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

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WP3 Value Chain Mapping

Activity 3.4 Roadmapping

D 3.4.1 Roadmap reports for all three VC

Roadmap Report

Bio-based Advanced Packaging Value Chain

Darja Osvald and Mateja Dermastia

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To learn more and to download additional information please refer to the <http://znanost.sta.si/2517825/bioplastics-movers-discussing-bioplastics-value-chain-in-ljubljana>

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Introduction of the DanuBioValNet project

The DanuBioValNet project is a cross-clustering partnership for boosting eco-innovation by developing a joint bio-based value-added network for the Danube Region. DanuBioValNet stands for 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 for supporting regional development.

The DanuBioValNet project, launched in 2017 through a cross-regional partnership involving 17 partners from 10 Danube regions, will enhance 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 a bio-based industry to minimize greenhouse gases and to optimize biomass resource utilisation. These measures are intended to improve the sustainability and regional development through diversification of the local economy while positively affecting the workforce. The focus on emerging transnational cooperation of clusters should serve to foster the bio-economy and eco-innovations and should lead to a strengthening of the regional economies.

The development of new bio-based value chains from primary production to consumer markets needs to be done by connecting enterprises from different regions and industries. However, due to a missing holistic transnational approach, the Danube actors in the current bio-based industry still operate disconnected and cannot properly benefit from their 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 common products, markets, technologies and interests. They are chosen to organize and carry forward the needed industry cooperation for the creation of new value chains. Properly performing clusters can help to upgrade industrial practices, generate new knowledge and contribute to regional policy-making.

The partners of the DanuBioValNet agreed that phytopharma, eco-construction and bio-plastic/advanced packing (bio-based packaging) have a high potential for improvement of their respective value chains and hemp is considered as a raw material suitable for all the three value chains. Project efforts are designed to allow partners to connect SMEs, farmers, universities, and research institutes within a value-added DanuBioValNet network. The partners intend to develop and implement a long-term, industry-driven roadmap for such collaboration along the entire value chain based on cluster partnerships for these processes. Focusing on the selected high potential sectors, and harnessing the nature of regional clusters within wider cross-regional selected value chains, DanuBioValNet will implement pilot actions, involving SMEs, universities, research institutions, policymakers, and civil society among others. The pilot actions serve as the prerequisite for creating a blueprint for cross-regional cooperation.



List of abbreviations

Bio-PE	Bio-Polyethylene
Bio-PET	Bio-Polyethylene Terephthalate
FabLab	Fabrication Laboratory
FNR	Fachagentur Nachwachsende Rohstoffe
FSC	The Forest Stewardship Council
NACE	The Statistical classification of economic activities in the European Community (French - Nomenclature statistique des activités économiques dans la Communauté européenne)
NCA	National Cluster Association – Czech Republic
NGO	Non-Governmental Organizations
PAYT	“Pay-as-you-throw”
PEFC	The Programme for the Endorsement of Forest Certification
PHAs	Polyhydroxalkanoates
PLA	Polylactic Acid
SME	Small and Medium Enterprises
VC	Value Chain
WG	Working Group
WP	Work Package



Glossary

Bioeconomy	Bioeconomy is the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy. Its sectors and industries have strong innovation potential due to their use of a wide range of sciences, enabling and industrial technologies, along with local and tacit knowledge. (Source: European Commission (2012). <i>Innovating for Sustainable Growth: A Bioeconomy for Europe</i> , p. 3)
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). <i>On Competition, Updated and Expanded Edition</i> . 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). <i>The Cluster Initiative Greenbook</i> , 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). <i>Uncovering excellence in cluster management</i> , 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). <i>Uncovering excellence in cluster management</i> , p. 3)
Cluster Policy	Cluster policy is an expression of political commitment, composed of a set of specific government policy interventions that aim to strengthen existing clusters and/or facilitate the emergence of new ones. Cluster policy is to be seen as a framework policy that opens the way for the bottom-up dynamics seen in clusters and cluster initiatives. This differs from the approach taken by traditional industrial policies which try (and most often fail) to create or back winners. (Source: European Commission (2016). <i>Smart Guide to Cluster Policy, Guidebook Series: How to support SME Policy from Structural Funds</i> , p. 11).
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). <i>Eco-innovation, When business meets the environment. FAQ: What is Eco-Innovation?</i> Online).
Smart Specialisation Strategies – S3	Smart Specialisation is a strategic approach to economic development through targeted support for research and innovation. It involves a process of developing a vision, identifying the place-based areas of greatest strategic potential, developing multi-stakeholder governance mechanisms, setting strategic priorities and using smart policies to maximise the knowledge-based development potential of a region, regardless of whether



it is strong or weak, high-tech or low-tech. (Source: Foray (2015). *Smart Specialisation, Opportunities and Challenges for Regional Innovation Policy*, Routledge).

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).



I. Background and relevance

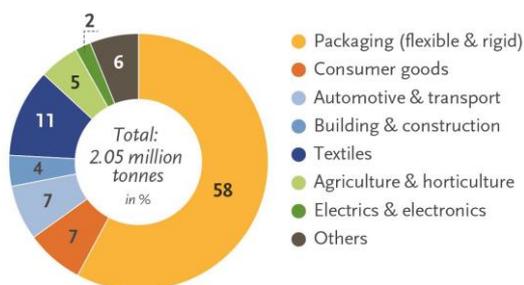
Importance of bio-based value chain - VC

It is evident that there is opportunity for the development of the bio-based packaging value chains in the Danube region. The region has a number of advantages with an abundance of raw materials, and more than 450,000 employees working in the (Bio-based) Packaging industry (in 2014). This equals a share of approximately 27 % of all related jobs in Europe. The share of respective firms in the Danube Region, compared to Europe as a whole, ranges at the same level (28%). Above-average growth rates of nearly 10 % since 2008 regarding the number of operating firms in the Bio-based Packaging sector indicate an increasing importance. However, it does not play an outstanding role¹. Contrary to these developments, employment in the Danube Region is regressive (-4,6 %) and, moreover, average wages display lower growth rates in the Danube Region than in Europe.

The packaging sector is the largest application sector for plastics in general (Figure 1). Bio-based drop-in plastics can lower the environmental footprint of plastic packaging and can be fully recycled. Biodegradable and compostable plastics offer additional end-of-life options for certain applications. Italy and France favour the use of biodegradable and compostable plastics through legislation while other countries do not see this as an option. So far, there is no common understanding, agreement or strategy in Europe on the question of which bio-based and/or biodegradable plastics can and should play a role in sustainable packaging and the circular economy. The understanding and political framework differ from one member state to the other. The correlation between framework conditions and market success of bio-based packaging is very high and also strongly affects future projections. Biodegradable plastic markets have become political markets to a large extent.

(Bio-based) paper and board packaging show an ongoing growth because of price, properties and an established collection and recycling system in many member states. Further growth is expected with new and advanced paper and cellulose fibre packaging materials².

Figure 1: Global production capacities by market segment (2017)



Source: *European Bioplastics, nova-Institute (2017)*³

Bio-based packaging materials can be defined as „materials derived from renewable sources“⁴. In addition, such materials recognised as biodegradable according to the standards outlined in the related EU Standards can be also understood as bio-based materials⁵.

¹ Further details of the individual cluster mapping exercises are given in the regional cluster mapping fact sheets available on the DanuBioValNet website (interreg-danube.eu/danubiovalnet)

² Current situation and trends of the bio-based industries in Europe with a focus on bio-based materials; BBI pilot study – Trends of the bio-based industries, nova-Institute, June 2017; <http://bio-based.eu/download/?did=106705&file=0>

³ More information: www.bio-based.eu/markets and www.european-bioplastics.org/market;

⁴ Claus J. Weber (eds), 2000, Biobased Packaging Materials for the Food Industry, Status and perspectives; The Royal Veterinary and Agricultural University, Denmark; page 14; ISBN 87-90504-07-0;

⁵ Claus J. Weber (eds), 2000, Biobased Packaging Materials for the Food Industry, Status and perspectives; The Royal Veterinary and Agricultural University, Denmark; ISBN 87-90504-07-0;



By the 1970s, petroleum-based materials had replaced, to a large extent, those materials derived from natural resources. But this trend is about to change again since recent developments are raising the prospects that natural resources will be a major contributor to the production of industrial products. Significant steps forward have been made over the recent past in terms of new products, materials and processes that will bring down costs and optimize performance of bio-based packaging materials. At the same time, environmental concerns are high on the policy agenda of industrial countries and public debates intensifying their interest in agricultural and forestry resources as alternative feedstocks. However, the development of new markets as well as costs and performance of competitive bio-based packaging materials remain the bigger challenge. A high potential market for such materials is the food packaging market, a highly competitive area with increasing demands from the market side.

There are many national and multinational initiatives that further fuel the demand for new bio-based packaging material. Among others, compostability (which is a very appealing property when the packaging meets the end of its useful life) is a key functional property needed to successfully reach the goal of the circular economy.

Paper and board-based packaging is very popular, particularly among consumers. This is one reason why paper and cardboard are among the most widely used packaging materials in the world. Paper and cardboard are bio-based (in Europe from sustainably managed woods, with PEFC or FSC mark), recyclable, biodegradable and suitable for thermal recycling (incineration). Apart from its application in paper and cardboard, wood is mainly used for transportation in the form of pallets and crates. The big advantage of wooden pallets is that they are sturdy, easy to repair and have a long life.

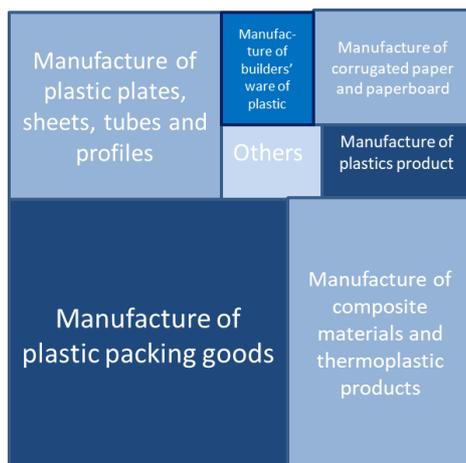
Renewables can be used to make bio-based plastics that are identical to petrochemical plastics. Well-known examples are bio-PE and bio-PET. These bio-based plastics are also referred to as ‘drop-in’ plastics. The advantage of both bio-PE (Polyethylene) and bio-PET (Polyethylene Terephthalate) is that these materials can be processed via the conventional recycling routes. The strong surge in the use of bio-based packaging is largely attributable to bio-PE and bio-PET. Other more recent bio-based plastics are PLA (Polylactic acid), starch blends and PHAs (Polyhydroxalkanoates). Besides being a chief component of paper, cellulose is also used to make products such as cellophane (film), viscose (fibres) and cellulose derivatives such as cellulose acetate. Cellophane is widely used as a packaging material for confectionery and floral bouquets, for example.

Relevance

The operationalisation of the bio-based packaging sector was developed within the DanuBioValNet project by an active involvement of the partners and cluster managers. This became necessary since the composition of this sector was unknown before. In the first step, the characteristic Value Chain for the bio-based packaging sector was jointly developed with the partners (Figure 2). The first node can be “cultivation” in case the raw materials can be cultivated. The node can be also defined by “collected”, in case the raw material has to be collected in the wild. However, all of the following nodes of the Value Chain remain the same.

Figure 2: DanuBioValNet Bio-based packaging industry and value chain





Source: Source: DanuBioValNet - Cluster Mapping Synthesis Report

The (Bio-based) Packaging industry composition illustrated in Figure 3 is based on the intensive work of the project partners and related cluster managers. It is based on more than 300 companies and their related NACE classifications. The size of the different boxes (NACE classifications) is proportional to the number of enterprises. As Figure 3 illustrates, the biggest share of enterprises (about 40 %) operate in the sector “Manufacture of plastic packaging goods” (NACE Code C22.22), and 8 % of the enterprises deal with “Manufacture of corrugated paper and paperboard” (NACE Code 17.21)⁶.

The sector involving the production of advanced packaging materials with biopolymers is still a niche market. Nevertheless, several companies are already operating in this field, even if it is only on a small-scale basis and no large quantities are produced. Although just a few companies are working on it, almost the whole value chain can be covered by different activities (either by doing research or by production activities).

Bioplastics are still an underdeveloped part of the industry and not many companies offer products that can compete with general alternatives. Most of the countries in the Danube region get their raw materials from foreign intermediaries. So, in many cases the first part of the bio-based packaging value chain is represented with R&D facilities and universities. The rest of the value chain in the Danube region is well-developed, in terms of production and R&D, but only a few of the companies actually produce bio-based packaging or similar products.

The main gaps, missing links and related policy obstacles have been identified along the bio-based packaging value chain⁷:

Table 1: Gaps, missing links and regulations of DanuBioValNet bio-based packaging value chain

Gaps	Missing links	Regulation / legislation
<ul style="list-style-type: none"> • High price of raw materials • Better production processes • Technical problems with manufacturing • Lack of knowledge • Better "End-of-life" infrastructure 	<ul style="list-style-type: none"> • Better networking connections with other regions • Suppliers of raw materials/manufacturers of adequate machinery • Market demand • Sustainability and environmental impacts 	<ul style="list-style-type: none"> • Need for joint bio-based strategy • Lack of legal regulations at EU and on national level • Clear distinction of compostable plastics from biodegradable plastics • Support for bioplastics on national level • Better recycling strategies

Source: Value Chain Mapping Synthesis Report: Bio-based packaging

⁶ According to NACE Rev. 2 2008; Eurostat – Methodologies and Working Papers (2008), ISSN 1977-0375

⁷ http://www.interreg-danube.eu/uploads/media/approved_project_public/0001/14/e0a299dcf467d6a85756a0a9c624903cfe71b372.pdf



II. Workshop Results

Objective of Roadmapping WS

The objectives of the Bio-based Packaging Roadmapping workshop were to:

- Gain insight into trends that will impact products and markets as well as opportunities and challenges for clusters active in the industry,
- Inform policy on how to improve conditions that currently hamper competitiveness and exploitation of opportunities along the bio-based packaging value chains in the region,
- Further the ties and common understanding among representatives of all relevant players and stakeholders in bio-based packaging and bioeconomy in general.

The primary focus of the workshop discussion was on market and consumer needs in the Danube region. The outcome of the workshop is intended to provide the input for the Joint Bio-based Industry Cluster Policy Strategy (WP4), new cluster management services (WP5) and the identification of feasible pilot actions (WP6).

The two-day international Roadmapping workshop on Bio-based Packaging value chain in the Danube region took place in Ljubljana from the 24th to 25th of May, 2018. It was organised by two European Interreg co-funded projects: DanuBioValNet and BIOCOPACK-CE. One of the reasons for the joint sponsorship was the benefit of combining the activity with the Central European project BIOCOPACK-CE, in which the national Institute for Chemistry is the Lead partner. The main objective of the Interreg Central Europe project BIOCOPACK-CE, which launched in 2017 and involves 10 partners from 6 European countries, is to provide stronger linkages between R&D institutions and companies in the area of paper-plastics packaging solutions with the objective of introducing verified biodegradable materials in paper and cardboard packaging. Paper and cardboard represented 41 % of packaging waste generated by weight in the EU-28 in 2013 (about 32.2 million tonnes).

The appearance of micro-plastics in recycled paper from secondary materials and compost is becoming a major concern. There is a high potential for mobilizing synergies between business and research institutions in the area of combined paper-bioplastics packaging design, production and recycling in Central Europe. Linkages are not sufficiently established due to lack of awareness among paper packaging producers on new bioplastics materials. Also, there is a separate focus on plastics and paper in clusters and branch organizations along with the lack of a common innovation strategy within the European and national legal and economic context. There is also a lack of dedicated tools to support SMEs in introducing new paper-plastics packaging solutions. The project foresees an innovative cross-sectoral approach with the involvement of clusters, branch organizations and stakeholders that will allow the effort to focus on regional economic specializations and to speed up technology transfer.

The organizers of the event were the Ministry of Education Science and Sport of the Republic of Slovenia, Anteja ECG and the National Institute of Chemistry, with support from the partners from Baden-Württemberg, BIOPRO, and Czech Republic, NCA.



Approach and methodology

The workshop on the Roadmapping for Bio-based Packaging Value Chains was a two-day interactive event proposed from the main organizers. On the first day there were plenary sessions and three parallel working group sessions. Discussion topics included the identification of value chain gaps, peer-to-peer discussion on trends, market development, the role of consumers and policy recommendations for fostering the bio-based industry and bioeconomy in the Danube region. The language of the workshop was English.

The three parallel working groups were organized in advance and composed of experts, clusters, industry leaders, researchers and policy makers.

During the plenary session, keynotes on trends and challenges of bioeconomy and three case studies on engaging the industry and consumers were presented. Prior to the discussions, an introduction to the Workshop Topics and presentation of the identified value chain gaps in the DanuBioValNet project were offered. Also, a background document was shared with the participants prior to the event.

The three working groups (WG), organized in parallel sessions, focused on the following topics and issues:

WG 1: NEW TECHNOLOGY DEVELOPMENT AND PRODUCTION PROCESSES focused on value chain gaps in engaging science with industry on new technology development (production processes).
WG 2: CONSUMER ENGAGEMENT & NEW MARKET DEVELOPMENT focused on value chain gaps in the industry, consumer engagement and new market development (consumer education).
WG 3: NEW BIO-BASED RAW MATERIAL, NEW RESOURCES focused on value chain gaps in overcoming the obstacles in assessing and obtaining new raw material and new resources (competitive bio-based material).

The participants of each WG were encouraged to be active in developing the roadmap. An experienced facilitator was appointed to conduct each of the parallel sessions, introducing the methodology to the participants, leading the discussions and stimulating the group to work together.

At the end of working group sessions, the working group representatives presented their findings from the parallel sessions of each group. The feedback from the other groups contributed to the incorporation of different perspectives.

Participants of the workshop

The roadmapping workshop for bio-based packaging brought together over 56 participants (experts, clusters managers, industry representatives, academia, researchers, policy makers and SMEs) and 11 speakers from 10 European countries (Slovenia, Germany (Baden-Württemberg), Austria, Czech Republic, Slovakia, Serbia, Romania, Bulgaria, Poland and Hungary) to discuss future trends and gaps in the Bio-based Packaging value chain. There were 11 participants in each working group.



Workshop Results

WG 1: NEW TECHNOLOGY DEVELOPMENT AND PRODUCTION PROCESSES focused on value chain gaps in engaging science with industry on new technology development (production processes). The session was facilitated by Dr. Luka Juvančič and the note keeper was Dr. Dominik Patzelt.

The aim of Working Group 1 was to discuss with experts recommendations for actions on already identified gaps in the Danube-wide bio-based packaging sector. The gaps were identified via expert interviews in WP3.2 and cluster mapping in WP3.3.

- Lack of better production processes / technology
- Identified technical problems with manufacturing

The Working Group acknowledged both gaps as being independent and provided the recommendations to overcome them. The first identified gap refers to the need for developing new instruments, technical equipment or production processes to provide satisfactory solutions for product development out of new bio-based materials (that might have different material properties than commonly used materials). New innovative approaches need to be developed to cope with the bio-based materials. The second gap mentioned above refers to the need for developing solutions for identified technical problems during the manufacturing process. These could either be in line with solutions for No. 1 or in line with providing adequate knowledge on how to adapt currently existing machinery or processes to the new materials to come to a marketable product.

Therefore, to overcome both gaps, there is a need to develop national and Danube-wide platforms for providing and extending knowledge about current existing technology, processes and process parameters. Such initiatives already exist on the national and international scale and should be expanded, connected and well managed. On the national scale in Germany, there is a project in the framework of the Fachagentur Nachwachsende Rohstoffe e. V. (FNR) with a consortium of research institutes that gathered information on already available bio-based materials. This project has researched the process parameters for different applications of such materials. The project provides a guideline of processing of bioplastics⁸ as well as a database⁹. Furthermore, the FNR itself provides a database¹⁰ on biomaterials such as bioplastics and bio-composites as well as literature about bioplastics, bio-composites and others. On the international level, comparable projects also exist. For example, the BIOCOMPACT-CE project under the Interreg Central Europe programme is designed to develop a transnational bio-composite packaging centre as a virtual RDI platform¹¹. Therefore, central points of contact that can provide adequate knowledge on existing national and international initiatives for bio-plastics and bio-composites throughout the Danube region need to be developed. These contact points should also be capable of researching currently available bio-based materials and play a key role in improving networking between academia and industry.

To address the demand for development of new technology and services for obtaining high quality products and services from bio-based materials, pilot installations should be developed. One approach could be the development of centres with the FabLab (fabrication laboratory) approach. These open labs should bring together knowledge and technology providers as well as actors in need of innovative processes and technology for a harmonized development of future production processes. The FabLabs also provide high-tech production technology for small working groups and might also engage a broader public if they gain free access to production technology and knowledge.

⁸ https://www.ifbb-hannover.de/files/IfBB/downloads/EV_Processing-of-Bioplastics-2016.pdf (status as of May 2018)

⁹ <http://ifbb-knvh.wp.hs-hannover.de/db/> (status as of May 2018)

¹⁰ https://biowerkstoffe.fnr.de/biokunststoffe/einfuehrung/?_mstto=en (status as of May 2018)

¹¹ <https://www.interreg-central.eu/Content.Node/BIOCOMPACT-CE.html> (status as of May 2018)



Thus, the idea of sustainable bio-based materials will penetrate further into the broader public. These platforms and FabLabs should be developed by interested SME, Academia and NGOs and supported by an appropriate political framework.

1. Lack of knowledge and knowledge exchange. To increase the knowledge development of SMEs and to offer the opportunity for knowledge exchange, different interest groups need to be connected. These networking events can be manifold and could, on the one hand, target the awareness of the public for bio-based plastics. On the other hand, the events could connect SMEs which have not been engaged in bioplastics or bio-composites with knowledge institutes that explain the benefits or offer research activities, as well as with companies that are already active in this field. Thus, new cooperation and increased knowledge will be the output. Cluster organizations should take the leading role in the above-mentioned activities. However, few cluster organisations that are dealing with bio-based plastics exist in the Danube Region. Currently, packaging cluster organisations exist but cover the topic of bio-based materials only marginally, if at all.

2. Missing sustainability and environmental impacts. New technologies in the bioplastics and bio-composites field will have to fulfil sustainability goals to prove to be more environmental friendly than commonly used products. These goals need to be underpinned by concrete measures on the national and on EU level. It is recommended to develop commonly accepted and applicable standards for a systematic procedure in the EU.

3. Research framework. To enhance the cooperation between science and business (especially the applied research for concrete products, processes or services) specialized tools need to be developed for streamlined research projects. Innovation vouchers, contracted research and rewarding professional performance of R&D institutions could potentially increase the output of joint projects. Policy measures need to set the right funding framework. Business, research and (public) research agencies need to agree and speak a common language to understand each partner, their capacities and motivations for commonly developed projects.

WG 2: CONSUMER ENGAGEMENT AND NEW MARKET DEVELOPMENT focused on value chain gaps in the industry, consumer engagement and new market development (consumer education). The session was facilitated by Dr. Gerd Meier zu Köcker and the note keeper was Darja Osvald.

The objectives of Working Group 2 were to: 1) discuss the already identified gaps and challenges related to consumer engagement and new market development for bio-based packaging value chain in the Danube region; 2) exchange and share of experience from industry by engaging consumers and new market development (consumer education); 3) articulate current gaps and future needs of the Bio-based Packaging VC for the purposes of the DanuBioValNet project.

Based on interviews conducted with representatives of the bio-based industry in the DanuBioValNet region, the following gaps were identified:

- Inadequate market demand;
- Absence of better recycling strategies;
- Lack of bioplastic support on national levels;
- Missing sustainability and environmental impacts.

The following outcomes were expected from the Working Group 2 session:

A report of the WG 2 discussion as input to the Roadmapping Bio-based Packaging VC Workshop Report. A list of discussed gaps and plans of activities and timeframe with responsible institution identified. The 11 participants at WG 2 session came from the following countries: Slovenia,



Germany, Serbia, Austria, Czech Republic and Slovakia. Participants were mainly experts from industry, clusters, entrepreneurs, advisors and researchers.

All session members took an active part in the discussions and finally came to the following findings:

Table 2: Findings - consumer engagement and new market development

Identified gaps	Responsible	Activities	Time frame
Inadequate / lack of market demand	<ul style="list-style-type: none"> retailers 	<ul style="list-style-type: none"> involve retailer assure information branding champions status symbol marketing 	
Missing better / advance recycling strategies	<ul style="list-style-type: none"> policy maker municipalities recyclers consumers 	<ul style="list-style-type: none"> policy formulation work conditions campaigns 	soon, high impact
Lack of bioplastic support on national levels	<ul style="list-style-type: none"> regional authorities country authorities national authorities EU 	<ul style="list-style-type: none"> incentives (Dutch approach) cross border 	as soon as possible, high impact
Information, explanation and awareness	<ul style="list-style-type: none"> NGOs clusters retailer state-policy education provision 	<ul style="list-style-type: none"> awareness campaign best practice pilot scheme consumer education and information 	very soon, high impact
Assured raw material (amount/volume available)			
Shelf-life not long enough (perception)			
Missing (knowledge) on sustainability and environmental impacts			

Group discussion and ranking of gaps

The group discussed four proposed gaps and added additional three gaps:

- **Assured, continuous in-flow of raw material.** Many producers would then consider using bio-based raw material in their production.
- **The shelf-life of some bio-based packaging** is, for some ingredients, not long enough. This is the perception from industry with an example of bio-based packaging for coffee beans. After half a year, the coffee beans (shelf-life one year) lose their aroma (if packed in bio-based packaging).
- **Information, explanation and awareness.** Existing knowledge about bio-based alternatives must be communicated to producers of packaging material, retailers and consumers to demonstrate their competitiveness. A low level of information and knowledge leads to misconceptions and false expectations.

DISCUSSION. Costs of new bio-based materials and processes are often higher compared to current, established, materials and processes. The costs for bio-based alternatives are likely to decrease in



the near future due to the increased market availability of raw materials and increased production volumes coupled with the increased production efficiency. Measures, such as subsidies or quotas, exist for the renewable energy sector, but not for the bioplastics industry. There is the so-called Dutch example “PlusPunten” or German “pay-as-you-throw” (PAYT) scheme. The missing link between suppliers of raw materials and manufacturers represents a barrier that must be overcome presently.

The material suppliers are not directly linked to the market players (brand owners, authorities and consumers) in the value chain. Better integration of all the players could greatly improve the adequacy of the material developments upon their launch into the market. This can be the new role of cluster managers.

The intermediary players are generally micro-, small- and medium-size companies, which do not have the resources to invest or alter processes in order to make the prototypes which could demonstrate the potential of new bio-based materials. There is a need for a link to R&D institutions as well as proposals for pilots and demonstration projects.

To better inform the consumers, the involvement of NGOs and consumer organisations is needed. Customers are looking for eco-solutions on the market and studies of consumer behaviour indicate that consumers are willing to pay more for environmentally friendly products. Demand: 80% consumers want to buy products with a minimal impact on the environment (Eurobarometer survey, 2013).

Many dry foods with a short shelf-life do not make very high demands on the packaging material. So, for these products, bio-based packaging can provide the required levels of gas barrier and hygiene protection. The same is true for take-away foods, which only need short contact or storage times.

Consumer goods are another potential application area. The main requirement for daily hygiene products, toys, household utensils, tools, sports articles, etc. is a transparent package to 'show-off' the content. Bio-based materials are able to provide realistic alternatives to petroleum-based plastic products for this purpose.

Biodegradable/compostable packaging materials promote a more thoughtful approach to dealing with (household) waste and offer reductions in waste production and landfill use.

Food safety regulation. Newly developed materials or combinations of materials can normally be approved if all components, including chemical reagents for the production of biopolymer derivatives, are approved for food contact. However, some substances have not (yet) been approved and some solutions can involve potential health risks (e.g. synthetic nanoparticles, allergens, by-products).

RANKING OF GAPS: The group made individual rankings of the gaps, the most prevailing of which are:

- | |
|---|
| <ol style="list-style-type: none">a. Inadequate / lack of market demandb. Missing improved / advanced recycling strategiesc. Lack of bioplastic support on national levelsd. Information, explanation and awareness. |
|---|

All other identified gaps are not considered to be as prevailing.

The group made also an assessment, based on the question of what (and when) will be the impact on economy if one of these gaps would be eliminated. The highest impact in the short run would result



from having support on the national level for bio-based packaging. This is followed by the provision of relevant and transparent information, explanation and awareness. Finally, the development and implementation of advanced bio-based and recycling strategies would also have a measureable impact.

WG 3: NEW BIO-BASED RAW MATERIAL, NEW RESOURCES focused on value chain gaps in overcoming the obstacles in assessing and obtaining new raw material and new resources (competitive bio-based material). The session was facilitated by Dr. Andrej Kržan and the note keeper was Gregor Švajger.

Working group 3 of the Roadmapping Bio-based Packaging Value Chain workshop focused on value chain gaps in overcoming the obstacles in assessing and obtaining new raw materials and new resources (competitive bio-based material). The identified gaps were preselected by means of interviews with stakeholders. They included gaps related to missing suppliers of raw materials/manufacturers of adequate machinery, high price of raw materials, missing sustainability and environmental impacts, and lack of incentives and legal regulations at the EU/national level. During the working group session, participants rated the identified gaps by level of importance. After the debate, the following listing was elaborated with descriptive instances for the involved stakeholders on how to tackle the gaps as well as a timeframe for the execution.

Gap 1: Missing suppliers of raw materials or small numbers of manufacturers of adequate machinery are the main reason why bioplastic packaging is yet to be more widely used in the consumer market. It was stated that this role should be adopted by multinational corporations which have a big stake in the market and can provide a market driven approach to using advance packaging as a substitute for common non-reusable packaging. In this regard, monopolies can be broken apart by having corporations compete in this field. Participants agreed that a possible solution to this gap could be projected in short to medium term.

Gap 2: The high price of raw material was stated to be the 2nd highest gap that bio-based packaging is facing. In turn, this is directly related to the free market and to consumer habits. Higher prices of raw materials can be reduced by finding a new free raw material or reusing waste materials. This is heavily dependent on implementation of circular economy best practices. The timeframe for reducing the gap was determined as short to medium term.

Gap 3: Missing sustainability practices and environmental impact throughout the whole value chain were evaluated as the third most important gap. It also correlates to missing data inputs and outputs for basic LCA (lifetime cycle assessment) for different bio-based packaging products. Responsible stakeholders, who can bridge this gap, were identified as research institutions (academia), consulting companies, and funding agencies. These include funding for national, regional or EU financial schemes on bio-based packaging or bioeconomy in general. For improvement in sustainability and reduction of the environmental impact, the number of collection points for processing and storing waste bio-based packaging should be increased. Financial schemes can help with these measures through appropriate research and innovation in the scope of different framework programmes. It was agreed upon that this kind of effort can be completed in the next 2-3 years.

Gap 4: Lack of incentives and legal regulation at the EU/national level was rated as the least prominent gap among the selected ones. This gap relates directly to policy makers and to government stakeholders who need to increase awareness of the public. This can be done through collection of incentives for public and private companies that could affect the level of awareness. Linking regulations with the main drivers for incentives is also a priority that must be addressed in the long term.



For the most part, the bio-based economy is held in the upmost regard as a research and development area, heavily dependent of the main market players (corporations) on one side and policy makers on the other. Participants of working group 3 also identified additional gaps related to CO2 optimization and reusability. Producers of bio-based packaging are encouraged to look into transition from crude oil-based plastics to biofuel-based plastics (or biopolymers from biomass) and thus lower their carbon footprint in the near future.

III. Recommendations and inputs for WP4, WP5 and WP6

WP4 Joint Bio-based Industry Cluster Policy Strategy

The main recommendations from the Roadmapping bio-based packaging workshop that can serve as inputs for the Strategy can be summarized as follows:

- National and Danube-wide platforms for providing and extending knowledge about current existing technology, processes, and process parameters, information about suppliers of raw bio-based materials, opportunities for cross-sectoral collaboration and innovation should be developed. These could be central points of contact that can provide adequate knowledge on existing national and international initiatives for bioplastics and bio-composites throughout the Danube region. These platforms should be developed by interested SME, academia and NGOs and supported by a political framework.
- Measures, such as subsidies and quotas, must be developed for bioplastics and the bio-based packaging industry. An example is the so-called Dutch example “PlusPunten” or German “pay-as-you-throw” (PAYT) scheme – on the national and Danube region level.
- To enhance the cooperation between science and business, especially the applied research for concrete products, processes or services, specialized tools need to be developed for streamlined research projects in the field of bio-based packaging. Innovation vouchers, contracted research and rewarding professional performance of R&D institutions could potentially increase the output of joint projects.
- Sustainability and environmental impacts measures should be developed on the national and Danube region level. Advanced recycling strategies should be set. Producers of bio-based packaging should look into transition from crude oil-based plastics to biofuel-based plastics (or biopolymers from biomass), thus lowering their carbon footprint in the near future.
- Funding schemes for transformation from oil-based to bio-based production should be developed.
- Assuring data inputs and outputs for basic LCA (lifetime cycle assessment) for different bio-based packaging products.
- Developing measures to better inform consumers by involvement of NGOs and consumer organisations.
- Provision of a market-driven approach to using advanced packaging as a substitute for common non-reusable packaging by involving multinational corporations and retailers.
- Information, explanation and awareness on bio-based products must be spread by involvement of all actors in the bio-based ecosystem.



WP5 Open Space Innovation Arenas and new Cluster Management Services

- Cluster organizations should take the leading role in provision of new services like networking and matchmaking events, training, project development, offering comprehensive information and education by covering the topic of bio-based materials.
- Better integration of all the players could greatly improve the adequacy of the material developments upon their launch into the market – new role of cluster managers.

WP6 Pilot Actions

- Pilot installations should be developed to address the demand of development of new technology and services for obtaining high quality products and services from bio-based materials.
- The intermediary players are generally micro-, small- and medium-size companies, which do not have the resources to invest or alter processes in order to make prototypes which could demonstrate the potential of new bio-based materials. It is important to link this to R&D institutions and proposals for pilot and demonstration projects.

