

BRANCHES

Boosting RurAl bioeconomy Networks following multi-actors approaCHES

Recommendations

Extract from deliverable report D4.4

(Report with practical recommendations for agriculture, forest and cropped biomass value chains)



1. Introduction

The analysis of regional bioeconomy progress, evaluation of its opportunities and the proposal of suitable actions to tackle its challenges is of importance for decision-makers and other quadruple helix actors involved in its development. It also aligns with the focus on local and rural areas emphasized in the EU's Bioeconomy Strategy (2018) and the recognized significance of bioeconomy for the implementation of the European Green Deal. Based on an analysis of bioeconomy development models in five European regions of diverse conditions and value chains, this report presents recommendations to share with regional decision-makers, forest and agriculture practitioners, and bioeconomy actors fostering innovation. On one side these recommendations concentrate in the sustainable and circular development on forest and agriculture value chains – including cropped biomass. On the other side we offer key recommendation specifically targeted to reinforce innovation ecosystems in the regions and to the analysed regional bioeconomies represented by the regional cases in BRANCHES, namely Warmia and Mazury (PL), Ebro Valley (ES), Central Italy (IT), Northern Finland (FI) and Central Germany (DE).

These recommendations have been elaborated based on the work carried out in Work Package 4 in the BRANCHES project. Over the project's three-year duration and with the support of the partners representing each regional case, crucial information on the state of their bioeconomy has been collected. A series of analyses have also been conducted using co-creation activities and engaging regional stakeholders in order to define strategic actions. Among these are (i) a combined SWOT – TOWS analysis focusing on selected value chains in the regions, (ii) an analysis of policy frameworks impacting the regional level in the countries, (iii) an identification of the determinant factors influencing innovation and adoption of innovative practices for the bio-based value chains and finally (iv) two Life Cycle Assessments (LCAs) for innovative produced coppice wood used in a central heating plant in Italy and biochar production through slow pyrolysis in Finland.

Main objectives of the recommendations are:

- To influence the development of regional strategies and roadmaps, presenting strategic actions for the strengthening of bio-based value chains in the regions.
- To guide regional decision-makers towards key areas for strategic action that generate value for the region with implementation circular bio-based value chains.
- To suggest paths for a more sustainable and circular development of the bioeconomy. Acknowledging the environmental risks and impacts of intensive biomass use and recommending strategies for its efficient use, towards a social, economic and environmental sustainability.
- To attract small and medium enterprises to strengthen the region development.
- To facilitate the uptake of useful good practices collected in WP2 and WP3 and boost innovative regional bioeconomy business models.

In the following sub-chapters, we detailed the sources of information and results from previous tasks utilised for the elaboration of the recommendations.

2. Recommendations by value chain

Strengthening value chains in the bioeconomy promotes the efficient use of resources for a diversification of productive activities in the regions, together with innovative practices that require the development of knowledge and learning activities to make them a reality. Therefore, strong and a regionally rooted value chain translates into a structural change in the region. For this an increasing participation of local actors and particularly farmers, foresters and small and medium enterprises is necessary in the generation of value added from bioeconomy activities. In this way, the bio-based value chains can retain more of the created value in the region.

This section offers recommendations for strengthening agricultural and forestry value chains and promoting their development considering social, economic and environmental sustainability. It takes into account the results of the LCAs, the defined regional determinant factors to regional innovation systems and the strategies co-generated with regional stakeholders in the TOWS workshops.

2.1 Recommendations applicable to both value chains

The LCA results demonstrate the environmental hotspots in the two case studies. The results are not completely transferable to all regions, because they highly depend on the regional infrastructure, e.g. availability of renewable power, feasibility of facilities like central heating systems, resource availability and transport distances. But still there are insights, which are applicable to other biomass-based value chains.

First of all, the results show that the use of biomass is not burden free, even though these environmental burdens are smaller than of fossil-based value chains. Therefore, these resources must still be handled carefully. Particularly the cultivation and harvest are responsible for most emissions. This is due to the fact that heavy machinery is used, which runs on fossil fuels such as diesel. In general, all processes, which use non-renewable energy from fossil fuels or electricity have the highest negative impact in the value chains and should be completely replaced in the future. Apart from that, biomass-based value chains always have a high demand for land use, which is why even more attention should be paid to resource efficiency.

General recommendations to reduce the environmental impacts:

- Keep materials as long as possible in the loop (like packaging materials, chemicals, etc.).
- Keep value chains as simple as possible, because every process step needs energy and/or materials and causes therefore more environmental impacts as well as costs (like conditioning of wood).
- Use solely renewable energy, which is suitable for the region, if possible. In Northern Europe photovoltaic shall not make as much sense as wind power. The used electricity mix is essential for the environmental impacts.
- Use by-products such as “waste” heat, e.g. check available infrastructure for district heating.

The SWOT-TOWS analysis and policy analysis revealed crucial hindering aspects to the success of biomass value chains and their integral developmental activities. Addressing these challenges requires the creation of enabling environments, marked by the implementation of supportive instruments. Actively engaging key actors in the transition process and leveraging existing structures for knowledge development and dissemination are vital components. In establishing these enabling environments, regions can proactively overcome obstacles, fostering resilience and the development of emerging biomass value chains within the bioeconomy.

General recommendations to strengthen existing value chains for the benefit of the region and to explore opportunities for emerging value chains with higher-added value:

- Chart available biomass resources in the region (wood, wood waste, crop residues e.g. straw from cereals, pruning residues, etc) and assess their mobilisation potential to main conversion paths.
- Identify demand-pull market niches where available resources in the region could be transformed into higher-added value bio-based products. This should include the prioritisation of biomass uses with a cascade use principle to reduce competition for biomass and the valorisation of biomass residues for energetic transition in the region.
- Evaluate existing and future demand for biomass from existing bioeconomy sectors and their expected development. A strategy about biomass priority uses and its boundaries is recommended.
- Develop regional strategies and roadmaps based on a comprehensive regional analysis that will include the three previous recommendations, and circularity analysis, among others. This process offers the opportunity to develop a common vision among regional bioeconomy stakeholders, find common ground between different sectoral interest and identify trade-offs. It also raises the willingness of regional public administrations and policy actors to keep an active role in dynamization of circular bioeconomy in the region. Inclusive campaigns to make society feel part of the change including basic info, agreed vision and regional purposes is suggested.
- Strengthen existing supportive instruments by promoting cohesiveness in the legal framework and working on removing identified regulatory hurdles by taking stake of good policy practices (see D4.2) and other success cased that evidence enhanced processes for regional bioeconomy activities (see business cases examples from Task 4.4).
- Implement backcasting strategies to develop instruments addressing specific desired bio-based products and circular utilisation of value chains' by-products. These can support the targeted development of necessary policy and financial instruments to impulse the needed innovative solutions, pilot programs, capacity building, among others.
- Innovate in promotion and communication strategies to facilitate market access for bio-based products and to highlight the economic and environmental benefits of forestry and agricultural value chains in order to attract investors and consumers.
- Leverage success stories in the territory and from other EU regions at diverse levels. For instance, using identified best practices in advocacy efforts to showcase the positive impact for regional actors, and for a dynamized regional economy. Also, to attract (public & private) investment and promote the scalability of emerging value chains. Finally, success stories can depict also examples of successful collaboration between industry stakeholders, policymakers and research institutions and integration of the general public for a higher consumer awareness of bio-based products.
- Implement measures to enhance the overall efficiency of biomass resource utilisation, including soil care and recovery of nutrients, sustainable harvesting practices to ensure longer availability of biomass, investment on technologies that uses biomass in more efficient ways and promotion of vertical and horizontal collaboration among industries (industrial symbiosis) to allocate and maintain in production loops limited biomass resources.

2.2 For agriculture value chains

From an environmental perspective, an important step towards increasing sustainability is the defossilisation of agricultural biomass production. It can be assumed that the provision of agricultural resources causes a large proportion of emissions in the product life cycle, just as in the case of forest value chains. Especially in the case of

food, the packaging plays an important role to keep the goods fresh and to reduce food waste. The general recommendation to make use of by-products is also very important for agriculture as there are many potentials unused. Examples to overcome this problem were demonstrated in the Italian and Spanish show cases about pelletizing olive or vine yard pruning.

From these observations, the following recommendations to reduce environmental burdens in agricultural value chains are summarized:

- Replace fossil fuels and use renewable energy sources for electricity.
- Take advantage of by-products or residues of agricultural goods (like demonstrated in the show cases about pellets from olive or vine yard pruning and the business case example on decentralized agriculture biogas plants).
- Use sustainable packaging materials, that keep in turn especially easily perishable food fresh, e.g. reusable bioplastic bags.

Recommendations addressing specific challenges and opportunities for value chains using agriculture resources from the SWOT-TOWS analysis and business cases examples are:

- Poor soil quality in European agriculture systems is one of the greater risks to food security and long-term biomass production. To address this soil problematic and promote soil caring and sustainable practices, principles and processes of regenerative agriculture can be applied. Some of these include cover cropping, agroforestry approaches and crop rotation, among many others.
- Provide education and training programs to farmers on regenerative agriculture practices and recovery of nutrients in organic cycles. Moreover, provide training to agriculture service providers, and advisors.
- Introduce circularity labels and awards to acknowledge outstanding practices. In food production, as well as in circularity practices and for approaches to new valorisation of agriculture residues for new biomaterials and efficient bioenergy practices.
- Use or establish (regional) resource exchange platforms for suppliers and buyers to facilitate the use and efficient allocation of agricultural residues. Use digital resources to aid the matching and to ease transactions.
- Promote visits to exemplary local pilots of innovative and collaborative practices among practitioners and open to investors, policy makers, SMEs and other industrial actors.
- Invest in infrastructure that will improve value chain activities and open opportunities for new value chains. This might include logistic hubs, transport infrastructure to sustain efficient biomass transport and local biomass processing close to biomass production, among others.
- Promote easily replicable initiatives for residue management and circularity and assure their dissemination.
- Design inclusive educational approaches and solutions considering the aged population in rural areas.
- Incentivize research-industry partnerships by introducing incentives and funding mechanism that encourage their collaboration towards new processes and technologies for the development of new and higher quality bio-based products.

2.3 For forest and lignin based value chains

The LCA results show environmental hotspots in wood-based value chains and many recommendations were already considered as generally applicable. Particularly related to forest, it can be pointed out that environmental burdens of the cultivation of wood are very low, even more, many benefits arise from forests. In contrast, harvesting, conditioning and transportation of wood have high negative environmental impacts due to the use of fossil fuels. In the future, a

defossilisation of these processes would be an effective improvement and subject for research. As the effects of timber harvesting are significant, the utilisation of wood residues is of particular interest, as in the biochar value chain.

Regarding the usage of wood, also the fossil fuel use has the highest influence in the biochar production. These impacts are strongly reduced by the usage of the syngas, which is a by-product of the pyrolysis process. Noticeable is the influence of the polypropylene bags as packaging material, although 80% of them are reused and the results only includes the replacement of 20%. Regarding the provision of district heating, the emissions from wood burning play an important role in the overall results as well as the distance to the central heating plant.

Beside the general recommendations, the following points can be derived from the results of the forest-based value chains:

- Keep transportation distances as short as possible (wood to plant, e.g. central heating plant in Italy).
- Use wood residues for energy utilisation and other purposes as far as possible.
- Avoid fossil fuel use as much as possible, e.g. by using by-products like here the syngas. In this way the impact on climate change is reduced, but also on acidification, ozone depletion, particulate matter and ecotoxicity.
- Use sustainable packaging materials, e.g. natural materials or bioplastic bags, and keep them as long as possible in the loop.
- Filters are important to reduce particulate matter emission, etc. from burning wood.

Recommendations addressing specific challenges and opportunities for value chains using forestry resources from the SWOT-TOWS analysis and business cases examples are:

- Encourage piloting and development of new services and business models that support the diversification of wood and forest use, promoting diverse sources of income for forest owners. Leverage regional culture, nature conservation in forest areas, recreational activities and tourism. Likewise, explore underdeveloped markets for renewable energy transition and Net-Zero concepts, such as capture of CO₂ and other processing emissions in long-lasting wood constructions.
- Promote the adoption of automation and digitalization to enhance efficient loading, unloading and other logistic processes, with the utilisation of renewable energies such as biogas and CHP units to power logistic infrastructure.
- Support more detailed and accurate declaration of forest and wood residues based on pollutant content instead than only categorizing as “waste”.
- Provide education and training for forestry professionals on future biomass utilisation (sectoral development perspectives). Link educational programs and the presentation of success stories to encourage initiatives that address employment challenges in the sector. These initiatives could be joint between the forestry sector, together with the regional public administration.
- Emphasize the importance of regional forest programs and spatial ecological planning processes to facilitate land-use coordination within forestry value chains. Use these tools and exchange between actors in the sector for strategic planning.

3. Recommendations for bioeconomy regions and their development models

As acknowledged in Task 4.3, supporting and further developing innovation ecosystems for the regional bioeconomy influence strongly the technological, social, political and knowledge base advancement through innovation activities. Following recommendations in this chapter are directed on one side to specific strategic actions towards strengthening key factors influencing regional innovation ecosystems, such as knowledge dissemination and learning among sectors, collaborative research initiatives and targeted infrastructure investments. On the other side, they present specific recommendations to the analysed regions, under two categorisations: Medium to high and Low to medium bioeconomy maturity development stage. These recommendations suppose a holistic approach, emphasising the integration of sustainable practices, continuous evaluation of implemented measures and the active engagement of diverse stakeholders.

3.1 For development and application of innovative practices and/or technological concepts.

- Establish innovation incubators towards the development of bio-based products in the region with sustainable use of biomass resources and pursuing short and local value chains. These could be in the form of “living labs” to bring together researchers, entrepreneurs and industry experts in the co-development of regional solutions (bioenergy and biomaterials). These living labs can provide a supportive environment for ideation, prototyping and testing. Likewise, it can provide services such as legal and administrative advisory, support with the request of public funds, connection to venture capital, among others.
- Education and awareness are essential to create favourable environments for the circular and sustainable bioeconomy. The population must know the benefits of the circular and sustainable bioeconomy, and how they can participate and contribute to the creation of a more sustainable future. Furthermore, and connected with the collaboration and knowledge transfer, building up human capital facilitating workforce, to be available for both, adopters and facilitators.
- Companies must invest in research and development to develop sustainable technologies and improve their production processes, and therefore governments are needed to create the stable conditions and promote the innovation processes.
- Foster international cooperation and intra-national cooperation. This relates to expanding the capacities of the individual structures of regions/states. They can take place through active actions to connect the regions and the local existing favourable environments for the circular and sustainable bioeconomy. As well the collaborative actions taking place in parallel at national or EU level in the promotion of the rural bioeconomy, in forms of projects or initiatives, usually temporal (like projects), but also long lasting (like CAP Networks, etc.). Cooperation can favour technology transfer, investment and trade promotion, and collaboration in research and development.
- Investment in the upgrading and enhancement of suitable small-scale technologies. This could be as in the needed from rural areas in Italy for efficient co-generation activities (Bioenergy) as well as for biomaterial solutions such as rural biorefineries.
- Integrate AI, and advance technologies, such as remote sensing, drones, and smart sensors, into forestry and agriculture value chains to enhance sustainable practices. This includes monitoring forest, crops and livestock health, optimizing harvesting processes, and ensuring responsible resource management.
- Explore innovative financing models for forestry and agriculture initiatives, as well as production of regional high-added value bioproducts utilising regional resources. Some of these innovative financing approaches include public-private partnerships, impact investments, and green bonds, community-supported agriculture and carbon credit financing.
- Incorporate bioeconomy-related topics into curricula of schools and undergraduate programs, to study the benefits of bioeconomy development and application of innovative solutions. Thus, promoting a deeper

understanding of circularity and sustainability approaches for the regional/national economic development and its relevance.

3.2 For leveraging of regional opportunities and tackling of existing challenges

Medium to high bioeconomy maturity development stage (selected regions in Finland and Germany)

Building on the results from the policy analysis, first recommendation for regions with high to medium mature bioeconomy development stage are summarized. In this project, these were the selected regions in Finland and Germany. From all the countries, in general the political obstacles were rated the lowest in Finland. This is because bioeconomy has a long history in the country and is therefore well established especially in the forestry sector. The major problems outlined by the Finnish and German survey participants were: vague policy goals, lack of efficient and transparent standards, missing international agreed sustainability criteria, complicated administration processes, no support for the use of bio-based construction materials and insufficient addressing of social and economic concerns in legislation. The German participants also emphasised the following problems: lack of green public procurement legislation, lack of collaboration (government and actors), lack of international agreed certification systems, difficult funding accessibility, low visibility of bio-based products and no support for material use before energy use of wood.

In terms of value chain stages, the consumption and end of life need more political support. To cope with the named problems, the adoption of some of the good policy examples collected in this work package could help. For the Finnish region the implementation of an information hub like the innovation Hub “Future Wood and Climate” or the “BioEconomy HUB” could be interesting to close loops in the wood production and foster e.g. bio-based construction materials (see Zinke, et al., 2022). In turn, the Finnish policies on forestry can be used to further develop the ones in Germany.

The following recommendations can be derived for the medium to highly developed bioeconomy regions:

- Simplify and accelerate administration processes.
- Support the cascading use of biomass respective the (re-) use of residues and excess heat (legal framework).
- Establish a regional green public procurement policy.
- Create a fairer competition of bio-based and conventional solutions to foster visibility and consumption of bio-based products in order to develop a strong bio-based market.
- Monitor (regional) bioeconomy strategies to be aware of demands and available resources. Make the results public.
- Build better cooperation between local ministries /agencies.
- Foster job creation and train skilled workers.
- Create long-term (investment) certainty for companies in the regions.
- Strengthen networks and make actors known to each other.
- Build bottom-up cooperations between industry, research and the regional government.
- Promote research and development for bio-based innovation to keep on track with political goals.

Low to medium bioeconomy maturity development stage (selected regions in Spain, Italy and Poland)

In this section recommendation for regions with low to medium mature bioeconomy development stage are summarized from the policy analysis. In this case, these were the selected regions in Spain, Italy and Poland. The major problems outlined by the Spanish, Italian and Polish survey participants were: vague policy goals, uncertainty due to frequent regulatory changes, lack of a green public procurement policy, lack of internationally agreed sustainability

criteria, insufficient commitment of policy makers to bioeconomy and complicated administration processes. The Spanish participants emphasized additionally, that stakeholders are not enough informed about bio-refining activities, that visibility of bio-based products is low and a cascading use of biomass isn't ensured. At the same time, the Italian participants highlighted, that funding possibilities are difficult to access, the use of rest streams isn't ensured, innovation is not enough supported and networks are weak. From the Polish participants, all the political barriers were rated the highest in comparison to other regions. Especially public awareness for sustainability is low, funding is difficult to access and the networks are rather weak.

Regarding value chain stages, biomass provision, consumption and the end of life need more political support. In the case of Poland also an enabling environment for bioeconomy needs to be set up. Generally, in regions with a lower maturity stage, first a reliable and sustainable biomass provision and an enabling environment with financing opportunities have to be established. The higher the maturity stage of a region, the more a monitoring of bioeconomy development and long-term strategies as enabling environment are demanded. To handle the problems mentioned for the Spanish regions, also some of the collected good policy practices could help. The establishment of an information hub like the innovation Hub "Future Wood and Climate" or the "BioEconomy HUB" could be an action to inform stakeholders as well as to connect them to make resource use more effective like cascading use of biomass (see Zinke, et al., 2022). This is also true for the Italian and Polish regions. For the Italian regions it can be helpful to establish bioeconomy or circular economy strategies more on regional level and to create and strengthen networks. The same is true for the Polish regions as well as a supporting scheme like the Rural Development Plan for Tuscany, which brings together actors from agriculture and forestry.

The following recommendations can be derived for the low to medium developed bioeconomy regions:

- Involve the society: Raise public awareness and acceptance by communicating the meaning, benefits and challenges of bioeconomy.
- Establish networks and make actors known to each other.
- Create a bioeconomy strategy well adapted to the region.
- Establish a regional green public procurement policy.
- Ensure the availability of financial support and make it easy to obtain e.g. by offering legal advice.
- Create an enabling policy framework, which is adaptable to new challenges but still reliable.
- Ensure sustainable and constant availability of a regional biomass feedstock e.g. with supporting and information provision schemes.
- Participate in an (international) exchange of experience and learn from other regions.
- Foster cooperation and commitment to bioeconomy of academia in the region.

4. Conclusions

As we conclude with this journey within BRANCHES project, the culmination of strategic analyses and the expertise of engaged stakeholder has resulted in recommendations that have profound implications for regions striving in the intricate task of advancing their bioeconomy. The insights gained from diverse regional cases over the three years of BRANCHES have resulted in this set of recommendations that provide a guidance towards the key areas and actions to continue and focus their efforts.

We hope these recommendations present for regional stakeholders and in particular their decision-makers an opportunity to redefine regional plans, coordination measures and to establish clear roadmaps. They offer crucial elements to strengthen bio-based value chains and present specific tools used in the regional BRANCHES cases that could be applied to other regions for the development of context-specific strategies. The call to action is to BRANCHES

partners, as well as to policy-makers and leaders in the regions that have made part of these activities to further use and disseminate the findings of the regional TOWS analysis and the recommendations here developed. Likewise, to strive for their integration in future regional projects, with the engagement of quadruple helix actors across sectors and favouring collaborative approaches.

At the heart of these recommendations lies a commitment to sustainability, not only related to environmental practices but also related to social and economic dimensions. Only in this way, will bioeconomy really fulfil its expected role as a catalyst for a changed development path. One that leaves behind linear and fossil-based activities and products, towards one in which ecosystems endure past several generations; circularity principles and efficient technologies allows to make the best of available biomass resources and the social and economic benefits of bioeconomy can be enjoyed in fairness and for all.

Regions and its actors are encouraged to take these recommendations as a potential for change. The development of favourable environments to create and foster innovation demand collaboration and commitment. It means also innovating on social practices and communication strategies, to attract different segments of the society, various areas of knowledge, entrepreneurs at different stages of the value chains, and to be able to harvest the richness of regional collective knowledge and expertise. Concerted efforts and targeted collaborations in the region will be the determinants for the successful application of above described strategies and to translate them into actionable steps.