AlpLinkBioEco

Creating BioBased Value in the Alpine Space

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AlpLinkBioEco is co-financed by the European Regional Development Fund through the Interreg Alpine Space Programme.

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Rights

This publication was produced within the framework of the AlpLinkBioEco Project funded by the Alpine Space INTERREG Programme of the European Commission. It was edited and designed by Erica Torti and Alessandro Ingegno (Confindustria Lombardia), in collaboration with Elisabetta De Berti (Freelance Designer).

This publication was drafted with information gathered from all Project Partners over the Project implementation period, based on the Project activities. The editors would like to thank all Project Partners for their significant efforts.

Disclaimer

AlpLinkBioEco

Creating BioBased Value in the Alpine Space


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Creating BioBased Value in the Alpine Space – Welcome to the AlpLinkBioEco Project

Michael Keller
Lead Partner AlpLinkBioEco

Jacques Bersier
Lead Partner AlpLinkBioEco

“Bio” is everywhere. From the products on the shelf of our supermarkets to the bills we receive from our energy providers, from the buzzwords in political debates to the pièce de résistance in research calls or the headlines of our newspapers. In the area of innovation and regional development, the concepts of bio- and circular economy have become indispensable companions of any researcher, practitioner or policymaker. The transition from a linear fossil-fuel based to a bio-based economy is recognised as a crucial contribution to the objectives of the European Green Deal. And indeed, this shift towards a bio-based economy seems particularly relevant for the regions of the Alps with an important reservoir of biomass resources and excellence in the development of sustainable solutions in sectors such as wood, agrofood, green chemicals or bio-based materials.

Obviously, an omnipresence of an idea in the public discourse can be the sign of an abundance of real opportunity or of hot air and empty talk and does, most often, combine aspects of both. How to draw the line? How to identify the potential for real value creation, while avoiding to be drawn into the jungle of ever-growing mountains of reports never read, concepts never tested, and strategies never implemented?

Our approach to this question has been, first and foremost, a practical one. The AlpLinkBioEco project was kicked-off in Fribourg, Switzerland, in the early summer of 2018 in one of those much-regretted real-world meetings, uniting interesting and interested project partners in flesh and blood, overflowing with motivating and beautifully enthusiastic ideas to make the project something special.

At the core of the project, a Value Chain Generator (VCG) was developed to provide a hands-on, data-driven contribution to overcoming existing information gaps and to unearthing unexploited business opportunities for bio-based value chains. The VCG tool is delivered as a web-based demonstrator software giving access to an anonymized database of actors of the bio-based economy, and to a set of natural language algorithms allowing to match these actors into value chain ideas. The creation of the VCG tool during the project was characterized by a continuous interplay between software development and practical work. On the one hand, project partners teamed up with their stakeholders and trawled the Alpine Space in search of bioeconomy actors and clusters to populate the database. On the other hand, new functionalities were added to the software on a regular basis. The source code of the final version of the software is available to all interested parties under a permissive software license.

In spring 2020, the growing database and the software allowed to take the developed ideas to a real-world setting and confront concrete actors with identified business opportunities. In spite of the pandemic that was paralyzing activities around the globe, the AlpLinkBioEco partners have been able to engage their stakeholders into discussing the feasibility of bio-based value chains from a technical, economic

and ecological perspective. The frail ideas grown under the shelter of the VCG tool were sent out to confront the rough climate of the business world. Can bio-based inputs replace fossil-fuel-based ones in existing production processes? Can residual outputs and waste streams of actors from the knowledge base become inputs for new innovative bio-based business models? Can an opportunity that works in a neighboring region be implemented at home? Can concrete actors be identified to move from ideas to action? Can suppliers or buyers from overseas be replaced by local alternatives?

The pilot experience was encouraging. Some of the identified business opportunities turned out, of course, to be illusional or at least difficult to implement under the given circumstances. On the whole however, many interesting approaches have been generated with a promising outlook for successful implementation, both intra- and cross-regionally, by a network of actors that could be continuously grown over time.

In parallel to the practical work of developing and using the VCG tool, the AlpLinkBioEco partners have also conducted comprehensive research and policy oriented activities throughout the project's implementation. Benefits and opportunities of bio-based value chains in the Alpine Space have been studied from multiple perspectives. Existing bio-based value chains and clusters have been mapped and documented. An inventory of existing regional strategies and policies has been established and updated throughout the project. The research activities provided a picture complementary to the empirical experience: the potential for bio-based value chains in the Alpine Space is immense, well-anchored in existing capacities and resources, and addressing alpine specific economic, societal and environmental challenges. In order to fully benefit from the potential however, actors and regions need to intensify cooperation across borders. In spite of all the significant complementarities and synergies, the Alpine Space remains a diverse territory, marked by almost as many regional borders as watersheds, home to a multitude of regional specificities and identities and a variety of administrative and political contexts. A joint strategic approach among Alpine regions is needed to ensure that bio-based business opportunities can bear fruit across the fertile bioeconomy soils of the Alps. To this end, a masterplan to move towards a joint bioeconomy strategy for the Alpine Space has been drafted.

Today, we are delighted to present this final project publication as a documentation of the project's main results. The book follows the three lenses through which the challenge of creating bio-based value in the regions of the Alpine Space has been studied during the project: the VCG software tool, the collaborative pilot experience, and the masterplan towards a joint Alpine Space bioeconomy strategy.

Creating Bio-based value in the Alpine Space – a complex objective, indeed. Only time will tell if AlpLinkBioEco has succeeded in providing valuable contributions. With its masterplan the project intends to promote the valorization of the bioeconomy potential at a macro-regional scale by proposing concrete fields of action and recommendations oriented towards a joint strategic approach. The pilot experience with bio-based value chain ideas, gathered thanks to the tireless and solidary cooperation among our project partners and their stakeholders, stands as an example for concrete implementation work, hopefully to be continued and imitated by other actors and regions in the future. And with its Value Chain Generator (VCG) tool, the project provides a hands-on contribution with a demonstrator software and source code, waiting to be discovered, improved, used to unearth business opportunities or applied to different contexts in new projects. As a very practical, tangible contribution it has, at the very least, the advantage that it can avoid the gruesome destiny of being sentenced to life in a drawer.

Take a look!
https://alplinkbioeco.tic.heia-fr.ch/

Muri bei Bern / Fribourg, March 2021

Michael Keller and Jacques Bersier
Lead Partners AlpLinkBioEco
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Foreword by the Chairman of the Advisory Board

Ulrich Daum,
UetlibergPartners GmbH

The AlpLinkBioEco project was based on existing potentials with the aim of developing a methodology to facilitate the tailor-made matching of bio-based actors, fostering high added value applications and products and providing recommendations for a common policy to strengthen and implement a cross Alpine Space circular bio-based economic strategy. It can be noted, that the Alpine Space Regions are very diverse in culture, tradition, language, structure and the development of national priorities as well as the progress towards the transition into a bio-based economy, following societal demands. In addition, the effects of the Corona pandemic had to be mastered during this project.

Four industry sectors to concentrate on were assigned: agriculture, wood as a bio-based feedstock and, as downstream industries, chemistry and packaging. Within this project, the various challenges arising from the diversity of the partners was overcome by open, result driven and structured communication links while the hurdles from the Corona pandemic were mastered using well organized web conferences and bilateral calls.

A methodology to enable new business opportunities was successfully developed. Instead of concentrating on the designation of a specific product to be bought, processed and sold, a novel Value Chain Generator (VCG) was developed that looks at the various properties of these products and, in addition, at the side streams of the production, defining them in “descriptors”. In this way, limitations of the designations in the search for new value chains could be avoided. The model applied assumes that the closer the descriptors of an “output” of a given actor (company or organization) are to the needed “input” of a second actor, the higher is the probability of finding a new value chain and a successive “biolink”. In a first test phase, this concept was validated and throughout the project it became more and more automated and computerized, so that in the end a new, very versatile VCG has been made available. Overall close to 2.000 actors have now been identified, characterized and described by more than 600 descriptors, leading to in excess of 200 new biolinks of which about 50 are currently in the implementation stage. It can be proudly stated that this outcome forms a concrete value for society and is a direct pay back of the investment in the funding of this project. This VCG is designed in such a way, that it is not limited to the current project only. Since it is open source, it can easily be applied to other applications to foster new business opportunities in other areas.

In addition, concrete and future oriented recommendations for policy makers could be identified, validated and formulated in order to support the transformation of the traditional linear society into a bio based and circular future.

I had the privilege to follow the progress of this project from the start, supporting the analysis and test stages as well as the development and implementation phases towards the end. I would like to state that I am proud to have been part of this very successful project, which has successfully delivered real value within the given time scale despite many obstacles, especially that of the Corona pandemic. This achievement was possible through the extraordinary and continued efforts of all partners involved and especially by the competent and result oriented leadership of PICC as a whole, and J. Bersier, R. Koopmans, A. Fischer and M. Keller in particular for the coordination and drive to obtain this outstanding achievement!

Many thanks, it was a pleasure.

Hallau, March 2021

Prof. Ulrich Daum
UetlibergPartners GmbH,
Chairman of the AlpLinkBioEco Advisory Board

An External Perspective on the Project

Christian Patermann
Director,
ret. European Commission

AlpLinkBioEco, the almost unpronounceable name of this Research Venture or evidence-based study is a unique project with respect to the future development of bio-based economies in the heart of Europe. It offers USPs in its aims and goals which make this project very different from other INTERREG ventures.

We see today a growing number of regional micro- and macroeconomic strategies, action plans and similar initiatives all over Europe, carrying the name of bioeconomy or the attribute bio-based. But most of them remain within abstract strategic descriptions, working out criteria, leading principles and general targets, sometimes also implementation concepts, which indeed might be helpful in enabling the transformation processes from a fossil-based economy, from a linear way of handling conflicts and issues to a non - fossil, circular, bio-based sustainable economy.

AlpLinkBioEco offers more! Indeed, one of its aims is also to provide the base for a masterplan to work out a regional macroeconomic bioeconomy strategy for 9 regions in the European states forming the so-called Alpine Region, i.d. France, Germany, Switzerland, Italy, Austria and Slovenia. This has only been done before for the Baltic region and the Northern Arctic by the Nordic Council of Ministers et al. The results of this careful analysis in AlpLinkBioEco with many concrete policy recommendations deserve really attention and will be an important piece of work to be continued in the future, and thus become a model for other regions in Europe.
But the real innovation element, the real ambition of this project goes far beyond: the core activity of more than 3 years of intensive work among more than 450 actors or stakeholders, ranging from about 400 SMEs, research institutions, associations of industries etc. goes beyond mapping, reaches beyond the elaboration of a strategy, and a roadmap: it aims at developing concrete “demonstrators“ for intelligently identifying, assessing, selecting and creating innovative new (cross) regional VALUE CHAINS (VCs) in a bioeconomy! The sectors in which this analytical, conceptual and practical work is carried out have been carefully preselected before, being highly relevant for the economy of the Alpine area and their regions: Agriculture (Agro), Wood, Packaging for Food and Pharma and Chemistry. This portion of the project is also worthwhile to be carefully looked at because of its valuable database.

Based on the results of the mapping exercise of existing resources, actors and relevant policies, a new cross-regional Value Chain Generating tool, the VC Generator, has been developed, with the additional assistance of so-called descriptors. Such descriptors are a set of descriptive data, with information on how individual actors, for instance companies or enterprises deal with bio-based activities, matching actors’ skills and demands, based on similarities and complementarities in business, and their potential scaling–up. This new and innovative instrument is a software tool based on natural language algorithms that helps identifying and bridging missing links within potential new VCs, arriving at new potential crosscutting

and cross-regional VCs in the above mentioned sectors of a bio-based economy in the alpine Region. And this activity is not just a theory: the Generator has been developed manually, tested and automated throughout the project to generate new potential VCs, thus demonstrating also a true pilot experience phase, from a knowledge base into a real value chain, a true business. And this aims at the very heart of the bioeconomy as a new economic model, it makes as a first step in 11 concrete business cases the bioeconomy impressively flies! I can only recommend to carefully look at these concrete 11 cases, and how they arrived, ranging from cultivation of mushroom on brewers‘ grain to replacing castor oil by slaughterhouse leftovers.

AlpLinkBioEco is highly attractive not only for research centres, applied and regular Universities, but for all kind of enterprises, including SMEs, sectoral agencies, professional industrial or trade associations, and also for interest groups, policy makers and NGOs, as these activities will take place by definition within the so-called planetary boundaries, as the acronym ECO in the name of the project clearly underlines.

This combination of biological knowledge, focused on a dedicated geographical region highly relevant for Europe (example: the Alps as the Water Tower of this continent…) with advanced knowledge, stemming from the integrated use of Digitalization and Artificial Intelligence offers the gate into a new phase of a knowledge-based Bioeconomy: from Algorithms to DNA!

What can this project applied within the geographical boundaries of the Alpine regions offer to Europe? I would like to highlight 2 aspects in the end:

Primo: The intensive activities, sometimes hampered by the limitations of the pandemic in its impacts on personalized links as source of even more innovation, might in its results serve as a model for other macroeconomic regions in Europe, like the Western or Eastern Mediterranean, the Black Sea, the Danube basin, or large urban agglomerations, like the Ruhrgebiet in Germany with parts of the Netherland and Belgium etc.

Secundo: The best practices and experiences gained in very concrete cases I mentioned in this project MUST be kept and further developed. In this respect an important part of the work is still to be done to exploit the full swing of the already noted practical success stories of AlpLinkBioEco.

Congratulations, and bonne chance for the future!

Bonn, March 2021

Dr. Christian Patermann
Director, ret. European Commission

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CHAPTER 1

“The Value Chain Generator Tool: Generating Value Chains”

1.1. Making the Bioeconomy Work – Business Opportunities and Value Chains

1.2. The VCG Tool – Knowledge Base and Methods

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1.1. Making the Bioeconomy Work – Business Opportunities and Value Chains

Michael Keller[1]

The transition from a fossil-based to a bio-based economy is among the key objectives of the European innovation landscape. It is recognized as a driver for regional competitiveness, high value-added businesses and jobs, and a crucial contribution to the objectives of the European Green Deal.[2] The shift towards a bio-based economy represents a particular opportunity for the regions of the Alpine Space with its important reservoir of biomass resources and knowledge and technology excellence in the development of sustainable solutions in sectors such as green chemicals, biopolymers or bio-based materials.[3]

The benefits of reducing dependency on fossil-fuel based resources are manifold and the shift towards bio-based solutions widely accepted as an indispensable contribution to overcoming the environmental and social challenges of the 21st century.

At the same time, the awareness of the business opportunities associated with the bioeconomy is steadily growing within business and industry communities, stakeholders of RDI ecosystems and at various policy levels. At the outset of the European Green Deal, the interest in the bioeconomy and circular solutions has, at least in the European context, reached previously unknown heights – to the point where the term "bioeconomy" is getting in danger of entering the treacherous backwaters of buzzwords, with its business opportunities being reduced to the indisputable advantage the term currently represents in the pursuit of public funding or to facile marketing strategies.

In order to come to fruition, to translate into increased competitiveness of businesses and regions, the business opportunities associated with bio-based solutions need to be understood in a fuller sense. If the "bioeconomy" is to live up to its promises, it is insufficient to be contended with the term as an attractive go-to slogan for research proposals or a fancy selling argument for old wine in new bottles. If the concept is to prove successful as an economic principle (as its terminology suggests), the undisputable environmental and societal benefits of turning away from a fossil-fuel based economy need to be coupled with the potential for value creation at the business level.

Ten years ago, when Michael Porter of the Harvard Business School introduced the concept of Creating Shared Value (CSV), he described the core of the challenge, which now shows to be fully relevant in the context of the European bioeconomy: "A big part of the problem lies with companies themselves, which remain trapped in an outdated approach to value creation that has emerged over the past few decades. They continue to view value creation narrowly, optimizing short-term financial performance in a bubble while missing the most important customer needs and ignoring the broader influences that determine their longer-term success" (Porter and Kramer, 2011, p. 1).[4]The concept of CSV intends to reconnect "social progress" with "company progress" by addressing societal and environmental needs and challenges "in a way that also [creates] economic value." Instead of overlooking the "depletion of natural resources vital to their businesses", companies should put the creation of shared value at the center of their business operations (Porter and Kramer, 2011, p. 1).

At the core of how value is created lies the concept of the value chain. Economic value is created by economic actors - "businesses" in the broad sense, encompassing the range from one-woman / man operations to large multinational companies. At the lowest level of an individual economic actor, the

[1] AlpLinkBioEco Lead Partner, Plastics Innovation Competence Center, University of Applied Sciences and Arts Western Switzerland - School of Engineering and Architecture of Fribourg (HES-SO//FR HEIA-FR)

[2] See, inter alia, the resources published by the European Commission's Knowledge Center for Bioeconomy: https://ec.europa.eu/info/research-and-innovation/research-area/bioeconomy_en

[3] An inventory of capacities for a bio-based economy in the Alpine Space has been drawn up in the different reports produced during the AlpLinkBioEco project and can be downloaded from the project results section of the project website: https://www.alpine-space.eu/projects/alplinkbioeco/en/home
As a basis for the AlpLinkBioEco Bioeconomy Masterplan, the most important facts and figures are summarized in chapter 3 of this publication.

[4] Michael Porter and Mark Kramer (2011). The Big Idea: Creating Shared Value. Harvard Business Review.

value chain describes a company's "technologically and economically distinct activities [performed] to do business" (Porter, 2011, p. 75).[5] Actors process inputs into outputs and a business is profitable if the value it creates along this process exceeds the cost of performing the activities. The created value as such is expressed by the amount other economic actors are willing to pay for the company's output. Thus, in order for value creation to exist at all, there need to be at least two economic actors willing to engage in an economic interaction based on shared business opportunities. In this sense, a company's value chain is always embedded in a larger value system of at least two, but typically many more actors and their individual process of turning inputs into outputs. The value system consists of the value chains of a company linked to the value chains of its suppliers and its buyers. Outputs created by economic actors are used by other actors as inputs for additional processes, et cetera.

It is as a designation of this complete value system that the term "value chain" is understood in the context of the AlpLinkBioEco Value Chain generator (VCG) - as a series of complementary activities (input – process – output) of economic actors. To put it simply, such a value chain "exists" when actors are linked together through mutual benefits. In this sense, an established, observable value chain can be considered at the same time as the means to create value, and the demonstration of the technological and economic feasibility of business opportunities.

What to take away from this in the context of the bioeconomy? As discussed above, to make "bio" work in and for the "economy", the undisputable environmental and societal benefits of turning away from a fossil-fuel based model need to be coupled with the potential for value creation at the business level. "Bioeconomy" needs to move from a buzzword to the core of companies' value creation processes as a real business opportunity. What we are looking for, in fine, is the generation of bio-based value chains – value systems of mutually beneficial economic interactions construed around bio-based resources, bringing together actors as diverse as bio-feedstock producers, intermediate processors, product developers, brand-owners, retailers or product end users.

The Alpine Region is indeed recognized as having huge potential for the development of bio-based value chains. But to move from lofty opportunities to action and value creation often turns out to be a complex practical exercise. The implementation challenges are manifold. Traditional ways of operating in a linear economy, where a product necessarily ends as waste, impede alternative, circular end of life solutions. There is a lack of understanding of the natural resources as alternative, unexploited bio-based inputs. In a globalized economy interregional opportunities and solutions based on locally available resources often remain untapped. Due to a missing holistic cross-regional approach many actors in bio-based industries operate in a disconnected mode. To summarize it in the terms of an economist, opportunity for value creation is not realized because of information asymmetries and unexploited positive externalities. As a result, business opportunities for producing high value applications lie idle and value chains that address critical environmental and societal needs, such as ecologic durability, local employment and quality of life remain untapped.

It is precisely the objective of the Value Chain Generator (VCG), developed during the AlpLinkBioEco project under the lead of the Institute of Complex Systems (iCoSys) at the School of Engineering and Architecture of Fribourg, to provide a hands-on, data-driven approach to overcome existing information gaps and to unearth unexploited business opportunities for bio-based value chains. The VCG, presented in further detail in the next section, is a software tool based on natural language algorithms allowing to match actors from a knowledge base into value chains. The VCG knowledge base can be understood as a set of descriptive data ("descriptors") containing information on individual actors dealing with bio-based activities and how they create value (input – process – output), on the business opportunities that link them to other actors, and on their complementarities in larger chains of value creation. The VCG methods, the algorithms applicable to the data of the knowledge base, allow to learn from successful existing value creation processes, to scale up business opportunities and adapt them to new contexts, to discover value chains and expand them through similarities and complementarities between economic actors.

[5] Michael Porter (2011). On Competition. Harvard Business Press.

To sum up, the VCG is a tool designed to embed the shift from fossil-fuel-based to bio-based economies into a context of shared value creation, to overcome information gaps and to unearth business opportunities for the generation and expansion of bio-based value chains. In short, it is a contribution to making the bioeconomy work.

1.2. The VCG Tool – Knowledge Base and Methods

Andreas Fischer[1], Michael Keller[2]

The value chain generator (VCG) is a novel software tool that aims to facilitate the discovery of value chains among actors in the bio-based economy of the Alpine Region. The primary users of the VCG are the stakeholders of innovation ecosystems, companies, researchers, policymakers, but also cluster managers who want to innovate new value chains in collaboration with the actors of their cluster. Both intra-regional as well as cross-regional value chains can be envisaged if data is shared among several cluster managers, as it was the case during

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[2] AlpLinkBioEco Lead Partner, Plastics Innovation Competence Center, University of Applied Sciences and Arts Western Switzerland - School of Engineering and Architecture of Fribourg (HES-SO//FR HEIA-FR)

Discover the AlpLinkBioEco Value Chain Generator

The VCG Software Tool
https://alplinkbioeco.tic.heia-fr.ch/

Web-based Demo VCG

A web-based demonstrator version of the software gives interested parties an insight into the functionalities of the tool, based on the knowledge base built up during the AlpLinkBioEco project. The demo version allows to access all entries of the database in an anonymized format. No real actor names are disclosed and map entries have been relocated randomly. A practical user guide explains the functionalities of the tool.

Personalized Access and Live Version

Until at least April 2023, the live version of the web-based software tool will be hosted by the Institute of Complex Systems at the School of Engineering and Architecture of Fribourg (iCoSys). Project Partners can continue to use the software and expand the database with a personalized access. New users are invited to join the venture with own data. Each user group has access to its own data in the database. Proprietary data of other user groups is anonymized. Nevertheless, all entries of the database indicate the user owning the respective data, in order to facilitate the generation of value chains across regions and clusters.

Source Code

The source code of the VCG software is available under a permissive software license.

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the AlpLinkBioEco project.
In the following, we describe the required knowledge base of the VCG, elaborate the methods used for generating new value chains and provide a conclusion and outlook to future work.

The VCG Knowledge Base

In order to create value chains, the VCG requires data about the actors in the bio-based economy. Figure **1.1** illustrates the data used for the proposed method in the form of a pyramid, reflecting the decreasing amount of available data when going from the bottom to the top of the pyramid.

At the "Actors" level, the knowledge base contains publicly available information about the actors, including their name, address, website, type (SME, large enterprise, research organization, …), categories (agro, chemistry, packaging, wood, …), as well as several NACE codes. The NACE codes (Nomenclature des Activités Économiques dans la Communauté Européenne) are a European industry standard to describe the activity of a company. Each code is accompanied by a brief explanatory phrase. Typically, only one NACE code is assigned to a company at the time of its formation. For providing the VCG with more detailed information, we have assigned several NACE codes to an actor to reflect different business activities known to the users.

In addition, the knowledge base also contains entries on clusters - groups of connected companies co-locating within a geographic area, and organized in some sort of formal effort (cluster initiative, regional network, etc.) – relevant for the bio-based economy.

The "Descriptors" level contains expert knowledge about the activities of an actor in the form of natural language, i.e. phrases that do not follow a standardized codification, such as NACE, but instead allow experts to use their own vocabulary to describe what inputs an actor receives, how they are processed, and what outputs are produced. An example of a descriptor is provided in Figure **1.2.**

Finally, the "Biolinks" level contains concrete links between two actors. What holds value chains together is an indeterminate number of such bilateral interactions between actors ("biolinks") based on shared business opportunities. Biolinks thus reflect business opportunities between two actors, typically based on the output of an actor that can be used as an input for another. The knowledge base allows to document biolinks ranging from simple ideas for potential new business opportunities to established and proven economic interactions between two actors of the knowledge base. In between these two extremes, it allows to record progress and follow-up actions that have been observed while

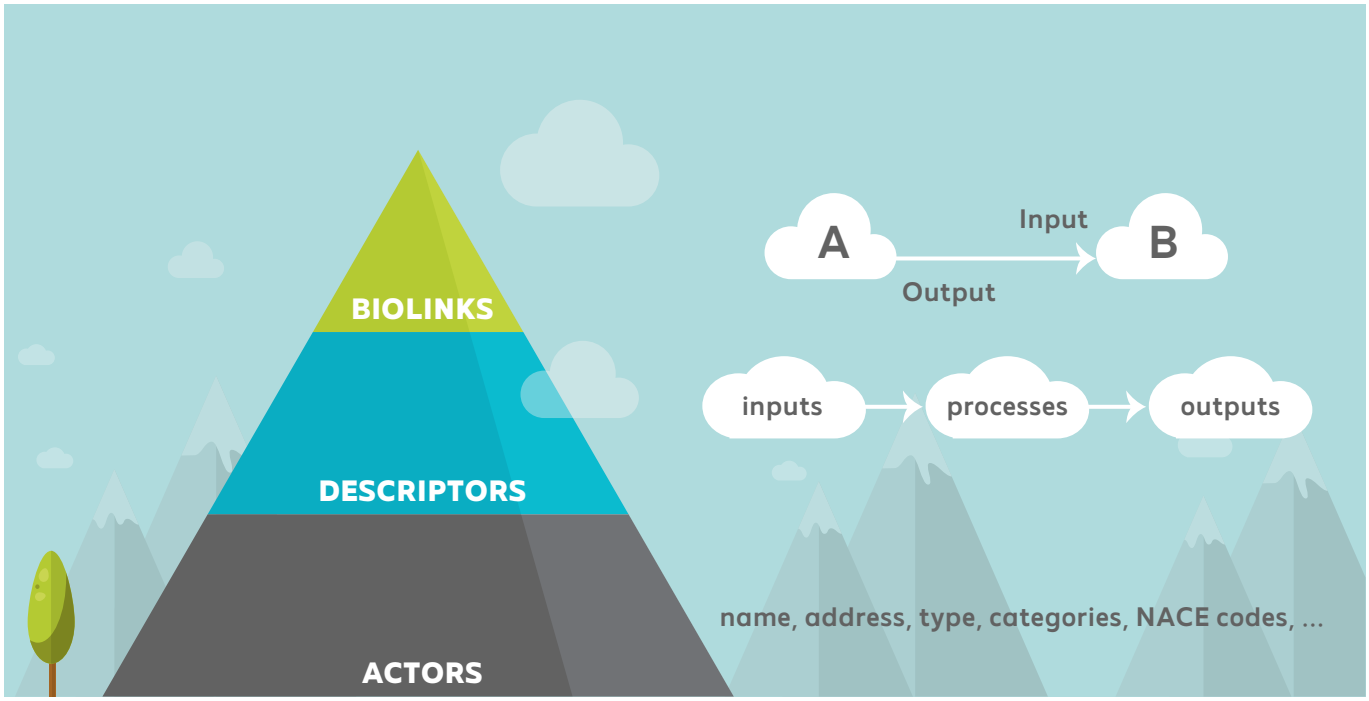

Figure 1.1: The VCG data pyramid

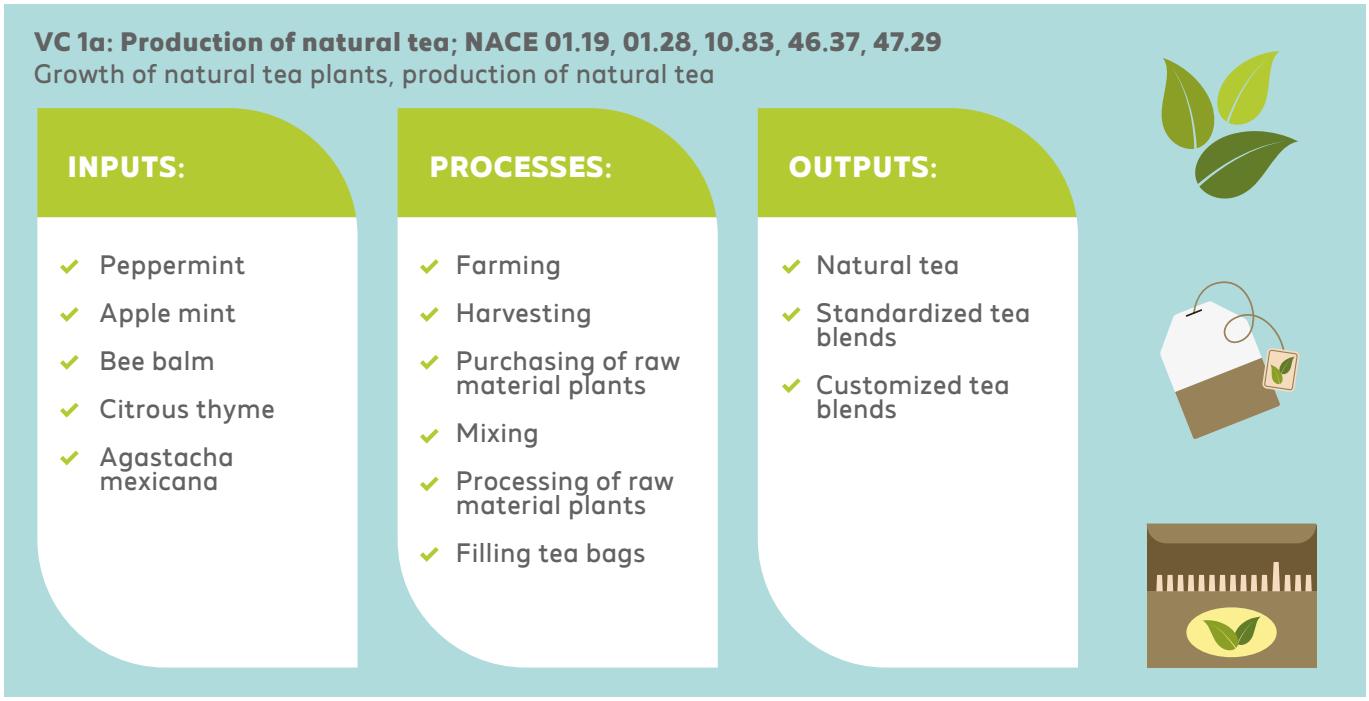

Figure 1.2: Input-Process-Output descriptor of an actor using natural language

working on a particular biolink in the real world.[3] In practice, business opportunities can prove to be technologically and economically feasible and be validated as a commercial success. But they can also turn out to be completely unsuccessful, or, mid-way, lead to necessary adaptions of a base idea that is confirmed in principle but requires additional actions to lead to value creation.

[3] Chapter 2 of this publication gives an insight into the real-world experience triggered by the development of the VCG software during the implementation of the AlpLinkBioEco project.

The VCG Methods

At the most basic level, the VCG knowledge base can be browsed with different search options to discover and get inspiration from the data gathered in the knowledge base. The lists of actors and clusters are available both in a standard list and interactive map view. The biolink lists allow to browse the documented biolinks, ranging from

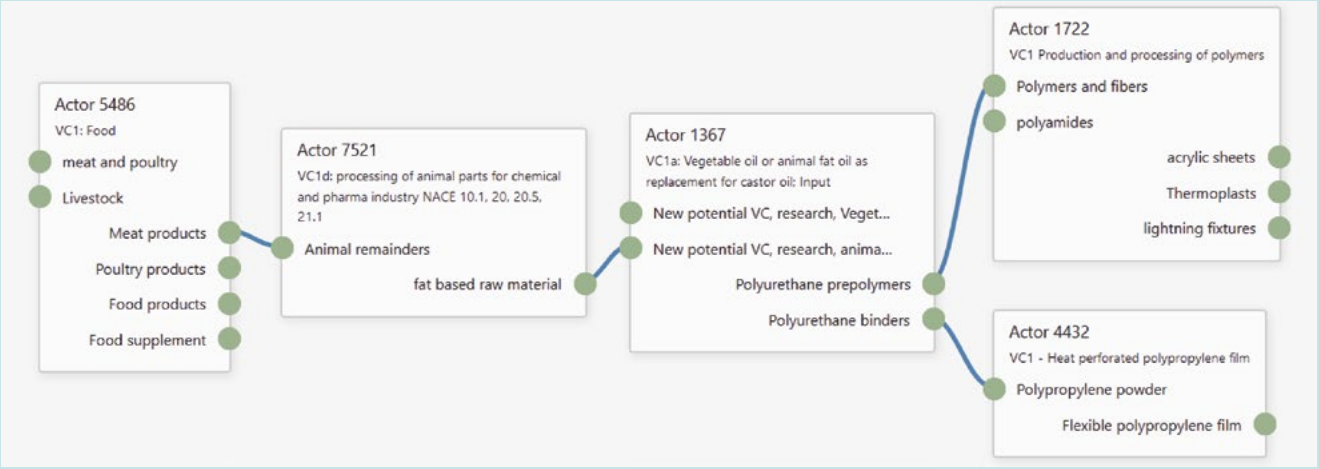

Figure 1.3: VCG interface for creating and editing new value chains

ideas for new business opportunities to confirmed business cases. The biolink lists also include a direct access to the identification of similar actors for which the documented business opportunities might be relevant as well, and that could contribute to scale up the underlying value creation process (see details below).

At a more elaborate level, the VCG provides a graphical user interface for creating and editing value chains in the form of graphs, as illustrated in Figure **1.3.**

The nodes of a value chain graph are descriptors from the knowledge base, which have been created for specific actors. Note that the actor names are anonymized in Figure 1.3 for demonstration purposes. The edges of the value chain graph are biolinks based on matching inputs and outputs.

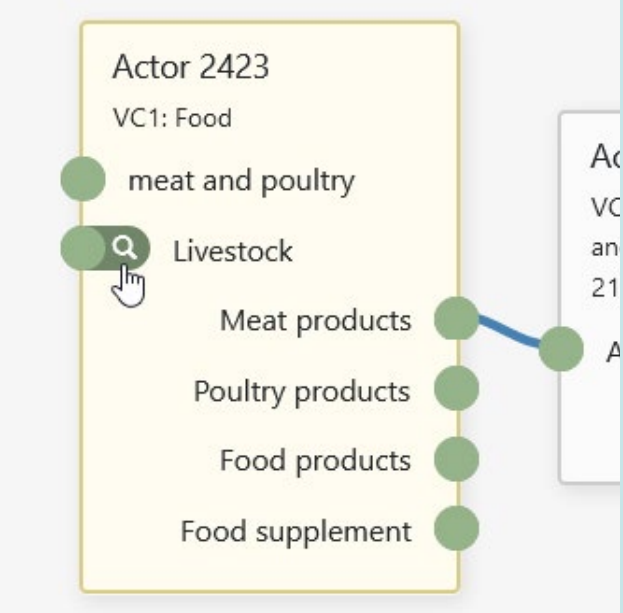

Figure 1.4: Search for new biolinks

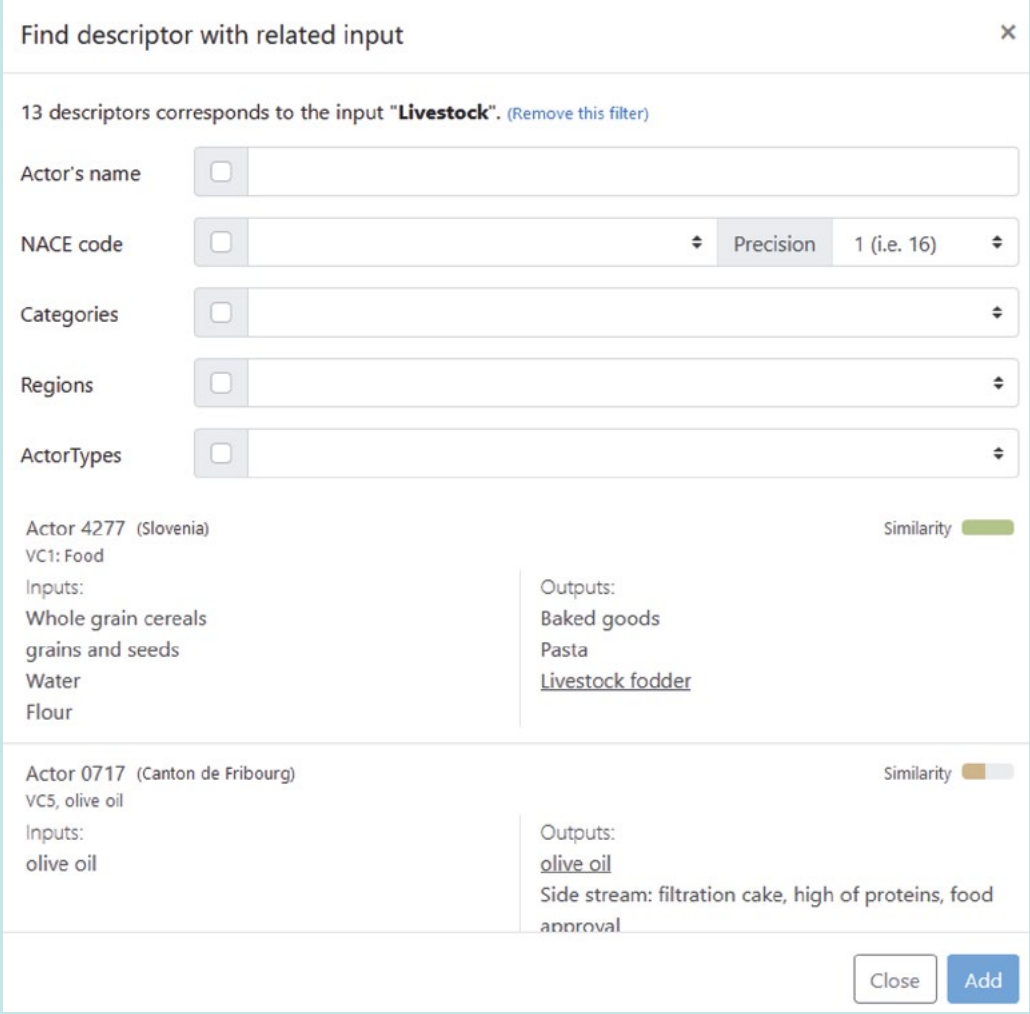

Figure 1.5: Proposed biolinks sorted by textual similarity

A value chain is a series of complementary activities of economic actors. Actors process inputs into outputs, used in turn by other actors as inputs for additional processes. The VCG interface allows to generate value chains in two steps.

In the first step, the user can expand a value chain horizontally by discovering new biolinks - links between two actors with matching outputs and inputs – and adding ever more actors to the chain. When clicking on an input or an output, a search is performed that identifies matching outputs for an input, or matching inputs for an output. This is illustrated in Figures **1.4 and 1.5.**

The search interface lists potentially matching descriptors, sorted according to their similarity with the input or output the user is looking for. Taking into account the fact that descriptors are created using natural language, the similarity reflects a knowledge base.

In the second step, the user can expand a value chain vertically, scaling up biolink ideas so to speak, by finding actors that are similar to those already

Figure 1.6: Search for similar actors

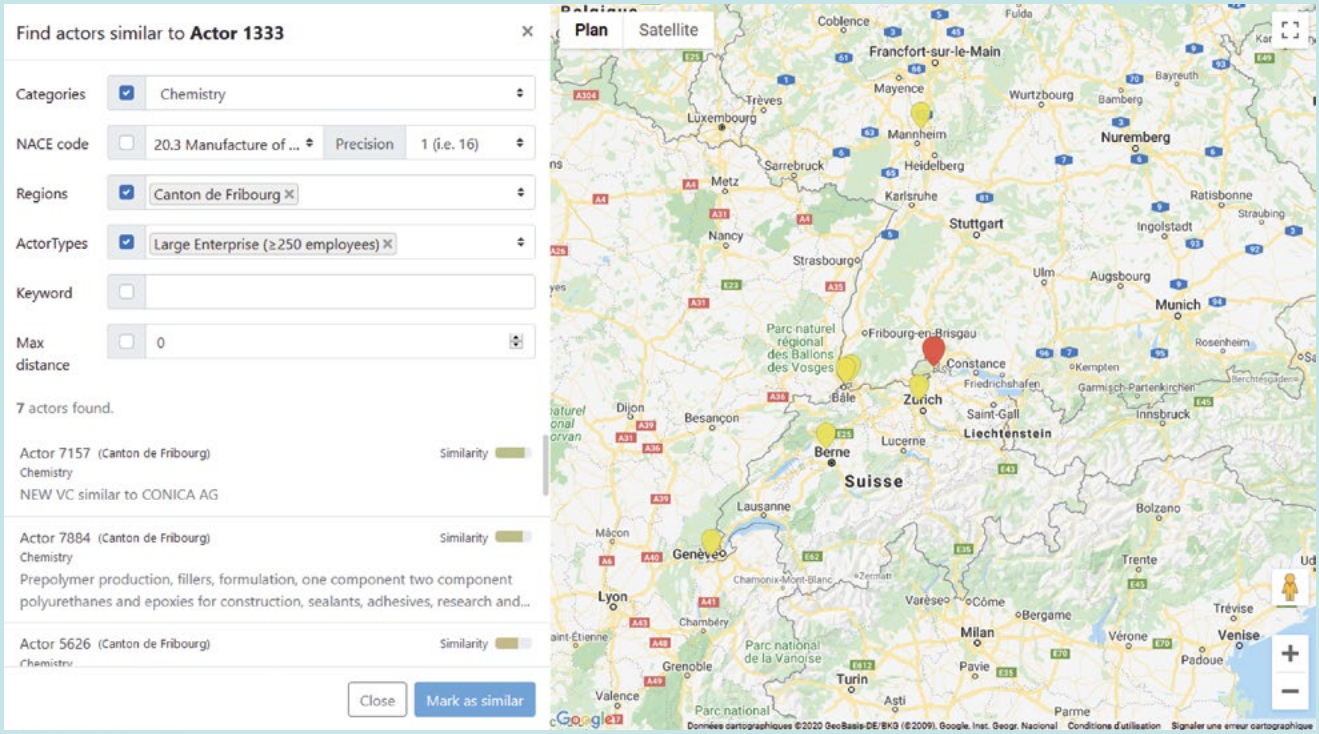

Figure 1.7: Proposed actors sorted by NACE and descriptor similarity

fuzzy match between the terms, e.g. stemming from slight differences in the terminology or typos in the text. Several filters are provided to narrow down the search results, e.g. by NACE codes. By clicking on "Add", a descriptor can be linked and added as a new node to the value chain. Biolinks discovered in this way can be added to the biolink list of the

added to a chain. When clicking on a descriptor, a search is performed to find alternatives that are similar to the actor of the descriptor. This is illustrated in Figures **1.6 and 1.7.**

The alternative actors are sorted by similarity. In the VCG, we define the actor similarity as the sum

of the NACE similarity and the descriptor similarity. The NACE similarity is the intersection over union (Jaccard index) of the two sets of NACE codes and the descriptor similarity is cosine similarity between the term frequency vectors of the descriptor texts. The alternatives are displayed on a map and several filters are provided to narrow down the search, e.g. by means of geographical distance. A particularly useful filter is the "keyword search" that does not only include texts in the knowledge base but also searches for keywords on the website of the actor. By clicking on "Mark as similar", the actor is added as an alternative to the node of the value chain graph as illustrated in Figure **1.8.** The functionalities of the similarity search are also directly available in the biolink list of the knowledge base.

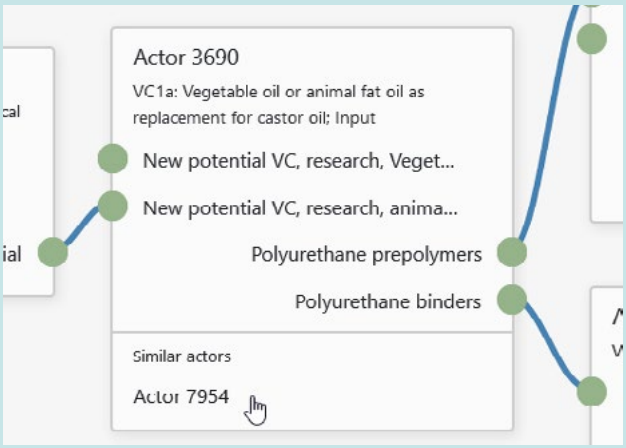

Figure 1.8: Similar actors added to a node of the value chain

Outlook

By using horizontal and vertical expansion, the VCG allows the generation of complex value chains, both intra- and cross-regionally, including several actors that may implement concrete business opportunities. During the AlpLinkBioEco project, several bio-based value chains were indeed successfully initiated in the geographic context of the Alpine Space and based on the specific data gathered during the project on relevant actors related to wood-based and agro-based industries, packaging and chemistry (see chapter 2).

Over and above that, the VCG is a general tool for building value chains that can also be applied to other domains, e.g. to the context of circular economy more broadly, and other geographical contexts by changing its knowledge base. There are also several promising ways of further improvement of the VCG methods themselves. For instance, it would be interesting to automatically add actors of a specific region to the knowledge base by means of an intelligent web search. Also, the similarity search between inputs and outputs could be improved by implementing semantic similarity measures in addition to the textual similarity. Finally, an automatic translation or multi-lingual search capabilities would be helpful to apply the VCG in a larger context.

It is hoped that clusters, companies and researchers from different regions and backgrounds will team up in the future to exchange data and generate value chains with the help of the VCG software application.

CHAPTER 2

"The Pilot Experience – Business Opportunities in Practice"

2.1. Defying the Pandemic – Business Opportunities: From Ideas to Action

2.2. Case Studies – Biolink Piloting Sessions in the Partner Regions

Interreg
Alpine Space

EUROPEAN UNION

AlpLinkBioEco

European Regional Development Fund

2.1. Defying the Pandemic – Business Opportunities: From Ideas to Action

Michael Keller[1], Dorian Wessely and Ashna Mudaffer[2]

The Value Chain Generator was designed as a hands-on, data-driven approach to unearth unexploited business opportunities for bio-based value chains in the framework of the Interreg project AlpLinkBioEco. Its development during the project was characterized by a continuous interplay between conceptual and practical work. On the one hand, project partners teamed up with their stakeholders and trawled the Alpine Space in search of bioeconomy actors and clusters to populate the knowledge base. On the other hand, new functionalities were added to the software on a regular basis.

In spring 2020, the growing knowledge base and the prototype software allowed to enter the piloting phase of the project and to start applying the VCG in practice. The collected data (descriptors) helped to identify existing interactions based on input and output flows between bio-relevant actors. At the core of the model, concrete ideas for mutually beneficial collaborations between actors were documented as business opportunities in the form of biolinks (see Chapter 1.2). Documented biolinks served as the starting point and inspiration for a cross-fertilizing reflection by other users of the VCG tool. Can bio-based inputs replace fossil-fuel-based ones in existing production processes? Can residual outputs and waste streams of actors from the knowledge base become inputs for new innovative bio-based business models? Can an opportunity that works in a neighboring region be implemented at home? Can concrete actors be identified to move from ideas to action? Can suppliers or buyers from overseas be replaced by local alternatives?

Such complex questions have been addressed by the AlpLinkBioEco partnership with the support of the VCG tool. Its newly developed functionalities have allowed to browse the ever-expanding knowledge base in two dimensions, to scale up the seed of business opportunities by growing branches and roots: horizontally to match complementary inputs with outputs, and vertically, to add alternatives to identified ideas and actors. The value of a business opportunity in real-life however, whether it can commercially succeed in a complex value system made up of technological, ecological and economical parameters, is ultimately and at the empirical level, a question of experience.

Under the lead of Business Upper Austria, the AlpLinkBioEco partners therefore used the piloting phase of the project to take the developed ideas to a real-world setting and confront concrete actors with identified business opportunities. A series of piloting sessions was organized to deepen the reflection and discuss the feasibility of bio-based value chain ideas from a technical, economic and ecological perspective. The frail biolink plants grown under the shelter of the VCG tool were sent out to confront the rough climate of the business world.

And the climate of the year 2020 was not only turbulent, it was tempestuous. The piloting phase of the AlpLinkBioEco project coincided with the outbreak of the COVID-19 pandemic. The participants of the planned piloting sessions – companies, SMEs, cluster managers, researchers, technical experts - came under the strain of the harsh sanitary restrictions and the dim outlook of a slow economic recovery across the partner regions. In times when companies are craving for a return to business as usual, the enthusiasm for innovative new business opportunities can rapidly become a call in the desert. For a project with a focus on cross-regional innovation cooperation, the situation was particularly challenging. The possibility to meet in person, to discuss, debate, convince, to experience innovation with all the senses, to see things with one's own eyes, to touch, handle, manipulate… all of this was dearly missed in the attempt of turning ideas into action and opportunity into value creation.

The year 2020 was definitively different than expected. Hours were spent in front of laptops, enormous energy put into organizing interactive web-meetings, colleagues' living rooms lost all their secrets, and a general feeling of exhaustion became common place. Unexpected developments, radical consequences and a mountain of challenges –

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[2] Business Upper Austria

what was formerly euphemized as the perfect opportunity for innovation suddenly lost much of its appeal, buried under piles of unscheduled tasks, hours spent online and a growing longing for social interactions.

On the bright side however, the opportunities for innovation were not just talk. The pandemic triggered inventiveness and adaption to change in ways that will have longstanding positive impacts on innovation cooperation across borders. In complicated situations, the value of cooperation increases drastically. Against the backdrop of a complicated external environment, the AlpLinkBioEco partnership proved to be adaptive, creative and solidary in engaging its stakeholders into piloting sessions on bio-based business opportunities, ceaselessly creating new ideas and opportunities for cross-regional cooperation.

Throughout the summer and autumn of 2020, the project partners have indeed been able to take the developed biolink ideas to the (virtual) field and use the VCG knowledge base and software to initiate real-world business opportunities with companies across the Alpine Space. Real-world actors could be convinced to use the opportunity of piloting sessions as a possibility to elaborate on new ecologically acceptable processes and product lines and an opportunity to associate and network with other actors and interest groups from the bio-based industry. Encouragingly, many of the participating actors were SMEs, whose availability was initially feared to be less likely since, even without the complicated sanitary situation, their daily core business is often characterized by a workforce who has to slip into many roles simultaneously.

The organization of the piloting sessions was paralleled by coaching support from Business Upper Austria and the AlpLinkBioEco Advisory Board. The sessions intended to unite key actors from the VCG knowledge base and served as a platform to pitch biolink ideas as concrete business opportunities. Project partners prepared their role in the piloting sessions in a series of virtual coaching meetings organized to jointly discuss and discover ways and strategies to approach the relevant actors with a biolink idea from an economic, ecological and technological perspective. The piloting sessions were not designed as a one-off occasion, but as the starting point for an ongoing discussion of bio-based business opportunities within a network of relevant stakeholders. Table 1 gives a general overview on the conducted piloting sessions. In the next section, a series of case studies presents the experience from the participating regions in further detail.

Overall, the outcome of the piloting sessions was encouraging. Naturally, some of the identified business opportunities turned out to be illusional or at least difficult to implement under the given circumstances. On the whole however, many interesting approaches have been generated with a promising outlook for successful implementation, both intra- and cross-regionally, by a network of actors that could be continuously enlarged throughout the project. The pilot experience with the VCG tool can certainly be considered a positive signal for future developments of meaningful and sustainable bio-based value chains in the Alpine Space.

TOPIC	INVOLVED REGIONS	RESULT
Wood-based biorefinery - sawdust and wood chips as basis for chemical intermediates.	Trentino, Bavaria, Upper Austria, South Tyrol.	Further investigations are planned within a more detailed feasibility study related to the forest-wood chain.
Mushroom cultivation on brewer's Grains Substrate.	Upper Austria.	Technical feasibility confirmed. Funding opportunities identified to support the implementation of the suggested cooperation financially.
From ligno-cellulosic biomaterial and residues from food production to biodegradable or recyclable end products.	Baden-Württemberg.	Technical feasibility confirmed. USP has already been protected as intellectual property.
Replacement of castor oil in polyurethanes	Switzerland.	Specifications and price range of potential replacements for castor oil have been defined in detail in order to be technically and economically feasible.
Cultivation, harvesting, cellulose, extraction, spinning, knitting or weaving of hemp fabrics.	South Tyrol, Upper Austria	Best practices and existing examples identified. Technical feasibility for small production capacities confirmed.
Biopolymers from viticultural waste for fashion, design and automotive sectors.	Lombardy.	Technical feasibility confirmed. Logistical considerations on the procurement of the raw material addressed.
Antioxidants from wine derivatives for cosmetics products.	Trentino.	Commercially successful example. Can be used as an example for other regions.
Miscanthus in the building industry.	Lombardy.	Further research and tests should be carried out to verify technical and economic feasibility.
Biorefinery from wet dredges of aromatic plants.	Provence-Alpes-Côte d'Azur, Lombardy.	Real potential for a cross-regional cooperation confirmed. Interested actors identified.
Valorization of bird feathers.	Auvergne-Rhône-Alpes.	Interest confirmed. Price range of the by-product proved to be prohibitive for further discussions.
By-products of the paper industry for high-value consumer goods.	Bavaria.	Set-up of a joint R&D project on the topic, including a start-up company and a multinational group in consumer products.
Keratin from chicken plumage for bio-based plastics.	Switzerland.	Applied R&D project for scale-up under way.
Technology for extraction of algal biomass from wastewater.	Slovenia.	The described value chain is technically feasible and there are ongoing pilots to increase economies of scale and support small farmers to enter this value chain successfully,

Table 1: Piloting Sessions within the AlpLinkBioEco project, 2020.

2.2. Case Studies – Biolink Piloting Sessions in the Partner Regions

Dorian Wessely and Ashna Mudaffer[1]

Each AlpLinkBioEco project partner was assigned to conduct at least one piloting session, including as a minimum two identified actors, needed to develop and implement a novel bio-based business opportunity in the Alpine Space. In order to trigger cross-regional cooperation, the consortium was deliberately asked to conduct joint piloting sessions. The sessions were organized in the form of a pitch of new biolink ideas and a discussion of their mutual benefits for the involved parties.

A list of questions was prepared by Business Upper Austria as a pre-defined guideline for the efficient and professional conduction of the individual piloting sessions. The sessions targeted the four focus sectors of the AlpLinkBioEco project and the objective was to conduct at least one demonstrator per sector: wood-based input substrates or residuals, agro-based input substrates or residuals, packaging solutions for pharmaceuticals, and food and chemistry-based business opportunities. Overall, 12 piloting sessions have been concluded and documented by the project partners and a series of additional ones initiated. Detailed documentation on the organization and results is available in a dedicated report,[2] as well as in a series of videos on the project's Youtube channel.[3]

The following case studies give an insight into the process and outcomes of the partners' work with their stakeholders.

CASE STUDY 1

https://www.youtube.com/watch?v=h6lzT78M0Rg

Wood-based Biorefinery - Sawdust and Wood Chips as Basis for Chemical Intermediates

Manuela Romagnoli[4], Elisabeth Rieger[5], Elisa Morganti[6], Pasqualina Sacco[7], Dorian Wessely.

Involved Project Partners
PP5 – Centro Studi Alpino Pieve Tesino (University of Tuscia)
PP14 – Chemie-Cluster Bayern GmbH
PP8 – Hub Innovazione Trentino
PP15 – Fraunhofer Italia Research Scarl

Due to the lack of active companies in this Bioeconomy field, as well as to the very limiting Covid-19 conditions, the piloting session was organized and conducted jointly online by four project partners The Piloting sessions were repeated at Regional level in Trentino to test the true feasibility and establish the new bio-based value chain.

Involved Actors
LXP Group (Specialized in lignocellulose disruption)
Autonomous Province of Trento – Forestry and Wildlife Department
Italian Ministry of Agriculture, Food and Forestry, Directorate General of Forestry
Chamber of Commerce of Trento
Confindustria Trento

[1] Business Upper Austria

[2] https://www.alpine-space.eu/projects/alplinkbioeco/en/project-results/demonstration-of-vcs-by-implementing-pilot-actions

[3] https://www.youtube.com/channel/UCWOknu-43q4Q4YI1PfRQnEQ

[4] CSALP University of Tuscia

[5] Chemie-Cluster Bayern GmbH

[6] Hub Innovazione Trentino

[7] Fraunhofer Italia Research Scarl

Background

The developed biolink idea and the associated piloting session were based on the fact that up to now the concept and process of wood cascade use have not been developed completely to exploit fully high added value chains. Actually, most of the residues from forest-wood chain are used for bioenergy purposes and, sometimes for particle/fiber-based panels. Lignocellulose should be considered from an additional point of view as it provides a wide range of basic platform chemicals and/or new generation bio-nanocomposites, after disruption into its constituent parts.

The use of wood waste does not compete with other classic uses of the wood industry and might become a solution, at least, for the first steps of the primary forest production chain. Actually, part of wood residues from forest harvesting are left at the site to enrich soil of organic matter and thus contributing also to increase biodiversity. The remaining residues are not often ready to be used even for bioenergy because of their high rate of moist content. The quantity of lignocellulosic residues from sawmills and from other wood industries (2nd generation biomass) is remarkable, when they are not contaminated by other synthetic compounds, they are more suitable because of less moist and lower content of impurities. Lignocellulosic exploitation of such material, in the perspective of a biorefinery concept, could result in a further bio-based carbon stock in the obtained products, hence replace fossil-based compounds. Furthermore, it might increase the economic value, thus creating new job opportunities in the rural territories. Indeed, biorefinery value chains, if accurately planned, do not generate conflicts of use, preserving good practices also in bioenergy or in other type of wood industries. The long-established and now well-developed technologies of oil refineries have led to new insights, thus leading to the concept of sustainable "green" biorefineries which have been extended also to lignocellulosic feedstock. Nowadays, some products from "green" biorefineries are considered quite competitive and the market is ready to include them. The involvement of political decision-makers to further accelerate bioeconomy, is crucial to increase the awareness on the new opportunities, to create financial tools and dedicated resources, to promote development of a more bio-based industry especially linking rural to urban area, introducing new potential synergies and a sustainable diversification in productive value chains. The concept of biorefinery applied to the forest sector, in this pilot session, fits the "bioeconomy change scenario" where the same input is to produce diverse every day products (Morland and Schier, 2020).

Purpose of the piloting session was to connect stakeholders from forestry sector and local industries from Italy with the LXP Group. The company has developed an interesting technology for separation of high-purity lignin and cellulose from 2nd generation lignocellulosic biomass. LXP products (lignin and cellulose) are different from those obtained by a pulp and paper-mill industry and since they show different characteristics, new application options of direct products can be pursued. Additionally, carbohydrates resulting from holocellulose are suitable to be transformed into chemical intermediates as succinic acid, levulinic acid, furfural, ethanol, while lignin can produce high value vanillin.

Process

The piloting session focused on the reuse of wood chips and sawdust from forest harvesting and/or sawmills, considered as the main building blocks of the lignocellulosic biomass lignin, cellulose, hemicellulose, to be used directly or to be manufactured into other products.

Traditional biorefinery in this field is related to the process of pulp extraction, associated from long tradition to the paper industry. Paper industries indeed, adopt well known and consolidated processes (such as Kraft and sulphite processes) applied to high amounts of wood biomass supply (mainly conifers but also hardwoods), in order to obtain cellulose for their end-use (paper). Lignin, which is the residue of the pulp and paper industry (lignosulfonate in sulphite process), can be used for energy or as additive for (i.e.) fertilizers, however, from this process, high added value products such as vanillin, cannot be obtained.

New generation biorefineries are trying to consider more "green solvents" and pre-treatments that include also microbiological organisms, to separate cellulose from lignin. New generation biorefineries

allow a wider selection of feedstock (not only from tree species commonly used in pulp and paper industry). They consider the original properties of biomass, use milder processes and do not require a high supply of feedstock. Bioeconomy aims, in this sector, at obtaining dissolved lignocellulose as raw material for production of lignocellulose-based derivatives and regenerated ligno-cellulosic fibers. The process of LXP can be summarized in the following steps (Schroedter et al., 2020; https://lxp-group.com/)

- Feedstock: LXP group can use different types of 2nd generation biomass residues including wood (forest materials), agricultural residues, grass, macro-algae, bio-waste also from municipalities and fermentation residues.
- Process: Biomass (2nd generation) is cracked under mild process conditions at temperatures below 80 °C and atmospheric pressure (about 70 °C and 1 atm) with phosphoric acid. Afterwards, cellulose precipitates by the use of a precipitation agent resulting in LX cellulose which is the solid matter remained after washing. This LX cellulose contains a higher percentage of cellulose and a lower concentration of hemicellulose.
- From the supernatant from the cellulose precipitation, the lignin is extracted by means of a solid/liquid separation and obtained in a suspension. After distillation, the solid LX-lignin is obtained. The distillate and the washing solutions are further purified. Subsequently, hemicellulose and ash are received, as well as phosphoric acid and the precipitation agent which can be further recovered and reused in the process.

After separation, lignin and cellulosic components can be further converted to high added value products biochemicals, biofuels and biomaterials: e.g. hexoses (sugars with six carbon atoms), can be used for intermediates such as PHA (for bioplastic), succinic acid (in food and dietary supplement, precursor in polymers and resins also in tissue engineering applications) while biofuel is produced by fermentation leading to bioethanol etc. Pentoses (sugars with five carbon (i.e. xylose)) on the other hand are the building blocks for powerful solvents (levulinic acid, furfural etc.) (Stafford et al., 2019; Chandel et al., 2018). Cellulose can also be used as nanocomposite and as reinforcing agent of fossil-based material (Siqueira et al., 2010; Kluge et al., 2017). Lignin, due to its aromatic character, has been proved to be a successful material for some raising applications such as natural binder (Marini et al., 2020) or promising coating (Zikeli et al., 2020), or other derivates (Vinardell and Mitjans, 2017).
Moreover, from the fermentation of feedstock, LXP produces also biogas or "bio-based" energy.

Results

All the involved actors of the piloting session committed to strengthen the research and investigate the technical, economic and environmental feasibility, of the envisaged biolink, in a macroregional perspective.
Strengths of the biolink. There are some advantages to use lignocellulosic feedstock from the forest-wood chain because wood chips and sawdust are available all-year round compared to agricultural waste. Another advantage is the size of the plant because LXP group technology is capable to process from 500 t (pilot plant) up to 25 k tons (industrial plant) of lignocellulosic biomass per year. The pilot session focused on the use of sawdust and woodchips from forests and sawmills, commonly utilized to produce energy. The amount of raw feedstock produced by the actors of the whole forest-wood (considering Trentino and South Tyrol) chain, reasonably exceed the needs to run the plant of biorefinery, as that described by LXP. Therefore, it does not generate any conflict with other parallel uses of biomass for bioenergy plants (DHP plants and wood panels). The LXP owners declare a high versatility of the plant because they can change the feedstock to be processed quite frequently, shifting from forest residuals to agricultural waste. Furthermore, the disposal of uncontaminated municipal waste could also become a resource while currently it is often rewarded with a disposal fee. Lignocellulosic biorefineries are expected to create additional job opportunities, especially in rural areas, since they will allow the developing of more branched value chains with positive impacts on the economic efficiency of the process.
Points to be clarified. Further investigations are planned within a more detailed feasibility study related to the forest-wood chain.
Some issues are related to the organization of the value chain, because, to some extent, the process requires provision of dry biomass. The processing of bio-based chemicals, and derived products, is very demanding and depends on several factors related

also to the heterogeneity of processed biomass which need to be investigated. According to the process developed by the LXP group, it is crucial to involve biotechnologists and chemists to optimize and to study the different steps of (bio)conversion after dissolving lignocellulose biomass.

In a perspective of macroregional management, different types of cooperation can be envisaged:

- **Possibility to use biomass produced in different regions to be transformed by the LXP plant, actually located in Bavaria.** From this point of view, there are some environmental, economic and maybe political concerns that must be further investigated and not underestimated. Thus, this option doesn't seem to be a so obvious and viable perspective.
- **Small-medium sized plants such as the LXP plant, might be promoted as a promising technology to be imported to strengthen cooperation on improving forest-based value chains in other regions of the Alpine area.**
- **Promotion of partnerships with companies and industries involved in biotechnology, coatings, adhesives, textile, paint, plastics, cosmetics and biofuel to test and use the biobased products of the LX Process (cellulose and lignin) by LXP group.**

During the study, participants became aware that the biorefineries and their products can only be supported if primary producers and industrial associations work together. Participants expect that consumers of these biorefinery products would accept also higher prices due to a more bio-based process.

The policy makers and stakeholders, invited to the pilot session realized an interesting new opportunity that could potentially provide value also to excesses of biomass caused, for example, to unexpected stressing climatic events (such as strong windstorms).

Biorefineries can be considered similar to petrochemical refineries and produce fuels, power, heat and other value-added chemicals and materials from biomass. The forest sector is becoming aware about the new potentialities. The ongoing COVID-19 pandemic is showing the importance to be, as much as possible, self-sufficient in our bioresources and production. The synergy in all the steps of this envisaged value chain and the new generation biorefineries can contribute to reach the goal.

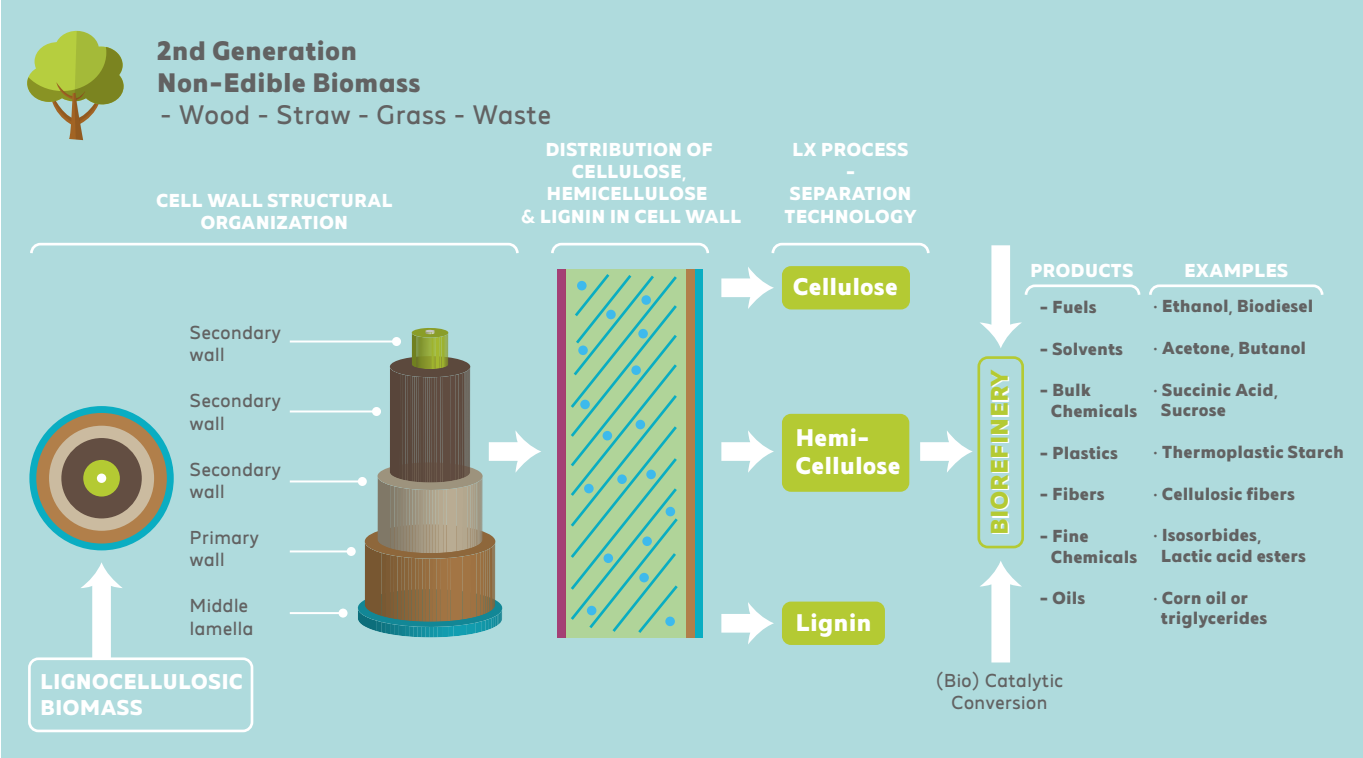

Figure 2.1: Discussed Biorefinery Process

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CASE STUDY 2

https://www.youtube.com/watch?v=Dg-IHKiK_ql

Mushroom Cultivation on Brewer's Grains Substrate

Dorian Wessely and Ashna Mudaffer[8]

Involved Project Partners
PP2 (Business Upper Austria)

Involved Actors
Brau Union AG
Mosberger Pilzmanufaktur

Background
The master brewer of the reintroduced "Linzer Bier" has turned to the Cleantech Cluster of the Business Upper Austria. He wants to implement sustainable recycling possibilities for the sidestream of spent grains in the brewing process, as part of the brewery which will be rebuilt in Linz next year. A local mushroom grower, in the immediate vicinity of the brewery, has been identified after the first meeting with the Brau Union AG, via AlpLinkBioEco - Value Chain Generator. Other ways of spent grains'- utilization (e.g. biogas production) were also considered, but they were not suitable, due to the brewery's rather urban location with local residents and available infrastructure in the surrounding area and above all lacking throughput quantities. Consequently, the cultivation of mushrooms on a specially produced nutrient-rich spent grains substrate, was selected as most promising solution in the sense of a bio-based circular economy

[8] Business Upper Austria

combined with regional value chain management, as the mushrooms can be sold in the restaurant of the brewery. A regional value-added process enables a sustainable and environmentally friendly product with an outstanding ecological balance. The spent grains for the future Linzer Bier, are characterized by a very high moisture content and a low preservability. Due to their high nutrient content, spent grains are mainly used as animal feed. However, there are still many applications such as in cosmetics or the food industry. The fact that 95% of the fresh mushrooms in the region are imported in combination with a detailed analysis of the market situation, supported the decision of the master brewer to pursue mushroom growing as a viable option.

Market and competition - industry analysis:
In Austria, about 1,200 tons of mushrooms are produced annually. An import of about 21,000 tons and an export of 2,200 tons results in a domestic use of about 20,000 tons with a per capita consumption of 2.2 kg and a self-sufficiency rate of 6%. In Asia, annual per capita consumption is around 20 kg. The mushrooms available in Austria come mainly from industrialized production systems in the Netherlands, Poland, Hungary and Italy as well as the Asian region. Regional products from agricultural production are only available seasonally and in small quantities. A breakdown of quantities by individual mushroom species is not available for the Austrian market. Therefore, the statistical bases of Germany and Switzerland are used for the sector analysis. In Germany, about 80,000 tons of mushrooms are produced, of which 76,000 tons of mushrooms (95 percent), 1,600 tons of herb seitlings (2 percent), 700 tons of oyster seitlings (0.9 percent), 850 tons of shitakes (1 percent), and 150 tons of other mushroom species).7 In Switzerland, about 7,800 tons of mushrooms, 137 tons of oyster seitlings and 76 tons of shitakes are produced.

Process
Research activities in advance and an additional exchange with the farm manager of Mosberger, was the basis for the planned process of recycling spent grains of beer for mushroom cultivation. A substrate must be produced that is inoculated with nutrients from the spent grains, that must be interspersed with fungal hyphae before the actual fruiting body can form on the enriched substrate. In addition, the limited storability of the spent grains must be considered. The Mosberger company currently uses purchased bio-certificated mushroom substrate, which uses wood wool as a carrier material. For the production of the substrate it was also considered to use lignocellulose waste from wood processing enterprises, as carrier material for the mushroom substrate. Following parameters have a decisive

Figure 2.2: Spent Brewer's Grains

influence on fungal growth and must be considered when producing the substrate:

- Ingredients (Carbon/Nitrogen - ratio)
- pH value
- Water content
- Microbiology

After a few weeks, the mushrooms have reached the required size and can be harvested. These can either be further processed or offered in raw form at the Mosberger mushroom factory and - prepared as dish - in the brewery's restaurant. Important conclusions for an end-of-life management of the consumed and harvested mushroom substrate were also gained, namely again as animal feed due to following advantages/assumptions regarding the leftover mushroom substrate:

- Polysaccharides are converted into proteins due to the higher content of amino acids
- High crude fibre content
- Positive effects on the microbiology of the digestive tract of the animals may occur
- Mycotherapy

Results

During the piloting session, the research results were discussed once more together, in order to draw conclusions on the feasibility of the biolink, which has been inserted in the database beforehand. The general technical feasibility, was supported by several scientific sources, that are listed in the corresponding piloting session document, which can be found in a dedicated report[9]. In general, both actors agreed on the fact that with an annual production of 6 500 hectoliters with a volume of 150 to 200 cubic meters of spent grains, sufficient input material for the production process is available, because beer is crafted all year round and mushrooms are cultivated under strictly regulated conditions without the influence of weather and climate. Regarding logistical considerations, the brewery's close proximity to the raw material suppliers offers advantages. Also, the mushroom cultivation would be installed within the brewery. This, combined with added value through the production of high-quality food, should ensure a positive return on investment. According to the current state of knowledge, no conflicts of use should arise, due to the availability of the required quantity of spent grains for further utilization possibilities. Competition for land must be ruled out in any case. It was announced that the residual flow would be split up into several recycling options. A small portion could also be taken by bakeries or meat producing companies without limiting the productivity of mushroom production.

No fossil input materials are substituted, but residual materials are used - in the sense of a bio-based circular economy. The recycling scenarios currently being considered are associated with investment costs. An amortization of the costs can be expected by the revenues of additional products from the residual material spent grains. High-quality, regional and resource-efficient spent grains products can be offered and consumed on site at the brewery - as well as at Mosberger. This is regarded as added value from a marketing point of view, which could also possibly -after a cost analysis- justify an increased sales price. Mosberger could face additional costs due to a production process adapted to the new substrate. Investment costs will be caused by the purchase of necessary machines and equipment. If indeed, higher prices for the mushrooms on beer grains should be needed, in order to be able to ensure a cost coverage, one assumes that an adapted marketing with consciousness development and product traceability, will encourage the consumer to buy. In addition, it is expected that the frugality of the mushrooms will lead to increased resource efficiency in the production process, which will result in overall cost reduction. From a circular economy, social and waste-hierarchical point of view, it makes sense to use the materials in the value chain under consideration. An energetic utilization of the spent grains (biogas production) is not a priority option in the sense of a cascading utilization of the residues, as this makes nutrient recycling more difficult. Due to the urban location of the brewery, disturbing odour emissions would have to be expected caused by the fermentation process of a connected biogas plant, that would not be tolerated by the citizen. In addition, it is currently not clear whether the necessary throughput rates for an economical biogas operation can be achieved that would legitimate investments. Thus, it is expected that the material use of this residual flow will be

[9] https://www.alpine-space.eu/projects/alplinkbioeco/en/project-results/demonstration-of-vcs-by-implementing-pilot-actions

economically advantageous for both actors.

In a further step, the possible occurrence of competition was discussed. Since according to market analysis, 95% of the fresh mushrooms are imported and the beer sales in Austria are going well, a good market positioning is predicted for the planned (overall) value chain.

Furthermore, the sale of additionally manufactured products could create new jobs while creating a new division of business. Three funding schemes have been identified to support the implementation of the suggested biolink financially. On the one hand, a cluster cooperation project, which is to be seen as an innovation stimulus program of the federal province of Upper Austria, offers a financing opportunity. On the other hand, there are also suitable funding schemes from the Austrian Research Promotion Agency (FFG) and the Kommunal Public Consulting that support production processes that make use of renewable resources. Finally, the discussion about legal limitations revealed a hurdle that could make the implementation of the biolink more difficult. The beer of the Brau Union AG is produced with conventional raw materials, that are not certified organic, quite the opposite of the mushroom assortment currently produced by Mosberger. However, there is no reason why a further non-bio certified, conventional production line should not be established for the project.

CASE STUDY 3

https://www.youtube.com/watch?v=gTqqyGqWTYQ

From Ligno-Cellulosic Biomaterial and Residues from Food Production to Biodegradable or Recyclable End Products

Janet Rosenberger and Udo Eckloff[10]

Involved Project Partners
PP9 (Technologiezentrum Horb)
PP7 (BIOPRO Baden-Württemberg GmbH)

Involved Actors
Carbonauten GmbH
Sonac
Daring ingredients
Plastics Innovation Competence Centre
Hochschule Aalen
SKZ Würzburg
Arburg GmbH & Co. Kg
Storopack Hans Reichenecker GmbH

Background
Industrial wood waste (pallets, masts etc.) and municipal green waste can often not be used sustainably due to contamination, separation or collection difficulties. While green waste from communities often ends up in composter plants, which allow for recycling, wood waste and bulky waste are mainly incinerated. Therefore, pyrolysis was considered as a thermal conversion technology to ensure the material use of the aforementioned waste for packaging applications. Positive aspects, which are pursued through the envisaged value

[10] Technologiezentrum Horb

chain, in terms of a bio-based and sustainable circular economy are described below.

Carbonauten GmbH is able to pyrolyze the residual biomass as input with a comparably low CO2-footprint, combined with a thermal energy as output producing a low-cost biochar that creates a long-term carbon sink by withdrawing the carbon from the natural cycle. Sonac produces medical and food gelatine and has a lot of technical products coming from animal-based biomass (bones, blood, skins) – where they find marginal technical use.

Process

The tree scientific link partners - Hochschule Aalen, the Plastics Innovation Competence Center and SKZ Würzburg - are specialized institutions for plastics processing with large experience in compounding. Arburg is one of the main producers of injection molding machines, taking fabrication process of bio-based material into deeper account.

Storopack Hans Reichenecker GmbH produces all types of packaging material based on celluloses, special customized technical products and expanded polystyrene (EPS) products for manufacturing and for the production of heat and impact resistant packaging solutions with little environmental impacts. Thus, the company shows interest in offering a compostable, biodegradable, bio-based packaging product for end-users.

The value chain is already in the execution phase, as the mentioned actors develop two different product lines jointly. The value chain of one scope uses PLA as a bio-based binding matrix, whereas the other production line focuses on animal-based proteins. The research institutes develop manufacturing processes for material, which are initially tested in

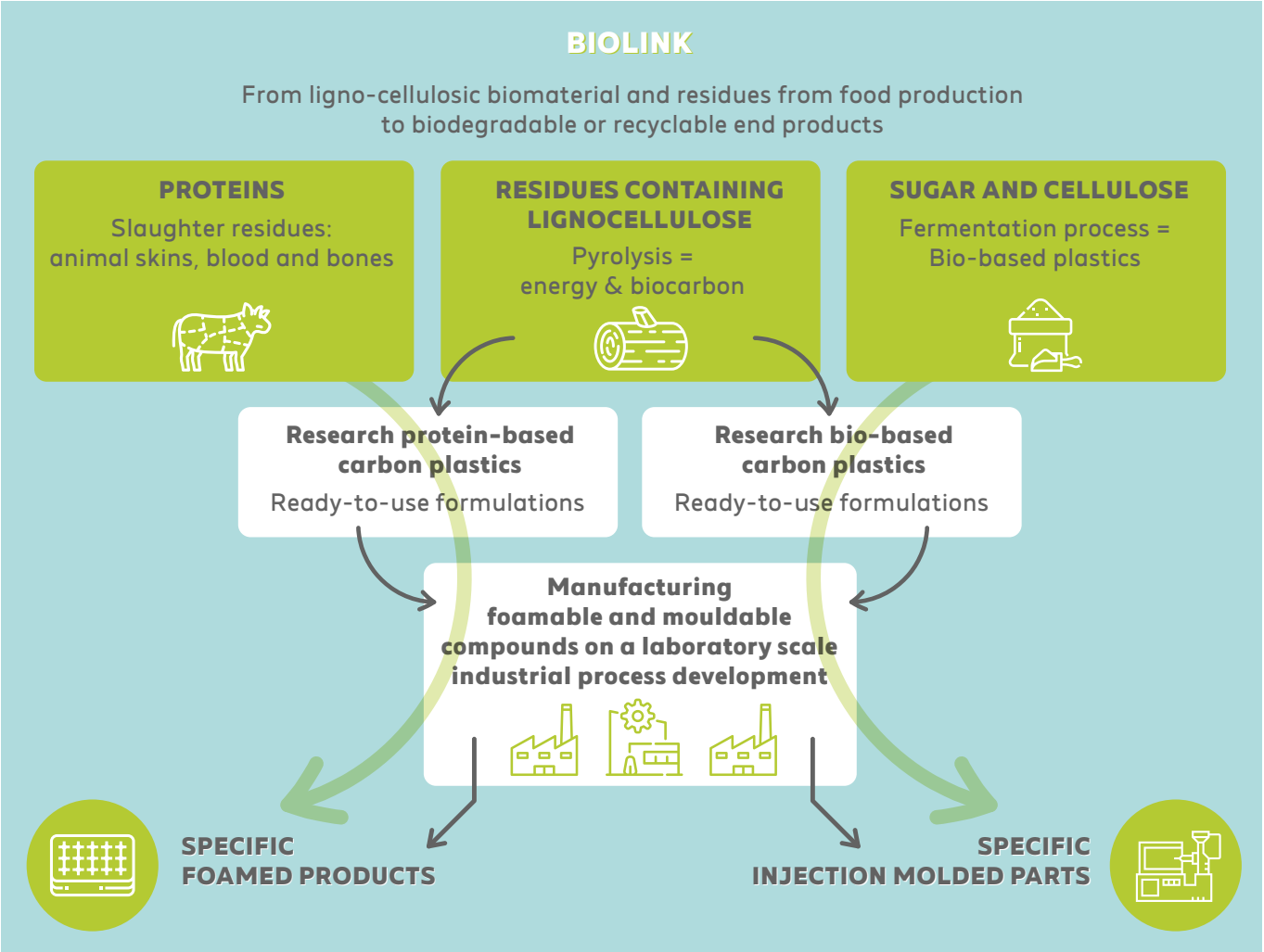

Figure 2.3: Visualization of the proposed cascading value chain as combination of several biolinks

research laboratories. Subsequently, cost-effective manufacturing processes for specific products are developed in the laboratories of the industrial partners. This is followed by industrial upscaling for series products and the development of sales strategies.

Results

The technical feasibility is confirmed by all participants. This is also evident in the commitment to discussions and interaction as well as in the provision of test materials and instruments. The value chain and the expected end products cannot replace the existing plastics for technological and price related reasons. Instead, the special properties and positive environmental impacts open up niche markets that will expand the current product range. With regard to biomass for biochar, no quantitative bottlenecks are expected. As far as proteins are concerned, the use of gelatine for medical technology and food, as well as for haemoglobin and bones, competes with the production of animal feed. However, a significant bottleneck due to the new value chain is not seen in this segment either.

All starting and intermediate products, namely polylactide acid (PLA), proteins, biochar, foam or molding compounds, finished parts, are storable goods. The minimum production quantities are mainly determined by the processing parameters. Conversion and set-up costs are the most decisive factors in the process. For the production of the compounds, extruders are used which should produce at least 10 tons in one run, in order to be able to work economically. The same applies to the manufacture of the end products using both foaming and injection molding processes. Here, too, the changeover and set-up costs as well as the cycle times and the price of the end products are key factors. In both processes, at least 1 tons of material is required to work efficiently. The capacity utilization of the pyrolysis plant of Carbonauten GmbH is flexible due to the modular design. Approximately 13 tons of biomaterial are required daily, all-year round. The volume of biomaterials used in the value chain is not exposed to seasonal fluctuations, thus seasonal shortages or price fluctuations are not to be expected.

PLA as a raw material can be provided by retailers in different qualities and applied according to the requirements of the final product. Proteins are produced in large-scale industrial plants while the technical gelatines and haemoglobins used may be varied only slightly in their material parameters by the manufacturer. However, the necessary processing parameters in the compounding process can be easily achieved by temperature control, drying or moistening.

Growth in demand for the raw materials -proteins and biochar- is expected to increase as both materials are processed into higher-value products. Today's compounding production process is comparable to technically sophisticated processing of plastics with glass fibres or other fillers. Higher costs can only be expected in connection with the cooling unit, which can have a negative effect on the cost of the granulate. In the processing of PLA into biochar-based plastics, the cost per part is currently similar to that of glass fibre reinforced plastics. The processing of the protein compounds, as solid or foam, will probably be somewhat more complex, as longer cycle times and other foaming agents must be expected. Due to the activated carbon sink resulting from the removal of carbon from the natural decomposition process, the comparatively easy recyclability of the solid plastic parts and the fact that they can be composted at home, the minimally higher prices can easily be argued for the end consumer. If necessary, the possible higher production costs can also be compensated by CO2 - certificates.

In terms of logistics, the only modification is the transport of the biomass to the pyrolysis plant. By placing the small, decentralized systems near the biomass production points, transport costs are minimized. All other products in the value chain can be easily integrated into the existing logistics processes and do not cause higher costs there, especially since existing and reliable logistics processes are used.

When processing PLA, it is essential that the biomass needed to produce this raw material does not conflict with food production. The cultivation of sugar beets, maize, potatoes or the use of palm oil production residues are the main targets of public criticism, as land is used for the production of technical products which urgently need to be available for food in the future. Regarding the

supply of proteins from slaughterhouse waste, there is a growing socio-political pressure on consumers to eat less meat, as this behaviour leads to increasing environmental pollution. The material uses of slaughterhouse waste (in accordance with the precautionary principle) should generally be promoted in the sense of a bio-based and resource-efficient circular economy. Currently, there are applications for all raw materials.

Proteins from slaughterhouse waste are used for example in pet food and niche products (e.g. glue). Biochar or charcoal is used in industrial processes (coke, power stations, etc.) or as barbecue coal. Special applications such as activated carbon, feed additives, use in biogas plants and sewage sludge, but also as a carrier component for organic and inorganic fertilizers to improve soil conditions (terra preta).
All areas of application depend on respective national legislations. The so-called soot is needed in various branches of industry (tyre production, colourants). It is industrially produced from petroleum, although both its production and use give rise to environmental concerns. For technical reasons, however, the requirements for carbon black are usually extremely high and a fluctuating material such as wood often does not achieve the required parameters. It is possible that future process developments could produce a material which could then also be used in these areas.
With respect to the economic feasibility of this biolink, involved partners are of the opinion that, under certain conditions, it makes economic sense to switch to bio-based plastics from fossil-based plastics. Among the main factors that contradict economic aspects are the expected material and process costs. Proteins are available at comparable petroleum-based plastic prices.

As it is assumed that lower greenhouse gas emissions are to be expected, CO2-certificates are a decisive factor in reducing the possibly leading process costs. An exact calculation in the form of a Life Cycle Cost Analysis, including existing value chains of all partners considered and end consumers involved, would show the actual environmental influence of the whole system. Additional resources for industry and more cost-effective waste disposal for the user could lead to further acceptance.

Cost-effective and environmentally friendly carbonisation with the Carbonauten system creates a new filling material for known and new binding matrices. This opens up new product properties and areas of application which definitely lead to an economically advantageous evaluation. The involved actors and project partners assume that the permanently cheap raw materials and the moderate increase in process costs will enable higher selling prices due to the increased product benefit. All participants of the piloting session agreed on the necessity to appeal to the conscience of society supported by politics in the form of laws and regulations in order to make a positive impact on the profitability of bio-based innovations on the long-run. However, in the medium term, we assume that a higher price is feasible for consumers.

The prerequisites for using mentioned input materials are sufficient availability, adequate material prices and certifiable process reliability. The filler carbon with the binding matrix proteins or PLA are largely unexplored, which has been shown by corresponding patent research. Certainly, there will be additional costs, in the opinion of the biolink partners, mainly in the area of process development. On the contrary, if one considers the receipt of disposal fees, a recycling/upgrading of waste and side streams makes perfect sense. Residual materials are usually available in relatively large quantities that must be returned to the material cycle using appropriate process technology to ensure a sustainable and future-oriented waste- and resource management.

The overarching goal should be to implement structures and processes that make it possible to catch up with the development progress of the short-sighted fossil-based products with competitive bio-based goods, without suffering an economic and technical disadvantage. There are scientific institutions such as IfBB and Thünen Institute that develop the corresponding processes together with partners of the industry. There is no doubt among the participants that a cascading use of resources is the superior goal of a sustainable economy, if an energetic use is the alternative. The utilization of biomass with processes mentioned, will compete with conventional petroleum-based products. Resulting pressure on market competition will become obvious after positive technical and economic results of a joint project that has already

been planned by participating parties, including first patent applications, which have been prepared with regard to material and processing, as part of an envisaged of a patent forest. This is an attempt to keep market competition in check until appropriate production quantities are achieved. Additionally, the general opinion is the following: active political support and committed business action will accelerate the cascading use and reintegration of materials towards a circular economy and thus lead eventually to economic success on the long term.

The market for products based on biochar, proteins from animal wastes or PLA is very large in theory. Nevertheless, Styrofoam in applications such as greenhouses, reforestation, packaging cannot be replaced by the considered value chain. However, it is already possible to penetrate niches in the areas mentioned and secure market shares there. It is therefore agreed that a USP defensively exists, which has already been protected as intellectual property.

The respective biolink would take over parts of the existing production, thus hardly any new jobs are created in industrial applications. In the procurement of materials for the carbonation process and in the production of biochar, however, a large number of new jobs can be created, especially in the agricultural and forestry sectors, which give both unqualified employees and technically and economically qualified specialists the opportunity to find employment. With regard to government financing and subsidies or grants to support the biolink depend on size, turnover, number of employees and are therefore very heterogeneous in the Europe-wide context. For the specific participating companies, research is underway on The Central Innovation Programme for small and medium-sized enterprises (ZIM), Horizon 2021 and fiscal research allowance.

CASE STUDY 4

https://www.youtube.com/watch?v=WJfocB6_7Lg

Replacement of Castor Oil in Polyurethanes

Dorian Wessely, Ashna Mudaffer[11], Ulrich Daum[12] and Michael Keller[13]

Involved Project Partners
LP - Plastics Innovation Competence Center

Involved Actors
Conica
Centravo

Note
We use generic company names throughout this case study. A list with complete company names can be found at the end of the case study.

Background
Polyurethanes (PU or PUR) are extremely versatile polymers which are formed by the reaction of two components: Di- or polyisocyanates and di- or polyalcohols react in a poly-addition reaction to form the characteristic urethane group as shown in figure 4 below. The choice of the two components, i.e. the use of more rigid or flexible chemical base structures for isocyanates and alcohols, results in an

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[12] Chairman of the AlpLinkBioEco Advisory Board, UetlibergPartners GmbH

[13] AlpLinkBioEco Lead Partner, Plastics Innovation Competence Center, University of Applied Sciences and Arts Western Switzerland - School of Engineering and Architecture of Fribourg (HES-SO//FR HEIA-FR)

extremely wide range of possible combinations. In addition, the functionality of the two components can be two or more, so that linear, slightly branched or three-dimensionally cross-linked polyurethanes can be produced. As a result, meltable and thermoset polyurethanes which can be soft and rubber-like or hard and brittle can be produced (Beck et al., 1993; Adam et al., 2005; R. Leppkes,. 2005; J. Cowie., 1991; L. Shen., 2009;).

Chances		
Regional source		Low transportation cost, lower CO2 footprint from transportation, short delivery times lead to low inventory and ease order to needs
		Reduction of land consumption for plantations in the tropics
		Reduced dependency on variations in harvest and seasonality in case animal based replacement can be found
		Increased security of supply and predictability of cost
Challenges		
Specifications		Physical properties need to be close; especially the viscosity needs to be between 100 – 400 mPa*s
		Chemical properties need to be close; especially the number of functional groups per molecule needs to be above 2 and below 4
		Specifications must be reproducible and below 5% variation
Reformulation		The mix of components within the formulation needs to be adjusted, leading to reformulation costs; the closer the replacement to castor oil, the lower the cost and the shorter the testing time
Cost		Needs to be in the range of castor oil or slightly higher
Supply		Security of supply needs to be given all year round
		Quantities of several 100 tons/year for every mid-sized player are needed. Big players will need several thousand tons/year

Table 2.1. Chances and challenges replacing polyalcohols (castor oil) in a polyurethane formulation

Table 2.1 shows, chances and challenges to be considered when components are to be changed in this value chain. Thus, the idea came up, to replace mostly imported bio-based castor oil with a (residual) animal-based fat or oil. It is crucial that the substitute features similar physical properties as the initial component castor oil, to replace it like a drop-in chemical. Some of these properties are listed below and needed to be examined and discussed in detail within the piloting session:

- Viscosity
- Water content
- Clear liquid
- Low acid content
- UV-stability
- OH-group-content
- Functionality
- Flammability
- Availability
- Reproduce-able specifications

The more the properties are comparable, the easier it is to reformulate and to mix the two components needed to produce polyurethanes. The considered animal fat / oil -source is a side stream of slaughterhouses, which is collected and processed. Consequently, it can be stated that in this envisaged value chain, a bio-based, mainly imported raw material is replaced by a regionally available animal oil or fat. Thus, any additional higher value application then e.g. bio-diesel out of this side stream of slaughterhouses, is beneficial for the society. Figure 2.4 shows the two mentioned molecular components, as a basis for the forming of the polyurethane polymer, e.g. a foam (Figure 2.5).

Process

Medium-sized formulators such as Conica (SIKA, Huntsman) of two-component polyurethanes buy isocyanates from isocyanate suppliers, which are mainly large conglomerates such as BASF and DOW. Consequently, they are either mixed or chemically partly converted into so called prepolymers, depending on the needs and requirements of the process to produce the final polyurethane and the product itself. In either case, component A contains isocyanate (-NCO) groups. Furthermore, they buy polyolyalcohols mostly from the same suppliers or from importers. These represent the second component B. A polyalcohol that is used in many 2-component polyurethane formulations, is castor oil which is imported from the tropics. All different polyolyalcohols from a specific formulation are mixed and sometimes additives, fillers, dyes etc. are added. In any case, component B contains in minimum 2 alcohol groups (-OH) per molecule in average. Components A and B are sold to processors who mix and process the components. After mixing/casting, the chemical reaction between isocyanate and alcohol groups forms the final polyurethane, in most cases a soft or hard rubber-like product.

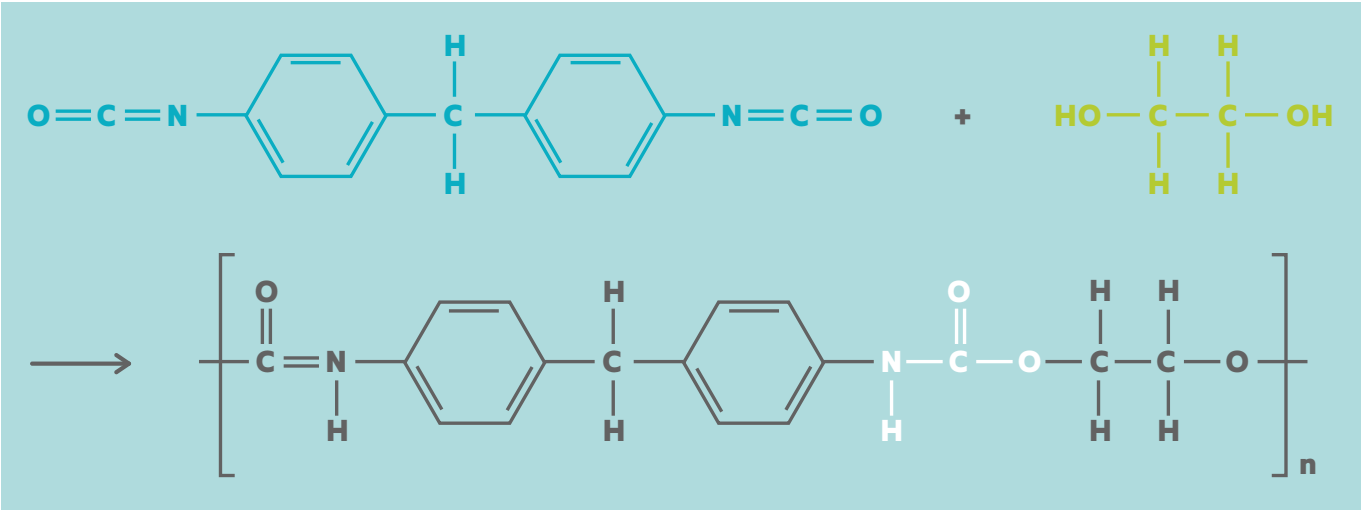

Figure 2.4:
Production of polyurethanes with the characteristic urethane group from diisocyanates such as diphenylmethane diisocyanate (or polyisocyanates) and dialcohols such as ethanediol (or polyalcohols)

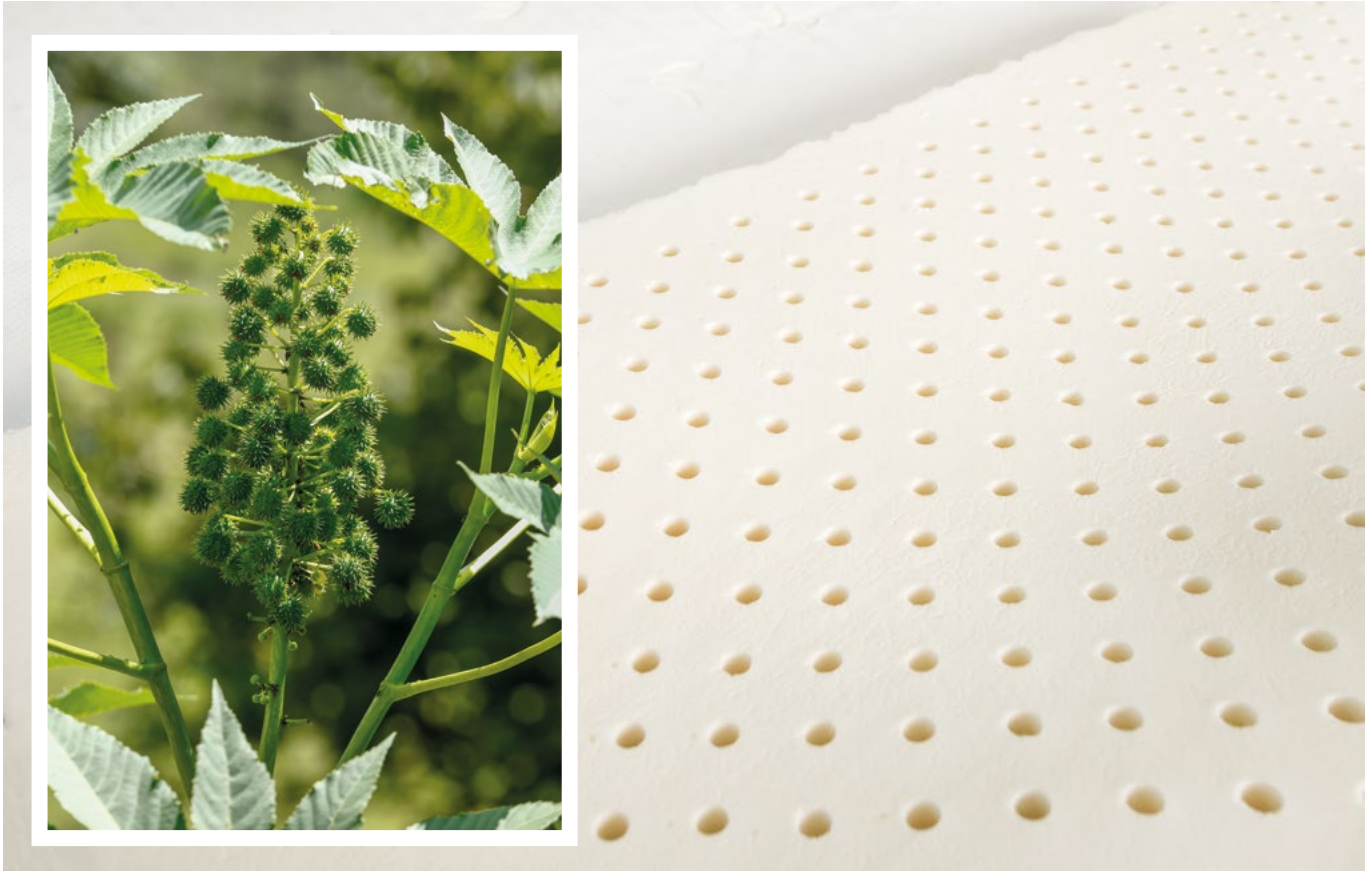

Figure 2.5: Mattress foam with 24% biogenic content from castor oil. Courtesy of BASF Polyurethanes GmbH

Results

The workshop took place in May 2020 between Centravo and Conica. Samples and specifications were exchanged. The specifications of castor oil and the price range of castor oil need to be met by a replacement (close to drop-in), to be technical and economical feasible. The discussion on the technical parameters that are important in order to use the substitute effectively led to the following ranges:

- Viscosity between 100-500 mPa*s
- Functionality between 2,5-4 (average number of OH - groups per molecule)
- Reproduce-able specifications; variation below 5%,
- Availability above 300 tons per year, all-year round
- Cost range 0.5-1 CHF per kg

The fat or oil from slaughterhouse waste is available in quantities above 500 tons per year without seasonal fluctuations. The quantity reported should be sufficient for a medium-sized player. If the project can be transferred to other actors, quantities must be substantially higher and in the range of several thousand tons per year. Due to the independence of the envisaged substitute from imports, which is not depending on harvest conditions, typical for castor oil, an improved or in minimum more stable profitability should be achieved.

There is no doubt among the parties involved, that in case higher added value chains can be found for animal-based oils / fats there will be conflicts of interest regarding available volumes with impact on pricing, consequently.

Since there are other vegetable oils - apart from the already used castor oil - there would still be bio-based alternatives to the animal based one in consideration, but they would have to be analyzed more closely in order to ensure an optimal drop-in replacement. These were identified in the initial scientific research. The discussion showed that plant oils show lower viscosity in general then animal fats- or oils. Low cost- or high-volume products are rape seed oil or sunflower seed oil, which are

both regionally available. The functionality rsp. the average number of OH groups per molecule or the potential to chemically convert other functional groups into OH groups of both needs to be evaluated though, according to the parameters mentioned above.
It is generally assumed that customers will accept a higher price if security of supply and an improved cost predictability can justify a slightly increased pricing. However, there is an existing market for animal-based fats and oils, in case they work as drop-in chemicals for polyurethanes, which are massively demanded in a wide variety of applications. Formulations for polyurethanes based on animal oils or fats and processing may need to be adapted. This depends on the exact specifications of the substitute and the product. It is therefore imperative that the new formulations are tested. In further consequence, this will lead to expenses that will have to be covered as an additional cost, which have an important impact on the profitability of polyurethane-chemistry. Raw materials cover typically between 15-60% of the costs of the final product turnover. Following features of the biolink are generally considered as Unique Selling Proposition (USP):

- Regional supply
- Ecological responsibility, as there is no need to cultivate reforested areas
- Less transportation (-costs) and thus less greenhouse gas emissions
- Higher added value for the producer of animal-based fats and oils, as side-stream of slaughterhouses

Since it is envisaged that the components used will be directly substituted (drop-in chemicals) and therefore existing production processes would be altered only marginally, it is assumed that no additional jobs can be created from the current perspective. To date, no suitable subsidies have been identified to support the implementation of biolinks. No legal hurdles are expected to impede implementation.
Finally, it turned out that the viscosity of the animal fat was too high to be used in this application for a simple drop in solution. Otherwise, the project could easily have been transferred to other 2-component polyurethane formulators such as SIKA, Huntsman, etc.

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Company List

BASF: BASF SE, Ludwigshafen, Germany
Centravo: Centravo Holding AG, Lyss, Switzerland
Conica: CONICA AG, Schaffhausen, Switzerland
DOW: The Dow Chemical Company, Midland, USA
Huntsman: Huntsman Corporation, Salt Lake City, USA
SIKA: Sika AG, Baar, Switzerland
UetlibergPartners, UetlibergPartners GmbH, Lachen, Switzerland

CASE STUDY 5

https://www.youtube.com/watch?v=_LdcG3zA-r8

Hemp Fabrics

Pasqualina Sacco[14]

Involved Project Partners
PP15 - Fraunhofer Italia Research Scarl
PP2 - Business Upper Austria

Involved Actors
Christine Ladstätter - Salewa Ltd.
Actor Gerald Beck - React Ltd.
Expert Robert Putz - Wood K Plus

Background
Thanks to the activities of the AlpLinkBioEco project we have come into contact with a company that deals with clothing and for years has been following innovative projects linked to the traditions of the territory. In this case, the traditional-innovative idea is to use local hemp in order to produce cloths.
It is significant to understand that hemp has a long and authentic tradition in the Alps, and Italy used to be the leading producer of high-quality industrial hemp. Until the beginning of the last century, industrially produced hemp was common, worldwide a large part of textiles and fabrics were made of hemp fibres. However, economic and political sanctions and restrictions brought hemp production to a virtual standstill. So, in the 1960s, much of the expertise, machinery and skills were transferred to China. Nevertheless, Salewa, a company based in South Tirol, is committed in the long term to a local sustainable economy with the aim of reducing waste and using natural resources. Therefore, they started a project to produce hemp-based cloths. They invest 10% of the revenues from the sale of Alpine Hemp clothing in local hemp cultivation and the regional production and manufacture of sustainable hemp products.
Currently, hemp is cultivated in the Alps, but it is mainly used in construction and nutraceutical, not in textiles; even though, it is known that a production of sustainable textiles from hemp is generally possible. About Austria and Italy, not every region has areas under hemp cultivation. According to current estimates, there is at least enough agricultural land available, depending on the cultivar and its harvest time. Hemp is seasonally available and can be cultivated in the winter season, as well as summer.
In principle, why choosing hemp instead of other fibres? We obtained stimulating answers from Salewa. First, cotton fibre is very impacting due to the chemical intense cultivation techniques that are killing the land. Further, it requires a lot of water which is an essential element in this century. For this reason, several companies are moving towards the use of polyester, which has a lower cost, but it hides other future environmental costs. Our skin is surrounded by synthetic; we live in an unnatural bubble. Instead, hemp is an intelligent material with historic roots, excellent sustainability references and a bright performance. It is by no means a new re-invention: the first woven fabric ever was made of hemp fibres.
Since climbers like to wear natural, comfortable and sustainable clothing, with a high level of breathability and thermal regulation, creating a natural and sustainable fibre as Alpine Hemp was necessary at Salewa.

Process
The qualities of this extraordinary plant are not limited to the characteristics of the fibre, but start from the cultivation. Unlike cotton, in fact, which needs a large number of herbicides to grow healthy and luxuriant, as well as a high amount of water, hemp only needs a soil in which to grow and little water, ensuring full respect for the surrounding environment. The hemp fibre is completely natural, not requiring this plant of chemicals for growth. Finally, hemp fabrics have antibacterial

[14] Fraunhofer Italia Research Scarl

Figure 2.6: Alpine Hemp Collection by Salewa
Salewa / Johannes Mair / Alibaba, Spain / Athlete: Anna Stöhr

and antifungal properties, thus ensuring maximum hygiene and safety even for children.
The discussed Value Chain involves: Cultivation, Harvesting, Cellulose Extraction, Spinning, Knitting or Weaving of the textile including finishing. At the base of hemp fabrics there is the long fiber that is obtained from the plant and which is characterized by a high resistance both to tearing and wear and by the particularity of being cool in summer and keeping warm in winter. For this reason, the use of hemp fabrics guarantees a wide range of uses, both for furnishing fabrics and clothing.
Harvesting starts in summer and takes advantage of the summer heat to facilitate the drying of the plants, which are collected in bundles organized in such a way as to make it easier for the leaves to fall off. The next steps involved a maceration that lasted about a week and, subsequently, the extraction of the fiber that in the past was done mainly with artisan tools but that now opened the doors to specific machinery that guaranteed a much faster extraction. The extracted fiber is further dried, combed and spun. At Salewa, the fabric hemp testing and development at the Alpine Hemp is possible thanks to the second harvest hemp, solving the problem of maceration by drying the collected hemp in vertical piles. In fact, through drying and storage protected from light, the year-round demand can be covered. In addition, for their Alpine Hemp collection, Salewa use complex knitting and weaving techniques to blend hemp with other fibers such as recycled polyester, organic cotton and elastane to achieve enhanced hybrid

functionality. Moreover, they have developed a new and unique elastic ripstop hemp fabric containing recycled polyester and elastane.

Results

The piloting session shows as the Alps are an excellent starting point, an environment spangled with stakeholders interested in discovering the use of this hemp plant. It is necessary to develop a common market to start the Alpine Hemp Cultivation. According to the actors, the monocultures of the South Tyrol should have a limit, tourism and agriculture are two very strong sectors for the economy of the area and they must find their balance to coexisting together. As for hemp, it´s a rotation plant, which enriches the soil, impoverished by monoculture. Interestingly to see how farmers are curious to diversify their cultures with hemp.

Moreover, from a Made in Alps Economy point of view, the use of hemp for fabrics made at Km0 would surely guarantee a further value to the local textile industry. The use of hemp in textiles certainly needs more culture, data and preparation.

Nowadays, consumers are more and more informed and aware of their environmental and social impact. Hemp certainly has all the answers of comfort in terms of fabric performance and sustainability in terms of environmental impact on the land. Currently hemp is a niche product, the change must take place at the political level, and financial support towards a more circular and sustainable economy.

All involved actors agreed on a technical feasibility of the hemp depends on the technical processing as such, which is linked to "major changes" in the production process of common cellulose fibers. In this regard, it would be interesting to create a network and a platform that unites all interested stakeholders to share a common path and create new synergies together.

Figure 2.6: Alpine Hemp Collection by Salewa

Salewa / Daniele Molineris, Storyteller Lab

CASE STUDY 6

https://www.youtube.com/watch?v=iDzca5IpXXw

Biopolymers from viticultural waste for fashion, design and automotive sectors

Fabiana Gatto and Ilaria Re[15]

Involved Project Partners
PP10 - Lombardy Green Chemistry Association

Involved Actors
Castello Bonomi – Tenute in Franciacorta
Vegea Srl

Background
In the context of the AlpLinkBioEco project, PP10 was involved in the management of a specific pilot session involving two Lombard companies to demonstrate the intrinsic potential of the interactive platform. The biolink is based on the production of "Biopolymers from viticultural waste for the fashion, design and automotive sectors". The idea is to use viticultural waste (grape marc, grape skins and stalks) as a starting feedstock for the development of biopolymer for different applications, such as fashion, design, automotive and furniture. For this reason, two actors have been identified and involved in this biolink. The first actor (Castello Bonomi), producer and supplier of this starting feedstock (grape marc, grape skins and stalks), the second actor (Vegea Srl) who extracts and transforms the raw material in new biopolymer. This idea was born mainly for two reasons: to implement the innovative model developed by Vegea Srl that enhances this type of waste to create bio-leather, but above all to minimize the waste of wine processing as Lombardy is one of the leading wine producing regions.

[15] Lombardy Green Chemistry Association

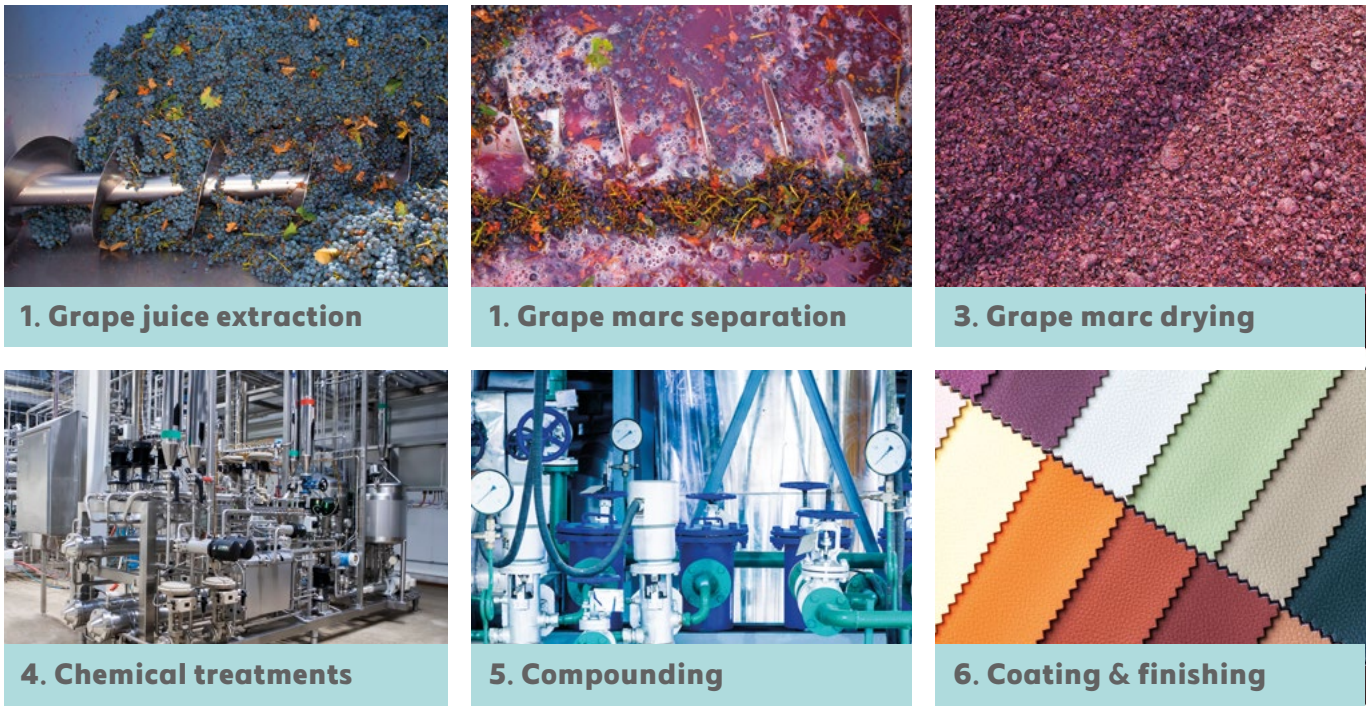


Figure 2.7. Source: Lombardy Green Chemistry Association

Market and competition - industry analysis:

In 2015 global wine industry reached the production of about 32,4million tons/year of wines grape, 20% of which turns into waste: the grape marc (about 6,5 million tons/year), which is the solid waste that remains after crushing the juice from the grapes. It could typically comprise skins, seeds and stalks. The disposal of enormous quantities of grape marc each year presents a considerable challenge for winemakers. From the transformation of the grapes, it is possible to obtain different by-products, including the grape marc. The grape marc used as starting feedstock in this process is constituted of skins (the external envelope of the grape bead) and seeds (seeds which are embedded into the grape bead), with a minimal amount (<2%) of stalks (woody part of the bunch connecting the different beads). Skins contain a high concentration of the sugar-derived compound and free phenolics, while the seed is rich in oil and lignin. This starting feedstock has some important properties that make it usable, such as season availability and not specific materials. Also, viticultural waste holds the same benefits: low-cost feedstock, local availability and sustainable exploitation of waste. Moreover, this type of biomass contains both residues lignocellulose than vegetable oils. Starting from these raw materials, through different processes (extracting technologies, compounding and coating) the idea is to obtain bio-based material that can be used for other products, such as the fashion industry.
The Actor B (Vegea Srl) promoted the diffusion of its model to create new commercial opportunities, identify new potential customers in different sectors (packaging, clothing, automotive) and also to understand better the technical characteristics required for biopolymer in the various applications. The constant demand for eco-friendly and organic biopolymer/bio-leather products is growing and expected to grow in the next years. For this reason, the fashion industry, and not only, tries to use more new cruelty-free or "vegan" textile, generally made with petrochemical polymers, for example, PVC, polyurethane, etc. However, both animal and vegan leather production are highly polluting processes, they diffuse harmful chemicals in the environment, and they heavily affect factory workers health and safety. Consequently, this has led to the development of new biopolymer that addresses environmental and social challenges, such as in this specific demo case.

Process

The research activities conducted in advance by Vegea Srl and a further exchange with the Castello Bonomi wine producer was the basis for the planned process of recycling the grape marc used for biopolymers production. In particular, the piloting session was conducted, taking into consideration the process implemented by Vegea Srl. The process that leads to obtaining a bio-based polymer of plant origin begins with the pressing of the grapes and the extraction of juice and pulp. The residue of the crushing, consisting of the pomace, contains a high concentration of sugars, which comes separated/ recovered from wineries. The grape marc is dried to avoid degradation processes and to ensure the preservation of the material and prevent any significant biological activity. This step is crucial to ensure a constant supply of raw material, not dependent on seasonality. The plant was created to purify the grape marc and transform it into flour, one of the two main components of the final polymer composite coating of the textile. The second essential component was the grapeseed oil used for the production of the polymer. The company Vegea shows a high experience in the development of the process in which to obtain a biopolymer with high mechanical and technical qualities it was necessary to have the right concentration of both oil and marc flour.

The breakdown of the vegetable matrix, which is functional for its use in the subsequent polymerisation process, is carried out through a thermo-hydro-mechanical process with low environmental impact, thanks to which it is possible to extract from vegetable biomass. Following patented chemical and physical treatments, the product is created final by mixing the two principal components, flour and oil from grape seeds. The process, compared to conventional treatments, is based on the limited use of chemicals. The obtained mixture is spread on suitable supports until real sheets are obtained of synthetic leather. The production process is completed with various finishing treatments to get a product with different characteristics of weight, elasticity and colour according to the specific needs of the customer.
There are several benefits and advantages of the bio-based final product, such as:

- quality, comparable with that of the traditional product
- versatility, which allows for tailor-made finishing treatments according to market needs
- use of a renewable raw material deriving from waste
- reduction of the use of chemicals in the manufacturing process, the zeroing of VOC (Volatile Organic Compounds)
- reduction of waste associated with the process; the alternative to the leather of animal origin.

Results

The workshop took place in September 2020 and all involved actors agreed on the technical feasibility of the envisaged biolink. During the piloting session, logistical considerations on the procurement of the raw material were addressed. The disposal of huge quantities of marc every year represents a considerable challenge for wine producers, especially in alpine space and Lombardy region. From the transformation of the grapes, it is possible to obtain different by-products, including the grape marc. It has also been widely discussed that this starting raw material (grape marc) has an affordable price, and it is easy to find. Therefore, it represents an excellent example of a business model that contributes to facilitating the transition from a linear economy to a circular bioeconomy,

For this reason, there are no conflicts because the marc is a by-product that is not reused, it is usually burned. In this way, problematic waste will be reintroduced into a new value chain. During the workshop, it was emphasized that it must be taken into account that it is important to use locally available raw materials to avoid high transport costs and long delivery times. Vegea Srl has, in fact, overcome this difficulty linked to procurement by building plants directly in the distillery.

The biolink promoted the diffusion of Vegea model to create new commercial opportunities, identify new potential customers in different sectors (packaging, clothing, automotive) and also to understand better the technical characteristics required for leather in the various applications. The constant demand for eco-friendly and organic leather products is growing and expected to grow in the next years, due to increased demand from animal protection groups. Consequently, this has led to the development of new biopolymer that addresses environmental and social challenges, such as in the VegeaTexile demo case.

This business model and development fits into the context of the transition from economy to bioeconomy, implementing guiding principles at the basis of the circular economy. In extreme synthesis, development of bio-based products (bioeconomy) and no waste economy (circular economy). In line with the European Commission, the present biolink addresses several EU challenges, first of all in the field of Circular Economy. The EU Action Plan for Circular Economy, in particular, the revised legislative proposals on waste sets clear targets for the reduction of waste and establishes an ambitious and credible long-term path for waste management and recycling (i.e. recycling 65% and reducing landfill by 10% of the municipal waste by 2030; recycling 75% of packaging waste by 2030).

CASE STUDY 7

https://www.youtube.com/watch?v=P8kyBgghucg

Antioxidants from wine derivatives for cosmetics products

Elisa Morganti and Silvio Antonioni[16]

Involved Project Partners
PP8 - Hub Innovazione Trentino

Involved Actors
Marco Pisoni - Azienda Agricola Fratelli Pisoni
Aeraderma

Background
While exploring the AlpLinkBioEco biolink generator, we stepped in this particular biolink between distillery and cosmetics producer. From a deeper research we discovered that the biolink was implemented recently by two Trentino actors. We decided to document this biolink since it is unique and not presented in other countries. We think it is innovative and it can offer interesting and relevant hints for the algorithm and the project.

Distilleries and winemakers produce tons of pomace that is usually disposed as waste, burned as biomass or used as fertilizer. Pomace and grape seeds are rich in polyphenols and anti oxydants that are valuable basis for anti-age cosmetic products.
The actual biolink can have great potentiality provided that it is fully supported by a marketing campaign and further investment.

We had a several meetings and discussion with the owner of the brand Ampeliè, a trademark owned by Azienda Agricola Fratelli Pisoni, that produces and sells natural based cosmetics starting from the winery residues and other organic components. The blending and preparation of the product is made through a third-party laboratory specialized in contract production of cosmetics and class I and IIA medical devices (Areaderma).

Process
Azienda Agricola Fratelli Pisoni collects young vine non-treated leaves and extracts the lymph. In addition, the company extracts the grapeseed oil from marcs obtained from their wine production, with the support of a small milling facility nearby. The final ingredients of Ampeliè cosmetics products derive from Pisoni red wine and olive oil produced locally.

All the components are sent to a cosmetic factory for the production of anti-age creams, serum and eyes cream.

The products have been tested by Fondazione Edmund Mach, a research organization specialized in agriculture, forests and environment, and they proved to be safe, with high quality and rich in antioxidants.
The biobased resources are largely available seasonally both for the young leaves, which are collected in spring and for which the final amount depends also from the weather conditions and for the grape marcs that are fully available at the end of the distillation process, in autumn.

Results
This biolink is currently active in Azienda Agricola Fratelli Pisoni and the Ampeliè products are commercially available.

The productivity is very low (the reference units of measure are litres) and the company is self-sustaining the production of the feedstock. Considering the low volume sales, the cost of the energy required for the grapeseed separation and

[16] Hub Innovazione Trentino

oil extraction is relevant. The choice of organic feedstock has an impact on the production and process logics and costs. The lymph is extracted from the young leaves of untreated vines. The distillery residues come only from the specific biodynamic wine production process. For this reason, only particular types of vines, that are naturally immune to parasites and grapevine disease, are used.
The use of organic bio-based materials can be economically attractive provided that starting material can be obtained at low cost (including transportation) and if the suppliers of the technology treatments, blending and packaging are in loco. The strength of Ampeliè is that everything is done in loco, with residues produced by the same company that is selling the final cosmetic products.
Nevertheless, the use of organic components would meet the requests of a certain segment of customers that are prone to pay more for high quality and safe product.
Cosmetics products created using organic natural components are trendy and appealing for a specific customers segment. Especially in the US, grapeseed oil is very appreciated and customers are sensible to biobased ingredients.

Azienda Agricola Fratelli Pisoni is leader in the biodynamic production of wines and grappa; they have low experience in the cosmetic market which is very different with respect to their main business. The project of commercializing cosmetic products is in stand-by and they are willing to find solutions and investments to market better their cosmetic products.

Figure 2.8: Grapeseed oil

CASE STUDY 8

https://www.youtube.com/watch?v=ipe5FBhKXdA

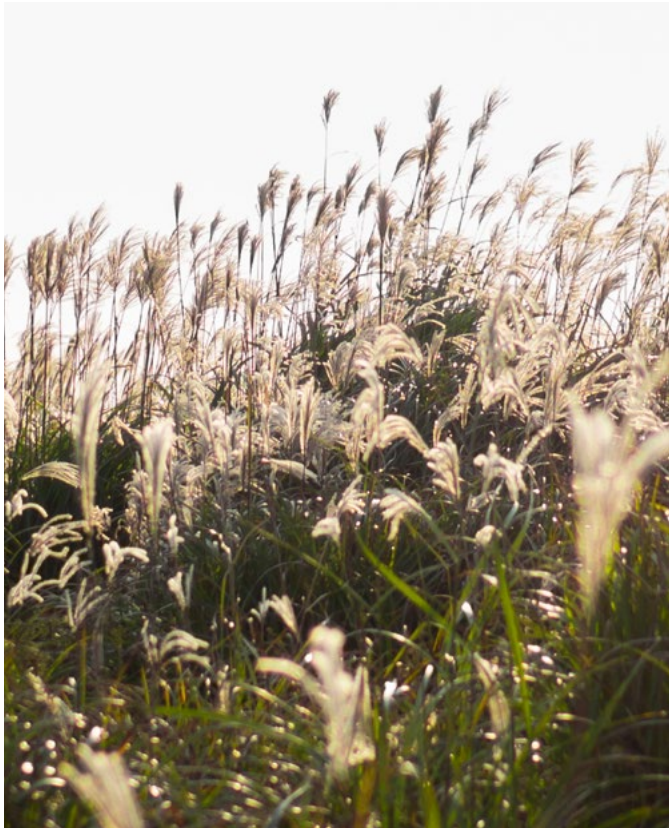
Miscanthus in the Building Industry

Erica Torti[17]

Involved Project Partners
PP6 – Confindustria Lombardia

Involved Actors
Planeta Renewables S.r.l.
Marlegno S.r.l.

Background
To begin with, we defined the two sectors to include in the value chain, agriculture and wood. Then, we developed the new biolink: the basic idea is to use a vegetable fibre as a reinforcement to enhance thermal insulation in building industry.
Conventional building materials contribute greatly to global carbon dioxide emissions and global solid waste production; switching to biobased composites made from vegetable raw materials will be beneficial for the environment (reduction of waste and CO2 emissions, renewability, independence from fossil resources).
We carried out some preliminary research to be sure that our idea was feasible: according to some studies, due to their high lignocellulose content, vegetable fibres reveal promising thermal insulation properties and they might be used as a reinforcement inside wood-polymer composites.
Miscanthus Giganteus is a perennial grass (also called elephant grass) currently used as biomass to produce heat and biofuels, as fibres or bricks to manufacture other biobased products. Due to its high lignocellulosic content, we consider it suitable to develop the new biolink.
Moreover, Miscanthus has an annual growth cycle: this entails a stable yield per hectare. It is harvested in spring, but it can be stored and distributed during all year; it needs very little maintenance and water.
Subsequently, we used the Value Chain Generator to search for companies based in Lombardy to further develop this business idea; we chose Planeta Renewables S.r.l., an innovative start-up that process Miscanthus Gigantheus in several byproducts, and Marlegno S.r.l., a small medium enterprise specialized in construction of tailor made prefabricated wooden structures.
Supported by Confindustria Bergamo and the Lombardy Energy Cleantech Cluster, we contacted the two companies and illustrated the Project, the Value Chain Generator and the biolink we created.
Both expressed their interest in meeting the counterpart to discuss the biolink and its economic and technical feasibility. Therefore, we set up a virtual meeting (Piloting Session).



[17] Confindustria Lombardia

Process

During the Piloting Session several development options were discussed; in fact, Miscanthus can be used as a reinforcement in wood, press wood, plywood products or as an alternative to wood (panels made of miscanthus).
Planeta Renewables S.r.l. already manufactures fibres made of Miscanthus. However, at present, Marlegno S.r.l. does not manufacture panels or insulating materials; these products are purchased from third parties and then processed.
Nowadays, the company business plan does not envisage the introduction of a new manufacturing process.
Alternatively, Miscanthus can be used as it is harvested as an insulating filler (blown between laminated wood layers or in cavities) to enhance wood insulating ability; in this case, it will not be necessary to introduce any new manufacturing process.
Depending on the application envisaged, it might be necessary for the biomass to undergo pre-treatments.

Results

Even though both companies showed interest in the biolink and exchanged contacts, further research and tests should be carried out to verify its technical and economic feasibility, its appeal to the market and whether it entails economic and ecological advantages compared to other insulating materials.
As far as market competition is concerned, both companies stressed that there are already many vegetable fibres used as insulating material (i.e. hemp, hay, flax) on the market.

Sources

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CASE STUDY 9

Biorefinery from wet dredges of aromatic plants

Lisa Besnard[18]
Patricia Guiraudie and Stéphane Moutard[19]

Involved Project Partners

PP12 – France Clusters- FR
PP10 – Lombardy Green Chemistry Association
OB15 – Novachim - FR

Involved Actors

A producer of essential oils from the South Region Provence-Alpes-Côte d'Azur in France
A biorefinery from Lombardy in Italy

Background

Thanks to Novachim, a French cluster from the chemicals' sector, we have identified a producer of essential oils interested in finding novel value-added ways of recovering its waste. This producer is located in the region of Grasse in France, where a significant quantity of wet residual biomass from steam or hydro-distilled aromatic plants, rich in lignocellulose, could be recovered.

[18] France Clusters - https://franceclusters.fr/

[19] Novachim - www.novachim.fr

Indeed, the average essential oil content in aromatic plants is below 5% (w/w) dry matter of the whole plant which generates a sizable amount of solid residues no-use. Moreover, distilled residues are solid residues with a high moisture content. We generally talk about wet residual biomass or wet dredges of aromatic plants.

Currently, these wet residues are mainly used only for soils amendments and/or anaerobic digestion and are commonly treated as a waste without economic value. Indeed, costs of waste disposal and treatment are too expensive for waste producers and collectors as compared as the added value of products for soil amendments, with poor environmental balance. According to the current state of knowledge, no conflicts of use should arise if there is a better way to valorized these residues. Thus, dual utilization of distillation biomass not only reduces the cost of finished product but also solve the problem of disposal of this huge biomass.

After comparing several recovery options for the wet dredges of aromatic plants, it appears that second generation biofuel is the best one as it is technically and economically more feasible than other options.

There is an increasing demand for second generation bio-based fuels (cellulosic ethanol) due to their dual use as fuel as well as for the production of important chemicals (cellulose, hemi-cellulose and lignin derived biochemical). Lignocellulosic biomass has been recognized as promising feedstock for biofuels production.

Thanks to the value chain generator developed by the AlpLinkBioEco project and thanks to a study we conducted, we identified that this biomass could enter the very innovative biofuel process of an Italian company, allowing to treat worldwide crops in a wide range of moisture content, size, and density thanks to a "smart" biomass cooking pre-treatment step. A new facility from this company is ready to convert the cellulosic biomass into second-generation sugars, which can be further processed into biofuels or biobased chemicals.

It wasn't yet possible to have an appointment with the Italian company to conduct a piloting session with the French producer of essential oil and see if they want to further explore the possibility to work together on this new value chain. But the study we conducted with an external expert helped us to prepare this piloting session by clarifying several issues regarding its technical, economical and legal feasibility.

Process

Best practice examples from scientific studies were gathered to give a positive outlook on the usability of different aromatic plants residues as a feedstock for the production of cellulosic ethanol and of cellulose derived-biochemicals. These results reaffirm the dual uses of aromatic plant waste for 2G biofuel production and co-products commercialization.

Technical feasibility and advantages of the new value chain were underlined:

1) The process developed by the Italian company allows to treat worldwide crops in a wide range of moisture content, size and density thanks to the "smart" biomass cooking pretreatment step. Besides, 20 different cellulosic biomasses, whose grasses, have been testing on pilot scale for the definition of:

- Sugars recovery;
- Substrate accessibility-to-enzymes and enzyme affinity to substrate;
- Ethanol conversion;
- Physical characteristic of the stream for proper equipment sizing.

2) Moreover, steam distillation of essential oil bearing aromatic crops may overcome the biomass recalcitrance problem of plant biomass for biofuel production. The steam treated biomass can easily be converted to ethanol as compared to biomass which has not been pre-treated with hot steam.

The economic feasibility was assessed and some issues still need to be clarified:

- The essential oil's production will not be changed and the biofuel production process is already implemented at an industrial scale. But additional costs of development will be necessary for the Italian company in order to adapt the production to this new lignocellulosic feedstock.

- The French aromatic oils' producer has currently high costs for the waste removal that could be saved through this possible recovery. Nevertheless, the investments for the waste management (storage area? Pretreatment?) need to be estimated. It is also necessary to check with the Italian company which would be the acceptable price to pay this waste to have an economic benefit compared with the costs of purchasing other waste or raw material as input in its process, the transport and the treatment.

The main constraints were analyzed and can be overcome:

- The issue of sufficient available quantities of biomass from the French producer of aromatic plants still shall be clarified according to the quantity needed by the Italian company. But even if the quantities from the French company appear not to be sufficient, a collective solution could be found as we are quite sure that the different aromatic oil producers in the region of Grasse in France are interested in more-value added recovery options for their waste.

- The acceptability of customers for "green" energy sources with higher prices is growing due to new regulation, incentives and the general awareness about the climate change challenge.
- The French national laws about "transition from waste status to co-product status" doesn't prohibit the realization of the value chain between the French waste's producer and the Italian biorefiner. But specific procedures have to be established between both companies: the companies could choose between two possible legal options to make the value chain legally compliant.

Future outlook:
At the present time, crude oil-based energy sources still are more competitive, but there is an increasing demand for bio-based fuel (ethanol) due to their dual use as fuel as well as for the production of major chemicals. Indeed, industry reports are very optimistic about the future potential of bio-based cellulosic ethanol, estimating the 2030 potential at 350 GL (a 372-fold increase over 2014 production levels).

Furthermore, the use of residual biomass from aromatic plants is a low-cost waste disposal strategy having additional social and environmental benefits. Social-environmental communication is very important for essential oils' producers both for the general public and public authorities. And such a social-environmental actions could even be subsidized. Indeed, Europe's involvement in favor of 2G/3G biofuel through subside could foster the competitiveness of these new generation of biofuel production and consequently the economic attractiveness for the use of these bio-based input materials.

Results
The study from the external expert shows the real potential for a Novel Bio-Based Value Chain with wet dredges of aromatic plants for biorefinery.
The French aromatic oil producer would have a more value-added recovery of its waste and the other essential oils producers from the region could follow this innovative and profitable example of waste recovery. The Italian biorefinery could enlarge the type of biomass used in its innovative process with wet dredges of aromatic plants and benefit from such steam treated biomass easier to convert in ethanol. We are in contact with both companies and plan to be able to link them on this comprehensive base of knowledge regarding the potential of this bio-based novel value chain they could create together.
As the two companies are from different regions of neighbour countries, it would be a real Alpine Space inspiring success story!

CASE STUDY 10

https://www.youtube.com/watch?v=Nasqwmj5a0k

Valorization of bird feathers

Sylvie Charrel[20]

Involved Project Partners
PP11 – Plastipolis – FR

Involved Actors
Actor A - An actor specialized in new solutions for bird feather by-products
Actor B - An actor specialized in the production of expanded packaging

Background
The first step was to identify two sectors which could be involved in the value chain. In the proposed value chain, we involved agriculture and packaging.
The next step was to develop the value chain. As pole of competitiveness and also economic player, Plastipolis is regularly contacted by partners for developing new material, and Actor A had informed us of his idea.
In France, bird feathers are available in large

[20] Plastipolis

quantities because there are a lot of bird breeding for food. The volume of feathers and downs to process amounts to approximately 20 000 tons per year. If most of the feather waste is reused in textile industries (upholstery, duvet padding, pillows, …), used feathers and downs raise recycling problems due to a surge in production.
Previously, the waste was sold to market gardeners, but the volume is now too large. In addition, grinding for animal feed is now prohibited. So, it's imperative to find new solutions of revalorization.
The less attractive feathers can be revalorized in cellular materials.
In this example, the value chain idea is to revalorize bird feathers which are until now valued in heat production or as soil conditioner, as much to say with no added value.

Process
What are the advantages of this by-product?
First the weight, second a low density, thirdly insulating, and also other characteristic like absorbent, biobased and biodegradable, and water resistance. Therefore, it could be used by a plastic company for replacing fossil polymer.

Most of this waste is profitable material. Due to its high concentration of keratin, feathers can produce plastics that are stronger than those made from other biobased polymer. It was decided to present the opportunity of this new development to an actor specialized in the production of expanded packaging.

The discussed issues involved: how do we introduce the feathers in plastics? What about the cleanliness of feathers (need for washing)? Which type of process do we need (drying, crushed, …)? How to facilitate the delivery/the conditioning (compaction, …)? What about regulation? What about food contact? What about the production process of the plasturgist – Is it suitable for using this material?

Results
The piloting session revealed that the feather by-products are an interesting bio-based source for packaging materials and can be used in replacement of fossil materials. During the piloting session, discussions were held about possibilities, new developments, price of the material, etc. Nevertheless, in the follow-up discussions, the two companies could not find an agreement on the price of the by-product.

CASE STUDY 11

https://www.youtube.com/watch?v=eRGY_7r4H58

Bio-based consumer products

Magdalena Buch[21], Elisabeth Rieger[22]

Involved Project Partners
PP14 – Chemie-Cluester Bayern GmbH

Involved Actors
Technology providing start-up
Multinational group in consumer products
(Due to a running application for funds the company names must be kept confidential)

Background
Thanks to the activities of the AlpLinkBioEco project the project partner got in touch with a company which is developing different technologies to transform by-products into useful products. The technology of interest regarding this biolink addresses the transformation of by-products from the paper industry (pulp mills). In addition to the sustainability benefit of using waste, the innovative idea is the adjustment and usage of the transformed products as basic ingredients in consumer products.
Wood has always been a traditional raw material in the Alpine region. However, in Bavaria, the possible wood cutting rate for sustainable forestry has not yet been reached. Woodcut and wood waste is used for multiple paths in value creation, including pulp production. One of these value chains involves pulp plants in Scandinavia and Germany which produce more than 50.000 t/year of a byproduct that usually is incinerated. The start-up known to the project partner has developed a technology and process that transforms substances from this by-product into valuable products. They are able to produce up to a few 100 grams of these substances on a "larger" lab scale and are planning a funded project to scale up the process. The process allows to adjust the properties of the final products to be used as ingredient in various consumer goods. With a personal care producer as a cooperation partner at hand, this allows for the joint development of an application driven ideal substance.
Currently in Northern Europe, the byproduct is sold to a large company for the first step of purification. The start-up is already in contact with this company, which can supply the purified raw material for the innovative process in large quantities. In the Alpine region and Western/Southern Europe equivalents could be identified. Wood is available throughout the year; thus the pulp producing plant also runs without seasonal limitations. Continuous availability of the by-product and the purified raw material is given as a consequence. It's also worth mentioning, that there is no competition with the food sector.
The pilot session discussed the use in various consumer products applied on human skin for a personal care product line.
The benefits of the new product from the start-up are the following: first, the traditional ingredient is fossil-based. It won't migrate but will be rubbed off or washed off during the use of those conventional consumer products. After/during usage, it will end up in the environment where it won't decompose. Also, there are findings that the traditional ingredient hampers the self-regulating function of human skin which opposes the desired effect. Second, the fossil-based ingredient usually contains toxic by-products, originated only from fossil oil. The new developed ingredient does not contain any toxic by-products, is highly purified and can be adjusted to be composable.
Consumers increasingly prefer to use natural, fossil-free products. Consumer apps as "code-check" for example tend to rate the fossil-based ingredients as risky for health and discourage consumers of its use. Personal care producers, as the multinational group present at the piloting session, aim at replacing the traditional fossil-based ingredient as a consequence. For this reason, several companies are moving towards the substitution by biobased

[21] Chemie-Cluster Bayern GmbH

[22] Chemie-Cluster Bayern GmbH

natural products. Third, the production of the new ingredient is less energy-consuming, therefore having a lower impact on the environment. The multinational group faces the challenge to adopt existing high-volume products to the increasing consumer expectations regarding a good life cycle analysis and low carbon footprint – always given the fact that the final product keeps its properties (in the perception of its consumers).

Process

Part of the innovation potential of the substance are connected to its production process. The process is advantageous in comparison to the production of the substance it will substitute because it has less impact on the environment, due to the absence of toxic by-products, lower quantities of unnecessary by-products and less toxic solvents involved. A life cycle analysis will be part of the joint funded project as it should cover the whole process from the pulp production to the final personal care product. Hence, various facts show that the process will be less polluting in terms of CO2 emission, less side-products to process and more energy-efficient. The processes' energy consumption will add to this positive balance: the start-up plans to use ideally only renewable and excess electricity that occurs due to timely overproduction.

Results

First, all involved actors agreed to share information on the required characteristics for diverse uses and to exchange a small batch for testing/analysis by the applying company. Second, the companies agreed to discuss the application for a joint R&D project, including additional partners to cover the whole value chain and submit it to an open call for projects on national level beginning of 2021.

Three weeks after the initial piloting session, a second session was organized by the two companies and PP14 was invited to join as facilitator. More detailed questions were exchanged, answered and the mutual interest of collaborating in a joint R&D project was confirmed. The deadline for the call for proposals was extended. Having an additional meeting in February, both parties agreed to submit a joint proposal for the call beginning of March 2021- being the reason for non-disclosure of their company names in this publication.

One week prior to the first piloting session the start-up had a first bilateral exchange equally initiated by PP14 with another innovative producer of home-building and do-it-yourself products which showed interest in applying the final product in one of their products. The company therefore decided to team-up in the same joint R&D project, mentioned in the described piloting session. In conclusion, in this case two applying company matches on the same biobased value-chain idea were realized through the work of Chemie-Cluster Bayern GmbH in AlpLinkBioEco.

CHAPTER 3

"The Masterplan – Towards a Joint Bioeconomy Strategy for the Alpine Space"

3.1 Broadening the Perspective – From Biolinks to a Bioeconomy Masterplan for the Alpine Space

3.2. Connecting the Dots: Bioeconomy Masterplan for the Alpine Space

Interreg Alpine Space
EUROPEAN UNION
AlpLinkBioEco
European Regional Development Fund

3.1 Broadening the Perspective – From Biolinks to a Bioeconomy Masterplan for the Alpine Space

Michael Keller[1]

The development of the Value Chain Generator (VCG) and the paralleling initiation of real-world experience with bio-based value chain ideas had a distinctively practical focus. The daily work of collecting and processing data and, even more so, applying it during the project's piloting phase, was experienced as an empirical immersion into the vast opportunity of the bioeconomy within and across the participating regions. In order to put this empirical approach on a broader analytical basis, the AlpLinkBioEco consortium paralleled its practical work with research- and policy-oriented activities throughout the project duration.

Under the lead of Hub Innovazione Trentino, a Whitepaper was drafted early on in the project to outline the benefits and opportunities of bio-based value chains in the Alpine Space. The following section in this chapter gives an overview of the analysis for the four main target sectors: agriculture, wood, packaging and chemistry.

Further detail on existing bio-based value chains in the Alpine Space has been documented in a cluster mapping report under the lead of Poly4Eml hosted by Anteja ECG, providing an overview of relevant activities and cluster actors.[2] In addition, an inventory of existing regional strategies and policies related to the bioeocnomy has been created and summarized in a policy synthesis report.[3]

The results from these research activities provided a picture complementary to the empirical experience made with the data-driven VCG development and the practical field work on concrete business opportunities: the potential for bio-based value chains in the Alpine Space is immense, well-anchored in existing alpine capacities and resources, and addressing alpine specific economic, societal and environmental challenges. And the potential is relevant at different levels of granularity:

- as a source for new markets and revenues between individual businesses (biolinks),
- as a source for cluster transformation, diversification and growth,
- as a source for regional and macro-regional development, competitiveness and resilience.

In other words, bio-based economic interactions between individual businesses –biolinks – are a sign pointing towards even bigger opportunities. Bio-based value chains can spark the transformation (bioeconomisation, so to speak) of complete clusters and form the nucleus of regional and macroregional development. The piloting phase of the AlpLinkBioEco project has demonstrated that biolinks can grow. In order to fully benefit from the bioeconomy potential, a joint strategic approach among Alpine Regions needs to ensure that biolinks are sowed and bear fruit across the fertile bioeconomy soils of the Alps.

This is, of course, no easy undertaking. In spite of all the significant complementarities and synergies, the Alpine Space remains a diverse territory, marked by almost as many regional borders as watersheds, home to a multitude of languages, regional specificities and identities and a variety of administrative and political contexts.

In order to move closer towards a joint approach, the participating regions of the AlpLinkBioEco project have engaged their policy stakeholders in a policy dialogue culminating in an Alpine Policy Forum, conducted online on February 16, 2021 and uniting more than 125 participants.

Under the responsibility of Fraunhofer Italia, regional policymakers and bio-based industry stakeholders have been questioned on the main challenges to overcome in order to foster a common macro-regional bioeconomy approach and invited to share best-practice examples of cross-regional settings. The results were summarized in a Roadmap available on the project website[4], and

[1] AlpLinkBioEco Lead Partner, Plastics Innovation Competence Center, University of Applied Sciences and Arts Western Switzerland - School of Engineering and Architecture of Fribourg (HES-SO//FR HEIA-FR)

[2] https://www.alpine-space.eu/projects/alplinkbioeco/en/project-results/cluster-mapping-report

[3] https://www.alpine-space.eu/projects/alplinkbioeco/en/project-results/policy-synthesis-report

[4] https://www.alpine-space.eu/projects/alplinkbioeco/en/project-results/roadmap-for-a-common-alpine-space-policy-on-circular-bio-based-economy

formed the basis for the debates at the Alpine Policy Forum organized by BIOPRO Baden-Württemberg GmbH and Poly4Eml. Based on all these inputs, a masterplan to move towards a joint bioeconomy strategy in the Alpine Region has finally been drafted. The complete masterplan is available on the project website[5] and its key elements are presented in the next chapter.

With its masterplan, and in complementarity to its hands-on, data driven and practical approach with the Value Chain Generator (VCG), the AlpLinkBioEco project hopes to promote the valorization of bioeconomy potential at a larger, macro-regional scale across the Alps. Not only does it contribute to recognizing and documenting the benefits and opportunities of bio-based value chains in the Alpine Space, but it proposes concrete fields of action and recommendations oriented towards a joint bioeconomy strategy for the Alpine Space.

Benefits and Opportunities of Bio-based Value Chains in the Alpine Space

Elisa Morganti[6]

The regions of the Alps are recognized to have significant biomass resources, strong industry sectors, and knowledge centers and expertise in bio-based fields. In addition, regional strategies and policies are conducive to the development of bio-based value chains. The main benefits and opportunities that a bio-based economy can bring to stakeholders of the Alpine Space (AS) regions have been summarized in a Whitepaper, available on the project website,[7] including suggestions on how to generate new business opportunities and recommendations for stakeholders.

The analysis focused on bio-based industries within the sectors “Agriculture” (Agro), “Wood”, “Packaging” and “Chemistry” and assessed their strengths and importance in the participating project regions in comparison to their overall economies.

The investigated sectors have great relevance in the regional strategies in terms of available feedstocks, market value, competences and excellence involved. The covered regions produce more than 35 million m3 of wood per year and employ more than 1.4 million people in the agri-food sector. Alpine regions also have a good track record in chemistry production with good potential for growth in the bio-based chemistry. Collected data show that only in few Alpine regions biomass and waste from agriculture, wood and food industry are used for bio-based packaging and polymers production.

Clusters play a fundamental role in generating new business opportunities within and/or across the regions in the Agricultural, Wood, Packaging for Food and Pharma and Chemistry sectors. The crucial role of Clusters has been extensively addressed by two Interreg projects during the last years, S3-4AlpClusters[8] and DanuBio ValNet[9] and by a Cluster Mapping report drafted within the AlpLinkBioEco project.[10] Clusters represent important local concentrations of bio-based capacities, entrepreneurial resources, cross-sectoral connectivity and actors of the quadruple helix. Nevertheless, some white spots and challenges have been identified:

- There is a lack of experience among the regions on how to use clusters and how to develop implementation tools to fully benefit SMEs in bio-based value chains
- Alignment between and knowledge about other regions’ strategies are very limited
- The Cluster initiatives focusing on bio-based industries are facing significant challenges as they operate within an emerging industry with specific demands that cannot be properly addressed by traditional networking and matchmaking

The following paragraphs give additional insights into the four covered sectors.

Wood sector (infographic page 71)

All the participating project regions are active within the Wood sector and the available resources are mostly the same for all the regions, i.e. cork, straw,

[5] https://www.alpine-space.eu/projects/alplinkbioeco/en/project-results/joint-masterplan-on-circular-bioeconomy

[6] Hub Innovazione Trentino

[7] https://www.alpine-space.eu/projects/alplinkbioeco/en/project-results/white-paper

[8] https://www.alpine-space.eu/projects/s3-4alpclusters/en/home

[9] http://www.interreg-danube.eu/approved-projects/danubiovalnet

[10] https://www.alpine-space.eu/projects/alplinkbioeco/en/project-results/cluster-mapping-report

timber, beams, and boards, residual biomass from sawmill processing, end-of-life wood, waste from wood processing. For instance, in the Canton of Fribourg they are used as feedstocks for manufacturing products of wood, cork, straw and plaiting materials, moreover, the lignin extracted from the starting biomass is used for bioplastic production; in Autonomous Province of Trento the timber, beams and boards are used for pallets, while the wood industry residuals are used for bioenergy production, even if sometimes it is used as mulching and as bedding for cattle; Lombardy region owns expertise also in the paper manufacturing from wood waste; in Slovenia the wood-based products are exploited for energy applications.

Source: AlpLinkBioEco Policy Memo #01[11]

Agricultural sector (infographic page 72)
In general, Agriculture is one of the most developed sectors, especially in Autonomous Province of Trento, Lombardy, Auvergne-Rhône-Alpes and Bavaria. In the Autonomous Province of Trento, the agricultural residuals (from apples and vines) and the animal manure, the wastewater and dry sludge represent the most abundant resources; the animal manure is mainly used in Biogas plant. In the Lombardy region, the wastewater/sewage sludge, corn silage, autumn-winter cereal silage, livestock animal waste, grass, flour products, glycerine, vegetable oils and urban waste of organic nature are the most abundant resources which are treated and used for biogas production. The Auvergne-Rhône-Alpes region produces biomass especially animal dung, intermediate cultures between two main crops and waste from the agro-food industries. In Bavaria cereals (wheat and barley), corn, silage maize and manure are mainly exploited for the Biogas production.

Source: AlpLinkBioEco Policy Memo #01[12]

Packaging sector (infographic page 73)
As for the Wood sector, also Packaging sector activities are widespread among regions. Biomass and waste from agriculture, wood and food industry are used for bio-based packaging and polymers production. For instance, in the Canton of Fribourg, Bavaria and Switzerland companies produce packaging material for the food industry; or in Baden-Württemberg the companies are using bio-based polymers for specific packaging applications.

Source: AlpLinkBioEco Policy Memo #01[13]

Bio-based Chemistry (infographic page 74)
According to the research carried out, the chemistry industry is developed in all the regions, especially in Austria and Bavaria regions. In Austria, the fine chemicals production is well developed, such as acetic acid, furfural, magnesium lignin sulfonate, Omega 3 fatty acids, succinic acid which can find applications in different fields like food, refining and printing industries. In Bavaria, the chemistry industry is one of the most powerful bio-based economy. The biomasses are used for the production of fine chemicals which can find application in drug production, biocatalysts, biofilms and biodegradable plastics.

Source: AlpLinkBioEco Policy Memo #01[14]

[11] https://www.alpine-space.eu/projects/alplinkbioeco/policy-memos/alplinkbioeco_policymemo-01.pdf

[12] https://www.alpine-space.eu/projects/alplinkbioeco/policy-memos/alplinkbioeco_policymemo-01.pdf

[13] https://www.alpine-space.eu/projects/alplinkbioeco/policy-memos/alplinkbioeco_policymemo-01.pdf

[14] https://www.alpine-space.eu/projects/alplinkbioeco/policy-memos/alplinkbioeco_policymemo-01.pdf

Implementing Value Chains in a Bio-Based Economy: RECOMMENDATIONS

Interreg Alpine Space
AlpLinkBioEco
European Regional Development Fund
EUROPEAN UNION

Baden-Württemberg

COMPANIES
Should find new applications for wood biomass in construction sector, investing in novel infrastructures/facilities for processing biomasses.

POLICY MAKERS
Should support new biorefineries with funding and/or tax incentives.

Bavaria

POLICY MAKERS
Should consider supporting cross-cluster and cross-industry value chains as well as the cascaded usage of raw material with funding and/or incentives.

Canton of Fribourg

COMPANIES
Should consider finding new applications and developments to further valorise biomass in the construction industry.

Autonomous Province of Trento

COMPANIES
Should consider investing in processing/reusing of wood materials. More knowledge is necessary to boost the new value chains.

Lombardy

COMPANIES
Should consider investing in new biorefineries and scale-up R&D activities to pilot plants and demonstrators.

Slovenia

COMPANIES
Should consider consider using wood to build woodbased efficient construction.

Auvergne-Rhône-Alpes

POLICY MAKERS
Should consider investing in novel infrastructures/facilities for deposit. For example by developing direct forms of cooperation of smallholders such as cooperatives, consortia; by fostering mediated collaboration through public or public controlled agencies.

Switzerland

COMPANIES
Should consider investing in processing/reusing of wood materials in added value products.

COMPANIES

Consider shifting the utilisation of low quality wood or industrial by-products resources **from energy towards chemicals and materials** by creating higher added value.

POLICY MAKERS

Consider to support this shifting with **funds and/or tax incentives** in order to launch small scale **pilot projects** for the utilisation of local biomass resources, to meet **local community need.**

#AlpLinkBioEco

WOOD SECTOR

one of the most abundant resources in the Alpine region

35M m³

harvested wood each year

Implementing Value Chains in a Bio-Based Economy: RECOMMENDATIONS

Interreg Alpine Space
AlpLinkBioEco
European Regional Development Fund
EUROPEAN UNION

Lombardy

COMPANIES
Should consider investing in new biorefineries and scale-up R&D activities to pilot plants and demonstrator.

Auvergne-Rhône-Alpes

COMPANIES
Should consider using biomass from animal dung, intermediate cultures between two main crops and waste from the agro-food industries to obtain high added value products.

Bavaria

COMPANIES
Should consider using biomass from cereals (wheat and barley), corn, silage maize and manure and food waste.

POLICY MAKERS
should consider increasing the number of networking opportunities among economic actors as well as increasing the public funding.

Autonomous Province of Trento

COMPANIES
Should consider investing in processing/reusing of wastes from vineries and lower quality fruit or side-streams from agri-food industry to develop new value chains.

Austria

COMPANIES
Should consider using the agricultural biomass to obtain high added value products.

Canton of Fribourg

POLICY MAKERS
Should consider increasing the numbers of networking opportunities among economic actors of the sectors in the regions.

CLUSTERS
Play a fundamental role in generating new business opportunities within and/or across the regions.

Baden-Württemberg
Switzerland
Slovenia

COMPANIES
Should consider using almost entire agricultural biomass in the production, making it a waste-free process.

COMPANIES

Consider shifting the utilisation of agricultural resources **from energy towards chemicals and materials** by creating higher added value. **Using biomass in these ways has the potential to generate higher value returns than when using it primarily to produce energy.**

POLICY MAKERS

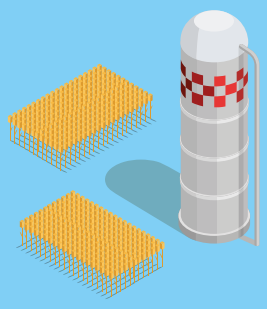
Consider to support this shifting with **funds and/or tax incentives** in order to launch small scale **pilot projects** for the utilisation of local biomass resources, to meet **local community need.**

#AlpLinkBioEco

AGRICULTURAL SECTOR

one of the most developed sectors in the Alpine region

1.400.000 employees | **€ 140** BILLION revenue



Implementing Value Chains in a Bio-Based Economy: RECOMMENDATIONS

Interreg Alpine Space
EUROPEAN UNION
AlpLinkBioEco
European Regional Development Fund

Switzerland

POLICY MAKERS
Should consider supporting the bio-based Packaging sectors for Food and Pharma in regions with similar policies.

Austria

POLICY MAKERS
Should consider supporting the bio-based Packaging sectors for Food and Pharma in regions with similar policies.

Canton of Fribourg

The Packaging sector plays a significant role in the development of the bio-based economy.

COMPANIES
In other regions should consider to use agricultural and wood biomass within the regions to develop bio-based packaging for food and pharma.

Lombardy

In the sector of bio-based Packaging, Lombardy is one of the top Alpine regions offering many job opportunities.

COMPANIES
New biorefineries could provide biomass from Wood and Agricultural sectors to develop bio-based Packaging applications for Food and Pharma.

Slovenia

Production of biopolymers and bioplastics is rather scarce.

COMPANIES
Further investments are needed in the bio-based Packaging sector for Food and Pharma in the regions.

COMPANIES

Further investments by companies are needed in the bio-based Packaging sector for Food and Pharma in the Alpine regions - thus **exploiting the new business opportunities.**

POLICY MAKERS

Incentives and necessary conditions for investments in the bio-based Packaging sector for Food and Pharma should be **enacted and/or improved.**

#AlpLinkBioEco

PACKAGING SECTOR FOR FOOD & PHARMA

represents a white spot

data show that only in some of the Alpine regions, biomass and waste from Agriculture, Wood and Food industry are used for bio-based packaging and polymers production

Implementing Value Chains in a Bio-Based Economy: RECOMMENDATIONS

Interreg Alpine Space
AlpLinkBioEco
European Regional Development Fund
EUROPEAN UNION

Bavaria

COMPANIES
The chemical industry in Bavaria is well developed, the bio-based chemistry amounts to about 15% of the total chemical sector.

Austria

COMPANIES
The chemical industry is the second largest sector in Austria.

Slovenia

COMPANIES
Chemical industry is one of the main pillars of the economy.

Canton of Fribourg

COMPANIES
Chemical and plastic sectors are among the main industries of the region and have substantial potential for growth in the bio-based economy.

Lombardy

COMPANIES
Lombardy is the second region in Europe for the number of employees within the chemical and pharmaceutical industry.

Auvergne-Rhône-Alpes

COMPANIES
Auvergne-Rhône-Alpes is 1st French region in chemical production.

Switzerland

COMPANIES
Chemical, pharmaceutical and biotech industry in Switzerland is highly developed.

COMPANIES

should consider using this leading position in Chemistry sector to move forward with **bio-based chemistry** (and exploit the **new business opportunities** bio-based chemistry is offering) **by using the biomass from the Agricultural and Wood sectors** to develop high added value products.

#AlpLinkBioEco

CHEMISTRY SECTOR

represents a white spot

Alpine regions have a good track record in chemistry production and some of the regions already have substantial potential for growth in the bio-based chemistry

3.2. Connecting the Dots: Bioeconomy Masterplan for the Alpine Space

Sergi Costa[1]

The capacities and resources mapped and analyzed in the AlpLinkBioEco project should be the basis for a common agenda on circular bioeconomy in the Alpine Space. In this regard, existing regional and national strategies can act as a lever. These strategies have indeed a focus on their regional specificity, but remain permeable to a process of internationalisation. Bio-based value chains often develop across borders and the strategies, when implemented through measures, should support this market opportunity. In short, raising competitiveness in the complex ecosystem of bioeconomy is more about thinking and acting across borders. Embedding the macro-regional approach to the regional policies is de facto a cornerstone for this common vision.

The EU Strategy for the Alpine Region (EUSALP) endorsed by the European Commission in 2015 is aimed to find ways to better use existing resources, legislation and structures for the benefit of the whole region[2]. The bio-based industries are emerging in most of the participating project regions. The Alpine Space counts with relevant assets to consolidate the transition towards circular bioeconomy: a) sufficient biomass, coming from agriculture, forestry and residues; b) a substantial critical mass of stakeholders, including well-matured clusters; c) regional strategies in place, though their different maturity; d) a post-pandemic need to enforce local versus global logistics, to be more resilient; and e) the new batch of Smart Specialisation Strategies (S3) and Operational Programmes 2021-27 acting as institutional instruments for a better alignment with the EUSALP.

The Masterplan aims at inspiring and contributing to the EUSALP integration in the seven countries (Austria, France, Germany, Italy, Liechtenstein, Slovenia and Switzerland) and 48 regions of the Alpine macro-region. The full deployment of the bioeconomy in the Alpine Space faces some challenges, that are closer to the ones inherent to the bioeconomy at European level:

- Lack of common definition for bioeconomy
- Lack of common indicators for harmonized data
- Lack of tailored cross-regional support schemes in place that allow interested actors to cooperate across borders
- Lack of commitment of most regions to align their regional strategies with the EUSALP

The Alpine Policy Forum on February 16, 2021 put together 125 stakeholders, mainly policymakers, regional agencies and clusters. Indeed, it was a good occasion to measure to what extent building synergies and working closer is expected or even needed. More than 30 surveys through the policy/industrial dialogues conducted for the roadmap (see Action B below) drew also interesting conclusions related to the current cooperation level among Alpine regions and its potential in a 2 years scenario.

The Bioeconomy Masterplan for the Alpine Space is driven by three ambitious goals:

- Unleashing potential: turning regional specificity into common assets and opportunities at macro-regional level
- Strengthening the macro-regional identity: paving the way for a renewed mindset, as outcome of the new batch of Smart Specialisation Strategies (S3) and more open regional frameworks
- Empowering digitalization: making broken bio-based value chains more robust against unforeseen circumstances i.e. pandemics.

The complete Masterplan is available on the AlpLinkBioEco project website[3]. For the purpose of this final publication, the key elements of the Masterplan have been summarized in four fields of action and five final recommendations.

[1] **BIOPRO Baden-Württemberg GmbH**

[2] https://www.alpine-space.eu/about/eu-regional-policy/macroregional-strategies

[3] https://www.alpine-space.eu/projects/alplinkbioeco/en/project-results/joint-masterplan-on-circular-bioeconomy

Action A - Funding opportunities and potential of the biomass in the mapped regions

Mateja Dermastia, Mateja Novak[4]

The research in each region[5] reveals that most of the regions do not follow a systematic approach when it comes to a strategic framework related to bioeconomy. Out of nine regions, four regions have national bioeconomy strategies (Auvergne-Rhône-Alpes, Upper Austria, Baden-Württemberg and Bavaria) and the two last have also a regional bioeconomy strategy in place. Lombardy is preparing a regional strategy and published a Roadmap for Research and Innovation on Circular Economy in May 2020, that has contributed to the definition of the new Smart Specialisation Strategy.

Most of the regions have the bioeconomy principles incorporated in wider regional and/or national strategies or they are embedded in their Smart Specialisation Strategies (Autonomous Province of Trento - Trentino, Baden-Württemberg, Lombardy, Slovenia, South Tyrol and Upper Austria), while in the canton of Fribourg the bioeconomy is one of the priorities of the new regional policy.

One of the enabling factors for the deployment of the bioeconomy are the funding programmes that provide different instruments, such as grants, loans, consultancy or networking services. Among them only two regions (Baden-Württemberg and Slovenia) are involved in transnational programmes such as EUREKA or EUROSTARS, which also shows the untapped potential for transnational partnerships, internationalization and new value chains that could be built within joint R&D projects funded by transnational programmes.

The funding opportunities in bioeconomy, circular economy or sustainability in each participating project region show relevant differences. A closer look at the funding opportunities reveals that the programmes in the Alpine Space most available are for R&D (53), development of technological or non-technological innovation (18) and creation of new innovative companies (17). The information provided by regions show that Slovenia has the highest number of funding programmes (30), followed by Auvergne-Rhône-Alpes (25) and Trentino (23), while Fribourg (5) and South Tyrol (4) have the least funding programmes with focus on bioeconomy.

When considering the thematic fields with high potential across regions, biomass resources coming from forestry, residuals from agriculture and municipal waste are among the sources with highest rate. The nine participating project regions identified the following priority thematic areas for cross-regional cooperation: forestry biomass (6 regions stated forestry biomass from primary source and 5 from secondary source), 6 regions deemed that the residuals from agriculture have a high potential in their region (5 regions stood for residuals from forestry and 5 from food respectively) and 6 regions assigned a high potential to municipal waste. The following Table 1 offers a general overview of the regional biomass potential by mapped region.

Table 1: Comparison of participating project regions based on potential of biomass availability and use (2018)[6]

[4] Poly4Eml hosted by Anteja ECG d.o.o.

[5] https://www.alpine-space.eu/projects/alplinkbioeco/en/project-results/regional-policy-inventory

[6] Adaptation from Table 3 in https://www.alpine-space.eu/projects/alplinkbioeco/policy-synthesis-report/d.t4.1.1-alplinkbioeco--synthesis-of-regional-reports-on-policy-instruments..pdf

BIOMASS RESOURCES IN ALPINE REGIONS

	AGRICULTURE	FORESTRY	BIOWASTE & RESIDUALS	FISHERIES & OTHER WATER ORGANISMS
Bavaria	**HIGH POTENTIAL** cereals, corn, winter rapeseed, hops livestock (pigs, cows)	**HIGH POTENTIAL** not meeting annual cutting rate 36 % of surface covered in forests annual harvest: 4.79 million m3	biowaste & residuals from: - food industry - cattle raising - agriculture - forestry and wood processing industry	low relevance
Baden-Württemberg	**MEDIUM POTENTIAL** agricultural land & certain livestock breeding in decline increase in poultry, goat breeding and organic farming	annual harvest: 11 million m3	biowaste & residuals from: - household organic waste - green cuttings, agriculture, aquaculture and forestry side streams	low relevance
Lombardy	strong sector with € 8.3 billion and more than 124.000 employees	Insufficient resources due to high divergence between natural resources and industrial sector use. Annual harvest 0.53 million m3	**HIGH POTENTIAL** but focus on reduction and production of bioenergy	aquaculture is one of the most important freshwater markets
Auvergne-Rhone Alps	**GOOD POTENTIAL** livestock plant sector	**HIGH POTENTIAL** but only 5.2 million m3 annual harvest	**GOOD POTENTIAL** - animal dung - sludge treatment - intermediate crops - end-of-life wood - waste from agri-food industry - biowaste	low relevance
Upper Austria	**MEDIUM POTENTIAL** cereals, root crops, oil plants	**VERY HIGH POTENTIAL** annual harvest: 17.65 million m3	**GOOD POTENTIAL** organic residues: biowaste, unused plant or animal by-products, household, industry, trade waste, sewage sludge, manure, slurry ...	low relevance
Slovenia		**GOOD POTENTIAL** 58 % of surface covered in forests annual harvest: 6 million m3	**GOOD POTENTIAL** - agriculture - waste from public utilities - organic landfill waste - organic kitchen waste - biodegradable waste from food processing industry	**GOOD POTENTIAL** due to algae production
Province of Trento	**GOOD POTENTIAL** 13.1 % cultivable area 62 % pastures and grasslands	**LOW POTENTIAL** 63 % of surface covered in forests, but only 0.34 million m3 annual harvest	**GOOD POTENTIAL** - 26 % waste residual biomass from sawmill processing - woody residuals from vineyards and apple cultivation - agri-food waste, wastewater sludge, food waste	**SOME POTENTIAL** due to aquaculture
Canton of Fribourg	strong sector poultry cattle farming fruits & vegetables	important sector for biomass supply	by-products of poultry and cattle farming (feathers, manure)	
South Tyrol	strong sector 89 % pastures, grassland, meadows 10% apples and vineyards dairy farming 37% of Province revenue	strong sector 42 % of surface covered in forests 60 million m3 of wood 23 % energy use	**GOOD POTENTIAL** - animal waste - agri-food waste - urban organic waste - wood waste from wood processing - woody agricultural residuals from vineyards and apples	low relevance

Table 1: Comparison of participating project regions based on potential of biomass availability and use (2018)

Action B - Prioritization of thematic areas for macro-regional cooperation

Pasqualina Sacco, Elena Rangoni Gargano[7]

Along the regional reports[8] completed in autumn 2018, more than 30 regional policy/industrial dialogues[9] were conducted in summer/autumn 2020 in all participating project regions; the input was used to draft the Roadmap for a common Alpine Space policy circular bio-based economy[10]. In those dialogues two questions were specifically referred to a macro-regional approach:

- What are in your opinion the main challenges to overcome in order to foster a common macro-regional approach to the circular bioeconomy in these specific thematic fields?
- Do you know best-practice examples of approaches at any administrative level which should be considered in the set-up of a macro-regional approach for the circular bioeconomy in the Alpine Space?

The interviewees were grouped in national policy stakeholders (NPS, 6 in total), regional policy stakeholders (RPS, 16) and industrial stakeholders (IS, 12). Some conclusions can be drawn: according to many NPS, a first big obstacle is the lack of harmonized standards among the different regions. There is no common multi-level governance in place, alongside with robust cross-departmental political structures. The absence of a common R&D policy represents a major shortcoming which could be overcome by supporting tools for sharing good practices in innovation governance. In this respect, the protection of intellectual property is necessary to create a network of regional actors and facilitate knowledge exchange among them. The harmonization of existing financial instruments is also an issue.

Most of the best practices mentioned in the survey are related to the industrial sector, regional networks and strategies, and European initiatives. Those practices were divided into four specific areas (Forestry & Wood, Agri-food, Bio-based industry, Chemical/Pharma) and three other transversal areas (Digitalization, Circular Economy and Sustainable Development). The Figure 1 below, that includes Governance as a transversal area, shows how each best practice is linked with more than one area.

[7] Fraunhofer Italia Research Scarl

[8] https://www.alpine-space.eu/projects/alplinkbioeco/en/project-results/regional-policy-inventory

[9] A detailed overview of the interviewees can be found in Table 2 of the Roadmap for a common Alpine Space policy circular biobased economy

[10] https://www.alpine-space.eu/projects/alplinkbioeco/d.t4.2.1-roadmap-for-a-common-alpine-space-policy-on-circular-bio-based-economy/alplinkbioeco--wpt4--roadmap.pdf

Figure 1: Matchmaking of best practices for macro-regional cooperation with main specific and transversal areas

Action C - Transnational dialogue with prioritization of dedicated actions

Sergi Costa, Olga Boyarintseva[11]

The potential topics for macro-regional cooperation are already identified[12]: bioenergy and biofuels, bio-based plastics (based on wood, starchy crops and algae) and plastics composites (based on wood, cork and hemp), pulp and paper products as high-tech products (i.e. printed conductors, fiber products with electronic application), biorefineries, food and feed (including food processing), biopharmaceuticals and bioconstruction.

The conducted policy/industrial dialogues in summer/autumn 2020 concluded that the current level of macro-regional dialogue on bioeconomy in each participating project region is medium-low[13]; till beginning of Autumn 2022 (a two year scenario) is expected to reach the medium-high level. In those dialogues, the Value Chain Generator (VCG) was rated as an item with high potential for the development of a common agenda for the Alpine macro-region. The possibility to identify and focus on emerging biolinks via the VCG can help to support the development of new value chains and contribute to implementing common strategies for specific sectors i.e. Forestry & Wood.

Through the policy/industrial dialogues six topics related to a common framework were considered to get an overview of their current level, and the expectations for progress in a near future (2 years). The main outputs show that a common policy, a common overall strategy and a common agenda are the three topics with highest potential to be exploited in the near future. As concluding remarks taken from policy-related project deliverables and the Alpine Policy Forum 2021, some dedicated actions to be prioritized for a richer transnational dialogue are pointed out:

- *Work politically towards a common vision*
  Among Alpine policy and industrial stakeholders, a willingness for a transnational dialogue on circular bioeconomy is emerging; it should be activated soon and be in progress by end of 2022.

- *Make it easy: use a single message*
  A common definition among regions is lacking; a first step of the transnational dialogue should aim to find a single definition by consensus; a common branding of the circular bioeconomy will increase public awareness and understanding of its potential among the Alpine citizens.

- *Embed the regional Smart Specialisation Strategies (S3) / Operational Programmes 2021-27*
  The new batch of S3 should be considered as an opportunity to facilitate cross-regional matchmaking within the Alpine macro-region and beyond. Circular bioeconomy can be used as pilot field for this embedding and funds from the new Cohesion Policy[14] can support this transition.

- *Synergize: use the existing EUSALP framework as lever for institutional collaboration*
  As an illustration, the set-up of synchronized models for support schemes should be aligned with the objectives of the EUSALP and can be streamlined by its Action Groups (AG).

- *Empower the role of clusters:*
  Clusters should act as catalyst or brokers for the circular bioeconomy transition, acting in the interface between policy and industry. Setting-up platforms (i.e. for mutual exchange) or transnational joint facilities for SMEs need from institutional support schemes, but also from clusters that know the regional specificity and are aware of the transnational opportunities.

[11] **BIOPRO Baden-Württemberg GmbH**

[12] **https://www.alpine-space.eu/projects/alplinkbioeco/en/project-results/policy-synthesis-report**

[13] **Chapter 6.3 in https://www.alpine-space.eu/projects/alplinkbioeco/d.t4.2.1-roadmap-for-a-common-alpine-space-policy-on-circular-bio-based-economy/alplinkbioeco--wpt4--roadmap.pdf**

[14] **i.e. Investment for jobs and growth - IJG goal**

Action D - Digitalization for resilient bio-based value chains

Mateja Dermastia, Mateja Novak[15]

Digital technologies change the way the industry and society exchange information, innovate, produce and consume. They lead to higher productivity and more innovation and create new channels to market. Prior to the Covid-19 pandemic, a shift towards digitalization was already underway, however, current events have accelerated the transition.
In order to identify the trends in value chains after Covid-19 breakout and to find out how digitalization can play part in making value chains more resilient in unforeseen circumstances, Anteja ECG conducted a survey among SMEs on value chain resilience and how digital tools helped SME to better cope with the negative effects, especially in case of supply chain issues. The preliminary findings of the survey presented at the Alpine Policy Forum showed the following:

1. In order to reduce the negative affect of their broken value chains, SMEs in the supply chain try to multi-source, shorten their value chains and find suppliers locally/regionally. However, the challenges they face are:
- difficulty to find suitable suppliers,
- it is a time-consuming process,
- it is difficult to find solutions for more robust value chains and new supply chain strategies.

Identified mitigation strategies to use digital tools to increase supply chain resilience:
- Virtual, digital platforms can help suppliers and buyers to connect, exchange demand and find alternative suppliers,
- Digital tools can be applied to help communicating/validating transparency and traceability of new suppliers.

2. Broken market structures are affecting retail, distribution channels, product portfolio optimization and are increasing online sales. It was revealed that the main issues do not come from the B2C market but from B2B segment, as SMEs lack the experience and capabilities to use digital support / tools.

Identified mitigation strategies to use digital tools to increase supply chain resilience:
- Market pattern transformed, consumer demands changed in time of COVID-19. Traditional sales channels did not function as before. Digital tools can help use new sales channels, like e-commerce, e-marketing or using social platforms for advertising bio-based products or services.
- Digital tools can help to develop and deploy new business models around bio-based products and services.

3. Covid-19 accelerated the digitalization of internal and external processes of SMEs. The two most important areas where SMEs intensified their digitalization are:
- communication with customers,
- communication and documentation with suppliers.

Identified mitigation strategies to use digital tools to increase supply chain resilience:
- Communication with customers and consumers matters and accelerated in times of COVID-19. The use of digital tools in this regard is almost a must, but at the same time they can help keep customers committed to the brand or related products.
- Customers and consumers are more and more interested to understand where the products are coming from, how they are sourced and manufactured. Social responsibility or environmental friendly productions are topics of increasing relevance. Businesses can use digital tools to document and communicate in a flexible and targeted way.

4. Overall, challenges faced by SMEs in the fast transformational process are:
- high cost of digitalization,
- lack of digital skills/access to talents,
- inappropriate digital readiness,
- lack of appropriate tools on the market to address their needs.

There is no doubt that these challenges are prevailing for SMEs. However, cost-benefit calculations clearly demonstrate the positive economic impact on a medium term when digital tools are applied in a targeted and efficient way.

The findings clearly show that Covid-19 accelerated the scaling of digitalization of bio-based value chains in the Alpine Space and digital tools such as the AlpLinkBioEco Value Chain Generator (VCG)

[15] Poly4Eml hosted by Anteja ECG d.o.o.

can help transform the value chains to become well-functioning, organized and resilient. Moreover, implementation of new digital solutions can have the following impacts:

- enhance traceability by integrating technologies in systems (IoT, Big Data, Artificial Intelligence),
- reduce risks in agricultural production, for example, detecting crop diseases early on in production, or risks related to emissions and climate change (drones can create detailed soil maps for damage control),
- allows better cooperation across value chains (digital applications can help farmers share machinery),
- improve efficiency in production, for example, the use of water and energy with smart farming technologies,
- increase resource efficiency with precision farming technologies,
- enable data sharing,
- engage smallholders in online platforms for marketing, distribution and exchange of knowledge with others,
- improve efficiency of the transportation systems to connect production and supply,
- improve storage systems, etc.

Recommendations

Mateja Dermastia, Mateja Novak [16]

Despite all the opportunities, there are still significant challenges on the way to a jointly implemented bioeconomy strategy in the Alpine Region. Bioeconomization of the industry within the Alpine Region will not be easy. It is unsure, expensive and cultural borders have to be bridged. The COVID-19 pandemic pushed the debate about sustainability and climate chain further.

To really move forward, we have to specifically address the four key challenges identified within the frame of the project:

- Challenge I: Lack of a common definition of bioeconomy.
- Challenge II: Lack of indicators for harmonized data.
- Challenge III: Lack of proper cross-regional support schemes that allow interested actors to cooperate across borders.
- Challenge IV: Lack of commitment of most regions to align regional strategies with EUSALP.

The recommendations of how to best address these four challenges with concrete actions are:

Recommendation I: Initiation of an Alpine Region dialogue related to a common understanding/ definition of bioeconomy

Proposed actions:

- Identify a smaller group of frontrunner Alpine regions in the field of bioeconomy.
- Gather responsible persons from these frontrunner regions that have a mandate to start a debate about a common understanding/definition of bioeconomy. So far, in most Interreg or ARPAF projects, the partners did not really have a mandate to act accordingly.
- Use established platforms, such as the EUSALP AG2 Sub-Group “Clusters & Bioeconomy”, to gather experts / regional representatives to kick-off said discussion.

[16] Poly4Eml hosted by Anteja ECG d.o.o.

Recommendation II: Identifying Alpine Region instigators to push the implementation of a common Alpine Region strategy forward

Proposed actions:

- The EUSALP AG2 Sub-Group "Cluster & Bioeconomy" or any well-established platform starts a process to identify such instigator(s) that can contribute to bring the implementation of an Alpine Region strategy for bioeconomy further.
- This action has to be well aligned with activities resulting from recommendation I.

Recommendation III: Expert workshop "Status-quo" of bioeconomy related data for the Alpine Region

Proposed actions:

- AlpLinkBioEco, the EUSALP AG2 Sub-Group "Cluster & Bioeconomy" or any well-established platform helps to identify a group of experts, able and willing to participate in such an event.
- Organizing the expert event with a limited number of participants to properly discuss the issue of availability of bioeconomy related data in the context of digital tools such as the AlpLinkBioEco Value Chain Generator (VG). It is important to also invite experts from outside the Alpine Region to learn how peer (macro) regions might have dealt with the data/indicator issues.
- Synthesis report of this workshop with dedicated follow-up actions needed to improve data availability on bioeconomy in the Alpine Region.
- Initiation of an ARPAF project with selected partners and experts to follow-up the key findings identified in the workshop and try to close the gap of missing data.

Recommendation IV: Initiate a common pilot funding scheme with selected frontrunner Alpine Regions that demonstrates the feasibility and impact of cross-regional cooperation

Proposed actions:

- Closely follow the ongoing activities related to the Innovation Express 2021 as well as by the Interreg project ARDIA-Net to understand how well synchronization to facilitate cross-border cooperation works in practice.
- Select 3 – 4 Alpine Regions that are able and interested to do a pilot call similar to the Innovation Express 2021. This action can be coordinated by the ARDIA-Net network or the EUSALP AG 2 sub-group "Cluster & Bioeconomy".
- Promoting the idea of setting up governance structures that enable cross-regional funding schemes on policy and programme agency implementation level to increase awareness and interest in these new kinds of support measures.

Recommendation V: Provide incentives for regions that are interested to align or coordinate their strategies with EUSALP

Proposed actions:

- Using established platforms, like ARDIA-Net or ALPGOV to start a dialogue between open-minded regions that are interested to align their Bioeconomy strategies or related programmes with the EUSALP strategy.
- Development of ideas on how to incentivize regional strategy alignments or cross-regional cooperation initiatives with EUSALP.
- Using good practices from outside the Alpine Region, e.g. the Baltic Sea Region, to learn how they succeeded in getting in touch with macro-regional strategies.
- Organize a policy forum under AlpGov or similar to present and discuss ideas/results from the dialogue.

Conclusions and Acknowledgements

Rudy Koopmans,
Lead Partner AlpLinkBioEco

Innovation starts with a vision of the future. The AlpLinkBioEco project is a major step forward to turn the vision of a sustainable bioeconomy into a reality. The project is also a demonstration of how a common purpose can enthuse diverse actors to collaborate. Collaboration is the essential key to start with a societal transformation. For companies and other stakeholders that have the ambition to commit to a bioeconomy it is critical to find the right partners for such a collaborative endeavor. This is what AlpLinkBioEco brings, the VCG tool, a smart digital assistant to boost collaborative efforts and create new value chains. Novel opportunities can be created for ensuring sustainable, economic prosperity at a regional level. The local strengths of resources and knowledge is leveraged regionally into a new network that exemplifies the regenerative economy of the future.

Making AlpLinkBioEco happen by delivering on the set forth objective was sometimes a stony road to travel. Perseverance however and keeping focused has provided not only the tools but also delivered a show case path for others to follow and for decision makers to set the right policies.

Creating a vision is one element but implementing the plan and the associated hard work of the many participating partners and their co-workers cannot be underestimated. A big thank you to all of you with my deepest respect for your commitment and contributions.

Nothing happens however without a project champion. Michael Keller, thank you for your tireless commitment.

Unfortunately, the COVID-19 pandemic does not allow me to congratulate you in person during the typical final get together. Nevertheless, this is a time to celebrate a major achievement! I hope you will find creative ways to enjoy the success of the AlpLinkBioEco project and your important contributions.

Fribourg, March 2021

Prof. Dr. Rudy Koopmans
Lead Partner AlpLinkBioEco
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AlpLinkBioEco was a big collaborative effort. Let the numbers speak for themselves.

Figure 4.1: The Project in Numbers

Project website:

https://www.alpine-space.eu/projects/alplinkbioeco/en/home

Youtube channel:

https://www.youtube.com/channel/UCWOknu-43q4Q4YI1PfRQnEQ

Acknowledgements

As Lead Partners at the Plastics Innovation Competence Center (PICC) of the School of Engineering and Architecture of Fribourg (HES-SO//FR HEIA-FR) we would like to express our gratitude to everyone who supported our project during the past three years. We had the privilege to be able to count on the expertise and involvement of multiple stakeholders. The daily management was backed by the team of Erica Torti, Alessandro Ingegno, Marisa Marini and Maria Rossetti at Confindustria Lombardia as communication managers, and Regina Bätje at Business Upper Austria as financial Lead Partner.

The design of the project idea significantly benefitted from the cooperation with the members of the EUSALP AG2 Sup-Group “Clusters and BioEconomy” and in particular with Gerd Meier zu Köcker (ClusterAgentur Baden-Württemberg).

The technical implementation of the project was organized under the responsibility of the different work package leaders. The value of their tireless efforts cannot be highlighted enough. The VCG tool was developed at the Institute of Complex Systems (iCoSys) of HEIA-FR under the lead of Andreas Fischer and his fantastic research team: Damien Goetschi, Jonathan Donzallaz and Beat Wolf. The piloting phase of the project was directed by Business Upper Austria and if the results of the experience were so encouraging it was to a significant degree thanks to the leadership of Dorian Wessely and Ashna Mudaffer who steered the ship through the complicated storm of the Covid pandemic. The research and policy-related activities benefitted from the extraordinary work of and coordination among Elisa Morganti, Luca Mion and Silvio Antonioni (all Hub Innovazione Trentino), Mateja Dermastia, Darja Osvald and Mateja Novak (all Poly4Eml hosted by Anteja ECG), Olga Boyarintseva, Sergi Costa, Dominik Patzelt and Mathias Palm (all BIOPRO Baden-Württemberg GmbH), and Pasqualina Sacco, Elena Rangoni Gargano, Riccardo Brozzi and Sara Boni (all Fraunhofer Italia Research Scarl).

Throughout the project, we could also count on the tireless support from the Joint Secretariat of the Alpine Space programme, in particular from Clotilde Mahé, Stefania Amorosi, Primož Skrt and Anne-Séverine Lay.

Our project participation as a Swiss partner would not have been possible without the funding of the New Regional Policy (NRP) and the much-appreciated support from our national Alpine Space Contact Point, in particular from Silvia Jost and Sébastien Rieben (ARE - Federal Office for Spatial Development, Switzerland), and from the Fribourg Development Agency, in particular from Alain Lunghi and Véronique Gruber.

We are also indebted to the members of our Advisory Board, Christian Patermann (ret. European Commission) and Riccardo Balestra (Federchimica), and to the Board’s chairman, Ulrich Daum (UetlibergPartners GmbH), whose involvement in the technical implementation of the project was a significant success factor. The different opportunities we had to exchange views with our Advisory Board were incredibly enriching, both on topics within and beyond the AlpLinkBioEco scope. Support from and time spent with UetlibergPartners GmbH (Ulrich Daum and Guido De Wit) was a highlight during the past three years.

But most importantly, our gratitude and thanks go to our wonderful project team, project partners and observers, everyone who worked on the project’s deliverables and activities during the last years. Even in front of our computers and with a mask on our face - it is thanks to you all that we continue to believe in the power and beauty of cross-regional cooperation!

Un Grand Merci, Herzlichen Dank, Hvala, Grazie Mille!

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- PP11: Plastipolis (FR): http://www.plastipolis.fr/
- PP12: France Clusters (FR): https://franceclusters.fr/
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- Regional Council Bourgogne-Franche-Comté
- Novachim
- Terralia
- VegePolys Valley
- Slovenian Ministry of Agriculture, Forestry and Food
- Bavarian State Ministry of the Environment and Consumer Protection
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- **Technologiezentrum Horb GmbH&Co.KG**
  Janet Rosenberger, Udo Eckloff.

- **Lombardy Green Chemistry Association**
  Diego Bosco, Ilaria Re, Fabiana Gatto.

- **Plastipolis**
  Sylvie Charrel, Patrick Vuillermoz, Maudez Ledantec.

- **France Clusters**
  Lisa Besnard, Xavier Roy, Victor Van Gucht.

- **Slovene Ministry of Education, Science and Sport**
  Gita Zadnikar, Tjasa Bericic, Katja Ceglar, Laura Kühn, Gregor Svajger.

- **Chemie-Cluster Bayern GmbH**
  Patrick Prühs, Magdalena Buch, Elisabeth Rieger, Laura Kühn.

- **Fraunhofer Italia Research Scarl**
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