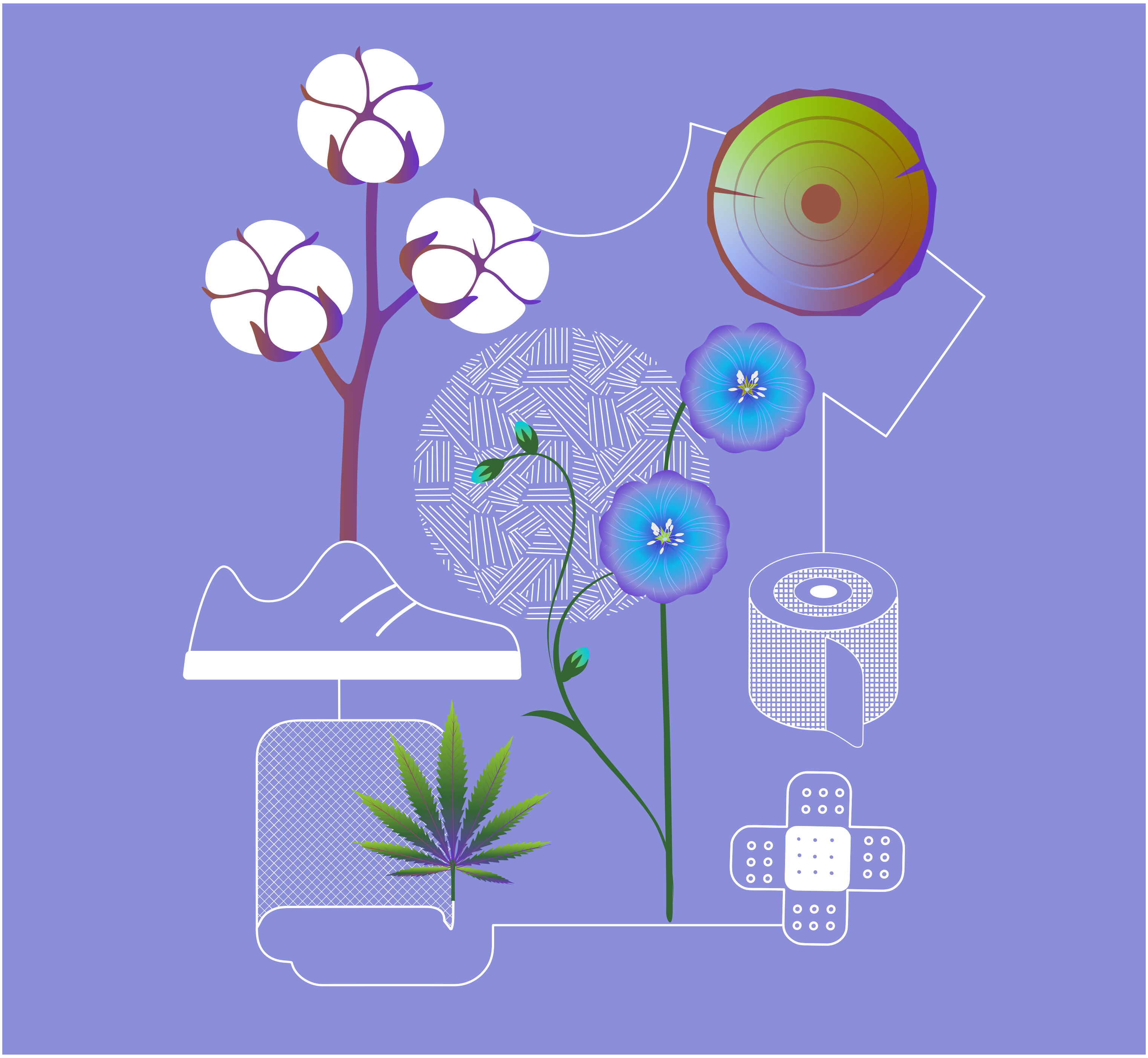
Bio-based Industries Consortium

Lead Markets for Europe's Bioeconomy

Textiles from Bio-based Fibres & Fabrics



1. Introduction

Creating alternatives to fossil-based fibres in a growing global market

The global textile system is characterised by sustained demand growth combined with a structural dependence on fossil-based synthetic fibres. Global fibre production has increased from 58 million tons in 2000 to 124 million tons in 2023 and is projected to reach around 160 million tons by 2030. Synthetic fibres account for approximately 67% of total production, with polyester alone representing roughly 57–60% of the global fibre market.

1.1 Overview

Despite growing attention to circularity, textile-to-textile recycling remains below 1%, reflecting structural weaknesses in collection, sorting and especially also processing.

Moreover, the vast majority of recycled polyester comes from PET bottles rather than post-consumer textiles. This underscores how limited the progress toward true fibre-to-fibre circularity has been so far. It also hampers the more efficient use of recyclable bottle-PET within the packaging system: bottle-PET can be recycled repeatedly bottle-to-bottle, but once it is diverted into textile production, it is not only removed from the packaging cycle—it exits circular use altogether, since there is currently no viable route back from fibre. In effect, this shortens the circular lifetime of the molecules, turning a potentially closed loop into a one-way step toward end-of-life.

At the same time, life cycle assessments show that roughly 60–63% of environmental impacts occur upstream, at the level of raw material extraction and fibre production, while waste management accounts for less than 1%. This highlights a structural challenge. Bio-based PET and other bio-based fibres offer a viable and sustainable alternative to fossil-based fibres, but must be complemented with robust recycling options to raise the fibre-to-fibre rate.

Europe holds a strong position in selected upstream segments, including man-made cellulosic fibres (MMCF) production, flax and growing hemp supply, as well as integration with chemical and biotechnology industries. However, it remains dependent on imports for synthetic fibres and cotton, creating both a vulnerability and an opportunity to develop domestic bio-based value chains.

While Europe represents a major market for textile products, textile fibre production takes place largely outside Europe (with some notable exceptions). The textile sector is characterised by:

- A steady increase in demand and production volumes: the global textile fibres production grew from 58 Mt/year in 2000 to 124 Mt/year in 2023.
- Cheap, fast-fashion products based on virgin fossil feedstock dominance.
- Very low rate of textile-to-textile recycling: recycled fibres represent less than 1% of the global fibre market.

1.2 Natural fibres

Natural fibres are obtained from plants (e.g. cotton, flax, hemp and animals (e.g. wool, silk). Cotton has the largest production among bio-based fibres (24.7 Mt in 2023), representing 20 % of global fibre production. The EU-27 hosts a small production of cotton (0.35 Mt per year, or 1.4% of the global production), with Greece and Spain being the main producers.

Besides cotton, other plant-based fibres, mainly jute and coir, contribute to the global production. In 2023 they accounted for 6.7 Mt. 64 % of the flax used for fibre in 2023 was grown in Europe. The average production of flax fibres in the EU-27 is 1.1 Mt per year (2024 data). Belgium, France, and the Netherlands are top producers and exporters of flax fibres, while Italy is the main exporter of linen fabrics in Europe.

Europe produces around 0.19 Mt per year (2024 data) of hemp, mostly in France and the Netherlands.

Global Hemp fibre production was estimated between 0.2 and 0.3 Mt in 2023, with EU contributing over 50 % of global hemp fibre production.

The annual production volume of clean sheep wool fibre is approximately 0.9 % of global fibre market (1 Mt). Recycled wool accounts for 6 % of the global wool market.

The EU production of wool for garments is negligible, as most of it comes from animals reared for meat and diary purpose. Their wool is usually treated as a by-product. Notwithstanding that, the approximately 0.2 Mt of coarse wool per year produced in Europe could become an important source of feedstock for technical applications.

1.3 Semi-synthetic fibres

Semi-synthetic fibres are man-made fibres of biological origin obtained from plants (mainly trees) containing cellulose, a natural polymer.

Cellulose pulp used for textiles, of higher quality than paper cellulose, is called dissolving cellulose pulp. It is converted into fibres by either chemical derivatisation or direct dissolution; regeneration in a solvent allows to obtain continuous filaments and to produce the cellulose fibres . Examples of cellulosic fibres are viscose and lyocell.

Global MMCF production has more than doubled since 1990, reaching 7.9 Mt in 2023 (6 % of the total global fibre production).

Viscose is the main MMFC fibre. Its production volume in 2023 was 6 Mt (80 % of the global MMCFs production, 5 % of all textile fibres). Modal fibres, lyocell and cellulose acetate cover respectively a 3 %, 4 % and 13 % share of the total MMCFs market. The EU production of MMCFs is estimated to be around 1.5 Mt.

New cellulose-based textile fibres highlight a shift from conventional viscose and lyocell processes that rely on chemically dissolved, highly purified pulp, towards technologies that can utilise a broader range of cellulose feedstocks (including recycled textiles or paper grade pulp) with alternative conversion pathways.

1.4 Bio-based synthetic fibres

Synthetic fibres are fibres obtained from the polymerisation of monomers. While largely relying on fossil-based feedstock, some bio-based monomers are being used for polymeric fibre production. Examples are PLA, PEF and (partially) bio-based PET.

Among the bio-based synthetic fibre polymers without a fossil-based analogue, polylactic acid (PLA) is the main commercially available 100 % bio-based polyester. PLA is a biodegradable polyester that has been actively developed since the 1990s for applications in single-use plastics such as food packaging and cutlery. PLA has a different chemical structure than PET, and especially thermal properties for textile applications are inferior compared to PET.

Other examples of new, fully bio-based polyesters are PEF (polyethylene furandicarboxylate) and PBF (polybutylene furandicarboxylate), which are still under development, and not yet widely available on the market. Of these, PEF is a potential fibre polymer candidate due to its promising fibre material properties.

In 2023, PET held a 57 % share of the global fibre production, equivalent to 71.1 Mt, while rPET fiber production is around 8.9 Mt. The market share of bioPET is still very low, around 0.02 % of global PET fibre production. The total production of PLA is in the range of 0.5-0.7 Mt and a 40 % annual growth (for all PLA applications, not only the textile) is expected.

2. Apparel

Driving the transition to more sustainable apparel

Apparel represents the largest textile end-market and is the primary driver of global fibre demand. The global apparel market is valued at approximately USD 1.8–1.9 trillion and is projected to grow at a rate of around 3–4% per year, reaching up to USD 2.5–2.6 trillion over the next decade.

2.1 Overview

The textiles–clothing–leather–footwear (TCLF) ecosystem represents nearly 200,000 companies, €170 billion annual turnover, and 1.3 million jobs in Europe.

In 2021, the bio-based textiles sector employed almost 700 000 people in the EU. The value added by this sector was 25 billion EUR, representing 3.5% of the total value added of biomass producing and converting sectors.

2.2 Competitiveness & innovation

The competitiveness of the apparel sector is primarily driven by the cost efficiency and scalability of polyester, combined with highly optimised global supply chains. These factors have led to a structural lock-in of fossil-based fibres.

At the same time, the sector is undergoing gradual transformation driven by brand-level sustainability commitments, increasing consumer awareness, and innovation in materials. Within this context, bio-based solutions are gaining relevance.

Bio-based synthetic fibres represent the only scalable pathway to substitute fossil carbon in synthetic fibres in the near term. Unlike recycling, which is constrained by structural and technological limitations, they enable immediate substitution of fossil feedstocks while remaining compatible with existing production systems. This makes them a critical complement to circular strategies, rather than an alternative to them.

2.3 Market data

Material use in apparel reflects strong fossil dependency, with polyester accounting for approximately 57–60% of fibres, followed by cotton at around 20% and MMCF at approximately 6%. Recycling remains limited, with fibre-to-fibre recycling rates below 1%. In absolute terms, this corresponds to roughly 70 million tonnes of polyester fibres annually, underlining the scale of substitution required.

Bio-based synthetic fibres currently represent only a marginal share of the market, although they are expected to grow rapidly over the coming decade.

2.4 Sustainability

The apparel sector has significant environmental impacts due to its reliance on fossil-based fibres, high volumes, and short product life cycles. In particular, polyester contributes to greenhouse gas emissions and microplastic release. Among natural fibres, cotton is associated with high ILUC, water consumption and heavy fertiliser intake.

Given that the majority of impacts originate upstream, addressing the origin of carbon in fibre production is essential. Bio-based fibres can reduce fossil carbon dependency and contribute to lowering life cycle emissions, especially when combined with improved circularity, as addressing upstream carbon is essential given its dominant contribution to lifecycle impacts.

Regarding end of life, circularity is still very limited as textile-to-textile recycling is still well below 1%. This is exacerbated by the growth of fast fashion sensibly reducing the average lifespan of garments. Fashion is the 4th most environmentally impactful sector in Europe.

Synthetic textiles persist for centuries and significantly contribute to ocean plastic pollution: about 8% of European microplastics released to oceans comes from synthetic textiles. A systemic change is needed to address sustainability issues upstream and downstream.

3. Nonwovens

Expanding bio-based materials in hygiene and industrial applications

3.1 Overview

Nonwovens represent a heterogeneous high-volume segment characterised by mostly single-use products with limited circularity pathway. Main end applications are in filtration, automotive and transport, building and construction, as well as hygiene and medical products.

3.2 Competitiveness & innovation

The sector is highly cost-sensitive and dominated by fossil-based materials, particularly polypropylene. However, innovation is increasing in response to sustainability concerns, including the use of cellulose fibres and emerging bio-based materials.

So far, consumer products such as wipes have witnessed a higher degree of penetration of cellulosic fibres compared to industrial nonwovens, which are still dominated by synthetic fibres.

Depending on the application, bio-based fibres may be well suited to this market segment, as they can be integrated into existing production systems and deliver immediate substitution of fossil-based materials; technical performance, price, heterogeneity of the sector, and sufficient availability are the mainobstacles.

3.3 Market data

The global market for industrial nonwovens was estimated at USD 27.1 billion in 2023 and projected to increase to USD 43.6 billion in 2028, with a CAGR of 7-8%. The global hygiene nonwoven market is estimated at USD 28.6 billion in 2025 and is projected to reach USD 48.3 billion by 2034, growing at approximately 6% annually.

3.4 Sustainability

In many applications nonwovens are coupled with other materials which makes the end products difficult to recycle.

Bio-based materials can reduce fossil resource use and contribute to lower life cycle emissions, with studies indicating potential reductions in the range of 10–20%.

4. Footwear

Advancing sustainable materials for footwear manufacturing

4.1 Overview

The footwear sector is a large and complex market, combining textiles, polymers and composite materials across a wide range of products.

4.2 Competitiveness & innovation

The sector is characterised by strong innovation dynamics driven by global brands. Materials play a central role in product differentiation, and there is increasing interest in bio-based alternatives.

While substitution is more complex than in apparel or hygiene due to multi-material products, bio-based polymers offer opportunities across several components.

4.3 Market data

Global footwear production exceeds 20 billion pairs annually, with a market value estimated at €350–450 billion.

Synthetic materials dominate across most product categories, reflecting the importance of polymers in performance and durability requirements.

4.4 Sustainability

Footwear has a high environmental footprint due to its complex material composition and limited recyclability.

Bio-based materials can contribute to reducing fossil dependency, although scaling remains more challenging due to product complexity and strict performance requirements, which slow the substitution of incumbent materials.

5. Biomedical Textiles

Supporting innovation in advanced medical textiles

5.1 Overview

Biomedical textiles represent a specialised and high-value segment of the textile market, covering applications such as wound care, implants and drug delivery systems.

The global medical textiles market is estimated at approximately USD 32.1 billion in 2025 and is projected to reach USD 43.5 billion by 2030, corresponding to a growth rate of approximately 6.5–7.2% CAGR, which is above the overall textile sector average.

While significantly smaller than core textile markets, the segment is strategically relevant due to its strong growth dynamics and focus on advanced material performance.

5.2 Competitiveness & innovation

The biomedical textile sector is driven primarily by functional performance rather than cost, with materials required to meet strict criteria such as biocompatibility, biodegradability and sterility. As a result, bio-based materials play an important role, particularly in applications where controlled degradation or biological interaction is required.

Current applications are largely based on PLA and cellulose-derived fibres, while a broader set of bio-based materials is under development. However, scaling remains constrained by high costs and regulatory requirements, which limit rapid market expansion.

5.3 Market data

Bio-based fibres currently account for approximately 10% of the biomedical textile market, with projections indicating potential growth to around 25% by 2030.

Europe holds a strong position in high-value technical textiles, contributing an estimated 30% of global advanced textile production. Despite this growth, the sector remains a niche in terms of overall fibre demand.

5.4 Sustainability

Bio-based materials in biomedical applications can reduce fossil carbon dependency and enable specific functional advantages, such as biodegradability.

However, the sector is characterised by limited circularity, as products are typically incinerated for safety reasons. Environmental performance therefore depends primarily on material choices and production systems rather than end-of-life solutions.

6. Technical Textiles
Enabling high-performance industrial applications

6.1 Overview

Technical textiles represent a highly diverse and application-specific segment, covering areas such as automotive, construction, filtration, and advanced composites.

In contrast to consumer textiles, this segment is fragmented across multiple industries and characterised by specialised performance requirements and long product lifetimes.

6.2 Competitiveness & innovation

The competitiveness of technical textiles is driven primarily by performance rather than cost, with materials required to meet specific functional criteria such as strength, durability, or resistance properties.

Bio-based materials are increasingly being explored in this context, including bio-based polymers and lignin-based carbon fibres, demonstrating the potential to contribute to advanced material systems.

At the same time, substitution remains challenging due to stringent performance requirements and certification processes, limiting rapid adoption compared to more standardised textile markets.

6.3 Market data

Unlike core textile markets, technical textiles do not constitute a single, well-defined market segment but rather a collection of heterogeneous applications across multiple industries.

As a result, comparable and consolidated market data on fibre volumes and material shares is limited, and the role of bio-based fibres remains difficult to quantify.

This fragmentation reflects the niche and highly specialised nature of the segment, which differs fundamentally from high-volume textile markets.

6.4 Sustainability

Technical textiles offer opportunities for integrating bio-based materials into high-performance applications, potentially reducing reliance on fossil-based inputs. However, due to long product lifetimes and specialised use cases, the overall impact on textile fibre demand and substitution dynamics is expected to remain limited in the short to medium term.

7. Cross-cutting Dynamics
Common trends shaping the future of bio-based textiles

Across all segments, a key challenge is the structural dependence on fossil-based carbon combined with the limited scalability of recycling. This highlights the need for a broader approach to circularity that addresses both recycling and the origin of carbon in materials.

Bio-based fibres play a critical role in this context by enabling immediate substitution of fossil carbon while supporting the long-term development of circular systems. This dual pathway is essential to avoid continued lock-in of fossil-based materials while recycling systems scale up.

8. Conclusions

Scaling bio-based fibres for Europe's textile transition

The textile system is structurally dominated by fossil-based materials, with strong growth and limited circularity.

Environmental impacts are concentrated upstream, making the origin of carbon in fibres a central and currently under-addressed factor in the transition towards sustainability.

Apparel, and footwear, provide the strongest opportunities to scale bio-based textiles. Apparel offers the largest substitution potential and enable immediate deployment in largely non-circular systems, and footwear provides a platform for innovation.

Together, these segments form a coherent pathway for scaling bio-based solutions, strengthening European value chains, and reducing dependence on fossil carbon at scale, representing a necessary complement to recycling in achieving a truly circular textile system.

In addition, emerging high-value segments such as biomedical, technical textiles, and nonwovens play an important role in advancing innovation in bio-based materials, although their contribution to overall fibre volumes remains limited.

Achieving sustainability in the textile sector requires systemic change across the entire value chain, with upstream shifts toward renewable and circular raw materials and cleaner production processes, and downstream transformation in product design, reuse, recycling, and consumption patterns.

Annex – References

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

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