

# Bio-based Business Opportunities Unearthed – The VCG Software Tool

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The Value Chain Generator (VCG) tool has been developed within the AlplinkBioEco project, co-financed by the **European Regional Development Fund** through the Interreg Alpine Space programme, and by the **New regional policy (NRP) of the Swiss Confederation and the Canton of Fribourg**.<sup>1</sup>

## Keywords

Bioeconomy, Bio-based Value Chains, Value Chain Generator (VCG), Software, Alpine Space

## Making the Bioeconomy Work – Business Opportunities and Value Chains

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.<sup>2</sup> 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.<sup>3</sup> 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 21<sup>st</sup> century.

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<sup>2</sup> 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](https://ec.europa.eu/info/research-and-innovation/research-area/bioeconomy_en).

<sup>3</sup> An inventory of capacities for a bio-based economy in the Alpine Space has been drawn up in the different reports produced during the Interreg Alpine Space project AlplinkBioEco and can be downloaded from the project website: <https://www.alpine-space.eu/projects/alplinkbioeco/en/home>

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).<sup>4</sup> 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 value chain describes a company’s *“technologically and economically distinct activities [performed] to do business”* (Porter, 2011, p. 75).<sup>5</sup> 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

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<sup>4</sup> Michael Porter and Mark Kramer (2011). The Big Idea: Creating Shared Value. *Harvard Business Review*.

<sup>5</sup> Michael Porter (2011). *On Competition*. Harvard Business Press.

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 potentials 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. This challenge was tackled over the last three years by the Interreg Alpine Space project AlpLinkBioEco, led by the Plastics Innovation Competence Center at the School of Engineering and Architecture of Fribourg and uniting 14 project partners from 9 regions of the Alpine Space.<sup>6</sup>

At the core of the project, the Institute of Complex Systems (iCoSys) at the School of Engineering and Architecture of Fribourg developed a Value Chain Generator (VCG) to provide a hands-on, data-driven approach to overcoming existing information gaps and to unearthing 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.

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<sup>6</sup> Project website: <https://www.alpine-space.eu/projects/alplinkbioeco/en/home>.

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.

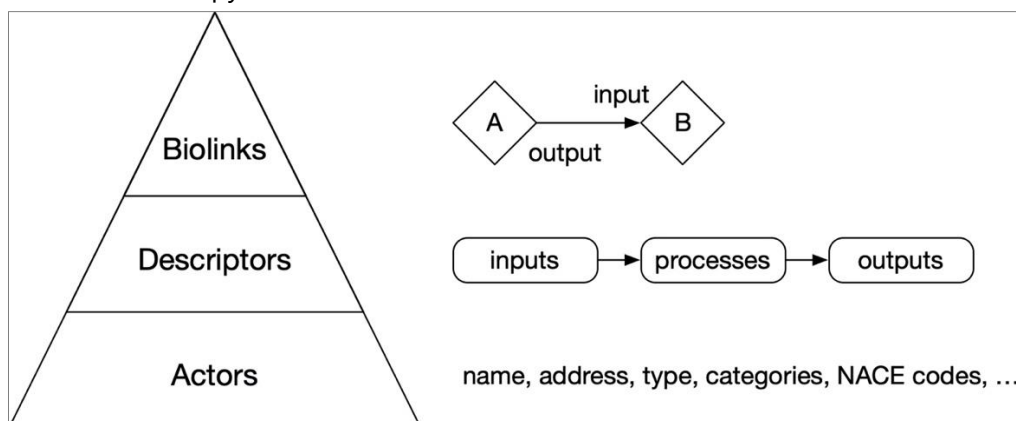
## The VCG Software Tool – Knowledge Base and Methods

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 the AlpLinkBioEco project. 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.

### The VCG Knowledge Base

In order to create value chains, the VCG requires data about the actors in the bio-based economy. Figure 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.

**Figure 1:** The VCG data pyramid



Source: Authors' elaboration.

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 organised 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 2.

**Figure 2:** Input-Process-Output descriptor of an actor using natural language

| <b>VC 1a: Production of natural tea; NACE 01.19, 01.28, 10.83, 46.37, 47.29</b>   |  |   |
|---|--|---|
| Growth of natural tea plants, production of natural tea   |  |   |
| Inputs:   | Processes:   | Outputs:  |
| <ul style="list-style-type: none"> <li>• Peppermint</li> <li>• Apple mint</li> <li>• Bee balm</li> <li>• citrous thyme</li> <li>• agastacha mexicana</li> </ul> | <ul style="list-style-type: none"> <li>• farming</li> <li>• harvesting</li> <li>• purchasing of raw material plants</li> <li>• mixing</li> <li>• processing of raw material plants</li> <li>• filling of tea bags</li> </ul> | <ul style="list-style-type: none"> <li>• natural tea</li> <li>• standardized tea blends</li> <li>• customized tea blends</li> </ul> |

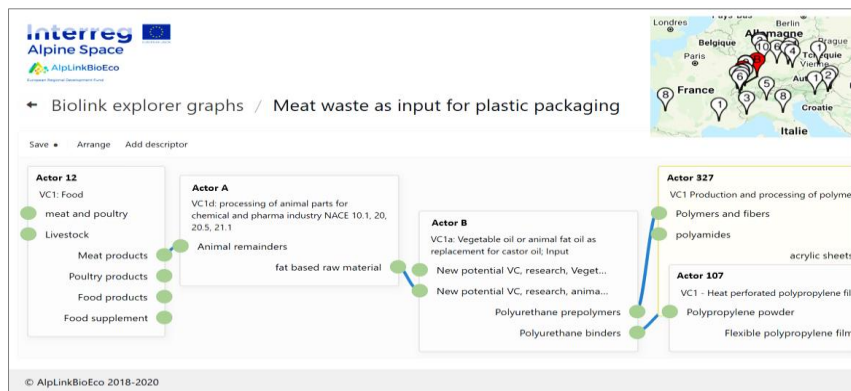
Source: Authors' elaboration.

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 working on a particular biolink in the real world.<sup>7</sup> 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 adaptations of a base idea that is confirmed in principle but requires additional actions to lead to value creation.

<sup>7</sup> As explained in further detail in the third section of this paper, extensive pilot experience from participating regions was documented during the implementation of the AlpLinkBioEco project. Project website: <https://www.alpine-space.eu/projects/alplinkbioeco/en/home>.

## Box 1: Discover the Value Chain Generator

### Discover the Value Chain Generator



Screenshot VCG Tool. December 2020.

### 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.

### Developers and Contact

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Source: iCoSys VCG Development Team

Damien Goetschi, Jonathan Donzallaz, Andreas Fischer, Beat Wolf, Michael Keller

## 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 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).

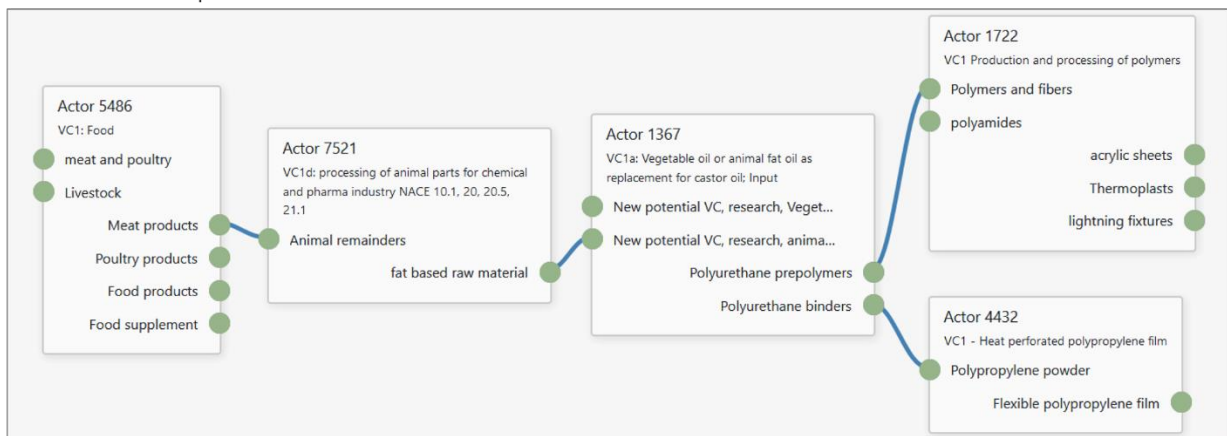
At a more elaborate level, the VCG provides a graphical user interface for creating and editing value chains in the form of graphs, as illustrated in Figure 3a. A value chain is a series of complementary activities of economic actors. Actors process inputs into outputs, used in turn by other actors as inputs for additional processes. The 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 3 for demonstration purposes. The edges of the value chain graph are biolinks based on matching inputs and outputs. The VCG interface allows to generate value chains in two steps. It allows to browse the knowledge base two-dimensionally, to scale up, so to speak, 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.

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 Figure 3b. 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 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. Descriptors discovered in this way can be linked and added as a new node to the value chain graph and documented as new biolinks in the knowledge base.

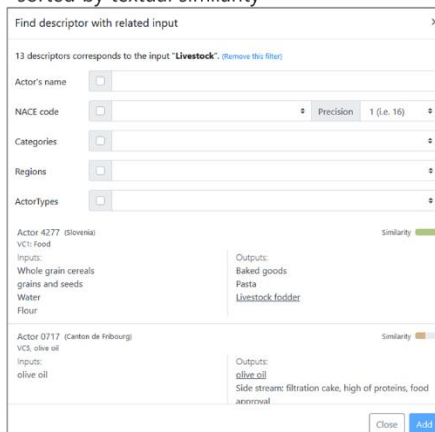
In the second step, the user can expand a value chain vertically by finding actors that are similar to those already added to a chain. When clicking on a descriptor, a search is performed to find alternatives that are similar to the actor of the descriptor. This is illustrated in Figure 3c. The alternative 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. Actors identified as similar can be added as an alternative to the node of the value chain graph. The functionalities of the similarity search are also directly available in the biolink list of the knowledge base.

**Figure 3:** The VCG interface for creating and editing new value chains

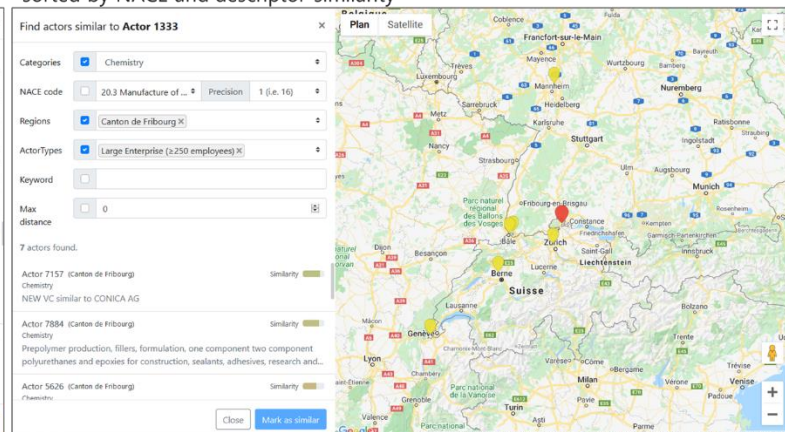
**3a:** Value Chain Graph



**3b:** Search for new biolinks sorted by textual similarity



**3c:** Search for similar actors sorted by NACE and descriptor similarity



Source: Authors' elaboration. Screenshots VCG Tool. January 2021.

## 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.<sup>8</sup>

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

<sup>8</sup> See next section of this paper.



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.

## **Defying the Pandemic – The VCG in Practice in the Alpine Space**

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 AlLinkBioEco. 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 above). 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 AlLinkBioEco 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 AlLinkBioEco 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 organising 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 – 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.<sup>9</sup> 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

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<sup>9</sup> The authors wish to thank Uli Daum (UetlibergPartners, Chariman of the AB), Christian Paternmann (Director EU Commission (ret.), Member of the AB), Riccardo Balestra (Federchimica, Member of the AB), Jacques Bersier (Deputy Director HES-SO//FR HEIA-FR), Rudolf Koopmans (Director PICC) and Guido De Wit (UetlibergPartners) for providing advice and support throughout the project.

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.

The pilot experience of the AlplinkBioEco project is documented on the project website and will be published in a series of case studies in the final project publication.<sup>10</sup> Table 1 gives an overview on the conducted piloting sessions. In addition, a series of videos has been published, in which the responsible project partners present their pilot experience on the project's youtube channel.<sup>11</sup>

**Table 1:** Piloting Sessions within the AlplinkBioEco project, 2020.

| 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.  |

<sup>10</sup> AlplinkBioEco (2021) (Forthcoming). *Creating bio-based Value in the Alpine Space – VCG Tool, Pilot Experience and Masterplan*. Interreg Alpine Space.

<sup>11</sup> AlplinkBioEco Youtube Channel: <https://www.youtube.com/channel/UCWOknu-43q4Q4Y11PfrQnEQ>

|   |                                      |   |
|---|--------------------------------------|---|
| Biorefinery from wet dredges of aromatic plants                 | Provence-Alpes-Côte d'Azur, Lombardy | Real potential for a cross-regional cooperation confirmed. Interested actors identified.  |
| Valorisation 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.            | Canton of Fribourg                   | 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, |

Source: Authors' elaboration.

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.

## Contact

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