CELEBio

D.3.1 Guidelines for National Bioeconomy Action Plans

This project has received funding from the Bio Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement ***No 838087***

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November 2020

This project received funding from the BBI JU under the EU Horizon 2020 research and innovation programme under grant agreement No.838087

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Key issues

- ✓ *BIOMASS IS ABUNDANT IN ALL COUNTRIES*
- ✓ *SIGNIFICANT BARRIERS IN INFRASTRUCTURE, ACCESS TO CAPITAL AND KNOWLEDGE TRANSFER FOR INNOVATIVE BIOBASED VALUE CHAINS*
- ✓ *FOLLOWING A SLOW START AND CAPITALISING ON THE SIGNIFICANT EFFORTS OF THE BIOBASED INDUSTRIES THE ENGAGEMENT IN DEMONSTRATION AND FLAGSHIP ACTIVITIES IN THE REGION IS GROWING*
- ✓ *DEMAND FOR BIOBASED PRODUCTS IS STILL LOWER THAN WESTERN EUROPEAN COUNTRIES DUE TO SLOW MARKET DEVELOPMENT BUT GROWING ESPECIALLY AMONG YOUNG PEOPLE*
- ✓ *POLICY MECHANISMS HAVE SO FAR BEEN MOSTLY RESPONSIVE TO EU REGULATIONS AND COMMITMENTS*
- ✓ *NEED FOR IMMEDIATE STRATEGIC ACTIONS TAILORED TO LOCAL CAPACITIES, ECONOMY AND ECOLOGY*

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1. Introduction

The aim of the report is to present an overview of the Guidelines for the National Bioeconomy Action Plans prepared, jointly with national stakeholders, in the CELEBIO project for Bulgaria, Croatia, Czech Republic, Hungary, Slovakia and Slovenia.

The guidelines for National Bioeconomy Action Plans delivered a set of specific, attainable, relevant biobased value chains and time-based (2020- 2030) Action Plans for the development of bioeconomy in these countries. The work has capitalised on the findings of the work in CELEBIO and is structured in four sections.

The first briefly outlines the current state of bioeconomy and discusses the countries' comparative strengths and opportunities. Detailed profiling of the existing policy landscapes per value chain stage (i.e. biomass production, conversion, distribution, end use) is provided within the individual country reports.

The second introduces the main recommendations of the Bioeconomy Visions as developed, together with national stakeholders, in each country.

The third presents an overview of the potential value chains selected by national stakeholders and provides information tailored to each value chain in terms of current exploitation of biomass raw materials, future actions that could steer innovative and resource efficient market uptake for biobased products, potential interventions and expected added value. This section also includes information on the relevance to the UN Strategic Development Goals (SDGs) and selected relevant operational projects.

Finally, the fourth part provides an outline of suggested actions in terms of technology, environment, economy, society and policy that could facilitate the future implementation of national bioeconomy action plans.

This section provides an overview of the main aspects analysed during the development of recommendations for the national action plans in CELEBIO. Detailed country relevant information can be found in the individual country reports that are included in the Annex.

2. Approach

The preparation of the guidelines for national action plans follows is built on analysis of domestic capacities and infostructure for: i) local, resource efficient value chains, ii) suitable market segments and industrial applications and iii) policy and financing, as shown in Figure 1 below.

Prioritising resource efficient value chains

Prioritisation of value chains within their geographic settings aims to place focus on resource efficient options that can use domestic biomass, contribute to rural and wider economic development, and meet overarching climate change, bioeconomy, and circular economy targets. Key issues considered during the analysis in CELEBIO include:

- Which is the current exploitation of biomass raw materials?
- Which actions could steer innovative and resource efficient market uptake for biobased products?
- Which future interventions are required and what is their expected added value?

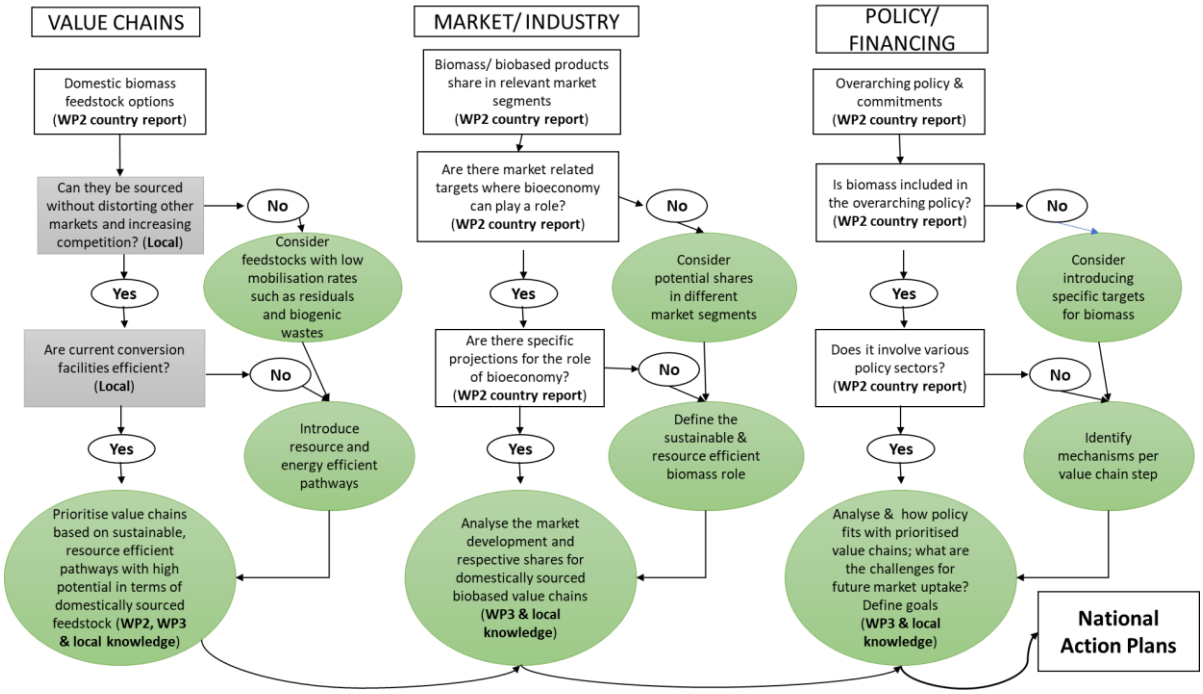

Figure 1 Decision tree for prioritising domestic value chains and understanding the market and policy relevant context (adapted from Panoutsou et al., 2020[1])

[1] Panoutsou, C., & Singh, A. (2020). A value chain approach to improve biomass policy formation. GCB Bioenergy, 12, 7, 464-475. https://doi.org/10.1111/gcbb.12685

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Markets

Markets including food, materials, fuels and energy and pharmaceuticals use diverse biomass feedstocks. Value chains are increasingly complex, more interrelated and expanding, which is leading to intense competition for raw materials.

The main goal of analysing the market context in the given geographical setting is to identify market development paths and respective shares for domestically sourced biomass value chains so that the National Action Plan can focus on optimal solutions with high market uptake potential. To do so they must consider resource efficiency and focus their activities on market segments where the selected value chains function and perform best.

Important considerations are the current share of biomass in the various market segments and whether there are market related targets where biomass can play a role in the future. If not, policy makers must consider potential shares in different market segments and further define the sustainable and resource efficient biomass role in these within the foreseeable future.

Policy

To assess future policy needs and design 'action plan related' interventions that increase market uptake whilst fostering resource efficiency, it is important to review existing policies within different sectors (agriculture, environment, regional economy, etc.) and their relevance to biomass value chain stages. A detailed policy landscape must be prepared to understand current interventions for biomass and to ensure balanced future interventions that will steer mobilisation of low impact, sustainable feedstocks plus facilitate their conversion to market products through efficient, innovative technologies.

The first question is whether biomass is included in overarching policies. If the answer to this question is negative, policy makers should consider introducing specific targets for biomass. On the other hand, if the answer is positive, the question is then whether biomass is appropriately reflected in the respective policy sectors.

Action Plans

For each recommended action the following information is included:

- What actions can be expected?
- By when they will take place, and for how long?
- Who will carry out these actions?
- What resources (i.e., human resources, infrastructure, etc.) are needed to carry out these changes?

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3. Bioeconomy in CELEBIO countries

Current state

The value added from the bioeconomy in CELEBIO countries was thirty-two billion Euros and in the same year there were 2.11 million people employed.

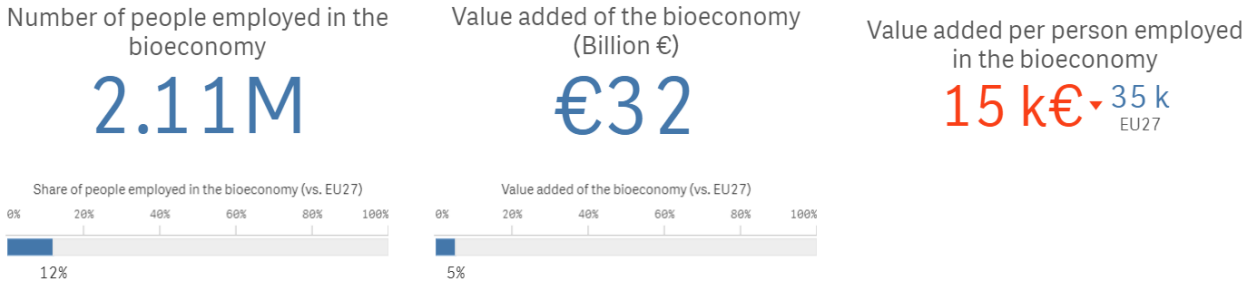

Figure 2 Jobs and wealth in the bioeconomy of CELEBIO countries in 2017 (source: datam.jrc.ec.europa.eu)

The annual turnover was a hundred and one billion Euros in 2017 which translates to 51,000 Euros per person employed in the sector with the EU27 average figure being 127,000 Euros.

Figure 3 Employment and turnover in the bioeconomy by sectors in the CELEBIO countries (2017)

Agriculture remains the biggest sector in terms of employment (1.16 million people) with food, beverage, and tobacco following. In terms of value-added food, beverage and tobacco lead with 46.2 billion Euros and agriculture follow with 28.7 billion Euros. Biobased chemicals and products have a turnover of approximately 2.3 billion Euros annually.

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Strengths, opportunities and barriers

This section provides an overview of the countries' strengths, opportunities and barriers grouped by the resource sector, i.e. agriculture, forestry and biowastes.

Agriculture

• Bulgaria	• Bulgaria has enough land to provide raw materials for food and biofuels production • Long tradition in agriculture and food processing • Regions with preserved biodiversity • Unused potential available from primary residues, secondary residues and unused lands. • Cost of biomass resources are relatively low in comparison to many regions in the EU • Still many underutilised biomass resources • A long agricultural tradition in planned economy • Non-utilised arable land	• Still many biomass resources that can be mobilised • Turning bio-waste, residues and discards into valuable resources and creation the innovations and incentives • Opportunities to produce low-ILUC biomass on abandoned lands • Production of healthy and functional food and drinks for a healthy Europe is a trend the Bulgarian market can connect to. • Production of medical aromatic plans for medicines, food additives and cosmetic products	• Depopulation of rural areas • Lack of labour in agriculture because of non-attractive remuneration in agriculture sector • Lack of rural population to produce and collect the biomass in the long term • No market for high added value biomass, uses only low-quality chains for heat/electricity • Pollution through inefficient use of biomass, firewood burned in low-efficient hearing devices in local heat production • Import of value-added products
• Czech Republic	• Agriculture sector is highly developed • Robust food and beverage value chains • Modern transport infrastructure	• Relatively large utilizable biomass • Growth opportunity in development of • Czech bio-organics market • Local bioeconomy hub development	• Climate change, more drought and high temperatures • Agricultural practices leading to inadequate soil and water management • Monopolies is some value chains leading to competitive lock-out
• Croatia	• Unused potential available from primary residues, secondary residues and unused lands • Roadside cost relatively low and good road connectivity within the country • Still many underutilised biomass resources • A long agricultural tradition in planned economy • Non-utilised arable land • Rural Development Program • Cost of biomass resources are relatively low in comparison to many regions in the EU	• Still many biomass resources that can be mobilised • Because of harbours (coastal and inland), local biomass resources can be combined with imported resources to strengthen security of supply • Unused land resource is significant, so opportunities to produce low-ILUC biomass on abandoned lands • Expansion of family farms (both in continental and coastal area) into tourism sector to generate additional income, entrance to new market - ecotourism • Production of healthy and eco-friendly food for European market • Europe is a trend the Croatian market can connect to.	• The risk for loss of HNV farmland when demand for biomass takes off • Lack of rural population to produce and collect the biomass in the long term • No market for high added value biomass, uses only low-quality chains for heat/electricity • Favourable work conditions outside of Croatia – increasing trend of labour outflow • Raising competitiveness and agricultural development in the EU market could pose a problem for Croatian farmers and their future placement of value-added products • Large land purchases for financial investment and industrial agricultural production, without stimulating local communities and creating jobs - Land-grabbing
• Hungary	• Regularly higher amounts of cellulose-based raw material (20 mio t/year) • Oil plants are on 0,9 mio ha- the crop and byproducts of crop could also be used for biodiesel • Semi- Warm-demanding plant species may also be involved in the production in extensive areas (e.g. Sorghum species) for bio-ethanol • Secondary biomass of livestock means 5-6 mio t manure • Feedstock price is low by cereal production with low quality • There are biogas industries in the country • High expertise regarding to using biomass (e.g. biogas) • There are worker training and engineer education in biomass skills • There are labors where MSZ EN ISO 17025:2005 standard used for analyzation of biomass • There are research projects of biomass sector at the universities and research institutes • A lot of employment opportunities Investors in biomass-processing: poultry farms, biogas-industries • Own biomass processing by livestock-farmsto risk minimization	• Public support for the use of biomass • Discount on fuel oil tax on vegetable oil • There are official regulations for productions and the market • Clarified legal and ownership system • Low rates of loan (good CAPEX possibility)	• General organic matter deficiency in soils • Increased imports of biodiesel into the EU due to tariff -it can influence the economical sustainability • The product range is scarce, only the biomass used • for heating is widely known Just on a few areas of land is infrastructure available • Transport are mostly on route in Hungary, tariffs of cargo are relatively high in the country • Additional land use might lead to in- direct land use changes, in worst case to deforestations • Low price of biomass-based energy 0,1 Eur/kWh- (OPEX min.0,13 kFh)
• Slovenia	• Accelerated generational renewal – improved age and education/skills structure • Accelerated investment cycle – improved technological and economic performance • Quality professional institutions and organizations in the field of research, education and consulting • Suitable conditions for irrigation (availability of water, precipitation) • Production systems with moderate intensity, resulting in quality products and solid environmental performance	• Promoting access to specialized advisory services • Increasing demand for sustainably produced local product of higher quality and products from above standard breeding. • Promotion of organic farming • Weak horizontal (eg. producer organisations) and vertical (eg. Value hains) integration in agri-food sector renders it difficult to organise biomass efficiently	• Agriculture in general is not very attractive to younger generations • Poor economic and environmental performance and high exposure to climate change • Restructuring is slow due to lack of own resources to co-finance investments
• Slovakia	• Appropriate size structure of agricultural holdings • Great potential for the use of agricultural land and especially natural grassland, good traditions in agricultural and forest land management • Favourable climate conditions • High soil quality in the lowlands • Sufficient water supply • The possibility of growing organic agricultural products In Slovakia, • Advanced information systems and sources of information on supply assessment and control	• Low added value production • Job creation, respectively job maintenance • Diversification of the rural economic base • Exploitation of local natural resources • Countryside capital inflow • Promoting the sale of local products • Farm production support • Development of inter-communal and cross sectoral cooperation • Large space for food processing in Slovakia, as the negative balance of food export / import is widening European Green Deal and its implementation in the Slovak Republic	• A high percentage of the rural population in the post productive age and an ongoing outflow of staffing capacities from rural areas • Inability to develop the land market as a prerequisite for business in agriculture • Foreign competition of agricultural products • Unresolved ownership relations to agricultural and forestry land • Insufficient anti-erosion measures in the country • Absence of rural development coordination • Frequently changing legislation • Climate change • The reluctance of manufacturers to create sales organizations and to participate in the formation of shortened sales chains • There are no strategies for agriculture and food processing development

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Forestry

• Bulgaria	• Dominating publicly owned pattern - large share of state ownership of the forest is a good prerequisite for sustainable management • A long tradition in forest management, uniform forest management system • Availability of 10-years local/regional forest plans, good planning of biomass flow balance, • Possibilities for additional mobilisation of primary forest resources • Forest processing industry is growing and leads to more secondary forestry residues • Well developed industry for glued boards and chipboard, pulp, paper… • High percentage of firewood in energy balance	• Mobilisation of unused biomass for future bio-based materials production • Development of new bio-based products on lignocellulosic base • Biomass production for low ILUC biofuels	• Climate changes - erosion of forest terrains, probability for fire occurrences, risk agents as insects) • Concerns for overharvesting • Short and vertical value chain • Presence of illegal logging and harvesting • Inefficient utilisation of firewood for heating • Attitudes towards the use of wood for electricity production
• Czech Republic	• Strong tradition of forestry management • Monitoring and surveillance of forest status	• Much under-utilized wood biomass • Relatively open market for wood product development • Lack of competition of novel technological solutions to the forestry derived products and service • Establish local sawmills and collective wood and timber processing centres in country	• Climate change effects lead to increasing drought and mild winters • Weak containment of the bark beetle • Lack of urgency in prioritizing forestry as a potential industry • Decrease ground water due to current agricultural practices, leading to the forest drying
• Croatia	• Unused potential available from primary residues, secondary residues and unused lands • Roadside cost relatively low and good road connectivity within the country • Still many underutilised biomass resources • A long agricultural tradition in planned economy • Non-utilised arable land • Rural Development Program • Cost of biomass resources are relatively low in comparison to many regions in the EU	• Still many biomass resources that can be mobilised • Because of harbours (coastal and inland), local biomass resources can be combined with imported resources to strengthen security of supply • Unused land resource is significant, so opportunities to produce low-ILUC biomass on abandoned lands • Expansion of family farms (both in continental and coastal area) into tourism sector to generate additional income, entrance to new market - ecotourism • Production of healthy and eco-friendly food for European market • Europe is a trend the Croatian market can connect to.	• The risk for loss of HNV farmland when demand for biomass takes off • Lack of rural population to produce and collect the biomass in the long term • No market for high added value biomass, uses only low-quality chains for heat/electricity • Favourable work conditions outside of Croatia – increasing trend of labour outflow • Raising competitiveness and agricultural development in the EU market could pose a problem for Croatian farmers and their future placement of value-added products • Large land purchases for financial investment and industrial agricultural production, without stimulating local communities and creating jobs - Land-grabbing
• Hungary	• New Forestry Act (potential of forest residues for energy purposes) • The volume of green trees increased continuously • Regularly higher amounts of raw material (3-4 mio t/year) • There are wood-based industries with high capacity in the country (300-360 MVH/year (Ajka, Pécs, Dorog) • High expertise regarding in using biomass • There are worker training and engineer education in forestry skills • There are laboratories (MSZ EN ISO 17025:2005 standard) for analyzation of biomass • There are research projects of biomass-sector at the universities and research institutes • Forestry biomass boilers available in the market • Clarified legal and ownership system	• Public support for the use of biomass • Stable internal market • Available regulations for productions and the market • Reduces soil erosion • More employment opportunities • Low interest rates of loan (good CAPEX possibility)	• Biomass is competitive with other sectors • Investor interested in biggest investments • General organic matter deficiency in soils • Infrastructure are available just a few areas of land (Biomass-industries and depos) • Transport are mostly on route in Hungary, tariffs of cargo are high in country • Additional land use might lead to in- direct land use changes, in worst case to deforestations • Low price of biomass-based energy in valuechange 0,1 Eur/kWh- (OPEX min.0,13 kFh)
• Slovenia	• Forestry abundance (58 % of surface is covered by forest) • Good accessibility (forest roads) • Availability of up-to-date data on forests (Slovenian Forest Service, Slovenian Forestry Institute, Wood Chain Manager) and strong support at sustainable management of forests	• Development of innovative and high-added value products • Job creation • Consolidation of local markets • Increased competitiveness of the country	• High dispersion and fragmentation of forest ownership hampering devoted management • Extensive export of wood instead of creating high value-added products within the county • Lack of owners' willingness to mobilise forest feedstock
• Slovakia	• Large woody biomass potential from standing forests, landscape elements and forest with a multifunctional use (combined nature protection with wood production, which has a wealth of biomass materials, products and full ecological functions available • State forest policy of Slovak Republic characterizes forests as a national wealth; therefore, the goal of sustainable economy is to • protect. • Existence of well-functioning associations with accepted leaders • High economic efficiency forest management • Non-state forest owners own up to 52.3% of Slovak forests and they are more efficient managed as the state-owned ones.	• Increasing demand for timber and other services • Non-state forestry sector support through rural development program • Use of external financial resources • New legislation (explicit division into state and non-state forests) • Investment in applied forestry and timber research • Involvement Slovak entities in projects supporting bio-economy within the BBI-JU; • Increasing share of renewable energy sources • (RES) from forestry in total RES production in SR, research activities in bioenergy • The development of rural business activities (including the involvement of business entities in cooperation projects) in relation to the creation of new value chains in the circular bioeconomy and the long-term improvement of the position in the value chains	• Negative persistent public view of foresters • Non-governmental organizations (conservationists) and their particular objectives violating the principles of sustainable forest management (Bark beetle overgrowth treatment). • Frequently changing persons in respective ministries (central organs) • Lack of financial resources from the state, Slow solution to the fragmentation of forest ownership - necessity to implement land consolidation at a higher pace and state funding • Demanding bureaucratic barrier from the side of the ministry when interested in applying from the EU funds and subsidies • Economic restriction by nature protection without financial compensation • Low law enforcement

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Biowastes

• Bulgaria	• Development of waste management infrastructure that can be used for energy and/or material recovery • High existing potential for utilization which is currently still going to landfill • Development of separate waste collection on household level • Utilisation of manure in agriculture • Utilisation of sewage sludge	• Opportunities for improvement of performance of waste management under the guidance of the EU directives. • Turning bio-waste, residues and discards into valuable resources and creation the innovations and incentives • Knowledge-based production and utilisation of biological resources, biological processes and principles • Knowledge transfer from more advanced countries in EU • Introduction of innovative technologies for biodegradable waste utilization • EU support/funding for improvement of waste management infrastructure and waste management system • Utilization of currently landfilled biodegradable waste • Implementation of "Waste Market"	• Negative public opinion on waste separation, utilization for energy/recovery purposes • Lack of recognition for the opportunities in waste utilization within bioeconomy principles • Backwardness and lack of change within legislation and strategic framework • Indifference of sector stakeholders
• Czech Republic	• Sludge is controlled by the municipalities, the accounting for its production and usage is likely to be reliable. • There is a trend to decrease landfilling	• A key opportunity will be the installation of new infrastructures within and around municipalities to harness both sludge and recycled food waste. • New legislation will need to put in place to recycle organic waste and use of the biomethane for public transport vehicles in cities.	• The main threat is political inaction and unwillingness to incorporate measures which may undercut existing business interests, even though the social, environment, and/or economic benefits favor a changed approach.
• Croatia	• Development of waste management sector • Existing and development of new infrastructure that can be used for energy/material recovery • High potential for utilization of existing waste streams, which are currently still going to landfills • Development of a unified waste collection system on household level	• Implementation of "Waste Market" • Innovative ways of biodegradable waste utilization are possible given that this still needs to be largely build up • Knowledge transfer from more advanced countries in EU • Utilization of biodegradable waste that is currently landfilled • Financing from EU funding, aligned with financing of waste management system (waste management centers)	• Lack of recognition for the opportunities in waste utilization within Bioeconomy principles • Backwardness and lack of change within legislation and strategic framework • Negative public opinion in terms of waste separation, utilization for energy/recovery purposes • Indifference of sector stakeholders
• Hungary	• Well-organised solid communal waste collection • Infrastructure are available most areas of land (Biomass-industries and depos) • Collection of hazardous household waste Collection of green household waste • Container supply is also organized for individuals and industry. • There are waste incinerators throughout the country (24) • Both civil society and business organizations are becoming increasingly aware of need for waste separation at source and separated collection and waste management	• Developing integrated waste management through national and EU financing. • Developing the waste utilization industry • The waste management sector has become a public organization	• Biomass is s competitor with other sectors • Increased transportation costs can occur due to rising fuel prices • In Hungary 67% of the waste is in landfill. • Infrastructure are available just a few areas of land (Biomass-industries and depos) • Low price of biomass-based energy in value-change 0,1 Eur/kWh-(OPEX min.0,13 kFh)
• Slovenia	• Awareness and willingness of citizens to separately collecting waste • Presence of the most modern regional waste management centre in Europe (RCERO)	• Development of innovative and high-added value products • Job creation • Increased competitiveness of the country • Reduction of landfill costs • Extension of landfill's lifetime	• Lack of better capabilities to treat broader spectrum of waste • Waste accumulation
• Slovakia	• The country has substantially reduced its greenhouse gas emissions and the energy intensity of its economy • More progress has been achieved in the management of industrial waste, where 39% now goes for recycling, while only 36% is landfilled. • Positive changes in the legislation (growing landfilling costs) • New policy and regulations on returnable PET & aluminium cans	• Still an enormous amount of waste that is not separated and that can be recycled, reused, used for energy generation once the separation and waste treatment system become further developed • Empowering bioeconomy through circular economy. Good opportunity for companies to invest in and improve the circular economy. E.g. instead of landfilling, using biowaste like retail food waste to empower the bioeconomy potential. • More recycling. • Increasing the efficiency of metal processing and of electricity generation from lignite could immensely increase the overall resource efficiency of the economy • Gradually increase the landfill tax. • Consider ICT for useful recycling.	• Insufficient municipal solid waste recycling. Only about 15% of the municipal solid waste is currently recycled. • Municipal waste management is underperforming and lacks appropriate economic signals that would divert waste from landfills and stimulate recycling and reuse • Wastewater insufficiently recycled. The generation of wastewater is relatively high and only a small share is "recycled". Wastewater treatment levels are among the lowest in the OECD; only 65% of the Slovak population benefit from a connection to a wastewater treatment plant. Water use is under-priced; and the user pays principle is not applied to all types of users. • Illegal dumping • Bad air quality • Air quality continues to suffer from heavy use of brown coal in power generation, and air pollution remains one of the main environmental challenges • Low law enforcement

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4. Vision

This section introduces the main recommendations of the Bioeconomy Visions as developed, together with national stakeholders, in each country.

	Vision statement
Bulgaria	✓ Boosting modern technologies for transformation of medical and aromatic plants as rich source of biologically active substances for development of traditional and modern medicines, nutraceuticals, food supplements/additives, functional foods ✓ Smart utilization of biomass resources for new products, fuels, and bioenergy. ✓ Valorisation of all biodegradable wastes for new products, fuels, and bioenergy. ✓ New flagship projects for existing and new bioeconomy-related industries ✓ Generation of high added value and job creation ✓ Contribution to health ecology system and mitigation of climatic change.
Czech Republic	✓ Ensuring food security ✓ Managing natural resources sustainably ✓ Reducing dependence on non-renewable resources ✓ Mitigating and adapting to climate change ✓ Creating jobs and maintaining European competitiveness
Croatia	✓ Sustainable activation of existing land resources and all available sources (soil, water, air, …) through implementation of innovative approaches, new ways of obtaining value from „green resources", maximum utilization of information technologies, new social networks for stakeholders networking, construction of new scientific and vocational capacities ✓ Development of various associations and organizations that encourage the implementation of Croatian sustainable bioeconomy (through communication with relevant stakeholders, organization of seminars, workshops, etc.) ✓ Utilization of RES in a sustainable manner, with environment protection in mind (reduction of primary resources consumption) ✓ Helping the existing biomass industry to survive in new, low-carbon environment, within the cooperation with innovative industry, scientific disciplines and SMEs ✓ Stimulating circular economy, development of new business models, resolving waste management problems, development of new workplaces ✓ Development of bio-based markets and competitiveness ✓ New value chains for biomass ✓ Identification of potentials and networking between stakeholders on topic of circularity within bio-based potentials ✓ Development of SME sector and innovative solutions, but also rural areas through better employment

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Hungary	✓ Reconciling economic growth and job creation with economic sustainability. ✓ Value creation, application of biotechnology, research and commercialization of technology. ✓ Development of integrated production systems and high-quality products with a territorial identity. ✓ Development of agricultural, food and municipal waste management, development of mechanization of biomass treatment. ✓ Utilization of the capacity of the existing power plants suitable for biomass utilization, increasing and expanding their efficiency. ✓ Exploiting the human and infrastructural potential of research and development in Hungary, connecting science and the market. ✓ Ecological sustainability, biodiversity, preservation of ecosystems, avoidance of soil degradation. ✓ Conversion and development of biological resources, optimized land use, involvement of less-favored areas in biofuel production, expansion and use of biomass-based resources, identification of "best practice", dissemination of circular and self-sustaining production methods.
Slovenia	✓ Boost productivity and value added in lagging bioeconomy sectors (in particular agricultural production) ✓ Consolidate economic and environmental performance of conventional biomass manufacturing sectors (food & drinks, wood processing, pulp & paper) by technological advancing and by closing local biomass flows and cascading use of biomass. ✓ Capitalise R&D excellence in technological innovations ready to deploy by biobased industries in Slovenia, in particular for more efficient biomass uses and low- bulk & high-value applications. ✓ Establish a modular network of biorefinery capacities to increasing the level of industrial symbiosis between conventional and novel bioeconomy sectors
Slovakia	✓ Become one of the main pillars of the national economy. ✓ Achieve a relative food self- sufficiency. ✓ Generate high added value within the whole value chain creation of the bioeconomy processes. ✓ Foster circular economy development. ✓ Increase revenue energy sources generation. ✓ Improve the environment and to mitigate of the climatic change.

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5. Value chains

This sections provides an overview of the selected value chains peR country, their relevance to SDGs and potentials B2B synergies with other BBI funded projects

	Agriculture	**Forest**	**Biowastes**
Bulgaria	Straw for animal bedding, heating and as a fuel for harvesting machines and in paper industry Medicinal and aromatic plants Residues form meat industry and manure could be used for as fuel for heat generation Utilisation of residues from distilleries Utilisation of waste from food and beverage industries Utilisation of waste from milk processing industries	Forest based biomass for bioenergy Wood for eco-innovation/ construction, residues from paper industry	Utilisation of biowastes (residues from wood industry, sunflower husks, etc) for solid biofuels and energy Utilisation of bio-wastes from different flows (households, industrial wastes, waste waters of food industry, etc) in anaerobic digestions installations Recovery of nutrients from wastewater treatment plants - sewage sludge
Czech Republic	Utilization of agricultural residues for novel technologies and products		
	Industrial crops on marginal land		
Croatia	Poultry (meat) side streams: • (Slaughterhouse waste) → pet food, taurine production • (feathers) → keratin-based sponge & absorbent materials • (chicken litter) → renewable nitrogen sourcing → AD (biogas / digestate) → protein for chicken feed	Secondary wood residues → lignin, hemicellulose, cellulose → bioproducts (advanced biofuels, bioplastics, biopolymers, fibres, chemicals)	Secondary residues from food processing → electricity and heat (anaerobic digestion process) → digestate → biorefinery → bioplastic, pharmaceutical industry, construction industry
	Industrial crops on marginal land		

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	Agriculture	Forest	Biowastes
Hungary	Unused potential of cereal straw – straw residues for electricity Corn stover for biofuel	Dendromass for electricity and heat	Communal waste for recycling plants Communal waste for electricity and heat
Slovenia	Manure for biogas & organic fertilisers dairy production (mainly sour whey) – > extraction / biotechnological processes -> food additives, enzymes / biorefinery -> platform chemicals -> biobased materials slaughter residues, residues from meat processing -> thermal processing -> processed fats (oleochemical industry, cosmetics) / proteins (animal feed) -> biogas insallations -> energy -> organic fertilisers residues from cereal processing (eg. beer pomace, residues in the processing of cereals) -> extraction / biotechnological processes -> enzymes, bioactive compounds -> food&feed additives, ; biorefinery (bioactive compounds, platform chemicals) -> biobased materials (bioplastic, biocomposites) -> biogas plants -> energy	Lower quality wood assortments (industrial processing eg. plywood / pulp & paper industry / biorefinery -> platform chemicals for biobased materials) Quality wood assortments (furniture production / construction -> wood composites / biorefinery use of side streams -> platform chemicals for biobased materials -> energy)	residues in the paper industry (primary sludge, in particular) -> biofuels / fertilisers (in case of primary sludge with high carbohydrate contents) / construction materials (in case of primary sludge with prevailing inorganic fraction) urban waste -> biogas installations -> energy -> composting food waste -> minimizing food waste -> the inclusion of usable discarded food for human consumption -> use of discarded food for animal consumption -> use of discarded non-food related food / biogas plant as probably the most rational alternative
Slovakia	Manure for biogas & organic fertilisers Dairy production (mainly sour whey) – > extraction / biotechnological processes -> food additives, enzymes / biorefinery -> platform chemicals -> biobased materials Residues from cereal processing to biobased materials (bioplastic, biocomposites) & biogas plants for energy	Forest residues biorefinery -> platform chemicals for biobased materials)	Biowastes to biogas installations for energy & composting

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Agricultural value chains

Value chain (country)	Relevant SDG	B2B synergies with other BBI funded projects
Straw for animal bedding, heating and as a fuel for harvesting machines and in paper industry (BG, HU)	6 CLEAN WATER AND SANITATION; 7 AFFORDABLE AND CLEAN ENERGY; 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE; 12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION; 15 LIFE ON LAND; 2 ZERO HUNGER; 8 DECENT WORK AND ECONOMIC GROWTH	Optisochem Web site http://optisochem.eu/
Medicinal and aromatic plants (BG)		EXANDAS
Manure fr biogas & fertilisers (SI, SK)		BIOGAS DONE RIGHT; 4PUR 1000; https://www.4p1000.org/
Residues form meat industry and manure could be used for as fuel for heat generation (BG)	6 CLEAN WATER AND SANITATION; 7 AFFORDABLE AND CLEAN ENERGY; 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE; 12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION	AgriChemWhey Web site https://www.agrichemwhey.com/; rimax w.agrimax-project.eu; DEMETER Web site http://www.demeter-eu-project.eu; CornSEED; PRO-ENRICH Web site
Utilisation of residues from distilleries (BG)		
Utilisation of waste from food and beverage industries (BG)		
Utilisation of waste from milk processing industries (BG)		
Dairy production (mainly sour whey); extraction / biotechnological processes; food additives, enzymes / biorefinery; platform chemicals; biobased materials (si, SK)		
slaughter residues, residues from meat processing -> thermal processing -> processed fats (oleochemical industry, cosmetics) / proteins (animal feed) -> biogas insallations -> energy -> organic fertilisers (SI)		
residues from cereal processing (eg. beer pomace, residues in the processing of cereals) -> extraction / biotechnological processes -> enzymes, bioactive compounds -> food&feed additives, ; biorefinery (bioactive compounds, platform chemicals) -> biobased materials (bioplastic, biocomposites) -> biogas plants -> energy (SI, SK)		

Value chain (country)	Relevant SDG	B2B synergies with other BBI funded projects

Industrial crops on marginal land CZ, HR)	6 CLEAN WATER AND SANITATION; 7 AFFORDABLE AND CLEAN ENERGY; 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE; 12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION; 15 LIFE ON LAND; 2 ZERO HUNGER; 8 DECENT WORK AND ECONOMIC GROWTH	GRACE Web site http://www.grace-bbi.eu; Magic
Polutry meat side-streams (HR)	6 CLEAN WATER AND SANITATION; 7 AFFORDABLE AND CLEAN ENERGY; 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE; 12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION; 15 LIFE ON LAND; 2 ZERO HUNGER	BIOGAS DONE RIGHT
Corn stover for biofuel (HU)	6 CLEAN WATER AND SANITATION; 7 AFFORDABLE AND CLEAN ENERGY; 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE; 12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION; 15 LIFE ON LAND; 2 ZERO HUNGER; 8 DECENT WORK AND ECONOMIC GROWTH	EXCornSEED Web site https://www.excornseed.eu/

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Forest based value chains

Value chain (country)	Relevant SDG	B2B synergies with other BBI funded projects
Forest based biomass for bioenergy (BG)	6 CLEAN WATER AND SANITATION; 7 AFFORDABLE AND CLEAN ENERGY; 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE; 12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION	BIOFOREVER Web site https://www.bioforever.org; EFFORTE Web site https://www.luke.fi/efforte/
Wood for eco-innovation/ construction, residues from paper industry (BG)		
Secondary wood residues → lignin, hemicellulose, cellulose → bioproducts (advanced biofuels, bioplastics, biopolymers, fibres, chemicals) (HR)		
Conversion of excess wood and its residues. Wood for eco-innovation/ construction, furniture, fertilizers, and bio-degradable packaging materials.(CZ)		
Local wood processing facilities need to be established in several regions in the country, on a small and sustainable scale, to enable wood and timber processing (CZ)		
Fosrest biomass for energy (HU)	6 CLEAN WATER AND SANITATION; 7 AFFORDABLE AND CLEAN ENERGY; 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE; 12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION; 15 LIFE ON LAND	
Lower quality wood assortments (industrial processing eg. plywood / pulp & paper industry / biorefinery -> platform chemicals for biobased materials) (SI)		
Quality wood assortments (furniture production / construction -> wood composites / biorefinery use of side streams -> platform chemicals for biobased materials -> energy) (SI)		
Forest residues biorefinery -> platform chemicals for biobased materials) (SK)		

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Biowaste value chains

Value chain (country)	Relevant SDG	B2B synergies with other BBI funded projects
Utilisation of biowastes (residues from wood industry, sunflower husks, etc) for solid biofuels and energy (BG)		B-Ferst Web site https://bferst.eu/
Utilisation of bio-wastes from different flows (households, industrial wastes, waste waters of food industry, etc) in anaerobic digestions installations (BG)		
Recovery of nutrients from wastewater treatment plants - sewage sludge (BG)		DEEP PURPLE Web site http://deep-purple.eu/
Secondary residues from food processing → electricity and heat (anaerobic digestion process) → digestate → biorefinery → bioplastic, pharmaceutical industry, construction industry (HR)		
Facilitate the conversion of municipal sludge to biogas. Additionally, enable the collection of food waste through recycling in cities to be an additional source for biogas (CZ)		
Stimulate the conversion of manure to fertilizer, to replace chemical fertilizers, and revitalize soil richness (CZ)		PERCAL Web site http://www.percal-project.eu
Communal waste for recycling plants		
Communal waste for electricity and heat		
residues in the paper industry (primary sludge, in particular) -> biofuels / fertilisers (in case of primary sludge with high carbohydrate contents) / construction materials (in case of primary sludge with prevailing inorganic fraction)		
urban waste -> biogas installations -> energy -> composting food waste -> minimizing food waste -> the inclusion of usable discarded food for human consumption -> use of discarded food for animal consumption -> use of discarded non-food related food / biogas plant as probably the most rational alternative		

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6. Implementation plans

Each participating country has co-created together with national stakeholders the recommendations for the implementation plan from 2020 to 2030 with intermediate timeline 2025. This section outlines the suggested actions per country and timeframe in terms of technology, environment, economy, society and policy that could facilitate the future implementation of national bioeconomy action plans.

Detailed information for each country can be found in the individual country reports.

Technology

	2020	2025	2030
Bulgaria	Inventory of existing technologies with potential to be modernized.	Support for old technologies modernization and new bioeconomy-related SMEs	Robust implementation of bioeconomy-related technologies
Czech Republic	Development of precision agriculture, new breeding technologies. Hemp fibers and new technology for harvesting	Spin-offs and start-ups to develop technological solutions to bioeconomy problems. Use harvesters more than we do or increase their efficiency. waste centre within the country (waste sorting, filtering of toxins, processing, distribution).	Innovations aimed at promoting sustainable forest management, better assortment, processing of lower quality wood. To move to more small scale, not large-scale sawmills, with the incorporation of new technologies. SMEs together with research centres should engage to develop new technologies.
Croatia	Encouragement of research and innovative solutions, connecting research with private sector, connecting various sectors (multidisciplinary)	Abandonment/modification of current waste management system (on Croatian level) Waste separation and reuse, existing biomass distribution (added value criteria) Waste separation and reuse, existing biomass distribution (added value criteria)	Cascading principle of smart biomass utilization (biomass pyramid value chain) Mapping and analysis of existing state-of-art, connecting biomass with existing and planning of new plants, institution synergy, strengthening logistic centers for collection and treatment of biomass Encouragement of new materials development and energy independence of islands

	2020	2025	2030

Hungary	Waste prevention is achieved, hazardousness of the generated waste is reduced. Development of waste recycling (plastic, metal, organic), agricultural and dendromass row material tecnology (harvesting, logistic, processing)	Regional logistics systems, mechanization, storage, preparation for use in power plants and for recycling, constant quality of raw materials Organised regional waste and bio-based Plant industry	Waste/plant industry network in country and with neighboring countries (Recycling 60 % of the communal waste) The efficiency of the power plants is optimal The use of biomass for district heating is doubled
Slovenia	Pilot, demonstration actions at small-scale, with technological pathways that can be flexible (modular) and adaptable for various domestic sources		Scale up and commercialisation of biobased pathways in the food and forest industries
Slovakia	Pilot, demonstration actions at small scale with technological pathways that can be flexible and adaptable to domestic raw mateials		Scale up and commercialisation of biobaed pathways in the food ad forest industries

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Environment

	2020	2025	2030
Bulgaria	Inventory of biodegradable wastes.	Transition to the valorization of biodegradable wastes and environmental friendly technologies	Robust valorisation of biodegradable wastes
Czech Republic	The opportunity for the Czech Republic could be to have the big farmers adopt the bioeconomy/green deal agenda, it could turn public opinion around.	Promote the integration of ecosystem services. The current practices, particularly in agriculture, leads to forest dryness, as water tables are depleted	Concrete actions needed to ensure high air and water quality standards meeting the European targets Development of waste to fertilizer actions will increase biodiversity through use of organic fertilizer, which will lead to increased soil richness.
Croatia			
Hungary	Diverse, sustainable crop rotations include high-mass biomass crops, direct energy crops in rudimentary areas The afforestation program will continue	The degradation of rudimentary areas and the pollution of waste incineration are reduced The use of fossil fuels is decreasing, the amount of green energy produced is increasing. Afforestation is 23 % of the country area	Environmentally friendly, productive land use Afforestation is on the ecological optimum (27 % of the country area Hazardous waste (eg manure pollution) is neutralized during green energy production
Slovenia	Restoration of damaged forests, gradual replacement of forest stands with more resistant species		
Slovakia	Restoration of damaged forests, gradual replacement of forest stands with more resistant species		

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Economy

	2020	2025	2030
Bulgaria	Planning of bioeconomy support actions into the next Operational programs (2021-2027)	Support for new bioeconomy related flagship projects	Support for new bioeconomy related projects
Czech Republic	SMEs should be supported, preferably from private money.	Establish a better setting for subsidies to support the concept of bioeconomy. An economically viable solution should be proposed to enable sustainable forestry and high-quality wood products. Incentivize new business ideas to bring wood products to the market	Research centres should directly contribute via supported innovation hubs (eg. AIT in Austria), in effect solving waste challenges through new projects.
Croatia		EU funds utilization, higher transparency in EU funds allocations for research and development, eradicate corruption in various sectors connected to bioeconomy Establishment of regulated waste market and utilization of waste as a resource, energy efficiency improvement in construction and building sector, development of national bioeconomy strategy	
Hungary	Sustainable biomass management for stakeholders in agriculture and forestry Positive discrimination for the biofuel tax	Investor groups for regional logistics centers with appropriate technical equipment for communal biomass collection and degradable waste in agrar sector, food and feed industry and forestry	Maximizing of the capacity of biomass power plants, reintegration of non-operating power plants Less tax on biofuels-less price Price premium for biomass-based energy

	2020	2025	2030

Slovenia	Increasing private financial lever for supporting investments in biobased technologies, in particular seed investments and venture capital		
Slovakia	Increasing private financing & venture capital in biobased technologies		

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Society

	2020	2025	2030
Bulgaria	Initiation and participation in bioeconomy-related projects	Initiation and participation in bioeconomy related projects	Positive behavioral change
Czech Republic	Showcase good examples through proper targeted PR; Local politicians should also spread the examples and messages of bioeconomy. We need to work with them to raise awareness. Broaden the involvement of society, encourage and involve local players, politicians, academia, private investors and entrepreneurs - support start-up and spin-off companies.	Develop a 'Made from Czech Forests" label, for wood products. Which would create demand for Czech wood and for high-added value products.	Education at the level of municipalities (cities) via workshops. Private sector actors need to make visible that they are engaged in bioeconomy (eg. national certificate label).
Croatia	Establishment of organisations/agencies that are oriented solely on topic of bioeconomy, and which rely on data from databases and import/export information of bio-potentials and bio-products (initially organized by Croatia) Connecting all stakeholders, subsidies for environmentally-friendly practices, raising of general awareness, education, organization of value chains Connecting various stakeholders – rural sector, scientists, researchers, policy-makers and decision makers, etc.		

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	2020	2025	2030
Hungary	Raising awareness of the need for biomass recirculation Separately collected biowaste Avoid the use of non-degradable materials	State and civil initiatives, active local groups to raise awareness of environmental awareness and local biomass management opportunities Sensitization strategies in education for sustainable organic matter management Biomass management is part of vocational training	Applying environmental management to everyday life Preference for products made from recycled materials Requiring sustainability certifications from the consumer side as well
Slovenia		a sensitized public that is aware of the need to reduce dependence on fossil fuels and favors bio-based alternatives (including own private purchases)	
Slovakia		Increase public awareness towards biobased products	

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Policy

	2020	2025	2030
Bulgaria	Circular economy and Bioeconomy strategies development, integration of bioeconomy aspects in NECAP.	Filling the regulation gaps	Continuing improvement of regulation
Czech Republic	Czech bioeconomy action plan, based on zero-carbon principles Government Plan in the form of a roadmap with targeted goals are needed.	Need for a national level framework to the endorsement of the European Green Deal. Set policies to establish the Policy needed to reduce the ecological footprint of per capita in Czech Republic (currently double of EU average).	Strategy – An independent working group should lead the bioeconomy strategy, in concert with relevant ministries (linking an inter-ministerial working-group). The independent body should own the agenda*Develop policies to recycle wood.* *Instate a land-fill tax or ban on wood in landfill.* *Incentivize new business ideas to bring wood products to the market (grants, vouchers, etc.)*
Croatia	Development of national strategy and action plan	Subsidies for production of bio-based plastic packaging Prevent non-professional and suspicious import of biowaste, gain control on plant management (biowaste, biogas, biomass), permissions to manage certain waste types, etc., and include general public in decision making Introduction of strategic guidelines in practice	Centralization of biomass capacities regulation Inventarisation and digitalisation of all potentials, stakeholders and resources, within the strategic framework

	2020	2025	2030

Hungary	Utilization plan in line with regional biomass potential, encouraging integration into energy systems Encouraged sectoral cooperation between actors in biomass value chains	Specific action plans to reduce the non-degradable waste emissions in certain sectors and to build sustainable energy management systems Encouraging regionalism based on the type and potential of biomass	Sustainability certifications by raw materials and energy in industry 30% increase in bioenergy consumption (Hungarian Climate and Energy Plan)
Slovenia	Dedicated bioeconomy strategy; Strong emphasis on cascading biomass use; support for multi-sectoral group investments, aimed toeards adding value to biomass		Encouraging development of bioeconomy clusters
Slovakia	Dedicated bioeconomy strategy Support multi-sectoral group investments	Encourage development of bioeconomy clusters	

Actors and funding opportunities as well as potential environmental and socio-economic impacts from the value chains and actions are individually described in the national action plans.

7. Annexes

D.3.1. Bioeconomy Action Plan_Bulgaria

D.3.1. Bioeconomy Action Plan_Croatia

D.3.1. Bioeconomy Action Plan_Czech Republic

D.3.1. Bioeconomy Action Plan_Hungary

D.3.1. Bioeconomy Action Plan_Slovakia

D.3.1. Bioeconomy Action Plan_Slovenia