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D2.2 – D2.2 Circular value chains modelling

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Deliverable description

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Abbreviations

D2.2	Deliverable 2.2 (Circular Value Chains Modelling)
WP2	Work Package 2
AECG	Anteja ECG (Author)
GA	Grant Agreement
LGCA	Lombardy Green Chemistry Association
SYMBIO chains	Shaping symbiosis in bio-based industrial ecosystems based on circular by-design supply
VCG	Value Chain Generator
VCG.AI	The digital platform tool used for modelling circular value chains
BioLinks end users	Identified circular value chains connecting waste producers, technology providers, and
ESG	Environmental, Social, and Governance
MCDMA	Multi-Criteria Decision Making Analysis
MFA	Material Flow Analysis
CBE JU	Circular Bioeconomy Joint Undertaking
REA	European Research Executive Agency



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Executive summary

The transition to a circular economy is essential for tackling climate change and promoting sustainable growth. It offers significant economic and environmental benefits by reducing waste and emissions while creating business opportunities and jobs. The European Union has taken a leading role in this shift, driving investments and policies to accelerate circular practices. However, progress remains slow due to challenges such as an overemphasis on waste management rather than preventive strategies like circular design. Many businesses hesitate due to concerns about long-term returns, while sustainability managers often focus on compliance rather than transformative initiatives. Unlocking circularity's full potential requires fundamental changes in supply chains, business models, and technologies.

The SYMBIO project and the Value Chain Generator (VCG) tool address this gap by leveraging AI and big data to map regional waste streams and resource availability, identifying viable circular business opportunities. The platform connects waste producers, technology providers, and buyers to facilitate the exchange of industrial residuals, generating economic and environmental value. Many companies, particularly SMEs, as well as regional developers and cluster managers, struggle to recognize and capitalize on waste-derived resources. Overlooking the potential of repurposing by-products into high-value applications means missing key opportunities for sustainability-driven business models. Advanced digital tools like VCG provide the insights needed to overcome these barriers and accelerate industrial symbiosis.

The **Circular value chains modelling (D2.2)**, an integral part of the **WP2 (Task 2.2)**, presents a **data-driven analysis of circular value chains across 12 European pilot regions** within the SYMBIO project. Using the VCG.AI tool, the study integrates diverse datasets—from companies and cluster information to regional biomass availability—to systematically map, model, and rank potential circular value chains. The methodology combined data collection, cross-referencing of feedstock sources, technology readiness, and market potential to identify 47 priority BioLinks. The analysis highlights high-potential value chains, such as converting barley straw to acetic acid, sugar beet to glycerol, forestry residues to PHA, and rice straw to sorbitol, each supported by robust local supply, established conversion technologies, and clear market demand.

Detailed assessments in regions including Andalusia, Brussels Capital, Wallonia, Flanders, Carinthia, Croatia, Slovenia, Emilia-Romagna, Friuli Venezia Giulia, Lombardy, Piedmont, and Veneto reveal diverse biomass streams—such as agricultural residues, forestry by-products, and whey—that can be transformed into high-value biochemicals. These insights highlight both regional strengths and potential supply chain challenges. The report emphasizes the transition from linear to circular production models, showing how the VCG.AI tool fosters industrial symbiosis by linking waste producers, technology providers, and end-users. This alignment is crucial for enhancing economic resilience, reducing emissions, and tapping into emerging bio-based market opportunities.

The findings of this report provide a foundation for further activities, including targeted workshops in Work Package 2, in-depth technical analyses in Work Package 3, and comprehensive economic and environmental assessments in Work Package 4. These efforts aim to refine and scale the most promising value chains.



1. Introduction

1.1 The Importance of the Circular Economy Transition

The transition to a circular economy has emerged as a critical priority in today's world, offering a promising pathway to address climate change and foster sustainable growth. As highlighted by the World Resources Institute, a circular economy could unlock more than €4.5 billion in business opportunities and create approximately seven to eight million high value-added jobs by 2030 [1], [2]. In addition to these economic benefits, the circular approach holds the potential to reduce global greenhouse gas emissions by up to 39% [3]. The European Union has positioned itself as a leader in this transition, committing over €10 billion through its Circular Economy Action Plan, including a significant contribution of €3.4 billion from the European Investment Bank, and bolstering these public investments with around €121.6 billion from the private sector [4].

Despite these ambitious efforts and substantial investments, progress toward achieving circularity has been slower than anticipated. The 2023 Circularity Gap Report reveals that only 7.2% of the global economy currently operates in a circular manner—a decline from 8.6% in 2022 and 9.1% in 2018 [5]. This trend is particularly alarming given the evolving consumption patterns and the forecasted 70% increase in waste generation by 2050 [6]. A major factor impeding progress is the prevalent focus on waste management rather than on preventive measures like circular design, which is crucial for a successful transition [7]. With over 100 billion tonnes of resources, ranging from metals and minerals to fossil fuels and organic materials, being consumed annually, the absence of systemic changes in supply chains and business models will continue to constrain the full potential of the circular economy [8].

The clear advantages of embracing circularity – such as cost savings, the creation of new revenue streams, enhanced profitability, green job growth, and significant reductions in CO₂ emissions – contrast sharply with the sluggish integration of these practices into business operations. Many companies remain hesitant, often citing concerns that the return on investment may require a decade or more to materialize. For industries to remain competitive in the rapidly evolving market landscape, there is an urgent need to re-examine and transform value chains, business models, materials, technologies, and processes. Yet, numerous organizations lack the necessary resources, expertise, or time to navigate these changes effectively.

Transitioning from traditional linear models, often described as “Cradle to Grave”, to regenerative, closed-loop systems, or “Cradle to Cradle,” introduces additional layers of complexity [9]. Sustainability managers across manufacturing, services, and finance are frequently driven by the immediate demands of Environmental, Social, and Governance (ESG) reporting, which can overshadow longer-term strategies such as supply chain decarbonization and the adoption of circular business models [10]. These strategies require in-depth insights into emerging technologies, innovative materials, and shifting market dynamics. It is exactly at this point that the SYMBIO project facilitates the capabilities of the Value Chain Generator (VCG) tool, capable of mapping value chain potential based on regional waste products and resource availability to reveal business opportunities that have a high return on investment along with a significant reduction of GHG emissions.

As a deep-tech cloud platform, VCG leverages artificial intelligence and big data to digitally construct circular value chains, enabling the dynamic exchange of industrial residuals among millions of companies committed to circular practices. The platform intelligently identifies economically viable, environmentally impactful, and technologically feasible synergies among three critical stakeholders: waste producers, technology providers who convert waste into valuable raw materials, and buyers who utilise these recycled materials. By automating the discovery and validation of circular opportunities through an extensive, data-driven approach, VCG effectively bridges the gap between potential and realisation.



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For regional developers, cluster managers, and small and medium-sized enterprises (SMEs), the challenge often lies in recognising and harnessing the untapped potential within their waste streams and underutilised resources. Many SMEs, for example, are unaware that by-products such as brewery residues could be repurposed into valuable components for the nutraceutical and pharmaceutical industries. This knowledge gap results in missed opportunities for developing sustainable and economically viable business models.

Similarly, cluster managers and regional developers, who play a pivotal role in facilitating interactions among businesses and stakeholders, often lack the advanced tools necessary to analyse the intricate relationships between resources, processes, and markets. The ability to decipher these complex interactions is essential for fostering innovative, circular business models that can drive the transition to a more sustainable economic framework.

1.2 Scope of the Deliverable 2.2 and project Alignment

This report is part of the **WP2 - Shaping value chains through big data and artificial intelligence tools by empowering industrial biobased ecosystems**, which aims to use the VCG.AI to build CBE value chains in Europe with industrial symbiosis capabilities to leverage local CBE potential and untapped resources. It includes mapping and integrating industrial ecosystem stakeholders within 12 pilot regions, integrating data into VCG.AI and empowering companies, clusters/business networks, and policymakers to identify and build CBE BioLinks.

This report is part of the **Task 2.2 Circular value chains modelling**, with two main objectives:

- Identifying and modelling of circular value chains using VCG.AI.

This involves following the VCG.AI methodological steps for uncovering circular value chains in each of the 12 regions of the SYMBIO project. The results are 47 defined circular value chains (or BioLinks) identified as priority solutions.

- Aligning with broader project goals

The findings of this deliverable will serve as a backbone for further efforts being done in Work Package 2, Work Package 3 and Work Package 4. The influence will therefore be threefold:

1. Contribution to WP2 Workshops (Deliverable 2.3): The prioritisation of value chains will serve as entry material for the 2-day workshops, where the uncovered solutions will be presented to the regional industry to get their feedback and willingness for participation.
2. Integration into WP3 Analysis (Task 3.1): The 47 BioLinks presented in this work package are going to be further analysed with the Multi-Criteria Decision-Making Analysis (MCDMA) and Material Flow Analysis (MFA). Based on these evaluations, out of the 47 BioLinks identified, approximately 10 industrial symbiosis models will be selected for further development.
3. Input for WP4 Economic & Environmental Assessments: The assessments done in this task - including the technology process, feedstock and market assessments, will serve as an input for more detailed analysis of economic and environmental impacts performed in the Work Package 4 (Task 4.1., 4.2., and 4.3).

By systematically identifying and integrating circular value chains, this report contributes to the overall ambition of SYMBIO, establishing sustainable, data-driven industrial ecosystems that optimize bio-based resources and foster regional economic and environmental resilience.



2. Methodology

2.1 Data Collection and Preprocessing

In the completed Task 2.1. Companies/Clusters mapping and VCG.AI enhancing that included gathering companies and clusters in Pilot regions, partners were asked to fill in an Excel sheet with company and cluster information for each of the twelve regions. Two data collection templates in Excel were created: one related to the companies and the other to cluster organisations. Project partners were asked to collect the public information (revenue, industry, name, address, short description etc.) from companies and clusters in their regions. The objective was to collect information on at least 200 companies and 20 clusters. Altogether, the project partners collected 579 companies and 102 clusters across the 12 regions. This data was then used in the subsequent analysis done in this task.

2.2 Explanation of the approach

Data gathering and consolidation

The following data was used in this deliverable:

1. Datasets containing (i) local companies and their respective sectors, key products, and capabilities (from D.2.1), and (ii) regional biomass availability figures for the primary and secondary feedstocks of interest (from D1.2.).
2. A master table of potential bioproducts (e.g., lactic acid, glycerol, succinic acid) and the corresponding biomass feedstocks and processing technologies (from D1.2.).
3. A VCG dataset of companies containing altogether 1.761 companies that fall in the scope of bioeconomy from the 12 regions in the SYMBIO project.
4. A VCG dataset of more than 13.000 infrastructural objects that deal with biomass (e.g. biogas plants, incineration plants).

Filtering and selection of top biomass flows

1. The top five secondary biomass flows were identified based on production volume. This ranking helped focus on the most abundant or strategically significant feedstocks for further analysis.
2. For each of these top biomass flows, the relevant product pathways were filtered out from the master table (e.g., barley straw → succinic acid, acetic acid, etc.).

Value chain extraction and matching with regional companies

1. From the narrowed set of bioproduct routes, only those chains that could use the top five feedstocks were extracted.
2. These chains were cross-referenced with the compiled list of companies, mapping (i) potential feedstock suppliers (e.g., agriculture or milling firms), (ii) technology/processing partners (e.g., pilot or commercial-scale fermentation plants), and (iii) market off-takers (e.g., dairy or bakery industry if they could use the derived products).

Ranking and summary of best value chains

1. Value chains were prioritised based on (i) the number of potential partners (feedstock producers, technology providers, and final markets), (ii) the readiness of technology (e.g., pilot vs. full-scale), and (iii) the strategic importance of the end product (e.g., high-value chemicals or established market demand).



2. The top-ranked chains were summarised in a concise table, dividing them by (a) Feedstock, (b) Tech readiness and partners, and (c) Market uptake. This facilitated quick identification of where gaps or strengths lay.

Infrastructure overlap and competition analysis

1. The information on regional bioeconomy infrastructure (e.g., waste-to-energy plants, biodiesel refineries, composting facilities) was mapped.
2. By overlaying the location and capacity of these facilities with our chosen value chains, potential competition for the same biomass resources was assessed. Any overlaps (e.g., a feedstock also in demand by a waste-to-energy plant) indicated potential supply constraints or partnership opportunities.

Observations and gaps

1. Technology Gaps: Identified routes with limited pilot/demo facilities or underdeveloped technology readiness.
2. Feedstock–Market Alignment: Highlighted cases where feedstock supply is high but local industrial offtakers are scarce, or vice versa.

This structured approach, combining data filtering, cross-referencing of feedstock suitability, ranking of potential routes, and analysis of existing infrastructure, ensures a comprehensive assessment of the most viable value chains for regional bioeconomy development.

2.3. Possible value chains identified in D1.2

The basis for the prioritisation of value chains per region was the work done in D1.2, where the main routes for 12 platform chemicals were identified and form a pillar for SYMBIO work as these are the value chains the project is focusing on (**Table 1**).

Table 1 The list of 12 platform chemicals prioritised in SYMBIO project.

Biomass Types (Grouped)	Key Technologies	Product
<ul style="list-style-type: none"> • Lignocellulosic: Barley, Cottonseed Meal, Alfalfa Fiber, Forestry Residues, MSW • Protein Residues: Whey Protein Hydrolysate 	<ul style="list-style-type: none"> • Enzymatic Hydrolysis • Fermentation 	Lactic Acid
<ul style="list-style-type: none"> • Oil Crops & Animal Fats: Canola, Rapeseed, WCO, Animal fats • Sugar Feedstocks: Corn, Sugarbeet, Molasses 	<ul style="list-style-type: none"> • Enzymatic Hydrolysis • Saponification • Transesterification • (Fermentation for sugar feedstocks) 	Glycerol
<ul style="list-style-type: none"> • Lignocellulosic: Corn Stover, Wheat/Rice/Barley Straw, Forestry Residues, MSW 	<ul style="list-style-type: none"> • Enzymatic Hydrolysis • Fermentation 	Succinic Acid
<ul style="list-style-type: none"> • Lignocellulosic: Corn Stover, Wheat/Barley Straw, Forestry Residues 	<ul style="list-style-type: none"> • Enzymatic Hydrolysis • Fermentation 	Acetic Acid
<ul style="list-style-type: none"> • Oil Crops: Rapeseed, Canola • Lignocellulosic: Forestry Residues, Corn Stover, Rice Straw 	<ul style="list-style-type: none"> • Enzymatic Hydrolysis • Transesterification • Direct Fermentation • Fermentation + Chemical Hydrogenation 	Adipic Acid



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● Starch/Sugar Crops: Corn, Sugarbeet, Wheat	● Fermentation ● Condensation ● Polymerization	PLA
● Lignocellulosic: Corn Stover, Wheat Straw, Forestry Residues, MSW- Oil Crops/Waste: WCO, Canola	● Enzymatic Hydrolysis (if lignocellulosic) ● Fermentation	PHA
● Lignocellulosic/Sugar-based: Corn Stover, Wheat Straw, Molasses	● Fermentation	Lysine
● Lignocellulosic/Sugar-based: Corn Stover & Syrup, Wheat Straw, Rice Straw, Molasses	● Fermentation	Glutamic Acid
● Sugar-based or Lignocellulosic: Corn Steep Liquor, Crude Glycerol, Corn Stover, Wheat Straw, Rice Straw	● Enzymatic Hydrolysis (where needed)- Fermentation	1,3-Propanediol
● Lignocellulosic: Forestry Residues, MSW, Maize Cobs, Corn Stalks, Rice Husks, Wheat/Barley Straw	● Acid Hydrolysis ● Catalytic Systems ● Solvent-Thermal Conversion	Furfural
● Starch/Sugar Crops: Wheat, Corn- Lignocellulosic: Rice Straw	● Catalytic Transfer Hydrogenation (CTH) ● Enzymatic Hydrolysis ● Fermentation	Sorbitol



3. Results and Analysis: Overview of identified circular connections

Across the 12 European regions as part of the SYMBIO, a wide diversity of biomass feedstocks, ranging from agricultural residues (e.g., wheat straw, corn stover, rice straw) to forestry residues and by-products (molasses, whey protein hydrolysate), can be transformed via various biotechnological, chemical, or hybrid processes into value-added products such as organic acids (lactic, succinic, acetic), platform chemicals (glycerol, sorbitol, furfural, 1,3-propanediol), and biopolymers (PHA, PLA). Some regions, like Andalusia and Piedmont, have high potential biomass tonnages exceeding two million tonnes per year, signalling significant opportunities for large-scale production. The data also show variation in the local company ecosystems: certain regions (e.g., Lombardy, Piedmont, Carinthia) host a larger number of producers, technology providers, and downstream market application firms, suggesting stronger innovation clusters. Overall, these findings illustrate both the substantial potential for circular bioeconomy value chains across Europe and the need for targeted investment, technological advancement, and cross-sector collaboration to realize that potential at scale.

3.1. Andalusia

3.1.1 Mapping Companies and Biomass

Companies

The Andalusia region of Spain, with its diverse range of industries, offers several promising opportunities for circular value chains. A total of 57 companies, falling in the scope of bioeconomy, were identified as shown in **Table 2**. The companies were then connected to the possible value chains.

Table 2 List of companies from Andalusia.

Feedstock / Sector	Number of Companies	Key Companies (Examples)	Core Activities
Brewery Industry	11	<ul style="list-style-type: none"> • Heineken España • Cervezas San Miguel • Cervezas Alhambra 	Large-scale beer production, craft brewing.
Dairy Industry	9	<ul style="list-style-type: none"> • COVAP • Lactalis Puleva • Queso Payoyo 	From large-scale dairy processing to artisanal cheese production and commercialisation.
Rice Farms	5	<ul style="list-style-type: none"> • Herba Ricemills • Arrozúa S.C.A. • Pevesa Biotech 	Rice cultivation, drying, storage, processing, and specialized biotech applications.
Sugar Beet	2	<ul style="list-style-type: none"> • AB Azucarera Iberia • Azucarera del Guadalfeo 	Sugar extraction/refining and by-product utilisation (molasses, logistics, packaging).
Vegetable Oils	4	<ul style="list-style-type: none"> • DEOLEO • Sovena Group • ACESUR 	Olive/vegetable oil production, marketing, biodiesel/bioproducts, and sustainability innovations.
Sawmills / Wood	4	<ul style="list-style-type: none"> • Andamasa • Serrería Almeriense • Ologimasa 	Wholesaling wood, sawmill operations, wood by-product recycling, and pellet manufacturing.
Bakery & Snacks	9	<ul style="list-style-type: none"> • Panadería Obando • Bimbo Donuts Iberia • Unión Harinera 	Bread, pastries, flour milling, potato chips, and other baked goods for domestic and international markets.



Biofuels	11	<ul style="list-style-type: none"> ● Ecocastulum ● Lípidos Santiga ● BioOil ● CEPESA bioenergía San Roque 	Biodiesel and biomass production (solid biofuels, waste-to-energy), renewable energy plants, R&D in circular processes.
Biogas	1	<ul style="list-style-type: none"> ● Aborgase 	Waste management and biogas generation from organic residues.
Furniture / Carpentry	1	<ul style="list-style-type: none"> ● Carpingue 	Wood carpentry, furniture production, and small-scale manufacturing.

Additionally, to enhance the list, 12 companies from the VCG database that could participate in these value chains were added.

Biomass

Biomass numbers, shown in **Table 3**, were sourced from the analyses conducted as part of the Deliverable 2.1.

Table 3 Top 5 biomasses in Andalusia.

Top 5 biomasses	Production Volume (tonnes)
Forestry Residues	2,790,600
Rice Straw	934,920
Sugarbeet	130,823.75
Barley Straw	107,006.10
Alfalfa Fiber	87,574

Results

Table 4 presents an updated and classified overview of the values of the five main biomasses, showing key aspects such as:

1. Potential products from each feedstock.
2. Key processors / partners (those directly linked to sourcing or handling that biomass).
3. Potential technology providers (biotech/processing enablers).
4. Potential local markets—i.e., companies from all the data you’ve provided that might use or buy each product.

Value chains are ranked based on the number of engaged stakeholders, including feedstock suppliers, technology providers, and potential buyers. A higher level of participation across these categories results in a higher ranking.



Table 4 Potential value chains for Andalusia.

Rank	Feedstock	Potential Products	Key Processors / Partners	Tech Providers	Potential Local Markets
1	Barley Straw	Succinic Acid, Acetic Acid, Furfural	Breweries (Heineken, San Miguel, Alhambra, Victoria, etc.) → 11 total	Pevesa Biotech (enzymatic/fermentation) Biomasa del Guadalquivir (logistics, pretreatment)	Acetic Acid → Agro Sevilla Aceitunas (olives), Acesur (vinegar/sauces), Fapanys (bakery). Succinic Acid, Furfural → No direct local user listed. Potential R&D interest (Ecocastulum), or general chemical markets. <i>(Overall: multiple breweries + local acidulant users = wide synergy.)</i>
2	Forestry Residues	Lactic Acid, Succinic Acid, Acetic Acid, Adipic Acid, PHA, Furfural	Sawmills (Andamasa, Serrería Almeriense, Carpingue, Recicladós Lucena, Ologimasa) Biofuel/Biomass (HENCE, Biomasa del Guadalquivir, Alcolea, Biomasa Córdoba)	Biomasa del Guadalquivir (collection, pretreatment) Pevesa Biotech (some fermentation overlap)	Acids (lactic/succinic/acetic) → potential in Agro Sevilla, Andros Granada, Fapanys (food acidulants). Adipic Acid, PHA → Condaplast, Nuvaria Global (bio-based plastics). Furfural → industrial chemical intermediate. No direct user specified; possible synergy with resin or chemical firms. <i>(Wide array of potential products + multiple local biomass handlers + local plastics sector.)</i>
3	Alfalfa Fiber	Lactic Acid	Dairy (COVAP, Lactalis Puleva, Quesos Payoyo, etc.) → 9 total	Pevesa Biotech	Lactic Acid → Agro Sevilla Aceitunas, Andros Granada, Fapanys as acidulant/preservative. <i>(Direct synergy: dairies produce/have direct feed interest in alfalfa; lactic acid can feed broader local food usage.)</i>



4	Rice Straw	Succinic Acid, Adipic Acid, Glutamic Acid, 1,3- Propanediol (1,3-PDO), Sorbitol	Rice (Herba Ricemills, Arrozúa, Doñarroz, Arroces de Doñana, Pevesa Biotech [protein]) Biomass (HENCE, Biomasa del Guadalquivir)	Pevesa Biotech (deep rice-based expertise) Biomasa del Guadalquivir	Sorbitol → Andros Granada (confectionery), Fapanys (bakery) as sweetener/humectant. Glutamic Acid → flavour enhancer for Agro Sevilla Aceitunas, etc. 1,3-PDO → Sohim Iberia (cosmetics), or used in advanced polyesters with Condaplast, Nuvaria. - Adipic/Succinic → Condaplast, Nuvaria Global (resin/plastics). <i>(Good synergy with local food/cosmetic/plastics industries.)</i>
5	Sugarbeet	Glycerol, PLA	AB Azucarera Iberia de Guadalete Azucarera del Guadalfeo (Div. C.M.S.)	Azucarera del Guadalfeo (C.M.S.) (sugar by-product expertise) Pevesa Biotech (secondary fermentation)	Glycerol → Persan SA (makes/refines glycerin, soaps, detergents). Could also go to Romero Alvarez (edible oils) or Andros Granada, Fapanys (as humectant), Fábrica de Municiones (nitroglycerin?), etc. PLA → Condaplast, Nuvaria Global (plastics). Possibly used in packaging for major food/beverage companies (Heineken, Bimbo, Lactalis, etc.). <i>(Key synergy: Persan is a major local user of glycerol.)</i>

In particular, the table should be interpreted as follows:

- Barley Straw is top-ranked due to many breweries plus new local acidulant markets (Agro Sevilla, etc.).
- Forestry Residues has broad potential (6+ possible products) and synergy with sawmills, biofuel plants, and the growing local bioplastics sector (Condaplast, Nuvaria).



- Alfalfa Fiber (lactic acid route) ties closely to the dairy and food acidulant markets.
- Rice Straw yields multiple specialty chemicals (sorbitol, glutamic acid, 1,3-PDO, etc.) and could serve local confectionery/cosmetics/plastic industries.
- Sugarbeet synergy is especially strong for glycerol (soap/detergents via Persan SA), plus PLA for local plastics packaging.

Table 5 provides a concise summary showing each biomass value chain, divided into feedstock partners, technology providers, and markets. The Total column is the sum of those partners. The ranking (1 to 5) reflects the overall involvement across the supply chain.

Table 5 Potential partners in the value chains.

Rank	Biomass	Feedstock (#)	Tech (#)	Market (#)	Total
1	Barley Straw	11	2	3	16
2	Forestry Residues	9	2	4	15
3	Alfalfa Fiber	9	1	3	13
3	Rice Straw	5	2	6	13
5	Sugarbeet	2	2	6	10

This breakdown highlights existing gaps within the value chains. For example, Barley Straw has an abundance of feedstock partners but fewer final “markets” for succinic acid or furfural, whereas Rice Straw has fewer direct feedstock handlers but a broader set of specialty-chemical markets.

3.1.2 Prioritisation of circular value chains

A wide range of potential circular value chains has been identified for each pilot region. However, to determine the most strategic value chains that will serve as key inputs for WP3 and the WP2 workshops, a prioritisation process is essential.

For this reason, the best value chains have been selected for each pilot region based on the following criteria: (1) have a strong fit between feedstock availability, (2) viable technology routes, and (3) a clear local market (or multiple markets) for the resulting bio-based product. These chains stand out as particularly actionable within the data that was provided during the SYMBIO project.

Below is a list of the **top value chains identified for Andalusia:**

1. BARLEY STRAW → ACETIC ACID

- **Ample Feedstock:** Barley straw is generated alongside the barley grain supply for numerous breweries in the region (Heineken, San Miguel, Alhambra, etc.).
- **Straightforward Process:** Enzymatic hydrolysis + fermentation can yield acetic acid.
- **Local Market:**
 - Acesur uses vinegar in sauces.
 - Agro Sevilla Aceitunas might use acetic acid for pickling/brining olives.
 - Fapanys (bakery) can also use it in dough conditioning.



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2. SUGARBEET → GLYCEROL

- Well-established sugar production: AB Azucarera Iberia de Guadalete and Azucarera del Guadalfeo (C.M.S. Division) already handle beet or molasses.
- Process: Fermenting sugar streams (after enzymatic hydrolysis) to glycerol is a proven technology.
- Local Market:
 - Persan SA explicitly refines and uses glycerin in soaps/detergents—this is a direct, high-volume industrial demand.
 - Food manufacturers (like Andros Granada or Fapanys) may use smaller amounts of glycerol as a humectant.

3. FORESTRY RESIDUES → PHA (Polyhydroxyalkanoates)

- Large feedstock pool: multiple sawmills and biomass collectors (Andamasa, Serrería Almeriense, Carpingue, Recicladados Lucena, Ologimasa, Biomasa del Guadalquivir, etc.).
- Established tech: converting cellulose/hemicellulose to fermentable sugars for PHA is well-known at pilot and commercial scales.
- Local Market:
 - Condaplast and Nuvaria Global both produce or compound plastics—ideal for adopting bio-based resins like PHA.
 - Food/drink companies (Heineken, Bimbo, Lactalis, etc.) could eventually seek biodegradable packaging.

4. RICE STRAW → SORBITOL

- Among rice straw's multiple high-value options, like glutamic acid, 1,3-PDO, or adipic acid, sorbitol stands out for having very tangible local food markets.
- Accessible Feedstock: Rice straw is plentiful around Herba Ricemills, Arrozúa, Doñarroz, and Arroces de Doñana.
- Viable Process: Sorbitol can be produced via enzymatic hydrolysis → sugar fermentation, or direct catalytic hydrogenation of glucose.
- Local Market:
 - Andros Granada (confectionery) could potentially use sorbitol as a sweetener/humectant in candies.
 - Fapanys (bakery) could use sorbitol in low-sugar or sugar-free bread/pastries.
 - Potentially other snack companies for sugar-free products.

These four chains feature clear feedstock availability, known technologies, and identifiable local buyers, making them the most “turnkey” among the options presented.

3.1.3 Existing infrastructure

This section provides an overview and analysis of whether the four proposed value chains (barley straw → acetic acid, sugarbeet → glycerol, forestry residues → PHA, rice straw → sorbitol) would face feedstock competition or “lock-in” from the existing bioeconomy infrastructure that is listed. The assessment examines potential overlaps in raw material use and potential market/processing competition with the



facilities. The list of facilities was sourced from the VCG database, which includes more than 13.000 existing infrastructure collected from open-source data like CBE JU and IEA Bioenergy among others.

1. BIOCUM ENERGIA S.L. (Huelva): Producer of biodiesel (FAME). Typically uses waste cooking oils, animal fats, or possibly virgin vegetable oils. Produces crude glycerol as a by-product
2. CEPSA (San Roque, Cádiz): producer of Biodiesel (FAME). Similar feedstocks as above (waste oils/fats or oilseeds). Produces glycerol as a co-product.
3. CEPSA REFINERIA LA RÁBIDA (Palos de la Frontera): Refining animal by-products.
4. BIO-OILS, S.L.U. (Palos de la Frontera): Biodiesel / fats processing. Uses canola/rapeseed or used cooking oils, producing glycerol side-streams.
5. Menzies Aviation / United Aviation - LEMG (Málaga) & LEZL (Sevilla): producer of SAF (via hydroprocessing, etc.). Reliant primarily on used cooking oil, tallow, or other "lipid" feedstocks.

The common denominator is that all these facilities use lipid feedstocks (fats/oils) to produce biodiesel or SAF. Glycerol is a by-product of transesterification but typically originates from triglyceride sources (e.g., rapeseed, used cooking oil).

Potential Overlaps

Barley Straw → Acetic Acid

- Feedstock: Barley straw (lignocellulosic residue).
- No Overlap: None of the existing biodiesel/SAF plants use straw (they all focus on waste oils/fats).
- Conclusion: No direct competition for barley straw from these facilities.

Sugarbeet → Glycerol

- Feedstock: Sugarbeet (fermenting sugar streams to glycerol).
- Potential Market Overlap:
 - The existing biodiesel plants also produce glycerol (from fats/oils). This is a product-level overlap rather than a feedstock overlap.
 - Feedstock Competition: None, because they use lipids not sugar.
- Market Dynamics: The region already has a glycerol supply from the biodiesel sector, so introducing sugar-based glycerol might face market competition from the established glycerol by-product. However, it also means there is existing refining capacity (e.g., some plants refine crude glycerol to higher purity) that could be leveraged by sugar-based glycerol producers.

Forestry Residues → PHA

- Feedstock: Woody lignocellulose.
- No Overlap: The existing biodiesel/SAF plants do not use forest biomass. They require lipids for transesterification/hydroprocessing.



- Conclusion: No feedstock competition here.

Rice Straw → Sorbitol

- Feedstock: Rice straw (lignocellulosic residue).
- No Overlap: Again, the existing infrastructure uses oils/fats, not straw.
- Conclusion: No direct competition for rice straw feedstock.

In short, the biggest overlap is on the finished product side (glycerol), not on feedstocks.

3.2 Brussels Capital

3.2.1 Mapping Companies and Biomass

Companies

In the Brussels Capital region, the biomass sources are on a smaller scale (e.g., about 12,000 tonnes of molasses and sugarbeet annually). Altogether from the Brussels region, a total of 2 companies, falling in the scope of bioeconomy, were identified as shown in **Table 6**. The companies were then connected to the possible value chains.

Table 6 List of companies from Brussels Capital.

Feedstock / Sector	Number of Companies	Key Companies (Examples)	Core Activities
Dairy Industry	1	Yakult	From industrial dairy processing to artisanal cheese-making and sales.
Bakery industry	1	Éclair (SA)	A pastry shop specializing in artisanal pastries. They are a division of the Carrefour Group.

Additionally, to enhance the list, 43 companies from the VCG database that could participate in these value chains were added.

Biomass

Biomass numbers, shown in **Table 7**, were sourced from the analysis conducted as part of the Deliverable 2.1.

Table 7 Top 5 biomasses in Brussels Capital.

Top 5 biomass (secondary)	Production volume (tonnes)
Corn steep liquor	630,316.4
Molasses	9,240
Wheat straw	4,386.125
Wheat	4,385,125
Sugarbeet	2,887.5



Results

Table 8 presents an updated and classified overview of the values of the five main biomasses, showing key aspects such as:

1. Potential products from each feedstock.
2. Key processors / partners (those directly linked to sourcing or handling that biomass).
3. Potential technology providers (biotech/processing enablers).
4. Potential local markets—i.e., companies from all the data you've provided that might use or buy each product.

Value chains are ranked based on the number of engaged stakeholders, including feedstock suppliers, technology providers, and potential buyers. A higher level of participation across these categories results in a higher ranking.

Table 8 Potential value chains for Brussels Capital.

Rank	Value Chain	Feedstock Providers	Tech Providers	Markets
1	Molasses → Glycerol	None explicitly	None listed	Pharma (Catalent, Pfizer, Roche...), Cosmetics (L'Oréal, Henkel), Food (Biscuits Delacre, Eclair (SA), Kellydeli...), etc.
2	Sugarbeet → Glycerol / PLA	None explicitly	None listed	Glycerol markets are the same as above. PLA could interest Solvay Specialty Polymers, packaging/food brands (Biscuits Delacre, Nestlé), and Henkel for adhesives or specialty polymers.
3	Corn Steep Liquor → 1,3-Propanediol	None explicitly	None listed	Pharma (Catalent, Pfizer, Roche...), Cosmetics (L'Oréal, Henkel), Chemical (Solvay, Umicore) for advanced polymers (PTT).
4	Wheat Straw → Succinic, Acetic, PHA...	Possibly Ceres (grain mill)	None listed	Solenis, Henkel, Tessenderlo, Air Liquide for chemicals (acids, furfural), Solvay Specialty Polymers for PHA, Food (Lysine, Glutamic Acid) though less direct.
5	Corn Stover → Succinic, PHA...	None explicitly	None listed	Similar potential chemical markets (Solvay, Henkel, etc.), plus pharma/cosmetics for 1,3-PDO. Lysine/glutamic acid might go to food producers.

In particular, the table should be interpreted as follows:

- Molasses → Glycerol stands out as the top chain because it connects to the largest set of pharmaceutical, cosmetics, and food companies in the Brussels region who commonly use glycerol.
- Sugarbeet → Glycerol/PLA follows closely, offering the same glycerol market plus an additional PLA bioplastic angle.

The other three (corn steep liquor → 1,3-PDO; wheat straw → multiple products; corn stover → multiple products) have slightly fewer clearly identified local partners in the dataset but still show some synergy with the region's chemical and pharma industries.

Table 9 shows a concise summary ranking the five value chains (those using the specified Brussels feedstocks) by the approximate number of potential partners that could participate in each chain. We have divided the partner counts as illustrated in the Table.



Table 9 Potential partners in the value chains.

Rank	Value Chain	Feedstock Providers (#)	Tech Providers (#)	Market (#)	Total
1	Molasses → Glycerol	0	0	12	12
2	Sugarbeet → Glycerol / PLA	0	0	11	11
3	Corn Steep Liquor → 1,3-Propanediol (1,3-PDO)	0	0	8	8
4	Wheat Straw → Succinic, Acetic, PHA, etc.	1	0	5	6
5	Corn Stover → Succinic, PHA, Lysine, etc.	0	0	5	5

In particular, the table should be interpreted as follows:

- Molasses → Glycerol ranks highest (12 total) due to a large local market of pharma, cosmetics, and food companies that commonly use glycerol.
- Sugarbeet → Glycerol / PLA is close behind (11 total) with similar market overlaps for glycerol plus additional bioplastics potential (PLA) among local chemical/polymer producers.
- Corn Steep Liquor → 1,3-PDO (8 total) offers moderate market potential (pharma, cosmetics, specialty chemicals) but no explicitly listed feedstock or technology partners.
- Wheat Straw and Corn Stover (ranks 4 and 5) each have limited, or no identified feedstock providers and fewer direct market matches in the data, though there are still some chemical and food end uses (e.g., acetic acid, lysine, PHA).

3.2.2 Prioritisation of circular value chains

Below is a list of the top value chains identified for Brussels capital, based on the following criteria: (1) have strong local potential for the feedstock, (2) lead to high-demand products, and (3) involve multiple local market partners. These are the most actionable or promising, based on the data provided by the Belgium SYMBIO partner.

1. MOLASSES → GLYCEROL

- Feedstock: molasses (possibly sourced via Tessenderlo Group’s bio-valorization).
- High-demand product: Glycerol is widely used as a humectant, solvent, or sweetener.
- Local markets: Large pharma (Pfizer, Catalent, Roche, etc.), cosmetics (L’Oréal, Henkel), food (Biscuits Delacre, Manufacture Belge de Chocolats, Eclair, Kellydeli, etc.) - all common glycerol users.
- Conclusion: Substantial synergy = top value chain.

2. SUGARBEET → GLYCEROL (and PLA)

- Feedstock: Sugarbeet could be integrated with Tessenderlo’s historical sugar-based experience, though not explicitly stated.
- Products:
 - Glycerol – same large end-market as above.



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- PLA (a biodegradable plastic) could interest local chemical and packaging players (e.g., Solvay Specialty Polymers).
- Conclusion: Access to the same big glycerol market plus added bioplastics potential.

3. CORN STEEP LIQUOR → 1,3-PROPANEDIOL (1,3-PDO)

- Feedstock: Corn steep liquor (major residue from wet milling); large volume.
- High-Demand Product: 1,3-PDO is used in personal care products (as a solvent or humectant), and in making PTT polymers.
- Local Markets:
 - Pharma (Catalent, Pfizer, Roche...) for possible solvent/excipient uses.
 - Cosmetics (L'Oréal, Henkel).
 - Polymers (Solvay Specialty Polymers, Industrie et Commerce Plastique).
- Conclusion: Significant potential in chemicals/cosmetics, albeit no direct feedstock aggregator is listed.

4. WHEAT STRAW → ACETIC ACID

- Feedstock: Wheat straw (4,386.125 t). No direct supplier from the list but milling/processing synergy might exist with Ceres.
 - Local chemical markets (e.g., Solvay, Henkel, Tessenderlo).
 - Acetic Acid could also be used in specialty foods (Kellydeli, Food Impact, etc.).
- Conclusion: Multiple downstream products are possible; thus, a broad but more diffuse market.

The Corn Stover → multi-products value chain was excluded as it closely resembles Wheat Straw but has a lower feedstock volume (1,200 t) and fewer identifiable feedstock partners, resulting in a slightly lower overall ranking.

These chains feature high-demand products (glycerol, PLA, 1,3-PDO, organic acids), clear local markets (pharma, cosmetics, food, chemicals/polymers), and at least a plausible path for feedstock procurement.

3.2.3 Existing infrastructure

In the VCG database, no infrastructure has been identified for the Brussels region, therefore the analysis for existing infrastructure is not viable.

3.3 Wallonia

3.3.1 Mapping Companies and Biomass

Companies

Wallonia possesses large volumes of wheat straw and sugarbeet, alongside other feedstocks like corn residuals. A total of 57 companies, falling in the scope of bioeconomy, were identified as shown in **Table 10**. The companies were then connected to the possible value chains.



Table 10 List of companies from Wallonia.

Sector / Sector	Number of Companies	Key Companies (Examples)	Core Activities
Dairy Industry	7	AGRAL, Arla Foods, Castle Dairy, Chimay Fromages, Corman, Eurofit, Mathot-Sofra	Butter, cheese, dairy powders, UHT milk, fermented dairy
Brewery Industry	5	Bieres de Chimay, Brasserie de Silly, St. Feuillien, Brasserie Dupont	Brewing, yeast production, spent grain management
Bakery Industry	7	Alysse Food, Avieta, Desobry, Smiling Baker, Dely Wafels, Avian Biscuiterie	Waffles, biscuits, frangipanes, bagels, frozen bakery
Food Processing	1	2.V.D. (Crousti Salade)	Croutons, dried fruits, snack products
Beverage Industry	2	Neobulles, Wave Distil	Alcoholic & non-alcoholic beverages, spirits

Additionally, to enhance the list, 121 companies from the VCG database that could participate in these value chains were added.

Biomass

Biomass numbers, shown in **Table 11**, were sourced from the analysis conducted as part of the Deliverable 2.1.

Table 11 Top 5 biomasses in Wallonia.

Top 5 biomass types (secondary)	Production volume (tonnes)
Wheat Straw	864,807.06
Sugarbeet	798,920.00
Corn Steep Liquor	630,316.40
Corn Stover	102,080.00
Barley Straw	70,377.00

Results

Table 12 presents an updated and classified overview of the values of the five main biomasses, showing key aspects such as:

1. Potential products from each feedstock.
2. Key processors / partners (those directly linked to sourcing or handling that biomass).
3. Potential technology providers (biotech/processing enablers).
4. Potential local markets—i.e., companies from all the data you've provided that might use or buy each product.

Value chains are ranked based on the number of engaged stakeholders, including feedstock suppliers, technology providers, and potential buyers. A higher level of participation across these categories results in a higher ranking.



Table 12 Potential value chains for Wallonia.

Rank	Value Chain	Feedstock		Tech Providers	Potential Local Markets
1	Sugarbeet → Glycerol / PLA	Isera & Scaldis Sugar Couplet Sugars		Oleon NV (Evergem) could potentially refine or process glycerol because of its oleochemical know-how	Glycerol → Food & Beverage (Ferrero Ardennes, Desobry, Poppies Bakery...) PLA → Chemicals/Plastics (Sabert, Gamma-Wopla, B.S.I., Ampacet...) Cosmetics/Pharma (e.g. Baxter, GSK)
2	Wheat Straw → Succinic / Acetic / PHA / Lysine etc.	Alia 2 (produces wheat)		None listed	Amino acids → Chemical (Mosselman, Ineos Feluy, Avient...) Food (bakeries, etc.) PHA → Plastics (: Sabert, Ampacet, B.S.I.)
3	Corn Stover → Succinic / Acetic / Adipic Acid	(No direct local aggregator listed)		None listed	Overlaps with Wheat Straw markets: chemical (acids, furfural) + food (lysine/glutamate)
4	Corn Steep Liquor → 1,3-PDO	(No direct local aggregator listed)		None listed	Chemical (Ineos, Mosselman, Signode, Avient, Michelman...) Cosmetics / Pharma (Polypeptide, GSK, Baxter, smaller labs)
5	Barley Straw → Succinic Acid/ Acetic Acid / Furfural	(No direct barley-straw provider; breweries only handle malt)		None listed	Possibly chemical (Signode, Mosselman, Ineos, etc.) for acetic / succinic acids or furfural

In particular, the table should be interpreted as follows:

1. Sugarbeet → Glycerol/PLA has multiple sugar companies plus broad usage in foods, chemicals, pharma, making it top-ranked.
2. Wheat Straw has at least one feedstock (Alia 2) and big potential in chemicals/food, ranking it #2.
3. Corn Stover, Corn Steep Liquor, and Barley Straw lack explicit feedstock providers in the dataset, so fewer total partners.
4. No dedicated tech providers (for hydrolysis, fermentation, etc.) were identified among these listings.



Hence, from a partnership perspective, Sugarbeet emerges as the strongest chain, followed by Wheat Straw, then Corn Stover, Corn Steep Liquor, and Barley Straw.

There are ample amounts of dairy processor companies in Wallonia and a whey processing value chain might be possible. Wallonia's whey-based value chain could potentially leverage its strong dairy industry, transforming whey byproducts from Laiterie des Ardennes, Arla, Castle Dairy, Chimay Fromages, Agral, Corman, and Eurofit into high-value products like WPC 80, lactose derivatives, bioplastics, and bioethanol. Processing could be supported by Tetra Pak, GEA, Bio-On, and Chr. Hansen, with key markets in sports nutrition (Ferrero, Mondelez), pharmaceuticals (GSK, Baxter), bioplastics (Smurfit Kappa, Avery Dennison), and bioenergy (INDAVER, Bioenerga). Logistics partners Roger & Roger, Ecofrost, and Mydibel Fresh could ensure supply chain efficiency.

Therefore, as the value chains ranked 3,4,5 do not have feedstock providers, they were excluded, and the whey value chain was included.

Table 13 provides a concise summary showing each biomass value chain, divided into feedstock partners, technology providers, and markets. The Total column is the sum of those partners. The ranking (1 to 5) reflects the overall involvement across the supply chain.

Table 13 Potential partners in the value chains.

Rank	Value Chain	Feedstock (#)	Tech (#)	Market (#)	Total
1	Whey → proteins + lactose	7	4	6	17
2	Sugarbeet → Glycerol / PLA	2	1	~12	15
3	Wheat Straw → Succinic / Acetic / PHA / Lysine / Glutamic / 1,3-PDO / Furfural	1	0	~10	11

Observations:

- Whey ranks highest as it offers significant feedstock potential, a sufficient technology environment and a present local market.
- Sugarbeet ranks second highest: multiple feedstock handlers (2), a potential technology partner (Oleon NV for glycerol/oleochemicals), and many local market consumers (food, chemical, cosmetic, and pharma) for either glycerol or PLA.
- Wheat Straw has at least one feedstock provider and diverse market uses, but no identified tech providers.

3.3.2 Prioritisation of circular value chains

A wide range of potential circular value chains has been identified for each pilot region. However, to determine the most strategic value chains that will serve as key inputs for WP3 and the WP2 workshops, a prioritisation process is essential. For this reason, the best value chains have been selected for each pilot region based on the following criteria: (1) have a strong fit between feedstock availability, (2) viable technology routes, and (3) a clear local market (or multiple markets) for the resulting bio-based product. These chains stand out as particularly actionable within the data that was provided during the SYMBIO project.



1. WHEY → PROTEINS

- Strong feedstock supply – seven dairy companies ensure abundant whey availability.
- Advanced tech & processing – established tech providers enable high-value whey conversion.
- Diverse market demand – food, pharma, and bioplastics sectors drive strong commercial potential.

2. SUGARBEET → GLYCEROL

- Glycerol is highly versatile (used in foods, cosmetics, pharmaceuticals, industrial applications).
- Multiple feedstock providers like Isera & Scaldis Sugar, Couplet Sugars.
- Many potential markets from Food (humectant), cosmetics/pharma (excipient) to plastics manufacturers (bioplastics).
- Possible tech provider in Oleon NV (glycerol refining/oleochemicals expertise).

3. WHEAT STRAW → SUCCINIC ACID

- Succinic acid is a common building block in food, chemical, and pharmaceutical industries.
- Wide market encompassing chemicals (e.g., Mosselman, Ineos Feluy), food (bakeries, snack producers might use amino acids) and plastics (PHA).
- No direct technology provider identified indicating a gap in the value chain.

3.3.3 Existing infrastructure

Below is an overview and analysis of whether the three proposed value chains would face feedstock competition or “lock-in” from the existing bioeconomy infrastructure that is listed. We specifically checked for overlaps in raw material use and potential market/processing competition with the facilities. The list of facilities was taken from the VCG database of more than 13.000 existing infrastructure listed collected from open-source data like CBE JU and IEA Bioenergy among others.

1. BioWanze (Wanze, Liège)
 - Type: Bioethanol facility
 - Feedstocks: Cereals (wheat, maize), sugar/syrups (possibly sugarbeet by-products)
 - Overlap: Competes for sugarbeet (VC#2) and wheat grain (VC#3), though straw is not typically used.
2. Ipalle – Thumaide (Hainaut)
 - Type: Waste-to-energy (~400,000 t/yr)
 - Feedstocks: Municipal solid waste (MSW), commercial/industrial waste
 - Overlap: None – does not use sugarbeet, cereal straw, or other agricultural residues.
3. ICDI – Charleroi (Pont-de-loup, Hainaut)
 - Type: Incineration (~110,000 t/yr)
 - Feedstocks: Municipal waste
 - Overlap: None—same reasoning as Ipalle.
4. Sebigas – Nivelles (Walloon Brabant)
 - Type: Biogas/AD (~116,000 t/yr)
 - Feedstocks: Manure, green waste, food waste, some agricultural residues
 - Overlap: Potential minor competition for wheat straw, corn stover, or sugarbeet pulp, but not a primary user.
5. Cycles Verts (Bastogne, Luxembourg)
 - Type: Biochar from woodchips (~200 t/yr)



- Overlap: None—requires woody biomass, not sugarbeet or cereal straw.
- 6. Intradel – Uvelia (Herstal, Liège)
 - Type: Waste-to-energy (~370,000 t/yr)
 - Feedstocks: Municipal & industrial waste
 - Overlap: None—same as Ipalle and ICDI.
- 7. Greenpoch s.a. (Wagnelée, Hainaut)
 - Type: Pyrolysis for biochar (woodchips/green waste)
 - Overlap: None—does not use sugarbeet or cereal straw.

Potential Overlaps

Most existing waste-to-energy or biochar facilities in Wallonia rely on municipal waste or woodchips, not sugarbeet, cereal residues, or corn streams. Hence, they do not compete for the feedstocks needed by the four proposed value chains. BioWanze is the main potential competitor because it can consume sugarbeet (or cereal grains) to make ethanol. For Sugarbeet → Glycerol (value chain #2), BioWanze might compete if they source beets. Because wheat grain used for ethanol production poses only a minor threat to wheat straw feedstock, farmers contracting with BioWanze may be less inclined to divert straw or sugarbeet pulp. Moreover, since straw is rarely incinerated or digested on a large scale, other facilities' feedstock streams do not significantly overlap with the proposed wheat straw value chain.

3.4 Flanders

3.4.1 Mapping Companies and Biomass

Companies

In Flanders, corn stover, wheat straw, and barley straw are available in high quantities. A total of 24 companies, falling in the scope of bioeconomy, were identified as shown in **Table 14**.

Table 14 List of companies from Flanders.

Feedstock/ Sector	Number of Companies	Key Companies (Examples)	Core Activities
Dairy Industry	8	Belgian Milk Company, Ysco, Capra, De Zuivelarij, Pur Natur, Kaasimport Jan Dupont, Farmel Dairy Belgie, Flandrien	Production and processing of dairy products (milk, cheese, yogurt, cream, ice cream), raw milk supply, and specialty dairy items (e.g. goat cheeses).



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Brewery Industry	10	Brouwerij Timmermans, Brouwerij Frank Boon, Brouwerij Strubbe, Brouwerij van Eecke, Brasserie Saint Bernard, Brouwerij Roman, Leroy Brewery, Het Anker, Brouwerij de Ryck, BOOB BROUWERIJ	Brewing a wide range of beers—from traditional lambic, geuze, ales to specialty and low-alcohol beers—using both traditional and modern brewing techniques.
Bakery Industry	5	Belgian Waffles, BAKER & BAKER, Bio de trog, Boulangerie de France NV, Diversi Foods	Production of a broad assortment of baked goods including breads, pastries, biscuits, and freeze-off bakery products; ranging from artisanal to industrial scale.
Confectionary	1	Callas Confiture	Production of high-quality jams and fruit preserves using traditional methods and natural ingredients.

Additionally, to enhance the list, 264 companies from the VCG database that could participate in these value chains were added.

Biomass

Biomass numbers were taken from the work that was done as part of the Deliverable 2.1.

Table 15 Top 5 biomasses in Flanders.

Biomass Type	Production Volume (Tonnes)
Corn steep liquor	630,316.40
Corn Stover (and residue)	495,240.00
Wheat Straw	393,947.75
Sugarbeet	384,117.50
Maize Cobs	74,286.00

Results

Table 16 presents an updated and classified overview of the values of the four main biomasses, showing key aspects such as:

1. Potential products from each feedstock.
2. Key processors / partners (those directly linked to sourcing or handling that biomass).



3. Potential technology providers (biotech/processing enablers).
4. Potential local markets—i.e., companies from all the data you’ve provided that might use or buy each product.

Value chains are ranked based on the number of engaged stakeholders, including feedstock suppliers, technology providers, and potential buyers. A higher level of participation across these categories results in a higher ranking.

Table 16 Potential value chains for Flanders.

Rank	Value Chain	Feedstock Providers	Tech Providers	Market (Approx. #)
1	Sugarbeet → Glycerol / PLA	Tiense Suikerraffinaderij (Tienen) Belgosuc (Beernem) (Additional: Cosucra, etc.)	Oleon (Evergem)	~12–15 local chem, food, cosmetics, plastics
2	Wheat Straw → Succinic / Acetic / PHA / Lysine / etc.	Généraux (Asse) – wheat grain (straw not explicit, but likely)	None listed	~10–14 chemical/feed/food packaging buyers
3	Corn Stover → Succinic / Adipic / PHA / etc.	(None explicit) (Possibly Cargill, Tereos, etc. for corn kernels, not stover)	None listed	~10–12 broad chemical & feed markets
4	Corn Steep Liquor → 1,3-PDO	Tereos Starch & Sweeteners (Aalst) Maselis (Roeselare) Possibly Cargill (Mechelen)	None listed	~8–10 chemical & cosmetics users

In particular, the table should be interpreted as follows:

1. Sugarbeet → Glycerol/PLA ranks highest due to multiple feedstock suppliers, at least one relevant tech provider (Oleon for glycerol refining), and a broad local market (food, chemicals, cosmetics, plastics).
2. Wheat Straw, Corn Stover, and Corn Steep Liquor have fewer direct feedstock players or tech providers listed but still overlap with large chemical or food/feed markets.

Table 17 provides a concise summary showing each biomass value chain, divided into feedstock partners, technology providers, and markets. The Total column is the sum of those partners. The ranking (1 to 5) reflects the overall involvement across the supply chain.

Table 17 Potential partners in the value chains.

Rank	Value Chain	Feedstock (#)	Tech (#)	Market (#)	Total
1	Sugarbeet → Glycerol / PLA	2–3	1	~12–15	15–19
2	Wheat Straw → Succinic / Acetic / PHA / Lysine / 1,3-PDO / Furfural	1	0	~10–14	11–15
3	Corn Stover → Succinic / Adipic / PHA / Lysine / 1,3-PDO / Furfural	0	0	~10–12	10–12
4	Corn Steep Liquor → 1,3-PDO	0–1	0	~8–10	8–11



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1. Sugarbeet → Glycerol/PLA ranks highest with multiple sugar processors (feedstock) plus widespread glycerol or PLA markets in chemicals, plastics, food, and cosmetics. Oleon can refine or process glycerol.
2. Wheat Straw offers at least one explicit feedstock supplier (Généraux) and broad chemical/food user bases for the multiple end products.
3. Corn Stover and Corn Steep Liquor each have more limited or less certain feedstock providers in the data, though still good market synergy on the product side.

Hence, from a partnership standpoint, Sugarbeet is the most robust chain, followed by Wheat Straw, Corn Stover, and Corn Steep Liquor.

3.4.2 Prioritisation of circular value chains

A wide range of potential circular value chains has been identified for each pilot region. However, to determine the most strategic value chains that will serve as key inputs for WP3 and the WP2 workshops, a prioritisation process is essential. For this reason, the best value chains have been selected for each pilot region based on the following criteria: (1) have a strong fit between feedstock availability, (2) viable technology routes, and (3) a clear local market (or multiple markets) for the resulting bio-based product. These chains stand out as particularly actionable within the data that was provided during the SYMBIO project.

1. Sugarbeet → Glycerol

Glycerol is a highly versatile product with applications in bioplastics (PLA), bio-based solvents, pharmaceuticals, and cosmetics. The demand for sustainable and bio-based solvents is growing, especially in the EU's push for renewable chemicals [11], [12]. Feedstock availability: Flanders has a well-established sugar processing sector with companies like Tiense Suiker, Belgosuc, and Cosucra that can provide sugar-based feedstocks. Technology readiness: Oleon (Evergem) is a notable tech provider for glycerol processing, meaning there is an existing industrial base to support scaling [13]. The demand for glycerol is robust across multiple industries, with major off-takers such as Croda, Procter & Gamble, and Unilever in cosmetics and personal care, as well as Puratos in food additives. With both a secure feedstock source and a diverse local market, this value chain stands as a viable, scalable circular solution.

2. Wheat Straw → Lysine

Wheat production in Flanders offers straw as a potential byproduct, with Cargill and Agrifirm involved in grain processing and feed production. Lysine, an essential amino acid used in animal feed, has strong demand from feed companies like Aveve, Arvesta, and Dumoulin. The fermentation technology for lysine is well-developed, making this a promising value chain for agricultural side-stream valorisation.

3. Corn Steep Liquor → 1,3-Propanediol (1,3-PDO)

Flanders' wet milling industry generates a valuable byproduct, corn steep liquor, which can be used in the production of 1,3-propanediol (1,3-PDO), a high-performance biopolymer ingredient. Companies such as Tereos, Maselis, and Cargill have the infrastructure to supply this feedstock, while major chemical players like Solvay, Covestro, and DuPont represent strong market off-takers for PDO in cosmetics, high-performance plastics, and fiber applications. The alignment between industrial-scale corn processing and major biobased material producers makes this an attractive and feasible circular value chain.



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4. Corn Stover → Succinic acid

Corn stover, an abundant agricultural residue in Flanders, can be valorised into succinic acid, a key precursor for bioplastics, coatings, and specialty chemicals. Cargill and Tereos can supply the feedstock, while leading chemical companies such as BASF, Reverdia, and Roquette provide an established market for succinic acid in coatings, polymers, and bioplastics. This value chain capitalises on the need for bio-based chemical alternatives and benefits from a strong regional agri-food sector, making it an ideal candidate for circular economy integration.

3.4.3 Existing infrastructure

Below is an overview and analysis of whether the four proposed value chains would face feedstock competition or “lock-in” from the existing bioeconomy infrastructure that is listed. We specifically checked for overlaps in raw material use and potential market/processing competition with the facilities. The list of facilities was taken from the VCG database of more than 13.000 existing infrastructure listed collected from open-source data like CBE JU and IEA Bioenergy among others.

Below is a categorized list of Flemish bioeconomy infrastructure facilities (excluding location details) that can be used to assess potential feedstock competition for the proposed value chains:

Biofuel and Biorefinery Facilities:

- Alco Biofuel – Produces bioethanol
- Cargill Bioro – Produces biodiesel (FAME)
- Tereos – Produces bioethanol

Waste-to-Energy & Incineration Plants:

- Bioenerga – Bionerga WtE Plant – Processes waste into energy (≈100,000 tonnes capacity)
- Bioenerga – Biosteam Ostend – Energy production via waste-to-energy (capacities of 65,000 and 180,000 tonnes)
- INDAVER – Waste-to-Energy Plant II – High-capacity waste incineration (≈1,000,000 tonnes)
- ISVAG Plant – Incineration facility (≈158,000 tonnes capacity)
- IVM WtE Plant – Processes waste into energy (≈100,000 tonnes capacity)
- Ipalle Plant – Waste-to-energy facility (≈400,000 tonnes capacity)
- Harelbeke Biomass Power Project – Biomass power generation (≈75,000 tonnes capacity)

Specialised and Integrated Conversion Facilities:

- Biorigin – Converts brewer’s spent yeast into yeast protein
- Skytanking N.V. – EBBR – Processes waste cooking oils, tallow, waste biomass, and MSW into sustainable aviation fuel (using hydroprocessing, isomerization, cracking, gasification, Fischer-Tropsch, fermentation, dehydration, and oligomerization)

Wood and Biomass Processing:

- TORRCoal – Processes woodchips into biochar via pyrolysis



Insect-Based Bioconversion Facilities:

- M-Food Ingredients – Converts migratory locusts, yellow mealworms, and house crickets into insect powders
- NUSECT – Converts migratory locusts and Tenebrio into whole insects

Industrial Wood Processing:

- Stora Enso Langerbrugge – Operates a large-scale wood processing mill

Potential Overlaps

1. Sugarbeet → Glycerol

- Potential Competition:
 - Tereos (Aalst, East Flanders) - Bioethanol production
 - Why it's a competitor: Tereos processes sugarbeet into bioethanol, meaning they already have established supply chains for sugarbeet molasses.
 - Impact: This could create competition for sugarbeet-derived feedstocks, making it harder to secure raw materials for glycerol production.

Conclusion: There is a direct competition for sugarbeet feedstocks from the bioethanol industry, particularly from Tereos. If glycerol production relies on sugarbeet molasses, access to feedstock may be limited, and alternative sourcing might be needed.

2. Wheat Straw → Lysine

- Potential Competition:
 - No direct competition identified in the infrastructure list.
 - Waste-to-energy plants (such as IVM, INDAVER, and ISVAG) may burn some agricultural residues like wheat straw, but this is not a high-value use case compared to succinic acid production.

Conclusion: No major feedstock competition identified for wheat straw, making it potentially a low-risk value chain in terms of feedstock availability.

3. Corn Steep Liquor → 1,3-Propanediol (1,3-PDO)

- Potential Competition:
 - Alco Biofuel (Ghent, East Flanders) - Bioethanol production
 - Why it's a competitor: Corn steep liquor is a byproduct of corn wet milling, which is also used in bioethanol production. Alco Biofuel likely sources corn for bioethanol, which could limit the availability of corn steep liquor for fermentation-based 1,3-PDO production.
 - Cargill Bioro (Ghent, East Flanders) - Biodiesel (FAME) production



- Why it's a competitor: Cargill processes agricultural feedstocks and may compete for the same supply chains that provide corn-based inputs.

Conclusion: Corn steep liquor may face competition from bioethanol production (Alco Biofuel), as it is a common byproduct in that industry. This could mean higher feedstock prices or limited access to corn steep liquor unless alternative sourcing strategies are in place.

4. Corn Stover → Succinic acid

- Potential Competition:
 - No direct competition identified.
 - Waste-to-energy plants (IVAGO, INDAVER, IVM) might incinerate some agricultural residues, but they are not a direct competitor for PHA feedstocks.

Conclusion: No major competition for corn stover, making it a strategic low-risk feedstock for PHA production.

3.5 Carinthia

3.5.1 Mapping Companies and Biomass

Companies

Carinthia predominantly leverages forestry residues, exceeding 1.1 million tonnes annually. A relatively large number of biomass producers (21 for forestry residues) indicates a strong supply base, while the presence of a few technology providers and market outlets underscores Carinthia's capacity to anchor these value chains locally, provided additional development or partnerships refine the conversion processes. A total of 90 companies, falling in the scope of bioeconomy, were identified as shown in **Table 18**. The companies were then connected to the possible value chains.

Table 18 List of companies from Carinthia.

Sector	Number of Companies	Key Companies (Examples)	Core Activities
Sawmills	10	HASSLACHER NORICA TIMBER, Holz Granitzer, Johann Offner Holzindustrie	Processing and trading of timber and wood-based products
Furniture Manufacturing	5	Heraklith, AGRICOLA Consultants, FREJO Wohndesign	Manufacturing of wooden furniture and interior design solutions
Brewery Industry	6	Hirter Bier, Villacher, Wimitzbräu	Production of beer and craft beverages
Dairy Industry	6	Kärntnermilch, Sonnenalm, Unterkärntner Molkerei	Milk processing, cheese, and dairy product manufacturing
Bakery Industry	3	Bäckerei Wienerroither, Wienerroither GmbH	Bread, pastry, and baked goods production
Wheat Production	2	Rudolf Sommeregger & Mario Ebner, Kärntner Mühle	Wheat cultivation and milling



Wood Industry	3	FUNDERMAX, Peter Seppel GmbH, Tilly Holzindustrie	Wood processing and construction materials
Wood Construction	2	Griffner Haus, Weissenseer	Prefabricated wooden houses and construction systems
Chemical Production	6	Akdeniz Chemson, Treibacher Industrie, Tribotecc	Industrial and specialty chemical manufacturing
Food Production	1	KARNERTA	Meat and food processing
Thermal Waste Treatment	1	KÄRNTNER RESTMÜLLVERWERTUNGS GMBH	Waste incineration and energy recovery
Recycling & Circular Economy	7	Lindner Recyclingtech, Plasticpreneur, PreZero	Waste recycling, plastic processing, and upcycling
Waste Management	5	SAUBERMACHER, Gojer GmbH, FCC Austria	Waste collection, sorting, and disposal
Energy & Bioenergy	4	Bioenergie Kärnten, Glock EcoEnergy, Biodiesel Kärnten	Renewable energy, bioenergy, and biodiesel production
Plastic Industry	1	Europlast Kunststoffbehälterindustrie	Plastic container and packaging manufacturing
Tech & Machinery	3	Flextronics International, Kostwein Maschinenbau	Industrial machinery and electronic manufacturing
Mining & Raw Materials	1	OMYA	Mineral extraction and processing
Pulp, Paper & Wood	1	Mondi Frantschach	Paper, packaging, and wood product manufacturing
Beverage Production	1	APO Fruchtsäfte	Juice and beverage manufacturing
Construction Materials	1	BMI Villas	Roofing and insulation materials

Additionally, to enhance the list, 17 companies from the VCG database that could participate in these value chains were added.

Biomass

Biomass numbers, shown in **Table 19**, were taken from the work that was done as part of the Deliverable 2.1.

Table 19 Top 5 biomasses in Carinthia.

Top 5 biomasses	Production Volume (tonnes)
Forestry Residues (wood and wood processing residues)	1,134,461.62
Soybean Meal	104,722.75
Corn	70,599.82
Maize Cobs	21,179.95
Barley Straw	16,057.75



Results

Value chains are ranked based on the number of engaged stakeholders, including feedstock suppliers, technology providers, and potential buyers (Table 20). A higher level of participation across these categories results.

Table 20 Potential value chains for Carinthia.

Rank	Value Chain	Biomass	Technology	Feedstock Suppliers	Processing & Conversion	Potential Local Markets
1	Furfural Production from Forestry Residues & Maize Cobs	Forestry Residues (1,134,46 1.62 tons), Maize Cobs (21,179.9 5 tons)	Acid Hydrolysis, Catalytic Systems, Solvent-Thermal Conversion	HASSLAC HER NORICA TIMBER, Johann Offner Holzindustrie, Holz Granitzer GmbH, Winterholz Sägewerk GmbH	Evonik Treibacher GmbH, Omya GmbH	Mondi Frantschach GmbH (paper industry), Beta Pura GmbH (chemical industry)
2	Succinic Acid Production from Barley Straw	Barley Straw (16,057.7 5 tons)	Enzymatic Hydrolysis, Fermentation	Local grain and straw producers	AGRANA Stärke GmbH, Beta Pura GmbH	Mondi Frantschach GmbH (biodegradable packaging), Treibacher Industrie (chemical applications)
3	Polyhydroxyalkanoates (PHA) Production from Corn	Corn (70,599.8 2 tons)	Enzymatic Hydrolysis, Fermentation	AGRANA Stärke GmbH, Wech-Geflügel Gesellschaft m.b.H. (corn by-products from poultry feed)	Steinbeis Polyvert GmbH, Europlast Kunststoffbehälterindustrie GmbH	Plasticpreneur – Going Circular, Pre Zero Polymers GmbH
4	Acetic Acid Production from Barley Straw	Barley Straw (16,057.7 5 tons)	Enzymatic Hydrolysis, Fermentation	Local grain and straw producers	Beta Pura GmbH, AGRANA Stärke GmbH	Mondi Frantschach GmbH, Josef Rzepa GmbH & Co KG



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						(food applications)
5	Glycerol Production from Soybean Meal	Soybean Meal (104,722.75 tons)	Enzymatic Hydrolysis, Saponification, Transesterification	Local soy processors	AGRANA Stärke GmbH, Beta Pura GmbH	Hermes Pharma Ges.m.b.H., Evonik Treibacher GmbH

Table 21 provides a concise summary showing each biomass value chain, divided into feedstock partners, technology providers, and markets. The Total column is the sum of those partners. The ranking (1 to 5) reflects the overall involvement across the supply chain.

Table 21 Potential partners in the value chains.

Rank	Value Chain	Feedstock Partners	Technology Providers	Market Partners	Total Partners
1	Succinic Acid	5	4	6	15
2	Furfural	6	3	5	14
3	PLA	4	3	5	12
4	Acetic Acid	5	3	4	12
5	PHA	4	3	4	11

Observations:

- Feedstock Strength: Forestry Residues and Corn have the highest number of feedstock suppliers, ensuring strong raw material availability.
- Market Weakness: Soybean Meal to Succinic Acid has a lower number of market players, showing a weaker commercial pull compared to other chains.
- Overall Trend: While feedstock supply is strong across all top value chains, gaps in technology providers and market players suggest the need for targeted investments in refining and commercialization.

3.5.2 Prioritisation of circular value chains

A wide range of potential circular value chains has been identified for each pilot region. However, to determine the most strategic value chains that will serve as key inputs for WP3 and the WP2 workshops, a prioritisation process is essential.

For this reason, the best value chains have been selected for each pilot region based on the following criteria: (1) have a strong fit between feedstock availability, (2) viable technology routes, and (3) a clear local market (or multiple markets) for the resulting bio-based product. These chains stand out as particularly actionable within the data that was provided during the SYMBIO project.

1. Forestry Residues & Maize Cobs → Furfural

- This value chain has the highest number of feedstock suppliers, ensuring stable input availability.
- Strong presence of processing companies specializing in acid hydrolysis and catalytic systems.



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- Broad applications in chemical manufacturing (e.g., Beta Pura GmbH, Nitro Quimica GmbH), ensuring strong demand.

2. Corn → PHA

- Corn is well-established in the region, with multiple feedstock suppliers ensuring continuous flow.
- Several fermentation technology providers are capable of processing the material into PHA.
- A high number of plastics & polymer companies (Steinbeis Polyvert GmbH, Europlast Kunststoffbehälterindustrie), indicating strong industry demand.

3. Barley Straw → Succinic Acid

- Barley straw is widely available, though less than forestry residues.
- Moderate presence of enzymatic hydrolysis and fermentation providers, but enough to ensure scalability.
- High number of chemical industry players (e.g., Treibacher Industrie, Evonik Treibacher GmbH), making commercialization viable.

4. Soybean meal → Glycerol

- Soybean meal is widely available and has good supply chains in the region.
- Enzymatic hydrolysis and transesterification technology providers are present but may require scaling.
- Glycerol has strong applications in food, pharma, and chemical industries (e.g., AGRANA Stärke GmbH, P&G Health Austria), supporting commercial viability.

The best value chains are those where feedstock supply is abundant, technology is readily available, and strong market demand ensures economic viability. The selected four offer the best balance across all three factors.

3.5.3 Existing infrastructure

Below is an overview and analysis of whether the four proposed value chains would face feedstock competition or “lock-in” from the existing bioeconomy infrastructure that is listed. We specifically checked for overlaps in raw material use and potential market/processing competition with the facilities. The list of facilities was taken from the VCG database of more than 13.000 existing infrastructure listed collected from open-source data like CBE JU and IEA Bioenergy among others.

Biodiesel Production Facilities:

1. Biodiesel Kärnten
 - i) A biodiesel production plant specializing in the production of Fatty Acid Methyl Esters (FAME), primarily from used cooking oils and other feedstocks. It plays a key role in renewable fuel supply for the region.
2. Biodiesel Süd
 - i) A facility focused on producing sustainable biodiesel from vegetable oils and waste fats. It contributes to reducing CO₂ emissions by providing an alternative to fossil fuels.

Waste Management & Processing:

1. Kärntner Restmüllverwertungs GmbH (KRV Arnoldstein)
 - i) A waste treatment and recycling plant that processes large volumes of municipal and industrial waste. It ensures efficient waste valorisation, reducing landfill dependence.



Biogas Plants:

1. Biogas Plant – Hermann Martin Michael
 - i) A biogas facility that processes digestate, manure, and organic residues to produce renewable biogas for energy generation.
2. Bioenergie Gadner (Registered Cooperative)
 - i) A cooperative-run biogas plant that utilizes agricultural waste to generate biogas and digestate, supporting local farming communities.
3. Biogas Plant – Markus Müller
 - i) A multi-feedstock biogas facility that converts agricultural waste, manure, and catering waste into biogas, used for heat and power.
4. Biogas Plant – Andreas Marko
 - i) A farm-based biogas plant utilizing livestock waste and organic residues to generate renewable energy, contributing to circular agriculture.
5. Biogas Plant – Hans Peter Krenn
 - i) A biogas production facility processing organic waste, including catering residues, into energy and fertilizer for agricultural use.
6. Biogas Plant – Manfred Armin Payer
 - i) A small-scale biogas plant that processes farm waste and digestate to produce sustainable biogas for heat and electricity.
7. Biogas Plant – Johann Hofer
 - i) A rural biogas operation that converts livestock manure and organic matter into biogas and nutrient-rich digestate for soil improvement.
8. Wasserverband Ossiacher See
 - i) A wastewater treatment plant integrating biogas production, converting organic sludge into renewable energy, helping to manage wastewater sustainably.

Potential Overlaps

To assess the competition for the feedstocks required to establish the four proposed value chains, we analysed existing infrastructure facilities in the region and their potential demand for the same raw materials.

Forestry Residues & Maize Cobs → Furfural

- Potential competition - low to moderate.
- Overlapping infrastructure - none identified
- Analysis:
 - Forestry residues are widely available and primarily used in wood processing, paper, and bioenergy sectors, but there is no direct competition from biodiesel or biogas plants.
 - Maize cobs are currently underutilized and could be diverted to furfural production without major competition.

Corn → PHA

- Potential competition - moderate
- Overlapping infrastructure:
 - Biogas Plants (e.g., Bioenergie Gadner, Müller Markus Ing., KRENN HANS PETER): May use corn residues as feedstock for biogas generation.
- Analysis:



- Corn is already used for food, animal feed, and bioethanol, so availability for PHA could face some pressure.
- Biogas plants may utilize corn stover and agricultural residues, but corn grain for PHA production remains mostly unclaimed.

Barley Straw → Succinic Acid

- Potential Competition - moderate
- Overlapping infrastructure:
 - Biogas Plants: Some might use straw and agricultural residues in digestion processes.
- Analysis:
 - Barley straw is typically used for livestock bedding, composting, or left unused.
 - Biogas plants might pose some competition, but not significant enough to threaten supply for succinic acid production.

Soybean meal → Glycerol

- Potential Competition - low
- Overlapping infrastructure:
 - Biodiesel Plants (e.g., Biodiesel Kärnten, Biodiesel Süd): These use waste oils and animal fats, but not soybean meal.
- Analysis:
 - No significant infrastructure competes for soybean meal.
 - Biodiesel plants focus on oil-based inputs, meaning soybean meal remains available for glycerol production.

The region's infrastructure supports all four value chains, with minor feedstock competition that won't disrupt supply. No major gaps or conflicts were identified.

3.6 Croatia

3.6.1 Mapping Companies and Biomass

Companies

Croatia stands out for its extensive feedstock streams—especially animal fats and corn, totalling almost 1.5 million tonnes. A total of 57 companies, falling in the scope of bioeconomy, were identified as shown in **Table 22** The companies were then connected to the possible value chains.

Table 22 List of companies from Croatia.

Sector	Number of Companies	Key Companies (Examples)	Core Activities
Agriculture / Farming	18	Belje d.o.o., NOVI AGRAR d.o.o., ŽITO d.o.o.	Crop production, dairy & livestock farming, agribusiness, and grain milling
Food Processing	8	PODRAVKA d.d., ZVIJEZDA PLUS d.o.o.	Processing of foods including packaged products, confectionery, and ready-to-eat meals



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Meat Industry	8	MESNA INDUSTRIJA BRAĆA PIVAC, PIK VRBOVEC PLUS d.o.o., GAVRILOVIĆ d.o.o.	Meat processing, sausage & cured meat manufacturing
Dairy Industry	7	VINDIJA d.d., DUKAT d.d., PASKA SIRANA d.d.	Production of dairy products (milk, cheese, yogurt) and milk processing
Chemical Industry	9	PETROKEMIJA d.d., SAPONIA d.d., HEMPEL d.o.o., SCOTT BADER d.o.o.	Manufacture of fertilizers, industrial chemicals, specialty resins, and coatings
Cosmetics	2	LUSH MANUFAKTURA d.o.o., METEOR GRUPA - LABUD d.o.o.	Production of personal care items and household cleaning products
Beverage / Brewery Industry	8	ZAGREBAČKA PIVOVARA d.o.o., COCA-COLA HBC HRVATSKA d.o.o.	Brewing, production and distribution of alcoholic and non-alcoholic beverages
Bakery Industry	8	MLIN I PEKARE d.o.o., MLINAR PEKARSKA INDUSTRIJA d.o.o.	Flour milling and manufacturing of breads, pastries, and other bakery products
Wood Processing & Furniture	7	PRIMA COMMERCE d.o.o., ŠERIF EXPORT IMPORT d.o.o., ELGRAD d.o.o.	Processing of timber, production of wood panels and furniture, flooring, and decorative wood products
Seasonings & Spices	2	KOTANYI d.o.o., ŠAFRAM d.o.o.	Manufacturing of herbs, spices, and seasoning blends
Salt Production	3	SOLANA PAG d.d., SOLANA STON d.d., SOLANA NIN d.o.o.	Extraction and processing of sea salt for food and industrial uses
Sugar	1	HRVATSKA INDUSTRIJA ŠEĆERA d.d.	Production and processing of sugar
Retail	1	STUDENAC d.o.o.	Supermarket chain and distribution of food and consumer goods
Winery Industry	4	KUTJEVO d.d., VINARIJA JOKIĆ d.o.o., ERDUTSKI VINOGRADI d.o.o.	Vineyard management, wine production (and in some cases olive oil and cheese production)
Fishery	2	CROMARIS d.d., RIBNJAČARSTVO KONČANICA d.d.	Aquaculture, fish farming, and seafood processing
Manufacturing (Agribusiness / Horticulture)	3	EURO-TIM d.o.o., LUNETA d.o.o., MUNDUS VIRIDIS d.o.o.	Organic farming, free-range egg production, and horticultural products
Agriculture Equipment	4	HANA d.o.o., PERFA - BIO d.o.o., ANAGALIS d.o.o., LUKAČ d.o.o.	Production/distribution of agricultural inputs and equipment (including day-old chicks and egg processing)
Waste Management & Recycling	3	FORTANOVA d.d., AGROINVESTO GRUPA, PPK VALPOVO (member)	Waste collection, recycling, and sustainable production practices
Forestry	1	HRVATSKE ŠUME d.o.o.	Management of forest lands, wood harvesting, and production of wood products



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Egg Production / Poultry	1	GALA JAJA d.o.o.	Poultry farming and production of table eggs
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Additionally, to enhance the list, 190 companies from the VCG database that could participate in these value chains were added.

Biomass

Biomass numbers, shown in **Table 23**, were taken from the work that was done as part of the Deliverable 2.1.

Table 23 Top 5 biomasses in Croatia.

Top 5 biomass types (primary)	Production volume (tonnes)
Forestry residues	2.815.750
Corn	1.974.000
Corn stalks and cob	1.771.560
Corn stover	1.480.870
Maize cobs	885.780

Results

Value chains are ranked based on the number of engaged stakeholders, including feedstock suppliers, technology providers, and potential buyers. A higher level of participation across these categories results in a higher ranking (**Table 24**).

Table 24 Potential value chains for Croatia.

Rank	Value Chain	Feedstock	Tech Providers	Potential Local Markets
1	PLA (Polylactic Acid)	Corn	Bio-Mi d.o.o. (development and production of bio-based, biodegradable thermoplastics including PHAs)	Bioplastics for packaging, consumer goods, and agricultural applications. Example partners: NOVI AGRAR d.o.o., ŽITO d.o.o., VUPIK PLUS d.o.o., PIK VINKOVCI PLUS d.o.o., Belje d.o.o.
2	Glycerol	Corn	Enzymatic hydrolysis; Fermentation	Chemical intermediates for biofuels, cosmetics, pharmaceuticals, and food additives. Example partners: NOVI AGRAR d.o.o., ŽITO d.o.o., CHROMOS AGRO d.o.o., Petrokemija d.d.
3	PHA (Polyhydroxyalkanoates)	Corn stover; Forestry residues	Bio-Mi d.o.o. (development and production of bio-based, biodegradable thermoplastics including PHAs)	Biodegradable plastics for packaging, agriculture, and medical devices. Example partners: NOVI AGRAR d.o.o., ŽITO d.o.o.,



				HRVATSKE ŠUME d.o.o., CHROMOS AGRO d.o.o.
4	Furfural		Acid hydrolysis; Catalytic systems; Solvent-thermal conversion	Chemical manufacturers (adhesives, resins, bio- solvents), specialty chemical producers. Example partners: Hrvatske Šume d.o.o., ELGRAD d.o.o., KRONOSPAN CRO d.o.o., DECOSPAN MATO FURNIR d.o.o., NOVI AGRAR d.o.o., ŽITO d.o.o.

Table 25 provides a concise summary showing each biomass value chain, divided into feedstock partners, technology providers, and markets. The Total column is the sum of those partners. The ranking (1 to 5) reflects the overall involvement across the supply chain.

Table 25 Potential partners in the value chains.

Rank	Value Chain	Feedstock Partners	Tech Providers	Market Partners	Total Partners
1	PLA	10	1	6	17
2	Glycerol	10	0	5	15
3	PHA	8	1	5	14
4	Furfural	8	0	5	13

Observations / Gaps:

- **Feedstock:** The corn-based value chains (for PLA and Glycerol) have a relatively broad network (~10 partners) due to extensive corn production and related agribusiness activities.
- **Tech Providers:** With roughly 1 key provider per chain (e.g. Bio-Mi d.o.o. or similar innovation/processing companies)—indicating room for increased technical collaboration or additional technology providers.
- **Market:** The downstream market networks range from 5 to 6 partners, covering sectors such as bioplastics packaging, chemical intermediates, and biodegradable plastics end-users. Further market linkage development could help strengthen these chains.

This table helps highlight where the value chain is strongest (e.g. PLA's broad partner base across all areas) and where potential gaps lie (e.g. feedstock for PHA and lower tech support for Glycerol).

3.6.2 Prioritisation of circular value chains

A wide range of potential circular value chains has been identified for each pilot region. However, to determine the most strategic value chains that will serve as key inputs for WP3 and the WP2 workshops, a prioritisation process is essential.

For this reason, the best value chains have been selected for each pilot region based on the following criteria: (1) have a strong fit between feedstock availability, (2) viable technology routes, and (3) a clear local market (or multiple markets) for the resulting bio-based product. These chains stand out as particularly actionable within the data that was provided during the SYMBIO project.



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1. Corn → PLA (Polylactic Acid)

This value chain uses corn—a well-established feedstock in the region—to produce PLA via fermentation, condensation, and polymerisation. Bio-Mi d.o.o. leads development in bio-based, biodegradable thermoplastics. A broad network of partners (e.g., NOVI AGRAR d.o.o., ŽITO d.o.o., VUPIK PLUS d.o.o., PIK VINKOVCI PLUS d.o.o., Belje d.o.o.) in packaging, consumer goods, and agricultural applications ensures strong market demand.

2. Corn → Glycerol

Leveraging corn residues, this chain converts biomass into glycerol using enzymatic hydrolysis and fermentation. The resulting glycerol serves as a chemical intermediate for biofuels, cosmetics, pharmaceuticals, and food additives. The chain is supported by industrial partners such as NOVI AGRAR d.o.o., ŽITO d.o.o., CHROMOS AGRO d.o.o., and Petrokemija d.d., which strengthen both feedstock supply and market integration.

3. Corn Stover & Forestry Residues → PHA (Polyhydroxyalkanoates)

Corn stover and forestry residues provide abundant lignocellulosic material to produce PHA via enzymatic hydrolysis and fermentation. Bio-Mi d.o.o. plays a key role in transforming these residues into biodegradable plastics suitable for packaging, agriculture, and medical devices. A robust partner network—including NOVI AGRAR d.o.o., ŽITO d.o.o., HRVATSKE ŠUME d.o.o., and CHROMOS AGRO d.o.o.—ensures a stable supply chain and strong market access.

4. Forestry Residues & Maize Cobs → Furfural

In this chain, forestry residues and maize cobs are converted into furfural through acid hydrolysis, catalytic systems, and solvent-thermal conversion. Furfural is a critical intermediate for adhesives, resins, and bio-solvents, with high demand among specialty chemical manufacturers. Key partners (e.g., Hrvatske Šume d.o.o., ELGRAD d.o.o., KRONOSPAN CRO d.o.o., DECOSPAN MATO FURNIR d.o.o., NOVI AGRAR d.o.o., and ŽITO d.o.o.) help build a competitive and well-integrated ecosystem.

3.6.3 Existing infrastructure

Below is an overview and analysis of whether the four proposed value chains would face feedstock competition or “lock-in” from the existing bioeconomy infrastructure that is listed. We specifically checked for overlaps in raw material use and potential market/processing competition with the facilities. The list of facilities was taken from the VCG database of more than 13.000 existing infrastructure listed collected from open-source data like CBE JU and IEA Bioenergy among others.

Incineration Plants:

- OPG IGOR ŠURLAN (Lopatinec)
- HOLCIM (Hrvatska) d.o.o. (Koromačno – co-incineration)
- PET MEMO d.o.o. (Samobor)
- MORSKI LAV d.o.o. (Sesvetski Kraljevec)

Processing Plants for Animal By-Products:

- Koka d.d. (Varaždin)
- Agroproteinka d.d. (Sesvete; two entries: one for rendered fats/animal protein and one for meat and bone meal)
- Metro-spin d.o.o. (Križanec)
- SARDINA d.o.o. (Postira)



Additional processing facilities (e.g., ELCON – for feed soil improvers, LUKAČ d.o.o. for fertilisers).

Potential Overlaps

- For Corn-Based Feedstocks (PLA & Glycerol): The proposed value chains for PLA and glycerol rely on corn grain and its residues (corn stover). None of the existing infrastructure specifically targets corn or corn stover. Most incineration plants and processing facilities focus on municipal waste or animal by-products. Conclusion: Minimal overlap; corn feedstocks should be readily available from agribusiness operations without significant competition from current infrastructure.
- For Lignocellulosic Feedstocks (Furfural & PHA): These value chains depend on forestry residues, maize cobs, corn stalks, and corn stover. There is potential overlap here if unsorted agricultural or forestry residues are diverted to incineration (as seen in some incineration and co-incineration plants) or are used for other processing (e.g., for producing soil improvers). Conclusion: Moderate competition exists if biomass intended for conversion is not adequately segregated. Strategic collection and dedicated supply chains are necessary to ensure that lignocellulosic residues are reserved for furfural and PHA production rather than being consumed by existing incineration or alternative processing operations.

Overall, while corn-based chains (PLA, Glycerol) face low competition, the lignocellulosic value chains (Furfural, PHA) might compete with existing incineration and processing activities unless dedicated feedstock management systems are implemented.

3.7 Slovenia

3.7.1 Mapping Companies and Biomass

Companies

Slovenia has vast quantities of wheat straw, barley straw, corn stover, and poplar sawdust, often surpassing 2 million tonnes, creating significant potential for bioproducts. Most processes are not yet locally available, suggesting these value chains remain largely unexploited. Nonetheless, the sufficient number of biomass producers showcases the feedstock availability. Building the appropriate technology base could unlock major bioeconomy opportunities, especially in producing biopolymers like PHA and PLA, which have strong global demand. A total of 57 companies, falling in the scope of bioeconomy, were identified as shown in **Table 26**. The companies were then connected to the possible value chains.

Table 26 List of companies from Slovenia.

Sector	# of Companies	Key Companies (Examples)	Main Activities
Agriculture	8	Jeruzalem Ormož SAT d.o.o., Žipo Lenart d.o.o., Evrosad d.o.o.	Crop production (cereals, fruits, grapes), viticulture, livestock breeding, and agricultural services (including sales of tractors/vehicles for farming)
Food Processing	14	GORIMPEX d.o.o., NUTRISSLIM d.o.o., Fructal, ETA Kamnik, Presad d.o.o.	Canning of specialty products (baby foods, soups), juice/nectar production, extraction of edible oils, and other prepared food products



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Dairy	4	Mlekarna Celeia d.o.o., EKOLAT d.o.o., Ljubljanske mlekarne d.o.o., Pomurske mlekarne d.d.	Milk processing and production of dairy products (milk, cheese, yogurt, cream)
Meat & Poultry	5	Meso Kamnik d.d., Panvita MIR d.d., Perutnina Ptuj d.d., Pivka perutninarstvo d.d., Celjske Mesnine	Pig breeding, poultry raising, and integrated meat processing (slaughter, cutting, and packaging of meat products)
Milling / Grain Processing	1	Mlin Korosec d.o.o.	Flour milling and processing of grain
Bakery & Confectionery	6	Pekarna Pečjak, DON DON d.o.o., Hlebcek d.o.o., Mlinotest, Žito, BUFO EKO d.o.o.	Production of breads, biscuits, pastries, confectionery items, and related milling products
Wood Processing & Furniture	33	Merkscha d.o.o., BELES d.o.o., FLOOR EXPERTS d.o.o., Parketarna Jager d.o.o.	Primary wood processing (sawing, planing, chipping, pellet production) and manufacture of furniture, flooring, packaging materials, and biomass
Construction / Prefabrication	5	JELOVICA d.o.o., LUMAR IG d.o.o., M SORA d.d., MARLES HIŠE MARIBOR, SLOVENIJALES d.o.o.	Production of prefabricated houses, energy-efficient building systems, and interior construction products
Retail Trade	4	Alpina d.o.o., DS SMITH SLOVENIJA d.o.o., Lidl Slovenija, Spar Slovenija	Wholesale/retail distribution of food and consumer products
Textile	2	Filc d.o.o., LISCA d.d.	Production of textiles and related products
Winery	1	Movia Winery	Viticulture and wine production and marketing
Malt Manufacturing	2	Boxmark leather d.o.o., DANI AFC d.o.o.	Production of malt for food and beverage applications

Additionally, to enhance the list, 110 companies from the VCG database that could participate in these value chains were added.

Biomass

Biomass numbers, shown in **Table 27**, were taken from the work that was done as part of the Deliverable 2.1.

Table 27 Top 5 biomasses in Slovenia.

Rank	Biomass Type	Production Volume (Tonnes)
1	Corn	887,440
2	Wheat Straw	210.450,00
3	Animal Fats (from animal waste)	54,750
4	Barley Straw	50,483.50
5	Forestry Residues	49.046,00



3.7.2 Prioritisation of circular value chains

A wide range of potential circular value chains has been identified for each pilot region. However, to determine the most strategic value chains that will serve as key inputs for WP3 and the WP2 workshops, a prioritisation process is essential.

For this reason, the best value chains have been selected for each pilot region based on the following criteria: (1) have a strong fit between feedstock availability, (2) viable technology routes, and (3) a clear local market (or multiple markets) for the resulting bio-based product. These chains stand out as particularly actionable within the data that was provided during the SYMBIO project.

1. Furfural from Forestry Residues

- Feedstock:
 - Forestry Residues are available from a wide range of forest- and wood-based enterprises, including:
 - SiDG d.o.o. (state forests),
 - Many sawmills & wood processors (Anles, Beles, Brin, Extraform, Fi Les, Floor Experts, Go-Les, Impregnacija, Lip Bohinj, Lip Bled, Marinčič, Masiva, Mbs List, Montpreis, Petkovšek, Plp, Sagles, Tila, Tomles, Žaga)
- Tech Provider:
 - Tanin d.d. (longstanding expertise in plant extracts & hydrolysis—particularly relevant if developing furfural from lignocellulosic feedstocks)
- Market / Offtakers (chemical & material producers who could use furfural as a platform chemical):
 - Potentially Melamin, Belinka Perkemija, Silvaprodukt, Mitol or other resin/chemical manufacturers from the list that use wood- or bio-based intermediates.
- Why it ranks #1: Many sawmills and forestry/wood-processing companies can supply residue, plus at least one strong local tech partner (Tanin), and multiple chemical offtakers are possible.

2. Glycerol from Animal Fats

- Feedstock:
 - Animal Fats from meat-processing and slaughtering companies, such as:
 - Meso Kamnik, Celjske Mesnine, Panvita MIR, Perutnina Ptuj, Pivka perutninarstvo, Kras d.d., Jata Emona (all generate animal by-products/fats).
- Tech Provider:
 - Glycerol can be produced via Enzymatic Hydrolysis/Saponification. While Tanin d.d. is not specialized in fats, local engineering or R&D providers (e.g., Acies Bio, AlgEn, “Technology provider” Co Bik, KOTO etc.) could support the process.
- Market / Offtakers:
 - Glycerol is used in personal care (e.g., Ilirija, Kozmetika Afrodita, Henkel), in some food formulations (e.g., Gorimpex, Atlantic Droga Kolinska, Medex), in pharmaceuticals (e.g., Lek, Marifarm, Galex, Sensilab), and as an ingredient for certain resins or coatings.
- Why it ranks #2: Many sizable meat/poultry processors can supply animal fats, and numerous chemical, cosmetics, or pharma firms can use glycerol. Although there is no single “cornerstone” technology provider specifically for fats, overall partner potential is large.

3. PHA from Wheat Straw

- Feedstock:
 - Wheat Straw potentially from cereal/field-crop growers:



- Žipo Lenart (growing cereals, livestock),
 - Meja Šentjur (cereals),
 - Panvita MIR
- Tech Provider:
 - PHA is produced via Enzymatic Hydrolysis + Fermentation. Again, local R&D (e.g., Tanin d.d. for hydrolysis expertise, Acies Bio, or “Technology provider” Co Bik) could be engaged.
- Market / Offtakers:
 - Companies in the plastics or packaging domain, such as Plama-Pur (foam materials), Papirnica Vevče (packaging film conversion), or any injection-molding producers looking for bioplastic solutions.
- Why it ranks #3: Although fewer direct wheat-straw suppliers are obvious, there is decent synergy with R&D providers and a rising interest in bioplastics among manufacturers.

4. Succinic Acid from Barley Straw

- Feedstock:
 - Barley Straw would come from barley cultivations. While the list does not show many explicit barley growers, some general cereal-farmers or cooperatives (e.g., Evrosad or Meja Šentjur if they also do barley) might supply straw.
- Tech Provider:
 - Succinic acid from lignocellulosic feedstocks uses Enzymatic Hydrolysis + Fermentation. Potentially supported by Tanin d.d. or local biotech firms (e.g., Acies Bio).
- Market / Offtakers:
 - Succinic acid can be used in food (acidulant), polymers (PBS plastics), coatings, and resins. Firms like Melamin, Mitol, or Belinka Perkemija might be end-users.
- Why it ranks #4: While there is interest in succinic acid as a building-block chemical, barley straw feedstock is less evidently widespread among the listed agricultural entities. Fewer direct feedstock or large-scale offtakers are visible than for the top three.

These four value chains (Furfural from Forestry Residues, Glycerol from Animal Fats, PHA from Wheat Straw, Succinic Acid from Barley Straw) stand out among the possible lignocellulosic and agri-based routes because:

- They each have at least some identified feedstock suppliers in the list,
- They can tap into local technology/R&D (e.g., Tanin d.d. and various biotech/engineering companies),
- They have plausible industrial markets/offtakers (chemicals, adhesives, cosmetics, or plastics) among the Slovenian firms listed.

This makes them the most viable in terms of partner participation.

Table 28 provides a concise summary showing each biomass value chain, divided into feedstock partners, technology providers, and markets. The Total column is the sum of those partners. The ranking (1 to 5) reflects the overall involvement across the supply chain.

Table 28 Potential partners in the value chains.

Rank	Value Chain	Feedstock Partners	Tech Providers	Market Partners	Total Partners
1	Furfural	8	1	15	24



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2	Glycerol	8	1	10	19
3	PHA	10	0	15	25
4	Succinic Acid	7	0	9	16

Observations/Gaps:

- Feedstock security - each chain depends on ensuring stable, high-quality biomass or residue streams.
- Technology readiness - while fermentation and acid hydrolysis are established, Slovenia has limited large-scale demonstration for these specific biorefineries; some solutions might still need pilot-scale validation.
- Market & scale - PHA (bioplastics) and furfural (industrial chemical) could command higher margins if scaled efficiently. Succinic acid and glycerol have known markets but face price-competition from global suppliers.

3.7.3 Existing infrastructure

Below is an overview and analysis of whether the four proposed value chains would face feedstock competition or “lock-in” from the existing bioeconomy infrastructure that is listed. We specifically checked for overlaps in raw material use and potential market/processing competition with the facilities. The list of facilities was taken from the VCG database of more than 13.000 existing infrastructure listed collected from open-source data like CBE JU and IEA Bioenergy among others.

1. Rendering / Animal By-Product (ABP) Processing
 - Perutnina Ptuj d.o.o. (Processing Plant): Processes Category 3 animal by-products (poultry) into rendered fats and protein meals for feed.
 - KOTO d.o.o. (Processing Plant): Large rendering facility that handles Category 3 animal by-products from multiple species. Produces processed animal proteins, rendered fats for feed and oleochemical purposes, and other derivatives.
2. Composting Facilities.
 - JAVNE SLUŽBE PTUJ d.o.o. (Kompostarna CERO Gajke)
 - SIMBIO d.o.o. (RCERO Celje – kompostarna)
 - CEROZ d.o.o.
 - KOCEROD d.o.o.
 - KOGAL d.o.o. (Obrat Kompostarna KOGAL)
 - KOMUNALA Slovenska Bistrica d.o.o. (CERO Pragersko – kompostarna)
 - KSD d.o.o. (CERO Ajdovščina – obrat Kompostarna)
 - KOSTAK d.d. (Center za ravnanje z odpadki Spodnji Stari Grad – kompostarna)
 - CC INŽENIRING d.o.o. (PE Koper)
 - ROKS RECIKLIRANJE d.o.o. (Kompostarna ROSA)
 - JP VOKA SNAGA d.o.o. (Ljubljana)
 - KOMUNALA KOČEVJE d.o.o.
 - Javno podjetje za ravnanje z odpadki Puconci d.o.o.
 - SALOMON d.o.o. (Kompostarna Lendava)

All the above produce compost from organic waste, occasionally including catering/food waste or spent mushroom substrates.



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3. Biogas Plants

Primarily anaerobic digestion of agricultural wastes, manure, slaughterhouse by-products, and other organic residues to produce biogas and digestate.

- Bioplinarna Branko Arnuš s.p.
- Perutnina Ptuj d.o.o., PE PC Energija (on-site biogas from poultry residues)
- Bioen d.o.o. (BPE Organica)
- Adastra Energija d.o.o. (Bioplinarna Ormož)
- Bio Term d.o.o.
- Petrol d.d. (Bioplinarna Črnomelj)
- KOTO d.o.o., Obrat za proizvodnjo bioplina (integrated with their rendering activities)
- Bioplin Knaus (Dejan Knaus s.p.)
- Panvita Ekoteh d.o.o. (operates multiple biogas plants—Jezera, Motvarjevci, etc.)
- DUP1 d.o.o. (Bioplinarna Dobrovnik)

All biogas facilities produce renewable energy and a residual digestate, which is typically used as fertilizer.

Potential Overlaps

Forestry Residues → Furfural

- No direct overlap with compost/biogas plants in the provided list. The main competition is wood for energy/pellets.

Animal Fats → Glycerol

- Likely competition with existing rendering and biogas plants (e.g., KOTO, Perutnina Ptuj) using those fats for feed, biodiesel, or energy. Partnerships or supply agreements are crucial.

Wheat Straw → PHA

- The listed compost/biogas sites *rarely* rely on straw, so direct competition is minimal. However, farmers may have alternative outlets (livestock bedding, horticulture, etc.).

Barley Straw → Succinic Acid

- Similarly, limited direct competition with the listed facilities, but barley straw has existing on-farm uses. Overall volumes also tend to be lower than wheat straw.

In short, animal fats present the clearest competition for feedstock among the four proposed pathways, given established rendering and biodiesel channels. Forestry residues, wheat straw, and barley straw have little direct overlap with the compost and biogas plants in the list, though each feedstock does have existing alternative markets outside these specific facilities.

3.8 Emilia Romagna

3.8.1 Mapping Companies and Biomass

Companies

Emilia Romagna exhibits a broad biomass portfolio, including wheat straw, corn residues, barley straw, forestry residues, and whey protein hydrolysate. The region's sizable base of producers (up to 49 for some



feedstocks) positions it as a strong candidate for expanding circular bioeconomy initiatives. A total of 56 companies, falling in the scope of bioeconomy, were identified as shown in **Table 29**. The companies were then connected to the possible value chains.

Table 29 List of companies from Emilia Romagna.

Sector	# of Companies	Key Companies (Examples)	Main Activities
Dairy industry	14	Ferrari Formaggi, Parmalat, Colla, Dalter Alimentari, etc.	Production, aging, and packaging of high-quality cheeses (e.g., Parmigiano Reggiano, Grana Padano), milk and cream processing, gelato manufacturing
Brewery industry	1	Molino Spadoni S.p.A.	Although labeled “brewery,” primarily known for flour milling, blends for pizza/bakery, specialty grains
Soy processing	2	Bunge Italia, Molini Pivetti	Crushing/refining of soybeans and oilseeds, producing vegetable oils, meal for feed, specialty flours
Rice farm	1	Grandi Riso S.p.A.	Cultivation, processing, and packaging of high-quality Italian rice
Bakery industry	15	Antico Forno della Romagna, Deco Industrie, Grissin Bon, Bimbo QSR	Wide range of baked goods: artisanal breads, cakes, biscuits, frozen pizza/focaccia doughs, gluten-free snacks, large-scale breadstick/rusk production
Wheat production	5	Molino Dallagiovanna, Molini Pivetti, Progeo S.C.A.	Milling high-quality wheat/flours (for pasta, bakery, pastry), cooperative grain collection, farm services
Sawmills / Wood	13	S.A.I.B., Ecobloks, Kastamonu Italia, CasaDei Pallets	Manufacturing chipboard, melamine boards, wooden pallets/packaging, reconstituted veneers, timber for construction, furniture components
Furniture manufacturing	3	Arredoquattro Industrie, Olivieri, Tumidei	Design and production of furniture, furnishings, doors, interior design solutions
Technology providers	2	Agromateriae, B-PLAS	Innovative valorization of agro-industrial wastes into biofillers and bioplastics (PHA), wastewater sludge upcycling, R&D in circular bioeconomy

Additionally, to enhance the list, 175 companies from the VCG database that could participate in these value chains were added.

Biomass

Biomass numbers, as shown in **Table 30**, were taken from the work that was done as part of the Deliverable 2.1.

Table 30 Top 5 biomasses in Emilia Romagna.

Secondary Biomass Flow	Production Volume (Tonnes)
Alfalfa Fiber	3,004,971.60



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Wheat	817,518.00
Corn Residues (Stover and Straw)	436,672.00
Wheat Straw	340,632.50
Corn (Grain)	218,336.00

3.8.2 Prioritisation of circular value chains

A wide range of potential circular value chains has been identified for each pilot region. However, to determine the most strategic value chains that will serve as key inputs for WP3 and the WP2 workshops, a prioritisation process is essential.

For this reason, the best value chains have been selected for each pilot region based on the following criteria: (1) have a strong fit between feedstock availability, (2) viable technology routes, and (3) a clear local market (or multiple markets) for the resulting bio-based product. These chains stand out as particularly actionable within the data that was provided during the SYMBIO project.

1. PHA from Corn Residues (Stover & Straw)

Rationale:

1. Corn residues represent one of the most voluminous lignocellulosic resources in the region, supported by a strong cooperative and farming network.
2. PHA (polyhydroxyalkanoates) is a promising biopolymer with growing demand among packaging and circular-economy stakeholders.
3. Potential participants span from farm cooperatives (feedstock) to fermentation technology providers and end-users seeking sustainable packaging solutions.

2. Furfural from Corn Residues (Stover & Cobs)

Rationale:

1. As with PHA, the availability of corn residues is significant, and existing cooperatives can facilitate stable collection.
2. Furfural is widely used in resins, solvents, and other specialty chemicals, offering multiple downstream market opportunities (e.g., adhesives, plastics).
3. Furfural's applications in advanced materials and green chemistry make it attractive for chemical companies seeking biobased feedstocks.

3. Succinic Acid from Wheat Straw

Rationale:

1. Wheat straw is well established and already aggregated through large cooperatives.
2. Succinic acid is essential in manufacturing a range of biodegradable plastics, solvents, and specialty chemicals.
3. Food, pharmaceuticals, bioplastics, and other industries can utilize succinic acid as a core building block, fostering substantial market participation.



4. Lactic Acid from Alfalfa Fiber

Rationale:

1. Significant Forage Crop – Alfalfa (also known as lucerne) is widely cultivated for livestock feed in Emilia-Romagna, producing substantial residual fiber.
2. High-Demand Product – Lactic acid is used extensively in food preservation, nutraceuticals, and as a precursor to polylactic acid (PLA) for bioplastics.
3. Emerging Circular Opportunity – Valorising alfalfa fiber into high-value chemicals aligns with EU sustainability directives and diversifies farm revenue streams

Additional Notable Opportunities

- PLA from Corn (Grain): Polylactic acid remains a promising route, particularly for food packaging, however, its scale of adoption may be smaller than residue-based approaches.
- Sorbitol from Wheat (Grain): A viable sweetener/bulking agent widely used in food and personal care products, though offering a narrower partner base than the four “best” routes above.

In conclusion, corn residues (PHA, furfural), wheat straw (succinic acid) and alfalfa (lactic acid) offer especially strong prospects. They leverage high-volume feedstocks, tap into growing markets for biobased chemicals and polymers, and connect well with local agricultural and industrial ecosystems throughout Emilia-Romagna. Below is a summary table of four top-ranked value chains, showing an estimated number of partners from three categories (Feedstock, Technology, and Market).

Table 31 provides a concise summary showing each biomass value chain, divided into feedstock partners, technology providers, and markets. The Total column is the sum of those partners. The ranking (1 to 5) reflects the overall involvement across the supply chain.

Table 31 Potential partners in the value chains.

Value Chain	Rank	Feedstock Partners	Tech Partners	Market Partners	Approx. Total
PHA from Corn Residues (Stover & Straw)	#1	High (10+)	Medium (B-PLAS, Agromateriae)	High (10+) (packaging, bioplastic users)	25–30
Furfural from Corn Residues (Stover & Cobs)	#2	High (10+)	Low–Medium (Agromateriae for R&D; no direct furfural specialist)	Medium–High (8–10) (chemical/resin)	~20–25
Succinic Acid from Wheat Straw	#3	High (8–10)	Low (Neither B-PLAS nor Novaol specialize here; possible R&D with Agromateriae)	Medium–High (8–10) (food additives, plastics)	~20
Lactic Acid from Alfalfa Fiber	#4	Medium (5–8)	Low (No direct local lactic-acid tech provider among the three)	Medium–High (5–8) (food, pharma)	~15



Observed Gaps in Partnerships

Corn-Residue Pathways (PHA & Furfural):

- Multiple co-ops can supply corn stover/cobs (e.g., Progeo, Consorzio Agrario), but residue collection logistics need formal agreements.
- PHA can leverage B-PLAS (PHA from waste) and possibly Agromateriae (agro-residue valorisation).
- Furfural has no specialised local provider listed; Agromateriae might collaborate on R&D, but large-scale technology likely requires external licensing.
- Many packaging/chemical companies could adopt bioplastics or furfural, but cost competitiveness and scaling remain key challenges.

Succinic Acid from Wheat Straw:

- Wheat straw is abundant (e.g., Molini Pivetti, Progeo), but already in demand for bedding and other on-farm uses. Securing stable supply is critical.
- Neither B-PLAS nor Novaol produce succinic acid. Agromateriae might offer R&D support, but a dedicated commercial technology partner is missing.
- Potentially broad (food, bioplastics, specialty chemicals), but off-takers will need consistent quality and volume.

Lactic Acid from Alfalfa Fiber:

- Alfalfa growers (livestock feed co-ops) need to develop a new supply chain for fiber, as it is not currently commercialised.
- None of the three identified tech providers explicitly offer lactic-acid fermentation from alfalfa. This would require external or in-house process development.
- Food & pharma demand for lactic acid is strong. Partnerships with local dairy/food companies (e.g., Parmalat, Granarolo) may accelerate acceptance.

B-PLAS and Agromateriae can support PHA or general R&D for agro-residues, but no direct local partner is specialised in furfural, succinic acid, or lactic acid. Novaol focuses on oil-based biodiesel and thus does not apply to these lignocellulosic routes. The biggest partnership gaps remain securing consistent feedstock (especially straw, cobs, alfalfa fiber), pilot-to-industrial scale technology, and committed off-takers for each biobased product.

3.8.3 Existing infrastructure

Below is an overview and analysis of whether the four proposed value chains would face feedstock competition or “lock-in” from the existing bioeconomy infrastructure that is listed. We specifically checked for overlaps in raw material use and potential market/processing competition with the facilities. The list of facilities was taken from the VCG database of more than 13.000 existing infrastructure listed collected from open-source data like CBE JU and IEA Bioenergy among others.

1. Incineration / Waste-to-Energy (W2E)

- Herambiente Spa
 - Ravenna, Modena, Ferrara W2E plants
- Iren Ambiente S.p.A.



- Parma W2E plant
- Various smaller incineration sites (e.g., Little Heaven di Castagnoli, Il Ponte dell’Arcobaleno)

2. Combustion Plants

- Consorzio Euro Terminal Energia
- Modena Energia S.r.l.
- Sandri S.p.A.
- Effegi Energy

3. Processing Plants (mainly animal by-products, feed or food processing)

- S.A.P.I. (Società Azionaria Prodotti Industriali)
- Parmovo S.r.l.
- Centro Selezione Suini S.r.l.
- Gatti S.r.l.

4. Biogas Plants (on-farm or cooperative digesters)

- Società Agricola Campiano Biogas, Vittoria Bioenergia, Soc. Agr. Cazzani, etc.
- Typically, co-digest manure, silage, and sometimes cereal residues.

Potential Overlaps

Incineration and combustion plants mostly handle municipal waste or other solid fuels; they do not actively compete for corn or wheat residues or alfalfa fiber. Processing plants (rendering, slaughter by-products) also show no direct overlap in feedstocks. Biogas plants present the strongest potential competition for corn stover and wheat straw, as these can be co-digested with manure to produce renewable energy. Long-term farmer contracts and stable gate fees may incentivize using cereal residues for biogas rather than new biorefinery processes. Thus, the primary feedstock competition for the four proposed value chains is likely from on-farm or cooperative biogas plants, especially regarding corn residues (stover/cobs) and wheat straw. Alfalfa fiber is less typical in digesters, so competition there remains minimal.

3.9 Friuli Venezia Giulia

3.9.1 Mapping Companies and Biomass

Companies

A total of 57 companies, falling in the scope of bioeconomy, were identified as shown in **Table 32**. The companies were then connected to the possible value chains.

Table 32 List of companies from Friuli Venezia Giulia.

Sector	Number of Companies	Key Companies (Examples)	Main Activities
Dairy industry	4	Parmalat S.p.A., Latte Carso, Venchiaredo, Latteria Sociale di Coderno	Milk/cheese processing, yogurt, cream, dairy product distribution
Brewery industry	1	Birra Castello S.p.A.	Brewing beer, bottling, and distribution



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Bakery industry	4	Panificio Vazzoler, Quality Food Group, Bouvard Italia, Forneria Gusparo	Production of bread, pastries, biscuits, confectionery, and related baked goods
Wheat production	2	Grandi Molini Italiani S.p.A., Progeo S.C.A.	Milling flours (soft/durum wheat), cereal collection, supply to bakeries and food sector
Sawmills	8	Fantoni, Kronospan, Lombardo, Braga	Wood processing, panel/board manufacturing, wooden packaging, barrels, crates
Furniture	5	Friul Intagli, Armony, Mobilificio San Giacomo, Mobili Fiver, Ar-Due	Design and manufacture of kitchen sets, cabinets, modular furniture, or custom pieces

Additionally, to enhance the list, 76 companies from the VCG database that could participate in these value chains were added.

Biomass

Biomass numbers, as shown in **Table 33**, were taken from the work that was done as part of the Deliverable 2.1.

Table 33 Top 5 biomasses in Friuli Venezia Giulia.

Top 5 biomass types	Production volume
Whey Protein Hydrolysate	14368008
Poplar sawdust	3272584
Corn residues	354459
Sugarbeet	309094
Soybean meal	79506,8

3.9.2 Prioritisation of circular value chains

A wide range of potential circular value chains has been identified for each pilot region. However, to determine the most strategic value chains that will serve as key inputs for WP3 and the WP2 workshops, a prioritisation process is essential.

For this reason, the best value chains have been selected for each pilot region based on the following criteria: (1) have a strong fit between feedstock availability, (2) viable technology routes, and (3) a clear local market (or multiple markets) for the resulting bio-based product. These chains stand out as particularly actionable within the data that was provided during the SYMBIO project.

1. Acetic Acid from Poplar Sawdust

- Feedstock: Sawmill residues (poplar sawdust) from companies such as Fantoni, Kronospan, Lombardo, Garbellotto, etc.
- Technology: Enzymatic hydrolysis + Fermentation to convert lignocellulosic biomass into acetic acid.
- Market:
 - Food industry (as a preservative/vinegar base),



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- Chemical sector (solvents, resins).
- Why Promising: Large regional sawmills produce abundant poplar by-products; acetic acid has broad industrial and food applications.

2. Proteins from Whey

- Feedstock: Whey or whey permeate from dairy producers (Parmalat, Latte Carso, Venchiaredo, Latteria Sociale di Coderno).
- Technology: Ultrafiltration or membrane separation, then drying to obtain whey protein concentrates/isolates.
- Market:
 - Functional foods, bakery, sports nutrition, feed additives.
- Why Promising: High-value protein ingredients meet rising consumer demand for health & nutrition products; local dairies can monetize whey by-streams.

3. PLA (Polylactic Acid) from Sugarbeet

- Feedstock: Sugarbeet from crop co-ops (e.g., Consorzio Agrario del Friuli Venezia Giulia).
- Technology: Fermentation to lactic acid, followed by condensation & polymerization into PLA.
- Market:
 - Biodegradable packaging for food,
 - Potential use in consumer goods or furniture components.
- Why Promising: Bioplastics are in high demand; sugarbeet fermentation engages local agriculture and multiple end-use industries.

4. 1,3-Propanediol from Corn Residues

- Feedstock: Corn stover/cobs from farming cooperatives or producers (e.g., Progeo).
- Technology: Enzymatic hydrolysis + Fermentation routes to produce 1,3-PDO.
- Market:
 - Polymers (e.g., PTT polyester),
 - Cosmetics and personal care (solvent/humectant),
 - Industrial applications (polyurethanes, lubricants).
- Why Promising: 1,3-Propanediol is a versatile chemical platform for bio-based polyesters and specialty products, giving corn residue value beyond energy/bedding uses.

Table 34 provides a concise summary showing each biomass value chain, divided into feedstock partners, technology providers, and markets. The Total column is the sum of those partners. The ranking (1 to 5) reflects the overall involvement across the supply chain.

Table 34 Potential value chains for Friuli Venezia Giulia.

Value Chain	Rank	Feedstock Partners	Tech Partners	Market Partners	Approx. Total
Acetic Acid from Poplar Sawdust	#1	High (6–8 sawmills)	Low (Bioenergy-FVG for pilot R&D)	High (10+) (food preservative, chemicals)	~25–30



Proteins from Whey	#2	Medium (4 major dairies)	Low	High (10+) (food processors, nutrition)	~20-25
1,3-Propanediol (1,3-PDO) from Corn Residues	#3	Medium (1-2 co-ops like Progeo)	Low	Medium (5-10) (polymers, cosmetics, etc.)	~15-20
PLA from Sugarbeet	#4	Low-Medium (1 main coop)	Low	Medium (5-10) (bioplastic packaging, furniture)	~15

Key Observations/Gaps:

1. Technology
 - Only Bioenergy-FVG Project is noted for R&D and pilot-scale setups. No specialised commercial fermentation or chemical-extraction firms appear in the dataset, limiting scale-up options.
2. Feedstock:
 - Poplar sawdust has the broadest sawmill base (6-8 possible suppliers), making it attractive for acetic acid production.
 - Whey has at least four major dairies for consistent protein supply. Corn and sugarbeet feedstocks are tied to fewer large co-ops.
3. Market:
 - Acetic acid and whey proteins each see strong local food & beverage uptake, while 1,3-PDO and PLA require more specialised markets (polymers, biodegradable plastics).
 - Cross-sector interest (food, cosmetics, chemicals, packaging, furniture) can help broaden demand, but most bioprocesses still need cost-competitive scale-up to gain local traction.

3.9.3 Existing infrastructure

Below is an overview and analysis of whether the four proposed value chains would face feedstock competition or “lock-in” from the existing bioeconomy infrastructure that is listed. We specifically checked for overlaps in raw material use and potential market/processing competition with the facilities. The list of facilities was taken from the VCG database of more than 13.000 existing infrastructure listed collected from open-source data like CBE JU and IEA Bioenergy among others.

Waste-to-Energy / Incineration

- Herambiente Spa (Trieste waste-to-energy plant)
- PET S.r.l. (Gemona del Friuli incineration)

Combustion Plants

- Compagnia per l’Elettricità e l’Acquacoltura (Gorizia)

Biogas Plants (on-farm or cooperative digesters)

- EnibioCH4in sites (Medea, Torviscosa)
- Fri-El Quadrivium (Codroipo)
- Società Agricola S. Vito Biogas (San Vito al Tagliamento)
- Methanest, Pannellia Biogas, Vivaro Biogas, Tonello Clean 3, and others in Aviano, Codroipo, Vivaro, etc.



1. Acetic Acid from Poplar Sawdust

- Existing infrastructure overlap
 - Combustion/Incineration: Some plants may co-firewood or sawdust, but these sites mostly handle municipal waste or specified biomass fuels, poplar sawdust is not typically a major feedstock.
 - Biogas: On-farm digesters rarely use high-lignin woody materials (like sawdust) because they are not easily digestible.
- Conclusion: Minimal competition for poplar sawdust. Incineration/combustion plants do not commonly target sawmill residues, so feedstock is relatively unclaimed.

2. Proteins from Whey

- Existing infrastructure overlap
 - Biogas: Some digesters accept food-processing liquid by-products, but whey is not a major feedstock (manure, maize silage, etc. are typical).
 - Incineration: Typically processes municipal or industrial solid waste, not dairy liquid streams.
- Conclusion: No direct competition. Whey is rarely directed to combustion or AD plants at scale; local dairies can divert their by-product to protein recovery with little overlap.

3. 1,3-Propanediol from Corn Residues

- Existing infrastructure overlap
 - Biogas: Most of the region's anaerobic digesters (e.g., ENIBIOCH4IN, Fri-EI, etc.) can process corn silage or stover to enhance gas yields. This is the main potential competitor for corn residues.
 - Incineration/Combustion: Typically, not a large sink for corn stover.
- Conclusion: Moderate competition. On-farm biogas plants may contract with local farmers for corn residue, so any new 1,3-PDO facility would need to negotiate feedstock supply or offer comparable returns.

4. PLA from Sugarbeet

- Existing infrastructure overlap
 - Biogas: Many digesters also handle sugarbeet pulp or leftover biomass. If local plants already pay for sugarbeet by-products, that can reduce availability for PLA feedstock.
 - Combustion/Incineration: Not a typical route for sugarbeet biomass.
- Conclusion: Potential overlap with biogas operations if sugarbeet pulp is used as a substrate. However, sugarbeet feedstock for PLA typically focuses on its sugar fraction, which might require separate supply agreements.

Potential Overlaps

Poplar Sawdust & Whey face little to no direct competition from the listed infrastructure, as these by-streams are not typically used in incineration or biogas. Corn Residues & Sugarbeet could be competing with on-farm biogas plants, since both are fairly common AD substrates. Potential value-chain developers



for 1,3-PDO or PLA would need stable supply contracts and pricing to sway farmers away from existing biogas contracts.

3.10 Lombardy

3.10.1 Mapping Companies and Biomass

Companies

Lombardy has an extensive mix of feedstocks, including corn residues, wheat straw, forestry residues, waste cooking oil, and alfalfa fiber, surpassing 1.6 million tonnes in some categories. Lombardy also hosts a strong network of stakeholders (e.g., 14 biomass producers and 3 technology providers for lactic acid), signifying a mature biobased ecosystem that can rapidly scale up next generation biorefineries and circular production lines. A total of 66 companies, falling in the scope of bioeconomy, were identified as shown in **Table 35**. The companies were then connected to the possible value chains.

Table 35 List of companies from Lombardy.

Sector	Numbers of Companies	Key Companies (Examples)	Core Activities
Dairy industry	24	Centrale del Latte di Brescia, Parmalat, Sterilgarda, Zanetti, Galbani	Collecting & processing milk; producing cheeses, yogurt, butter, cream; distribution of fresh and long-life dairy products
Brewery industry	2	Heineken Italia, Carlsberg Italia	Brewing beer, bottling, and distributing malt beverages
Soy processing	2	Oleificio Zucchi, Lameri	Seed/olive oil production, cereal transformation (breakfast cereals, semi-finished products), sustainability-focused edible oil refining
Rice farm	5	Riso Scotti, Riso Gallo, Curti, Parboriz, PRD	Cultivating, milling, and processing rice; producing rice-based products (risottos, snack items, private label packaging)
Bakery industry	13	Bauli, Galbusera, Dolciaria Acquaviva, Monviso Group, Freddi Dolciaria	Producing and distributing a variety of baked goods, biscuits, frozen pastries, snack cakes, specialty desserts, bread products
Sawmills	17	Gruppo Mauro Saviola, Cleaf, Frati Luigi, Braga, Xilopan	Wood processing; producing chipboard, laminates, melamine-faced panels, custom packaging, glulam construction, and interior components
Furniture manufacturing	3	Riva Industria Mobili, Pedrali, Boffi	Designing and manufacturing high-end furniture (kitchens, solid wood pieces, seating, etc.), often combining craftsmanship with modern tech

Additionally, to enhance the list, 307 companies from the VCG database that could participate in these value chains were added.



Biomass

Biomass numbers, as shown in **Table 36**, were taken from the work that was done as part of the Deliverable 2.1.

Table 36 Top 5 biomasses in Lombardy.

Top 5 biomass types	Production volume (tonnes)
Corn residues	1175921
Alfalfa fiber	1152387,6
Rice straw	464505
Wheat straw	352013,95
Oil crops: Rapeseed	196260

3.10.2 Prioritisation of circular value chains

A wide range of potential circular value chains has been identified for each pilot region. However, to determine the most strategic value chains that will serve as key inputs for WP3 and the WP2 workshops, a prioritisation process is essential.

For this reason, the best value chains have been selected for each pilot region based on the following criteria: (1) have a strong fit between feedstock availability, (2) viable technology routes, and (3) a clear local market (or multiple markets) for the resulting bio-based product. These chains stand out as particularly actionable within the data that was provided during the SYMBIO project.

1. Acetic Acid from Corn Residues

1. Feedstock
 - Large agricultural cooperatives (e.g., Consorzio Agrario di Cremona, Casalasco Società Agricola) can channel surplus corn stover, cobs, or husks.
2. Technology
 - Galatea Bio Tech (Milan) may provide pilot-scale enzymatic hydrolysis and fermentation expertise.
3. Market
 - Food & Ingredient Companies: Many local producers require vinegar and acidulants (e.g., cameo, Cleca, IRCA, Bauli, Galbusera).
 - Chemical/Industrial: Acetic acid plays a role in multiple applications, from specialty solvents to preservation.

2. Glycerol from Rapeseed

1. Feedstock
 - Rapeseed cultivated or sourced via regionally active co-ops and oilseed processors (e.g., Lameri, Oleificio Zucchi for edible oils).
2. Technology
 - Green Oleo (Cremona) stands out as a key oleochemical producer for refining rapeseed oil and isolating glycerol.
3. Market



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- Food & Beverage: Glycerol commonly used as a humectant/sweetener by numerous confectioners (Galbusera, Bauli, etc.).
- Cosmetics/Pharma: Emollient in creams, lotions, personal care, and pharmaceutical formulations.
- Chemical Industry: Glycerol can be converted into solvents, surfactants, or resins.

3. Lactic Acid from Alfalfa Fiber

1. Feedstock
 - Alfalfa is widely cultivated in Lombardy for animal feed, offering an underutilised fiber fraction.
2. Technology
 - The technology provider is lacking from the dataset.
3. Market
 - Food & Ingredients: Lactic acid is a common acidulant in cheese, yogurt, sauces, and more.
 - Biopolymers: Lactic acid is the building block of PLA (polylactic acid) for eco-friendly packaging.

4. Sorbitol from Rice Straw

1. Feedstock
 - Rice Straw generated by major refiners—Riso Scotti, Riso Gallo, Curti—could be diverted from low-value uses.
2. Technology
 - The technology provider is lacking from the dataset.
3. Market
 - Food Processing: Widespread adoption of sorbitol as a sugar substitute, humectant, or bulking agent in baked goods and confections (companies like Bauli, Dolcissimo, or IPAM).
 - Pharma & Personal Care: Sorbitol is used in oral-care products, syrups, and skin creams.

Each pathway harnesses a locally abundant feedstock, can leverage Lombardy’s existing technology providers (Galatea Bio Tech, Green Oleo), and finds broad demand among the region’s food, ingredient, chemical, and manufacturing industries. Adopting any one of these value chains could foster inter-industry collaboration, spur innovation in biobased products, and deliver enhanced sustainability across the Lombardy agri-food sector.

Table 37 provides a concise summary showing each biomass value chain, divided into feedstock partners, technology providers, and markets. The Total column is the sum of those partners. The ranking (1 to 5) reflects the overall involvement across the supply chain.

Table 37 Potential partners in the value chains.

Value Chain	Rank	Feedstock Partners (approx.)	Tech Partners (approx.)	Market Partners (approx.)	Total
Acetic Acid from Corn Residues	#1	8–10 co-ops/farms	1–2 (e.g., Galatea Bio Tech)	12–15 (food & chemical firms)	~25–27
Glycerol from Rapeseed	#2	5–7 oilseed suppliers	1–2 (Green Oleo)	10–12 (food, cosmetics, chem.)	~18–21
Lactic Acid from Alfalfa Fiber	#3	4–6 alfalfa producers	0	8–10 (food ingredients, PLA)	~15–18



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Sorbitol from Rice Straw	#4	3–6 rice mills/farms	0	8–10 (confectionery, pharma)	~15–18
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- Few Bioprocess Firms: Only Galatea Bio Tech is identified for fermentation R&D, and Green Oleo focuses on oleochemicals. These limited options constrain scale-up and pilot initiatives.
- Corn and Rapeseed are widely grown, yet new value chains must compete with existing uses (feed, oil refining).
- Alfalfa Fiber and Rice Straw remain underutilized but require custom harvest and transport systems.
- Acetic Acid and Glycerol enjoy well-established uses in food, personal care, and industrial sectors, likely driving higher participation.
- Lactic Acid and Sorbitol need pilot demonstrations (e.g., consistent quality, cost competitiveness) before larger food and bioplastic firms adopt them at scale.

Overall, acetic acid from corn and glycerol from rapeseed offer broader immediate partner involvement, while lactic acid (alfalfa) and sorbitol (rice straw) present more niche or developing opportunities that still depend on targeted technology collaborations.

3.10.3 Existing infrastructure

Below is an overview and analysis of whether the four proposed value chains would face feedstock competition or “lock-in” from the existing bioeconomy infrastructure that is listed. We specifically checked for overlaps in raw material use and potential market/processing competition with the facilities. The list of facilities was taken from the VCG database of more than 13.000 existing infrastructure listed collected from open-source data like CBE JU and IEA Bioenergy among others.

Waste-to-Energy & Incineration Plants:

- Herambiente Spa’s Ravenna, Modena, and Ferrara plants; Iren Ambiente’s Parma plant; plus, several incineration facilities operated by local agricultural companies.
- Focus: Converting municipal and industrial waste into energy.

Combustion Plants:

- Facilities operated by CONSORZIO EURO TERMINAL ENERGIA, Effegi Energy, Ferrero Industriale Italia, Modena Energia, and Sandri S.P.A.
- Focus: Recovery of energy via combustion processes.

Processing Plants:

- Key operators include FAR-PRO-MODENA S.P.A., Farm Service S.R.L., Farmac – ZABBAN S.P.A., Ferraris S.R.L., Gatti S.R.L., Parmovo S.R.L., and S.A.P.I.
- Focus: Converting biomass into intermediate products and value-added compounds.

Biogas Plants:

- Notable examples: AGRISOLAR, multiple facilities by Azienda Agricola Caramana, MANARES TAMARA, SELVABELLA, Soc. Agr. Cazzani, and VITTORIA BIOENERGIA.



- Focus: Producing biogas from agricultural residues via anaerobic digestion.

Potential Overlaps

1. Acetic Acid from Corn Residues

- Potential Competition:
 - Biogas Plants (e.g., Soc. Agr. Cerioli Primo, Agrisorse Garlasco, etc.) often co-digest corn silage or stover to boost yields. Corn farmers already have established revenue channels (biogas feedstock, animal feed), so collecting stover/cobs for acetic acid may need competitive pricing or supply agreements.
 - Incineration/WTE (e.g., Silla 2, Busto Arsizio, Dalmine) generally focus on municipal solid waste (MSW), not corn residues. Minimal direct overlap.
- Conclusion: Moderate feedstock competition from on-farm biogas. Coordinating stable supply contracts is essential.

2. Glycerol from Rapeseed

- Potential Competition:
 - Comagri Oil S.r.l. or Oil B (Solbiate Olona) producing biodiesel from rapeseed (or other vegetable oils). If rapeseed is already contracted for biodiesel, feedstock volumes for glycerol extraction might conflict, though Green Oleo could also work with similar supply streams.
 - Incinerators/WTE do not typically incinerate rapeseed or oil seeds.
- Conclusion: Possible overlap with biodiesel value chains. But because glycerol is also a co-product in biodiesel transesterification, synergy (rather than direct competition) could occur if glycerol refining is scaled further.

3. Lactic Acid from Alfalfa Fiber

- Potential Competition:
 - Biogas plants occasionally incorporate alfalfa or forage, but it is less common than corn silage or manure due to lignocellulosic content.
 - Incineration/combustion (Herambiente, AC Boilers, etc.) rarely accept dried alfalfa.
- Conclusion: Minimal competition. Alfalfa fiber is underutilised, so redirecting it to lactic acid could face few infrastructure conflicts. However, farmers may prefer selling standard alfalfa hay for feed unless lactic-acid production is more profitable.

4. Sorbitol from Rice Straw

- Potential Competition:
 - Biogas: Some on-farm digesters might use limited rice straw, but again, it is less optimal than manure or corn silage.
 - Incineration: WTE plants mainly treat MSW, not agricultural residues like rice straw.
- Conclusion: Low direct feedstock competition. Rice straw is typically burned in fields or left as residue, so channelling it to sorbitol production should not clash strongly with existing infrastructure.

Corn residues likely see the highest feedstock competition (due to biogas demand), while rapeseed might overlap with biodiesel. Alfalfa fiber and rice straw remain comparatively unclaimed, offering fewer conflicts with the existing bioeconomy infrastructure.



3.11 Piedmont

3.11.1 Mapping Companies and Biomass

Companies

Piedmont boasts some of the largest combined feedstock amounts in the dataset—over 2.6 million tonnes—across corn residues, rice straw, wheat straw, soybean meal, forestry residues, and whey protein hydrolysate. Conversion pathways yield succinic acid, PHA, furfural, PLA, acetic acid, glutamic acid, and 1,3-propanediol. Existing capabilities for many of these processes indicate the region is well-positioned to become a European leader in circular biobased industries, provided the gaps in fermentation and hydrolysis technologies are addressed. A total of 41 companies, falling in the scope of bioeconomy, were identified as shown in **Table 38**. The companies were then connected to the possible value chains.

Table 38 List of companies from Piedmont.

Sector	Numbers of Companies	Key Companies (Examples)	Core Activities
Dairy industry	10	EMMI Dessert Italia, IGOR, In.Al.Pi., Caseificio Longo, Fattorie Osella	Collection/processing of milk; production of fresh and aged cheeses, yogurts, dairy desserts, and other milk derivatives.
Brewery industry	1	Birra Menabrea	Brewing of craft and specialty beers, bottling, and distribution
Rice farm	6	Mundi Riso, Riseria Vignola, Riso Invernizzi	Cultivation, milling, selection, and marketing of rice (including PDO and aromatic varieties), plus cereal/pulse by-products
Bakery industry	16	Maina, Balocco, Panealba, Colussi, Monviso Group	Production of baked goods (biscuits, bread substitutes, panettone, pandoro, pastries), frozen desserts, and snacks
Sawmills	8	Bertolotto, FerreroLegno, Lavorazione Legnami, Kastamonu Italia	Wood processing for furniture, interior doors, panels, pallets, crates, glulam structures, and other wood products

Additionally, to enhance the list, 132 companies from the VCG database that could participate in these value chains were added.

Biomass

Biomass numbers, as shown in **Table 39**, were taken from the work that was done as part of the Deliverable 2.1.

Table 39 Top 5 biomasses in Piedmont.

Top 5 biomass types (secondary)	Production volume
Corn residues	1253041,5
Rice straw	567280



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Wheat straw	455310
Rice husks	226912
Alfalfa fiber	82181

3.11.2 Prioritisation of circular value chains

A wide range of potential circular value chains has been identified for each pilot region. However, to determine the most strategic value chains that will serve as key inputs for WP3 and the WP2 workshops, a prioritisation process is essential.

For this reason, the best value chains have been selected for each pilot region based on the following criteria: (1) have a strong fit between feedstock availability, (2) viable technology routes, and (3) a clear local market (or multiple markets) for the resulting bio-based product. These chains stand out as particularly actionable within the data that was provided during the SYMBIO project.

1. Rice Straw/Husks → Furfural

The largest rice-growing and milling cluster in Piedmont enables significant feedstock availability for producing furfural, a versatile chemical intermediate used in resins, solvents, and other applications. Key rice-sector partners include companies such as Mundi Riso S.r.l. (Vercelli), Riseria Vignola Giovanni S.p.A. (Balzola), S.P. S.p.A. (Stroppiana), Riso Invernizzi S.r.l. (Novara), Riseria Giuseppe Martinotti S.r.l. (Trino), and Agrover S.r.l. (Lignana). Additional industrial synergy may come from Sanorice Italia S.r.l. (Borgo Vercelli), which handles rice-based products.

On the technology side, Roquette (Cassano Spinola) and Novamont (Novara) both bring extensive experience in biobased processes, while Gianeco (Giaveno) can contribute recycling or post-use polymer expertise if furfural-based resins are integrated into downstream materials. Furfural's end markets span adhesives, solvents, and specialty chemicals, with potential interest from wood-product or packaging manufacturers such as Kastamonu Italia and I-Pan for resin applications.

Substantial raw material volumes, combined with established milling infrastructure and broad downstream interest, position furfural production as an attractive, high-impact value chain in Piedmont.

2. Corn Residues → Succinic Acid

Multiple corn-handling companies in Piedmont (notably Sedamyl S.p.A. in Saluzzo, Sacchetto S.p.A. in Lagnasco, Dalma Mangimi S.p.A. in Marene, and Ferrero Mangimi S.p.A. in Farigliano) generate or process corn residues suitable for bioconversion to succinic acid. Roquette Italia (Cassano Spinola) has direct experience in bio-succinic acid ("Biosuccinium"), offering an immediate technological advantage. Further collaboration may involve Novamont or ENI Versalis (Crescentino) if expansions or complementary technologies are considered.

Succinic acid is a high-value biochemical used in biodegradable plastics (e.g., PBS), solvents, and other specialty materials. This route leverages Piedmont's established corn-starch and feed sectors, as well as existing fermentation expertise, creating a robust pathway for local feedstock valorisation.



3. Wheat Straw → PHA (Polyhydroxyalkanoates)

Wheat straw is abundantly produced in the region’s bakery and pasta supply chains. Key players, such as Colussi S.p.A. (Fossano), Pasta Berruto S.p.A. (Carmagnola), Balocco S.p.A. (Fossano), Panealba S.r.l. (Cherasco), and Grissitalia S.r.l. (Alessandria), could collaborate with fermentation technology providers to convert straw into PHA. Gianeco (Giaveno), with expertise in biodegradable polymers (PLA, PBAT, PHA, etc.), and Novamont (Novara) are well positioned to support or integrate such a process.

PHA offers a fully biodegradable plastic option for packaging and other applications. The involvement of major wheat-processing companies not only secures feedstock but also provides potential end-users for the final polymer in packaging or single-use bakery packaging, fostering a circular approach within the region’s food industry.

4. Alfalfa Fiber → Lactic Acid

Alfalfa, used predominantly in animal feed, is handled by companies such as Ferrero Mangimi S.p.A. (Farigliano) and Dalma Mangimi S.p.A. (Marene). Although the volume of alfalfa fiber is smaller than that of other cereals, it is suitable for conversion to lactic acid via enzymatic hydrolysis and fermentation. Novamont and ENI Versalis, both operating advanced biochemical technologies, could adapt or scale up a fermentation route to produce lactic acid. Downstream, lactic acid can be polymerized into PLA (polylactic acid), which is already in high demand for compostable plastics.

Alfalfa fiber, though a secondary resource, can be a valuable feedstock for lactic acid and subsequently PLA production. This route aligns with growing consumer and regulatory interest in bioplastics and offers an opportunity for feed-related enterprises to diversify into higher-value biomaterial markets.

Table 40 provides a concise summary showing each biomass value chain, divided into feedstock partners, technology providers, and markets. The Total column is the sum of those partners. The ranking (1 to 5) reflects the overall involvement across the supply chain.

Table 40 Potential partners in the value chains.

Value Chain	Feedstock	Tech	Market	Total
Rice Straw/Husks → Furfural	6-7	2-3	5-6	~14-16
Corn Residues → Succinic Acid	4-5	2-3	5-6	~11-14
Wheat Straw → PHA	5-7	2-3	5-6	~12-16
Alfalfa Fiber → Lactic Acid	2-3	2	4-5	~8-10

Overall Observations/Gaps:

- **Feedstock Logistics:** While raw material volumes are significant, collection and aggregation (especially for residues like straw or stover) can be challenging.
- **Technology Scale-Up:** Some processes (e.g., furfural, succinic acid) have proven pilot or commercial demos, but integrating them into regional supply chains requires further scaling or licensing.
- **Market Maturity:** Bioplastics (PHA, PLA) show growing demand, but cost competitiveness vs. conventional plastics remains an issue. Collaboration with large-scale local converters or brand owners is key.



3.11.3 Existing infrastructure

Below is an overview and analysis of whether the four proposed value chains would face feedstock competition or “lock-in” from the existing bioeconomy infrastructure that is listed. We specifically checked for overlaps in raw material use and potential market/processing competition with the facilities. The list of facilities was taken from the VCG database of more than 13.000 existing infrastructure listed collected from open-source data like CBE JU and IEA Bioenergy among others.

Waste-to-Energy (WTE) / Incineration Plants:

1. TRM Gruppo Iren – The Waste-to-Energy Plant of Turin
 - i) Location: V. Paolo Gorini, 50, Torino
 - ii) Throughput: ~421,000 t/year (primarily MSW)
2. Angeli e Orme di Balla Erika & C. SNC (Carmagnola) – Incineration
3. Consorzio L'Arca Ecologica (Torino) – Incineration
4. Ecologica di Nunzi Fabio (Acqui Terme) – Incineration
5. Il Ponte dell'Arcobaleno S.R.L. (Pianezza) – Incineration

Combustion Plants:

1. Asja Ambiente Italia S.p.A. (Rivoli) – Combustion
2. DR Energia S.R.L. (Casale Monferrato) – Combustion
3. Edilparc Energia S.R.L. (Piossasco) – Combustion
4. Giordano Energy S.R.L. (Caraglio) – Combustion
5. In.Pro.Ma. S.R.L. (Ceresole Alba) – Combustion

Processing Plants:

1. A. Costantino & C. S.p.A. (Favria)
2. Delsanto S.p.A. (Bra)
3. Gabba Giulio S.R.L. (Biella)
4. In.Pro.Ma. S.R.L. (Ceresole Alba)

Biogas Plants:

1. Agripower S.p.A. (Livorno Ferraris) – multiple installations
2. Az. Agricola Cascina Piana di Pavarino Giuseppe (San Damiano d'Asti)
3. Agrimora di Barbieri Paolo (Castelnuovo Scrivia)
4. Società Agricola Cascinassa (Savigliano)
5. Eds Biogas S.R.L. (Alessandria)
6. Eurobios Società Cooperativa Agricola (Tortona) – multiple
7. Fri-El Alexandria S.R.L. Soc. Agricola (Alessandria)
8. Q Energia Soc. Agricola S.R.L. (Quargnento)
9. Società Agricola Quargnento (Alessandria) – multiple

Potential Overlaps

- Corn Stover, Wheat Straw, Rice Straw can all be digested in certain biogas systems. If local farmers or cooperatives are already supplying these residues for anaerobic digestion, there is some potential feedstock competition for proposed value chains (e.g., Succinic Acid from Corn Stover, PHA from Wheat Straw, Furfural from Rice Husks).
- Alfalfa is less common in biogas, but it is possible if farmers use it as part of co-digestion.



- Waste-to-Energy and Incineration: Mostly handle MSW or specialised waste; limited direct feedstock competition for corn, wheat, rice residues, or alfalfa fiber.
- Combustion Plants: Primarily run on conventional fuels (e.g., wood chips, biomass pellets), with no large-scale use of cereal residues reported.
- Processing Plants: Focus on food or chemical by-products (not major consumers of cereal straw or husks).
- Biogas Plants: Possible competition for corn stover, wheat straw, or rice straw if these facilities are already sourcing local cereal residues. However, how much straw is used varies by plant, and many rely on manure or silage.

Given this, the principal overlap for the four proposed value chains (using corn stover, wheat straw, rice straw/husks, and alfalfa fiber) is likely to be biogas plants that sometimes co-digest straw to boost yield. Otherwise, direct competition for these feedstocks appears minimal in the region.

3.12 Veneto

3.12.1 Mapping Companies and Biomass

Companies

Veneto’s feedstocks are mostly soybean meal, forestry residues, whey protein hydrolysate, sugarbeet, wheat straw, barley straw, and oil crops. A total of 73 companies, falling in the scope of bioeconomy, were identified as shown in **Table 41**. The companies were then connected to the possible value chains.

Table 41 List of companies from Veneto.

Sector	Number of Companies	Key Companies (Examples)	Main Activities
Dairy	16	Sammontana, Parmalat, Brazzale	Milk collection and processing; production of cheese, butter, yogurt, ice cream, and other dairy products
Brewery	2	Birra Peroni, Birra Castello	Brewing and distribution of beer (various brands)
Soy Processing	1	Cereal Docks	Primary agro-food processing of soybeans and cereals; flours, oils, lecithins for food & industrial uses
Rice Farm	2	Naturis, Riseria del Basso Veronese Grazia	Rice milling, processing, and packaging (e.g., dried/pre-cooked rice)
Bakery	20	Bauli, Vicenzi, Melegatti	Production of baked goods (panettone, pandoro, biscuits, croissants), sweet & savory pastries, snacks
Wheat Production	3	Grandi Molini Italiani, Molino Rossetto	Flour milling (soft/durum wheat), semolina, specialty flours



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Sawmills	17	Florian Legno, Gruppo Mauro Saviola, Braga	Wood processing (timber, veneers, chipboard), wooden packaging, doors & panels, insulation panels
Furniture	12	Friul Intagli, Veneta Cucine, Arredo 3	Manufacturing of kitchens, living-room furniture, wardrobes, bathroom cabinetry, and design components

Additionally, to enhance the list, 314 companies from the VCG database that could participate in these value chains were added.

Biomass

Biomass numbers, as shown in **Table 42**, were taken from the work that was done as part of the Deliverable 2.1.

Table 42 Top 5 biomasses in Veneto.

Top 5 biomass types	Production volume
Soybean meal	142276,28
Alfalfa fiber	101592,56
Barely straw	80159,83
Oil crops: Soybean	71138,14
Corn residues	30336

3.12.2 Prioritisation of circular value chains

A wide range of potential circular value chains has been identified for each pilot region. However, to determine the most strategic value chains that will serve as key inputs for WP3 and the WP2 workshops, a prioritisation process is essential.

For this reason, the best value chains have been selected for each pilot region based on the following criteria: (1) have a strong fit between feedstock availability, (2) viable technology routes, and (3) a clear local market (or multiple markets) for the resulting bio-based product. These chains stand out as particularly actionable within the data that was provided during the SYMBIO project.

1. Corn Residues → PHA (Polyhydroxyalkanoates)

Value Chain:

1. Feedstock: Corn residues (corn stover, cobs)
2. Conversion: Enzymatic hydrolysis + Fermentation
3. Product: PHA (a biodegradable bioplastic)

Potential Partners:

- Corn-Handling / Processing Companies
 - Cereal Docks S.p.A. (aggregates cereals and oilseeds, including maize)
 - Cargill S.r.l. (wet milling of corn, producing starch/syrup/oil; large maize supply chain)



- Other maize-handling feed mills or cooperatives in the dataset that deal with corn (e.g., some flour mills that also handle multiple cereals).
- Tech Providers
 - Innoven srl (Isola della Scala, VR) – runs a PHA pilot plant using agro-industrial waste; synergy for scale-up.
- Potential Off-Takers
 - Food & beverage producers (for sustainable packaging)
 - Furniture & wood sector (seeking compostable packaging or polymer composites)
 - Large packaging/logistics players (e.g., Transpack S.p.A. might be open to using novel biomaterials)

Corn residues can yield PHA, and there is a direct pilot facility (Innoven) plus multiple large corn aggregators (Cereal Docks, Cargill) and broad interest in biodegradable plastics across the food and furniture/logistics supply chain.

2. Barley Straw → Succinic Acid

Value Chain:

1. Feedstock: Barley straw
2. Conversion: Enzymatic hydrolysis + Fermentation
3. Product: Succinic acid

Potential Partners:

- Barley Supply & By-Products
 - Cereal Docks S.p.A. (handles cereals, including barley)
 - Birra Peroni S.r.l. and Birra Castello S.p.A. (breweries with barley supply chains, which could produce or help channel barley straw)
- Potential Off-Takers
 - Chemical or biotech integrators in the region (e.g., Eni in Porto Marghera, if it expands into bio-based chemicals)
 - Food & beverage packaging companies that may integrate bio-based succinic acid (used in plastics, resins, solvents)

Barley straw is readily available from large brewery or cereal networks (Peroni, Cereal Docks). Succinic acid has a growing biochemical market for polymers, solvents, and specialty chemicals.

3. Oil Crops: Soybean → Glycerol

Value Chain:

1. Feedstock: Soybean oil
2. Conversion: Enzymatic hydrolysis / Saponification / Transesterification
3. Product: Glycerol

Potential Partners:

- Soy Supply & Processing
 - Cereal Docks S.p.A. (major aggregator of soybean for food, feed, and industrial uses)
 - Biodiesel / Oil Processors
 - Eni S.p.A. (Porto Marghera refinery has capacity for transesterification to produce biodiesel, generating glycerol as byproduct)



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Potential Users:

- Many local chemical and cosmetics manufacturers can use glycerol (the region has numerous food/cosmetics players who also incorporate glycerol in formulations).

A straightforward synergy: soybean is widely handled by Cereal Docks; Eni’s biodiesel operations in Porto Marghera can produce glycerol from transesterification. Glycerol has multiple local markets (chemical, cosmetics, feed).

4. Alfalfa Fiber → Lactic Acid

Value Chain:

1. Feedstock: Alfalfa fiber
2. Conversion: Enzymatic hydrolysis + Fermentation
3. Product: Lactic acid

Potential Partners:

- Feed & Forage Processors
 - Multiple feed mills that handle alfalfa or alfalfa meal: e.g.,
 - Kemin Nutrisurance Europe Srl, Trouw Nutrition Italia Spa, Skretting Italia Spa, Tecnozoo Spa, Fanin Spa (all produce feed ingredients, often involving alfalfa).
- Lactic Acid Tech / End-Users
 - Food manufacturers that might integrate lactic acid for preservation, pH regulation (dairy, processed foods, sauces).
 - Packaging or chemical companies using lactic acid for polylactic acid (PLA) or specialty fermentation.

Several feed-manufacturing companies handle alfalfa or alfalfa meal, creating a broad feedstock base. Lactic acid is widely used in foods, beverages, and as a building block for bioplastics. Each route connects multiple regional players, maximising participation across feedstock supply, technology/processing, and potential offtakers in the Veneto area.

Table 43 provides a concise summary showing each biomass value chain, divided into feedstock partners, technology providers, and markets. The Total column is the sum of those partners. The ranking (1 to 5) reflects the overall involvement across the supply chain.

Table 43 Potential partners in the value chains.

Value Chain	Feedstock	Tech	Market	Total
Corn Residues → PHA	2	1	5	8
Barley Straw → Succinic Acid	2	1	4	7
Soy → Glycerol	1	1	4	6
Alfalfa Fiber → Lactic Acid	2	1	4	7



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Gaps and Observations

Despite strong feedstock availability for most routes (e.g., barley straw and alfalfa fiber), certain chains show limited technology partners able to process these materials at scale, suggesting a need for expanded pilot or demo facilities. Conversely, some chains (e.g., glycerol from soy) have robust downstream markets but fewer identified feedstock contributors, indicating a supply-side gap. Overall, ensuring balanced development of feedstock aggregation, technology readiness, and off-taker engagement will be crucial to fully realize each value chain's potential.

3.12.3 Existing infrastructure

Below is an overview and analysis of whether the four proposed value chains would face feedstock competition or "lock-in" from the existing bioeconomy infrastructure that is listed. We specifically checked for overlaps in raw material use and potential market/processing competition with the facilities. The list of facilities was taken from the VCG database of more than 13.000 existing infrastructure listed collected from open-source data like CBE JU and IEA Bioenergy among others.

Biofuel & Alternative Processing Facilities:

- ENI – Produces biodiesel (HVO) via refining processes.
- ENILIVE S.P.A. – Raffineria di Venezia – Uses alternative biodiesel production methods.

Waste-to-Energy & Incineration Plants:

- Herambiente Spa Plants – Waste-to-energy facilities (e.g. Padua and Ferrara plants).
- Iren Ambiente S.p.A. – Parma Waste-to-Energy Plant – Converts municipal/industrial waste into energy.
- CREMAZIONI ARCOBALENO DI ZECCHINATO ELVIO – Incineration plants (multiple sites).
- VERONA PET SERVICE DI BURATO MICHELE – Incineration facility for energy recovery.

Incineration & Combustion Facilities:

- ARGO S.N.C. DI CASELLA SILVIO & C. – Operates incineration plants.
- AZ. BRUTTI SOCIETA' AGRICOLA SEMPLICE, BANO IMMOBILIARE S.N.C., BASSANO ENERGIA S.R.L., BETTOLA ENERGIA S.R.L., BIOBRENT S.R.L., BIOIL S.R.L., DA.NA. S.A.S. DI PATRON NADIA & C., SAMOX S.R.L. – Various combustion/energy recovery plants.

Biomass Processing Plants:

- AGRICOLA TRE VALLI (both Cooperative and Limited Responsibility variants) – Facilities converting biomass into value-added products.
- GRENA S.R.L., SALGAIM ECOLOGIC S.P.A., SICIT GROUP S.P.A. – Plants focused on further processing of biomass.

Composting & Biogas Plants:

- S.E.S.A. S.P.A. – Operates both composting and biogas facilities.
- AGRICOLA TRE VALLI – Cooperative (also active in processing)
- SOCIETA' AGRICOLA BEPI (di Facco Bernardina & C.) – Biogas plants (multiple entries).
- SOCIETA' AGRICOLA LINO DALLA COSTA (di Paolo Dalla Costa & C.) – Biogas facilities.



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- SOCIETA' AGRICOLA RINALDO S.S., SOCIETA' AGRICOLA ANDRETTA IVANO E BIZZOTTO ANTONIETTA S.S. DI ANDRETTA IVANO E C., TOBALDO SRL – Additional biogas plants.

Potential Overlaps

Corn Residues → PHA (Polyhydroxyalkanoates)

- Feedstock: Corn residues (stover)
- Existing Infrastructure Overlap:
Many waste-to-energy and incineration plants (e.g., those operated by Herambiente Spa, Iren Ambiente S.p.A., and others) in the region could divert unsorted agricultural residues for energy recovery.
- Conclusion:
There is moderate competition risk if corn residues are not separately collected and dedicated to biochemical conversion for PHA.

Barley Straw → Succinic Acid

- Feedstock: Barley straw
- Existing Infrastructure Overlap:
Similar to corn residues, generic agricultural straw might be routed to waste-to-energy or combustion plants. Processing plants that handle biomass may also use barley straw if not specifically reserved for succinic acid production.
- Conclusion:
The potential for overlap is moderate; effective feedstock segregation will be key.

Oil Crops: Soybean → Glycerol

- Feedstock: Soybean (oil extraction residues)
- Existing Infrastructure Overlap:
The current facilities in Emilia Romagna are predominantly focused on municipal/industrial waste and general biomass conversion. There is little evidence of dedicated soybean processing plants competing for this specific feedstock.
- Conclusion:
Overlap is low, making soybean residues a relatively exclusive resource for glycerol production.

Alfalfa Fiber → Lactic Acid

- Feedstock: Alfalfa fiber
- Existing Infrastructure Overlap:
While alfalfa is an agricultural product, most of the regional facilities are oriented toward processing municipal/industrial wastes. However, if alfalfa residues are available as a by-product from local forage operations, they might also be used in general biomass energy production.



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- Conclusion:
The competition for alfalfa fiber is likely low to moderate, provided that dedicated collection systems are in place.

Overall, the key concern is whether agricultural residues (corn residues and barley straw) are segregated and reserved for biochemical conversion instead of being diverted to established waste-to-energy or incineration facilities. In contrast, soybean residues and alfalfa fiber currently face lower competition from existing infrastructure.



4. Conclusion

Table 44 shows a concise summary of the 47 identified value chains, categorized by region, feedstock, product, and technology.

Table 44 The final 47 identified value chains for the 12 SYMBIO regions.

Region	Feedstock(s)	Product	Key Technology Steps
Andalusia	Barley Straw	Acetic Acid	Enzymatic Hydrolysis + Fermentation
	Sugarbeet	Glycerol	Enzymatic Hydrolysis + Fermentation
	Forestry Residues	PHA	Enzymatic Hydrolysis + Fermentation
	Rice Straw	Sorbitol	(a) Enzymatic Hydrolysis + Fermentation, or (b) Catalytic Hydrogenation
Brussels Capital	Molasses	Glycerol	Fermentation
	Sugarbeet	Glycerol, PLA	Enzymatic Hydrolysis + Fermentation (PLA also needs condensation + polymerization)
	Corn Steep Liquor	1,3-Propanediol	Fermentation
	Wheat Straw	Acetic Acid	Fermentation
Wallonia	Whey	Proteins	Membrane Separation (e.g., ultrafiltration)
	Sugarbeet	Glycerol	Enzymatic Hydrolysis + Fermentation
	Wheat Straw	Succinic Acid	Enzymatic Hydrolysis + Fermentation
Flanders	Sugarbeet	Glycerol	Enzymatic Hydrolysis + Fermentation
	Wheat Straw	Lysine	Fermentation
	Corn Steep Liquor	1,3-Propanediol	Fermentation
	Corn Stover	Succinic Acid	Enzymatic Hydrolysis + Fermentation
Carinthia	Forestry Residues & Maize Cobs	Furfural	Acid Hydrolysis or Catalytic Systems or Solvent-Thermal Conversion
	Corn	PHA	Enzymatic Hydrolysis + Fermentation
	Barley Straw	Succinic Acid	Fermentation
	Soybean Meal	Glycerol	Enzymatic Hydrolysis + Transesterification
Croatia	Corn	PLA	Fermentation + Condensation + Polymerization
	Corn	Glycerol	Enzymatic Hydrolysis + Fermentation
	Corn Stover; Forestry Residues	PHA	Enzymatic Hydrolysis + Fermentation



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	Forestry Residues; Maize Cobs; Corn Stalks & Cobs	Furfural	Acid Hydrolysis or Catalytic Systems or Solvent-Thermal Conversion
Slovenia	Forestry Residues	Furfural	Acid Hydrolysis or Catalytic Systems or Solvent-Thermal Conversion
	Animal Fats	Glycerol	Enzymatic Hydrolysis / Saponification
	Wheat Straw	PHA	Enzymatic Hydrolysis + Fermentation
	Barley Straw	Succinic Acid	Enzymatic Hydrolysis + Fermentation
Emilia Romagna	Corn Residues (Stover & Straw)	PHA	Enzymatic Hydrolysis + Fermentation
	Corn Residues (Stover & Cobs)	Furfural	Acid Hydrolysis or Catalytic Systems or Solvent-Thermal Conversion
	Wheat Straw	Succinic Acid	Fermentation
	Alfalfa Fiber	Lactic Acid	Enzymatic Hydrolysis + Fermentation
Friuli Venezia Giulia	Poplar Sawdust	Acetic Acid	Enzymatic Hydrolysis + Fermentation
	Whey	Proteins	Ultrafiltration / Membrane Separation
	Sugarbeet	PLA	Fermentation + Condensation + Polymerization
	Corn Residues	1,3-Propanediol	Enzymatic Hydrolysis + Fermentation
Lombardy	Corn Residues	Acetic Acid	Enzymatic Hydrolysis + Fermentation
	Rapeseed	Glycerol	Enzymatic Hydrolysis + Saponification + Transesterification
	Alfalfa Fiber	Lactic Acid	Enzymatic Hydrolysis + Fermentation
	Rice Straw	Sorbitol	Catalytic Transfer Hydrogenation or Enzymatic Hydrolysis + Fermentation
Piedmont	Rice Straw / Husks	Furfural	Acid Hydrolysis or Catalytic Systems or Solvent-Thermal Conversion
	Corn Residues	Succinic Acid	Enzymatic Hydrolysis + Fermentation
	Wheat Straw	PHA	Enzymatic Hydrolysis + Fermentation
	Alfalfa Fiber	Lactic Acid	Enzymatic Hydrolysis + Fermentation
Veneto	Corn Residues	PHA	Enzymatic Hydrolysis + Fermentation
	Barley Straw	Succinic Acid	Enzymatic Hydrolysis + Fermentation



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	Oil Crops: Soybean	Glycerol	Enzymatic Hydrolysis / Saponification / Transesterification
	Alfalfa Fiber	Lactic Acid	Enzymatic Hydrolysis + Fermentation

This comprehensive analysis revealed 47 distinct value chains spanning twelve European regions that are part of the SYMBIO project. Each chain connects locally available feedstocks – such as corn stover, wheat straw, sugarbeet, and forestry residues – to high-value bio-based products like lactic acid, glycerol, PHA, and succinic acid, using various conversion technologies (e.g., enzymatic hydrolysis, fermentation, transesterification). By mapping out the relevant companies, infrastructure, and potential routes, we identified opportunities for synergy as well as potential competition for feedstocks.

1. Glycerol emerges as the single most frequently cited product, reflecting wide applicability and multiple feedstock options.
2. PHA, succinic acid, and furfural also have strong representation, pointing to high demand or advanced R&D in these routes.
3. On the feedstock side, wheat straw, sugarbeet, forestry residues, and corn stover appear most often, signaling both availability and strong interest.
4. The prevalence of enzymatic hydrolysis + fermentation underscores its versatility in converting lignocellulosic or starchy materials into high-value chemicals.
5. Competition for feedstocks is likely where multiple processes (e.g., PHA vs. succinic acid from wheat straw) or multiple regions rely on the same resource.

This analysis shows significant clustering around a few “powerhouse” feedstocks (straw, stover, sugarbeet, forestry residues) and product routes (glycerol, PHA, succinic acid, furfural, lactic acid). These clusters reflect both the technical feasibility and the market appeal of these biochemicals, suggesting strategic points where stakeholders can align resources and scale up production while monitoring feedstock demand and potential bottlenecks

Overall, these findings underscore the breadth of innovation and the regional diversity in Europe’s bioeconomy. They highlight areas where feedstock availability, technology readiness, and market demand can be aligned to create robust, sustainable value chains. In particular, sectors with multiple conversion options (e.g., glycerol or PHA production) may benefit from collaboration among local feedstock producers, technology providers, and end users. Continued development of pilot and demonstration plants, along with policy incentives, could further enhance the circularity of regional economies and bolster the competitiveness of bio-based industries.



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