. Other Member States opted to integrate the bioeconomy in sector-specific or cross-cutting policies. Bulgaria is currently developing a Strategy for “Strengthening the Role of the Agricultural Sector in the Bioeconomy” and the “National Strategy for Transition to a Circular Economy”. Estonia is preparing a national policy framework document and action plan on the bioeconomy, which is planned to be adopted in 2022.

There are several policies, Smart Specialization Strategies (RIS3) in particular, in which bioeconomy has some importance either at a regional or a national level. The careful examination of these strategies reveal that CEE countries focus mostly on **primary biomass production** (agriculture, food &

<sup>19</sup> EU13 countries: BIOEAST countries extended with Cyprus and Malta

<sup>20</sup> JRC – Biomass estimates <https://datam.jrc.ec.europa.eu/datam/public/pages/dataList.xhtml>

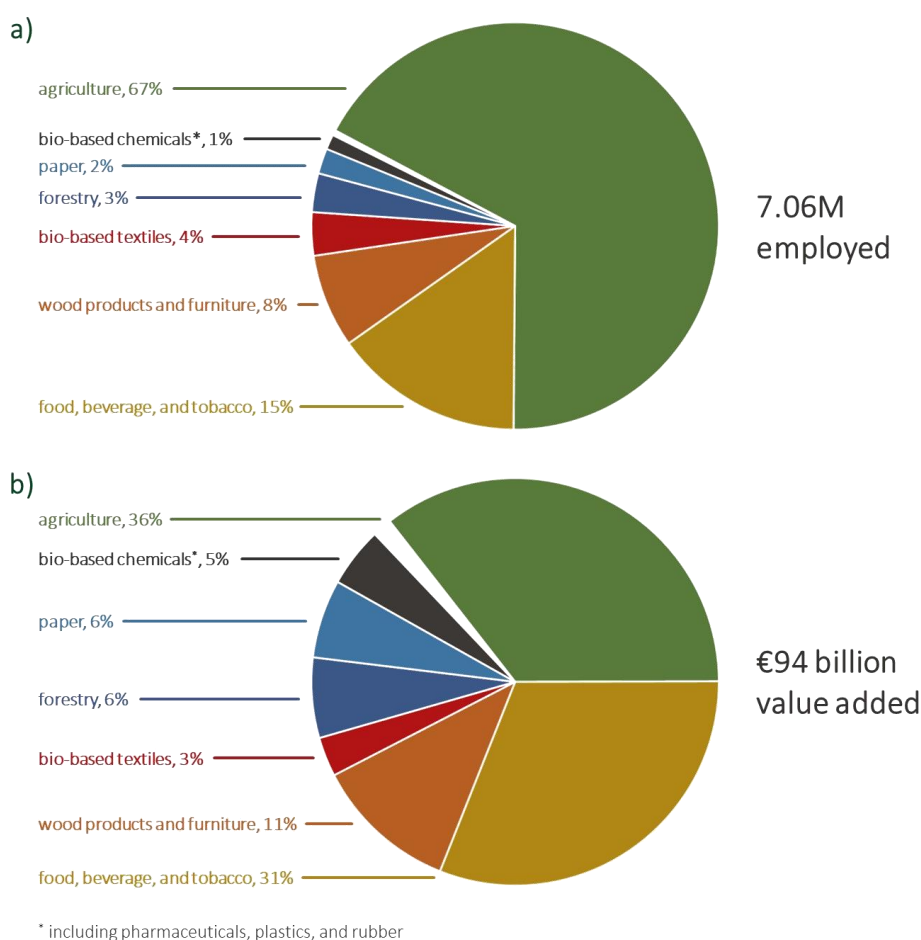
<sup>21</sup> Piotrowski S. and Dammer L. State-of-play-of-central-and-eastern-Europes-bioeconomies – SCAR CASA study [https://www.scar-swg-sbg.eu/lw\\_resource/datapool/items/item\\_33/state\\_of\\_play\\_central\\_and\\_eastern\\_eu\\_bioeconomies.pdf](https://www.scar-swg-sbg.eu/lw_resource/datapool/items/item_33/state_of_play_central_and_eastern_eu_bioeconomies.pdf)

<sup>22</sup> JRC - Jobs and Wealth in the European Union Bioeconomy <https://datam.jrc.ec.europa.eu/datam/mashup/BIOECONOMICS/>  
<sup>23</sup> <https://bioeast.eu/bioeastsup/>

<sup>24</sup> Haarich, S. and Kirchmayr-Novak, S., Bioeconomy strategy development in EU regions, Sanchez Lopez, J., Borzacchiello, M.T. and Avraamides, M. editor(s), Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-50040-7, doi:10.2760/15613, JRC128740.

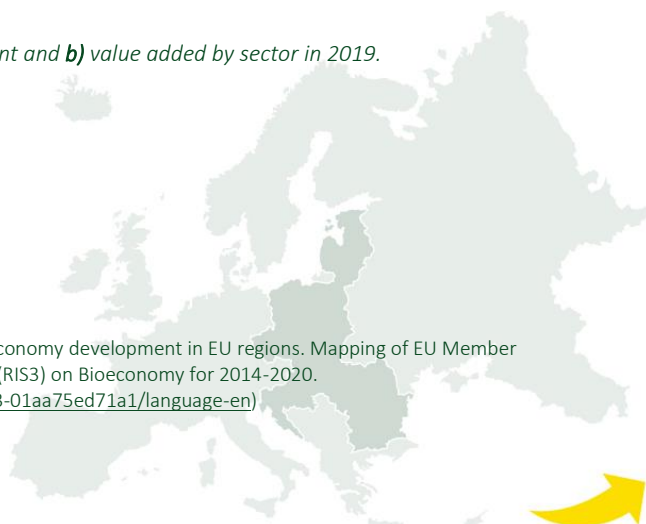


beverages, forestry) rather than utilizing secondary or tertiary biomass<sup>25</sup>. This also means that these Member States miss a focus on products with high added value on a strategic level, which is well reflected by the employment and added value data presented in **Figure 3**, even though the high amount of renewable raw materials gives a strategic advantage to these economies. Blue economy, the utilization of waste streams, and the **development of biorefinery capacities** are not in the focus of the RIS3 strategies of many BIOEAST Member States. Notably, while biorefineries are not prioritized, several BIOEAST regions emphasize R&D activities in biochemicals, biopolymers, and biopharmaceuticals, i.e., the most common products of biorefineries. The lack of a strategic focus reflects the **lack of political support** in this area: without sufficient political support, BIOEAST countries clearly cannot advance substantially in the field of bioeconomy.



**Figure 3** The CEE bioeconomy in numbers; **a)** employment and **b)** value added by sector in 2019.

<sup>25</sup> Spatial Foresight, SWECO, ÖIR, t33, Nordregio, Berman Group, Infyde (2017): Bioeconomy development in EU regions. Mapping of EU Member States'/regions' Research and Innovation plans & Strategies for Smart Specialisation (RIS3) on Bioeconomy for 2014-2020. (<https://op.europa.eu/en/publication-detail/-/publication/15189f4a-2216-11e8-ac73-01aa75ed71a1/language-en>)

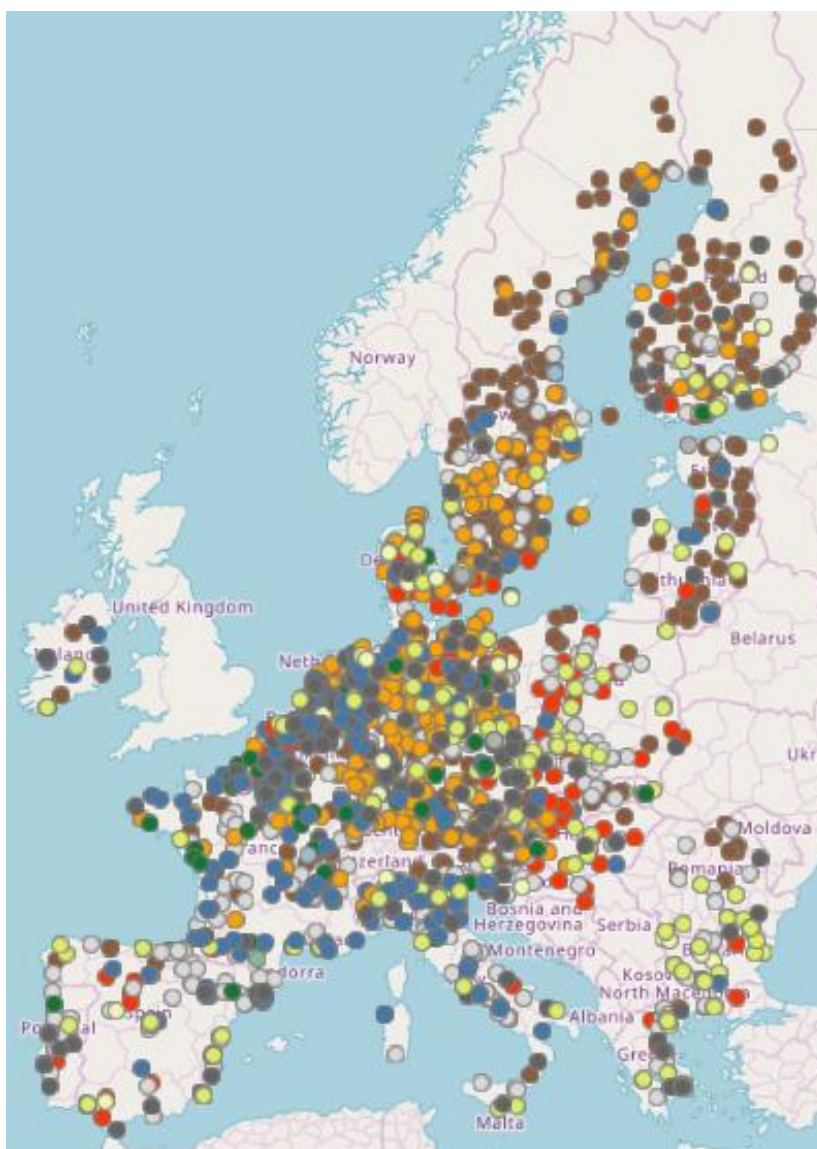


### Biorefineries

The BIOEAST region lags behind in the number of biorefineries compared to the rest of the EU (Figure 4). The **biomass related facilities** that are common are mostly pulp and paper mills or sugar & starch plants. High added value production, e.g., that of biobased chemicals, on the other hand, is less relevant. **Liquid biofuel production** is available in the region, although these plants typically utilize primary biomass as a raw material, competing with the food sector, which is not sustainable in the long run.

There is a dire lack of **pilot, demo, and R&D facilities** in the region, making it challenging for researchers to conduct state-of-the-art innovation, which hinders their relative competitiveness in comparison with their Western colleagues. This also increases investment costs for companies in research and innovation projects, due to the necessity of having to find external partners for validation at a long distance, often in more advanced economies. The

ecological footprint of such projects increases also, due to the transportation of materials, researchers, etc. One upside could be the enhanced cooperation between BIOEAST stakeholders and the rest of the EU; yet, the economic barriers arising from this inequality in infrastructure hinder R&D activities as a whole. BIOEAST countries – while being able to significantly contribute to technological advances – may require funding for “copycat projects” to adopt and adapt to local conditions infrastructures that already exist elsewhere in the EU. For the highest impact, new biorefinery capacities should yield multiple products and multiple product categories. Finally, the lack of infrastructure also hinders the establishments of start-ups and spin-offs, due to inadequate possibilities for scaling-up and testing.



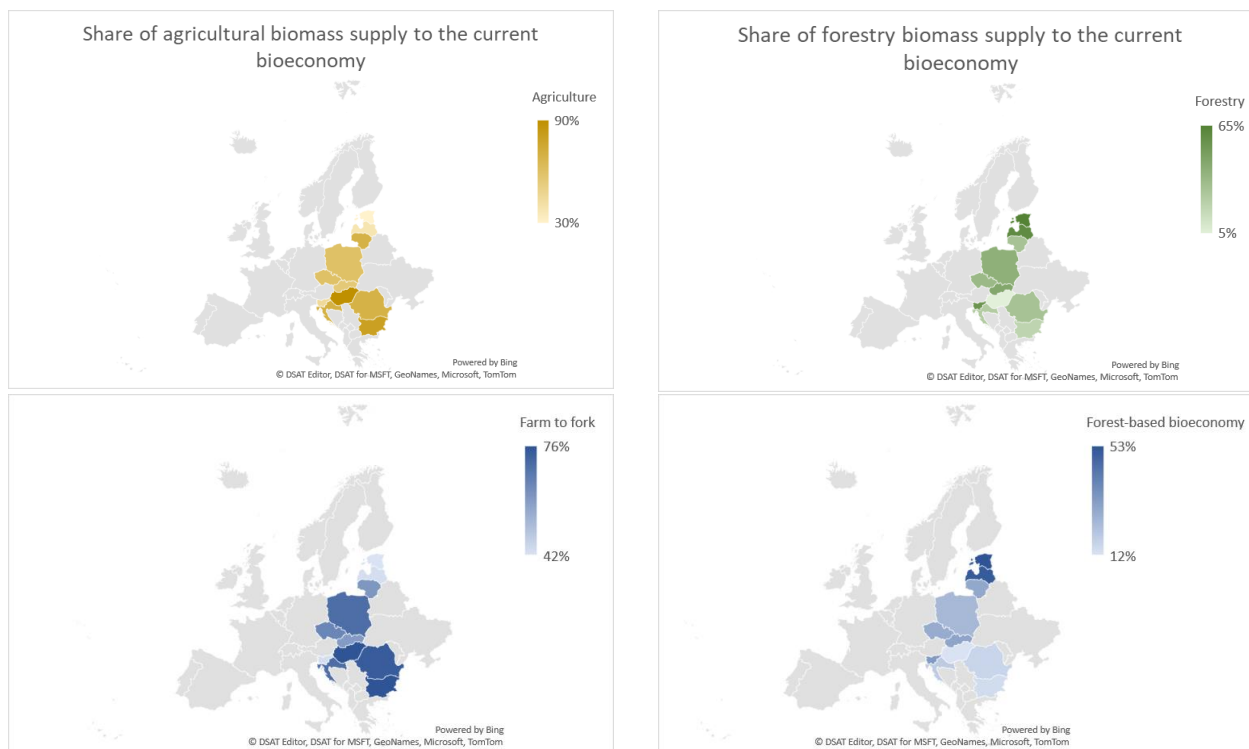
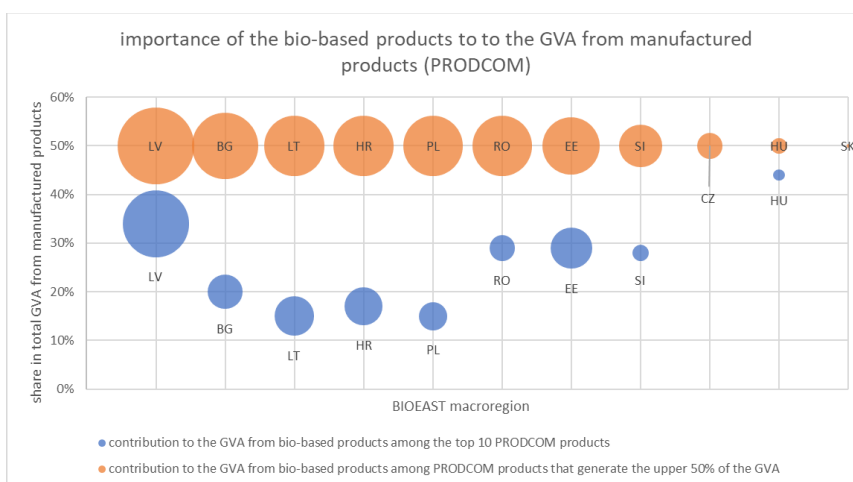
**Figure 4** The distribution of biorefineries across the EU<sup>1</sup>: ■ pulp & paper mills, ■ biomethane plants ■ starch & sugar plants ■ bio-based chemicals ■ timber ■ liquid biofuels ■ composites & fibres ■ more than one product.





### Current performance of the linear bioeconomy

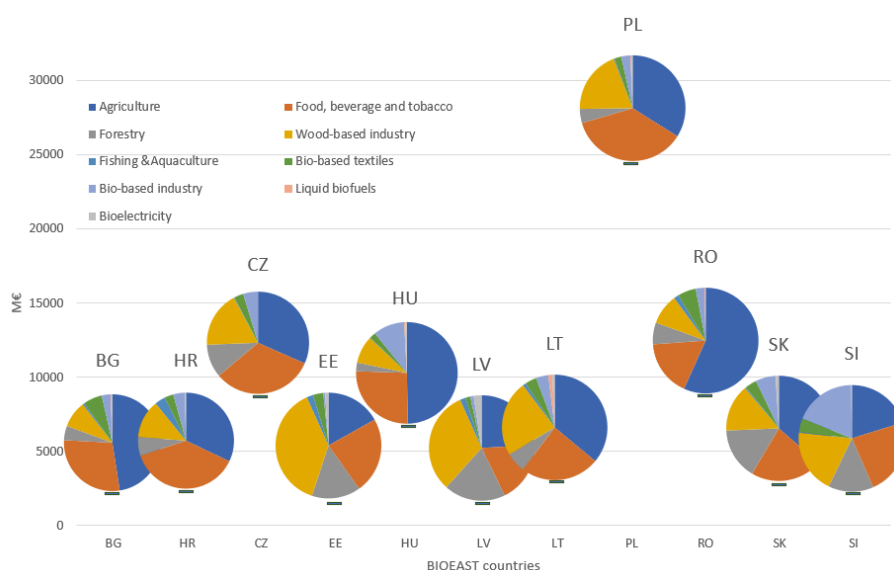
The BIOEAST macro-region is abundant with biomass and economies reliant on biomass (**Figure 3**), but still has a high specialisation in labour assigned to the traditional, linear bioeconomies: the agri-food chain and the wood processing industry (**Figure 5**). The importance of Latvia being the only BIOEAST country with a national bioeconomy strategy is highlighted by the fact that 45% of the gross value added from the upper half of manufactured goods in this MS is attributed to biomass. The other economies that are significantly relying on a linear bioeconomy are Bulgaria, Lithuania, Croatia, Poland, Romania, and Estonia, in which at least one quarter of GVA is generated from biomass-related sectors. The Visegrad group, with the exception of Poland, records lower shares of bioeconomy contributions, due to it being overshadowed by a strong automotive sector and related activities.



**Figure 5** The relative Importance of the linear bioeconomy across the 11 BIOEAST countries<sup>26</sup>

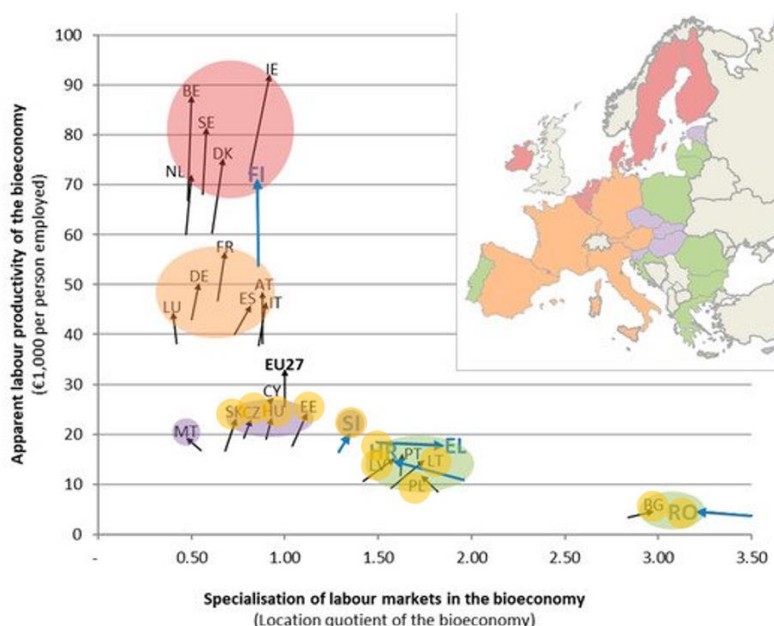
<sup>26</sup> Kulisic, B., Lier, M., Perović, M., Matijašević, N., Mandarić, A., and Sauvola-Seppälä, T. (2020). D 1.2: Report on Analysis of BIOEAST National Bioeconomy Related Sectors. Horizon 2020 Project: Advancing Sustainable Circular Bioeconomy in Central and Eastern European Countries. BIOEASTsUP.

Slovenia is the BIOEAST country with the largest relative share of the bio-based industry, followed by Hungary and Slovakia (Figure 6). Notably, Czechia is the largest producer of biogas in the BIOEAST macro-region and 2<sup>nd</sup> in the EU in terms of the number of biogas plants per million capita<sup>27</sup> (these values are not represented in the Figure below).



**Figure 6** Structure of VA from sectors attributed to bioeconomy in BIOEAST countries<sup>28</sup>(2019)

The location quotients and apparent labour productivities presented in Figure 7 further refine the above picture. BIOEAST countries with larger shares of a bio-based industry tend to have lower labour productivities, due to more people being employed in low-productivity biomass production sectors, while high-productivity manufacturing sectors are favoured in Northern and Western European MSs.



**Figure 7** Evolution of the location quotients and apparent labour productivities in the bioeconomies of the 27 EU Member States, 2008–2010 to 2015–2017<sup>29</sup>; BIOEAST macro-region countries are highlighted in yellow.

<sup>27</sup> Annual Statistical Report of the European Biogas Association (2018): <https://www.europeanbiogas.eu/eba-statistical-report-2018/>

<sup>28</sup> Ronzon, Tévécia; Piotrowski, Stephan; M'barek, Robert; Carus, Michael; Tamošiūnas, Saulius (2022): Jobs and wealth in the EU bioeconomy / JRC - Bioeconomics. European Commission, Joint Research Centre (JRC) [Dataset] PID: <http://data.europa.eu/89h/7d7d5481-2d02-4b36-8e79-697b04fa4278>

<sup>29</sup> Ronzon, T.; Piotrowski, S.; Tamošiūnas, S.; Dammer, L.; Carus, M.; M'barek, R. Developments of Economic Growth and Employment in Bioeconomy Sectors across the EU. *Sustainability* **2020**, *12*, 4507. <https://doi.org/10.3390/su12114507>



Some prominent linear bioeconomy sectors in the BIOEAST macro-region that need much assistance in becoming circular, either due to high GHG emissions or abundant side- and by-streams of biomass, are discussed in further detail below.

### 1) Beer industry<sup>30</sup>

BIOEAST member countries produce about 26% of the total EU27 beer production, meaning that brewery spent grain (BSG) and brewery spent yeast are abundant resources to consider when creating a regional and national bioeconomic strategy. Among the BIOEAST countries, the largest potential for BSG processing to higher added-value bio-based products is in Poland, with an annual BSG production of 816 kt, followed by Czechia (403 kt) and Romania (359 kt). Other relevant member countries (and BSG production data for 2019) are Hungary (120 kt), Bulgaria (96 kt), Croatia (65 kt), Lithuania (63 kt), Slovakia (34 kt), Estonia (28 kt), Slovenia (19 kt), and Latvia (15 kt). According to 2021 data provided by the European Beer Association, there are currently ca. 11,000 active breweries in the EU, producing around 400 million hL of beer per year. Calculated from market movements in the last 5-year period, by 2030, the EU will produce about 425 million hL of beer and 8.5 million tonnes of BSG per year, which makes BSG a significant biomass resource for the future biorefineries<sup>31</sup>.

### 2) Meat and dairy industry<sup>32</sup>

The meat and dairy sectors are important parts of the linear bioeconomy of the BIOEAST countries. According to the PRODCOM database, related products such as sausages, fresh or chilled meat and carcasses, milk and other fermented products, as well as all sorts of cheese, are in the top 10 in terms of value generated from the production of manufactured goods in Bulgaria, Croatia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, and Slovenia. In Czechia and Slovakia, meat and dairy products are among the top 30 most valuable goods.

### 3) Wood processing industry

Wood-related territorial capital is significant in the Baltic States, Slovenia, Slovakia, Poland, Czechia, and Croatia. Sankey diagrams of biomass flows indicate that all BIOEAST countries but Hungary and Poland are net exporters of roundwood and wood pellets<sup>33</sup>. The Baltic States are at the strongest relative disbalance in missing the opportunity to defossilize their economies with renewable carbon from forest-based biomass as well as to reduce the GDP gap with a greater proportion of value-added wood-based products.

<sup>30</sup> Zeko-Pivač, A. et al. The Potential of Brewer's Spent Grain in the Circular Bioeconomy: State of the Art and Future Perspectives REVIEW article. Front. Bioeng. Biotechnol.(2022) Sec. Bioprocess Engineering. <https://doi.org/10.3389/fbioe.2022.870744>

<sup>31</sup> The Brewers of Europe (2019). Country Profiles. <https://brewersofeurope.org/site/countries/key-facts-figures.php> (Accessed April 14, 2021).

<sup>32</sup> BIOEAST Methane Strategy Brief, TWG Bioenergy and New Value Added Materials, 2021

<sup>33</sup> Kulisic, B., Lier, M., Perović, M., Matijašević, N., Mandarić, A., and Sauvula-Seppälä, T. (2020). D 1.2: Report on Analysis of BIOEAST National Bioeconomy Related Sectors. Horizon 2020 Project: Advancing Sustainable Circular Bioeconomy in Central and Eastern European Countries. BIOEASTsUP.



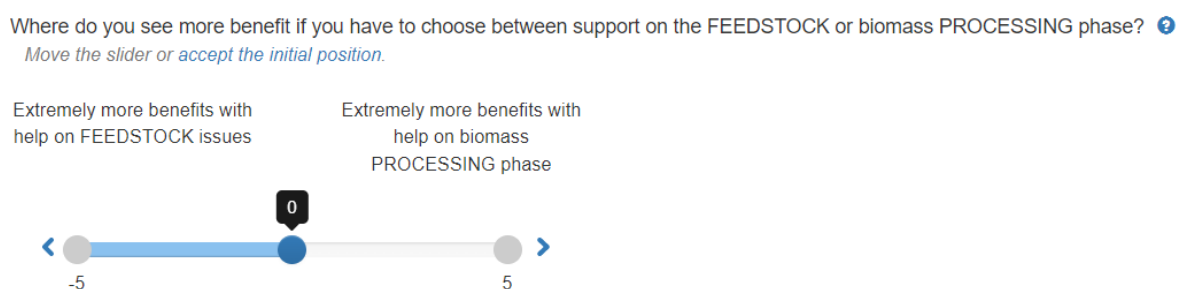
### 3. Methodology

The **purpose of this research** was to detect where to streamline the limited resources to aid the transition of the linear bioeconomy in the BIOEAST macroregion through providing assistance to current, emerging, and existing **circular and sustainable bioeconomy** players, creating national CSBE ecosystems.

With *action with the most benefit to the business* set as a goal, the priorities defined in the CBE JU Strategic Research and Innovation Agenda (SRIA) have been organised in a hierarchy. **Action areas** were set as criteria and **Strategic priorities** as alternatives to perform a weighted pairwise analysis using an analytical hierarchical process (AHP) (**Figure 9**). **30 Actions** to address Strategic priorities emerged from the internal discussions of various BIOEAST TWGs and were evaluated (**Figure 10**) via **Action priority matrices** (**Figure 11**) as alternatives. The impact of Actions was weighted by the Strategic priorities and ranked.

AHP has been praised for its transparency, intuitiveness, and simplicity for collecting expert opinions on a complex topic, combining versatility with high accuracy, which made it one of the most popular **multiple-criteria decision making** (MCDM) tools<sup>34</sup>. A hybrid version of AHP, **fuzzy AHP** (fAHP) has been introduced later to handle imprecisions, acknowledging that the problems investigated by MCDM can be too complex for a single person to have complete knowledge on all aspects (criteria) of the topic<sup>35</sup>.

In the **online survey**, BIOEAST bioeconomy stakeholders were asked to give their opinion as to where would they benefit the most from receiving assistance or participating in an R&D project, and what kind of specific actions would yield a significant impact. Instead of using Saaty's verbal expressions scale, the stakeholders chose between priorities by using a **sliding scale** with the two verbal extremes labelled; the starting position in the middle was considered as the two concepts being equally important. In the analysis, the values along the slider were converted into a 1-9 Saaty crisp scale.



**Figure 8** The sliding scale used in the survey

The threshold for the consistency ratio (CR) was set to 30%, i.e., responds with a CR between 0 and 30% were investigated, given the complexity of the problem and the high probability of none of the stakeholders having a complete knowledge of the entire bio-based value chain. The rankings have been compared for  $CR \leq 10\%$ ,  $\leq 20\%$  and  $\leq 30\%$ , respectively, and rankings under 20% were used for further analysis.

<sup>34</sup> de FSM Russo, Rosaria, and Roberto Camanho. "Criteria in AHP: a systematic review of literature." *Procedia Computer Science* 55 (2015): 1123-1132.; Emrouznejad, Ali, and Marianna Marra. "The state of the art development of AHP (1979–2017): A literature review with a social network analysis." *International journal of production research* 55.22 (2017): 6653-6675.; Yu, Dejian, et al. "Analysis of collaboration evolution in AHP research: 1982–2018." *International Journal of Information Technology & Decision Making* 20.01 (2021): 7-36.

<sup>35</sup> Liu, Yan, Claudia M. Eckert, and Christopher Earl. "A review of fuzzy AHP methods for decision-making with subjective judgements." *Expert Systems with Applications* 161 (2020): 113738.



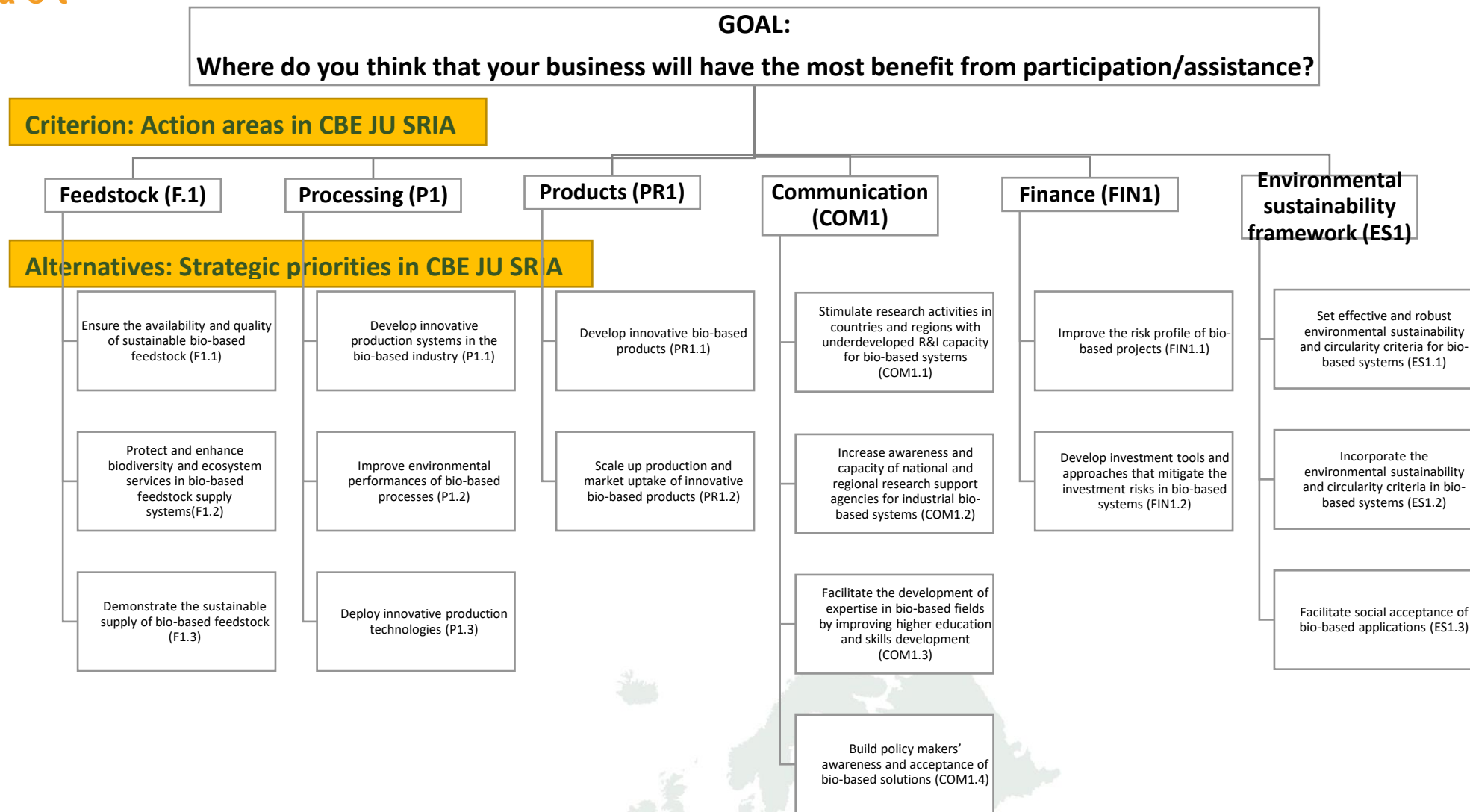


Figure 9 fAHP hierarchy of CBE JU SRIA with the BIOEAST-related question ("goal" in AHP analysis) on top

**Where do you think that your business will have the most benefit from participation/assistance?**

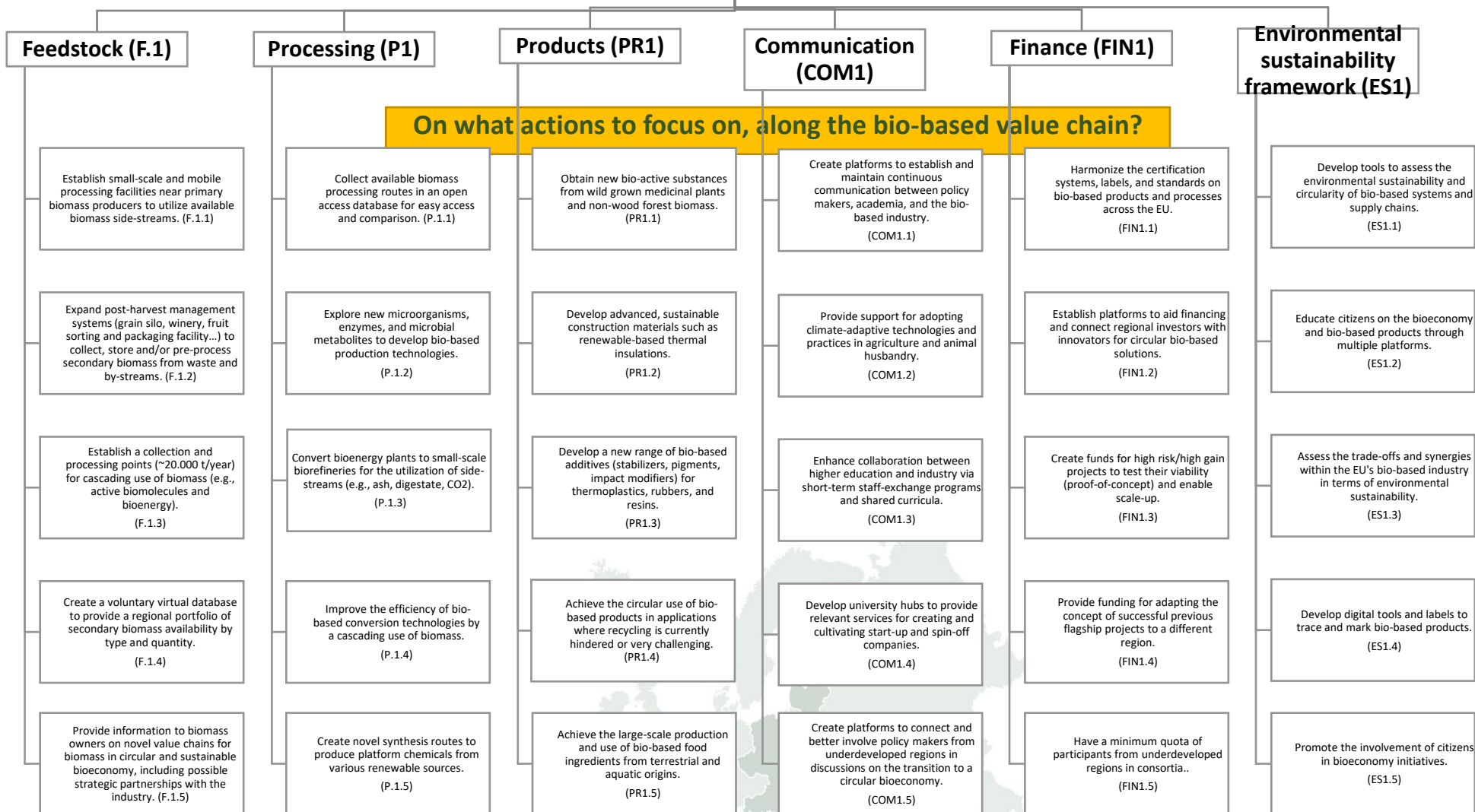


Figure 10 fAHP with CBE JU SRIA Action areas as Criterion and 30 BIOEAST Actions as alternatives, evaluated via Action priority matrix

The Action priority matrix<sup>36</sup> is a simple strategic management tool to derive a list of priorities based on the impact and effort ratio of actions, considering the available resources. In short, actions are placed in a coordinate system according to their impact-effort ratios (**Figure 9**):

- **Quick Wins (high impact – low effort)** are the most attractive projects and should be prioritized.
- **Major Projects (high impact – high effort)** yield good returns but require time. One major project can crowd out many quick wins. Their number is to be limited or they should be divided into stepwise actions to allow quick wins.
- **Fill-Ins (low impact – low effort)** are to be delegated or performed when time is not a constraint.
- **Thankless Tasks (low Impact – high effort)** offer little return yet require a serious amount of time and effort that could be better spent. They are to be avoided.



*Figure 11 Action priority matrix with interpretation of the positions<sup>37</sup>*

<sup>36</sup> Slack, N. (1994), "The Importance-Performance Matrix as a Determinant of Improvement Priority", International Journal of Operations & Production Management, Vol. 14 No. 5, pp. 59-75. <https://doi.org/10.1108/01443579410056803>

<sup>37</sup> <https://www.productplan.com/glossary/action-priority-matrix/>



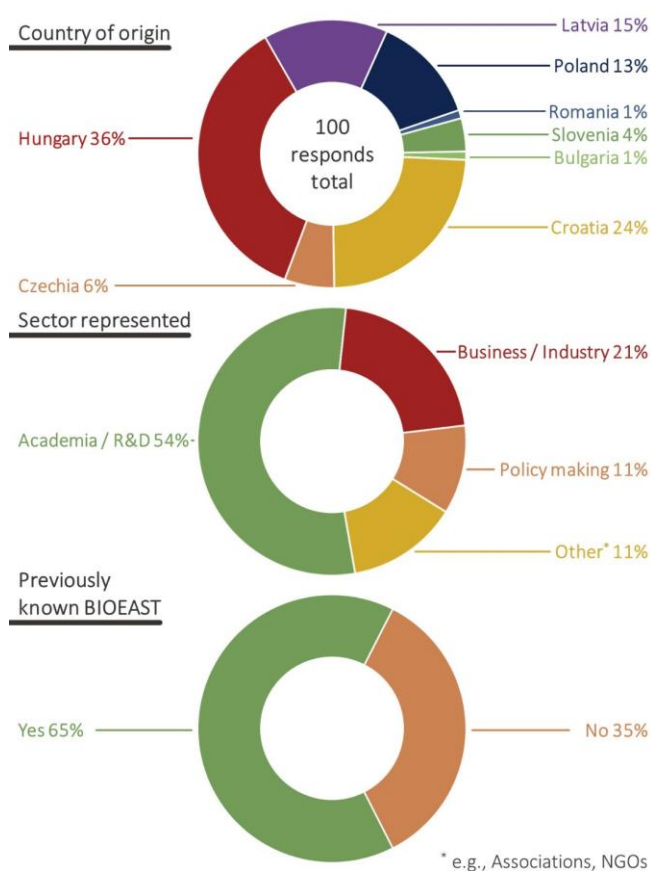
## 4. Results

### Outcome of the online survey

#### Action areas and Strategic priorities

The online survey was conducted between June 1 and August 31, 2022, by using the BIOEAST network. Despite the holiday season being a considerable hindrance, answers were collected from 7 out of 11 BIOEAST countries (**Figure 12**). Business and industry were emphasized as targeted audience, but given the emerging state of circular and sustainable bio-based industry in the BIOEAST macro-region, the survey welcomed opinions from all bioeconomy stakeholders. Business / Industry had a 21% representation in the total population of respondents, with an additional 11% marked as “Others”, comprising representatives of industry and farmers’ associations, NGOs, biomass owners, etc.

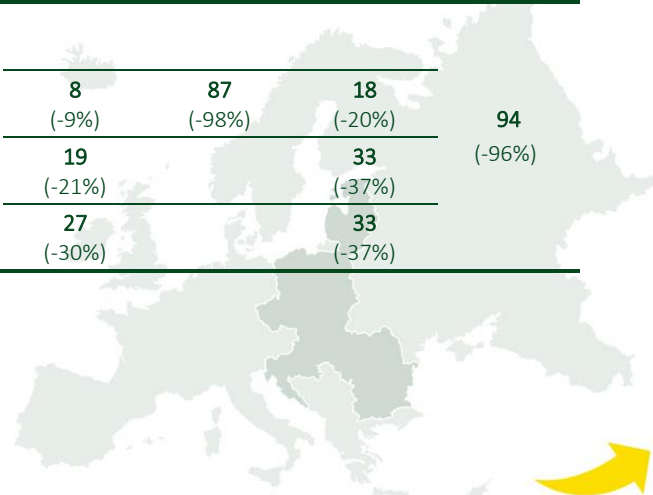
From close to 100 replies collected (**Table 1**), one third were included in the analysis ( $CR \leq 20\%$ ) when weighting and ranking the Action areas of CBE JU SRIA, and 21-47% in the weighted ranking of Strategic priorities of CBE JU SRIA. The Action matrix had a high turnout (96%) due to its simplicity resulting in a high consistency ratio.



**Figure 12** Profile of the respondents

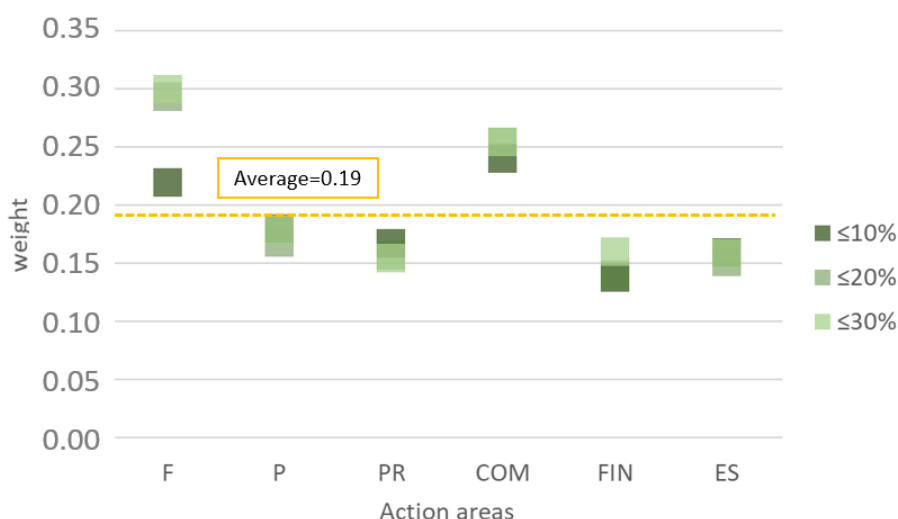
**Table 1** Survey turnout and statistics per each section

fAHP – alternatives								
N = 98	fAHP – criteria	Feedstock (F)	Processing (P)	Product (PR)	Communication (COM)	Financing (FIN)	Environmental sustainability (ES)	Action matrix
Valid answers:	89 (-96%)							
CR ≤ 10%	12 (-13%)	23 (-26%)	19 (-21%)	87 (-98%)	8 (-9%)	87 (-98%)	18 (-20%)	94 (-96%)
CR ≤ 20%	29 (-33%)	33 (-37%)	42 (-47%)		19 (-21%)		33 (-37%)	
CR ≤ 30%	45 (-51%)	39 (-44%)	46 (-52%)		27 (-30%)		33 (-37%)	





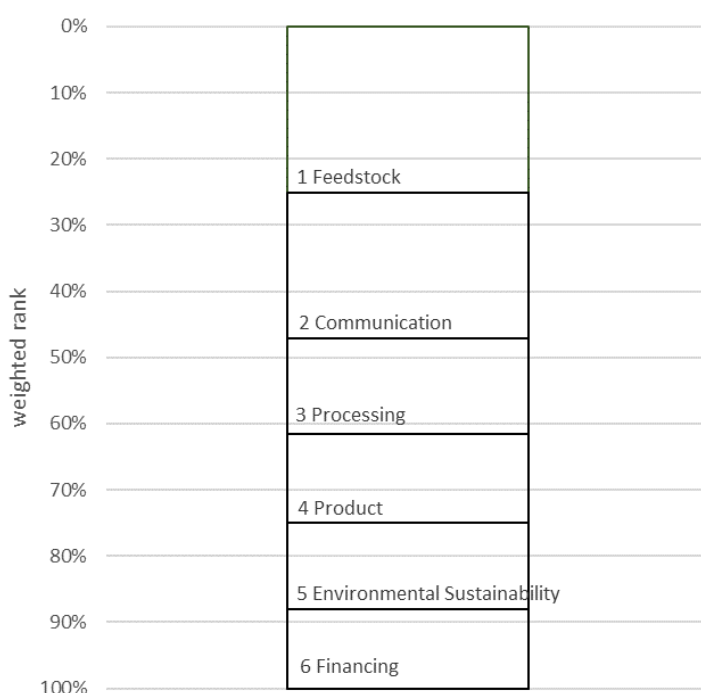
Sensitivity analysis of weighted ranking highlighted **Feedstock (F)** and **Communication (COM)** as **Action areas** with above average weight at all investigated levels of consistency (**Figure 13**). At  $CR \leq 20\%$ , those two Action areas carry **47% of the total weight**, whereas the remaining 53% is divided between the other 4 action areas.



**Figure 13** Sensitivity analysis of Action areas CBE JU weighted ranking across consistency ratios from  $CR \leq 10\%$  to  $CR \leq 30\%$

The weighted ranking (**Figure 14**) of survey results indicates that BIOEAST stakeholders would benefit the most from participation/assistance within the Action areas of Feedstock and Communication, given that resources to allocate are limited. Nonetheless, focusing on these two aspects does not diminish the importance and necessity for action in the remaining areas.

The **Online Validation Workshop** confirmed the above outcome. As anticipated, Feedstock proved to be a common and tangible issue to all respondents. Remarkably, **Financing** was ranked as the least important Action area, indicating that available financing is not sufficient for stakeholders in the BIOEAST macro-region to engage in the transition to a circular and sustainable bioeconomy.



**Figure 14** Weighted ranking of BE JU Action areas according to the opinion of BIOEAST stakeholders

Whereas there was a clear distinction of priorities among the Action areas, the results indicate hesitation and indecisiveness by the respondents when it comes to comparing the more specific **Strategic priorities** defined within each Action area (see **Figure 9**). Several respondents reported that they found the survey overly difficult to complete, indicating a knowledge gap between BIOEAST

stakeholders and respective actors in member states where the transition to a circular and sustainable bioeconomy is more advanced. Discussions during the Validation workshop revealed a need for **parallel actions**; for instance, progress with feedstock-related strategic priorities cannot be achieved without addressing Priorities COM4 and ES1, ranked as 6<sup>th</sup> and 7<sup>th</sup>, respectively (**Table 2**). In addition, Priorities COM2, ES1 and COM4 were highlighted as crucial if one policy domain (e.g., energy sector) is to set the mandates that another sector (e.g., land-based sectors with biomass supply) must fulfil. While the above comments are fully valid in terms of the need for concerted policy framing and systemic thinking, one must keep in mind that the primary goal of the AHP exercise was to identify priority areas and maximise the benefits of participation/assistance to businesses.

The highest-weighted Strategic priority carries a mere 9% of the total weight, 7 priorities make up 52% of the total weight, and 8 out of 17 priorities have at least average weight or above. Setting a threshold to identify the most significant priorities above average weight (0.0472) is difficult, as mid-range priorities (8-12) show a very narrow weight distribution between 0.0494 and 0.0415 (**Table 2**).

**Table 2** Weighted ranking of Strategic priorities CBE JU by BIOEAST stakeholders

Rank	Code	Strategic priority	≤20%	Cum. weight
1	F2	Protect and enhance biodiversity and ecosystem services in bio-based feedstock supply systems	0.0741	9%
2	F3	Demonstrate the sustainable supply of bio-based feedstock	0.0614	17%
3	P2	Improve environmental performances of bio-based processes	0.0605	24%
4	COM2	Increase awareness and capacity of national and regional research support agencies for industrial bio-based systems	0.0602	32%
5	F1	Ensuring the availability and quality of sustainable bio-based feedstock	0.0544	39%
6	COM4	Build policy makers' awareness and acceptance of bio-based solutions	0.0537	45%
7	ES1	Set effective and robust environmental sustainability and circularity criteria for bio-based systems	0.0534	52%
8	COM1	Stimulate research activities in countries and regions with underdeveloped R&I capacity for bio-based systems	0.0494	58%
9	COM3	Facilitate the development of expertise in bio-based fields by improving higher education and skills development	0.0472	64%
10	P1	Develop innovative production systems in the bio-based industry	0.0462	70%
11	FIN1	Improve the risk profile of bio-based projects	0.0454	75%
12	PR1	Develop innovative bio-based products	0.0415	81%
13	PR2	Improve environmental performances of bio-based processes	0.0375	85%
14	P3	Deploy innovative production technologies	0.0363	90%
15	ES3	Facilitate social acceptance of bio-based applications	0.0302	94%
16	ES2	Incorporate the environmental sustainability and circularity criteria in bio-based systems	0.0296	97%
17	FIN2	Develop investment tools and approaches that mitigate the investment risks in bio-based systems	0.0221	100%

### Action priority matrices

All 30 specific actions to address the CBE JU Action areas were identified as **Major Projects** (Figure 15) by the respondents, i.e., offering considerable benefits in return for significant time and effort. To rank the **Actions**, priority was given to those 9 with *below-average effort* resulting in *above-average impact* (Table 3), after weighted ranking for Action areas. However, as the weighted ranking results are rather close to each other (Tables 4-5), they should be interpreted within the context of the respective bioeconomy ecosystems currently existing in each BIOEAST country. Tables 4 and 5 provide rankings by different criteria (effort and impact, respectively), providing guidance to build national SRIA priorities for emerging circular and sustainable bioeconomies in the BIOEAST macro-region. Bold text represents Actions with either below-average effort (Table 4) or above-average impact (Table 5).

Priority should be given to breaking down the 9 specific Actions with beneficial Impact-Effort ratios into more easily achievable tasks (Quick wins) and setting up a roadmap for realizing these. Moreover, as feedback received during the validation workshop indicated, some Actions could be directly transformed from Major Projects into Quick Wins.

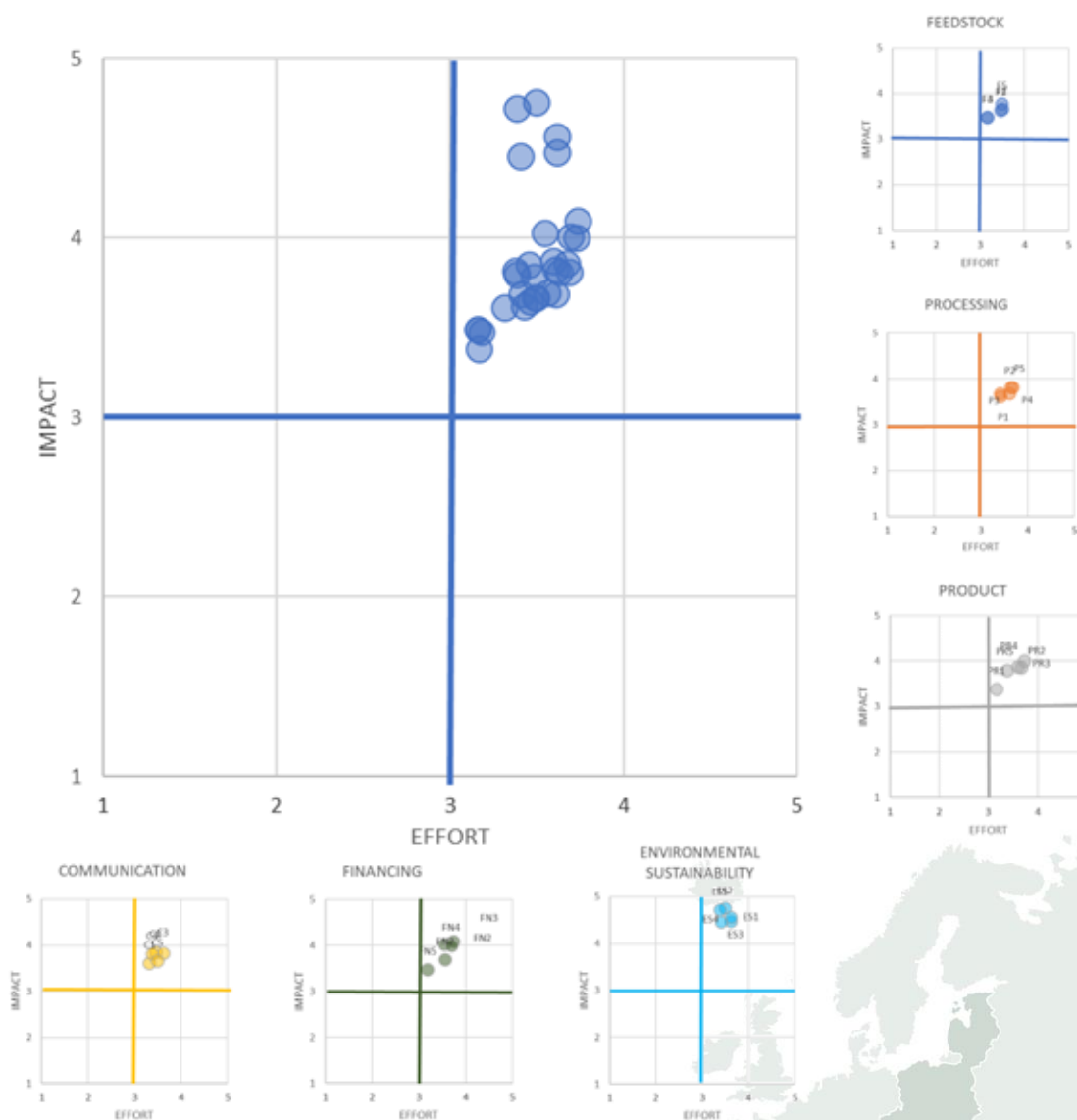


Figure 15 BIOEAST action priority matrix (aggregated in top-left) and by Action area

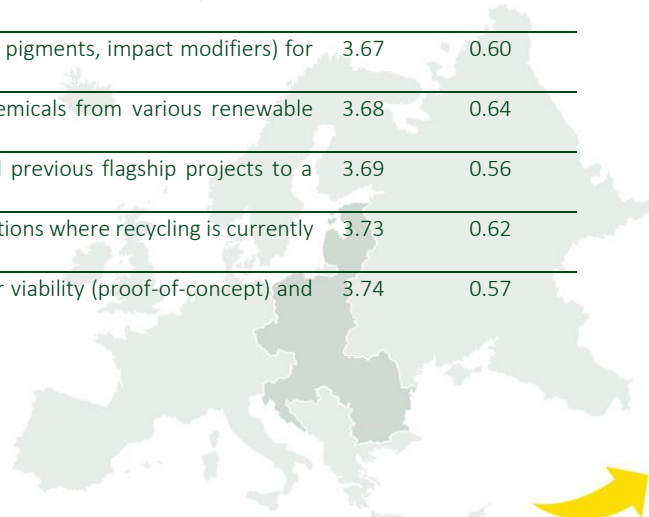
**Table 3** *Ranking of Actions with below-average Effort and above-average Impact*

Rank	by IMPACT > average and EFFORT < average		EFFORT	IMPACT
1	F5	Provide information to biomass owners on novel value chains for biomass in circular and sustainable bioeconomy, including possible strategic partnerships with the industry.	3.48	1.11
2	F2	Expand post-harvest management systems (grain silo, winery, fruit sorting and packaging facility...) to collect, store and/or pre-process secondary biomass from waste and by-streams.	3.49	1.07
3	F1	Establish small-scale and mobile processing facilities near primary biomass producers to utilise available biomass side-streams.	3.46	1.07
4	F3	Establish a collection and processing points (~20.000 t/year) for cascading use of biomass (e.g. active biomolecules and bioenergy).	3.16	1.02
5	F4	Create a voluntary virtual database to provide a regional portfolio of secondary biomass availability by type and quantity.	3.16	1.02
6	C2	Provide support for adopting climate-adaptive technologies and practices in agriculture and animal husbandry.	3.45	0.98
7	C4	Develop university hubs to provide relevant services for creating and cultivating start-up and spin-off companies.	3.38	0.97
8	C5	Create platforms to connect and better involve policy makers from underdeveloped regions in discussions on the transition to a circular bioeconomy.	3.49	0.93
9	C1	Create platforms to establish and maintain continuous communication between policy makers, academia, and the bio-based industry.	3.32	0.92



**Table 4** Ranking Actions by EFFORT (from the least to the most effort)

Rank	By EFFORT		EFFORT	IMPACT
1	F3	Establish a collection and processing points (~20.000 t/year) for cascading use of biomass (e.g. active biomolecules and bioenergy).	3.16	1.02
2	F4	Create a voluntary virtual database to provide a regional portfolio of secondary biomass availability by type and quantity.	3.16	1.02
3	PR1	Obtain new bio-active substances from wildgrown medicinal plants and non-wood forest biomass.	3.17	0.53
4	FN5	Have a minimum quota of participants from underdeveloped regions in consortia.	3.18	0.49
5	C1	Create platforms to establish and maintain continuous communication between policy makers, academia, and the bio-based industry.	3.32	0.92
6	C4	Develop university hubs to provide relevant services for creating and cultivating start-up and spin-off companies.	3.38	0.97
7	PR2	Develop advanced, sustainable construction materials such as renewable-based thermal insulations.	3.39	0.59
8	ES5	Promote the involvement of citizens in bioeconomy initiatives.	3.39	0.71
9	ES4	Develop digital tools and labels to trace and mark bio-based products.	3.41	0.67
10	P4	Improve the efficiency of bio-based conversion technologies by a cascading use of biomass.	3.41	0.62
11	P1	Collect available biomass processing routes in an open access database for easy access and comparison.	3.43	0.61
12	C2	Provide support for adopting climate-adaptive technologies and practices in agriculture and animal husbandry.	3.45	0.98
13	F1	Establish small-scale and mobile processing facilities near primary biomass producers to utilise available biomass side-streams.	3.46	1.07
14	F5	Provide information to biomass owners on novel value chains for biomass in circular and sustainable bioeconomy, including possible strategic partnerships with the industry.	3.48	1.11
15	C5	Create platforms to connect and better involve policy makers from underdeveloped regions in discussions on the transition to a circular bioeconomy.	3.49	0.93
16	F2	Expand post-harvest management systems (grain silo, winery, fruit sorting and packaging facility...) to collect, store and/or pre-process secondary biomass from waste and by-streams.	3.49	1.07
17	ES2	Educate citizens on the bioeconomy and bio-based products through multiple platforms.	3.49	0.72
18	FN2	Establish platforms to aid financing and connect regional investors with innovators for circular bio-based solutions.	3.55	0.56
19	FN1	Harmonize the certification systems, labels, and standards on bio-based products and processes across the EU.	3.56	0.52
20	PR5	Achieve the large-scale production and use of bio-based food ingredients from terrestrial and aquatic origins.	3.59	0.60
21	C3	Enhance collaboration between higher education and industry via short-term staff-exchange programs and shared curricula.	3.61	0.97
22	P3	Convert bioenergy plants to small-scale biorefineries for the utilization of side-streams (e.g., ash, digestate, CO <sub>2</sub> ).	3.61	0.62
23	ES1	Develop tools to assess the environmental sustainability and circularity of bio-based systems and supply chains.	3.61	0.68
24	ES3	Assess the trade-offs and synergies within the EU's bio-based industry in terms of environmental sustainability.	3.62	0.69
25	P2	Explore new microorganisms, enzymes, and microbial metabolites to develop bio-based production technologies.	3.63	0.64
26	PR3	Develop a new range of bio-based additives (stabilizers, pigments, impact modifiers) for thermoplastics, rubbers, and resins.	3.67	0.60
27	P5	Create novel synthesis routes to produce platform chemicals from various renewable sources.	3.68	0.64
28	FN4	Provide funding for adapting the concept of successful previous flagship projects to a different region.	3.69	0.56
29	PR4	Achieve the circular use of bio-based products in applications where recycling is currently hindered or very challenging.	3.73	0.62
30	FN3	Create funds for high risk/high gain projects to test their viability (proof-of-concept) and enable scale-up.	3.74	0.57



**Table 5** Ranking Actions by weighted IMPACT (from the most to the least impact)

Rank	by IMPACT		EFFORT	IMPACT
1	F5	Provide information to biomass owners on novel value chains for biomass in circular and sustainable bioeconomy, including possible strategic partnerships with the industry.	3.48	1.11
2	F2	Expand post-harvest management systems (grain silo, winery, fruit sorting and packaging facility...) to collect, store and/or pre-process secondary biomass from waste and by-streams.	3.49	1.07
3	F1	Establish small-scale and mobile processing facilities near primary biomass producers to utilise available biomass side-streams.	3.46	1.07
4	F3	Establish a collection and processing points (~20.000 t/year) for cascading use of biomass (e.g. active biomolecules and bioenergy).	3.16	1.02
5	F4	Create a voluntary virtual database to provide a regional portfolio of secondary biomass availability by type and quantity.	3.16	1.02
6	C2	Provide support for adopting climate-adaptive technologies and practices in agriculture and animal husbandry.	3.45	0.98
7	C3	Enhance collaboration between higher education and industry via short-term staff-exchange programs and shared curricula.	3.61	0.97
8	C4	Develop university hubs to provide relevant services for creating and cultivating start-up and spin-off companies.	3.38	0.97
9	C5	Create platforms to connect and better involve policy makers from underdeveloped regions in discussions on the transition to a circular bioeconomy.	3.49	0.93
10	C1	Create platforms to establish and maintain continuous communication between policy makers, academia, and the bio-based industry.	3.32	0.92
11	ES2	Educate citizens on the bioeconomy and bio-based products through multiple platforms.	3.49	0.72
12	ES5	Promote the involvement of citizens in bioeconomy initiatives.	3.39	0.71
13	ES3	Assess the trade-offs and synergies within the EU's bio-based industry in terms of environmental sustainability.	3.62	0.69
14	ES1	Develop tools to assess the environmental sustainability and circularity of bio-based systems and supply chains.	3.61	0.68
15	ES4	Develop digital tools and labels to trace and mark bio-based products.	3.41	0.67
16	P2	Explore new microorganisms, enzymes, and microbial metabolites to develop bio-based production technologies.	3.63	0.64
17	P5	Create novel synthesis routes to produce platform chemicals from various renewable sources.	3.68	0.64
18	PR4	Achieve the circular use of bio-based products in applications where recycling is currently hindered or very challenging.	3.73	0.62
19	P4	Improve the efficiency of bio-based conversion technologies by a cascading use of biomass.	3.41	0.62
20	P3	Convert bioenergy plants to small-scale biorefineries for the utilization of side-streams (e.g., ash, digestate, CO <sub>2</sub> ).	3.61	0.62
21	P1	Collect available biomass processing routes in an open access database for easy access and comparison.	3.43	0.61
22	PR5	Achieve the large-scale production and use of bio-based food ingredients from terrestrial and aquatic origins.	3.59	0.60
23	PR3	Develop a new range of bio-based additives (stabilizers, pigments, impact modifiers) for thermoplastics, rubbers, and resins.	3.67	0.60
24	PR2	Develop advanced, sustainable construction materials such as renewable-based thermal insulations.	3.39	0.59
25	FN3	Create funds for high risk/high gain projects to test their viability (proof-of-concept) and enable scale-up.	3.74	0.57
26	FN2	Establish platforms to aid financing and connect regional investors with innovators for circular bio-based solutions.	3.55	0.56
27	FN4	Provide funding for adapting the concept of successful previous flagship projects to a different region.	3.69	0.56
28	PR1	Obtain new bio-active substances from wildgrown medicinal plants and non-wood forest biomass.	3.17	0.53
29	FN1	Harmonize the certification systems, labels, and standards on bio-based products and processes across the EU.	3.56	0.52
30	FN5	Have a minimum quota of participants from underdeveloped regions in consortia.	3.18	0.49





## Results of the survey vs. in-person opinion – the focus group in Hungary

Along with the online survey, a national workshop was organized in Hungary, where stakeholders from all sectors could attend and express their opinions. The event hosted by the **Hungarian Ministry of Agriculture** attracted 37 participants in leading positions across different sectors: policy makers, business executives, and heads of research groups alike. The high interest of decision makers indicates the urgency of this topic, as well as its relevance beyond the chemical industry and agriculture.

Opening presentations by representatives of the Ministry and the founder and CEO of **Smobyta**, who introduced the start-up company producing biobased leather alternative for the fashion industry, were followed by a panel discussion on the challenges facing bioeconomy actors at different levels. The panel consisted of a regional executive of **BASF** (biobased chemicals and materials), the CEO of **Smobyta** (biobased materials), a professor from **Budapest University of Technology and Economics** (biobased technologies and products), an independent policy advisor (food sector), a policy maker from the **Hungarian Ministry of Agriculture**, and a researcher from the **Institute of Agricultural Economics Nonprofit Ltd.** (agriculture), along with a member of the **CBE JU Scientific Committee**. During the discussion, the speakers were asked to identify the key challenges they face in their respective fields with respect to the bioeconomy. Participants were encouraged to join in and ask questions, and a lively discussion arose, in which the following problem areas and challenges were identified:

- Lack of systemic thinking by decision makers at a national level
- Difficulties with the complete replacement of fossil-based carbon
- Strengthening knowledge transfer and communication
- Involvement of market and social actors into policy making, enhancing trust among stakeholders
- Developing a national strategy concerning food systems
- Providing raw materials for the chemical industry
- Competition between use for food and chemicals/materials
- Scale-up domestic biorefinery capacities
- Improve support systems and tools for start-ups

The panel discussion was followed by parallel breakout sessions. Participants could sign up to join thematic Breakout Groups of equal size (8-9 people), looking for potential solutions and intervention points in their respective areas. As an indicator of interest towards the respective bioeconomy-related topics, the Groups were filled in the following order:

- 1) Feedstock
- 2) Biobased products and technologies
- 3) Policy and financial solutions
- 4) Education and communication

During the breakout session, the Groups had intense discussions until the very end of their time limits. In the end, they phrased the following messages and intervention points (without prioritizing them):

- The technology to process non-primary biomass is missing in Hungary. Smaller-scale, regional technological developments and projects should be supported, including the logistics infrastructure necessary for their operation.



- There is a need for domestic biorefinery capacities, which requires governmental support and state financing. Such a biorefinery should not address bioenergy production directly, rather convert biomass into high-value products, such as polymers.
- Future workforce for a bioeconomy needs to be trained and provided; education programs should be altered accordingly.
- KPIs and indicator systems needs to be developed to aid “green financing”.
- Educating society is key to a successful switch to bioeconomy; while awareness needs to be raised among national decision makers too; both requires appropriate legal support.
- Mining carbon-dioxide should be banned; the carbon-dioxide in air should be utilized instead.
- Good practices should be identified at national and international levels.
- Beyond research and innovation of novel materials and technologies, technology transfer and the adoption of *best practices* should also be financially supported.
- There is a need for adequate, coordinated, and transparent policies and the cooperation of policy makers to build up a biobased value network.

Notably, although feedstock came up most often in its dedicated Breakout Group, participants in all groups were very vocal about insufficient communication and the need for a platform bringing together stakeholders from various sectors. On the one hand, this outcome is in accordance with the results of the online survey, while also highlighting the significance of communication as an overarching issue in the macro-region.



## 6. Conclusions

With the establishment of the **Circular Bio-based Europe Joint Undertaking**, the European Commission, along with the Bio-based Industries Consortium, pledged their continued support to the development of the **bioeconomy in the European Research Area**. Recognizing that the EU13 Member States lag in this transition, while having an abundance of available biomass, the CBE JU in its SRIA formulated the objective of engaging relevant stakeholders in these countries and promote the development of the bioeconomy. The **BIOEAST Initiative**, comprising 11 Member States of the EU13, has recognised this effort, and created this Strategic Plan to collect and express the needs of the macro-region. By providing **feedback** to CBE JU decision makers, we intend to aid the partnership in maximising the impact of its support by the optimal allocation of the resources at its disposal.

Needs were collected by conducting an online survey, in English as well as in several local languages, in the 11 BIOEAST countries between July 1 and August 31, along with a national workshop organised in Hungary. The results were evaluated by using an analytical hierarchical process and by placing specific actions in a priority matrix according to their expected impact and the effort required for their implementation.

The outcomes of both the survey and the national workshop point to **Feedstock** and **Communication** being the most relevant for the macro-region: stakeholders expect to benefit the most from support in the CBE JU **Action areas** listed below. Providing adequate financing options alone is not sufficient. Stakeholders signalled their willingness to attend intersectoral events and be actively engaged in discussions on the bioeconomy. The place, timing, and timeframe of such discussions must be chosen carefully to attract the most participants without excluding stakeholders from rural areas.

Action Area	Strategic priority
Feedstock	Protect & enhance biodiversity & ecosystem services in bio-based feedstock supply systems
Feedstock	Demonstrate the sustainable supply of bio-based feedstock
Product	Improve the environmental performance of bio-based processes
Communication	Increase awareness and capacity of national & regional research support agencies
Feedstock	Ensuring the availability & quality of sustainable bio-based feedstock
Communication	Build policy makers' awareness and acceptance of bio-based solutions
Sustainability	Set effective & robust environmental sustainability & circularity criteria for bio-based systems
Communication	Stimulate research activities in countries & regions with underdeveloped R&I capacity
Communication	Facilitate the development of expertise by improving higher education & skills development

While the prioritization of Action areas displays a clear picture, the stakeholders demonstrated more hesitance and indecision when it came to evaluating **specific actions**. Possibly due to the underdeveloped state of the bioeconomy in these countries, each option offered was considered to be a **major project**. Nonetheless, ones with beneficial **impact to effort** ratios were identified and used to formulate the below **recommendations** for specific actions at a national or international level.



### Actions recommended – at a national level

- **Secure funding for the establishment of small-scale processing facilities** near primary biomass producers
- **Reorganize post-harvest management systems** to collect, store, & pre-process secondary biomass
- **Establish local distribution centres, collection & processing points** for the cascading use of biomass
- **Support BIOEAST in facilitating communication** between policy makers, academia, & the bio-based industry, to educate policy makers on the bioeconomy & raise awareness
- **Inform stakeholders about & providing support for adopting climate-adaptive technologies & practices in agriculture & animal husbandry**
- **Create platforms bringing together ministries** for continuous discussion between policy makers
- **Develop shared curricula with industry involvement** to enhance collaboration between universities & industry

### Actions recommended – at a European level

- **Call for a CBE JU Deployment Group to advance this exercise & reassess the Strategic Plan in 3 years / assign policy support action with external experts driving the exercise with local stakeholders**
- **Call for an IA on creating a virtual database** that provides a regional portfolio of the availability of secondary biomass by type and quantity
- **Highlight in the scope & impact sections of CBE JU calls** specific to BIOEAST-relevant Strategic priorities the requirement of covering the BIOEAST macro-region & requesting the involvement of a significant number of beneficiaries from CEE
- **Call for a CSA to evaluate the outcomes of BBI JU projects** with respect to opportunities for knowledge transfer towards the BIOEAST macro region: investigate and map results that could be brought to CEE and invent delivery platforms to ease knowledge transfer in the respective Member States
- **Organize national conferences on how to develop the bioeconomy**, as well as to raise awareness of green public procurement & bio-based application-oriented procurement
- **Call for a CSA on providing national language information to biomass owners** on novel value chains for biomass in the circular & sustainable bioeconomy, including strategic partnerships with the industry
- **Extending the Marie-Curie-Sklodowska Actions and/or Erasmus+ programmes** with short-time staff exchanges to enhance collaboration between higher-educational institutions & industry
- **Call for a CSA to develop university hubs** that provide relevant services for creating and cultivating start-up and spin-off companies (can be done at a national level too)
- **Call for a Deployment Group as a platform on bio-based technologies** to connect & better involve policy makers from underdeveloped regions in discussions on the transition to a circular bioeconomy
- **Call for a CSA on educating citizens on the bioeconomy and bio-based products** through multiple platforms
- **Call for a CSA to upscale this exercise and conduct similar activities** to survey the needs & interests of bioeconomy stakeholders in the BIOEAST macro-region



Notably, when stakeholders from different fields had the opportunity to interact and exchange ideas during the national and validation workshops, they were able to find **simple solutions** to some of the challenges regarding bioeconomy-related actions. This might indicate that respondents to the survey, due to their limited knowledge on the topic, tend to overestimate the effort required in some cases. At the same time, such fruitful discussions highlight the need to **establish lines of communication** vertically and across different sectors, facilitating the **multistakeholder approach** necessary for the successful transition to a circular and sustainable bioeconomy.

Lastly, we must address the **low level of participation** in the survey across the macro-region. Despite our best efforts, mobilising our limited resources in the middle of the summer season, the survey received only 100 responses from 7 countries, while 37 and 26 participants attended the in-person national and the online validation workshops, respectively. Beyond the unfortunate timing, the low turnover reflects how challenging it is to engage CEE stakeholders who often display a **lack of recognition towards bioeconomy-related business opportunities**, as well as a general **distrust** between peers and towards decision makers and similar initiatives. Beyond this lack of trust, bottom-up organisations are historically rare in the macro-region and actors tend to expect guidance from local and national governments or the EU, in a top-down fashion. The current policy framework, however, does not explicitly and effectively promote the transition to the circular and sustainable bioeconomy. Industrial actors and policy makers alike are, therefore, reluctant to move beyond the status quo. As a most encouraging sign, on the other hand, stakeholders that we could reach reacted very positively to the opportunity of being involved in shaping the development of the bioeconomy. Nonetheless, extensive **information campaigns** are needed to raise awareness and engage more actors, while adequate funds should be allocated to **conducting surveys** at a national or macro-regional level.

The current energy crisis and the lack of secure supplies of critical raw materials present a strong push towards transitioning to a circular economy, in which the bioeconomy plays a central role. It is crucial to build bridges between bottom-up and the top-down initiatives to facilitate this transition. A particular effort needs to be made to identify and recognize national and regional actors who can drive change and have the ability to mobilize networks and a wide circle of stakeholders. The BIOEAST macro-region requires both financial support and guidance to overcome the current obstacles and facilitate those systemic changes that would enable the advancement of its currently underdeveloped bioeconomies.

