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Knowledge-based agriculture in Central and Eastern European Countries' bioeconomy

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Abstract: The European Union's agriculture, aquaculture, forestry and food industry see significant internal disparities in terms of research and innovation performance to the disadvantage of the CEE countries. This divide hinders the unlocking of excellence in low-performing research, development and innovation regions and the establishment of transnational cooperation for knowledge-based development, thus the appearance of specific research topics relevant to the CEE macro-region among others in Horizon 2020 work programmes. To bridge the gap the specific challenges in the sector should be faced through the lens of bioeconomy. At the same time there is no doubt that bioeconomy requires accompanying strategies and shared strategic research and innovation framework. As this framework has already been offered by the Central-Eastern European Initiative for Knowledge-based Agriculture, Aquaculture and Forestry in the Bioeconomy, i.e. by the BIOEAST Initiative, the CEE countries are provided with an opportunity to achieve further progress in sustainable growth of agriculture, aquaculture, forestry and food industry.

The paper is aimed at providing a brief theoretical background on bioeconomy and related bioeconomy strategies and policies and analysing key socio-economic indicators of the 'BIOEAST countries' bioeconomy (Visegrad Countries, Bulgaria, Romania, Slovenia and Croatia). Furthermore, it interprets the results of the 'BIOEAST Bioeconomy Capacity Building Survey', the respondents of which were chosen randomly through personal contacts of experts (who created a judgement sample) and by snowball sampling to get further contacts. The questionnaire was sent to a small subset of the target groups – business, academic, public sector stakeholders – and the answers were examined through descriptive and inferential statistical analysis. The focus was set on what stakeholders think the most beneficial for the CEE macro region in developing the bioeconomy and what type of intervention they identify as necessary to overcome barriers, to manage bottlenecks. The results highlight some implications for policymakers and point out that the creation of sustainable bioeconomy requires triple-helix stakeholders to find efficient collaboration mechanisms and build synergies.

Keywords: bioeconomy, circular economy, sustainable growth, CEE countries, knowledge-based agriculture

JEL codes: Q01; Q16; Q18; Q5

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1. Introduction

After joining the European Union (EU) the resources of the Common Agricultural Policy have helped the Central and Eastern European (CEE) regions to improve their agri-business sectors in a wider context. In the near future, however, to achieve further progress in sustainable growth of agriculture, aquaculture, forestry and food industry there is a need to face specific challenges - arising from climate change in the Continental Biogeographical Region (Juhász-Vásáry, 2017), and the common societal and governance issues of the CEE countries – through the lens of bioeconomy. This new approach requires laying a heavy emphasis on research, innovation and transnational cooperation for knowledge-based development. As identified in the Innovation Union Scoreboard (EC, 2018) the research and innovation performance of the CEE countries is lagging behind the other EU countries' performance. Thus, the CEE countries are hindered in effectively joining the European Research Area. Unfortunately, the research and innovation divide in Europe hinders the unlocking of excellence in low-performing research, development and innovation (RDI) regions, and the appearance of specific research topics relevant to the CEE macro-region in Horizon 2020 work programmes (Juhász-Vásáry, 2017) As for the latter, the CEECs have to tackle their own challenges, among which there are quite a few being absolutely different from the challenges posed to other EU member states, for example strengthening the Region as a buffer zone against emerging and changing pathogens or motivating knowledge-based modern farming (economic optimization of production systems) and cooperation among farmers. The low performance and topic representation of the CEE macro-region restricts the creation of synergies with the European Agricultural Fund for Rural Development (EAFRD), the European Maritime and Fisheries Fund (EMFF) and the European Structural and Investment Funds (ESIF). It needs to be emphasized that “the identification and implementation of specific research areas for the CEE macro-region in Horizon 2020 would not threaten the main principle of excellence in research in Horizon 2020, and after 2020; on the contrary it would enhance it” (<http://bioeast.eu/>). “Similarly, it would not mean the exclusion of other countries or macro-regions from the research: the experiences of other Regions (e.g. Mediterranean drought and Atlantic storms) would be essential for reaching relevant results” (Juhász-Vásáry, 2017: 77).

Accordingly, considerable efforts are required to address present and future challenges successfully and to undertake these efforts efficiently a holistic bioeconomy strategy as well as a suitable shared strategic research and innovation framework is necessary. This framework ought

to be one for working towards the development of a sustainable bioeconomy in the CEE countries, for boosting and maximising the underutilized potential of the region and for boosting the sustainable productivity of primary sectors. The framework itself has already been offered by the Central-Eastern European Initiative for Knowledge-based Agriculture, Aquaculture and Forestry in the Bioeconomy, i.e. by the BIOEAST Initiative. This Initiative can help to focus the EU's agricultural research agenda, especially Horizon 2020, the research and innovation framework programme for the period 2014-2020 or Horizon Europe 2021-2027 to enhance inclusive growth through the quintuple helix of innovation (industrial partners, institutions, governments, society-oriented approach, environmental sustainability of a specific region) (BIOEAST, 2018) and last but not least to create bioeconomy strategies in the region.

The study is aimed at providing a brief theoretical background on bioeconomy and related bioeconomy strategies, analysing key socio-economic indicators of the 'BIOEAST countries' bioeconomy and describing the implications for policymakers based on the results of the 'BIOEAST Bioeconomy Capacity Building Survey'.

2. Methodology

The study is based on a literature review and descriptive statistics is used for the analysis of the data gathered in the 'BIOEAST Bioeconomy Capacity Building Survey'. Relevant national and international literature and documents on circular economy, bioeconomy and related strategies, policies were compiled. The Survey was adopted in the framework of the BIOEAST Initiative from the Survey jointly elaborated during the Danube-INCO.NET project by the Central European Initiative and PANNON Pro Innovations. It was hosted on the website of the Hungarian Research Institute of Agricultural Economics in Summer 2017. It was designed for respondents from the public sector, research and academia, as well as businesses that are active along the biomass value chain. The intention was to get a closer look at the activities and potential for advanced bio-based products of the stakeholders and the main challenges arising in the bioeconomy in the Visegrad Countries, Bulgaria, Romania, Slovenia and Croatia, or – in short – BIOEAST countries, more precisely the bottlenecks preventing the production of advanced bio-based materials and fuels which are produced from biomass sources not competing with current patterns of food and feed production and mostly regarded as waste or by-product. Furthermore, the focus was set on what

stakeholders think the most beneficial to the CEE macro region in developing the bioeconomy and what type of intervention they identify as necessary. The respondents were chosen randomly through personal contacts of experts working in the Hungarian Research Institute of Agriculture, Ministry of Agriculture and the Chamber of Agriculture (they created a judgement sample) and by snowball sampling to get further contacts from respondents. The questionnaire was sent to a small subset of the target groups and the answers were examined through a descriptive and inferential statistical analysis. (For more information see Vásáry and Szabó, 2018) It needs to be stated as a premise that the size of the sample was rather small, and a larger sample would have been more beneficial from the point of view of the analysis. The lack of conceptual clarity on bioeconomy among stakeholders and the lack of budget to hire pollsters led only to indicative results at this stage of the research. The results are however valuable and orienting, despite the lack of representativeness.

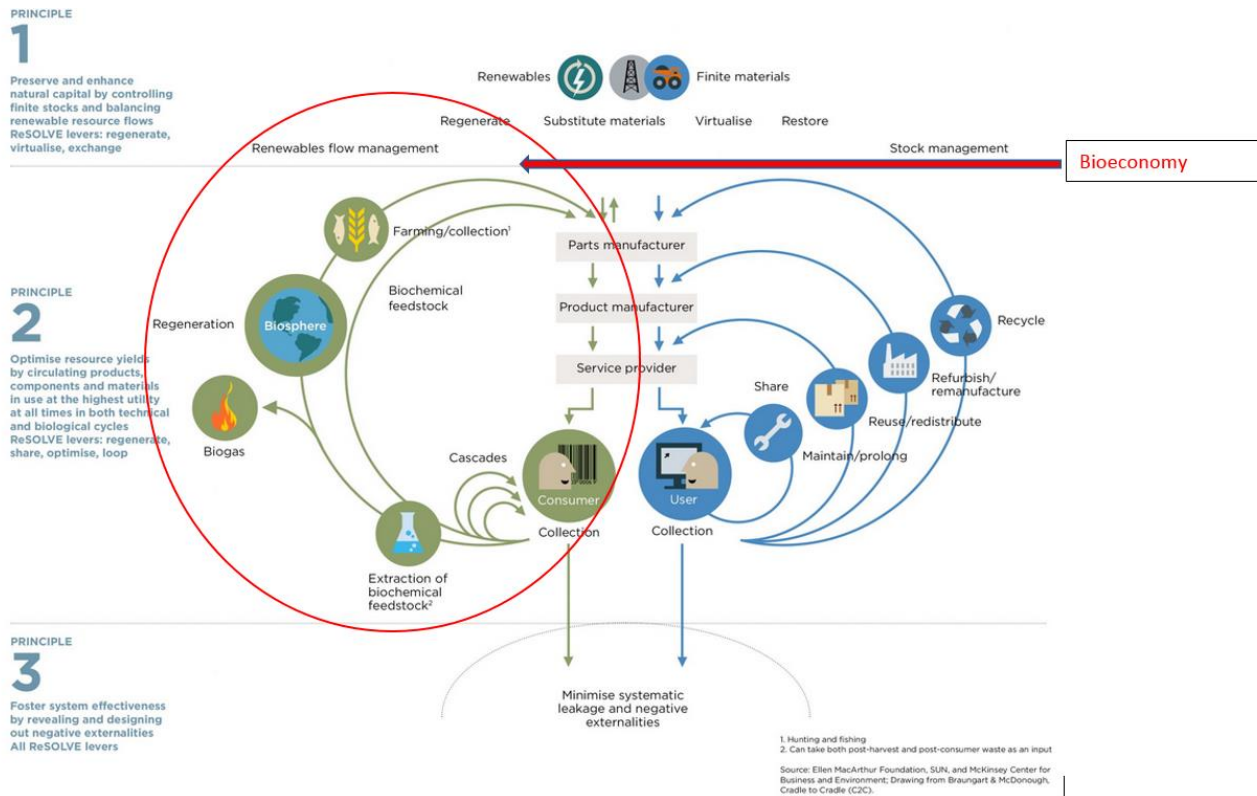
3. Theoretical background

The conceptual clarity on circular economy (CE) and bioeconomy as well as the definite connection between these terms, plus the concept of sustainability – the term often used together with CE and bioeconomy – are not declared unambiguously in the relevant international literature and documents. Detailed results of the literature review on CE, bioeconomy, different visions of bioeconomy, sustainable and circular bioeconomy are summarized by Vásáry and Szabó (2018). In addition, Dietz et al. (2018: 2) even “distinguish between four bio-based transformation paths: (1) substitution of fossil fuels with bio-based raw materials; (2) productivity increase in bio-based primary sectors; (3) increasing efficiency in biomass utilization; and (4) value creation and addition through the application of biological principles and processes separate from large-scale biomass production.” At the same time other scholars such as Nedelea et al. (2018) upgraded it to a higher level and modelled interdependencies between intellectual capital, circular economy and economic growth in the context of bioeconomy, or Bracco et al. (2018) assessed the contribution of bioeconomy to the total economy. Furthermore, we can agree with von Braun’s statements: “Bioeconomy must be studied in a context of much larger changes of societal, technological, and economic transformations. It is an opportunity and a challenge for governments, scientists of many disciplines, inventors, and small and large businesses, including farmers, and environmental social

entrepreneurs. The essence of such transformational strategies is not only technological (new science) and behavioural (adjusted consumption), but the central issue may very well be institutional, i.e., providing the regulatory frameworks and long-term incentives for industry, consumers and resource protection” (2018: 83).

In a nutshell, CE and bioeconomy complement each other as both intend to improve resource and eco-efficiency, create low GHG footprint, reduce the demand for fossil carbon and enhance waste and side streams. Thus, at the intersection of bioeconomy and circular economy there is ‘Circular Bioeconomy’ (EC, 2017).

Figure 1. Circular economy and bioeconomy



Source: based on Allan Macarthur Foundation

Beyond clear concepts concrete progressive national bioeconomy strategies are highly needed in the region. There are some scholarly articles available on bioeconomy strategies and policies (e.g. Staffas et al., 2013; de Besi et al., 2015, Scordato et al., 2017; Urmetzer et al., 2018;

Bioeconomy Council, 2015a, 2015b, 2018) that might offer some best practices for CEE countries. Although the European Bioeconomy Strategy presented by the European Commission in 2012 and updated in 2018 laid the foundation for national bioeconomy policy development, there is still only one dedicated bioeconomy policy strategy in the CEE macro region, it was adopted in Latvia. In addition, Estonia has announced that it will prepare dedicated bioeconomy policy. (Bioeconomy Council, 2018¹) The other CEE countries do not have a holistic bioeconomy strategy, their bioeconomy is usually linked with research and innovation strategies for smart specialization (RIS3) or some national policies. The examples of Hungary and Poland can confirm this statement. Currently there is no dedicated strategy which could give a framework for the existing initiatives, ideas, developments linked to the field of bioeconomy in Hungary or in its regions. The National Smart Specialization Strategy is linked to bioeconomy to a certain extent. (As an example, for Regional strategy most closely linked to bioeconomy the Research and Innovation Strategy for Smart Specialisation (2014-2020) for the Southern Great Plain Region of Hungary (2013) could be mentioned. Biotechnology is one of the priority sectors defined by this strategy. Within this priority sector, the industrial & environmental biotechnology subsector includes the utilisation of biomass for the production of bio-based materials and energy purposes, but this topic is not detailed from the implementation point of view.) Besides, the existing national policies related to the utilisation of biomass are focused predominantly on energy use. These are the 'National Energy Strategy 2030' and the 'Hungarian Renewable Energy Utilisation Action Plan 2010-2020'. According to Wozniak and Twardowski (2016, 2018) in Poland, there is no single complex or strategic document dedicated to bioeconomy either. Issues related to the development of bioeconomy are incorporated in three integrated strategies – Strategy for Innovation and Efficiency of the Economy, Strategy of Energy Safety and Environment and Strategy for Sustainable Development of Agriculture, Rural Areas and Fisheries, which are included in the implementation of the Strategy for the Development of the Country. “National smart specializations, which refer to the bioeconomy in particular, include innovative technology processes and products of the agri-food and forestry-timber industries, high quality and organic production of food and biotechnological processes in chemistry or engineering.” (Wozniak and Twardowski, 2018) In Poland, there are also several functioning

¹ “49 countries worldwide have now created policy strategies related to bioeconomy development, 15 of which, including the European Union and the West Nordic Countries, have developed dedicated bioeconomy policy strategies – with the trend rising” (Bioeconomy Council, 2018: 13).

bio-clusters and bio-parks such as Bioenergy in the Region in Łódź, Food Cluster in Greater Poland–Kalis or Organic Food Valley in Lublin. (Wozniak and Twardowski, 2016)

4. Bioeconomy in numbers in the BIOEAST Countries

The bioeconomy's importance in the EU is unquestionable. The socioeconomic indicators – used in the study by Ronzon et al. (2018) and Vásáry and Szabó (2018) prove it. (NB: despite these statistical data, documenting bioeconomy is still a challenge; scientists and researchers need to further elaborate on useful indicators.²⁾

The EU-28 bioeconomy employed 18 million people (8.2% of the labour force) and generated 2.3 trillion of turnover or 620 million of value added (4.2% of the EU-28 GDP) in 2015. About two thirds of the value added and turnover of the bioeconomy and three quarters of bioeconomy employment are generated by agriculture and the manufacture of food, beverages and tobacco. Sectoral contributions vary, however, according to the degree of labour intensiveness of the sector.

In the BIOEAST Countries, in the period between 2008 and 2015, there was a decreasing trend in the number of people employed in agriculture, forestry, fishing and aquaculture, food, beverages, tobacco (Table 1).

Table 1. Development of the number of people employed by selected sectors (total number) in the bioeconomy (2008, 2012, 2015)

		BG	HR	CZ	HU	PL	RO	SK	SL
Agriculture	2008	224600	207600	125000	150500	2139700	2635700	70700	80100
	2012	168100	172700	115100	173200	1878400	2498100	55100	73200
	2015	177300	127700	114200	178800	1768600	2129600	57900	60100
Forestry	2008	25000	13000	30900	12600	60500	49100	25400	4500
	2012	19300	14400	32000	19000	73600	56600	20300	3400
	2015	28600	15100	30100	25300	72700	51600	18400	4000
Fishing and Aquaculture	2008	1921	6782	0	0	8609	3544	0	138
	2012	1995	6779	0	0	8184	3439	0	141

² The attempt made by Lier et al. (2018) is very instructive. They identified most suitable indicators grouped by EU bioeconomy strategy objectives (Creating jobs and maintaining competitiveness; Reducing dependence on non-renewable resources; Mitigating and adapting climate change; Ensuring food security). The full list is available in Lier et al., 2018: 26)

	2015	2651.5	7298	0	0	10255	2894	0	139
Food, Beverages, Tobacco	2008	110696	68373	125239	111303	445337	208537	40029	17845
	2012	97346	65127	115725	104090	422246	187037	40003	15899
	2015	98611	61722	116887	107914	423197	182514	39488	16468

Note: '0' means there is no available data in the dataset.

Source: own composition based on JRC Bioeconomics dataset

<https://datam.jrc.ec.europa.eu/datam/perm/od/jrc-datam-biomass-estimates>

As regards the turnover and value added (Table 2) generated by these sectors there was a decline recorded in both from 2008 to 2009 due to the global financial and economic crisis, followed by a recovery. In 2012, the level of the turnover reached that measured in 2008, while in 2013, the level of the value added came close to that measured in 2008; it slightly dropped in 2014 and 2015. (NB: Table 2 contains a few selected years, but JRC Bioeconomics dataset contains all the above-mentioned years.)

Table 2. Development of value added (million EUR) in the bioeconomy (2008, 2012, 2015)

		BG	HR	CZ	HU	PL	RO	SK	SL
Agriculture	2008	2019.6	1715.2	2291.2	3427	8215.9	8730.8	1916.7	447.7
	2012	1724	1329.5	2657.5	3600.4	9154.3	5668.3	1783.4	443.4
	2015	1642.3	1219.5	2656.9	3879.1	8064.3	5909.9	1906.8	578.4
Forestry	2008	156.7	221.6	812.1	194.3	1023	455.4	521.8	177.6
	2012	175.9	211	1110.3	209.8	1160.4	529.5	566.2	199.3
	2015	210.1	211.9	1073.1	213.8	1327.6	647.2	728.2	203.1
Fishing and Aquaculture	2008	10	99.6	18.2	15.1	47.3	12	4.7	4
	2012	12.7	128.3	25.5	15.7	59.5	33.9	1.7	4.2
	2015	20.9	137.3	23.4	15.2	79.6	152.2	37.3	5.3
Food, Beverages, Tobacco	2008	862.3	1374.3	2843.4	2058.4	10069.9	2565.5	636.3	469.2
	2012	948.5	1259.1	2729.4	1781	9332.2	2001.3	772.2	446.3
	2015	1059.1	1224.2	2658.6	2086.5	10290.7	1661.1	755.7	505.9

Note: '0' means there is no available data in the dataset.

Source: own composition based on JRC Bioeconomics dataset

<https://datam.jrc.ec.europa.eu/datam/perm/od/jrc-datam-biomass-estimates>

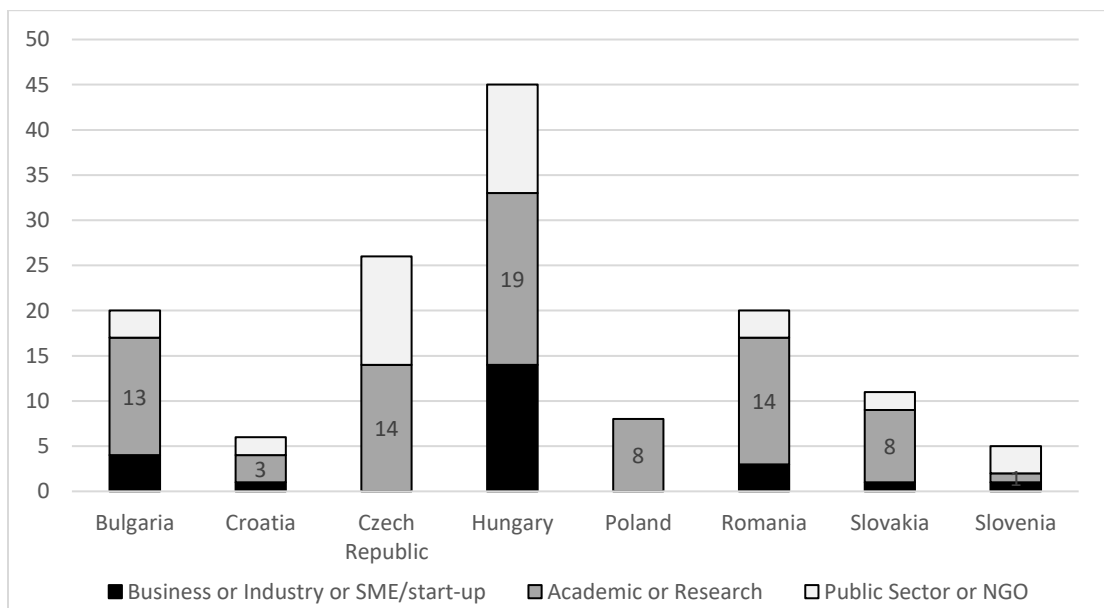
The apparent labour productivity (calculated by using the JRC Bioeconomics dataset) increased from 2008 to 2015 in almost all the countries and sectors analysed. The degree of improvement is, however, different among the countries. The sectoral levels of apparent labour productivity show very wide ranges of variation at the level of the BIOEAST countries.

Based on the concentration of national labour markets into the bioeconomy (as a proxy for the employment situation) and apparent labour productivity of the bioeconomy (as an indicator reflecting economic growth potential of Bulgaria, Croatia, Poland and Romania can be defined by a strong specialisation of national labour markets in the bioeconomy and a level of apparent labour productivity of the bioeconomy below half the EU-28 level. The Czech Republic, Hungary, Slovakia and Slovenia can be defined by a medium specialisation of the national labour markets in the bioeconomy on the EU-28 scale and a level of apparent labour productivity of the bioeconomy of between half the EU-28 level and the EU-28 average level (Ronzon et al., 2018).

5. Results of the BIOEAST Survey

Regarding the respondents' demographic status, the academic research sector was the most represented sector and stakeholders of businesses, industry or SME/start-ups – the least represented one. As regards the countries Hungary, the Czech Republic, Bulgaria and Romania were more active in filling in the survey. The total number of respondents was 141, the relative proportions of stakeholder groups are indicated in Figure 2.

Figure 2. Responses to BIOEAST Survey by stakeholder group and country



Source: own research

Major results of the capacity mapping are indicated in Table 3. Beside that information, the companies' activities focus primarily on animal feed (25%), food products (17%), advanced bio-based materials: chemicals, pharmaceuticals (12.5%), advanced liquid biofuels (12.5%) and liquid biofuels (12.5%). The biomass production activity focuses mainly on forestry products and energy crops. Among the R&D and consulting activities there are the knowledge transfer (29%), the process design (29%) and the education and training (25%) to mention. Most departments of the academic or research institutes study agricultural residues (18%), conventional arable crops (14%), energy crops (14%), wastes of livestock/dairy sector (11%) or forestry products, residues (10%).

Table 3. Capacity mapping

to better understand the activities of:		
companies	research institutes	government agencies
Most companies operate in the energy (45%) , agriculture (37%) and environmental protection (29%) sectors. The majority of business activities of the 'Business' sector's respondents are related to biomass production (37%) , R&D service and consulting (37%) and biomass conversion (29%).	The academic activities of the respondents are principally related to agriculture (30%) , environmental studies 15% and bio-sciences (14%). Cover principally horizontal topics (34%) such as economics of the supply chain (22%), sustainability and climate change (18%).	The majority of the third stakeholder group are employed by Governmental Agencies or Bodies (32%) and NGOs (29%). The focus of the organizations in the public sector is on agriculture (12%) , research and innovation (12%) , biomass (11%) .

Source: own research

The companies involved in the biomass supply chain see *bottlenecks* preventing the production of advanced bio-based materials and fuels mostly at the following steps of the supply chain: conversion technology (37%), economics of process (29%) and standardisation and labelling (29%). The answers of respondents to the question, at which step of the supply chain they would be able to provide solutions in order to move forward the production of advanced bio-based materials and fuels are quite complementary (Table 4).

Table 4. Potential provision of solutions in order to move forward the production of advanced bio-based materials and fuels

Start-up companies or R&D/consulting services	Research institutes	Government agencies
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conversion technology (29%), <i>economics of process</i> (25%), conversion efficiency (17%), standardization and labelling (17%)	<i>economics of process</i> (20%), impact assessment of life cycle analysis (19%), biomass sourcing (availability) (16%), resource efficiency of the process (14%), demand for products (12%)	Respondents in the public sector would be able to provide guidance or tool in order to move forward the production of advanced bio-based materials and fuels mostly in terms of biomass sourcing.
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Source: own research

It should, however, give us food for thought that more than 2/3 of the respondents in the public sector are not aware of any specific support instrument or tool in favour of the bioeconomy.

In terms of what is the *most beneficial to the CEE macro region in developing the bioeconomy* there are both similarities and differences to be observed depending on the answers of different stakeholder groups. On the whole, the main feedstock for bioenergy/biorefinery purposes is considered the agricultural residues which is followed by energy crops, forestry residues, conventional arable crops, algae, forestry products, and industrial products. All three stakeholder groups think that agricultural residues could be the main feedstock for bioenergy/biorefinery purposes. In the opinions obtained from representatives of the academic and public sectors, wastes of livestock/dairy sector, industrial wastes or by-products come as second and third in their ranking, the business sector, however, named – instead of the abovementioned – forestry residues and energy crops.

The respondents pointed out some *missing elements hindering the region to become competitive* and listed their *main opportunities*, as well. As for the barriers, half of all respondents considered the lack of financial possibilities to be the major missing element followed by not suitable policy framework (43%), lack of industrial interest (36.9%) and lack of cooperation networks (36.2%). With regard to the opportunities, more than half of all the respondents referred to biomass potential as the main opportunity, followed by creation of cooperation networks (36.9%), exploitation of geographical location (34,8%) and establishment of adequate research infrastructure (34.8%).

In terms of identification of *wished interventions by CEE countries and by certain old EU Member States*,³ which are supposed to support growth in the bioeconomy, the following results

³ Data for France, Germany, Italy, Spain and Great-Britain originates from the article by Hodgson et al., 2016.

were obtained (Table 5). In the BIOEAST countries ‘counteracting the resistance to change’, ‘knowledge exchange’ and ‘resource mobilisation’ were deemed the most important innovation system functions.⁴ The least important ‘knowledge development’ was addressed only by Slovakia and Romania. In France, Germany, Italy, Spain and Great-Britain ‘counteracting the resistance to change’, followed by ‘guidance of the search’ and ‘resource mobilisation’ were the most important innovation system functions. Among individual interventions ‘providing access to financial support’ played the leading role in the BIOEAST countries, followed by ‘furthering academia to business collaboration’, ‘building investor confidence in bioeconomy’, ‘ensuring continuity of policy’ and then by ‘championing utilization of local resources’ and ‘raising public awareness of bio-based products.’ (Table 5).

Table 5. Interventions grouped by innovation system function and the top five selected as the most important by respondents from BIOEAST countries and certain Western European Countries*

Category	Intervention	C Z	P L	H U	S K	B G	C R	R O	SI	F R	D E	IT	E S	U K
I. Knowledge development (R&D)	1. Easy access to pilot facilities				x			x						
	2. Establish knowledge of best conversion routes for biomass type											x		
	3. Identify and address knowledge gaps									x	x			
	4. Promote access to Intellectual Property													
II. Knowledge exchange	1. Further academia to business collaboration	x	x			x	x							
	2. Develop regional networks or clusters						x			x		x		
	3. Develop international networks or clusters		x											
	4. Facilitate business to business collaboration				x									
III. Guidance of search	1. Boost engagement with policy makers		x	x									x	
	2. Stimulate industrial symbiosis - sharing of resources										x			
	3. Institute standards and regulations for the bioeconomy									x	x	x		
	4. Advocate use of standardised LCA (Life Cycle Analysis)								x					
IV. Market formation	1. Champion utilisation of local resources	x			x				x					
	2. Create conditions for niche markets	x												
	3. Build stakeholder consensus on how best to develop bioeconomy													

⁴ Innovation system functions as defined by Hekkert et al., 2007 (“The goal of any innovation system is to generate and diffuse innovations which lead to technological change.” Hodgson et al., 2016)

	4. Implement green public procurement													
V. Resource mobilisation	1. Provide access to financial support		x	x	x	x		x						x
	2. Develop a skilled workforce			x		x						x	x	x
	3. Ensure competitive feedstock costs													
	4. Stable feedstock supply													
VI. Resistance to change and legitimacy	1. Build investor confidence in the bioeconomy			x	x		x	x				x	x	x
	2. Ensure continuity of policy			x		x	x		x	x	x		x	x
	3. Raise public awareness of bio-based products	x					x		x				x	
	4. Promote demonstration of technologies and products	x							x	x	x			x

Note: * - result gained by Hodgson and his colleagues who analysed France, Germany, Italy, Spain and Great-Britain

Source: own research and results based on Hodgson et al. (2016: 511)

In the old EU member states, there was, however, a different ranking. Their priority is 'building investor confidence in bioeconomy' followed by 4 equally weighted interventions: 'providing access to financial support', 'ensuring continuity of policy', 'stimulating industrial symbiosis' and 'promoting demonstration of technologies and products' (Hodgson, 2016).

The importance of individual interventions in the BIOEAST countries seems to differ among the stakeholder groups. The interventions 'furthering academia to business collaboration' and 'building investor confidence in bioeconomy' are equally important for the Academic or Research and the Public sectors. The interventions 'boosting engagement with policy makers' and 'ensuring continuity of policy' are equally weighted by the Business and the Public sector. The intervention 'providing access to financial support' was highlighted by the Business and the Academic sectors. The remaining interventions were selected as most important only by one of these stakeholder groups. There are only a few interventions, where the difference between stakeholder groups seems to be rather considerable. In these cases - 'improving access to pilot facilities', 'furthering academia to business collaboration', 'developing regional networks and clusters', 'championing utilization of local resources', 'developing start-up incubation programs with bioeconomy focus' and 'promoting open innovation approaches' – the perceived importance is higher for the academia than for the business sector and it is the highest in the public sector. In the research carried out by Hodgson et al. (2016: 515) the results are very similar: "Between stakeholder groups (academic, industrial, policy) significant difference between the perceived levels of importance was observed for only a small number of specific interventions. Academic

respondents placed greater importance on the need to address knowledge gaps and stimulate industrial symbiosis than industry or policy stakeholders. Industry stakeholders placed greater importance on aspects of financial support, feedstock cost, and conditions for niche markets than the two other groups.”

4. Conclusion

The results firmly confirm the low level of bioeconomy maturity, strong willingness of the different stakeholder groups to cooperate, point out the interventions, which would help develop innovation in the CEE countries’ bioeconomy and some key areas of consensus and disparity between perceptions of the different stakeholder-groups. At the same time the findings verify and strengthen the objectives of the BIOEAST Initiative (Table 6).

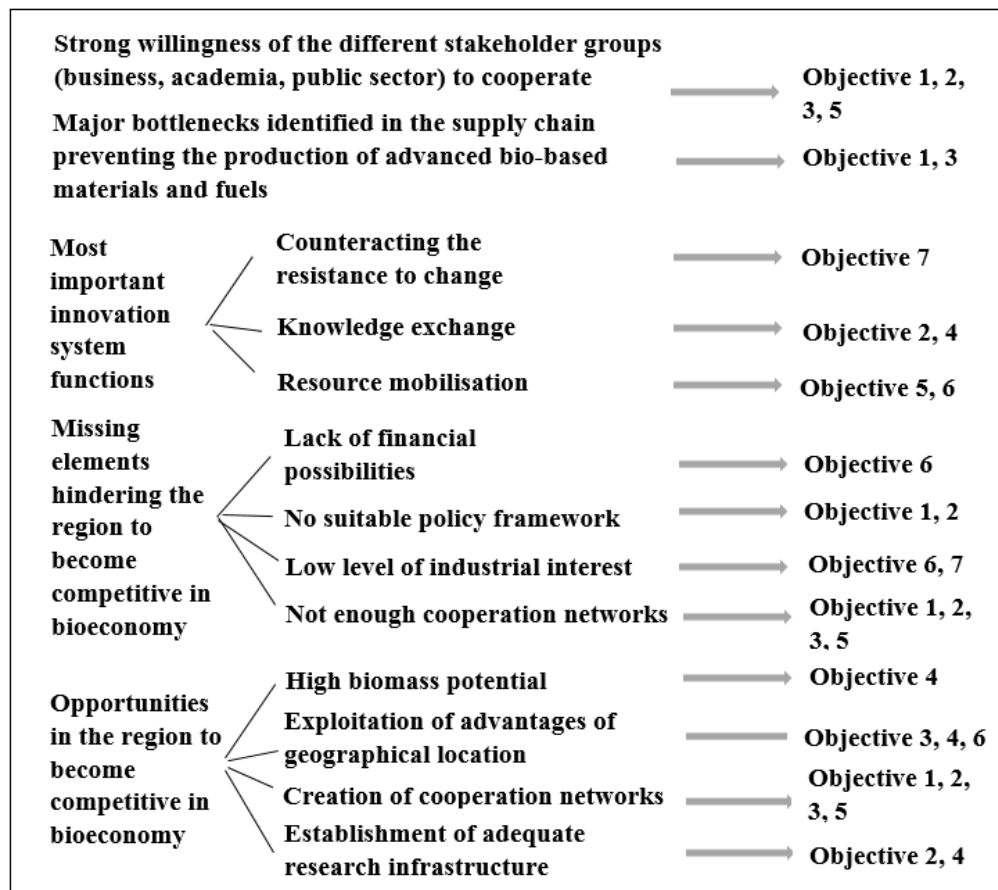
Table 6. Objectives of the BIOEAST Initiative

Objectives	Content of objectives
Objective 1. Initiate cooperation and the development of knowledge-based policies	establish a multi-stakeholder network and cluster at European level to facilitate joint actions, backed up by a renewed commitment to closer cooperation at both the political and operational levels through close personal contacts and communication between the countries concerned at the operational level;
Objective 2. Identify common challenges and validate common research topics	map specific challenges for a Strategic Research and Innovation Agenda and foster innovative multidisciplinary research and cooperation activities. These should address the relevant common CEE challenges by means of common work carried out by experts as a follow up to the Visegrad4+3 Common Declaration as a starting point for the discussion;
Objective 3. Initiate strategies	create a cross-sectorial approach for the development of a national circular and bioeconomy strategy;
Objective 4. Provide an evidence base	establish data-driven support for implementation of policies through the creation of an interoperable, fully integrated observing and forecasting system. This would promote continuous, long-term observation based on open data structures to guarantee easy access;
Objective 5. Improve skills	train a new generation of dedicated multi-stakeholder actors;
Objective 6. Initiate development of synergies	promote regional, national, EU and international funding opportunities to develop innovative technologies, methodologies and approaches. The purpose would be to boost the sustainable and circular economic growth of the European bioeconomy sectors and the conservation and upgrading of the regional environment, resources and cultural heritage;
Objective 7. Increase visibility	draw attention to specific challenges and research potential of the macro-region, through involving society and promoting public awareness.

Source: BIOEAST, 2018

The most important innovation system functions considered necessary by the respondents – counteracting the resistance to change; knowledge exchange and resource mobilization – are related to objectives 2, 4, 5, 6 and 7. Further suggestive results – in terms of what the missing elements hindering competitiveness in the bioeconomy are, the opportunities to raise competitiveness, or major bottleneck in the supply chain – definitely support the objectives respectively (See Figure 3).

Figure 3. Findings of the BIOEAST Survey verifying the Objectives of the BIOEAST Initiative



Source: BIOEAST, 2018

The size of the sample of the research is definitely small and the lack of representativeness leads to further questions. Despite methodological difficulties, we can state – even at this first stage of research and following in Hodgson and his colleagues' footsteps – that innovation system

frameworks were proven to be able to provide a better understanding of the drivers of bioeconomy, a thought-provoking assessment of perceptions on policy interventions, and useful implications for policymakers both by countries and by academic, business and policy stakeholder groups. Thus, this kind of research ought to be carried out on a regular basis. Further results and implications could help develop comprehensive bioeconomy strategies in the region, support our society in embracing sustainable bioeconomy and contribute to regional collaboration of triple-helix stakeholders.

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Rolnictwo oparte na wiedzy w biogospodarce krajów Europy Środkowej i Wschodniej

Streszczenie

Rolnictwo, akwakultura, leśnictwo i przemysł spożywczy w Unii Europejskiej dostrzegają znaczne różnice wewnętrzne w zakresie wyników badań i innowacji na niekorzyść krajów Europy Środkowej i Wschodniej. Podział ten utrudnia odblokowanie doskonałości w mało wydajnych regionach badawczych, rozwojowych i innowacyjnych oraz ustanowienie współpracy ponadnarodowej na rzecz rozwoju opartego na wiedzy, a tym samym pojawienie się konkretnych tematów badawczych istotnych dla makroregionu Europy Środkowo-Wschodniej, między innymi w programach prac programu „Horyzont 2020”. Aby wypełnić lukę, należy stawić czoła specyficznym wyzwaniom w tym sektorze poprzez pryzmat biogospodarki. Jednocześnie nie ma wątpliwości, że biogospodarka wymaga towarzyszących jej strategii i wspólnych strategicznych ram badań i innowacji. Ponieważ ramy te zostały już zaoferowane przez Inicjatywę Europy Środkowo-Wschodniej na rzecz rolnictwa, akwakultury i leśnictwa w biogospodarce, tj. Przez inicjatywę BIOEAST, kraje Europy Środkowej i Wschodniej mają możliwość osiągnięcia dalszego postępu w zrównoważonym rozwoju rolnictwa, akwakultur, leśnictwa oraz przemysłu spożywczego. Dokument ma na celu dostarczenie krótkiego tła teoretycznego na temat biogospodarki i powiązanych strategii i polityk biogospodarki oraz analizę kluczowych wskaźników społeczno-ekonomicznych biogospodarki krajów „BIOEAST” (kraje Grupy Wyszehradzkiej, Bułgaria, Rumunia, Słowenia i Chorwacja). Ponadto interpretuje wyniki „BIOEAST Bioeconomy Capacity Building Survey”, których respondenci zostali wybrani losowo poprzez osobiste kontakty ekspertów (którzy stworzyli próbkę oceny) oraz przez próbkowanie śnieżkami w celu uzyskania dalszych kontaktów. Kwestionariusz został wysłany do niewielkiego podzbioru grup docelowych - interesariuszy biznesowych, akademickich, sektora publicznego - a odpowiedzi przeanalizowano za pomocą opisowej i wnioskowej analizy statystycznej. Skupiono się na tym, co interesariusze uważają za najbardziej korzystne dla makroregionu Europy Środkowo-Wschodniej w rozwijaniu biogospodarki i jaki rodzaj interwencji identyfikują jako konieczne do pokonania barier, do zarządzania wąskimi gardłami. Wyniki podkreślają pewne implikacje dla decydentów i wskazują, że tworzenie zrównoważonej biogospodarki wymaga od zainteresowanych stron o potrójnej helisie znalezienia skutecznych mechanizmów współpracy i budowania synergii.

Słowa kluczowe: biogospodarka, gospodarka o obiegu zamkniętym, zrównoważony wzrost, kraje Europy Środkowo-Wschodniej, rolnictwo oparte na wiedzy