Circular & Biobased Textiles
Innovation Hub

by ETP Fibres Textiles Clothing
EUROPEAN TECHNOLOGY PLATFORM

A Bioeconomy Innovation Strategy for the European Fibres, Textiles, and Apparel Industry

A Strategic Roadmap developed by the Circular & Biobased Textiles Innovation Hub

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Circular & Biobased Textiles
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This Strategy was developed under the **Circular & Biobased Textiles Innovation Hub** initiative, with the input and support of the Hub's industry, research and cluster members.

The Circular & Biobased Textiles Innovation Hub is run by the **European Technology Platform for the Future of Textiles and Clothing** (Textile ETP), together with STFI, RISE Research Institutes of Sweden, Centexbel, Centrocot and CETI.

The strategy builds on extensive desk research carried out between February and August 2026 by Textile ETP staff members Tilla Kross, Kamilla Drubina and Lutz Walter, complemented and validated through two co-creation sessions held on 26 March and 4 June 2026 with experts from across the European biotextile value chain. Five partner sector and material-specific representative bodies from the European chemicals, nonwovens, cotton, wool, flax and hemp industries were also consulted, providing written input and/or presenting their point of view in a webinar on 1 July 2026. The document further contains a number of illustrative cases of textile bioeconomy innovation by European companies.

The Hub is a community-driven initiative designed to help European textile companies, research organisations, brands and retailers learn, network and collaborate on circular and biobased textiles. Its activities are organised around five core innovation themes: Biobased Materials & Processes, Sustainable Chemistry, Sustainable Supply Chain, Circularity & Recycling, and Ecodesign.

These themes are delivered through monthly learning webinars, in-person meet-ups at major European trade fairs, and a dedicated community platform that brings together industry, research, technology providers, and policy actors.

More information on: https://www.textile-platform.eu/innovation-hub-circular-and-biobased-textiles



The present Circular & Biobased Textiles Innovation Hub strategy brings together biobased and circular approaches rather than treating them as competing pathways and sets out how feedstocks, fibres, bioprocessing, manufacturing, recycling and markets can become part of an integrated European textile bioeconomy. Its ambition is clear: by 2050, biobased and circular materials should form a major part of Europe's textile material base, with the corresponding industrial value chains firmly rooted in Europe.

Europe's textile bioeconomy is not only a sustainability opportunity, it is an industrial opportunity.

The European fibres, textiles and apparel ecosystem is at a defining moment. For decades, the share of fossil-based fibres has increased, while Europe has become increasingly dependent on materials and production capacities located outside our continent. Reversing this trend is therefore about much more than reducing environmental impact. It is about strengthening Europe's competitiveness, resilience and strategic autonomy, while creating new industrial value and high-quality jobs.

Europe has many of the capabilities needed to lead this transformation: world-class textile know-how, strong natural and man-made cellulosic fibre value chains, emerging leadership in biopolymer-based fibres and biobased synthetics, advanced biotechnology and biorefinery expertise, innovative SMEs, excellent research organisations and a highly developed testing, standardisation and certification infrastructure. The opportunity is therefore not limited to replacing individual fibres, but to building an entirely new and diversified renewable material base for the European textile industry.

The present Circular & Biobased Textiles Innovation Hub provides a roadmap for doing exactly that. It brings together biobased and circular approaches rather than treating them as competing pathways and sets out how feedstocks, fibres, bioprocessing, manufacturing, recycling and markets can become part of an integrated European textile bioeconomy. Its ambition is clear: by 2050, biobased and circular materials should form a major part of Europe's textile material base, with the corresponding industrial value chains firmly rooted in Europe.

The opportunity is significant. The Strategy estimates that an ambitious, Europe-anchored transition could mobilise €55-65 billion of annual value across the wider EU value chain and support around 80,000 direct jobs at fibre and processing stage alone. But this potential will not materialise by itself. It requires coordinated action by industry, researchers, investors and policy makers; from research and scale-up funding to market demand, infrastructure, skills and a regulatory framework that recognises both sustainable biobased and recycled materials.

The choice is ours: Europe can become a market for the bioeconomy, or it can become one of the places where the bioeconomy is invented, scaled and manufactured. Textile ETP is committed to the latter.

I invite all stakeholders across our ecosystem to use this Strategy not simply as a vision for 2050, but as a call to action for the decade ahead.

Marina Crnoja-Cosic
President of the European Technology Platform for the Future of Textiles and Clothing (Textile ETP)





This potential will not materialise by itself. It requires coordinated action by industry, researchers, investors and policy makers; from research and scale-up funding to market demand, infrastructure, skills and a regulatory framework that recognises both sustainable biobased and recycled materials.

The European fibres, textiles and apparel industry (some 194,000 companies, 1.2 million workers and €166 billion in annual turnover) rests on a material base that is facing both environmental and strategic competitive challenges. Roughly two thirds of textile fibres Europe consume across a broad spectrum of diversified end markets is fossil derived. The production of those fibres and/or their feedstocks and consequently also a significant part of their processing into final products is heavily concentrated outside the EU, mainly in Asia. The EU Bioeconomy Strategy adopted in November 2025 names fibres and textiles a priority lead market for biobased materials; this strategy presents a transition pathway that translates that policy mandate into an industrial reality in the EU textile market.

To ground its objectives in evidence, the Circular & Biobased Textiles Innovation Hub strategy is underpinned by a purpose-built quantitative model of EU-27 textile fibre consumption spanning 2000 to 2050, studying seven end markets and eleven fibre types across three future scenarios. It reconciled against Eurostat/PRODCOM apparent-consumption statistics for apparel, European Commission's Joint Research Centre's 2023 textile-waste study for a range of other textile products and further sub-sectoral studies and expert consultations for a complete overview of EU textile fibre consumption. Four key insights from the model underpin the Strategy:

A solid and precise baseline. In 2025 the EU consumed about 18.6 Mt of textile fibre, 62.7% synthetic and 37.3% biobased or natural. The biobased share has declined steadily for decades, from roughly 51% in 2000.

An opportunity assessment by market segment. About 11.3 Mt of current fibre consumption is fossil-based synthetic, heavily concentrated in technical and industrial (4.3 Mt), interior (1.4 Mt) and hygiene and medical (1.6 Mt) textiles, segments where defossilisation efforts would be most impactful, but are for various reasons least advanced. Other segments like home, household and hospitality textiles as well as certain clothing segments are where biobased materials today are most prevalent and may be easier to defend and even gradually re-grow.

A quantified cost of inaction. On a **Business as Usual** trajectory the biobased share falls further to about 30% by 2050, locking in some 12.2 Mt of virgin fossil fibre every year and deepening Eu-rope's strategic dependency on the predominantly Asian suppliers of these materials.

Two proactive forward-facing scenarios. The Strategy targets an action corridor between two preferable model scenarios: first a **Circular Biobased** Scenario with a total 63% renewable fibre share at horizon 2050 (of which 45% biobased and 24.5% recycled) and an **Aggressive Bioeconomy** Scenario with a total 71% renewable fibre share (of which 63% biobased and 11% recycled), both with reinforced European production and regional economic value creation.

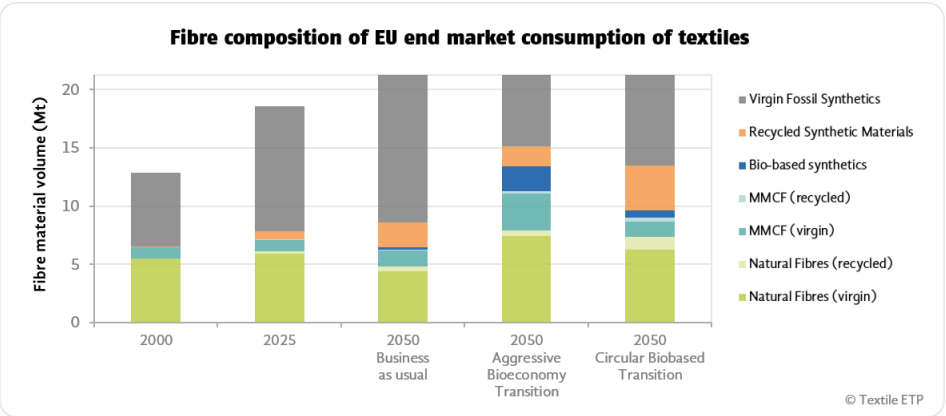


Figure 1: Evolution and fibre composition of EU textile end market consumption 2000-2050

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Under the **Circular Biobased** Scenario and at an assumed EU-and-neighbourhood country origin share of about 45% for natural fibres and 40% for man-made cellulosics, biosynthetics and recycled synthetics, this represents on the order of €15 billion a year of fibre-stage value, about €20 billion including downstream bio-processing, and €55-65 billion across the wider value chain, supporting an estimated 80,000 direct fibre- and processing-stage jobs and several times that number downstream

Five distinct but interlocking **building blocks** for the textile bioeconomy

- biobased feedstock & biorefinery processes,
- manmade cellulosic fibres,
- biopolymer based fibres and biobased synthetics,
- sustainable natural fibres,
- and biobased chemicals and bioprocessing

are described in detail, with specific innovation focus areas and their related challenges and opportunities.

Several broad **technology drivers** support innovation across all the five building blocks. These include rapid advances in agronomy, synthetic biology, precision fermentation, various biorefinery pathways for lignocellulosic, agricultural crops and residues, organic waste and captured CO2, bioprocessing and functionalisation of textiles as well as data-driven infrastructure for more robust impact assessment, optimisation and communication.

Numerous **cross-cutting challenges** need to be addressed in parallel such as regulatory, economic and environmental impediments to rapid scaling of biobased textile innovation, feedstock quality and quantity guarantees, access to innovation and industrialisation finance, market awareness and readiness.

Based on the detailed analysis of market and technology drivers, economic opportunities and cross-cutting challenges, the stakeholders came up with a list of **10 concrete policy recommendations** across areas such as policy making, research & innovation funding, demand side enablement, infrastructure, SME capacity and skilling.

In summary, the decisive question is not whether there is great economic potential in a biobased textile transition in Europe, but if value chain stakeholders, policy makers and funding providers can effectively and expeditiously work together to make it happen.

The **EU Textile Strategy of 2022** provided a vision for a more sustainable, circular and competitive EU textile sector, while putting a lot of emphasis on the industrial cycle of the circular economy (i.e. recycling). It is time that it becomes **a dual strategy** enabled and accelerated with a second strong leg representing the biological cycle, making smart use of available biobased resources, becoming value-adding textile products for a while, before returning safely into the next biological or industrial loop. Making smarter use of the renewable resources available in Europe (and nearby), doesn't only protect the climate by leaving fossil fuels in the ground, it is also smarter from a competitiveness, diversification and strategic autonomy point of view, reducing a concerning and growing dependency on critical material supplies from other parts of the world.

An important caveat however must always be kept in mind: biobased does not automatically mean more sustainable. For textiles that remain in use for years or decades, sustainability depends on safe, intensive use over a long service life. A fossil-based fibre without a functional equivalent may therefore still be the most sustainable option today.

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The decisive question is not whether there is great economic potential in a biobased textile transition in Europe, but if value chain stakeholders, policy makers and funding providers can effectively and expeditiously work together to make it happen.


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Towards a Biobased & Circular European Textile Industry in 2050

The European fibres, textiles and apparel industry remains one of Europe's largest and most strategically important manufacturing ecosystems: some 197,000 companies, 1.2 million workers and €166 billion in annual turnover, overwhelmingly composed of micro, small and medium-sized enterprises. Yet the material base on which it depends is fundamentally unsustainable, in both feedstock and geographic origin. Roughly two thirds of the fibre consumed globally is fossil-derived, predominantly polyester, and the share of natural and biobased fibres has declined almost without interruption for fifty years. At the same time, man-made fibre production has become dangerously concentrated (over 90% of global polyester fibre and filament production capacity is located in Asia, with well over 70% in China alone): a directional trend also observed for polyamide, acrylic and man-made cellulosic fibres, leaving Europe structurally dependent for the raw materials of a strategic manufacturing industry making mission-critical products for sectors such as safety and security, healthcare, transport or food production.

Three converging imperatives make the biobased transition a necessity rather than an option.

The first is **sustainability**. Global per-capita fibre consumption has risen from 8.3 kg in 1975 to 16.2 kg in 2024 and is still climbing; on a business-as-usual path the additional demand is met almost entirely with fossil synthetics, incompatible with the Paris Agreement and the European Green Deal.

The reasons for the rise of synthetics are manifold. Material functionality is one key driver. When synthetic fibres were first invented in the 1930-60's they already possessed properties such as strength, hydrophobicity, abrasion-resistance that were superior to their natural counterparts. Through subsequent material engineering since the 1970's, such as finer filaments, better texturing, shaped, hollow or bicomponent fibres, drawing and heat-setting etc., many more functions were added increasing versatility

of synthetics and making them sometimes almost indistinguishable from natural fibres. A second strong driver was economic, especially for polyester. Thanks to greater production scale, integration and process efficiencies the cost of polyester staple fibre has decline by almost 60% in inflation-adjusted terms between 2000 and 2024 (while the price of oil increased by over 30%). Cotton prices in real terms only declined by about 37% over the same time. Finally end markets where synthetics are favoured due to their properties have grown faster than classic natural fibre markets; these include many technical textile and nonwoven markets but also apparel types such as sports and outdoor wear or the more recent athleisure trend in everyday fashion and footwear.

The European Union overall is not a fast-growing textile fibre consumption market anymore due to stable demographics with an ageing population and increasing consumption shifts from goods to services. For the EU-27, the fibre model built for this Strategy shows total consumption growing at a compound annual growth rate (CAGR) of 1.48% for the 2000-2025 period (from 12.9 Mt to 18.6 Mt) and more modest forward CAGR of 0.54% from 2025 to 2050 (from 18.6 Mt to 21.3 Mt). Over these two periods the biobased material share declines first from about 50% in 2000 to 38% today and will, under a business-as-usual scenario, decline further towards only 30% by 2050. **For Europe, aligning consumption more closely with planetary boundaries therefore means defossilising today's material use, rather than sourcing additional renewable resources to sustain further growth.**

The second imperative is **strategic resilience**. Europe's dependence on a handful of non-European suppliers – for polyester, polyamide or elastane, for the fossil monomers behind it (PTA, MEG, caprolactam, BDO), for specialty fibres, finishing chemicals and the basic textile materials made of them – is no longer an acceptable risk for a sector of this industrial and cultural importance. The EU Bioeconomy Strategy calls for mobilising Europe's own farmlands, forests, oceans, agricultural and forestry residues and industrial-biotechnology base to meet most of its biomass needs domestically. For textiles this means converting EU bast fibres, responsibly produced wool and cotton, certified forestry pulp, material crops, agricultural residues and the growing volume of separately collected post-consumer textiles into a sovereign, resilient material to final product value chain.

The third imperative is **competitiveness.** Europe enters the bioeconomy transition from strength: its bioeconomy already generates €863 billion in value added and 17.1 million jobs, and it holds globally leading positions in man-made cellulosic fibre processing, industrial biotechnology, biorefinery technology and certified sustainable forestry, together with the world's most sophisticated research, higher education, testing, standardisation and certification infrastructure for all types of advanced textiles including biobased materials and processes. The EU Bioeconomy Strategy justifiably names fibres and textiles a priority lead market, and the surrounding regulatory framework (ESPR and its Digital Product Passport, the upcoming Biotech Act 2, Extended Producer Responsibility under the Waste Framework Directive and proposed changes to the EU chemicals legislation) creates a uniquely favourable environment for European innovators to scale ahead of global competitors. The companies and regional production clusters that build the next-generation spinning lines, regional biorefineries and bio-chemistry plants of the coming decade may define the global standard; the alternative is to repeat in innovative biobased textiles the industrial leadership Europe ceded in solar and batteries.

The hereby presented European Textile Bioeconomy Strategy's is guided by the following vision:

> **By 2050, the decades-long growth of the fossil share in EU textile fibre consumption is halted and reversed. The European textile industry operates on a materially different basis, in which biobased AND circular materials account for at least half of all fibre consumed, and the value chain that produces them is rooted in Europe.**

This vision spans four interlocking layers, from feedstock to end-of-life.

At the feedstock layer, Europe sources a growing share of textile materials from a diversified, regional and regenerative resource portfolio (sustainably managed forestry biomass, EU-grown bast fibres and cotton, regionally collected wool, agricultural and forestry residues, non-food and second-generation crops, captured CO_2, and post-consumer textiles) underpinned by regional biomass aggregation and coordinated land-use planning that balances food, fibre and biodiversity.

At the bio-processing and refining layer, an industrial engine of integrated lignocellulosic biorefineries, decentralised regional mini-refineries and industrial-scale microbial fermentation converts this biomass into dissolving pulp, sugars, biobased monomers and lignin intermediates, later complemented by carbon capture and utilisation.

At the fibre and material production layer, European producers turn these building blocks into the full range of textile materials: next-generation lyocell and ionic-liquid cellulosics that displace hazardous legacy viscose; drop-in biobased polyester, polyamide and elastane; novel biopolymer fibres (PLA, PHA, PEF, PBS and protein-based) for niche applications; and improved EU natural fibres from modernised bast, wool and regenerative-cotton chains, increasingly organised into regional and circular bio-manufacturing hubs.

At the market, demand and end-of-life layer, coordinated demand-side pull (long-term brand off-take agreements, Green Public Procurement, trusted bio-content labelling embedded in the Digital Product Passport, consumer willingness to pay a small premium for robust trustworthy sustainability claims and dedicated circular bio-loops for take-back and recycling) draws the material through the system and back again.

These four layers are not isolated investment silos but a single, self-reinforcing system: feedstock supplies processing, processing supplies fibre production, and demand-side pull and circular bio-loops keep material, and value, moving through the chain.

The Strategy's task is to build all four layers together, and to build them preferably in Europe. The following chapters quantify the market opportunity, set out the enabling technologies and building blocks, and define the scenarios and propose actions and policy recommendations to operationalise the strategy rapidly.



EU Textile Consumption: Present and Future

The EU Fibre Market: Baseline and Trajectories to 2050

The objectives and premises of this Strategy are based on a dedicated quantitative model of EU-27 textile fibre consumption, developed specifically for this work. The model reconstructs annual end market material consumption from 2000 to 2050 across seven end markets and eleven fibre types, distinguishes virgin, recycled and biobased feedstocks, and projects three composition scenarios on a single, common volume path. Its base year is reconciled against Eurostat/PRODCOM apparent-consumption statistics and the Joint Research Centre's 2023 textile-waste study, giving the figures the best available empirical anchor rather than a purely top-down estimate. Several fragmented end market segments for which official statistics were unavailable, were validated by either industry associations or individual experts with deep sector expertise. The model is the analytical backbone for the End Markets, Building Blocks and Scenarios chapters that follow.

A precise 2025 baseline

In 2025 the EU-27 consumes an estimated 18.6 million tonnes of textile fibre on an apparent-consumption, fibre-equivalent basis. Of this, 61.7% is fossil synthetic (with a small share of bottle-recycled rPET) and 38.3% is biobased. The headline to remember is not only the absolute level but also the trend: the biobased share in total textile fibre consumption has fallen almost without interruption for decades (from around 50% in 2000, and much higher throughout the 20th century) as cheaper and more functional fossil synthetics, above all polyester, captured successive waves of demand growth, especially in market segments with above average growth rates like technical textiles, nonwovens, functional outdoor apparel and sporting goods. Total material consumption volume, by contrast, has grown only modestly in the years since 2000 and is expected to slow down further in the years ahead against the backdrop of an ageing, slow-growing European population, a marked difference from rapid volume growth in the worlds emerging economies.

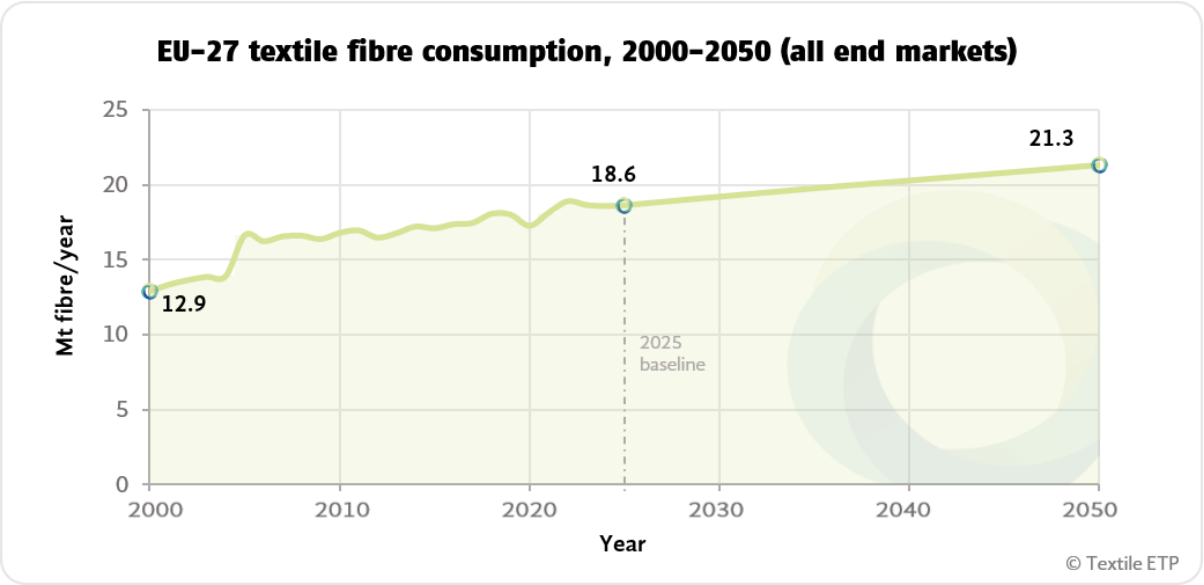


Figure 2: EU-27 textile fibre consumption 2000-2050 (all seven end markets)

Fossil intensity of different end markets

The model resolves consumption into seven end markets, which differ sharply in both size and fossil intensity. Consumer clothing is the largest single segment (about 5.0 Mt, 27% of volume), but almost three quarters of the textile material consumption today is outside the apparel category. Crucially, current fossil intensity determines where defossilisation effort would be most impactful, while not necessarily most straightforward, given that synthetics use in the respective segments is mostly based on the functional property of the materials. The highest fossil material intensity is present in technical and industrial products, followed by interior textiles such as carpets and upholstery and the medical textiles subsegment, while hospitality, home and household as well as consumer clothing (especially underwear and close-to-skin outerwear) retain the most substantial natural and man-made cellulosic fibre shares. In total about 11.5 Mt of EU textile fibre consumption is fossil-synthetic, representing about 12% of global production of such fibres. The largest volume opportunity therefore lies in the heavily synthetic technical, interior and medical segments (together some 7.2 Mt of fossil fibre) while clothing and home textiles offer the most immediate routes to gradually scale biobased and natural materials.

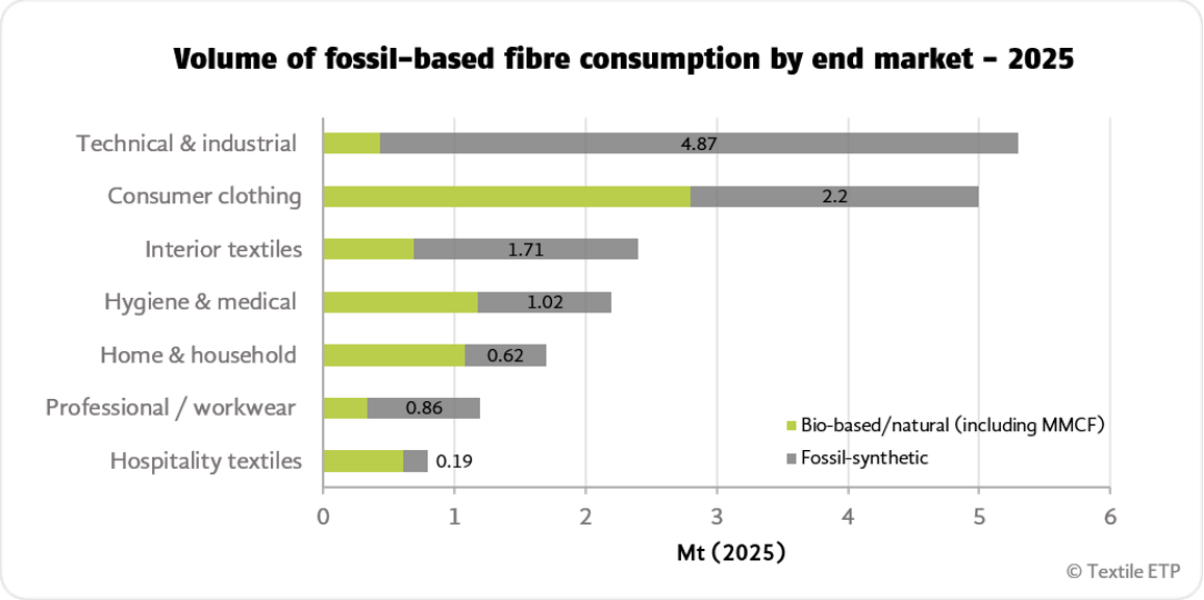


Figure 3: 2025 end market consumption of fossil vs biobased fibre materials

End market	2025 volume (Mt)	Volume share	Fossil-synthetic (Mt)	Synthetic share
Technical & industrial	5.3	28.5%	4.87	92%
Consumer clothing	5.0	26.9%	2.20	44%
Interior textiles	2.4	13.0%	1.71	71%
Hygiene & medical	2.2	11.8%	1.02	46%
Home & household	1.7	9.0%	0.62	37%
Professional / workwear	1.2	6.5%	0.86	71%
Hospitality textiles	0.8	4.3%	0.19	24%
Total EU-27	**18.6**	**100%**	**11.5**	**61.8%**

Table 1: Fibre volumes and material type shares by end market

Three trajectories to 2050

On the basis of the 2025 baseline market volume and fibre composition analysis and using the same projected annual compound growth rate of 0.54% from 2025 to 2050 (resulting as a composite of assumed different segment growth rates) the following three future material composition scenarios have been developed.

Under **Business as Usual** the material shifts observed in the last 2.5 decades are extrapolated resulting in a mix that drifts further towards synthetics and the biobased share falls to about 30% by 2050.

The **Circular Biobased** scenario, driven by a dual driver of incentivisation of both virgin biobased AND recycled fibres, lifts the biobased share to 45% and the renewable (biobased plus recycled) share to 63%, with recycled content reaching 24.5%. Since a share of recycled fibres are generated from biobased feedstock (6.5%) only the 18% of recycled synthetics is added to the 45% biobased materials to give the combined 63%.

The **Aggressive Bioeconomy** scenario, based on the assumption that natural and man-made biobased fibre production including biosynthetics are technically and economically faster to scale than recycling, despite regulatory incentivisation of both, reaches 63% biobased and 71% renewable material share by 2050, reducing the virgin fossil share to sub-30%.

The gap between the three trajectories is ultimately large. The difference between **Aggressive Bioeconomy** and **Business as Usual** is about 6.7 Mt of additional biobased fibre a year by 2050, and the difference in virgin-fossil use is roughly halved, from 12.7 Mt to about 6.2 Mt for the **Aggressive Bioeconomy** or 7.8 Mt for the **Circular Biobased** Scenario. These three trajectories, and the question of where their value is captured, are developed fully in the Scenarios chapter.

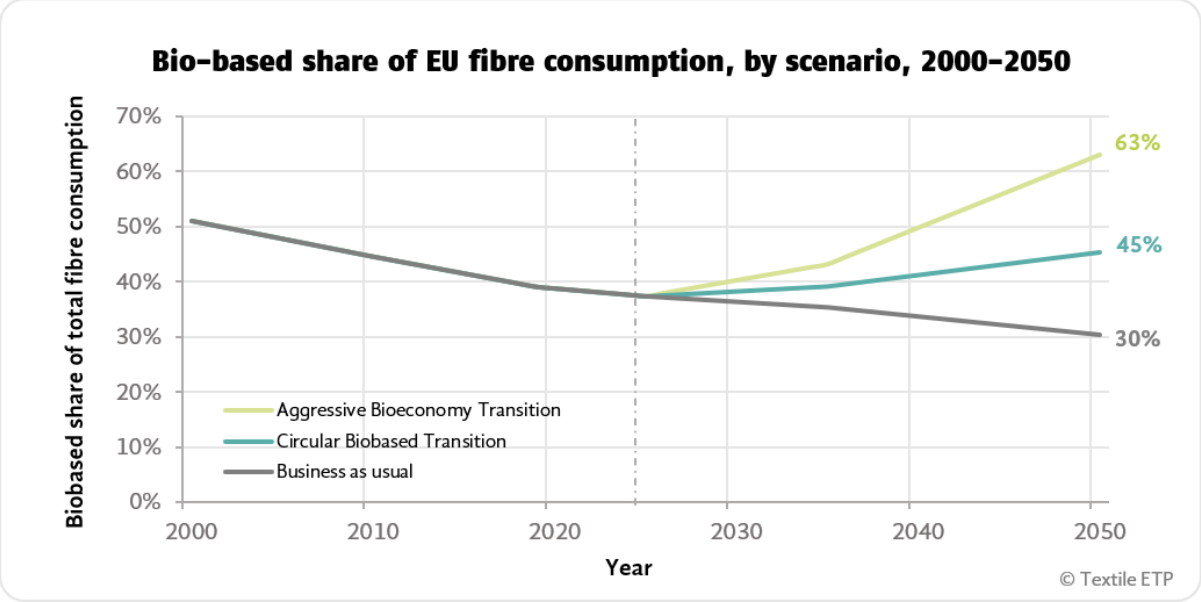


Figure 4: Biobased share of EU textile fibre consumption under the three scenarios, 2000-2050

The End Markets and their Material Composition

The European textile market is large, mature and materially diverse, a profile that opens a very broad opportunity set for biobased textile innovation to create value. As set out in the preceding chapter, the model puts total EU-27 textile material consumption at about 18.6 million tonnes in 2025, split 61.7% synthetic and 38.3% biobased or natural. In terms of total volume Technical and Industrial textiles represent the largest segment with 28.5% share (5.3 Mt), having in recent years overtaken the consumer clothing segment which represents about 27% (5.0 Mt).

The following segments in descending volume order are interior textiles at 13% (2.4 Mt), hygiene and medical at 11.8% (2.2 Mt), home and household at 9.0% (1.7 Mt), professional and workwear at 6.5% (1.2 Mt), and hospitality textiles at 4.3% (0.8 Mt). See technical annex 1 for a more detailed description of each market segment, its subsegments, product categories included, current volume and fibre share trends.

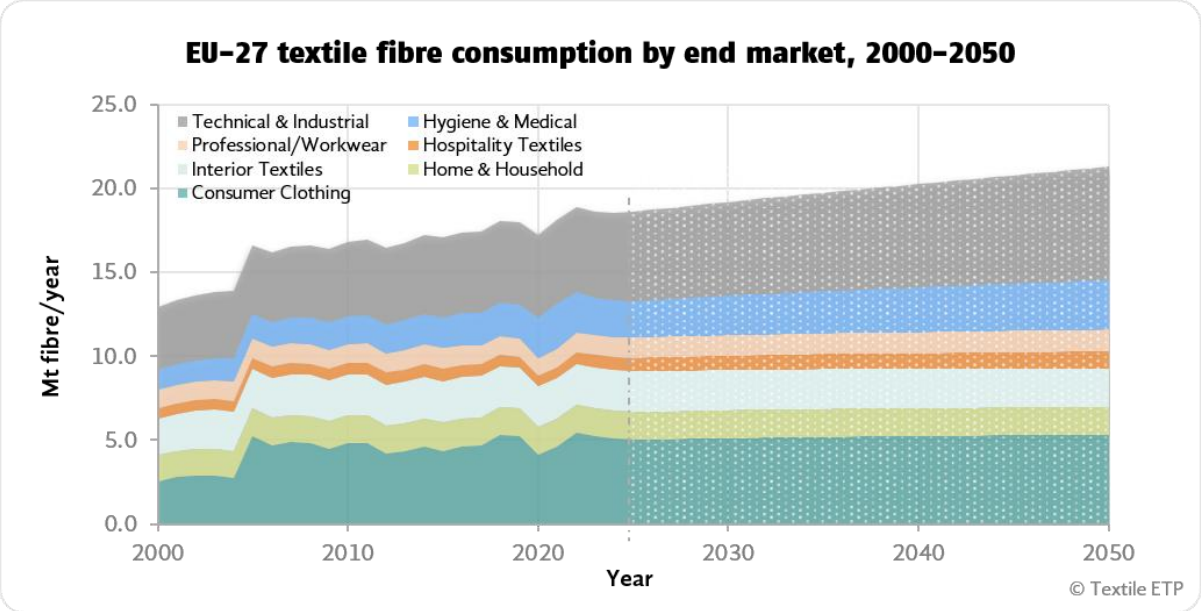


Figure 5: EU-27 textile fibre consumption by end market, 2000-2050 (Mt)

Current biobased material intensity varies sharply by end-market, which determines where substitution effort is most urgent and where it is most immediately feasible. The model quantifies the fossil-synthetic content of every segment: technical and industrial textiles are more than 90% synthetic (4.9 Mt of fossil fibre), interior textiles (carpets, mattresses, upholstery, curtains) 71% (1.7 Mt), and professional and workwear 71% (0.9 Mt), while hospitality textiles (only 24% synthetic), home and household (37% synthetic) and consumer clothing (44% synthetic) retain a substantial natural-fibre and man-made cellulosic share. In volume terms the largest defossilisation opportunities therefore lie precisely in the heavily synthetic technical, interior and workwear/PPE segments (together almost 7.5 Mt of fossil fibre), although realising this potential may take longer due to high functional performance that materials are required to meet in these markets, which make biosynthetics or chemical recycling the only renewable route. In consumer clothing and home textiles, where especially polyester is often used partially for economic reason, changed economic incentives or regulatory environment may offer a faster track to scale biobased and natural fibres.

Crucially, the biobased opportunity is not predicated on overall market volume growth. The model projects total EU consumption rising only modestly, from 18.6 Mt in 2025 to about 19.7 Mt in 2035 and 21.3 Mt in 2050, almost flat in per-capita terms. The pockets of growth are concentrated in professional and technical markets: hygiene and medical textiles as the population ages, and hospitality textiles as the tourism and services economy expands. Under the **Business as Usual** scenario the overall material mix drifts further towards synthetics with the biobased share falling from 37.3% today to about 30% by 2050.

However, a combination of market-driven innovation, a smart regulatory framework and demand-side policy intervention that both incentivise biobased and circular materials can reverse that drift. Such drivers are explicitly assumed for the **Circular Biobased** or **Aggressive Bioeconomy** scenario to play out and to lead a significant rebound of the total share of biobased or otherwise renewable fibre share in the total EU consumption mix as of the early 2030's.

For a mature market, competitiveness must be decoupled from volume: value will come from higher-margin, better and more sustainable products rather than from more of them. **This reframes the biobased transition as a value-creation and resilience strategy rather than a response to growth, fully consistent with the EU Bioeconomy Strategy's emphasis on higher value retention and regionally rooted supply chains for biobased textile fibres.**

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The Biobased Textile Transition

The Technology Enablers

Biobased materials and technologies have broad application potential across the textile value chain, and many have reached (or are rapidly approaching) the maturity threshold for industrial deployment. This chapter maps the enabling technology families that will drive the transformation set out in the 2050 vision, focusing on what each technology is and how ready it is to scale. The concrete innovation priorities and deployment actions for each are developed in the Five Core Building Blocks chapter that follows.



Synthetic Biology, Precision Fermentation and Enzymatic Engineering

Synthetic biology is turning microorganisms into 'cell factories' that produce specific monomers, polymers, structural proteins, enzymes and dyes during fermentation, from bio-monomers for synthetics to recombinant protein fibres analogous to spider silk and collagen, and marine-biodegradable polyhydroxyalkanoates (PHAs). Enzymatic engineering, in parallel, is unlocking two of the industry's most intractable problems: the selective separation and recycling of blended fabrics, and the bio-depolymerisation of post-consumer PET into reusable monomers at lower temperature and energy than chemical recycling. Readiness is advancing quickly from high-throughput discovery platforms towards commercial pilots, with impact spanning fibres, colourants and recycling.



Next-Generation Cellulosic Fibre Spinning

Lyocell and ionic-liquid based spinning offer a fundamentally cleaner alternative to legacy viscose chemistry, producing high-tenacity cellulosic fibres in closed-loop solvent systems with substantially reduced hazardous-chemical use. Critically, they accept a far broader range of dissolving pulps (including those derived from agricultural residues and post-consumer cellulosic textile waste) which turns cellulosic recycling into a genuine feedstock stream. Several next-generation processes are already at the demo-to-industrial threshold, with European producers among the global leaders, giving this route high near-term impact reaching beyond apparel into home, hygiene and technical applications.

Biorefineries: Lignocellulosic, Waste-Based and Carbon Capture Pathways

Biorefineries are the industrial engines that convert biomass into the chemical and material building blocks the fibre industry needs. A key design principle for next-generation plants is to move beyond the carbon-and-hydrogen logic of petrochemistry and instead manage carbon, hydrogen and oxygen together: biomass already contains oxygen and useful chemical functionality, which can be preserved and selectively transformed rather than stripped away to recreate fossil-like intermediates (for example converting sugars into the oxygen-bearing monomer FDCA and onward to polyesters such as PEF) improving carbon efficiency and cutting energy and hydrogen requirements. Carbon capture and utilisation is an emerging complement, converting captured industrial CO_2, combined where useful with renewable hydrogen, into ethanol, methanol and downstream monomers as a non-land-based feedstock option. Lignocellulosic biorefining to textile-grade building blocks is already an industrial reality in Europe, through both dedicated routes to novel biobased chemicals and drop-in routes that blend biomass into existing petro-chemical assets.

Bio-Coatings, Bio-Dyes and Enzymatic Functionalisation

Functionalisation (coatings, dyes, finishes, flame retardants and water- and oil-repellents) is one of the most chemically intensive stages of the value chain, and therefore one of the highest-impact targets for biobased substitution, directly advancing the regulatory agenda by displacing PFAS and other hazardous substances. Emerging routes include fully biobased and durable, wash-resistant coatings, PFAS-free repellents at performance parity, bio-dyes with high light- and wash-fastness, and biobased flame retardants, antioxidants and UV stabilisers for technical textiles. Industrial-scale enzymatic finishing (biocatalysis) is among the most promising near-term opportunities, cutting energy and water use, and builds on already-mature processes such as enzymatic desizing and bio-stoning.

Improved Natural Fibre Agronomy and Primary Processing

For natural fibres the technology agenda is less about biotechnology and more about consistent, modern primary processing combined with improved agronomy and breeding: upgraded scutching, decortication and hackling for bast fibres, precision and regenerative farming, breeding of textile-grade crops, climate-resilient varieties (including EU cotton for water-stressed Southern regions) and regional wool collection, sorting, scouring and processing chains. The decisive lever is industrialising and standardising these well-understood steps rather than deploying exotic biotechnology, and European actors are already demonstrating each of them at regional scale.

Digital Infrastructure for Bio-Traceability and Bio-Content Claims

Biobased credentials are only as valuable as they are verifiable. The Digital Product Passport (DPP) and its supporting infrastructure (digital identifiers and certificates, sectoral data spaces and physical-digital tracers such as DNA markers, isotope signatures and luminescent pigments) provide the trust system that makes bio-content claims credible and tradable. The same data infrastructure underpins the mass-balance accounting needed to introduce biobased and recycled feedstocks before they reach commodity scale, while AI-driven biomass mapping and industrial-symbiosis platforms help match feedstock availability, seasonality, quality and footprint to demand. Elements of this trust infrastructure (including field-to-product traceability with embedded, database-ready environmental data) are already operating in Europe today.

Key Challenges and Barriers

While biobased technologies for textiles are increasingly mature, the European industry faces structural, financial, regulatory and cultural barriers that could prevent or severely delay their adoption. The following cross-cutting barriers (distinct from the technology-specific priorities set out in the Building Blocks chapter) deserve particular attention.

The Green Premium and the Competitive Pressure of Low-Cost Imports

Biobased fibres and chemicals typically carry a significant cost premium over fossil incumbents: biobased polyamide can cost 20-60% more than virgin nylon, novel polymers such as PLA even more, and next-generation cellulosics carry high, CAPEX-driven scale-up costs against fully depreciated conventional assets. This is amplified by direct competition from low-cost imported fibres and textiles made in integrated Asian clusters with structurally lower labour, energy and capital costs (the single biggest obstacle for biobased alternatives) and the premium persists even though raw material is only a small share of final product cost, as mark-ups cascade through disintegrated supply chains all the way to the consumer. Without mechanisms that internalise these externalities, decisive action against clear dumping, and demand-side measures such as preferred-material quotas, green public procurement, drop-in adoption and closer supply-chain integration, biobased alternatives will remain confined to niches and low-percentage blends.

Scaling Biological Production Systems and Securing Feedstock Supply

Scaling biological production systems (from precision and regenerative farming to advanced fermentation, bast-fibre processing and lignocellulosic biorefining) is a top constraint, compounded by variable regional feedstock quality and volatile prices. Apart from wood-based biomass for cellulosics, most biobased feedstocks are potentially available at scale but still lack textile-focused supply chains: flax and, increasingly, hemp in North-West Europe, EU cotton in Northern Greece and Southern Spain, and viable wool clips in the UK, Ireland and the Nordic countries, though often directed to non-textile uses. Building competitive, textile-grade feed-stock supply (through both domestic production and open strategic trade partnerships) is a decisive determinant of cost-competitiveness and a fundamental supply-side bottleneck unless deliberately addressed.

Fragmented, Sub-Scale European Supply Chains

European natural-fibre and bio-textile supply chains are typically fragmented, small-scale and undercapitalised, and Europe's midstream processing capacity is actively eroding: spinning, weaving and dyeing mills are closing under high energy and labour costs, wool scouring and sorting infrastructure is disappearing, and European chemical capacity has contracted, so that European fibre increasingly leaves the Union and returns as finished goods. Coarser biobased fibres such as bast can also be hard to run on installed equipment, so the transition must budget for retrofitting or replacing assets, not only for fibre. The most promising path runs through deliberate cross-sector value-chain integration and industrial symbiosis, and through regional bio-manufacturing hubs, rather than within-sector consolidation alone.

The Capital Intensity and 'Valley of Death' in Financing

Bio-textile innovations face a notorious 'valley of death' when moving from pilot to commercial scale: a commercial biorefinery, fermentation facility or next-generation cellulosic line requires hundreds of millions of euros of capital expenditure, and venture capital, with its software-like return expectations, is ill-suited to the hardware risks of industrial biotechnology. Long-term off-take agreements between brands and bio-fibre producers have emerged as one of the most powerful tools to unlock project finance, but they remain too rare in Europe.

Insufficient Demand-Side Pull

Even where biobased capacity is technically feasible, the European market often lacks the structured demand needed to justify investment: green public procurement, dedicated retail and e-commerce channels for verified biobased collections, and uptake by technical end-markets remain weak, while consumer-facing labelling suffers from credibility gaps. Demand (not technology) is now widely seen as the binding constraint on scaling: the routes and products already exist, but without market-pull through mandatory bio-content, procurement and off-take they cannot reach cost-competitive volumes. Trusted labelling, bio-content attributes embedded in the Digital Product Passport, and procurement that sets a demand floor are the most direct levers available.

Capital, Skills and SME Accessibility Gaps

EU innovation frameworks and funding mechanisms tend to favour large fibre producers, even though most textile innovation occurs at SME level; funding, cascade and brokerage mechanisms flow upward rather than reaching SMEs, and simplified, SME-accessible instruments are urgently needed. In parallel, dedicated skills profiles (university degrees and continuing professional development for biobased textile science, engineering, design and production) are largely absent, and the resulting skills gap risks leaving the next generation of professionals unprepared for the biobased transition.

Regulatory Bottlenecks for Industrial Biotechnology

Despite the tailwind from the EU Bioeconomy Strategy and the ESPR, deploying industrial bio-technology (fermentation facilities, GMO-based bioprocesses, and the use of waste streams as feedstock) continues to encounter authorisation bottlenecks. The frameworks that determine when an agricultural, forestry or post-consumer stream ceases to be 'waste' and becomes a tradeable bio-feedstock are especially critical, and the Biotech Acts and end-of-waste rules must be implemented with industrial deployment, not just laboratory innovation, in mind.

Performance, Functionality and Durability Gaps of Biobased Alternatives

Several barriers are, at root, performance challenges that decide whether biobased options can actually displace incumbents: the durability and industrial-wash resistance of biobased finishes and coatings against PFAS-based incumbents, the colour depth and light- and wash-fastness of bio-dyes, inks and pigments, and long-term durability uncertainty for some biobased fibres. Until performance parity is demonstrated and certified at industrial scale, buyers in demanding and regulated end-markets will keep defaulting to fossil-based materials regardless of the sustainability case.

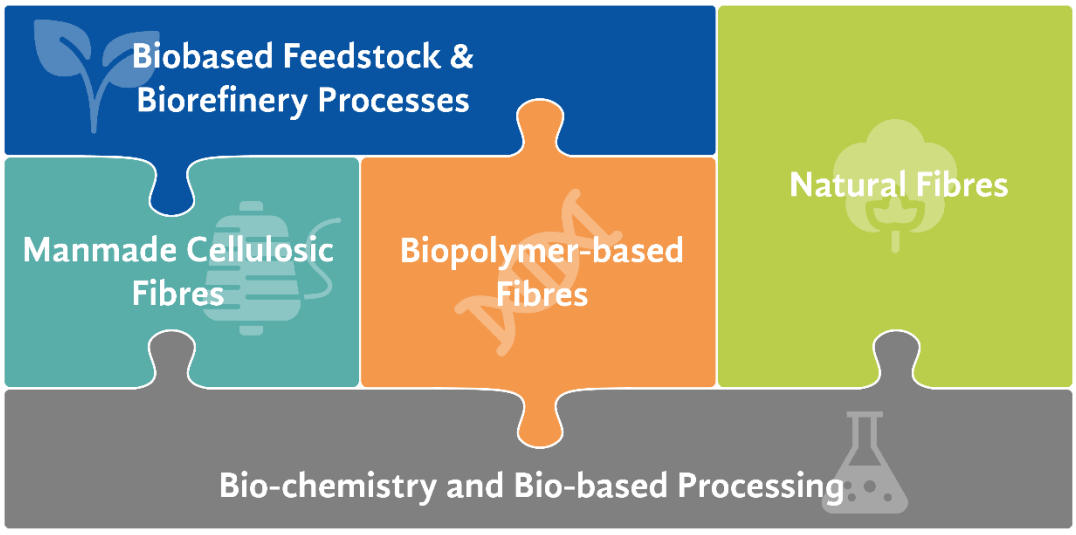
Footprint Methodologies and Standards that Disadvantage Biobased and Natural Materials

A cross-cutting barrier is that the way sustainability is currently measured works against biobased and natural materials: life-cycle and Product Environmental Footprint methods can rate a polyester garment as more sustainable than a wool one because they discount end-of-life, microplastic release and how the fibre is farmed, and today's rules effectively give no bonus for biobased content, only for recycled. Fair treatment of biogenic carbon and of mass balance in life-cycle accounting, representative reference data for European natural fibres in the main databases, and fit-for-purpose European standards and certification (including schemes suited to Europe's small-flock wool breeds and per-garment verification linking batch certifications to Digital Product Passport declarations) are prerequisites for credible bio-content claims, and therefore for demand.


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The 5 Core Building Blocks

This chapter translates the vision and the technology landscape into concrete, actionable innovation priorities across the five strategic building blocks: Biobased Feedstock & Biorefinery Processes; Sustainable Manmade Cellulosic Fibres; Biosynthetics and Novel Biopolymer Fibres; Sustainably Sourced and Functionally Improved Natural Fibres; and Biochemistry and Biobased Processing. For each priority within each building block, we describe what it is, the pain points it addresses, its current maturity, what must happen to achieve rapid industrial adoption, the key performance indicators that will measure progress, and a lighthouse project idea that could anchor pre-competitive collaboration.



Building Block 1:
Biobased Feedstock & Biorefinery Processes

The Opportunity: feedstock & biorefinery

The feedstock and bio-refining layer underpins the entire biobased textiles supply chain build-out: at the blended 2050 target it supplies the ~13.8 Mt of biobased and recycled material that displaces virgin fossil fibre (of which about 5.9 Mt is realistically EU or neighbourhood in origin) representing an estimated €20 billion a year of EU fibre- and processing-stage value and roughly three times that across the downstream chain.

Although the primary focus of this Strategy is the textile, apparel and fibres industry, the bio-textile value chain ultimately rests on an upstream foundation that lies largely outside the textile sector itself: the supply of diversified sustainable biobased feedstocks, and the biorefining capacity to convert them into textile-grade intermediates. Building out this supply chain is the single most binding constraint on the European bio-textile transition. On the other hand, it was also ranked as the single highest opportunity from an adoption of industrial symbiosis and circular value chains systems.

This Building Block, in addition to the agricultural part of the natural fibre system represents the upstream part of the Biobased Textiles Strategy, in alignment with the EU Bioeconomy Strategy's pillars on scaling innovation, ensuring sustainable biomass supply across value chains, and building integrated lead markets.

Diversified Biobased Feedstock Supply

What is needed	A diversified portfolio of textile-relevant feedstocks: certified forestry biomass, agricultural feedstock crops or residues, post-consumer biobased textile waste, marine and aquatic biomass, microbial fermentation inputs and (further into the future) captured industrial CO_2-supplied to the fibre and textile processing industry at predictable quality, volume and cost through regional aggregation, pre-treatment and digital tracking infrastructure.
Pain points	Scaling biological production systems is the top feedstock challenge, followed by feedstock quality and supply variability and high or volatile prices. The Capacity Audit identified renewable bio-mass supply for alternative feedstocks as the area with the highest 'weak but potential to improve' consensus across the entire audit. Strategic land-use planning and digital biomass tracking must be considered to avoid undesirable food competition and adequate traceability for authentication and environmental footprint.
Current maturity	Mixed. Forestry biomass and certified pulp supply chains are mature; agricultural feedstocks or residues are mostly explored for other end markets such as packaging or composites; marine and aquatic biomass and microbial fermentation feedstocks are at pilot to early industrial scale; CO_2-based feedstock pathways are at demonstration.
What needs to happen	• Co-fund regional biomass aggregation and pre-treatment networks integrating agricultural and forestry residues, and post-consumer textile waste, anchored in biomass-rich regions and/or regions with existing textile processing capacities. • Build digital biomass tracking platforms covering availability, seasonality, quality and carbon footprint, integrated with the EU bio-feedstock data infrastructure and the DPP.

	• Develop strategic land-use frameworks that balance food, feed, fibre, bioenergy and biodiversity, consistent with the EU Bioeconomy Strategy.
Key performance indicators	Volume of textile-grade biomass aggregated through regional networks (kt/year). Share of textile feedstocks meeting verified sustainability and traceability standards. Number of EU regions with operational digital biomass tracking infrastructure.

Integrated and Decentralised Biorefineries Anchored in Textile Value Chains

What is needed	A network of integrated lignocellulosic biorefineries (co-located with pulp, paper or chemical clusters) combined with decentralised regional mini-refineries closer to biomass sources, converting agricultural feedstocks or residues, forestry biomass, post-consumer textile waste and captured carbon into the dissolving pulps, sugars, bio-monomers, lignin derivatives and bio-chemicals that the textile fibre and processing industries require
Pain points	Pre-treatment and conversion difficulties are the top biorefinery challenge, followed by integration into existing textile value chains and the lack of decentralised mini-refineries for textile-grade feedstock. Logistics and supply chain complexity and regulatory bottlenecks for industrial biotechnology and GMO processes further constrain deployment.
Current maturity	Demo to early industrial. Integrated lignocellulosic biorefineries operate in Europe, largely outside textile applications; textile-anchored biorefining is sub-scale; decentralised mini-refineries for textile-grade feedstocks are largely absent; lignin valorisation is at pilot stage.
What needs to happen	• Co-fund a network of integrated lignocellulosic biorefineries explicitly anchored inside textile clusters, with dedicated textile-grade output streams (dissolving pulp, bio-monomers, lignin derivatives). • Build decentralised mini-refineries close to agricultural feedstock/residue production regions, sized for SME-accessible volumes. • Use the Biotech Acts to streamline authorisation for industrial fermentation, biocatalysis and GMO-based bioprocesses, alongside end-of-waste frameworks enabling textile waste streams to be used as bio-feedstocks. • Establish lignin valorisation as a strategic feedstock stream rather than a residual question.
Key performance indicators	Number of operational textile-anchored/textile-oriented biorefineries and local mini-refineries in the EU. Share of textile-grade intermediates sourced from EU biorefineries. Industrial-symbiosis volumes exchanged between agriculture, forestry, food, waste management and textile sectors (t/year).

Success case

Glaukos: Innovative Fishing Gear and Textile Prototyping

The Glaukos project addressed ocean pollution by developing biobased, recyclable alternatives for traditional fishing nets and clothing that she d microplastics and permanently damage marine ecosystems. Their mission was to redesign these textiles from the molecular level up, ensuring they degrade safely or enter a complete circular recycling loop. A major mi lestone in validating this technology was their new prototypes: clothing and fishing gear.

Glaukos
Circular solution for the textile industry

For the clothing prototype (socks) a yarn (48 filaments) was produced with a fineness of 202-210 dtex, a tenacity of 12-18 cN/tex and an elongation of 67-115%. In order to give the yarn and the final prototype a nice touch, the manufactured yarn was subjected to the false-twist texturing process. The texturized yarn was further processed using a round knitting machine, as this made it possible to produce a small, flawless knitted fabric in the form of a sock.

For the fishing gear prototype, a novel biobased polymer was melt-spun into 1,800 dtex yarn, reaching a tenacity of almost 40 cN/tex, double that of the polymer used for the project's clothing prototype. Braided into rope, it matched polyamide 6 on linear strength and clearly outperformed it on knot efficiency, the property that governs how netting behaves in u se. After a prototype net was produced by hand in a mesh size common to trawl cod-ends and heat-set on a netting stretching line, closing the loop from biorefinery output to finished gear.





Through rigorous research and innovation, the project has developed new biopolymers that offer improved biodegradability without compromising on performance. This breakthrough is crucial for both fashion and fishing industries, where the environmental impact of materials has been a longstanding concern.

The Glaukos project received funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 887711.

Learn more:
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Building Block 2:
Sustainable Manmade Cellulosic Fibres

The Opportunity: a diverse supply of differentiated man-made cellulosic fibres

MMCF reaches about 2.4 Mt in the **Circular Biobased** scenario and up to 3.3 Mt in the **Aggressive Bioeconomy** scenario. At an EU-origin share of about 40%, conceding that capacity expansion may locate nearer the Asian manufacturing base even where the innovation is EU-driven, roughly 1.0 Mt is EU-made, an estimated €2.9 billion a year of EU fibre-stage value, building on Europe's existing strength in cellulosic fibre production.

Man-made cellulosic fibres (MMCF) (viscose, modal, lyocell and emerging next-generation cellulosic platforms) have substantial potential to scale and substitute fossil-based synthetics across clothing, home, hygiene and technical textile applications, all markets in which MMCF are already in widespread use today. Europe combines abundant sustainably managed forestry feedstock, additional cellulosic biomass from agricultural residues and post-consumer textile waste, and a global leadership position among MMCF producers. Hence further scaling of a diversified MMCF production system is assessed as one of the most strategic and actionable bio-fibre opportunities for Europe, with the scale-up costs of next-generation processes the dominant challenge and the energy intensity, especially of solvent recovery, and the cost competition with conventional viscose from non-European production as a further complicating factors.

Demand signals point to potential for fossil fibre substitution in nonwovens. EDANA, the European nonwovens association, ranks man-made cellulosics its most relevant biobased route, ahead of biosynthetics, and rates biobased innovation a 'relevant and core' priority for single-use nonwovens and 'relevant' for durable nonwovens. It sees biobased nonwoven solutions as increasing across most end-markets (notably wipes, absorbent hygiene products, medical and protective textiles, agriculture and packaging, and construction, insulation and geosynthetics) driven by market demand, company sustainability strategy and new product functionality.

MMCF's also have potential in the home, household and hospitality markets where it can either replace polyester as durability provider in cotton-polyester blends or provide more softness and better moisture management in polyester-heavy materials such as duvets, pillow filling or curtains. High-tenacity viscose filament has traditionally been used in tyre cord due to its excellent dimensional stability at high temperatures. Now also high-tenacity lyocell is industrialised, allowing a broader range of technical end markets to be addressed, such as hoses, conveyor belts or composites.

Next-Generation MMCF, including Lyocell and Ionic-Liquid Spinning

What is it?	A coordinated transition from legacy viscose chemistry to next-generation closed-loop cellulosic spinning processes (including industrial Lyocell, ionic-liquid-based systems and emerging alternative spinning platforms) with progressively diversified pulp feedstocks and lowered overall processing chemicals load.
Pain points	Scale-up costs for next-generation cellulosic fibre processes are the main challenge, especially in the face of fierce price competition with materials produced in conventional processes. The Capacity Audit identified ionic liquid or next-gen Lyocell spinning for high-tenacity cellulosic fibres as currently weak but with potential to improve.

Current maturity	Demo-to-industrial. Several European producers operate Lyocell at industrial scale; ionic liquid and other next-generation platforms are at demo or early commercial deployment.
What needs to happen	• Co-fund 3-5 next-generation MMCF industrial demonstration plants in Europe by 2030, with priority for installations co-located with existing pulp or chemical clusters and integrated solvent recovery. • Establish or extend open access pilot-to-industrial scale-up facilities for next-generation cellulosic processes that SMEs and start-ups can use without building dedicated infrastructure. • Incentivise research and development work targeting functional property improvement of next-generation cellulosic fibres for end market diversification in areas such as home and interior, technical, hygiene and medical textiles and nonwovens. • Disincentivise use of materials originating from legacy viscose processes, especially those where closed-loop process chemistry recovery and state-of-the-art effluent treatment isn't ensured.
Key performance indicators	Share of European MMCF consumption produced through closed-loop, low-hazard next-generation processes (target: 50% by 2035, 100% by 2050). Energy consumption per kilogram of next-generation cellulosic fibre relative to 2025 baseline.

Feedstock Diversification for Cellulosic Pulp

What is it?	Progressive diversification of MMCF feedstocks from primarily certified wood pulp to include agricultural residues such as straw, miscanthus, switchgrass, EU bast fibre by-products and post-consumer cellulosic textile waste.
Pain points	Continued reliance on a relatively narrow wood pulp base creates competition for biomass between bioenergy, pulp and paper, biobased chemicals and textiles. Inadequate functional proper-ties to replace synthetics (or cotton) and fierce cost competition between conventional and sustainable cellulosics are reinforced when the feedstock base is narrow.
Current maturity	Pilot to early industrial. Several producers have demonstrated textile-to-textile cellulosic recycling at pilot or first commercial scale. Agricultural-residue dissolving pulp is at pilot stage.
What needs to happen	• Fund 2-3 European integrated biorefineries demonstrating dissolving-pulp production from agricultural residues at industrial scale by 2030. • Scale dedicated cellulosic textile-to-textile recycling capacity in Europe with binding offtake agreements from EU MMCF producers and brands. • Build digital tracking infrastructure for feedstock availability, seasonality, quality and carbon footprint, integrated with the EU bio-feedstock data platform proposed in the Recommendations chapter.
Key performance indicators	Share of EU MMCF dissolving pulp sourced from agricultural residues, post-consumer cellulosics or other non-wood feedstocks (target: 15% by 2035, 40% by 2035). Volume of post-consumer cellulosic textile waste recycled into MMCF feedstock in Europe (kt/year).

Success case

TreeToTextile

Swedish-based TreeToTextile is driving systemic change in the textile industry, by providing the next-generation cellulose fibres. The patented fibre technology illustrates a shift from incremental sustainability improvements toward sustainability by design. Rather than adapting an existing fibre production route, TreeToTextile has developed a new MMCF process in which life-cycle performance, resource efficiency, and chemical circularity are embedded from the outset.

The process dissolves wood-based dissolving pulp in a cold alkaline solution (sodium hydroxide and low amounts of zinc oxide in water), into a cellulose solution, a spin dope, which is then wet-spun in an alkaline spin bath into a tow of filaments. After washing, the filaments are cut into staple fibres and are ready for use in yarn spinning and nonwoven processes. The process includes chemical recovery, enabling the water and chemicals used in the production to be recycled. It differs from conventional man-made cellulosic fibres such as viscose and lyocell in its processing route, unique fibre characteristics and environmental footprint.





The output is a fibre with low CO_2 emissions; <1 kg CO_2 equivalents/kg fibre cradle to factory gate, based on LCA report (2020), 3rd party verified (2021), built on pilot plant data simulated to full scale production of staple fibres, using Swedish energy mix and steam from biomass, including pulp produced in Scandinavia, thereby contributing to reducing CO_2 emissions in the textile industry.

In 2022, TreeToTextile received a grant for the EU LIFE TreeTex project, demonstrating an allalkaline production process for innovative cellulose fibres for textile applications. TreeToTextile has a demonstration plant in Nymölla, a R&D center in Mölndal, and is headquartered in Stockholm, Sweden.

Samples produced for apparel and home textile applications show a cotton-like hand-feel, low pilling, and excellent dye uptake, combining performance attributes valued by end consumers and brands alike. Depending on the application, the fibre can serve as an alternative or complimentary material to cotton, viscose, and polyester in textiles and nonwovens.

With the Lenzing Group as majority owner and supported by the other shareholders H&M Group, Inter IKEA Group, Stora Enso, and LSCS Invest, TreeToTextile develops and commercializes the fibre and will make it available on the global market as a fibre producer. A first commercial-scale plant is envisioned somewhere in Europe in the coming years.

Learn more:
Website: www.treetotextile.com
Social Media: www.linkedin.com/treetotextile

Low-impact Water, Energy and Chemical Management

What is it?	Industry-wide deployment of closed-loop water, solvent, energy and chemical management systems across MMCF production, ensuring that next-generation processes deliver the sustainability profile that the regulatory framework demands.
Pain points	Energy intensity of solvent recovery and the continued use of hazardous chemistry in traditional viscose are among the most binding constraints on MMCF sustainability claims and competitiveness.
Current maturity	Established for Lyocell; partial for other processes. Industrial best practice exists; the challenge is generalised deployment across the European (and global) producer base and across emerging feedstock pathways.
What needs to happen	• Develop and adopt sector-specific BAT (Best Available Techniques) reference documents for closed-loop MMCF production under the Industrial Emissions Directive framework. • Mandate disclosure of closed-loop performance metrics (solvent recovery rate, water consumption per kg of fibre, energy intensity, hazardous chemical inventory) of MMCF for sustainability claims/legal incentives.
Key performance indicators	Average solvent recovery rate across European MMCF facilities (target: > 99% by 2030). Water and energy consumption per kilogram of fibre relative to 2025 baseline (target: -40% by 2035).

Success case

Next-generation multifunctional nonwoven: Integrating lignin for sustainable high-performance textiles

Global textile production has risen dramatically, from 58 million tons in 2000 to 132 million tons in 2024 and is expected to reach 169 million tons by 2030. Today, petro-based synthetics fibres and cotton dominate the market with an 88% share, while regenerated cellulosic fibres account for about 6%.

Centre for Nanotechnology and Advanced Materials

Driven by the need for greener materials, industry and researchers are developing biobased textiles from renewable or recycled sources. Lignin, a multifunctional biopolymer, has gained attention for its UV-blocking, flame-retardant, hydrophobic, antioxidant, and antibacterial potential. Kraft lignin (KL), a major by-product of the kraft pulping process, is mostly used for energy production, despite its significant untapped potential for valorisation as a functional product within the emerging biorefinery concept. A cellulose-lignin blended fibre was created by incorporating 10% KL directly into the Lyocell spinning dope, producing doped filaments without further finishing. The needle-punched nonwoven produced with those fibres showed a strong increase in water repellence (contact angle ~120°), excellent UV protection (UPF > 50), enhanced photothermal performance with surface temperatures ~10 °C higher under irradiation, and 99% antibacterial efficacy against S. aureus.

This innovative product demonstrates that lignin can be directly integrated into Lyocell fibres to deliver hydrophobic, UV-protective, photothermal, and antibacterial functionalities, enabling high-performance and sustainable technical textiles for protective and advanced applications.





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Learn more:
Website: www.centi.pt
Social Media: https://www.linkedin.com/company/centi-centre-for-nanotechnology-and-smart-materials/
Project's website: www.bioeconomy-at-textiles.com

Building Block 3:
Biosynthetics and Novel Biopolymer Fibres

The Opportunity: biosynthetics

Biobased synthetics reach about 1.3 Mt in the **Circular Biobased** scenario and up to 2.0 Mt in the **Aggressive Bioeconomy** scenario. At a 40% EU-origin share, about 0.5 Mt is EU-made, an estimated €1.9 billion a year of EU fibre-stage value, and the key biobased gap-filler for the heavily synthetic technical and interior textile segments that today account for 5.8 Mt of fossil fibre.

Replacing fossil-based feedstocks with biobased ones for conventional synthetic fibres (polyester, polyamide, polyacrylic, elastane, polypropylene), and developing novel biopolymer fibres for niche applications, has the double advantage of substituting renewable resources while maintaining the fibre processing and functional properties that the industry and end users already understand. The dominant challenges are the cost differential of biosynthetics versus fossil-based conventionals, high capital investment needs for scaling fully biobased industrial production, and the lack of biobased feedstock supply, particularly for bio-PTA. In addition to the functional equivalence of biobased and fossil synthetics, the reuse of existing processing capacity, and the ability to flex price points through variable drop-ins and mass-balance accounting alleviate the cost and investment challenges significantly.

Drop-in Bio-Polyester (Bio-MEG, Bio-PTA and Bio-PEF)

What is it?	Scale-up of biobased polyester production through bio-MEG (already commercially mature), bio-PTA (the strategic bottleneck for fully biobased PET), and PEF (a fully biobased polyester based on furandicarboxylic acid (FDCA)) as an emerging high-performance alternative.
Pain points	Replacing currently used / conventional PET in fashion, home textiles and technical textiles was the single most cited biobased materials opportunity across all market segments in the Circular & Biobased Textiles Innovation Hub's expert co-creation session. The Capacity Audit confirms volume production of biobased PET, as currently weak but with potential to improve.
Current maturity	Bio-MEG: industrial. Bio-PTA: pilot to demo, with major scale-up announcements but no large industrial European producer yet. PEF: demonstration, with first commercial-scale facilities under construction.
What needs to happen	• Provide dedicated EU project finance for 2-3 first commercial/pre-industrial scale bio-PTA and PEF facilities by 2030, leveraging Innovation Fund, EIB and Member State co-financing. • Secure long-term off-take agreements between European brands, OEMs and bio-polyester producers to underpin financing of new capacity with a focus on polyester-heavy market segments such as functional apparel, interior and technical textiles. • Integrate bio-polyester intermediates into European lignocellulosic biorefinery roadmaps to anchor production close to feedstock and reduce import dependency.
Key performance indicators	Share of EU polyester fibre demand met by biobased PET or PEF (target: 10% by 2030, 25% by 2035, 50% by 2050). Number of operational industrial-scale bio-PTA / PEF facilities in Europe.

Success case

UPM BioPolyester: 100% wood-based polyester for next-generation textiles

Polyester is the world's most widely used textile fibre, yet it remains heavily dependent on fossil resources. UPM BioPolyester demonstrates how renewable carbon can be integrated into existing polyester value chains to produce 100% wood-based polyester without compromising performance, quality or scalability.

The solution combines BioMEG from sustainably sourced hardwood produced at UPM's biorefinery in Leuna, Germany, and renewable naphtha derived from pulp production residues at UPM's biorefinery in Lappeenranta, Finland, enabling terephthalic acid production from renewable carbon. Together, these feedstocks enable polyester made entirely from wood-based carbon.

What makes UPM BioPolyester unique is its integrated European value chain, connecting sustainably managed forests, advanced biorefining, chemical production and textile manufacturing. The material is fully compatible with existing polyester infrastructure, enabling industrial deployment without major process changes.





By reducing fossil dependency and lowering lifecycle emissions, UPM BioPolyester demonstrates how the bioeconomy can deliver high-performance materials while strengthening European competitiveness, resilience and circularity.

"UPM BioPolyester demonstrates how renewable carbon can be transformed into high-performance polyester at industrial scale - without compromising quality, performance or manufacturability."

- Dominik Müller, UPM Next Generation Renewables

Learn more:
Website: www.upmbiochemicals.com
Social Media: www.linkedin.com/company/upm-next-generation-renewables

Bio-Polyamide, Bio-Elastane and Other Biobased Drop-ins

What is it?	Development and scaling of biobased polyamides (PA6, PA66, PA11, PA10.10), biobased elastane (combined with end-of-life recycling solutions), biobased polypropylene, polyacrylic and non-elastane polyurethane fibres for the wide range of clothing, home and technical textile applications they serve today.
Pain points	In additional to the cost challenges already highlighted for bio-polyester, these other biosynthetics must always prove their functional equivalence (or possibly superiority) to their conventional fossil-based counterparts. Especially long-term performance and durability uncertainty of biobased fibres are common challenges as are processing technology maturity gaps. Feedstock challenges include cost, seasonal availability and potential competition with food and feed requirements
Current maturity	Mixed. Castor-oil-based PA11 and PA10.10 are commercially mature in niche applications; biobased elastane and biobased PP are at pilot or early industrial stage; biobased polyacrylic is at research stage.
What needs to happen	• Fund pilot-to-industrial scale-up programmes for bio-PA66 from bio-adipic acid and bio-hexamethylenediamine, and for next-generation bio-elastane with improved end-of-life behaviour. • Develop a dedicated EU programme on biobased elastic materials for technical textiles (medical, sports, protective equipment), where the green premium is more easily absorbed. • Establish standardised performance and durability testing protocols for biobased drop-in fibres to address market uncertainty.
Key performance indicators	Number of biobased polyamide, elastane, PP and PU fibre products certified for use in major end-markets (apparel, automotive, medical). Share of EU PA fibre demand met by biobased polyamides (target: 15% by 2030).

Novel Biopolymer Fibres for Niche Applications (PLA, PHA, PEF, PBS, Protein-Based)

What is it?	Targeted development of novel biopolymer fibres: PLA, PHA, PBS, protein-based fibres (recombinant silk and collagen analogues), and other emerging biopolymers, for applications where their specific functional properties (controlled biodegradability, biocompatibility, marine-degradability, unique mechanical or thermal properties) justify higher unit costs.
Pain points	Novel biopolymer fibre commercialisation (PLA, PHA, PBS and protein-based fibres) was rated as 'weak' in the Capacity Audit. Medical applications which exploit specifically the biocompatibility with the human body is an attractive niche opportunity for biopolymer-based fibres, but development and market introduction timelines are particularly long and expected material volumes rather small. Biodegradable packaging, agro- and geotextiles and nonwovens provide a larger volume opportunity with lower regulatory hurdles, but much greater price-sensitivity.
Current maturity	Pilot to early industrial. PLA is established at commercial scale in a few selected nonwoven and home-textile applications; PBS is at early commercial scale. Recombinant protein fibres are at industrial demonstration and PHA at pilot scale.

What needs to happen	• Fund dedicated programmes for novel biopolymer fibre scaling in medical, agro/geotextile, technical nonwoven, packaging and high-value home-textile applications where their functional benefits justify the green premium. • Build pilot-to-industrial scale-up infrastructure for fermentation-based protein fibres (silk/collagen analogues) • Develop tailored end-of-life pathways (industrial composting, biodegradation in soil or marine environments) and regulatory clarity for compostability and biodegradability claims to prevent greenwashing.
Key performance indicators	Industrial-scale European capacity for PLA, PHA, PBS and protein-based fibres (kt/year). Share of agro/geotextile, medical nonwoven and PPE markets met by novel biopolymer fibres.

Success case

Fully biobased garments

Within the Horizon 2020 project HEREWEAR, Centexbel and project partners demonstrated that biobased materials can be successfully transformed into attractive and functional clothing.

The project focused on replacing conventional fossil-based polyester with innovative biopolyester solutions centred around polylactic acid (PLA), while maintaining the performance and comfort required for apparel applications.

To make PLA more suitable for clothing, extensive work was carried out on yarn development, including the use of biopolyester blends and textile processing strategies aimed at improving softness, comfort and wearability.

In addition, the project developed a novel PLA- and PHA-based printing ink to complement the biobased fabrics. This innovation ensured that the finished garments remained aligned with the HEREWEAR vision of biobased, local and circular textiles.

A key achievement was the development of fully biobased demonstrator garments, including a polo shirt and a women's shirt, validating the complete textile value chain. The resulting garments demonstrated that biobased alternatives can successfully combine sustainability, aesthetics and technical performance.

By producing and showcasing real garment prototypes, HEREWEAR provided tangible proof that Europe's bioeconomy can deliver innovative textile products with reduced dependence on fossil resources, helping pave the way for a more sustainable textile industry.





The HEREWEAR project has received funding from the European Union's Horizon 2020 research and innovation programme under the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101000632.

Learn more:
Website: www.centexbel.be/en
Project's website: www.herewear.eu

Building Block 4:
Sustainably Sourced and Functionally Improved Natural Fibres

The Opportunity: natural fibres

Biobased synthetics reach about 1.3 Mt in the **Circular Biobased** scenario and up to 2.0 Mt in the **Aggressive Bioeconomy** scenario. At a 40% EU-origin share, about 0.5 Mt is EU-made, an estimated €1.9 billion a year of EU fibre-stage value, and the key biobased gap-filler for the heavily synthetic technical and interior textile segments that today account for 5.8 Mt of fossil fibre.

Natural fibres (cotton, wool, flax, hemp, silk, nettle and others) used to dominate textile end-markets before the rise of fossil-based synthetics. While their growth has been constrained by economic, functional and environmental factors, they continue to play key roles in clothing, home textiles and in certain technical applications. Improvement in agricultural practices, primary processing and functionalisation along the value chain holds significant promise to re-expand the global market share of a wide range of natural fibres, many of which are available locally in Europe or can be sourced from strategically aligned producing regions. The dominant challenge is the competition with low-cost imported fibres and textiles, especially fossil synthetics-based ones.

Modernised EU Bast Fibre Value Chains (Flax, Hemp, Nettle)

What is it?	Coordinated modernisation of European bast fibre value chains (from agronomy and harvest through scutching, hackling and cottonisation) to deliver consistent textile-grade fibre at the volumes, quality and cost required by EU spinners, weavers, nonwoven and composite producers.
Pain points	Limited primary processing capacity and skills for bast fibres, fragmented and small-scale supply chains and lack of farmer knowledge and incentives for fibre crops, and growing exposure to climate variability affecting yields and fibre quality collectively cap the upside of EU bast fibre production. To avoid head-on cost competition with low-cost man-made fibres, European producers are positioning bast fibres as high-value technical and innovative solutions, backed by field-to-product traceability certifications and robust environmental data embedded in main LCA databases.
Current maturity	Mixed. Flax is a mature European value chain (Europe produces ~75% of global flax fibre) with strong upstream expertise in growing, harvesting and scutching, well-established in France, Belgium and the Netherlands. Strategic downstream refining (hackling and degumming for hemp) and spinning need to be strengthened, as these stages are dominated by Asia with a few remaining facilities in Europe. Hemp production and processing is rapidly emerging but still sub-scale; nettle is at pilot stage
What needs to happen	• Fund modernisation programmes for scutching and hackling for hemp, and equivalent upgrades for flax and nettle. • Support European hackling, degumming and spinning capacities to strengthen the complete flax and hemp textile value chains. • Support multi-use crop value chains (flax/hemp for seed + fibre + biorefinery feedstock) and the full valorisation of by-products (shives,

	short fibres, other plant fractions and dusts) to improve farm-level economics and de-risk farmer adoption. • Strengthen R&I on climate resilience, particularly varieties, seeds and agronomic solutions adapted to increasing climate variability • Grow beyond-textile technical applications for European flax and hemp fibres and by-products (composites, construction, insulation) to support greater European industrial sovereignty. • Build local-for-local short textile material supply chains combined with recyclinganchored in regional bio-manufacturing hubs. • Co-fund regional fibre demonstration and primary processing facilities accessible to SMEs.
Key performance indicators	Total EU-grown bast fibre production volumes (kt/year). Number of operational European bast fibre primary processing facilities. Share of EU clothing and home textile volumes containing EU-grown bast fibre. Growth of bast-fibre based composites market.

European Wool: Regional Collection, Sorting, Scouring and Upgrading

What is it?	Reconstruction of European wool collection, sorting, scouring and upgrading chains (currently fragmented and operating well below their potential) to convert under-utilised EU wool into a competitive natural fibre input for clothing, home textiles and technical applications.
Pain points	Lack of an EU wool collection and processing chain was specifically called out as a structural barrier. The Capacity Audit found that EU wool farming and processing capacity was heterogeneously rated, signalling both unevenness and unrealised potential. Wool is also potentially suffering from environmental concerns, especially in comparative LCA studies with man-made fibres where the complexity of land-use and aspects such as regenerative benefits from sustainable grazing and its environmental services is not sufficiently taken into account. Also? wool's treatment as waste under the EU Animal By-Products Regulation complicates its valorisation as a circular biobased resource. Finally, the lack of common technical standards for European wool types hampers processing and commercialisation.
Current maturity	Weak. Europe is home to some 60 million sheep producing around 180 million kg of wool a year, yet about half of it goes unused and is destroyed, most of the rest exported for processing to Asia. Several regional initiatives are emerging but lack scale, integration and supply chain pro-cessing capacities.
What needs to happen	• Positioning European wool as a premium, traceable, heritage material for fashion and interiors, complemented by technical uses (insulation, rugs, furniture, bedding) for coarser grades. • Establish at least 3 regional EU wool valorisation hubs by 2030, integrating collection, sorting, scouring and primary processing. • Co-fund pilot lines for upgrading short, coarse or contaminated wool into technical, insulating, nonwoven or composite applications. • Integrate EU wool into the broader regional bio-manufacturing hub strategy described in Building Block 1.
Key performance indicators	Share of EU raw wool processed into value-added textile products within the Union (target: 50% by 2035, 80% by 2050). Number of operational regional EU wool valorisation hubs.

Success case

Natural felting: European wool for high-performance technical nonwovens

Wool is the only textile fibre that bonds to itself. Textil Olius (Catalonia, Spain; wool nonwovens since 1946) has industrialised this property: raw wool becomes an engineered nonwoven through mechanical action, water and heat: no chemical binders, no synthetic carrier fibres, and none of the formaldehyde-releasing binder chemistry of bonded nonwovens.

Felting ability is the decisive selection criterion, and European wool meets it: over 80% of the wool in our technical range is EU-origin, valorising a fibre often treated as a low-value by-product of European sheep farming. Process parameters are tuned to each end use (density, thickness, resilience, surface finish) serving a long-established industrial market that spans mechanical engineering, sealing, acoustics, industrial machinery, composites and many further applications in over 40 countries. From that consolidated base, wool felt is now displacing fossil materials: replacing PU foam in padding and backing, and blended with other biobased fibres, replacing synthetic nonwovens in furniture.





Verified, not claimed: OEKO-TEX® STANDARD 100 Product Class I across the range, GRS-certified recycled-wool constructions, ISO 9001, and third-party verified EPDs (ISO 14025) for our interior design range.

The targeted impact: a shorter European supply chain for an under-used fibre, and a monomaterial, biobased alternative to fossil technical materials.

Learn more:
Website: www.textilolius.com
Social Media: www.linkedin.com/company/textil-olius

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European Cotton: Regenerative Agriculture, Resilience, Traceability & New Technology

What is it?	Embedding regenerative agricultural practices, biodiversity-positive farming, and resilient EU cotton production into the EU textile industry's regional feedstock base, supported by traceability, improved breeding for climate-adapted varieties and precision agronomy. Further explore greenhouse based hydroponic cotton growing concepts.
Pain points	Water challenges in EU cotton growing (Greece, Spain). Lack of value creation from traceable integration of EU-grown and Mediterranean rim cotton in European textile and apparel supply chains. Shrinking number of EU cotton spinners. Lack of knowledge of specific qualities of EU cotton. Challenging economics for greenhouse concepts due to high operating costs and competition with higher yield food crops.
Current maturity	Mixed. Regenerative agriculture is at early commercial deployment in cotton, often led by brand-driven programmes. Greenhouse-based cotton cultivation at pilot level. EU cotton breeding for climate resilience is at research stage.
What needs to happen	• Co-fund regenerative agriculture programmes for EU and partner-country cotton production, integrated with the new CAP framework. • Fund EU cotton breeding programmes targeting water efficiency, salt tolerance and disease resistance for southern European growing regions. • Develop credible certification, monitoring and DPP-linked claims for regenerative and biodiversity-positive EU cotton supply, also as basis for Green Public Procurement. • Develop viable business model for greenhouse cotton based on higher efficiency, yield and unique varieties.
Key performance indicators	Hectarage of EU cotton production under certified sustainable or regenerative agricultural practices. Volume/percentage of EU cotton production delivered to EU mills. Greenhouse cotton economics reaching profitability in select niche markets.

Success case

Locally produced alternative natural fibres from agricultural wastes and sustainable farming approaches

The development of alternative natural fibres and more sustainable production systems is essential to reduce the environmental footprint and resource dependency of the textile sector. CITEVE is investigating innovative approaches that combine fibre crop diversification, controlled cultivation systems and advanced fibre processing to support the development of locally produced textile raw materials.

citeve
TEXTILE TECHNOLOGY

Hemp is being studied as a promising sustainable alternative lignocellulosic fibre, with research addressing cultivation conditions, fibre extraction and processing, and the relationship between fibre characteristics and textile performance. The work enabled the selection of the best seeds, while exploring innovative biotechnological processes for hemp retting and implementing industrial scale spinning facilities in Portugal.

In parallel, CITEVE is exploring hydroponic cotton cultivation, investigating controlled growing conditions as an alternative to conventional soil-based production. This approach aims to optimise resource use while enabling greater control over plant growth and fibre development. The preliminary results show enhanced fibre quality, enabling the customisation of fibre properties.







By integrating agricultural innovation, biotechnology and textile engineering, these research activities contribute to the establishment of more resource-efficient and resilient regional fibre value chains. The work supports the transition towards locally sourced renewable materials while exploring new production models for sustainable natural fibres.

Learn more:
Website: www.citeve.pt
Social Media: www.linkedin.com/company/citeve and www.instagram.com/citeve

be@t project
Website: www.bioeconomy-at-textiles.com

Building Block 5:
Bio-Chemistry and Biobased Processing

The Opportunity: bio-chemistry & processing

Bio-dyes, bio-coatings and enzymatic/fermentation-based processing form a cross-cutting layer applied to the ~5.9 Mt of EU-origin biobased and recycled material at the blended 2050 target, an estimated €5.3 billion a year of EU processing-stage value, and the enabler of PFAS-free, verifiable bio-content across all fibre types.

By Textile manufacturing uses a wide range of chemical substances for preparation, dyeing, printing, finishing and functionalisation. Many organic inputs are wholly or partly derived from fossil feedstocks, while processing also relies on inorganic chemicals, including salts, acids, alkalis and oxidants. Some substances used in textile production have hazardous properties, and their manufacture, use and release can create risks for workers, consumers and the environment.

Biobased chemistry and biological processing offer complementary opportunities to reduce fossil-feedstock dependence, substitute hazardous substances and improve resource efficiency. These benefits are not automatic: renewable origin does not itself establish chemical safety, biodegradability or lower environmental impact. Alternatives should therefore be assessed against application-specific performance requirements and conventional baselines, considering the complete formulation and process, production costs, water and energy use, emissions, durability and end-of-life implications. Near-term opportunities include wider use of established enzymatic treatments, selected biobased colourants meeting defined fastness requirements, and biobased water-repellent finishes. More demanding functions, including durable oil repellence, require separate development and validation.

The European chemical industry, an upstream supplier of polymers, colourants and functional ingredients to textiles, also identifies the bioeconomy as an opportunity to strengthen competitiveness and resource security. In its published positions, Cefic advocates competitive access to sustainably sourced biomass, support for investment and scale-up, and measures to create demand for biomass-derived products. Its proposals include product-specific content requirements recognising both physically biobased and mass-balance-attributed inputs, alongside coherent implementation through relevant EU policy initiatives, including ESPR and Biotech Act II. These are broad industry recommendations rather than established requirements for textile products.

Deployment can involve new production routes and adaptation of existing industrial assets. Claims about renewable content and climate benefits should distinguish physical biobased content from mass-balance attribution and use transparent life-cycle accounting. Across the innovation areas, common priorities are credible performance validation, chemical safety, substantiated environmental benefits and access to the capabilities needed for commercial scale-up.

The following innovation areas describe three distinct technology and application opportunities (enzymatic textile processing and recycling; biobased functional coatings and finishes; and biobased dyes, pigments and textile inks) and one shared enabling infrastructure requirement: accessible fermentation and biochemical production facilities supporting scale-up of the relevant biological production routes.

Biobased Dyes, Pigments and Textile Inks

What is it?	Scale-up and industrial adoption of textile colourants produced from renewable feedstocks through extraction, fermentation or biological/chemical synthesis, together with compatible dyeing and printing formulations. The objective is to meet application-specific colour, fastness and processing requirements while

	reducing dependence on fossil feedstocks and demonstrating environmental benefits across colourant production and textile application.
Pain points	Barriers vary by colourant and production route. They include achieving consistent shades and colour strength, adequate fixation and fastness, reliable supply, and compatibility with mill equipment and recipes. For fermentation-derived products, productivity and recovery costs can constrain scale-up; extracted natural colourants may face feedstock variability and purification challenges. Pigment inks additionally require stable dispersions, suitable binders and reliable printing performance. Biobased origin alone does not establish chemical safety or lower environmental impact.
Current maturity	Established natural colourants coexist with newer biotechnology routes ranging from research and pilot development to initial commercial deployment. Selected biobased colourants, including indigo, have entered commercial textile products. Broader adoption still requires validation of production economics, repeatability, shade range and performance across specific fibres and end-uses.
What needs to happen	• Fund industrial demonstration and repeat production trials on priority colourant-fibre-application combinations, with defined colour strength, fastness, throughput and cost requirements. • Use existing textile testing standards to establish comparable benchmarks, specifying reference recipes, shade depth, substrates and end-use acceptance criteria. Validate complete formulations, including binders, mordants and auxiliaries where used. • Support strain and enzyme engineering alongside fermentation optimisation, product recovery and formulation development. Where relevant, provide access to shared pilot facilities and mill trials. • Build demand through mill-supplier-brand partnerships and offtake commitments, while assessing chemical safety, effluent impacts and resource use across the complete process. • Document colourant identity, verified biobased content and relevant performance information, preparing for applicable ESPR and Digital Product Passport requirements as these are specified. • Study, quantify and optimise lower toxicity and better biodegradation benefits of bio-functionalised textiles
Key performance indicators	Number of colourant-formulation-fibre systems independently validated against defined end-use fastness and shade-reproducibility requirements. Actual annual commercial production and textile application volumes. Share of EU dyed and printed textile output meeting a defined minimum biobased-colourant threshold, reported by application and fibre type. Track processing cost, right-first-time colour matching, water and energy use, and relevant effluent indicators against equivalent conventional recipes. Set adoption targets following baseline measurement and assessment of available capacity and deployment potential.

Biobased Functional Coatings and Finishes

What is it?	Industrial deployment of PFAS-free textile coatings and finishes with verified biobased content, progressing towards fully biobased formulations. Applications include durable water-repellent finishes and functional coatings, binders and membranes based on renewable feedstocks. Performance should meet defined end-use requirements; durable oil repellence should be treated as a separate development challenge where it is necessary for protection or functionality.

Success case

Biobased additives for sustainable dyeing and finishing

The transition towards more sustainable textile processing requires the development of biobased alternatives to conventional chemical auxiliaries, particularly in dyeing and finishing processes. The valorisation of agro-industrial residues offers an opportunity to develop functional additives while reducing waste and promoting circular resource use.

CITEVE is collaborating with LAMEIRINHO to investigate the potential of ash residues and agricultural wastes, such as wine pruning, as sources of biobased compounds for textile printing. These residues are being explored as alternative dyes and pigments for the development of fully biobased pastes with applications in conventional printing processes, being particularly suited for applications in the home textiles industry, interior decoration, and/or fashion.

In particular, the approach followed in this case study focused on the combination of different biopolymers and biobased residues, to enable their suitable adequation to a 100% printing paste with excellent fastness properties to light and washing.





By transforming locally available residues into value-added ingredients, the approach contributes to reducing the reliance on fossil-based and conventional chemical inputs while promoting more circular production models.

This case demonstrates how industrial symbiosis and bioeconomy approaches can be integrated into textile processing, converting agricultural and industrial residues into innovative biobased solutions and creating new value streams within local value chains.

Learn more:

LAMEIRINHO
Website: www.lameirinho.pt/en
Social Media: www.linkedin.com/company/lameirinho and www.instagram.com/lameirinho1948

be@t project
Website: www.bioeconomy-at-textiles.com

Pain points	Challenges vary by application. They include maintaining performance after laundering, abrasion and weathering; achieving adequate adhesion, flexibility and breathability; and integrating formulations into existing production at competitive cost. Durable PFAS-free oil repellence remains a particular challenge, especially when combined with high biobased content. Verification must cover the complete coating system, including crosslinkers and auxiliaries, rather than only the principal active ingredient.
Current maturity	Mixed and application-specific. Biobased water-repellent finishes are commercially available, although biobased content and durability vary by formulation and textile substrate. Fully biobased systems combining durable water and oil repellence should be treated as an emerging development objective, with performance validated for each intended use. Other biobased coatings, backings and membranes require separate maturity assessments.
What needs to happen	• Co-fund industrial trials and deployment of biobased, PFAS-free finishes against application-specific performance requirements. Prioritise water-repellent applications where oil repellence is unnecessary, alongside targeted research for demanding oil-repellent uses. • Support development of complete coating systems, including biobased binders and crosslinkers, with evidence on processing compatibility, cost, durability and recyclability. • Establish distinct validation programmes for PPE, outdoor gear, artificial leather, carpet backing and breathable membranes, reflecting their different protection, mechanical and comfort requirements. • Require transparent biobased-content and PFAS-substitution claims supported by formulation documentation and appropriate analytical testing. Comply with applicable chemical restrictions and prepare relevant composition, durability and care data for emerging ESPR and Digital Product Passport requirements. • Study, quantify and optimise lower toxicity and better biodegradation benefits of bio-coated and bio-finished textiles
Key performance indicators	Number of coating-textile systems independently validated against specified end-use require-ments after defined laundering, abrasion or weathering exposure, reporting water and oil repellence separately. Verified biobased content of coating solids, with the measurement basis stated. Share of eligible EU textile output using these validated coatings, segmented by application. Track durability, processing cost and the quantity of PFAS-containing treatments displaced against defined baselines.

Enzymatic Textile Processing and Recycling

What is it?	Wider deployment of enzymatic and other biocatalytic processes in textile preparation and finishing (including desizing, bioscouring, biopolishing, denim treatment and peroxide clean-up) and scale-up of emerging enzymatic recycling routes, particularly PET polyester depolymerisation. Depending on the application, these processes can replace or complement conventional treatments, reducing processing temperatures, rinsing requirements and selected chemical inputs while maintaining product quality.
Pain points	Barriers differ by application. For established wet-processing treatments, wider adoption depends on competitive total processing costs, reliable fabric quality, enzyme compatibility with operating conditions, and integration into mill workflows. Emerging recycling routes face additional challenges in feedstock sorting and pretreatment, enzyme productivity, recovery and purification of

	outputs, and financing scale-up. Environmental and economic benefits need validation across the complete process, including pretreatment and downstream recovery.
Current maturity	Mixed and application-specific. Enzymatic starch desizing, cellulase biopolishing and bio-stoning, and catalase-based peroxide clean-up are commercially established. Bioscouring is commercially available, with suitability depending on fabric and process requirements. Leading PET enzymatic recycling routes have reached demonstration scale; this maturity should not be generalised to all synthetic fibres. Enzymatic treatment of blended textiles remains emerging, with performance and maturity dependent on blend composition and the intended recovered products.
What needs to happen	• Co-fund mill trials, retrofits and process integration for lower-water, lower-energy enzymatic treatments, including combined processing steps where compatible. Link support to verified resource savings, throughput and fabric-quality requirements. • Support shared pilot and demonstration facilities for emerging recycling routes, including sorting, pretreatment and product purification. Validate performance on representative post-consumer waste and secure feedstock supply and offtake commitments. • Improve enzyme productivity, stability and cost-effectiveness through enzyme engineering, fermentation optimisation and recovery or reuse where technically and economically feasible. • Identify specific regulatory and permitting barriers affecting industrial biotechnology deployment and pursue proportionate simplification through relevant EU initiatives, including the industrial biotechnology strand of the Biotech Act agenda.
Key performance indicators	Share of eligible EU textile-processing tonnage treated enzymatically, reported separately by application and fibre type. Water use (litres/kg), energy use (kWh/kg) and relevant chemical inputs (kg/tonne) compared with equivalent conventional processes delivering the same product quality. Track processing cost, throughput and reject rates alongside resource savings. For recycling, report actual annual textile-waste throughput, recovery yield and purity of usable outputs, and the share returned to textile production.

Accessible Fermentation and Biochemical Production Facilities

What is it?	Expansion and upgrading of accessible European infrastructure for fermentation, biocatalysis and downstream processing to support textile-relevant enzymes, colourants, polymers and functional chemical intermediates. Facilities should connect laboratory development, pilot and demonstration campaigns, and transfer to commercial manufacturing, with access to product recovery, purification, formulation and textile application testing.
Pain points	Scale-up is constrained by access to suitable equipment, affordable demonstration campaigns, experienced personnel and investment for commercial deployment. Technical challenges include maintaining product concentration, yield, productivity and batch consistency as scale increases, alongside contamination control and effective heat and mass transfer. Recovery losses, purification requirements, utility costs and insufficient plant utilisation can undermine economics even where fermentation performs well. Requirements vary substantially by product and production route.

Success case

Colours Inspired by Nature into Scalable Industrial Solutions

Colorifix is a pioneering biotechnology company using synthetic biology to tackle the massive industrial pollution associated with colouration, starting with textiles and expanding into plastics and coatings.

Traditional chemical dyeing relies on petroleum-based synthetic compounds, toxic fixatives, and massive volumes of water, responsible for roughly 20% of global industrial water pollution.

To create colours, Colorifix identifies a colour in nature, looks up its DNA sequence in online databases, never using a live specimen, and introduces the engineered sequence into microorganisms. Once fermented, these microorganisms then produce, deposit, and fix colours directly onto fabric, with a lower footprint. This process uses up to 77% less water and up to 53% less energy* while reducing toxic heavy metals.





To facilitate adoption, Colorifix also supplies ready-to-use inactivated concentrates for polyester and printing, allowing mills to apply them directly like conventional dyestuff without needing on-site fermentation. Backed by partners like H&M Group Ventures and Inter IKEA Group, Colorifix delivers high technical performance and vibrant quality at a lower price point on select product lines.

Learn more:
Website: www.colorifix.com
Social Media: www.linkedin.com/company/colorifix and www.instagram.com/colorifix

Contacts:
info@colorifix.com

*This data is taken from a third-party LCA comparing Colorifix technology (dyeing and final washes) to conventional dyeing on a 52% recycled cotton, 48% polyester blended fabric

Current maturity	Europe has established industrial fermentation and multipurpose pilot and demonstration infrastructure. The textile-relevant challenge is to identify and close specific gaps in capability, accessible capacity, downstream processing and commercial manufacturing. Infrastructure readiness should be assessed separately from the maturity of the products it may manufacture.
What needs to happen	• Map textile-relevant demand against existing European facilities, building on Pilots4U and related initiatives. Prioritise upgrades, shared access and new capacity where documented gaps justify investment. • Co-fund integrated demonstration capabilities covering fermentation or biocatalysis, recovery, purification and formulation. Provide SME access support, transparent booking arrangements and clear provisions for confidentiality and intellectual property. • Support process improvements selected through technical, economic and environmental assessment. Compare submerged and solid-state fermentation where appropriate, including the energy, water and recovery requirements of the complete production route. • Develop validated process monitoring and control for operating conditions, productivity and product quality. Verify biobased content separately through feedstock traceability and appropriate analytical testing. • Link demonstration investment to textile application trials, customer qualification and credible pathways to commercial manufacture, supported by trained operators and technology-transfer expertise.
Key performance indicators	Accessible fermentation working volume and available campaign days, reported by process capability and scale, together with associated downstream capacity. Actual annual output of textile-relevant products, reported by category on a defined dry-mass or active-content basis. Number of unique SME and start-up users completing campaigns, access waiting times, and the share of projects progressing to customer qualification or commercial manufacture. Track product-specific yield, productivity, recovery efficiency, cost and energy use against defined baselines.



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Beyond 2035, the capabilities developed through this transformation can position European bio-textiles for even greater ambitions. The biobased infrastructure built in the next decade will be the platform on which this next generation of innovation is constructed.



Key Actions and Players

The biobased transition of the European textile and apparel industry is a collective endeavour that cannot be achieved by any single actor alone. This chapter outlines actions that each key stakeholder group must initiate to contribute its share to a successful transition. Many of these actors are already in motion, innovating, pilot-testing, scaling biobased solutions.

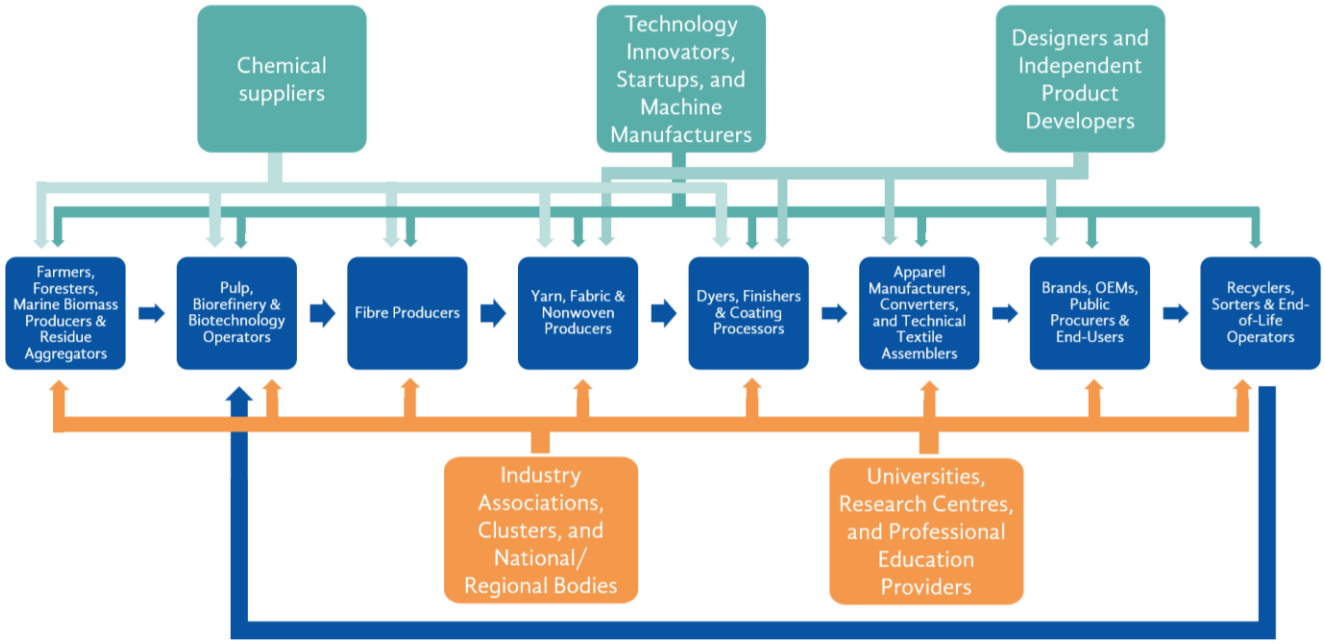


Figure 6: Key players of the European textile bioeconomy value chain

Farmers, Foresters, Marine Biomass Producers and Residue Aggregators

These actors sit at the origin of the bio-textile value chain. They produce or aggregate the bio-mass - cotton, bast fibres, wool, wood and residues, bio-feedstock crops, agricultural residues, aquatic biomass, on which everything else depends.

Key actions:

- Organise in clusters and associations to collectively engage with the processing chain, end users and policy makers
- Participate in regional biomass aggregation and pre-treatment networks, sharing data on availability, seasonality, quality and carbon footprint.
- Engage in multi-use crop systems (flax/hemp for seed + fibre + residues) that improve farm-level economics and provide multiple downstream value streams.
- Seek long-term off-take agreements with biorefineries, MMCF producers and natural fibre processors to underpin investment in harvesting and pre-treatment infrastructure.
- Adopt and scale regenerative agricultural and forestry practices for EU cotton, wool and MMCFs, supported by improved breeding and precision agronomy/forestry/aquaculture
- Improve quality, yield, resistance and lower impact of EU cotton farming through precision agriculture, species adaptation and best practices

Pulp, Biorefinery and Biotechnology Operators

These actors are the industrial converters: they transform raw biomass and waste streams into the chemical and material building blocks that downstream fibre and chemical producers need.

Key actions:

- Invest in integrated lignocellulosic biorefineries co-located with textile clusters, with explicit textile-grade output streams.
- Collaborate with textile fibre producers and brands on long-term capacity planning and offtake structures.
- Scale industrial fermentation capacity (precision fermentation, biocatalysis, gas fermentation) at the volumes required for textile applications, with explicit cost-reduction roadmaps.
- Provide real-time bioprocess monitoring, bio-content and impact traceability data, for regulatory compliance such as the DPP.
- Establish decentralised mini processing plants for textile-grade feedstock close to bast fibre and wool production regions.

Fibre Producers/Processors

Fibre producers are the structural converters: they take biobased chemical and material inputs and deliver them as fibres or filaments that the textile or nonwoven manufacturing system can process.

Key actions:

- Invest in bio-PTA, bio-PA and bio-elastane production capacity, supported by long-term brand and OEM off-take agreements.

- Modernise primary processing for EU bast fibres (scutching, hackling, cottonisation) and EU wool (collection, scouring, upgrading), including through participation in regional bio-manufacturing hubs.
- Accelerate the transition from legacy viscose to next-generation closed-loop cellulosic processes (Lyocell, ionic liquid, emerging alternatives).
- Provide digital fibre property datasets and verified bio-content claims through DPP-compatible formats.
- Scale novel biopolymer fibre production (PLA, PHA, PEF, PBS, protein-based) in alignment with niche end-market needs.



Yarn, Fabric and Nonwoven Producers

These manufacturers transform fibres into yarns, cords, ropes, nets, fabrics or nonwoven materials. Their machinery, know-how and quality control infrastructure must adapt to a broader and more varied range of biobased fibres than the historical synthetic-and-cotton dominated portfolio.

Key actions:

- Adopt biosynthetics and natural fibres (flax, hemp, wool…) for technical textile applications
- Co-locate with regional bio-manufacturing hubs to enable integrated fibre extraction + spinning + fabric construction in one region with focus on efficient small-scale operations.
- Develop specialised spinning, weaving and knitting capabilities for bio-fibre properties and for hybrid bio-synthetic/natural fibre blends.
- Invest in nonwoven production lines for biobased fibres (MMCF, wool, PLA, bast fibres) across hygiene, technical and home textile applications.
- Adopt 3D-knitting and precision weaving technologies that reduce waste when using premium bio-yarns.



Dyers, Finishers and Coating Processors

These processors are at the heart of the bio-chemistry transition. They hold the levers for replacing fossil-based and hazardous chemistry with biobased alternatives across dyes, coatings, finishes and functional chemistries.

Key actions:

- Adopt fully biobased, PFAS-free coatings and finishes, validated against industrial-level wash resistance and performance benchmarks.
- Transition wet processing operations from conventional to enzymatic and biocatalytic routes where economically and technically viable.
- Develop a broader range of bio-dyes and bio-pigments with verified light/wash fastness across major fibre types.
- Integrate real-time monitoring of process parameters, water, energy, chemical consumption and bio-content, with reporting through the DPP framework.

Apparel Manufacturers, Converters and Technical Textiles Assemblers

These are the companies that assemble the finished fabrics or nonwoven parts into end products such as garments, footwear and PPE, furniture and car interiors, filtration systems, tents and other outdoor products, medical devices, incontinence products and many more.

Key actions:

- Work with brands and end users to ensure certification and authorisation for alternative products made of biobased materials especially in demanding/regulated markets like PPE, medical or filtration
- Integrate sewing threads, trims and accessories of similar biobased and ideally chemically equivalent materials while maintaining function and durability
- Adapt cutting, handling and joining processes to the special needs of unconventional biobased materials

Brands, OEMs, Public Procurers and End Users (including Designers and Product Developers)

Brands, retailers, automotive, medical, construction and other technical-textile OEMs as well as public procurers and professional end users have the market power to drive biobased adoption across the entire supply chain. Their designers and product developers often hold the keys to spec innovative biobased materials into their products, deciding if end user expectations or technical standards can be met with an innovative solution. Public procurers can act as lead customers providing financial certainty and early market visibility to start-ups and SME innovators.

Key actions:

- Use public procurement power to prefer European biobased textile innovations, particularly in technical applications where the green premium is more easily absorbed.
- Set clear bio-content, recycled-content and bio-chemistry requirements for suppliers, aligned with regulatory and end market demands.
- Sign long-term off-take agreements with bio-fibre, bio-polymer and bio-chemistry producers to underpin financing of European industrial manufacturing capacity.
- Invest in transparent consumer-facing labelling and storytelling around verified bio-content, supported by DPP infrastructure.
- Ensure testing and certification of biobased alternatives to conventional products, especially in technical and regulated end markets
- Co-fund and participate in lighthouse projects that demonstrate end-to-end biobased value chains.

Collectors, Sorters, Recyclers and other End-of-Life Operators

Collectors, sorters, refurbishers, pre-processors, recyclers and other end-of-life operators close the bio-circular loop. Their data, infrastructure, technology and business models determine whether bio-textile material loops actually circulate or whether they leak into landfill, incineration or non-EU export streams.

Key actions:

- Provide systematic feedback on bio-textile recyclability to fibre producers, brands, and designers, closing the design-to-recycling intelligence loop.
- Invest in advanced sorting and pre-treatment infrastructure dedicated to biobased material streams (cellulosic, bio-synthetic, natural fibre).
- Explore effective and safe biodegradability options for suitable biobased textile waste streams and their efficient handling
- Deploy enzymatic and other bio-depolymerisation pathways for post-consumer bio-synthetic and blended textiles, where economically viable.
- Participate in regional and EU-wide data spaces to share end-of-life intelligence with upstream producers and brands.



Biochemistry and Biotechnology Suppliers and Innovators, Start-ups, and Machine Manufacturers

Developers, manufacturers, formulators, distributors and service providers of biochemicals (enzymes, natural dyes & pigments, biocoatings etc.) and processing, measuring and testing equipment. These also include many start-ups in the biotech sector. They co-develop innovative solutions together with industrial users, incorporate industry and end user feedback for further development, efficiency and quality assurance purposes.

Key actions:

- Develop drop-in/add-on solutions that can easily integrate with established processes and scaled flexibly
- Ensure registration of biochemical innovations and certification and standardisation of processes
- Engage in collaborative research and development projects with textile process experts, machine manufactures and potential textile industry users of the biotech solutions
- Develop clearly differentiated solutions for niche markets with high value added to mitigate development costs and compete against lower cost conventional chemicals/processes



Universities, Research Centres, and other Professional Education Providers

Research, technology and education institutions create the knowledge base and talent pipeline that the bio-textile transition needs. They also serve as research and technical expertise providers to industry, especially SME's and dispose of the infrastructure to test and evaluate novel materials and formulations and produce sample or small pilot quantities ahead of industrial scale-up. The have access to public funding programmes and expertise in building collaborative research consortia with industry.

Key actions:

- Build pilot-to-industrial scale-up infrastructure (bioreactors, fermentation units, spinning lines, mini dye houses) accessible to industry partners.
- Lead applied R&D programmes on next-generation cellulosic processes, novel biopolymer fibres, bio-dyes, bio-coatings and bio-functional chemistry in collaboration with industry.
- Create flexible continuing professional development programmes for mid-career upskilling in bio-textile science and engineering.
- Develop hybrid curricula and university degrees that combine textile science with bioeconomy, industrial biotechnology, bio-chemistry, regenerative agriculture and circular value chain design

Industry Associations, Clusters, Standardisation Bodies and Regional Authorities

These organisations coordinate collective action, anchor regional ecosystems, facilitate standardisation work and amplify the sectoral voice in EU policy.

Key actions:

- Facilitate matchmaking between technology providers (biotech start-ups, machine manufacturers, software developers) and textile industry users.
- Advocate for industry-specific funding instruments and regulatory clarity through structured dialogue with EU institutions.
- Anchor and run regional bio-manufacturing clusters, integrating local feedstock supply, primary processing, fibre and material production, finishing and end-of-life infrastructure.
- Coordinate industry participation in EU standardisation processes for bio-content claims, biodegradability, compostability, mass balance accounting and DPP integration.
- Initiate and host hands-on learning programmes for industry, especially SME's providing easy and cost-effective access to state-of-the-art practical know-how and latest developments

Collective Actions Across the Ecosystem

Several of the most critical actions in this Strategy cannot be accomplished by any single stakeholder group acting alone. They require coordinated, pre-competitive collaboration across the value chain, often involving actors who are otherwise competitors or who have no established working relationships.

The Circular & Biobased Textiles Innovation Hub's Co-creation Session revealed that the industry's most pressing calls were not for individual company action but for collective infrastructure, shared standards and collaborative frameworks.

The following **five cross-cutting actions require multi-stakeholder commitment** to succeed:

1. **Co-develop regional bio-manufacturing hubs that integrate feedstock production, primary processing, fibre and material production, dyeing/finishing and circular end-of-life infrastructure**

   These cannot be assembled by any single fibre or chemical producer; they require farmers, foresters, biorefineries, fibre and chemistry operators, brands, recyclers and regional authorities to act together. Industrial symbiosis and circular value chains, the highest-rated opportunity in the entire Circular & Biobased Textiles Innovation Hub's Co-creation Session (3.70/4.0), depend structurally on this collective action.

2. **Build cross-sector value chains between agriculture, forestry, pulp and paper, chemicals, biotechnology and textiles**

   Bio-textile feedstocks and intermediates are produced largely outside the textile sector; the value chains must therefore be designed across sectoral boundaries, with shared data, standards and governance.

3. **Establish bio-content traceability and DPP infrastructure (including verified bio-origin and mass-balance accounting)**

   This requires fibre producers contributing material attributes, processors contributing transformation data, brands contributing product-level attributes, certifiers and standardisation bodies contributing assurance frameworks, and software providers contributing interoperable platforms.

4. **Form demand-side coalitions to scale bio-fibre off-take**

   Long-term off-take commitments from coalitions of brands, OEMs and public buyers are the single most effective de-risking instrument for industrial-scale bio-fibre and bio-chemistry capacity in Europe. Building these coalitions requires brand-to-brand cooperation that has historically been difficult.

5. **Develop a pan-European bio-textile skills and talent pipeline**

   Hybrid bio-textile professionals (combining textile domain expertise with bioeconomy, industrial biotechnology, regenerative agriculture and circular design competencies) will not emerge from any single university or training programme. Universities, RTOs, industry, clusters and associations must coordinate cross-border curricula, placements, exchanges and upskilling pathways.


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Recommendations to EU Policy Makers

Based on the analysis, expert input from the Circular & Biobased Textiles Innovation Hub's Co-creation Session and the Strategic Capacity Audit, and the structured assessment presented in this document, we make the following recommendations to EU policy makers, Member States and programme managers. The recommendations are ordered to reflect the priorities validated by the Hub's members, with policy engagement, targeted research & innovation funding, demand-side incentivisation at the top, followed by enabling infrastructure, dedicated EU-networks, SME accessibility, standards and skills.

Recommendation 1:

Fully engage with the fibres and textiles innovation ecosystem in the implementation of the EU Bioeconomy Strategy

Ensure that the fibres, textiles and apparel sector is explicitly recognised and consulted in the implementation of the EU Bioeconomy Strategy as a priority application area for biobased innovation and industrial transformation, on equal footing with biofuels and biobased chemicals and materials for other end-markets. Ensure that textile ecosystem experts are represented in advisory panels, expert workshops and programme and project evaluation groups.

Recommendation 2:

Support continued research and innovation programmes at EU level focussed on the priority areas identified

Implement a strategic research and innovation programme prioritising the focus areas highlighted under the 5 textile bioeconomy building blocks of this strategy. Firmly link these activities to a Biobased and/or Textile-specific Partnership under the future Horizon Europe programme. Encourage cross-project clustering and joint disseminations activities under a suitable European umbrella initiative such as ECOSYSTEX.

Recommendation 3:
Support material or value chain specific knowledge networks, project clusters and capacity building

To overcome fragmentation and duplication of sub-scale efforts at local and regional levels, EU-wide expert and stakeholder networks dedicated to specific biobased feedstock, fibre or market-oriented value chains should be supported through appropriate funding instruments to accelerate knowledge sharing, innovation, value chain capacity building and scaling, business development, market awareness raising and sustainability education.

Recommendation 4:
Fund Regional Bio-Refinery Demonstrators Linked to Textile Value Chains

Co-fund a network of integrated lignocellulosic biorefineries and decentralised mini-refineries explicitly linked to textile value chains and combined with industrial symbiosis and circular value chains concepts. Tackle the lack of decentralised mini-refineries as a critical infrastructure gap for novel materials or biobased chemicals for various niche applications and end markets. Without textile-anchored biorefinery capacity, the bio-textile value chain will continue to depend on intermediates produced for other industries or feedstock/materials made outside Europe.

Recommendation 5:
Develop SME-Accessible Funding, Cascade and Brokerage Schemes

Most textile innovation occurs at SME level, yet most EU funding flows toward large-scale funding projects more suited for larger enterprises or RTO's. Create simplified, low-administrative-overhead funding schemes for bio-textile SMEs, including cascade funding via industry associations and clusters, innovation vouchers, subsidised bio-feedstock access, and matchmaking between established companies and start-ups. Funding and brokerage mechanisms must reach the companies that need them, without commensurate administrative overhead. The complexity of many current schemes, especially at EU level, feel discouraging for many SMEs.

Recommendation 6:
Fully Harness Green Public Procurement (GPP)

Encourage and incentivise sustainable choices, including using renewable materials in public procurement for uniforms, workwear, hospital textiles, military and emergency-services equipment, public-building interior textiles and other public-sector textile applications. Combined with firm off-take agreements, GPP can provide the stable baseload demand that justifies industry-scale investment in Europe. Procurement mandates should be paired with buyer-awareness support, so public purchasers know what renewable textiles can offer and in which markets.

Recommendation 7:
Incentivise Renewable Materials through Market-specific and Cross-Sectoral Legislation

Make use of appropriate market-specific and cross-sectoral legislative approaches to incentivise renewable materials application without compromising on product safety, functionality and creative product design concepts. Link any incentives to robust sustainability criteria and comprehensive LCA approaches including fair recognition of biogenic carbon, credible mass-balance accounting (where applicable) and robust verification and market surveillance.

Recommendation 8:
Develop an EU-sovereign renewable textile materials strategy for industrial competitiveness and strategic autonomy

Undertake a strategic assessment of EU's critical dependencies on non-European textile feedstock and materials for strategic end markets such as healthcare, protection or defence and develop a comprehensive strategy with all supply chain stakeholders to ensure that renewable materials of EU or preferred partner country origin can support industrial competitiveness, resilience and strategic autonomy.

Recommendation 9:
Build Trusted Science-based Frameworks for Robust Sustainability Claims & Apply them with Minimum Administrative Burden

Develop transparent, science-based, harmonised frameworks and methodologies and apply them without undue administrative burden and through accessible tools for demonstration of sustainability benefits of renewable materials and related processes, preventing unsubstantiated green claims.

Recommendation 10:
Launch a Skills and Talent Programme for the Bio-Textile Transition

Fund the development of new and adapted higher education, vocational training and continuing professional development programmes for biobased textile science, engineering, design, production and circular value chain management. Link those programmes with related domains such agronomy, forestry, marine bioscience, chemistry, bioengineering and biotechnology. Create hybrid programmes and support exchanges between scientists and educators across the different disciplines.


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3 Scenarios to 2050 and the Choice for Europe

The choices made (or not made) over the next decade will determine which of three material trajectories the European fibre base and its subsequent manufacturing value chain follow and, cutting across them, whether the resulting value is captured in Europe or abroad. The three trajectories are the quantified scenarios of the fibre model introduced earlier; the geography of value capture (EU-anchored versus offshore) is the second, decisive axis. Together, they define where the European bio-textile industry lands in 2050. These are not predictions but a decision frame: the model fixes the targeted material volumes, while policy, investment and industrial deployment determine the geography of economic value capture.

During a Circular & Biobased Textiles Innovation Hub's stakeholder co-creation session, sector experts were specifically asked to assess the geography question. A majority of experts assessed a textile bioeconomy shift as plausible, but expressed doubt about Europe's ability to capture the economic opportunity. The consensus could be described as 'bio-branded in Europe, but bio-grown/bio-manufactured abroad'. A significant number also assigned a high likelihood to a business as usual outcome with a continued drift towards more fossil material use. Only a small share of experts saw a true EU industry-anchored biotextile renaissance as the most likely outcome. The message is sobering: the stake-holders closest to the sector do not currently expect Europe to capture the economic opportunity inherent in a local bio-textile value chain, and rate the probability of continued offshoring higher than the desired outcome. This Strategy is precisely the set of interventions needed to raise the probability of an EU-anchored, high-bio-content textile future above what the market today expects.

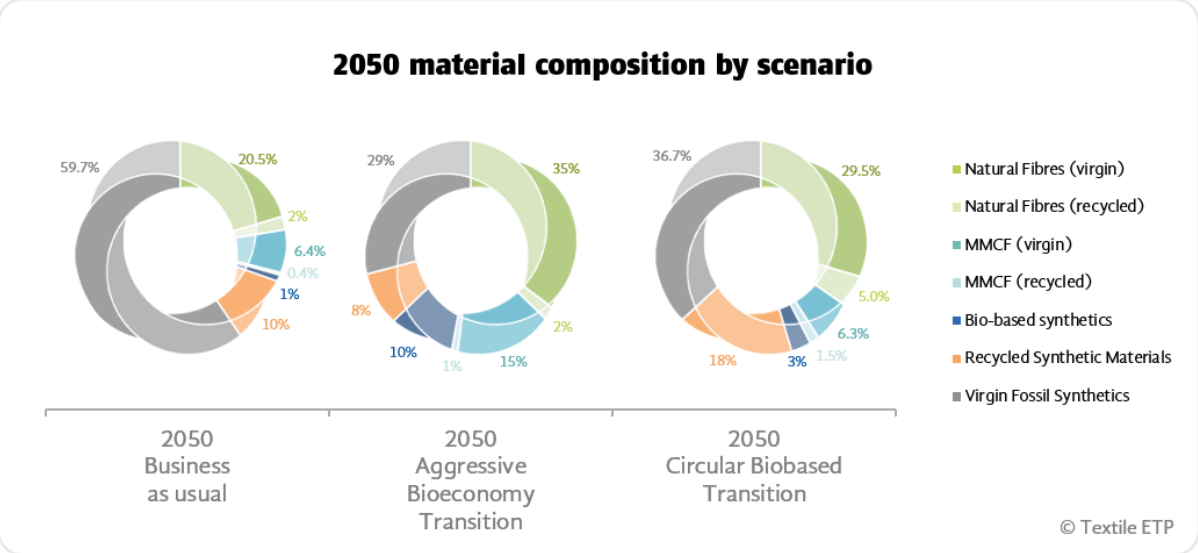


Figure 7: 2050 material composition by scenario

Scenario 1:
Business as Usual: the fossil drift

In the **Business as Usual** trajectory the material mix continues its long drift towards synthetics: the biobased share falls from 38% today to about 30% by 2050, and virgin fossil fibre use rises to some 12.2 Mt a year. This is the outcome if the regulatory pivot and the bioeconomy transition both fall short: ESPR performance requirements or EPR ecomodulation never meaningfully incentivise bio-content in consumer textiles, the Biotech Act 2 delivers only marginal regulatory and demand-side improvements for the EU bioeconomy, long-term off-take agreements do not materialise at scale, public and private finance for bio-textile innovators stays thin, and carbon pricing on imports remains too modest to change buyer behaviour. Industry takes the path of least resistance: more imports to keep consumer prices low, a few high-margin lines in luxury and niche technical markets remaining in Europe, and exit from everything else.

Geography overlay. **Business as Usual** is almost always an offshore outcome. It means Europe either loses its textile material and manufacturing base altogether or retains only a very small natural fibre heavy luxury segment and a mostly fossil-based technical niche, while the bulk of price-sensitive volume consumption is imported from countries from countries with fossil-anchored production clusters. Europe fails on both axes this Strategy exists to address: it neither closes the widening fossil vs. renewable materials gap nor reduces its strategic import dependency, and it forgoes the industrial value the transition will create elsewhere.

Scenario 2:
Circular Biobased: recycling-led renewal

The **Circular Biobased** trajectory lifts the biobased share to 45% and the renewable share (biobased plus recycled) to 63% by 2050, with recycled content reaching 24.5% of all fibre (recycled synthetics rising to 18%, complemented by recycled cotton and cellulosics). It is driven both by circularity and bioeconomy levers: separate collection of post-consumer textiles across the EU under the Waste Framework Directive and ecomodulated Extended Producer Responsibility schemes; ESPR mandated recycled and biocontent quotas, the Digital Product Passport as proof; and the industrial scale-up of fibre-to-fibre recycling, especially for polyester and cellulosics as well as reinforced natural and biobased fibre capacities in Europe.

Geography overlay. Circularity, if implemented smartly, can boost regional value chains: the feedstock (used textiles) is generated in Europe, and the collection, sorting and (potentially) the recycling infrastructure can be built here too. This makes **Circular Biobased** the trajectory most naturally anchored in the EU, provided the recycling capacity and onward material processing capacities are indeed built/maintained here rather than the collected waste being exported for processing abroad, which is a clear risk flagged by stakeholders.

Scenario 3: Aggressive Bioeconomy: biomanufacturing-based leadership

The Aggressive Bioeconomy trajectory is the most ambitious: 63% biobased and 71% renewable by 2050, cutting virgin fossil fibre to about 6 Mt a year, less than half the Business as Usual level. It is driven by material substitution at the molecule and fibre level: strong bio-content thresholds in ESPR; the Biotech Acts streamlining authorisation for industrial bio-manufacturing; a build-out of regional biorefineries and fermentation capacity producing bio-monomers (bio-MEG, bio-PTA, bio-PA precursors) and next-generation cellulosics; long-term off-take coalitions between brands and producers; and Green Public Procurement pulling verified bio-content into technical and institutional markets.

Geography overlay. This is the trajectory with the highest value at stake and the greatest geographic risk. The bio-manufacturing capacity it requires can equally be built in Asia. Examples include massive MMCF production capacity build-out in China and India, potentially dominant bio-MEG (for polyester) capacities from India and Taiwan or China dominance of bio-Pentanediamine production (for biobased nylon filament). Without decisive EU industrial deployment (project finance, large-scale demonstrators, EU-production offtake agreements), the bio-transition succeeds but its factories, jobs and value are located outside Europe. Aggressive Bioeconomy is only a European economic success if its production is deliberately EU-anchored.

The Blended Target and the Choice for Europe

This Strategy does not suggest that Europe must choose between recycling and bio-manufacturing. Its target is the corridor between the Circular Biobased and Aggressive Bioeconomy trajectories (combining Circular's near-term, locally-anchored recycling gains with Aggressive Bioeconomy 's higher-value bio-manufacturing build-out) and, decisively, anchored in Europe. The three trajectories outline what is materially possible. **The strategic flex is to move Europe up the renewable material axis while holding the economic value on the European side of the geography axis.**

The economic opportunity: EU economic value creation

Sizing the economic value creation potential illustrates why the geography axis matters. At the blended 2050 target, Europe would consume roughly 14 Mt of biobased and recycled material a year, of which about 6.0 Mt is realistically European or neighbourhood in origin. Valued at the fibre and material stage using the transparent assumptions below (an EU-origin share and an indicative per-kilogram value for each material family), this represents on the order of €15 billion a year of fibre-stage turnover, rising to about €21 billion once the bio-chemistry and processing layer is included. Applying a conservative downstream multiplier for spinning, weaving, finishing and product manufacture puts the value mobilised across the wider EU value chain at €55-65 billion a year, supporting an estimated 80,000 direct fibre- and processing-stage jobs and several times that number downstream. Every point of this value that is not anchored in Europe is, by definition, captured abroad.

Value pool / Building Block	2050 target (Mt)	EU-made (Mt)	€/kg (indic.)	EU value (€bn/yr)
Natural fibres (bast, wool, cotton; including recycled)	7.6	3.4	2.5	8.5
Man-made cellulosics (including recycled)	2.5	1.0	3.0	3.0
Recycled synthetics	2.8	1.1	1.8	2.0
Biobased synthetics	1.4	0.5	3.5	1.9
EU Bio-processed textiles	—	5.9	0.9	5.3
Total (fibre + processing stage)				**≈ 21**

Table 2: Indicative EU value creation at the blended 2050 target. Figures are order-of-magnitude, based on stated per-kg and EU-share assumptions; they size relative opportunity, not a forecast.

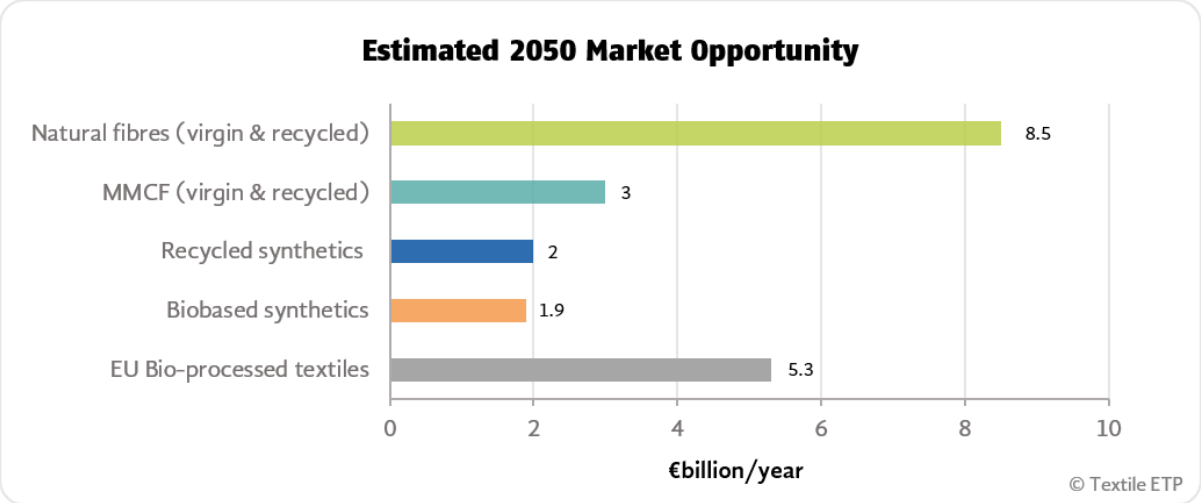


Figure 8: Indicative EU fibre/material-stage value creation by material family at the blended 2050 target.

The assumptions are deliberately conservative and fully transparent. Natural fibres are valued at a blended €2.5/kg with about 45% of volume realistically sourced from Europe and its immediate neighbourhood (EU bast fibres (flax & hemp), cotton (Greece, Spain) and wool, cotton from Türkiye and Egypt, and wool from the United Kingdom, Norway, the Balkans and Türkiye) and this pool also includes roughly 0.7 Mt of mechanically recycled cotton and wool, which is strongly EU-anchored because its feedstock is European textile waste. Man-made cellulosics, biobased synthetics and recycled synthetics are each assigned a 40% EU-origin share: innovation in these subsectors can be strongly EU-driven, but industrial capacity expansion may still occur closer to the rest of the manufacturing value chain in Asia. Per-kilogram values are €3.0 (MMCF), €3.5 (biobased synthetics) and €1.8 (recycled synthetics), with a €0.9/kg bio-processing and chemistry layer applied across the EU-origin biobased and recycled volume. Readers can adjust any of these levers in the underlying model; the point is not the precise figure but the order of magnitude, and the fact that it is contestable between Europe and its competitors.

The choice

The three trajectories are all materially plausible; none is predetermined. **Business as Usual** is the default if neither the regulatory pivot nor the bioeconomy transition is deployed at industrial scale. Without EU-anchored deployment, even the ambitious transition scenarios deliver the majority of their economic value abroad: the 'bio-branded in Europe, bio-grown/manufactured abroad' outcome that many of our surveyed stakeholders consider likely. This Strategy charts a deliberate course to the blended, EU-anchored target: biobased, circular and rooted in Europe. The above-described Building Blocks are the industrial means; the highlighted EU Policy Recommendations are the regulatory levers that decide which trajectory, and which geography, prevails.



The Circular & Biobased Textiles Innovation Hub Strategy deliberately refrains from presenting a detailed operational roadmap with fixed milestones and timelines. The landscape is complex and moving fast, and the political and industry commitments that would give such a roadmap credibility do not yet exist. Instead, the Circular & Biobased Textiles Innovation Hub will develop concrete implementation strategies for the key action items laid out in the Recommendations chapter throughout the remainder of 2026 and into 2027 and invites all interested stakeholders to join forces.


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Conclusions and Outlook

The European fibre, textile and apparel industry stands at a decisive inflection point. The convergence of regulatory imperatives, climate constraints, strategic autonomy concerns and circular economy requirements has made the biobased transition not merely advantageous but rather existential. The evidence assembled in this Strategy (from desk research, the Circular & Biobased Textiles Innovation Hub's Strategic Capacity Audit and the Co-creation Sessions) converges on a clear conclusion: the European industry that does not engage seriously with biobased materials, bioprocessing infrastructure and regional value chains by 2035 will not survive in any recognisable form. The massive volumes and rock-bottom prices of the fossil-anchored Asian textile supply chains will simply crush the last remaining EU producers outside some small highly protected niches.

The fibre model built for this Strategy quantifies both the stakes and the economic opportunity. On current trends the biobased share of EU textile fibre falls to about 30% by 2050, locking in some 12.2 Mt of virgin fossil fibre a year. The Strategy's blended target (between the **Circular Biobased** and **Aggressive Bioeconomy** trajectories, and anchored in Europe) instead lifts the biobased share to 45-63% and the renewable share to as much as 71%, mobilising an estimated €55-65 billion a year across the EU value chain and around 80,000 direct fibre- and processing-stage jobs. The difference between these outcomes is not primarily technological; it is a matter of deliberate policy, investment and industrial deployment over the next decade.

But this is not a story of threat alone. It is, fundamentally, a story of opportunity. Europe possesses unique assets for this transformation: abundant sustainably managed forestry and agricultural biomass, global leadership in man-made cellulosic fibre production, strong industrial biotech and fermentation capabilities, world-class research institutions, the most advanced regulatory framework for sustainable textiles anywhere in the world, an existing (though fragmented) natural fibre base (flax, hemp, cotton, wool), and a fully developed testing, standardisation and certification infrastructure for biobased textiles. Many innovators are already in motion: developing next-generation cellulosic processes, scaling biosynthetic

drop-ins, building regional bast fibre value chains, piloting bio-coatings and bio-dyes, and integrating biorefinery infrastructure into textile clusters.

The challenge now is not to ignite momentum but to channel and scale the momentum that already exists. The Strategy laid out in these pages is ambitious but achievable. Its core message can be distilled into three imperatives:

First, **build a regionalised, diversified biobased feedstock and bio-processing infrastructure that anchors the European bio-textile value chain in European soil**, through integrated lignocellulosic biorefineries, decentralised mini-refineries, modernised bast fibre and wool value chains, and industrial-scale fermentation capacity.

Second, **scale the concrete technologies that will make biobased textile production cost-competitive and verifiable**: next-generation MMCF processes, drop-in biosynthetics, novel biopolymer fibres for niche applications, bio-dyes, bio-coatings, enzymatic processing and digital traceability infrastructure.

Third, **ensure that every actor in the ecosystem**, from the smallholder flax grower to the global luxury brand, from the regional biorefinery operator to the medical textile OEM, from the university researcher to the EU policy maker, **has a clear role and the resources to play it**.

This Strategy deliberately refrains from presenting a detailed operational roadmap with fixed milestones and timelines. The landscape is complex and moving fast, and the political and industry commitments that would give such a roadmap credibility do not yet exist. Instead, the Circular & Biobased Textiles Innovation Hub will develop concrete implementation strategies for the key action items laid out in the Recommendations chapter throughout the remainder of 2026 and into 2027 and invites all interested stakeholders to join forces.

The urgency is not in question. The EU Bioeconomy Strategy, ESPR and the Biotech Acts have created a regulatory window of opportunity. The competitive dynamics of global textile markets create an equally strong incentive to act expeditiously. Within these constraints, the European industry has the opportunity to shape its own future, to build an industrial system that is not only compliant and competitive but genuinely sustainable, regenerative, circular and resilient.

Beyond 2035, the capabilities developed through this transformation can position European bio-textiles for even greater ambitions: regenerative agricultural systems that sequester carbon while supplying fibre, refineries that fully valorise agricultural residues, post-consumer textiles and captured CO2, bio-fabricated materials that perform beyond their fossil-based predecessors, and circular bio-loops that fundamentally decouple economic value from virgin resource consumption. The biobased infrastructure built in the next decade will be the platform on which this next generation of innovation is constructed.



The urgency is not in question. The EU Bioeconomy Strategy, ESPR and the Biotech Acts have created a regulatory window of opportunity. The European industry can shape its own future, to build an industrial system that is not only compliant and competitive but genuinely sustainable, regenerative, circular and resilient.

Technical Annex:
EU Textile Fibre Consumption Model 2000–2050

Segments and sub-segments: product scope, 2025 fibre composition, and volume-trend assumptions

1. Purpose and scope

This annex documents the assumptions behind the EU Textile Fibre Consumption Model. For every end market and sub-segment, it sets out three things: the product types and end-use markets included; the 2025 baseline fibre composition and the split between biobased and fossil-based fibres, with the reasoning behind it; and the basis on which historical and projected volume trends were calculated/estimated.

It is intended as a reference companion to the Textile Bioeconomy strategy, so that any volume or percentage share in text or graph can be traced to a stated product scope, a fibre-mix rationale and a growth assumption.

2. Methodology at a glance

2.1. Structure

- Coverage: EU-27 apparent consumption of textile fibres, 2000-2050, on an annual basis, resolved by end market × fibre × scenario.
- Seven end markets, subdivided into 21 sub-segments (listed in the sections below).
- Eleven fibre categories: five biobased (cotton, wool, other natural fibres (including flax, hemp, jute, sisal, coir and in the case of non-wovens wood pulp), viscose/modal, lyocell), and six fossil-based synthetics (polyester, polyamide, polypropylene, acrylic, elastane, other synthetics such as polyethylene, aramids and other specialty fibres). Carbon and mineral-based fibres are excluded from the analysis as are non-fibre natural materials such as leather, natural rubber, feather and down.
- Total EU fibre consumption is 18.6 Mt in 2025, rising to 21.3 Mt by 2050 (about 0.5%/yr).

2.2. Base year, calibration and reconciliation

2025 is the calibration base year. Base-year volumes are bottom-up estimates by segment, reconciled to public apparent-consumption data (Eurostat PRODCOM and trade series, the JRC 2023 textile recycling study for consumer-related products and various industry sources for the professional and technical categories); the population trajectory uses Eurostat EUROPOP2025. Volumes and fibre tonnes are balanced by iterative proportional fitting (RAS) so that every sub-segment adds up exactly to its segment, and every segment×fibre cell is consistent with both the segment volume and the aggregate fibre totals.

2.3. Biobased versus fossil

"Biobased" here means fibres of renewable origin: the natural fibres (cotton, wool, and other natural fibres such as flax, hemp, and in hygiene, wood/fluff pulp) plus the man-made cellulosics (viscose, modal and lyocell), which are regenerated from wood pulp. "Fossil-based" means synthetic polymers derived from

petrochemicals: polyester, polyamide, polypropylene, acrylic, elastane and other synthetics (including polyethylene).

At the 2025 base year, bio-based synthetics (e.g. bio-PET, PLA) are considered negligible and set to zero; they enter only in the forward scenarios. Recycled synthetics such as rPET are fossil-origin and counted as fossil. On this basis the biobased share of total EU fibre consumption is 38.2% in 2025.

The term renewable material refers to the totality of fibres either derived from biological or recycled/recovered sources other than primary extracted fossil fuels.

2.4. Fibre-mix conventions

- "Other natural fibres" denotes flax/hemp (and technical bast fibres) in the apparel, interior and technical markets, but represents wood/fluff pulp in the Hygiene & Medical market, where it is the absorbent core of hygiene products. Pulp is renewable and therefore counts as biobased.
- Within the man-made cellulosics, viscose/modal and lyocell are split 85/15 by default in the markets where lyocell penetration is otherwise negligible (technical, interior, professional, hospitality); the clothing and hygiene markets carry their own evidence-based splits.

2.5. Volume trends and composition scenarios

Historical and projected volumes are set per segment from documented demand drivers (given in each section). Consumer Clothing is built on the actual PRODCOM apparent-consumption series (JRC/DS-056120) for the full 2000-2022 period, with a direct-to-consumer and otherwise-uncaptured uplift phased in from 3% (2000) to 10% (2025) and held at 10%; the other markets use segment-specific node assumptions and, where a market has a distinctive dynamic (the COVID PPE surge in medical textiles, the compound-growth path of sports and outdoor equipment), an explicit volume path.

The fibre composition over time is described by three scenarios (**Business as Usual**, **Aggressive Bioeconomy Transition** and **Circular Biobased Transition**) which set the aggregate biobased/synthetic trajectory to 2050 (the biobased share reaching 30.3%, 63.0% and 45.3% respectively). This annex documents the 2025 base-year composition by segment; the forward composition follows these scenarios at the aggregate level and is distributed back across segments by the same reconciliation engine.

2.6. Sources and caveats

The model is a reconciled estimate built on public apparent-consumption data, not a measured fibre inventory. Sub-segment splits and fibre mixes are expert estimates informed by the technical-textile application taxonomy, the JRC 2023 textile recycling study and validation exchanges with European industry associations for selected segments. In the Technical & Industrial market, sub-segment fibre mixes are balanced (RAS-reconciled) to the segment total, so individual sub-segment percentages are best estimates within a fixed segment envelope rather than independently surveyed values.

All figure represent apparent consumption (production plus imports minus exports, at fibre level). They do not include any material losses through the manufacturing supply chain of the respective products which in the case of complex assembled products such as garments, footwear, sports and protective equipment can be substantial.

The figures presented are typical for highly industrialised economies like Europe, North America, Japan or Australia, but shouldn't be extrapolated to the global level, where textile material consumption is more strongly tied to Apparel with segments like Technical & Industrial, Hygiene and Medical or Hospitality representing smaller shares.

3. Summary: all end markets (2025)

Volumes are EU-27 apparent consumption. CAGR is the 2025-2050 compound annual growth rate of volume. Biobased and fossil are shares of the segment's 2025 fibre mix.

End market	2025 (Mt)	2050 (Mt)	CAGR	Biobased	Fossil
Consumer Clothing	5.00	5.33	+0.3%	56%	44%
Home & Household	1.68	1.66	-0.1%	63%	37%
Interior Textiles	2.42	2.29	-0.2%	29%	71%
Hospitality Textiles	0.80	1.00	+0.9%	76%	24%
Professional/Workwear	1.20	1.30	+0.3%	29%	71%
Hygiene & Medical	2.20	2.95	+1.2%	54%	46%
Technical & Industrial	5.30	6.75	+1.0%	8%	93%
EU-27 total	**18.61**	**21.28**	**+0.5%**	**38%**	**62%**

4. End markets in detail

4.1. Consumer Clothing

Coverage. All garments and apparel placed on the EU market: outerwear and everyday wear, underwear and basics, and sportswear/outdoor/activewear. Footwear and travel/sports accessories (bags, luggage) are captured under Technical & Industrial → Sports & Outdoor Equipment, not here; household and flat textiles sit in their own markets.

2025 volume. 5.00 Mt, 56% biobased / 44% fossil. Projected to 5.33 Mt by 2050 (+0.3%/yr).

Past trend. The clothing series is built on the actual PRODCOM apparent-consumption figures (JRC, DS-056120) for the full 2000-2022 period. Before 2005 the EU market was quota-protected (higher domestic production at higher prices, lower imports) with apparent consumption of about 2.5-2.8 Mt, peaking in 2003. The removal of the Multi-Fibre Arrangement quotas then drove a step-change of about 91% from 2004 (2.64 Mt) to 2005 (5.04 Mt) as low-cost imports surged: a structural break that should be read cautiously in trend terms. The 2005 import surge wasn't fully absorbed by consumer demand and imports eased again somewhat in subsequent years. Apparent consumption was volatile through the 2010s, with high points in 2018 (4.90 Mt) and 2022 (4.99 Mt, the series maximum) and a sharp COVID dip in 2020 (3.80 Mt). A direct-to-consumer and otherwise-uncaptured uplift is phased in from 3% (2000) to 10% (2025) and held at 10% thereafter; on the resulting modelled series the high point is 2022 (~5.5 Mt) and 2025 stands at 5.0 Mt.

Future trend. Broadly flat with a slight upward drift (5.0 → 5.3 Mt, ~0.3%/yr). Structural headwinds (an ageing population, the shift of spending from goods to services, overall consumer price inflation and resale/second-hand cannibalisation) largely offset by minor population and market volume growth.

Fibre mix. Biobased-leaning (56%). Cotton is the single largest fibre across everyday and basic apparel for comfort and skin contact; wool features in tailoring and knitwear, viscose/modal in drape and linings. Polyester dominates the performance-oriented sportswear line, with polyamide and elastane for stretch and durability, which pulls the segment average toward the middle.

Sub-segments: product scope

- **Outerwear & everyday apparel.** 3.00 Mt (60% of segment), 67% biobased. Jackets, coats, trousers, shirts, dresses, knitwear and general everyday clothing. Cotton-led (denim, shirting, jersey) with polyester blends, some wool in tailoring/knitwear, acrylic in lower-cost knitwear, viscose for drape and elastane for stretch.
- **Underwear & basics.** 0.75 Mt (15% of segment), 73% biobased. Underwear, socks, T-shirts, leggings and basic layers. The most cotton-intensive line (comfort, breathability, skin contact), with viscose/modal, a little elastane for fit and low synthetic content: the most biobased clothing sub-segment.
- **Sportswear, outdoor & activewear.** 1.25 Mt (25% of segment), 20% biobased. Performance and athleisure apparel, technical outerwear and base layers. Polyester-dominated for moisture management, quick-dry and durability, with polyamide, elastane (stretch) and acrylic; only ~20% biobased, reflecting functional performance requirements.

4.2. Home & Household

Coverage. Domestic linen: bed and bath textiles and kitchen/table linen. Curtains and soft furnishings are classified to Interior Textiles.

2025 volume. 1.68 Mt, 63% biobased / 37% fossil. Projected to 1.66 Mt by 2050 (-0.1%/yr).

Past trend. A mature market, broadly flat across the period.

Future trend. Net flat (1.68 → 1.66 Mt). A general decline in goods consumption is offset by household fragmentation: more single-person and less stable households raising per-household textile needs somewhat but do not fully offset overall decline.

Fibre mix. Cotton-rich (biobased 63%) for absorbency and hand-feel in towelling and bed linen, blended with polyester for durability and easy-care in poly-cotton articles. Both sub-segments carry the same composition (kitchen/table linen inherits the parent segment mix).

Sub-segments: product scope

- **Bed & bath linen.** 1.32 Mt (79% of segment), 63% biobased. Sheets, duvet covers, pillowcases, towels and bathrobes. Cotton-rich for absorbency and hand-feel, blended with polyester for durability and easy-care.
- **Kitchen & table linen.** 0.36 Mt (21% of segment), 63% biobased. Tea towels, tablecloths, napkins and aprons. Inherits the parent Home & Household mix, cotton-led with a polyester blend.

4.3. Interior Textiles

Coverage. Furnishing textiles for buildings and furniture: carpets and floor coverings, mattresses and bedding textiles, upholstery and furniture fabrics, and curtains/blinds/decorative interiors.

2025 volume. 2.42 Mt, 29% biobased / 71% fossil. Projected to 2.29 Mt by 2050 (-0.2%/yr).

Past trend. Long-run structural decline, driven mainly by falling EU carpet consumption as hard flooring gained share.

Future trend. Slight continued decline (2.42 → 2.29 Mt) on slow EU housing turnover and consumption.

Fibre mix. The most synthetic-heavy of the consumer-facing markets (biobased 29%). Carpets and curtains are dominated by polyester, polypropylene and polyamide for abrasion and stain resistance, light-fastness and cost; some wool and cotton persist in premium carpets, mattress tickings and upholstery.

Sub-segments: product scope

- **Carpets & floor coverings.** 0.77 Mt (32% of segment), 10% biobased. Tufted and woven carpets, rugs and floor coverings. Face yarns are predominantly polypropylene, polyamide and polyester (durability, stain and abrasion resistance, cost); premium ranges retain wool. Only ~10% biobased.
- **Mattresses & bedding.** 0.51 Mt (21% of segment), 42% biobased. Mattress tickings, toppers, quilts and bedding textiles (excluding bed linen). Cotton and wool tickings and fillings alongside polyester wadding and polypropylene; ~42% biobased.
- **Upholstery & furniture.** 0.42 Mt (18% of segment), 43% biobased. Furniture covers and upholstery fabrics. Cotton and wool covers with polyester and acrylic for durability and fade resistance; ~43% biobased.
- **Curtains, blinds & decorative interiors.** 0.72 Mt (30% of segment), 33% biobased. Curtains, drapes, blinds and decorative interior fabrics. Polyester-dominated for drape, dimensional stability, flame-retardant options and light-fastness, with cotton and linen ('other natural') for a natural look; ~33% biobased.

4.4. Hospitality Textiles

Coverage. Contract flat linen for professional hospitality and care settings: hotel and restaurant linen, and healthcare/care-facility linen.

2025 volume. 0.80 Mt, 76% biobased / 24% fossil. Projected to 1.00 Mt by 2050 (+0.9%/yr).

Past trend. Growth based increasing tourism and elderly care provision, overcompensating a slight decline in number of hospital beds; a sharp dip in 2020 with the COVID collapse in travel and hospitality, now fully recovered.

Future trend. Solid growth (0.8 → 1.0 Mt) on continued tourism and elderly-care capacity expansion.

Fibre mix. Cotton-rich (biobased 76%, the highest of any market) for comfort and repeated industrial laundering, with polyester in poly-cotton blends for durability and dimensional stability under institutional wash cycles. Both sub-segments share the parent segment fibre mix.

Sub-segments: product scope

- **Hotel & restaurant flat linen.** 0.48 Mt (60% of segment), 76% biobased. Bed linen, towels, table linen and napery for hotels and restaurants. Cotton-rich for comfort and repeated industrial laundering, with polyester in poly-cotton blends (parent mix).
- **Healthcare & care-facility linen.** 0.32 Mt (40% of segment), 76% biobased. Bed linen, towels and flat linen for hospitals and care homes. Inherits the parent Hospitality mix, cotton-rich with a polyester blend for institutional wash cycles.

4.5. Professional/Workwear

Coverage. Occupational clothing: protective workwear and personal protective equipment (PPE), and corporate/uniform and image wear. Disposable nonwoven PPE (masks, gowns) is recorded under Hygiene & Medical.

2025 volume. 1.20 Mt, 29% biobased / 71% fossil. Projected to 1.30 Mt by 2050 (+0.3%/yr).

Past trend. Stable to marginal growth, declining industrial employment offset by growing customer-facing service and public sector employment.

Future trend. Continued marginal growth (1.2 → 1.3 Mt): declining industrial-workforce numbers are offset by rising public- and service-sector employment.

Fibre mix. Synthetic-leaning (biobased 29%). Protective workwear carries high polyester and specialty 'other synthetic' content (aramids, modacrylic and other flame-/chemical-resistant fibres) plus

polypropylene in disposable coveralls; corporate uniforms use polyester-cotton blends for easy-care and appearance retention, which lifts cotton content.

Sub-segments: product scope

- **Protective workwear & PPE.** 0.78 Mt (65% of segment), 21% biobased. High-visibility, flame-retardant, chemical- and cut-protective clothing and durable PPE. Polyester with a large 'other synthetic' share (technical/FR fibres such as aramids and modacrylic), polypropylene (nonwoven coveralls), FR-treated cotton and acrylic: ~21% biobased, the lowest in this market.
- **Corporate/uniform & image wear.** 0.42 Mt (35% of segment), 43% biobased. Corporate uniforms, service-sector and image wear. Polyester-cotton blends for durability, easy-care and colour retention, with some wool in tailored uniforms; ~43% biobased.

4.6. Hygiene & Medical

Coverage. Nonwoven and durable textiles for personal hygiene and medical/care use. Personal Hygiene Products cover baby diapers, adult incontinence, feminine care and wipes; Durable and Disposable Medical Textiles cover PPE (masks, gowns, drapes), wound care and bandages, covers, surgical products, medical wipes/pads, bags and pouches. Patient personal-hygiene items and filtration media are included in other segments.

2025 volume. 2.20 Mt, 54% biobased / 46% fossil. Projected to 2.95 Mt by 2050 (+1.2%/yr).

Past trend. An ageing-driven grower. From 2020 the COVID surge in nonwoven PPE lifted the medical line sharply (peaking in 2021, then normalising); personal hygiene grew steadily on demographics.

Future trend. ~1.2%/yr (2.2→2.95 Mt) on an ageing population, rising adult incontinence, wound-care and surgical demand.

Fibre mix. Biobased 54% overall, driven by wood/fluff pulp (recorded under 'other natural') as the absorbent core and by viscose in wipes; polypropylene dominates the nonwoven cover layers. Convention: in this market 'other natural' denotes wood/fluff pulp, which is renewable and counts as biobased.

Sub-segments: product scope

- **Personal Hygiene Products.** 1.20 Mt (55% of segment), 65% biobased. Baby diapers, adult incontinence products, feminine hygiene, wipes and other personal-hygiene textiles. Roughly half wood/fluff pulp (the absorbent core), with polypropylene in top/back sheets, viscose in wipes and small cotton and polyester shares; ~65% biobased under the wood-pulp convention.
- **Durable and Disposable Medical Textiles.** 1.00 Mt (46% of segment), 40% biobased. PPE (face masks, gowns, hoods, covers), wound care and bandages, covers, surgical products (sutures, meshes, grafts, stents), medical wipes and pads, bags and pouches. Polypropylene-dominated (nonwoven PPE and drapes) with polyester, viscose/lyocell (wound care, wipes), cotton (gauze/bandages) and pulp; ~40% biobased.

4.7. Technical & Industrial

Coverage. Industrial and technical textiles across the '-tech' application areas: automotive and transport, construction and geotextiles, agro-textiles, filtration, packaging and other industrial textiles, and sports and outdoor equipment (footwear textiles, travel/sports/outdoor goods and artificial turf).

2025 volume. 5.30 Mt, 8% biobased / 93% fossil. Projected to grow to 6.75 Mt by 2050 (+1.0%/yr).

Past trend. Steady growth (~1.4%/yr) on automotive, construction and filtration demand.

Future trend. Growth driven by material substitution and light-weighting: textiles and fibre-reinforced composites replacing metals, wood and glass in automotive, construction and industry (~0.8%/yr for the established areas). Sports & Outdoor Equipment is modelled separately at 2.5%/yr from 2000 to 2021 and 2%/yr thereafter.

Fibre mix. Overwhelmingly fossil-based (biobased 7.5%). Performance, cost and durability requirements favour polyester, polypropylene and polyamide across nearly all applications; natural fibres appear only as flax/hemp in composites and minor cotton content.

Sub-segments: product scope

- **Automotive & other transport.** 1.38 Mt (26% of segment), 3% biobased. Seat fabrics, carpets, headliners, airbags, seatbelts, tire cord and acoustic/NVH nonwovens for all types of passenger transport vehicles. Tarpaulins, covers, nets, ropes and other textile-based products for heavy-duty land, sea and air transport. Polyester (seating, tarpaulins, tire cord), polyamide (airbags, seatbelts) and polypropylene; ~3% biobased.
- **Construction & geotextiles.** 1.15 Mt (22% of segment), 8% biobased. Geotextiles, membranes, reinforcement, roofing and construction fabrics. Polypropylene and polyester dominate; 'other natural' is flax/hemp in composites. ~8% biobased.
- **Agro-textiles.** 0.55 Mt (10% of segment), 7% biobased. Crop covers, shade and hail nets, mulch, silage wrap and other agricultural textiles. Polypropylene-led (UV-stabilised) with polyester; ~7% biobased.
- **Filtration.** 0.60 Mt (11% of segment), 8% biobased. Air and liquid filter media and industrial filtration textiles. Polyester and polypropylene media with polyamide, acrylic and some specialty cellulosics; ~8% biobased. Hygiene/medical filtration is excluded by design.
- **Packaging & other industrial.** 0.92 Mt (17% of segment), 7% biobased. FIBCs/big bags, strapping, tarpaulins, belts and hoses, industrial wovens and miscellaneous industrial textiles. Polypropylene and polyester dominated; ~7% biobased.
- **Sports & Outdoor Equipment.** 0.70 Mt (13% of segment), 17% biobased. Footwear textiles (uppers, linings, laces), travel and sports goods (bags, luggage, tents, sleeping bags, nets, inflatables) and artificial turf. Polyester-led (coated fabrics, footwear textiles, turf backing) with polyamide (technical fabrics, nets, footwear), polyethylene and other synthetics (turf yarn, coatings), polypropylene and cotton (canvas footwear and bags); ~17% biobased. The leather/rubber/EVA components of footwear are excluded as non-textile.

Abbreviations

A

AI Artificial Intelligence

B

BAT Best Available Techniques

BDO 1,4-Butanediol (platform monomer)

C

CAGR Compound Annual Growth Rate

CAP Common Agricultural Policy (EU)

CAPEX Capital Expenditure

CBAM Carbon Border Adjustment Mechanism

CEFIC European Chemical Industry Council

CITEVE Portuguese Textile and Clothing Technology Centre

CO_2 Carbon dioxide

COM European Commission document reference (e.g. COM(2025) 960 final)

D

DNA Deoxyribonucleic acid (used here for physical-digital traceability markers)

DPP Digital Product Passport

E

EIB European Investment Bank

EPD Environmental Product Declaration

EPR Extended Producer Responsibility

ESPR Ecodesign for Sustainable Products Regulation

ETP European Technology Platform (for the Future of Textiles and Clothing)

EU European Union

EURATEX European Apparel and Textile Confederation

F

FDCA 2,5-Furandicarboxylic acid

G

GMO Genetically Modified Organism

GPP Green Public Procurement

GRS Global Recycled Standard

I

IRENA International Renewable Energy Agency

ISO International Organization for Standardization

J

JRC Joint Research Centre (European Commission)

K

KL Kraft Lignin

L

LCA Life Cycle Assessment

LIFE EU LIFE Programme (EU funding for environment and climate action)

M

MEG Mono-ethylene glycol

MMCF Man-Made Cellulosic Fibres

O

OEKO-TEX OEKO-TEX® textile testing and certification system (e.g. STANDARD 100)

OEM Original Equipment Manufacturer

P

PA Polyamide (nylon); grades referenced include PA6, PA10.10, PA11, PA66

PBS Polybutylene succinate

PEF Polyethylene furanoate (biobased polyester)

PET Polyethylene terephthalate

PFAS Per- and polyfluoroalkyl substances

PHA Polyhydroxyalkanoates

PLA Polylactic acid

PP Polypropylene

PPE Personal Protective Equipment

PRODCOM EU statistics on the production of manufactured goods

PTA Purified Terephthalic Acid

PU Polyurethane

R

REACH Registration, Evaluation, Authorisation and Restriction of Chemicals

ROI Return on Investment

RRP Recovery and Resilience Plan

RTO Research and Technology Organisation

S

SME Small and Medium-sized Enterprise

U

UK United Kingdom

UPF Ultraviolet Protection Factor

USD US Dollar

UV Ultraviolet

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The European Technology Platform for the Future of Textiles and Clothing, Textile ETP in short, is the largest network for textile research and innovation in Europe. It acts as a think tank, strategic connector and EU funding access facilitator for textile industry, research, education and cluster organisations.

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