

CONCEPTS, TOOLS AND APPLICATIONS FOR COMMUNITY-DRIVEN BIOECONOMY DEVELOPMENT IN EUROPEAN RURAL AREAS – THE SCALE-UP PROJECT

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ABSTRACT: The overall goal of SCALE-UP is to support regional multi-actor partnerships, consisting of private businesses, governments and policymakers, civil society organisations, and researchers, in identifying and scaling-up innovative and sustainable bio-based value chains that leverage regional resources. SCALE-UP aims to adapt, implement, and evaluate tools to help regional actors overcome barriers and fully exploit bioeconomy potential. The methodology consists of four phases: establishing existing knowledge and creating regional platforms, facilitating cross-regional knowledge transfer and capacity building, forming a pan-European 'Community of Practice,' and disseminating project results in collaboration with key stakeholders. SCALE-UP also includes a business development program that promotes co-creation, transparency, and open innovation to support local communities in assessing market conditions, developing business plans, and identifying funding sources for 12 bio-based solutions. This paper presents the project's methodology, scientific relevance, and expected outcomes.

Keywords: bio-based products, bioeconomy, biomass, rural development, innovative concepts, project

1 INTRODUCTION

It is widely acknowledged that an innovative, circular, and resource-efficient bioeconomy can offer social and economic opportunities to entrepreneurs in rural areas while reducing greenhouse gas emissions. However, small-scale technological developments that utilize regional biomass resources have not yet gained momentum. Questions about promoting equitable distribution of benefits among local communities and avoiding detrimental effects of increased biomass production on regional ecological systems remain partially unanswered [1]. Therefore, exploring the sustainability of bio-based innovations is crucial to mainstreaming bio-based solutions in European rural areas. Within SCALE-UP, a "bio-based solution" refers not only to specific products or services but also to the entire value chain that relies on the involvement and interaction of various actors.

Transitioning to sustainable, regenerative, inclusive, and just regional bioeconomies requires a comprehensive framework that links bio-based solutions to rural development goals and sustainable development principles. This framework enables rural communities to identify, compare, and implement alternative bio-based development pathways.

Despite numerous EU-funded projects and initiatives supporting the uptake of the bioeconomy at the regional level, the capacity of rural actors to collaborate and develop sustainable bio-based products and services remains low. This is also evident in SCALE-UP's focal regions (Figure 1): Northern Sweden, Mazovia (PL), the French Atlantic Arc, Upper Austria (AT), Strumica (MK), and Andalusia (ES). Although these regions possess abundant, underutilized biomass resources and various promising valorisation options, stakeholders face challenges due to a lack of technical expertise, competitive networks, and market knowledge. SCALE-UP aims to

address these bottlenecks through a multi-actor approach. The six focal regions, with their diverse biomass streams and valorisation options, provide a high potential for replicating the project's outcomes in rural areas across Europe. Therefore, they have been selected as case studies to achieve the project objectives outlined below.

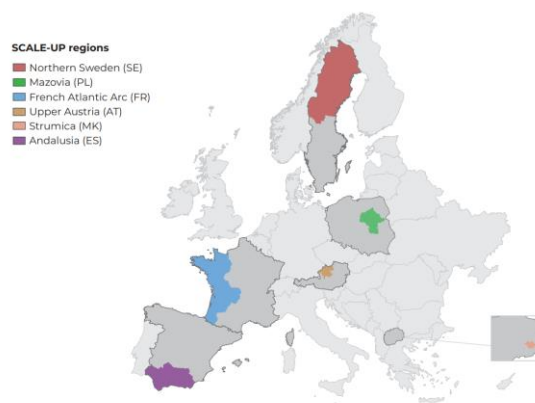


Figure 1: Locations of SCALE-UP's focal regions.

Source: own elaboration.

2 THE SCALE-UP PROJECT

The overall goal of SCALE-UP is to support regional multi-actor partnerships, consisting of private businesses (including primary producers and associated organisations), governments and policymakers, civil society organisations, and researchers in identifying and scaling-up innovative and sustainable bio-based value chains that build on regional resources. The expected results of the project are:

- Enhanced cooperation between key players and knowledge holders resulting in sustainable business model pathways for bio-based innovations in rural areas;
- Provision of tailored and independent innovation support services to innovators in order to accelerate the development of marketable products and services and to improve the market penetration of bio-based solutions in rural areas;
- Successful deployment of existing scientific and practical knowledge and more bio-based solutions introduced in rural areas in line with relevant policy initiatives.

To achieve these results, SCALE-UP incorporates multiple stakeholder groups and contextual considerations and relies fundamentally on mutual capacity building and the generation and transfer of knowledge. The identification and promotion of regionalised, innovative bio-based solutions requires a pooling of knowledge and experience, which is the foundation of the project's conceptual approach. This conceptual approach is represented in four phases of knowledge gathering, capacity building and innovation support, mainstreaming and exploitation. These phases interact with facilitation groups, which are groups of actors that add knowledge, provide guidance, and validate findings. The outcomes of these four phases and of the interaction with the facilitation groups directly relate to the key stakeholders from business, academia, civil society, policy as well as from the financial sector.

The first phase focuses on preparing existing scientific and practical knowledge for uptake and utilization in the regional project activities and on establishing regional platforms for innovation support.

The second phase focuses on cross-regional transfer of knowledge and demand-driven capacity building and on providing direct support to multi-actor partnerships with regard to market assessment and business model design.

The third phase sees the six regions become the foundation for a pan-European 'Community of Practice' (CoP), which will facilitate the wider sharing of good practices and lessons learned with other European regions and actors.

The fourth phase focuses on the dissemination and exploitation of project results. Outcomes of the project will impact various key stakeholder groups: Private businesses, academia, civil society representatives, governments and policymakers and the financial sector.

The concept of the SCALE-UP project is rooted in a holistic approach to foster the development of regional bioeconomies and promote social, environmental, and economic benefits within the broader context of rural development (Figure 2). In this regard, the 'second pillar' of the EU's Common Agricultural Policy (CAP), which aims to enhance the social, environmental, and economic sustainability of rural areas, provides a relevant framework for the proposed activities. Considering the need to integrate the bioeconomy into the realm of rural development, SCALE-UP will align its efforts with the six priorities of the EU's Rural Development policy. By promoting social and technological innovations that generate regional value for a diverse range of actors and rural communities as a whole, while considering the capacities of regional ecological systems, SCALE-UP will ensure that the introduction of bio-based solutions in rural areas aligns with the relevant policy objectives outlined in

the European Green Deal. This approach will also take into account the priorities and actions specified in the EU Bioeconomy Strategy, national bioeconomy strategies, regional development plans, and smart specialization strategies.

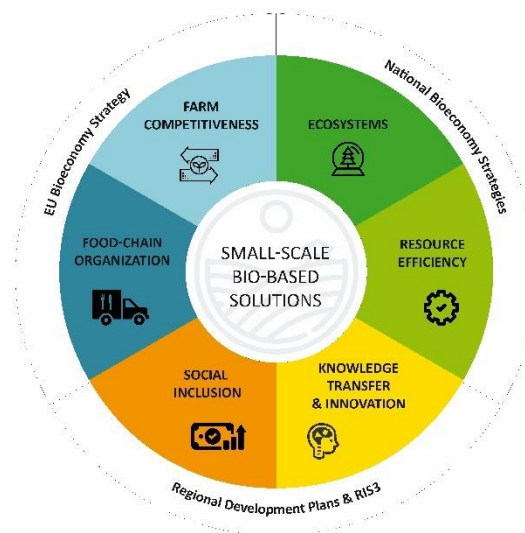


Figure 2: Visualisation of the project's conceptual framework. Source: own elaboration.

Overall, the SCALE-UP project aims to foster sustainable regional bioeconomies, encompassing social, environmental, and economic dimensions, in line with rural development objectives and aligned with the broader policy frameworks established at the European level.

3 RESULTS

The SCALE-UP project is running since September 2022 and first results are already available. This chapter summarises the most important outputs reached so far. These relate mainly to the regional platform establishment, knowledge gathering and business programmes conducted in the first project phase, which was completed in first half of 2023.

3.1 Regional Implementation and Stakeholder Engagement

SCALE-UP established six regional platforms that provide targeted and independent innovation support services to multi-actor partnerships during and after the project life. The platforms were created as permanent structures within the existing infrastructures of the regional project partners, who play an intermediate role in their regions and already offer networking, funding and consultation services for regional stakeholders. Within the regional platforms, steering groups composed of regional knowledge holders will oversee the effective implementation of dedicated innovation support services and will facilitate engagement with regional stakeholders.

3.1.1 Northern Sweden

The region is characterized by vast forest resources and sparsely populated areas, with active management and processing of the forests into sawn goods and pulp and paper. Consequently, significant volumes of forest

industry and forestry by-products are available, primarily utilized for district heating and energy generation. The SCALE-UP platform aims to further enhance the bioeconomy in northern Sweden by facilitating information sharing, networking, study visits, and other region-specific activities. The platform seeks to strengthen existing networks comprising academia, regions, municipalities, and industry, with a particular emphasis on promoting value-added utilization of forest industry by-products such as sawdust and bark, as well as mobilizing the currently underutilized biomass resource of logging residues.

3.1.2 Mazovia

Mazovia region (Województwo mazowieckie) is located in the central part of Poland. Its economy stands out due to its significant industry diversification, making it less susceptible to cyclical fluctuations compared to regions with a more uniform economic structure. Agriculture is one of the most important sectors and it is characterized by very fertile soils enabling a thriving development of agricultural economy. Usable agricultural land covers about 65% of the area, hence there is a large role of horticulture, orcharding and related activities. In order to boost bioeconomy development, the Mazovia Bioeconomy Platform will engage the entire spectrum of bioeconomy stakeholders in the region to ensure effective knowledge exchange and facilitate the matchmaking of regional players, as well as to oversee the implementation of targeted innovation support services. It will be built and promoted on existing relationships and networks of UNIMOS Foundation – coordinator of AgroBioCluster – with a focus on fostering cross-fertilization with other local, regional, national and European initiatives.

3.1.3 The French Atlantic Arc

The four regions of the French Atlantic Arc (Brittany, Normandy, Pays de la Loire and New-Aquitaine) share many characteristics: covering an area of 89,656 km², agriculture is predominant, with a high proportion of livestock and crop productions. These regions also share critical environmental issues that are already impacting agriculture (climatic hazards, reduction in water resources), combined with a strong demographic pressure due to their proximity to the Atlantic coast and the English Channel.

Given the urgent need to mitigate climate change, decarbonising the building sector (which accounts for 43% of France's annual energy consumption and generates 23% of greenhouse gas emissions) has become essential, and is being pushed forward by the "RE2020" national law which favours the use of materials that store carbon and have good insulation properties.

Despite many environmental assets and excellent technical properties, the use of bio-based materials made from plant fibres (such as hemp, linen, straw or miscanthus) in new buildings and renovation projects remains unknown and marginal, due to a lack of information for farmers on the potential markets and for the construction industry on the guarantee of a supply of quality biomass.

Therefore, SCALE-UP multi-actor platform in the French Atlantic Arc aims to support the development of bio-based construction value chains, by gathering the relevant stakeholders (primary producers, construction industry, public authorities, research, civil society) to develop innovation, share information and best practice,

and provide market access for new bio-based solutions for the building industry. The platform will build on existing clusters and networks in the four regions to enhance stakeholder engagement, training and communication activities that will be implemented as part of the SCALE-UP project.

3.1.4 Upper Austria

The food industry is a major economic factor in Upper Austria and encompasses a wide range of activities. These range from agricultural production to the distribution of food and beverages. The aim of the SCALE-UP regional platform is to further broaden the bioeconomy network in Upper Austria and push bioeconomy in rural areas. Furthermore, knowledge transfer and exchange between existing partners and new stakeholders will be facilitated with the aim to contribute to finding innovative solutions for the individual challenges of bioeconomy. The role of the regional platform will be to identify best practices and to facilitate the implementation of innovative project ideas in collaboration with relevant stakeholders.

To facilitate the engagement with regional stakeholders in the context of the regional platform, the communication channels of the Food Cluster Upper Austria will be used.

3.1.5 Strumica

Located in North Macedonia, Strumica region is considered as a national frontrunner in agriculture production, thus eased exporter due to its location and close connections with two EU countries. As such, Strumica has an abundance of agricultural networks and associations eager to accelerate the regional bioeconomy development in a sustainable manner. One of the catalysts in the bio-based transition is the Regional Platform consisting of knowledgeable stakeholders covering the Quadruple Helix. The stakeholders will be the driving force for organization and implementation or participation in all capacity building activities, regional meetings, bio-based value chain development, project based workstreams training, etc. Hence, their regional promotion and media support are of the utmost importance for maximized effect on a broader level. The regional platform will be focusing on the value chain related to multiple processes and uses for composting. Several biomass streams (primary producers, processing industries, residential and commercial waste sector) for composting are being explored to assess their availability, quality and spatial distribution. Moreover, if assessed that there is beneficial environment in the following period within the project during, the second value chain that could be of further interest for Strumica region is packaging and insulation materials from agricultural residues combined with mycelium. This value chain will add value to the innovative aspect of the conventional plastic uses.

3.1.6 Andalusia

Andalusia has been one of the first regions in Europe in issuing a regional Circular Bioeconomy Strategy, developed by the regional ministry. Recently, this strategy has been supported by the Andalusian Biocircular Economy Law leading Andalusia's transformation towards an economy with a greater profile of value-adding activities. The SCALE-UP project will support this transformation with dedicated stakeholder engagement activities in the context of the regional platform.

The platform's aim is to support new solutions that

allow the region to leverage on its potential. To do this, the Andalusian platform will cooperate with technology developers and entrepreneurs in order to provide capacity building activities that provide stakeholders with relevant skills to create new value chains that can contribute to regional development. The financial sector is involved for providing relevant information and feedback on funding opportunities.

Concerning the engagement approach, a communication plan has been designed to create a highly attractive platform identity for creating awareness of the project and for reaching out to the target audiences.

3.2 Assessment of regional biomass and nutrient availabilities

Based on regionally available nutrients in biomass (including manure and sewage sludge), possibilities for nutrient recycling will be worked out for relevant value chains of the six SCALE-UP regions. Obtained knowledge will feed into the SCALE-UP training programme for trans-sectoral and cross-regional knowledge transfer.

3.2.1 Northern Sweden

Northern Sweden (BioFuel Region) spans 221,800 km², with 67% of it being forest land (148,920 km²). The forest has a total growing stock of 1,314 million m³ and grows by 45 million m³ annually. About 20% of the productive forest land is protected, with additional areas voluntarily set aside by private forest owners. The quantity of woody biomass supplied depends on individual forest owners' decisions influenced by timber prices. The region's average annual harvest is 31 million m³, and imported round wood can also contribute to the market. Forest biomass use for energy purposes has grown rapidly, with a future increase expected in biorefineries. By-products like sawdust and bark are mainly used for power and heat generation. Despite available logging residues, most are unused due to higher costs compared to market prices for sawdust and bark.

3.2.2 Mazovia

Poland is the largest apple-growing country in the European Union and the fourth largest producer in the world, after China, the USA and Turkey) with over 143,000 ha. More than 45% of the country's apple production comes from Mazovia region with 68,816 ha. Hence, there is regional biomass available, especially related to apple production. Apple pruning (branches) generate a substantial number of residues, which must be disposed, and apple pomace is a left-over solid residue resulting of extraction of juice from apple. The regional platform will support the discovery and facilitation of potential bio-based innovations coming from apple production by fostering collective entrepreneurship, learning and knowledge exchange.

3.2.3 The French Atlantic Arc

The regions of the French Atlantic Arc were historically growing plant fibres such as hemp and linen for textile and ropes, and after this production came to a halt in the 1950s, they are now making a comeback for various applications in textile, chemicals, and construction. France is now the first EU country for hemp production, with 21,700 ha in 2022.

Hemp, flax, straw and miscanthus are the biomass streams in focus in SCALE-UP, as they are all present in the four Atlantic regions and have great potential for

development in these rural areas, as they have many interests for agriculture (crop rotation diversity, lower input levels, co-product valorisation, consolidation of producers' remuneration, etc.). A study is currently carried out by the SCALE-UP team to investigate existing biomass resources, and to develop two scenarios forecasting the development of these biomasses, taking into account expected market developments, the threats and opportunities posed by climate change and the need for agriculture to adapt to these changes. Knowledge holders engaged in the SCALE-UP platform will support this study, providing expertise on market and production assessment.

3.2.4 Upper Austria

Austrian food production generates between 13.5 and 20 billion euros annually, consists of 3,500 companies and employs 70,000 people. 250 large companies turn over between 90 and 95% of the goods.

In the frame of SCALE-UP, Upper Austria's regional platform is dealing with two different biomass streams: side products of beer production and side and waste streams of bakery products.

Side stream 1: In February 2012, a questionnaire survey of the Austrian brewing industry was carried out by the Federal Environment Agency. The responses cover around 82% of the Austrian market and show that around 17.4 kg of spent malt is produced per hectolitre of beer. In 2020, 8.0 million hectolitres of beer were produced in Austria [2]. This results in a generation of the waste type SN 11404 "spent grains" of about 151,400 tons.

Side stream 2: Based on the reports of a well-known bakery producer, the waste dough production amounts to 3.5% of the bakery production. If this percentage is applied to the total baked goods produced 2022 in Austria of about 430,513 tons [3], this results in an annual generation for SN 11111 "Dough" of about 15,000 tons.

3.2.5 Strumica

Strumica extends to an area of 321.9 km², and a vast part (46%) is arable land, which is a prerequisite for successful agriculture development in the region with an emphasis on grain and vegetable crops production. To assess the regional biomass availability, review of multi-level data was conducted. The bio-based overview summarised the potential on agricultural and forest areas, different residues (grain, forage crops, vegetables, fruits, and vineyards) quantity, timber and waste generation. Nonetheless, for the purpose of closely depicting the on-ground situation regarding the generated biowaste from the main processing and production industries, a questionnaire was prepared and shared with the business sector in Strumica. The survey consisted of 10 questions related to the company environment itself, produced (bio)waste and further (bio)waste management. As a result, positive, yet limited feedback on waste selection and collection is in place, thus the approached companies expressed their interest in joint activities dealing with organized collection and further treatment of such waste for the production of compost or other bio-based products, processes and services.

3.2.6 Andalusia

In terms of industrial production in the olive sector, the Andalusian Government has reported the existence of over 852 active mills and 252 active millers [4]. Over the past five seasons, the average production figures were as follows: 5.6 million tonnes of oil mill olives, 1.1 million

tonnes of oil, 4 million tonnes of Alperujo (a mixture of vegetation water or alpechines, solid parts of the olive, and fatty residues), and 479,252 tonnes of table olives. During the 2021/2022 campaign, olive production was recorded in 802 mills and 222 mills in Andalusia. For the upcoming campaign, it is anticipated that olive oil production in Andalusia will reach 587,000 tonnes.

The SCALE-UP project will primarily focus on two significant feedstocks. The first one encompasses olives, olive stones, and olive shells. The second one is the alpechin, which refers to the wastewater generated during the olive processing. The alpechin holds considerable potential as a solid waste due to its impressive characteristics, including a moisture content of approximately 10%, favourable fuel properties, and a calorific value of around 4,200 kcal/kg on a dry basis. This makes it suitable for both thermal energy and electricity generation.

Furthermore, the utilization of olive mill wastewater (OMW) has been investigated by Chatzistathis and Koutsos [5], who have determined its advantages in agriculture. OMW serves as a valuable source of nutrients, particularly nitrogen (N), phosphorus (P), potassium (K), magnesium (Mg), and iron (Fe), as well as water and organic matter. The authors have also described various applications for OMW, including the rehabilitation of degraded croplands in mountainous areas, eroded regions, or areas lacking organic matter.

3.3 Mutual learning and capacity building

The aim of the SCALE-UP project is to facilitate knowledge exchange between the regions and to build capacity among the stakeholders. For this needs-driven training programme covering multiple aspects of rural bioeconomy development was developed.

In the first phase, the capacity needs of the SCALE-UP regions were identified with a “needs analysis” questionnaire. It was distributed to over 450 stakeholders of the SCALE-UP regional platforms via e-mail, phone calls and discussion rounds. In total 98 stakeholders filled in the questionnaire. The participating stakeholder groups were primary producers and landowners (6 %), large-scale enterprises (8 %), SMEs and start-ups (12 %), governments and policymakers (13 %), civil society (9 %), academia, research and education (19 %), financial sector (1 %) and other stakeholder groups (30 %) which consist mostly of clusters, associations and business support organisations.

The questionnaire contained a knowledge-interest rating of different topics clustered in 7 thematic work streams, which focus on improved nutrient recycling with cross-sectoral approaches, how to integrate primary producers into bio-based value chains, digitalisations in the bioeconomy, efficient regional infrastructures and biomass logistics, how to develop and implement practices of ‘social innovation’ in the context of rural bioeconomies, the effective and innovative governance of regional bio-based systems and on strategies to address social, ecological and economic trade-offs of regional bioeconomy development. In addition, the survey participants were asked to rate the relevance of different hurdles and barriers of bioeconomy development in their regions to further assess the priorities of each region.

In the second phase, the contents of the training programme were derived from the results of the needs analysis. On the one hand the individual needs of the regions were assessed and on the other key knowledge

holders for the knowledge exchange were identified. The cross-regional comparison showed that the participants have a high interest especially in efficient regional infrastructures and biomass logistics, ways to integrate primary producers into the bio-based value chains and nutrient recycling in circular bioeconomies.

With a combination of cross-regional knowledge exchange in forms of live-presentations and individual workshops with different idea processing methods to address the needs of each region, the participants of the training programme shall broaden their existing knowledge in bioeconomy topics and should be able to transfer the theoretical input to their respective applications. Furthermore, a discussion round with experts in different fields of the work stream provide a platform for specific questions from the attendees and opens further possibilities to get the knowledge needed for the involvement of the participants ideas for bio-based solutions. One barrier of a cross-regional knowledge exchange is the existing language barrier, as the SCALE-UP projects involves 6 different model regions with 6 respective languages. In order to facilitate the cross-regional communication, an AI-based translation tool will be used.

3.4 Bio-based Business Models, Value Chains & Markets

The overall goal of SCALE-UP is to support regional multi-actor partnerships, consisting of private businesses, governments and policymakers, civil society organizations, and researchers in identifying and scaling innovative and sustainable bio-based value chains that build on regional resources. Through its approach, SCALE-UP will adapt, implement and evaluate tools to help regional actors to overcome the apparent bottlenecks towards fully exploiting bioeconomy potentials in their region.

For that, SCALE-UP has designed a regional innovation support programme that includes external assistance to conduct a comprehensive assessment of the regional market and to design a suitable business model, help to build a strong business strategy to enter the regional market and support to identify compatible public and private funding sources for further development and commercialisation of the selected solutions.

To allow for a well informed and actionable assessment of the regional market for bio-based solutions, SCALE-UP sets up regional Task Forces for market assessment and business model design. These Task Forces consist of incumbents of regional bio-based value chains, and may include biomass producers/owners/distributors, developers of other bio-based products and services, developers/distributors of enabling technologies and equipment, and potential and/or existing paying customers and end-users, and other knowledge holders. By getting these types of stakeholders acquainted with the business idea, the innovators will gain valuable market intelligence, visibility and networking opportunities.

3.5 Social Innovation in Rural Bioeconomies

In the frame of the project, participatory governance in rural bioeconomies is targeted via application of the social innovation concept. With social innovation, as well as participatory governance, inclusive transition can be fostered as well. There are several reasons behind that idea. First of all, social innovation promotes inclusion and empowerment of local communities in decision making processes. It also encourages the development of context-

specific solutions that address the unique challenges and opportunities of rural bioeconomies. Furthermore, social innovation brings together individuals, organizations, and institutions from various sectors, including government, academia, civil society, and the private sector, to work collectively towards common goals. Another important perspective is the role of social innovation in achieving the goal of limiting global warming to 1.5 °C, as outlined in the Paris Agreement. The article "Social tipping dynamics for stabilizing Earth's climate by 2050" by Ilona M. Otto et al. (2020) proposes that social tipping interventions can trigger tipping points in energy systems, leading to a rapid transition towards a state of net zero anthropogenic greenhouse gas emissions [6]. As a result, social innovation is a proper tool to reach sustainable development, besides climate resilience. By embracing social innovation approaches, rural communities can actively shape their own futures, participate in decision-making processes, and create sustainable and inclusive bioeconomic systems.

Considering the research gap of the social innovation concept and due to the fact that it is an emerging concept, one of the project outcomes is to write a handbook on the topic. For this purpose, social innovation practices in the project regions are being researched, case studies and good practices are being analysed. Consequently, an assessment tool, stakeholder mapping and guidelines on how to increase the role of societal actors in a rural bioeconomy context will be presented for the benefit of all.

4 CONCLUSIONS

In conclusion, the SCALE-UP project aims to support the development of regional bioeconomies in European rural areas by identifying and scaling-up innovative and sustainable bio-based value chains. The project focuses on establishing multi-actor partnerships and regional platforms to overcome bottlenecks and fully exploit the bioeconomy potential in the selected regions. The project follows a four-phase methodology that involves knowledge gathering, capacity building, cross-regional knowledge transfer, and the creation of a pan-European 'Community of Practice'. The project also emphasizes the principles of co-creation, transparency, and open innovation, providing advisory support to innovators and stakeholders in assessing market conditions, developing business plans, and securing funding for bio-based solutions.

The expected outcomes include enhanced cooperation between key players, provision of tailored innovation support services, and the successful deployment of bio-based solutions in rural areas. The project has established regional platforms in Northern Sweden, Mazovia, the French Atlantic Arc, Upper Austria, Strumica, and Andalusia, with each platform focusing on specific regional challenges and opportunities. Through the project, the aim is to promote sustainable and inclusive rural development while aligning with relevant policy initiatives and strategies at the European and national levels. The project has already made progress in terms of platform establishment, stakeholder engagement, assessment of regional biomass and nutrient availabilities, and the implementation of business supporting programs. These achievements pave the way for further advancements in the project and contribute to the overall goal of mainstreaming bio-based solutions in European

rural areas.

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SCALE UP
community-driven
bioeconomy development