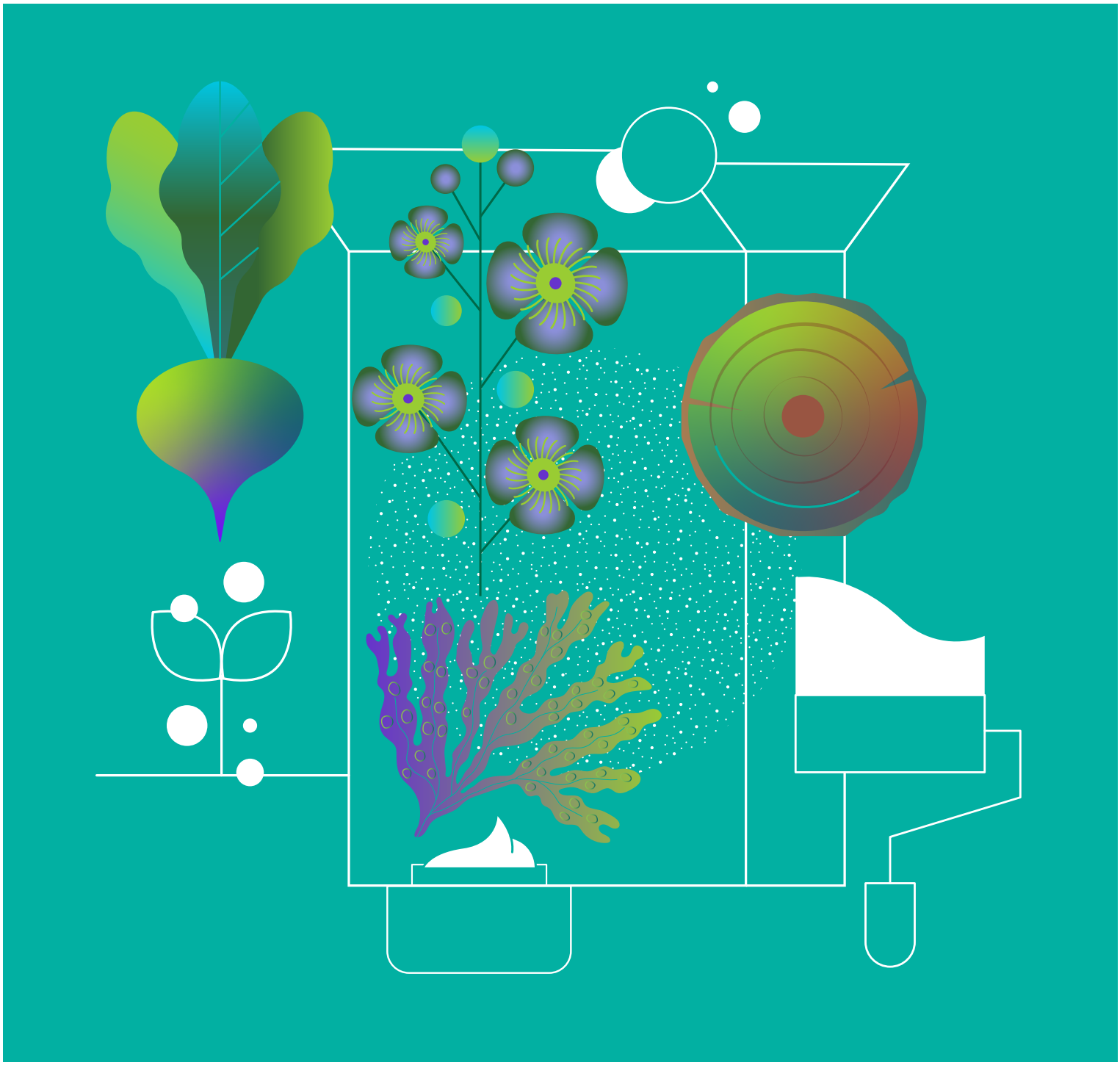
Bio-based Industries Consortium

Lead Markets for Europe's Bioeconomy

Bio-based Chemicals



1. Introduction

Building competitive and sustainable value chains for Europe's industry

The European chemicals market is substantial in scale and offers significant potential for the development of lead markets. The industry represents around €655 billion in annual turnover, employs more than 1.2 million people, and supports key sectors such as pharmaceuticals, automotive, construction, electronics. The current share of bio-based products in the EU chemical industry is estimated at around 8%.

(Bio-based) chemicals are enablers across multiple value chains, and hence an integral part of the European industrial ecosystem.Bio-based chemicals are chemical products derived from biological resources — including primary and secondary feedstocks as well as organic waste streams — rather than from fossil carbon feedstocks.

This report describes the end-markets sectors for using bio-based chemical products, such construction, personal care, and agriculture. At the same time, the report acknowledges that bio-based chemicals can serve several end-markets, and which is reflected in separate chapters (Bio-based platform chemicals and derivatives as well as chapter "Intermediates").

1.1 Competitiveness and innovation

Europe's competitive advantage in chemicals lies in a combination of:

- industrial expertise;
- highly integrated chemical clusters connected to advanced manufacturing sectors such as automotive, pharmaceuticals, aerospace, construction, and consumer industries;
- innovation leadership;
- highly skilled workforce; and
- leadership in high-value chemicals.

1.2 Market data

Examples for bio-based platform chemicals and derivatives:

1,4-butanediol (BDO)

The global market for 1,4-butanediol (BDO) is estimated at around USD 8–11 billion in 2025/2026. Most market studies estimate global demand at approximately 2.6–3.0 million tons per year, with expected growth of around 4–8% CAGR over the next decade.

Europe is estimated to represent roughly 10–15% of the global BDO market, corresponding to approximately 250–400 thousand tons annual demand with roughly USD 1–1.5 billion market value, and strategically important for high-value chemicals, pharmaceuticals, engineering plastics, and specialty materials.

Pelargonic acid

Current market estimates for 2025/2026 place the global pelargonic acid market at approximately USD 180–240 million, with expected growth rates of 7–10% CAGR through 2030–2035.

Key growth drivers include bio-based herbicides replacing glyphosate, sustainable crop protection, personal care and cosmetics. Europe is the leading market region for pelargonic acid because of strong sustainability regulation and restrictions on conventional herbicides.

Most studies estimate Europe accounts for roughly 38–46% of global demand. A major sustainability trend is the shift toward plant-based pelargonic acid, which already represents around 69% of the market.

Propionic acid

The global propionic acid market is estimated at approximately USD 1.2–1.6 billion in 2025, with an expected growth of 3–6% CAGR over the next decade.

The main applications include animal feed preservatives, food preservation, herbicides, pharmaceuticals, plastics and coatings. Europe is one of the most important markets globally, projected to reach around USD 540–550 million by 2030.

Bio-based production represented around 7–8% of global production in 2024, and this share is expected to increase.

Tetrahydrofuran (THF)

The global market for tetrahydrofuran (THF) is estimated at approximately USD 4–5 billion in 2025, with global demand of roughly 1.0 million tons per year. Most market studies forecast growth of around 4–7% CAGR through 2030–2035.

THF is primarily used for the production of polytetramethylene ether glycol (PTMEG), spandex/elastane fibers, industrial solvents, pharmaceuticals, coatings and adhesives, and battery electrolytes.

Europe represents an estimated 20–25% of the global THF market corresponding to USD 0.6–1.0 billion market value and an estimated annual demand of roughly 180–250 thousand tons.

A key market trend is the emergence of bio-based THF especially for specialty chemicals and sustainable materials, and the demand linked to electric vehicle batteries and high-performance textiles.

Azelaic acid

The global market for azelaic acid is estimated at USD 200–300 million in 2025. Most industry studies project growth of around 5–8% CAGR through 2030–2035, driven by demand

in cosmetics, dermatology, pharmaceuticals, lubricants, and bio-based polymers.

Europe is one of the leading markets and production regions for azelaic acid, representing 25–30% of global demand, corresponding to roughly USD 60–90 million market value and 9,000–12,000 metric tons annual consumption. Azelaic acid is also attracting attention as a bio-based dicarboxylic acid, produced from renewable feedstocks such as oleic acid from vegetable oils.

The bio-based azelaic acid market size was valued at USD 78.80 Million in 2023 and is projected to reach USD 100.20 Million by 2030, growing at a CAGR of 13.05%.

Lactic acid

The global market for Lactic acid is estimated at approximately USD 3,5-4,0 billion in 2025, driven by demand in food and beverages, pharmaceuticals, personal care, solvent and bio-based polymers, particularly polylactic acid (PLA). Global demand is estimated at 1.8-2.2 million tonnes per year, with bio-based polymers production representing the fastest-growing outlet for lactic acid consumption.

Europe is one of the most important and structurally mature markets, accounting for an estimated 30-35% of global demand, corresponding to approximately 550-750 thousand tonnes per year and a market value in the of USD 1.2-1.5 billion.

The European market is strategically important due to its strong regulatory focus on sustainability, circular economy and defossilisation of materials, which support the uptake of lactic acid as a strategic platform chemical.

1.3 Sustainability

90% of carbon feedstock for chemicals is fossil. In other words, most hydrocarbon inputs (naphtha, natural gas, etc.) used as raw material in chemicals come from crude oil or gas. The chemical industry currently accounts for around 5–6% of global greenhouse gas emissions.

Studies show that replacing major petrochemicals with bio-based alternatives could reduce greenhouse gas emissions by around 45% on average and lower total emissions from primary chemical production by up to 19% globally.

[1] European Asphalt Pavement Association (EAPA) "Towards Net Zero - A Decarbonisation Roadmap"

2. Construction
Lower-carbon materials for the construction sector

2.1 Introduction

The EU Energy Performance of Buildings Directive requires all new buildings to become net-zero emission by 2030, which is accelerating demand for advanced construction chemicals that improve durability, insulation, and carbon performance.

At the same time, more than 90% of the European roads are surfaced with asphalt, the European asphalt industry has the potential to become a key tool in the decarbonisation process of Europe and is already active in various fields to target a climate-neutral future.[1]

2.2 Competitiveness and innovation

Bio-based epoxy resins

Bio-based epoxy resins are expected to play a growing role in the construction industry as demand increases for low-carbon, high-performance, and circular building materials.

Epoxy systems are widely used in flooring, coatings, adhesives, sealants, composites, and concrete repair due to their excellent mechanical strength, chemical resistance, and durability.

Replacing fossil-based epoxy components with renewable feedstocks such as lignin, vegetable oils, glycerol, and bio-based phenols can significantly reduce embedded carbon while maintaining performance characteristics required for demanding construction applications.

Bio-based epoxy resins are particularly promising for durable protective coatings, lightweight composite panels, wind-energy-related construction, and low-VOC indoor applications.

30% bio-resin could cut an 8 MW turbine's carbon footprint by 14%.

Bio-based asphalt additive

The market for bio-based asphalt additives and materials such as lignin, vegetable oils, terpenes currently represent about 11% of total asphalt additive consumption globally, but is growing rapidly due to sustainability regulations, low-carbon and net zero infrastructure policies, and demand for circular construction materials.

Key applications include reclaimed and warm-mix asphalt, biobased materials replacing fossil-based bitumen, asphalt modifiers, antistripping agents, emulsifiers, rejuvenators, and roofing systems. The largest application segment is road construction and paving, accounting for approximately 75–76% of total demand.

Bio-based additives used in warm-mix asphalt technologies can lower asphalt production and paving temperatures by 20–30°C, reducing energy

consumption and CO_2 emissions during manufacturing and application by approximately 15–30%, and some lignin- and bio-oil-based pavements can reduce lifecycle greenhouse gas emissions by 20–50% depending on formulation and feedstock sourcing.

2.3 Market data

The global construction chemicals market is estimated at approximately USD 60–70 billion, with expected growth of 4–7% CAGR over the next decade. The European construction chemicals market is estimated at approximately USD 13–15 billion in 2025 projected to grow to roughly USD 20–21 billion by 2033–2035.

2.4 Sustainability

The construction sector is responsible for nearly 37% of global energy-related CO_2 emissions, making low-carbon materials a major priority.

Bio-based chemicals can significantly improve the sustainability performance of the construction industry by reducing dependence on fossil-based materials, lowering greenhouse gas emissions, and supporting circular construction models. They are increasingly used in adhesives, coatings, insulation materials, concrete additives, sealants, resins, and composite materials.

In addition, bio-based chemicals can help store biogenic carbon in long-life building and road pavement materials, contributing to long-term carbon sequestration in the built environment.

Typical embodied carbon reductions (CO2 reduction vs fossil alternative) from bio-based chemicals and materials are:

- bio-based polyurethane insulation, 20–50%;
- bio-based resins and adhesives, 30–70%;
- lignin-based concrete additives, 20–40%;
- natural fiber composites, 40–80%;
- bio-asphalt additives, 20–60%.

3. Agriculture
Supporting climate-resilient and resource-efficient farming

3.1 Introduction

Bio-based fertilizers and biostimulants

Bio-based fertilizers and biostimulants both support sustainable agriculture but serve different functions. Bio-based fertilizers primarily provide nutrients such as nitrogen and phosphorus from renewable biological sources, while biostimulants stimulate natural plant processes that improve nutrient-use efficiency, stress tolerance and crop quality.

In practice, the distinction is increasingly blurred as many next-generation biological agricultural products combine nutrient supply with biostimulant effects to support regenerative and climate-resilient farming systems.

Biostimulants are increasingly important in sustainable agriculture because they improve nutrient-use efficiency, crop resilience and soil health while reducing environmental impacts. They help crops better tolerate drought, heat and salinity stress and can increase yields by 5–15% under many conditions.

Europe is one of the leading markets for biostimulants, driven by Green Deal objectives, fertilizer reduction targets and the transition toward climate-resilient, low-input farming systems.

Biopesticides

Biopesticides are plant protection products and biocidal products wholly or partially derived from renewable biological resource.

They are increasingly important in sustainable agriculture because they can reduce reliance on conventional synthetic pesticides while lowering environmental impacts, pesticide residues and risks to biodiversity and human health.

Their global market is growing rapidly due to stricter environmental regulations, resistance management needs and increasing demand for low-residue food production.

3.2 Competitiveness and innovation

Europe is emerging as a global leader in innovative biostimulants, particularly in seaweed-derived products, microbial solutions and precision agriculture integration.

Current innovations focus on improving nutrient efficiency, climate resilience and soil regeneration while reducing fertilizer dependency and environmental impacts. The EU Fertiliser Action Plan (19 May 2026) can be a further growth driver.

Europe is emerging as a global leader in innovative biopesticides, driven by Green Deal objectives and EUs Vision for Agriculture and Food, pesticide reduction targets and strong growth in sustainable agriculture.

Major innovation areas include microbial biopesticides, RNAi-based crop protection, pheromone technologies and precision biocontrol systems integrated with AI and sensor technologies.

3.3 Market data

Biostimulants

The global biostimulants market is valued at approximately USD 4–4.5 billion in 2024–2025 and is expected to exceed USD 11 billion by 2034, growing at around 10–12% annually.

Europe is the world's leading market, representing nearly 40% of global demand, with a market size of roughly USD 1.7–1.9 billion..

Growth is driven by sustainable agriculture policies, climate resilience needs, fertilizer reduction targets and increasing demand for low-input farming systems. Major product categories include seaweed extracts, humic substances, amino acids and microbial biostimulants.

Bio-based fertilisers

The global market for bio-based fertilizers is estimated at approximately USD 1.5–2.7 billion in 2024–2025 and is expected to grow strongly toward USD 3–6 billion over the next decade.

Europe is among the leading regions worldwide, with a market size of roughly USD 0.5–1.5 billion. Recent estimates place the European biofertilizers market at approximately USD 0.5–1.5 billion in 2025 depending on market scope, and USD 1.5–2.1 billion by 2030–2034 with an expected CAGR of approximately 6–13% annually. Europe represents approximately 20–40% of the global biofertilizers market.

Biopesticides

The global biopesticides market is estimated at approximately USD 3.5–10 billion in 2024–2025 and is expected to grow rapidly over the next decade, driven by increasing demand for sustainable crop protection and stricter regulation of synthetic pesticides.

Europe is one of the leading regions worldwide, with a market size of roughly USD 2–3 billion and annual growth rates of around 10–15%. Major growth areas include microbial biopesticides, biofungicides and integrated biological crop protection systems,

3.4 Sustainability

Biostimulants

Biostimulants can significantly reduce the environmental footprint of agriculture by improving nutrient-use efficiency, reducing fertilizer losses and enhancing soil health and crop resilience.

Field studies report nutrient-use-efficiency improvements of typically 5–20%, while fertilizer application rates can in some systems be reduced by 10–30% without major yield impact.

Biostimulants can also improve crop yields by around 5–15% and enhance water-use efficiency under drought stress conditions.

By reducing synthetic nitrogen fertilizer demand, they contribute to lower greenhouse gas emissions and reduced nitrate leaching and eutrophication risks. Since nitrous oxide (N_2O) from fertilizers has a global warming potential approximately 273 times higher than CO_2, even modest reductions in fertilizer losses can generate significant climate benefits.

Bio-based fertilisers

Bio-based fertilizers can significantly reduce the environmental footprint of agriculture by recycling nutrients from renewable biological resources while lowering dependence on fossil-based synthetic fertilizers. Synthetic nitrogen fertilizer production is highly energy-intensive, accounting for roughly 1–2% of global energy use and approximately 1.4% of global CO_2 emissions.

Bio-based fertilizers can partially replace these fossil-derived inputs and in some agricultural systems reduce synthetic fertilizer demand by 10–30% or more. They also contribute to improved nutrient-use efficiency and can reduce nitrate leaching and eutrophication risks.

Organic and compost-based fertilizers can increase soil organic carbon stocks over time and improve soil water retention by 10–20% in degraded soils under long-term application scenarios. Recycling nutrients from digestate, manure and food waste additionally supports circular bioeconomy objectives and reduces dependence on imported phosphate fertilizers, of which the EU imports more than 85–90% of its phosphate rock requirements.

Biopesticides

Biopesticides can have a lower environmental impact than conventional synthetic pesticides because they are biodegradable, more target-specific and often less toxic to non-target organisms. Their use can also help reduce pesticide residues in food and lower risks of groundwater contamination.

Biopesticides support integrated pest management (IPM) systems and can contribute to reduced chemical pesticide use, which is important since conventional pesticides are considered a major driver of biodiversity decline in agricultural ecosystems.

In the EU, agriculture-related pesticide use exceeds 350,000 tonnes annually, while the Farm-to-Fork Strategy aims to reduce chemical pesticide use and risk by 50% by 2030.

4. Household and Personal Care

Replacing fossil-based ingredients in everyday consumer products

4.1 Household Care

Introduction

The global market for bio-based household care products — including soaps, detergents, surface cleaners and other cleaning products — is growing rapidly, driven by consumer demand for sustainable. EU Green Deal policies, and EUs Detergent Regulation. Per Detergents Regulation, all surfactants used in detergents in EU need to be readily biodegradable.

In general, the sector generally relies on chemical inputs. Different sub-groups of detergents (laundry, dishwasher, household) have different level of organic ingredients. Such categories will require more granular approach.

In addition, the EU's European Commission Ecodesign for Sustainable Products Regulation (ESPR) is expected to become a major driver for sustainable and bio-based formulations in cosmetics, detergents and household care products by 2030.

Competitiveness & innovation

Several breakthrough innovations are currently accelerating the commercialisation of **bio-based surfactants**[2] in household care applications such as detergents, dishwashing liquids and surface cleaners.

The most important innovation is the industrial scale-up of glycolipid bio-based surfactants, especially sophorolipids, rhamnolipids, mannosylerythritol lipids and surfactants/ lipopeptides.

These are produced through microbial fermentation using renewable feedstocks such as sugars, plant oils and waste biomass. Compared with conventional petrochemical surfactants these molecules offer high biodegradability, lower aquatic toxicity, lower skin irritation, effective cleaning at lower concentrations, good performance at low washing temperatures.

Europe has maintained a meaningful domestic manufacturing base in surfactants, with only small volumes of imports, e.g. ~100-200 kt of surfactants.

The global bio-based surfactants market size was estimated at USD 3.13 billion in 2023 and is projected to reach USD 4.74 billion by 2030, growing at a CAGR of 6.1% from 2024 to 2030. Europe dominated the global bio-based surfactants market with a share of 52.6% in 2023.

Market data

The global market for bio-based household care products — including soaps, detergents and cleaning products — is estimated at roughly USD 10–12 billion today and is expected to grow at 6–8% annually over the coming decade.

Europe represents approximately 30% of the global market, corresponding to an estimated EUR 2.5–3 billion market size. Growth is driven by increasing consumer demand for sustainable and non-toxic cleaning products, EU regulatory pressure on hazardous chemicals, and innovation in bio-based surfactants, enzymes, etc.

Bio-based surfactants offer important environmental benefits compared with conventional fossil-based surfactants, and can reduce lifecycle greenhouse gas emissions by 30–70%, depending on feedstock and production route.

Many bio-based surfactants also show high biodegradability and lower aquatic toxicity, reducing persistence and environmental impacts in wastewater systems.

Additional benefits include reduced dependence on fossil resources, and compatible with circular economy feedstocks such as waste plant-based oils and agricultural residues.

These advantages make bio-based surfactants an important enabling technology for more sustainable household care products.

4.2 Personal Care & Cosmetics

Introduction

In cosmetics and personal care products, formulas are composed of active ingredients and functional ingredients that serve different purposes.

Active ingredients are the components that deliver the intended cosmetic benefit to the skin, hair, or body (e.g. retinol reducing wrinkles and improving skin texture, hyaluronic acid providing hydration, etc.): they represent low volumes in the overall ingredients sourced and are usually at a higher price.

Functional ingredients make the product "work", remain stable, and provide the desired sensory properties, such as surfactants

[2] Bio-based surfactants are also used in other applications, such emulsifiers in binders, wetting agents used in adjuvants etc.

as cleansing and foaming agents in shampoos and body washes, and solvents to dissolve and carry ingredients: they represent the largest volumes of the overall ingredients sourced and a large part of them are commoditized with price around a few euros per kilogram.

Bio-based ingredients play a major role in the cosmetics and personal care sector: they support the defossilizaton of the sector (that, for example, can be monitored via corporate sustainability targets) and are necessary, but not sufficient, to qualify product as natural, which addresses certain specific consumer preferences around naturalness. Noteworthy, impacts on overall defossilization depends on the volumes of ingredients used in each product category, hence it relies on the ability to transition functional ingredients.

Personal care and cosmetic formulations vary widely in composition, and some categories are inherently unsuitable for broad biobased ambitions. Makeup, suncare and hair color rely on inorganic ingredients by nature, while sun protection products and hair dyes rely on regulated ingredients that limit substitution.

At the other end, categories like hair care and perfumes already carry a high biobased content.

More broadly, the sector has long used bio-based ingredients at scale —surfactants, fragrance molecules, some solvents, some emollients, and fermentation-derived actives — and is actively working to explore bio-based solutions for other classes of ingredients, including preservatives, polymers and film-formers.

Compared with conventional petrochemical alternatives, bio-based ingredients can offer environmental benefits such as reduced fossil carbon use, improved biodegradability or lower aquatic toxicity, however a full LCA is required to assess all sustainability dimensions.

Competitiveness & innovation

Europe is a leading innovation region for sustainable personal care ingredients, supported by strong industrial biotechnology capabilities and EU sustainability policies. EU Cosmetics Regulation (EC 1223/2009) and ESPR JRC priority study (2024) both identify cosmetics as a priority product category for new eco-design requirements by 2030.

Many major functional ingredients such as surfactants, emollients, and solvents are already highly bio-based, while additional bio-based ingredients are under development at different stage of maturity, including preservatives, natural vanillin as a fragrance ingredient, lignin carbohydrate complexes (LCCs), and bio-calcium carbonate (a mineral ingredients, but derived via organic streams such a sea shells).

However for several of these materials that are at an early stage their functionality and performance and their commercial potential still need to be demonstrated.

Market data

The global personal care and cosmetics market exceeds USD 600 billion annually, with Europe representing one of the world's largest and most innovative markets. Within this market bio-based and natural ingredients are among the fastest-growing segments.

The European beauty & personal care market is estimated at EUR 147bn (2026), growing at 4.2% CAGR to 2031.

Sustainability

Bio-based personal care and cosmetic ingredients can contain from 50 to 100% renewable carbon depending on their manufacturing. They can provide environmental benefits compared with conventional fossil-based ingredients.

Moreover, some of these ingredients bring biodegradability function, which in certain cases can help preventing microplastics release in sewage sludge and water.

The impact on greenhouse gas emission have to be assessed carefully to ensure reductions that can typically range from 20–80%, depending on feedstock cultivation, production technology and energy use along the value chain.

5. Intermediates
Products that can serve several end-markets

5.1 Binders

Introduction

Bio-based binders (glues) are renewable alternatives to fossil-based resins and adhesive systems used in applications such as construction materials, coatings, composites and adhesives. They are produced from renewable feedstocks including lignin, vegetable oils, starch, proteins and fermentation-derived building blocks.

Competitiveness & innovation

Key innovation areas include lignin-based resins, bio-based epoxy systems, formaldehyde-free wood adhesives and fermentation-derived polymer intermediates. Europe is emerging as a major innovation hub.

Market data

Global bio-based binder market estimated at approximately USD 3.6 billion in 2024, and to reach around USD 6.3 billion by 2034. The expected CAGR is 5.7% over 2024–2034.

Europe represents appr. 30–40% of global demand depending on the segment.

Based on the available global estimates, the European bio-based binder market is therefore roughly estimated at EUR 1.1–1.5 billion in 2024–2025 likely growing toward EUR 2–2.5 billion by 2035.

Sustainability

Bio-based binders can reduce lifecycle greenhouse gas emissions by 20–80%, lower fossil resource use and improve circularity compared with conventional petrochemical systems.

Lignin-binder technology avoids formaldehyde and isocyanates (SVHC under REACH). Replacing urea-formaldehyde resins with lignin-based binders: eliminates formaldehyde emissions (carcinogen; EU Carcinogens Directive 2004/37/EC) and isocyanates, both significant occupational health hazards.

5.2 Paints, inks & adhesives

Introduction

Paints, inks and adhesives are essential intermediate products for construction, furniture, packaging, publishing, and industrial manufacturing.

These formulations rely heavily on fossil-based binders, resins, and solvents, yet bio-based alternatives (plant-based alkyds, bio-epoxies, lignin-based adhesives, natural rubber PSA, bio-solvents) are already commercially available and compatible with existing production assets. The sector therefore offers near-term decarbonisation potential without requiring end-user system change.

Competitiveness & innovation

Bio-based binders for paints (plant-based alkyds, partly bio epoxy resins) are in late development (TRL 7–9).

Innovation is largely incremental and formulation-driven, enabling rapid diffusion once cost and standards alignment are achieved.

Market data

The global market for **bio-based adhesives** is estimated at roughly USD 4–6 billion in 2024. Most forecasts expect the market to grow strongly toward USD 8–15 billion by 2030–2035, with annual growth rates generally between 7% and 10%.

Europe is one of the leading regions for bio-based adhesives and is estimated to account for approximately 30–35% of the global market. This implies a current European market size of around USD 1.2–2.0 billion.

The global market for **bio-based paints and coatings** is currently estimated at approximately USD 4–8 billion in 2024/2025, depending on the exact scope and inclusion criteria used.

Most forecasts project strong growth toward USD 8–16 billion by 2030–2035, with annual growth rates generally between 8% and 10%. Recent European market analyses indicate that the European market could reach approximately EUR 6.6 billion by 2034.

The global market for **bio-based inks** is estimated at approximately USD 1.4–3.3 billion in 2024. Most forecasts expect the market to grow to roughly USD 2.8–5.9 billion by 2032–2034, corresponding to annual growth rates of around 7–8%. Growth is driven by increasing demand for sustainable packaging, stricter VOC regulations, and the replacement of petroleum-based inks in publishing, labels and flexible packaging.

Europe is one of the leading markets for bio-based inks. Recent market analyses estimate the European bio-based ink market at around USD 300–350 million in 2024.

Sustainability

Conventional **paints and adhesives** are heavily dependent on petrochemical binders, solvents and additives, whereas bio-based alternatives use renewable feedstocks such as vegetable oils, lignin, starch, cellulose, natural resins and soy proteins.

Depending on formulation and feedstock, life-cycle assessments indicate that bio-based formulations can reduce greenhouse gas (GHG) emissions by appr. 20–80% compared with fossil-based equivalents.

A second important benefit is the reduction of volatile organic compounds (VOC) emissions. Paints and adhesives are major sources of indoor and outdoor VOC pollution, contributing to smog formation and indoor air-quality problems. Waterborne and bio-based systems can significantly reduce VOC emissions, in some cases by 50–90%, especially when replacing solvent-based systems. This is particularly important in Europe, where VOC restrictions under industrial emissions and indoor-air-quality legislation are becoming stricter.

One of the main environmental benefits is the use of renewable raw materials such as soy oil, linseed oil, vegetable oils, algae-based feedstocks and natural resins instead of petroleum-derived solvents and binders.

Depending on formulation and feedstock origin, life-cycle assessments indicate that bio-based inks can reduce greenhouse-gas emissions by approximately 20–70% compared with conventional solvent-based inks.

Biobased inks can reduce VOC emissions by approximately 30–80%, depending on the application and printing technology. This is particularly important for packaging and indoor printing applications.

Another major advantage is improved recyclability of printed paper and packaging. Many vegetable-oil-based inks are easier to de-ink during paper recycling processes than mineral-oil-based inks, improving fibre recovery and reducing contamination.

This supports circular economy objectives in the paper and packaging industries.

5.3 Coatings

Introduction

Bio-based coatings are coating formulations produced partly or fully from renewable biological feedstocks such as vegetable oils, lignin, starch, cellulose, natural resins and bio-based polymers instead of fossil-derived chemicals.

Bio-based functional coatings include barrier, antimicrobial, and surface-functional layers applied to packaging and industrial surfaces.

These coatings are typically only a few micrometres thick but enable recyclability, shelf-life extension, or material protection, replacing fossil-based polymers or metal layers that otherwise prevent recycling or increase environmental burden

Competitiveness & innovation

Natural polymers like chitosan (from crustacean shells) or whey protein show promising barrier properties on food packaging films. Also, nanocellulose combined with plant-based antimicrobials (essential oils, peptides) can form protective coatings that extend food shelf-life. Some solutions are on a pilot-scale, with tests by major packaging firms. They must prove compatibility with current production lines and food-contact safety.

Ultra-thin functional coatings (few µm) applied on packaging or surfaces to provide a barrier (e.g., to moisture, oxygen) or antimicrobial effect, made from bio-based compounds. These coatings can replace synthetic or metallic layers that make paper/plastic packaging non-recyclable.

Market data

The global market for bio-based coatings is estimated at approximately USD 10–14 billion in 2024–2025 and is expected to grow strongly over the next decade, driven by increasing demand for low-VOC, renewable and low-carbon coating systems.

Europe represents roughly 30% of global demand and is one of the leading regions worldwide due to REACH regulation, Green Deal policies and strong adoption of sustainable construction and industrial materials. Major growth areas include water-based coatings, bio-based epoxy systems, bio-polyurethanes and advanced lignin-derived coating technologies.

Sustainability

Bio-based coatings can significantly reduce the environmental footprint of paints and protective materials by lowering fossil resource dependency, reducing VOC emissions and decreasing GHG emissions compared with conventional petrochemical coatings.

Depending on formulation and feedstock, bio-based coatings may contain approximately 20–100% renewable carbon content, while life-cycle GHG emissions can be reduced by around 20–50% relative to fossil-based alternatives.

Water-based bio-based coatings are particularly important because they can substantially lower VOC emissions, which is relevant since paints and coatings are estimated to account for roughly 40–50% of industrial VOC emissions in Europe.

Many bio-based coating systems also improve indoor air quality and reduce worker exposure to hazardous solvents.

5.4 Solvents

Introduction

Bio-based solvents are solvents produced from renewable biological feedstocks such as sugars, vegetable oils, starch, lignocellulosic biomass and fermentation-derived chemicals instead of fossil resources. They are increasingly used in paints and coatings, cleaning products, cosmetics, pharmaceuticals and industrial processing.

Common examples include bioethanol, ethyl lactate, bio-based acetone, d-limonene and glycerol derivatives.

Methyl lactate and ethyl lactate are noted as versatile green solvents (cleaners, paints). Other green glycols (e.g., bio-propylene glycol from glycerin) are on the market in cosmetics and food, proving reliability.

Competitiveness & innovation

Most bio-solvents are TRL 8–9 – already industrialized (e.g., in France, bio methyl acetate is produced; in the US, CN and BE, ethyl lactate from biomass is large-scale). Europe currently imports some due to limited local capacity.

Bio-based ethanol (from sugar, starch, biomass residues, etc.) can fully or largely substitute fossil-based ethanol in these segments (fuels, industrial, pharmaceutical and solvent uses).

Market data

The market for bio-based solvents is expanding rapidly as industries seek lower-carbon, low-toxicity and low-VOC alternatives to petrochemical solvents. Europe is currently one of the leading regions due to strong environmental regulation, green chemistry policies and demand from coatings, cleaning, cosmetics and pharmaceutical industries.

The global market for bio-based solvents is estimated at approximately USD 8–16 billion in 2025 and is expected to grow strongly over the next decade. Recent estimates place the European bio-based solvents market at approximately USD 2.4–4.9 billion in 2025–2031 forecasts. Europe represents approximately 30–40% of the global market.

The European Commission's Joint Research Centre (JRC) estimated earlier EU bio-based solvent production at approximately 75 kt/year with approximately 43% bio-based share in production for selected solvent categories.

Sustainability

Bio-based solvents can significantly reduce the environmental footprint of industrial chemicals by lowering fossil resource dependency, improving biodegradability and reducing greenhouse gas (GHG) emissions compared with many petrochemical solvents.

Depending on the feedstock and production pathway, life-cycle GHG emissions can be reduced by approximately 20–80% relative to fossil-based alternatives, while renewable carbon content may reach 50–100%. Many bio-based solvents also exhibit lower toxicity and reduced volatile organic compound (VOC) emissions, contributing to improved indoor air quality and lower occupational exposure risks.

Solvents account for roughly 50% of industrial VOC emissions in Europe, making low-VOC alternatives particularly important for coatings, cleaning products and adhesives.

In addition, many bio-based solvents such as ethyl lactate, ethanol and glycerol derivatives are readily biodegradable, reducing persistence and bioaccumulation risks in aquatic environments.

5.5 Lubricants

Introduction

Biolubricants are particularly valuable in environmentally sensitive applications such as marine, forestry and agricultural equipment, where lubricant leakage can contaminate soil and water systems.

They are strategically important because of their use in (electric) automotive, wind energy, heat pumps and all electrical and combustion engines.

Competitiveness & innovation

Bio-lubricants are fully commercialised and standardised. There is a EU Ecolabel for lubricants (Decision 2018/1702) with mandates 60% biodegradability and 25% bio-carbon content.

Market data

Biolubricants represent a growing niche within the lubricants industry, driven by stricter environmental regulation, demand for biodegradable products, and applications in transport, marine, forestry, agriculture, construction and industrial machinery.

The global market is currently estimated at roughly USD 3 billion, with projections toward USD 4–6 billion over the next decade. Europe is an important lead market, supported by sustainability policies, eco-labels and demand in environmentally sensitive applications; its market is estimated at roughly USD 0.3–0.7 billion, with expected annual growth of around 6%.

Sustainability

Many biolubricants achieve 60–90% biodegradation within 28 days according to OECD biodegradability tests. This makes them particularly valuable in environmentally sensitive sectors such as forestry, marine transport, agriculture, hydraulic systems and construction equipment.

Biolubricants also generally exhibit lower aquatic toxicity and reduced ecotoxicological impacts. Leakage losses from lubricants are substantial worldwide; estimates suggest that more than 50% of lubricants used globally eventually enter the environment through spills, evaporation, leakage or improper disposal.

Biolubricants can reduce GHG emissions by approximately 20–80%, depending on feedstock, production pathway and allocation methodology.

In addition, biolubricants typically have higher lubricity and viscosity index, lower volatility, improved flash points, reduced oil consumption and maintenance needs in some applications.

Annex – References

The complete list of references is available in the separate publication Annex – References.

Bio-based Industries Consortium

Bio-based Industries Consortium (BIC)

Square de Meeûs 38/40, 4th floor
Brussels 1000, Belgium

info@biconsortium.eu

www.biconsortium.eu

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