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The Bio-based Packaging Value Chain

in the Danube Region

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Disclaimer

Glossary

Bioeconomy	The bioeconomy covers all sectors and systems that rely on biological resources (animals, plants, micro-organisms and derived biomass, including organic waste), their functions and principles. It includes and interlinks: land and marine ecosystems and the services they provide; all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture); and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services. *(Source: European Commission (2018). A sustainable bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy. p. 4)*
Cluster	Clusters are geographic concentration of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (for example, universities, standards agencies, and trade associations) in particular fields that compete but also cooperate. *(Source: M. Porter (1998). On Competition, Updated and Expanded Edition. Harvard Business Review Book, p. 213)*
Cluster initiative	Cluster initiatives are organised effort to increase the growth and competitiveness of a cluster within a region, involving cluster firms, government and/or the research community. *(Source: Ö. Sölvell, G. Lindqvist and Ch. Ketels (2003). The Cluster Initiative Greenbook , p. 9)*
Cluster organisation	By a cluster organisation one should understand organised efforts to facilitate cluster development, which can take various forms, ranging from non-profit associations, through public agencies to companies. *(Source: PricewaterhouseCoopers (2011). Uncovering excellence in cluster management, p. 6)* Cluster management can be defined as the organisation and coordination of the activities of a cluster in accordance with certain strategy, in order to achieve clearly defined objectives. *(Source: PricewaterhouseCoopers (2011). Uncovering excellence in cluster management, p. 3)*
Eco-innovation	Eco-innovation aiming at significant and demonstrable progress towards the goal of sustainable development. Eco-innovation projects will therefore aim to produce quality products with less environmental impact, whilst innovation can also include moving towards more environmentally friendly production processes and services. Ultimately, they will contribute towards the reduction of greenhouse gases or the more efficient use of various resources. *(Source: European Commission (2015). Eco-innovation, When business meets the environment. FAQ: What is Eco-Innovation? Online).*
Value Chain	The value chain describes the full range of activities that firms and workers do to bring a product from its conception to its end use and beyond. A value chain refers to the full lifecycle of a product or process, including material sourcing, production, consumption and disposal/recycling processes. This also includes activities such as design, production, marketing, distribution and support to the final consumer. *(Source: University of Cambridge (2017). What is a value chain? Definitions and characteristics. Online).*

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1. The Bio-based Economy

Climate change and decreasing biodiversity are critical problems for modern society which must be tackled in order to protect our planet. Fossil resources are finite, and alternatives need to be developed. Another issue that should not be underestimated is sustainable consumption – currently a major focus of attention among academics as well as in many other fields. So how can we best tackle these issues, and where can we seek solutions?

This is where the bioeconomy (also known as the bio-based economy) comes into play. The bioeconomy is defined as "the production and utilization of biological resources (including knowledge) to provide products, processes and services in all sectors of trade and industry within the framework of a sustainable economy". The aim of the bioeconomy is to make the carbon stored in renewable resources accessible for industrial value-added chains. This may mean using food and feed crops for the sustainable production of food and feed products. Alternatively, it may mean utilizing specific technologies (e.g. biogas plants, biorefineries, gasification and other conversion methods) to convert plants, residual biomass and biowaste into ethanol, methane, phenol, biopolymers, pharmaceuticals and many other products for use in industrial applications. Those involved in the bioeconomy are keenly aware that natural resources (such as arable land and water) are limited, so there is a concerted focus on sustainability, resource efficiency, and material/waste cycles. As a result, the burden on individual resources is considerably lower than in fossil-based economies. Furthermore, the technologies associated with the bioeconomy can open up additional development potential for rural areas. This applies to countries that have large areas available for agriculture and forestry. By unlocking such new opportunities, the technologies used in the bioeconomy can facilitate progress.

The concept of the bioeconomy is gaining traction and prominence worldwide. A number of countries have already launched their own bioeconomy strategies, and many more are working towards this. The European Union promotes the bioeconomy in a variety of ways; national and European governments have established many programmes in recent years aimed at fostering the bio-based economy.

The Danube Region too is seeking to build an innovative economic system that makes sustainable agriculture and the industrial use of renewable resources possible while also protecting the environment and safeguarding biological diversity. Furthermore, eco-innovations are likely to boost regional growth by diversifying local economies and creating new employment opportunities. New bio-based value chains (leading from primary production to consumer markets) need to be developed by bringing together enterprises from different regions and industries. However, no holistic transnational approach currently exists, so bio-based industry stakeholders in the Danube Region are not able to act in a connected way or properly benefit from existing potential.

This is where the DanuBioValNet project ("Cross-clustering partnership for boosting eco-innovation by developing a joint bio-based value-added network for the Danube Region") comes into play. The project is financed by the EU under the Danube Transnational Programme. Its main aim is to develop new methods and tools to connect businesses (SMEs) from different regions and countries involved in bio-based industry. This can only be achieved through effective, coordinated interaction among relevant stakeholders – including policymakers and participants from industry, public institutions and academia. The stakeholders in the DanuBioValNet consortium come from ten countries in the Danube Region. Clusters representing a number of companies are sustainable partners which guarantee upgradeability across industry, science and government, and they have been selected to coordinate cooperation among the industrial partners and to spearhead the creation of new value chains. The project focuses on three bio-based value chains – phytopharma, bio-based packaging, and eco-construction – and it also forecasts their future development in the Danube Region. The vision is for the region to become a front-runner in the bioeconomy by supporting "bioeconomic distributed manufacturing environments" to achieve manufacturing scenarios that use locally available renewable raw and residual materials for conversion into locally required materials.

2. The Formation of Closed Bio-based Value Chains

2.1 Competitive Danube Region

The Danube Region possesses good potential for biomass production due to the large available area of forests and agricultural land in all project partner countries. Forests make up a significant proportion of the landscape in the Danube Region: in Montenegro they comprise 70% of the country's entire area, in Slovenia 63.3%, in Croatia 47%, and in both Austria and Slovakia 42%. In fact, Romania has the largest area of old-growth forests in Europe. Woodland and forests have traditionally been very important in the DanuBioValNet countries – ecologically, economically and socio-culturally. They contain a great diversity of species, ranging from broad-leaved trees (with oak and beech the most widespread species) to conifers (mostly spruce and pine).[1] According to the latest data provided by the project partners, almost half of the territory of the participating countries (49.4%) consists of agricultural land. This includes arable land, permanent crops, agricultural grasslands and horticultural land. The proportion of agricultural land is well above the EU-27 average (40% of the total land area in 2014). A wide variety of agricultural crops are cultivated in the Danube Region. Most of the land is used for cereal crop production (wheat, barley, rye, oats, maize, millet, sorghum – Romania and Serbia rank among the top 5 maize producers in Europe), oilseeds (particularly rape, soy and sunflowers), vineyards and orchards, wild and cultivated medicinal plants, grass, clover, and alfalfa.

Figure I: Area of forested land

x axis = DanuBioValNet countries;
y axis = area of forested land as a percentage of total surface area

Figure 2: Area of agricultural land

x axis = DanuBioValNet countries;
y axis = area of agricultural land as a percentage of total surface area

1) Dermastia, M. & Maric, Z. (2017). The Bio-based Status in the Danube Region Report. DanuBioValNet.

Wood, agricultural biomass and bio-waste are the most important biomass sources in the Danube Region. However, their industrial use varies in different parts of the region. In most cases, the biomass that is not used for food and feed is used as a primary energy source for power and heating plants, for domestic use (combustion), and for the production of biofuels and biogas. Agriculturally produced bio-based feedstock is now used in the production of medicines, cosmetics, food, fine chemicals, construction materials, textiles, chemical building blocks, and fuels for electricity production or transport. A highly developed bioeconomy uses green resources firstly in the production of food and feed, and only afterwards (or simultaneously in the case of waste products) to produce chemicals, materials and energy. This is known as the cascading principle. The industrial structure of the DanuBioValNet participating countries includes all industries related to the bioeconomy. An analysis of the strengths and opportunities of the bioeconomy in the DanuBioValNet countries shows that all ten Danube countries/regions possess good preconditions for conversion to a bio-based economy in terms of their natural geographic conditions and resources, traditional industries, R&D infrastructure, and high-quality human resources. This capacity also offers new opportunities to complement traditional products with new products and services in order to maintain and boost the region's competitiveness. In addition to the potential within the industrial sector (where agriculture and forestry have long played a key role), the development of the bioeconomy also offers inherent opportunities for the increased use of biomass raw materials within other commercial sectors. This applies to areas such as plastics and biopolymers, construction, phytopharmaceuticals and packaging.

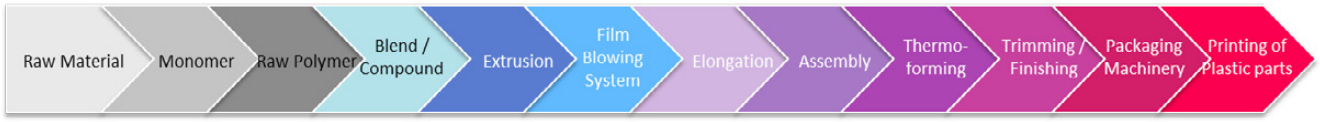
2.2 The Bio-based Packaging Value Chain

Bio-based packaging materials can be defined as "packaging materials derived from renewable sources". However, according to EU standards, biodegradable materials are also categorized as bio-based materials. Therefore, in order to distinguish between both terms, this report defines bio-based materials solely as those materials that originate from renewable materials.

Significant steps towards the use of renewable resources in the production of packaging (bioplastics, fibre-based solutions) have been made over recent years. Products, materials and processes have been developed that will bring down costs and optimize the performance of bio-based packaging materials.[2] Important companies from 4 countries/regions were interviewed in order to map the bio-based packaging industry's value chain. The figure below illustrates the structure of the bio-based packaging value chain for the purposes of the DanuBioValNet project.[3] The entire value chain of the bio-based packaging sector (i.e. all the value-adding steps which make up the chain) is represented in the Danube Region; however, most companies are located in the middle or at the end of the value chain, starting with the purchase of the monomer or blend/compound.

2) Claus J. Weber (eds), 2000, Biobased Packaging Materials, The Royal Veterinary and Agricultural University, ISBN 87-90504-07-0.

Figure 3: DanuBioValNet bio-based packaging (bioplastics) value chain



The above illustration of a simplified bio-based packaging value chain consists of several levels – starting from the raw material (which may originate from forestry, agriculture or waste recycling) and ending with the final product.

The raw materials are mostly processed into monomers outside the Danube Region. The monomers are then imported by companies in the Danube Region for further processing. The interviewees reported that the variety of monomers used is diverse, but the most important monomer is polylactic acid (PLA). The other main monomers used in bio-based packaging production are polybutylene succinate (PBS), cellulose acetate, bio-based polyethylene (PE), biodegradable polyester and starch. Most of the source material comes from distributors in Germany, France, Italy and from outside Europe, e.g. from the USA and Brazil. Czech companies also import bioplastic foils (which are suitable for use in the food industry, i.e. for contact with food) from the USA, Japan and the UK. The main processing technology used in bio-based packaging production is injection moulding, but this process requires challenging processing temperatures compared to commonly used plastic injection moulding methods. Companies that produce bio-based packaging materials are likely to have R&D high on their agenda, and they also tend to be involved in innovation projects as part of EU framework programmes. The companies are mainly supported by universities and research centres. The final products are most often supplied to the food and pharmaceutical sectors.

Key criteria when purchasing raw materials are quality, price, volume and processability. Regarding the availability of bio-based source material, companies expect lower prices, better supply and 100% biodegradable material to replace current source materials in the near future.

Current obstacles include the difficulty of obtaining more source material in adequate volumes, high prices of the source material, complex life cycle assessment methods, and a lack of standardized production processes which makes in-house quality control and R&D management more expensive.

The bio-based packaging value chain challenge is substantial. The real competitors are not companies that are also active in the field of bio-based packaging, but rather those that make cheaper oil-based products. There is also a considerable lack of legal regulations at EU and national level which would favour the use and development of advanced packaging materials made from biopolymers. In this context, countries should support the development and use of biopolymer products and provide support for agriculture, forestry and the recycling industry to produce renewable resources or to recycle waste that is suitable for biopolymer production.

Given the huge potential of bio-based packaging to contribute to the achievement of climate change targets by making use of renewable resources, it is essential to develop recycling strategies based on the principles of the circular economy in order to enhance the economic system.

3) The value chain map was not designed to shed detailed insights on dynamics within and between nodes (e.g. separate nodes and channels for large commercial operators vs. SMEs and informal enterprises), but simply to identify the nodes themselves as clearly as possible.

3. Innovation Ecosystems for Closing Bio-based Packaging Value Chains

3.1 Sustainable Partners for Change: Clusters

A cluster can be understood as a geographic concentration of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (e.g. universities, standards agencies and trade associations).[4] By definition, enterprises in clusters naturally tend to align themselves along the value chain of a particular industry, harnessing and exploiting the positive spillover effects of the network. Cluster organizations can help companies to better engage with other local actors within their cluster and to organize collective actions to strengthen their competitiveness.

Cluster mapping is the process of measuring the presence of cluster actors (companies, R&D institutions, public sector bodies) in a given region across defined sector-specific value chains. Cluster mapping, especially in "emerging industries" such as bio-based packaging is of substantial importance as it enables us to better understand the key competencies of the cluster actors as well as to evaluate the extent to which the relevant value chain is properly covered.

Selected cluster initiatives in the bio-based packaging sector within the Danube Region are listed in the table below:

4) M. Porter (1998). On Competition, Updated and Expanded Edition. Harvard Business Review Book, p. 213

Name	Country	Number of cluster actors	Establishment
Plastics Cluster	Austria	>400	1999
INNONET Kunststoff Horb	Germany (BW)	>100	2004
Packaging Valley	Germany (BW)	48	2007
Plastic Cluster	Czech Republic	50	2006
Omnipack	Czech Republic	57	2005
Cluster of Chemical, Plastic and Rubber Industry	Croatia	24	2013
Slovak Plastic Cluster	Slovakia	29	2009
Plasttechnics Cluster	Slovenia	68	*
Poly4Emi	Slovenia	7	2014

3.2 Engaging New Business Models

The bio-based industries, such as bio-based packaging, have been identified as cross-sectoral, highly innovative industries in which most parts of the Danube Region possess complementary competitiveness advantages and strong potential that can be harnessed by the development of eco-innovation, thus contributing to the prosperity of the region as a whole. From this perspective, bio-based value chains require companies to adopt new technologies and to act as part of interconnected value chains (VCs). These VCs must bring together producers, users, service providers, academics and buyers within the individual parts of the Danube Region and connect them along the axis of the Danube. A systematic multilevel approach to improving framework conditions for eco-innovation in bio-based industries demands new tools and business models on all levels.

Cluster services are the key tools enabling cluster organizations to support their cluster actors' efforts to innovate and become more competitive. The DanuBioValNet project has identified the most promising cluster services that cluster management organizations and other similar bodies may use when helping SMEs (including SMEs operating in bio-based industries, such as bio-based packaging, to engage in cross-sectoral innovation along VCs or when matching up appropriate partners in order to bridge existing VC gaps.

One outcome of the project is the Cluster Tool Box, which provides a variety of ready-to-use best-practice services supplied by well-established and competitive cluster management and business support organizations. The tools can be used by any cluster management organization or similar body seeking to facilitate competitiveness and enhance cluster excellence.

The main types of cluster services usually provided by cluster management organizations are:

- Innovation-related activities reaching beyond mere information-sharing: collaborative technology development, technology transfer, R&D etc.;
- Matchmaking and general sharing of information and experience among cluster participants (internal networking);
- Matchmaking and networking with external partners/promotion of cluster locations etc. (external networking);
- Business and commercial activities: export promotion, sales promotion, offshoring/outsourcing etc.;
- Entrepreneurship support;
- Policy support.

Practical examples of these cluster services form a part of the Cluster Tool Box publication "New Cluster Services to Support SMEs in Bio-based Industries".[5]

5) http://www.interreg-danube.eu/uploads/media/approved_project_output/0001/32/92be3e66154430dbe1e68b16d5fe324bd9068316.pdf

3.2 Engaging New Business Models

In order to successfully develop the bio-based packaging industry in the Danube Region, a supportive environment, especially on the policy level, is an essential requirement.

In general, the bioeconomy is still in the emerging phase – despite the fact that some bio-based industry value chains, such as bio-based packaging, have already achieved good levels of development in the Danube Region. Nevertheless, the more effective involvement of policymakers, as well as stronger international links among them, could facilitate, synchronize and catalyze financing schemes and programmes for clusters and other actors in bio-based industries.

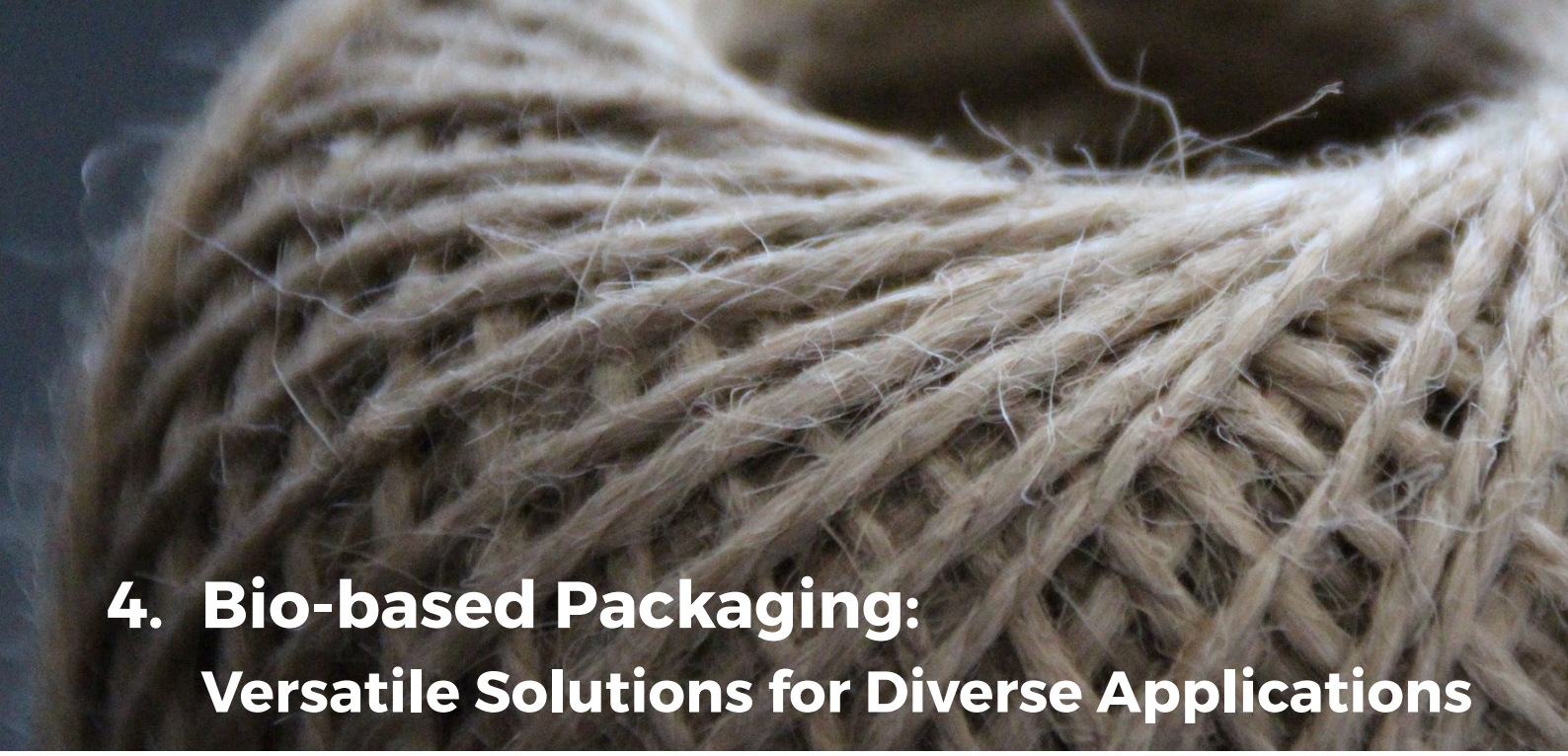
The bio-based packaging industry is one of the main markets for bio-based polymers in the Danube Region. There is huge and still unexploited potential in the field of biodegradable compostable materials. Additionally, products that can be used in the agricultural sector offer major opportunities for market development.

Given that the bio-based packaging industry possesses very high potential, it should be backed by systematic and serious policymaking including structural and programmatic intervention. The Danube Region therefore needs to make a joint effort in designing a suitable pathway and taking actions as well as influencing and engaging all relevant policymakers. It is important to develop appropriate policy measures that can de-risk investments in this industry and to apply synchronized measures/funding schemes at the macro-regional level along the entire bio-based packaging value chain in order to plug existing gaps and fill missing links. To achieve this, it is essential to use follow-up Calls in order to implement all conclusions on the level of local and national politics, as well as on the cluster level.

To support activities that push the boundaries of knowledge forward, it is critically important to remain well-informed about evolving market tendencies and opportunities as well as to gain a better understanding of socio-economic and environmental impacts. Where certain gaps in the bio-based packaging value chain have been detected or highlighted, specific policy directives or programmatic measures can be of value.

The main socio-economic constraints on the bio-based packaging industry in the Danube Region were identified as an inadequate level of knowledge about the potential of bio-based materials, a lack of information and general awareness (e.g. regarding bioplastics, biodegradability, data inputs and outputs for basic life cycle assessment), the lack of a composting system for bioplastics (end-of-life infrastructure), and the lack of knowledge-sharing among SMEs. A serious issue is also the exploitation of agricultural products for non-food processes.

Regarding policy, the business environment and legislation affecting the bio-based packaging industry, it is important to develop a joint bio-based materials strategy that involves bioplastics and bio-based packaging, better recycling strategies and closer involvement of NGOs and consumer organizations. Policymakers should take a more proactive approach to supporting the development of the industry.



4. Bio-based Packaging: Versatile Solutions for Diverse Applications

4.1 Future Perspectives for Bio-based Packaging

Significant efforts need to be made in order to raise public awareness regarding the benefits of bio-based materials compared with materials originating from fossil resources, including related public health and environmental impacts.

According to the 2018 Updated EU Bioeconomy Strategy, the European Commission will address the packaging sector and encourage it to make wider use of bio-based materials. However, with regard to bioplastics, it is necessary to create better binding legal frameworks for the use and application of bioplastics at EU and national level.[6]

The value chain for bio-based packaging could be improved by technical advancements and the development of innovative materials and products. Markets for bio-based products include the packaging sector, disposables and consumables. In addition, products that can be used in the agricultural sector offer major opportunities for market development. The most significant potential markets for bioplastic products in the next 5–10 years are disposable bioplastic packaging, disposable bioplastic products, and the packaging of luxury goods (a market segment where packaging is not price-sensitive). Potential markets for bio-based plastics can be found across Europe. Companies are generally interested in further cooperation along the local value chain and within the Danube Region in order to build up their missing know-how, secure a steady supply of raw materials and develop new products.[5]

Future perspectives for bio-based packaging also depend on tackling recycling-related issues in general and recycling of bioplastics in particular; some non-biodegradable bioplastics have the same properties as oil-based plastics and can be recycled together with them, but new polymers require an advanced sorting system. However, the recycling system in general requires innovation in order for it make a real contribution to the circular economy. Consumers must be made aware of the fact that correct waste separation is essential for successful recycling in general, and also for bioplastics. For this reason, it is important to develop better recycling strategies and a better end-of-life infrastructure at both the national and the EU level.

Further measures that would support the sector include a progressive ban on conventional plastic packaging, CO_2 taxation, taxation of crude oil used in plastic production, and better mechanisms in place for the promotion of biodegradability and environmentally friendly plastics.[5] Additionally, there is huge and still unexploited potential in the field of biodegradable compostable materials, if used in a reasonable way. Due to various environmental concerns, the use of biodegradable materials may contribute to sustainability and the reduction of environmental impacts, to a better greenhouse gas balance, etc.[5]

6) Švajger, G., Dermastia, M. & Meier zu Köcker, G. (2017). Synthesis value chain mapping report Bio-based Packaging. DanuBioValNet.

4.2 Future Perspectives for Bio-based Packaging in the Danube Region

Most bioplastic producers in the Danube Region receive their raw materials, monomers or polymers for bioplastic production from foreign intermediaries. Consequently, it may be possible to create better connections and networks with companies from other regions and countries operating in the same or a similar sector. In the long term, producers in the Danube Region should develop strategies and technologies enabling them to produce their own raw materials, monomers and polymers for the production of bioplastics or bio-based packaging materials.

Governments should encourage the production and use of bioplastic products and provide support for agriculture to produce the necessary crops, as well as for related sectors contributing to biopolymer production (e.g. manufacturers of machinery and technical equipment for processing raw materials). Production processes utilizing already-used raw materials to produce bioplastics could help to push down the price of bioplastic products. This would expand their market and contribute to an enhanced price/performance ratio that would further help reduce the cost of the production process.[5]

The establishment of national and Danube-wide platforms for networking and information sharing – such as Central Contact Points (developed by SMEs, academics and NGOs and supported by a political framework) – could facilitate the dissemination of information about currently existing technologies, processes and process parameters, suppliers of raw bio-based materials, and opportunities for cross-sectoral collaboration and innovation. For example, Central Contact Points could act as a source of information on existing national and international initiatives for bioplastics and bio-composites throughout the Danube Region.[7] The creation of pilot facilities where companies can experiment (e.g. the FabLab fabrication laboratories) would enable producers to plug the gaps in their know-how.[6]

On the national and Danube Region levels, the bioplastics and bio-based packaging industry should adopt a system of subsidies and quotas (taking the Dutch "PlusPunten" or the German "pay-as you-throw" [PAYT] schemes as examples), similarly to the renewable energy sector. Additionally, specialized tools should be developed to support streamlined research projects in the field of bio-based packaging – such as innovation vouchers, contracted research, and performance-based reward schemes for R&D institutions. The transition from oil-based to bio-based production should be supported via funding schemes.[6]

Sustainability and environmental impacts could be measured on the national and Danube Region levels. Advanced recycling strategies for bio-based packaging have the potential to lower the carbon footprint.[6] An essential step here is the implementation of a joint bio-based strategy addressing bioplastics on both the regional and national levels, drawing a clear distinction between on the one hand compostable plastics from made biodegradable plastics, and on the other hand advanced packaging materials made from biopolymers, whose development and use should be prioritized (e.g. via bans on plastic bags).[5]

All actors involved in the bio-based ecosystem should help to spread information and raise consumers' awareness of the need for bio-based products. A significant impact can also be made by information-sharing among NGOs, consumer organizations, multinational corporations and retailers, creating a market-driven approach to the use of advanced packaging as a substitute for common non-reusable packaging.[6]

7) Osvald, D. & Dermastia, M. (2018). Roadmap Report. Bio-based Advanced Packaging Value Chain. DanuBioValNet.

4.3 Next Steps

The packaging sector is the largest application sector for plastics in general (accounting for almost 65% of the total bioplastics market). According to the latest market data compiled by European Bioplastics in cooperation with the nova-Institute (a leading research institute), global bioplastic production capacity is set to increase from around 2.11 million tonnes in 2018 to approximately 2.62 million tonnes in 2023.[8]

To support the transition towards sustainable change in the Danube Region, it is of paramount importance to boost the engagement of industry actors in regional value chains in order to secure a steady supply of raw materials for the sector. Material self-sufficiency could also ensure independence from fossil resources that are derived from fossil fuel production, originating from e.g. Russia, the USA and the Middle East. In view of the depletion of non-renewable fossil resources, renewable raw materials offer a sustainable alternative.

Regions could benefit greatly from identifying adequate and appropriate raw material streams (providing sufficient quantities for the production of packaging materials) from agriculture, forestry or waste recycling. To make use of waste streams, advanced recycling strategies first need to be drawn up in order to improve standardization in waste collection and separation systems across regions and throughout Europe as a whole. Advanced recycling should be one of the key priorities in the upcoming years.

Both within and outside Europe, biorefineries are becoming crucially important. One example is the Sunliquid® Cellulosic Ethanol plant in Romania[9], with an investment that represents the biggest industrial commitment by an international corporation in the region of Craiova, which possesses "technology … pioneering not only in Europe but also globally". Further pilot facilities should be developed to produce high-quality materials as a basis for downstream industries such as packaging.

Using renewables as a resource can bring a multitude of ecological advantages: they are resource-saving, compostable, pollutant-free, climate-friendly, and recyclable. The use of bio-based packaging can therefore make a major contribution to environmental protection. However, marketing and communication in this regard still offers room for improvement. By using bioplastics, a company commits itself to sustainable development and can position itself as an innovator. Furthermore, the introduction of new products made from renewable plastics ensures high media effectiveness and differentiates the company from its competitors. The Danube Region can thus stand out from the rest of Europe and play a pioneering role in bio-based packaging; this requires a well-developed level of public awareness.

Strong interconnections among players all along the value chain should be developed: micro, small and medium enterprises that do not have the resources to invest or alter their processes have to collaborate in order to make prototypes which demonstrate the potential of new bio-based materials. It is important to strengthen links between industry and R&D institutions and to design pilot and demo projects.

Legislation of relevance to sustainability and environmental impacts needs to be synchronized at the EU, Danube and national levels via positive regulation and incentives for the increased use of bio-based materials.[10]

8) https://www.european-bioplastics.org/wp-content/uploads/2016/02/Report_Bioplastics-Market-Data_2018.pdf
9) https://www.clariant.com/en/Corporate/News/2018/09/Groundbreaking-for-Clariantrsquos-sunliquidreg-cellulosic-ethanol-plant-in-Romanianbsp
10) Eder, K., Rogl, D., Švajger, G. & Osvald, D. (2019). Pilot actions for closing bio-based value chains: Bio-based Packaging. DanuBioValNet.

5. Solutions for the Danube Region: Bioeconomic Distributed Manufacturing Environments

The bioeconomy is a modern way of dealing with renewable raw materials and associated biological resources in an ecologically prudent and economically viable manner.[11] The transition from a fossil-based to a bio-based economy reduces society's dependency on fossil fuels, increases sustainability and contributes to environmental and climate protection. However, even though excellent initiatives and bio-based products already exist, this complex transition will not happen suddenly and unexpectedly; it will most likely take up to several decades. In order to succeed, this process must be wanted and prepared for by governments, science, industry and society – especially in the Danube countries, with their great diversity of cultures and landscapes. Moreover, this process must be gradually integrated into the existing value systems of all economic sectors – including industry, services and agriculture. Consequently, large-scale national and international programmes, cooperative measures and initiatives are critically needed. Measures also need to be implemented on the regional level in order to achieve a successful transition. An important feature of the bioeconomy is its strongly regional character – meaning that it primarily targets local resources which move along short supply chains. Regional bioeconomy-centred strategies will help bring the strengths of a region to the fore, making existing development potential more clearly visible and promoting the utilization of regional resources rather than relying on imports – thus making communities more self-sufficient. Furthermore, these regional strategies will integrate regional research and industry capacities, analyze material flows and establish interfaces with internal and external partners.[2]

Local bio-based product chain scenarios offer the potential for diversification in the local economy, creating employment opportunities in rural areas, yet many goods and services are still produced only in specific parts of the Danube Region. Consequently, due to the re-orientation of the global economy into distinct transnational and local solutions, regions can benefit from local or regional excellence and competencies via cross-sectoral and cross-border cooperation.

Many new business models and income opportunities are to be found in distributed bio-based concepts, which not only contribute to positive environmental impacts, but are at the same time a powerful engine for economic growth in rural areas.

11) Jonischkeit B., Bächtle C. (2013). Bioeconomy – Baden-Württemberg´s path towards a sustainable future.

Educated and competent people are needed to operate distributed plants and to design products and services with higher added value. Primary production, cultivation, and harvesting will be closely linked to secondary production and the utilization and recycling of products. New opportunities will thus arise not only in agriculture, forestry and fish farming, but also in the food, chemical, pharmaceutical and energy industries. This will boost manufacturing of technologies and equipment, and it will generate a need for knowledge-intensive services such as consulting and legal services in planning, operation, optimization and maintenance.[12]

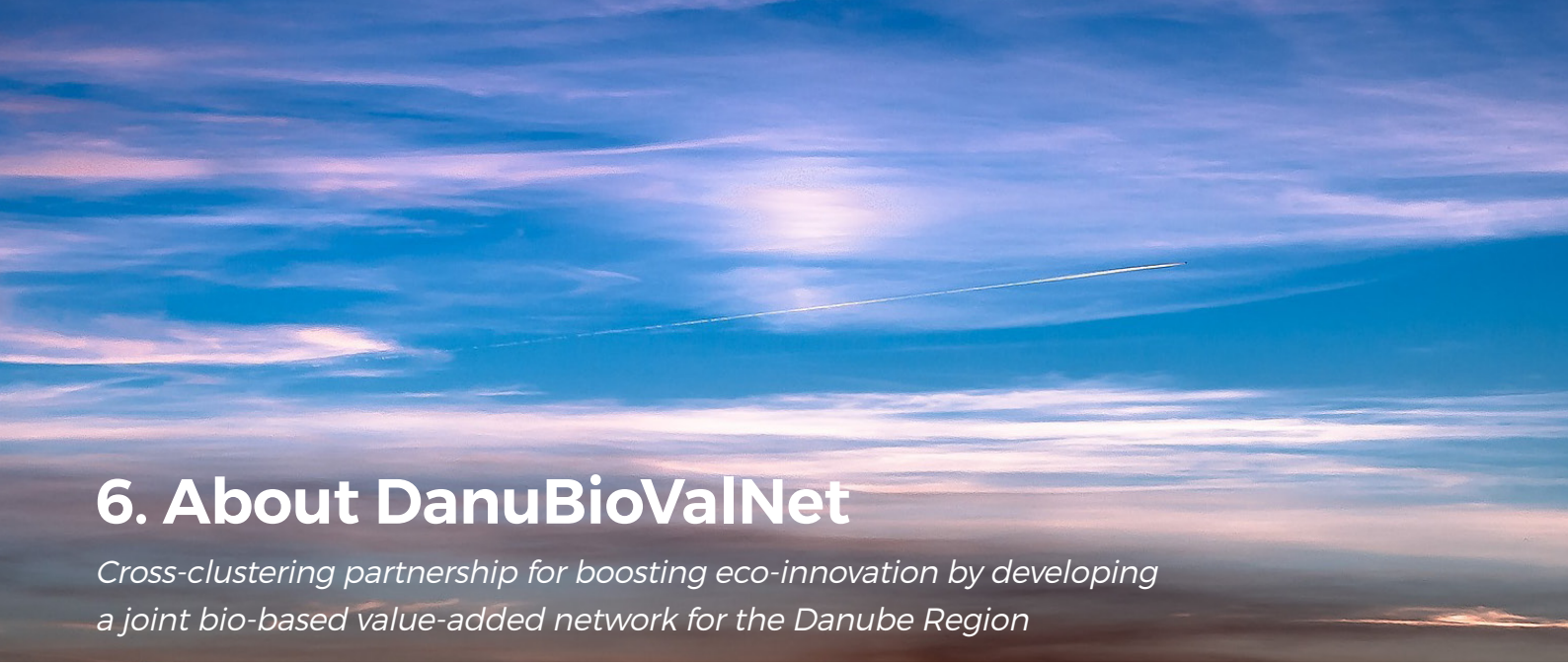
If properly implemented and managed, the approach described above – which is also known as the Bioeconomic Distributed Manufacturing Environments (BDME) approach – offers strong potential to help build a highly sustainable way of life by providing opportunities to substitute scarce resources with renewable ones. The BDME approach focuses on distributed manufacturing in order to achieve local manufacturing scenarios that use locally available renewable raw and residual materials in conversion processes in order to deliver locally required materials. The current idea is to develop a bioeconomy focused on the introduction of renewable resources and their conversion products as intermediates in existing value-added chains. In some more complex scenarios, value-added chains are interconnected with wider value-added networks, so that more sophisticated products can be developed. In this manner, all components of a particular plant (or another regionally available renewable resource) can be synergistically used. Examples may include the following:

1) Use of locally available lignocellulosic raw or residual materials to develop bio-based packaging material for local industries;
2) Lignin-based glue-type resins for smart packaging solutions for fruit or vegetable packaging.

Such condensed decentralized manufacturing environments need machinery infrastructure of a highly integrated, scaled-down modular type. As this machinery is potentially transportable in 40-ft container setups, it means that modern logistics scenarios (in which raw material streams converge at conversion plants) are replaced by scenarios in which manufacturing equipment is used for the conversion of locally available resources. This joint usage of highly advanced technologies is applied especially by agricultural cooperatives. The applicability and economic sense of the BDME approach needs to be investigated by using value chain models as well as applying technological and economical manufacturing simulation tools.

The bioeconomy model is interdisciplinary, as it encompasses and influences many areas of the economy, science and society. Thus, the bioeconomy concept must be understood as a system, within which many subsystems and processes are interlinked. The transition from a fossil-based to a bio-based economy will only be successful when many stakeholders are involved and when we are ready to change our mindset.[13]

12) Luoma P., Vanhanen J., Tommila P. (2011). Distributed Biobased Economy – Driving Sustainable Growth
13) Jonischkeit B., Bächtle C. (2013). Bioeconomy – Baden-Württemberg´s path towards a sustainable future.



6. About DanuBioValNet

Cross-clustering partnership for boosting eco-innovation by developing a joint bio-based value-added network for the Danube Region

The DanuBioValNet project is a cross-clustering partnership which seeks to boost eco-innovation by developing a joint bio-based value-added network for the Danube Region. DanuBioValNet stands for the development of a joint bio-based industry cluster policy strategy, clusters connecting enterprises transnationally, new bio-based value chains in the Danube Region, and eco-innovations supporting regional development.

The DanuBioValNet project, launched in 2017 through a cross-regional partnership involving 17 partners from 10 Danube regions, will enhance the transformation from a fossil-based economy towards an economy using renewable resources by creating bio-based value-added networks. The project will connect Danube actors in bio-based industry to minimize greenhouse gas emissions and optimize biomass resource utilization. These measures seek to enhance sustainability and regional development through diversification of the local economy, with a positive impact on the workforce. The focus on emerging transnational cooperation among clusters will serve to foster the bioeconomy and eco-innovations, leading to a strengthening of regional economies.

In order to develop new bio-based value chains leading from primary production to consumer markets, it is essential to connect enterprises from different regions and industries. However, due to the current lack of a holistic transnational approach, the Danube actors in the current bio-based industry still operate disconnected from each other, and cannot properly benefit from their mutual potential. Therefore, the aim of this project is to develop new methods, strategies and tools to connect enterprises transnationally. Clusters represent groups of industries that are closely linked by their products, markets, technologies and interests. They are chosen to organize and spearhead the industry cooperation that is necessary to create new value chains. Properly performing clusters can help upgrade industrial practices, generate new knowledge, and contribute to regional policymaking.

The partners in the DanuBioValNet project have agreed that phytopharma, eco-construction and bioplastic/advanced packaging (bio-based packaging) are three areas where there exists strong potential for improvement in their respective value chains; hemp is considered to be an appropriate raw material for all three value chains. The project activities are designed to enable partners to form links with SMEs, farmers, universities and research institutes within the value-added DanuBioValNet network. The partners intend to develop and implement a long-term, industry-driven roadmap for this collaboration encompassing the entire value chain, based on cluster partnerships. Focusing on the three selected high-potential areas, and harnessing the potential of regional clusters within wider cross-regional value chains, DanuBioValNet will implement pilot actions involving SMEs, universities, research institutions, policymakers, civil society groups and other stakeholders. The pilot actions are an essential first step before creating a blueprint for cross-regional cooperation.