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New technologies to integrate PLASTIC waste in the Circular Economy

ARTICLE

Indian Textile Recycling Market and Barriers for Trade with the European Union: A PLASTICE Pathway for Circular Textile Innovation and Replication

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1. Introduction

India plays a central role in the global textile value chain as one of the largest producers, exporters, and processors of textile materials worldwide. The country is also a major generator and exporter of textile waste, positioning it as a key actor in global recycling dynamics (World Bank, 2023). However, despite this scale, the transition toward a circular textile economy remains uneven, particularly in the recycling segment, which is still largely dominated by low-value processes and informal systems (EXIM Bank of India, 2023).

At the global level, the textile sector is undergoing a structural transformation driven by sustainability concerns, regulatory pressure, and the need to reduce environmental impacts. The European Union (EU) has taken a leading role through the *EU Strategy for Sustainable and Circular Textiles*, which aims to ensure that by 2030 textile products are durable, recyclable, and increasingly made from recycled fibers (European Commission, 2022). This regulatory shift is particularly relevant given that the EU relies heavily on imports, with a large share of textile products sourced from countries such as India (European Commission, 2024).

Within this evolving landscape, technological innovation is a key enabler of circularity. The European-funded project **PLASTICE¹ (New technologies to integrate plastic waste in the circular economy)** represents a significant effort to advance recycling capabilities for complex waste streams, including textiles containing synthetic fibers. The project focuses on developing and demonstrating advanced chemical recycling technologies—such as pyrolysis, hydrothermal liquefaction, gasification, and enzymatic hydrolysis—to overcome the limitations of conventional mechanical recycling and increase the valorization of plastic and textile waste. These approaches are particularly relevant for addressing mixed and contaminated textile materials, which are difficult to recycle using existing methods.

In this context, international collaboration is essential. The contribution of experts such as **Dr. Tania Dey¹** is particularly relevant in bridging European technological developments and emerging markets like India. Such collaboration facilitates knowledge transfer, supports regulatory alignment, and enables the adaptation of advanced recycling technologies to local conditions, contributing to the integration of India into global circular textile value chains.

Despite these opportunities, significant challenges remain. The textile recycling sector in India faces structural, technological, and regulatory barriers that limit its ability to meet the EU's increasing requirements for traceability, quality, and sustainability (European Environment Agency, 2021). Against

¹ PLASTICE is a European project funded by the Horizon Europe Programme of the European Union. The initiative brings together 19 consortium partners from 11 countries, combining expertise from research institutions, industrial stakeholders, consultancy companies, and non-governmental organizations to accelerate the transition towards circular plastics value chains. Additional information regarding the project, its partners, activities, deliverables, and public resources can be found on the official project website: <https://www.plastice-project.eu>.



this background, this article analyzes the textile recycling market in India and examines the main commercial and production barriers affecting trade with the European Union.²

2. Overview of the Textile Recycling Market in India

India's textile recycling sector is one of the largest globally, both in terms of volume and employment. Recycling activities are concentrated in clusters such as Panipat (in Haryana), where large quantities of post-industrial and post-consumer textile waste are processed. However, the sector is characterized by a high degree of informality and fragmentation, with limited technological upgrading (EXIM Bank of India, 2023). The next major hubs for textile recycling are Amroha and Bhojpur (in Uttar Pradesh) which produces new yarns from synthetic and cotton wastes, Tirupur and Coimbatore (in Tamil Nadu) focusing on recycling pre-consumer wastes from local garment manufacturers, and Surat and Ahmedabad (in Gujarat) managing local synthetic and polyester wastes. In this context, the Indian industries that have shown compassion towards circularity and have come forward are Arvind Limited (In Gujarat) and Birla Cellulose (in Maharashtra) along with some startups like Tooused, ReCircle and ReSpun. An EU-funded project 'Green Thread' is already in place to promote sustainability cluster brand, traceability mechanism, production practices, green financing and policy ecosystem (Switch-Asia, 2025).



Photo credits: Photo: De Kringwinkel Antwerpen

² Dr. Tania Dey has spent 20 years of her post-PhD work life in North America and Europe and has recently held the R&D Manager position in a textile research institute in Coimbatore, India. Her expertise is in chemistry and materials for diverse applications including textiles with a strong focus on environment and sustainability.



Most recycling in India relies on mechanical processes, which involve shredding and re-spinning fibers. While cost-effective, these processes result in fiber degradation and are generally limited to downcycling applications, such as insulation, wiping cloths, or low-quality yarns (European Environment Agency, 2021). As a result, only a small fraction of textile waste is recycled into high-value applications, such as fiber-to-fiber recycling.

A key structural challenge is the increasing complexity of textile products, particularly the widespread use of blended fibers (e.g., cotton-polyester). These materials are difficult to separate and recycle using conventional technologies, leading to low recovery rates and reduced material quality (Systemiq, 2025). Additionally, inefficient waste collection and sorting systems further limit the availability of high-quality feedstock for recycling.

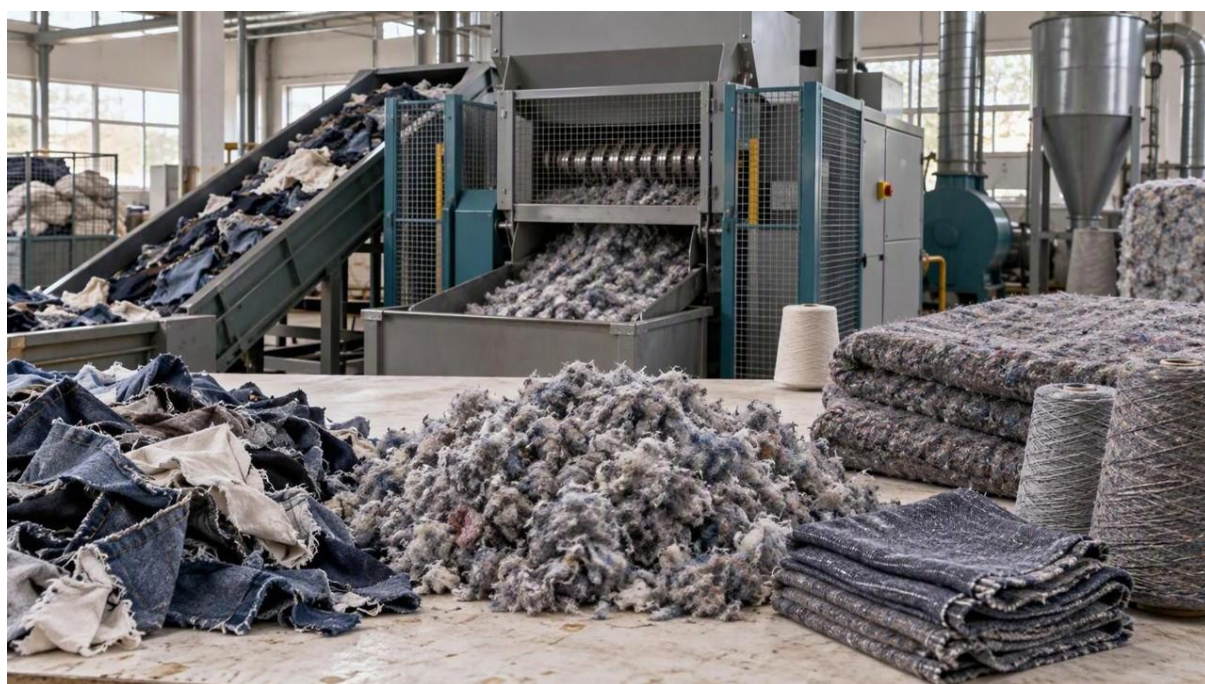


Photo 2: AI-generated illustrative image

3. Commercial Barriers to Trade with the European Union

3.1 Regulatory Compliance and Standards

The EU has introduced stringent regulatory frameworks to promote circularity in the textile sector, including ecodesign requirements, Extended Producer Responsibility (EPR), and digital product passports. These measures require detailed information on material composition, recycled content, and environmental performance (European Commission, 2022).

Indian recyclers often face difficulties in complying with these requirements due to:

- Limited traceability systems
- Lack of certification and standardization
- Insufficient harmonization in testing infrastructure



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This creates a significant barrier to accessing EU markets, where compliance with sustainability standards is increasingly mandatory.

3.2 Quality and Consistency Requirements

European manufacturers require high-quality recycled materials with consistent properties. However, the variability of input waste streams in India—combined with limited sorting technologies—results in inconsistent output quality. This limits the ability of Indian suppliers to meet EU specifications for recycled fibers (European Environment Agency, 2021). Near-infrared technology is a rapid, non-invasive, and highly accurate method for sorting blended fabric, which can be further automated by AI-powered hyperspectral system. India has full potential for adopting these technologies into their waste textile recycling activities.

3.3 Informality and Supply Chain Transparency

Most of the discarded textiles in India are burnt in incinerators or buried in landfills. Apart from that, a large portion of textile recycling in India operates in the informal sector, which poses challenges for:

- Documentation and traceability
- Compliance with labor and environmental standards
- Integration into formal international supply chains

These factors create reputational and regulatory risks for EU companies sourcing recycled materials from India (World Bank, 2023).

3.4 Trade and Cost Barriers

Additional barriers include:

- Certification and compliance costs
- Tariff and non-tariff barriers
- Limited infrastructure for reverse logistics
- Lack of government incentives in India

These factors increase transaction costs and reduce the competitiveness of Indian recycled textile exports.

4. Production and Technological Barriers

4.1 Limitations of Mechanical Recycling

Mechanical recycling remains the dominant technology in India but has inherent limitations:

- Degradation of fiber quality
- Inability to process blended textiles effectively
- Limited scalability for high-value applications



As a result, materials are often downcycled rather than reintegrated into textile production cycles (European Environment Agency, 2021).

4.2 Need for Advanced Chemical Recycling

Advanced recycling technologies, such as those developed under the PLASTICE project, offer significant potential to address these limitations. Chemical recycling can process mixed and contaminated materials, enabling the recovery of high-quality raw materials suitable for textile production.

However, in India, the adoption of these technologies is still limited due to:

- High capital investment requirements
- Lack of technical awareness
- Limited policy incentives

This creates a technological gap between India and the EU, where significant investments are being made in next-generation recycling systems (Systemiq, 2025).

4.3 Sorting and Feedstock Challenges

Efficient recycling depends on high-quality feedstock, which requires advanced sorting technologies. In India, sorting is largely manual, resulting in:

- Contamination of materials
- Inefficient separation of fiber blends
- Reduced recycling efficiency

Improving sorting infrastructure is therefore a critical priority for scaling up textile recycling.

5. PLASTICE Textile Demo-site

The PLASTICE textile demo-site brings together organizations from Austria, Belgium and Türkiye, representing complementary segments of the textile value chain and different perspectives on textile circularity. Through this collaboration, the project combines expertise in textile waste collection and reuse systems, recycling technology development, research and innovation, fibre production, and textile manufacturing.

The strength of the demo-site lies in the integration of these competencies across multiple stages of the value chain. By connecting waste management actors, research organizations, technology providers and industrial textile manufacturers, the consortium aims to demonstrate innovative approaches for improving the circularity of textile materials and increasing the recovery of valuable resources from textile waste streams.



Consortium Partners



AustroCel Hallein Industrial Innovation and Bio-Based Technologies

AustroCel Hallein is an Austrian industrial company with extensive experience in cellulose-based products, biorefinery processes and industrial biotechnology. Through its continuous focus on innovation and resource efficiency, the company has developed expertise in the valorisation of biomass and industrial by-products, supporting the transition towards more sustainable production systems.



Kringwinkel Antwerpen , Reuse and Circular Economy Operator

Kringwinkel Antwerpen is part of the Belgian network of social enterprises dedicated to reuse, repair and circular economy activities. The organization plays an important role in extending product lifetimes, reducing waste generation and promoting resource efficiency through collection, sorting, reuse and resale activities.



Centexbel – Textile Research and Innovation

Centexbel is the Belgian research and technology centre for the textile and plastics industries. The organization supports companies through applied research, testing, certification and technological innovation activities, contributing to the development of sustainable and circular solutions across textile value chains.



TCKT – Transfercenter für Kunststofftechnik

TCKT is an Austrian research and technology organization specializing in plastics engineering and polymer technologies. The organization supports innovation, technology transfer and industrial implementation activities related to advanced materials, recycling processes and circular economy solutions.



KORTEKS – Leading Polyester Yarn Producer

KORTEKS is one of Europe's largest polyester yarn manufacturers and a key actor within the Turkish textile industry. The company operates large-scale production facilities and has extensive experience in fibre production, textile innovation and sustainability initiatives, including the incorporation of recycled materials into textile products.



SUN Tekstil – International Apparel Manufacturer

SUN Tekstil is an internationally recognized textile and apparel manufacturer supplying garments to leading global fashion brands. The company combines product development, design and manufacturing capabilities and is actively engaged in sustainability initiatives throughout its operations.



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RINA Consulting- Industrial Replication Leader



RINA Consulting acts as the Industrial Replication Leader within the PLASTICE project, playing a key role in facilitating the transfer and uptake of circular economy solutions across the plastics value chain. In this capacity, RINA supports the identification, assessment, and replication of innovative practices demonstrated within the project, ensuring their scalability and applicability in different industrial and territorial contexts. Through its expertise in sustainability, industrial innovation, and stakeholder engagement, RINA contributes to bridging the gap between pilot actions and large-scale implementation, maximizing the project's impact and fostering the transition toward a more circular and resource-efficient plastics sector.

Country context for the Textile Industry:

Austria: Textile Waste Management and Recycling Context

Austria is recognized for its advanced waste management system and strong environmental performance. However, textile waste remains an important challenge within the transition towards a circular economy. According to Environment Agency Austria, significant quantities of textile waste are generated annually, while collection, sorting and textile-to-textile recycling systems still face important technical and economic limitations (Environment Agency Austria, 2022). These challenges have stimulated growing interest in innovative recycling technologies and improved resource recovery solutions.

Belgium: Collection Systems, Reuse and Textile Innovation

Belgium has developed a mature ecosystem for textile collection, reuse and innovation. Organizations such as Kringwinkel have contributed to establishing extensive collection and reuse networks, while research organizations such as Centexbel support the development of advanced textile recycling and circular economy solutions. Despite this progress, challenges remain regarding fibre sorting/separation, recycling economics and the scaling-up of closed-loop recycling systems.

Türkiye: Industrial Textile Manufacturing and Circularity Challenges

Türkiye is one of the world's leading textile and apparel manufacturing countries and a major supplier to European and international markets. The textile sector represents a strategic component of the national economy and is characterized by significant production capacities, particularly in synthetic fibres and polyester-based products. Increasing sustainability requirements from brands, regulators and consumers are driving growing interest in recycled fibres and circular production models, although challenges remain regarding post-consumer collection, traceability and large-scale integration of recycled materials.



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Relevance for India

Austria, Belgium and Türkiye represent complementary dimensions of textile circularity. Austria contributes expertise in industrial innovation and recycling technologies; Belgium provides experience in textile collection, reuse and research; and Türkiye offers insights from large-scale textile manufacturing and market deployment.

These dimensions are highly relevant for India, which is simultaneously one of the world's largest textile producers, exporters and recyclers. Similar challenges related to feedstock quality, collection systems, fibre blends, recycling economics and market uptake of recycled materials can be observed across all contexts. Consequently, the experiences generated through the PLASTICE textile demo-site may provide valuable insights for the development of more integrated and circular textile value chains in India.

6. Opportunities and Strategic Alignment

Despite these barriers, there are significant opportunities for strengthening collaboration between India and the EU.

6.1 Technology Transfer and Innovation

Projects such as PLASTICE demonstrate the potential of integrating advanced recycling technologies, digital tools, and circular business models. These innovations could be adapted to the Indian context through international partnerships and knowledge exchange .

6.2 Policy Alignment

India is increasingly adopting policies related to circular economy and waste management. Aligning these policies with EU regulations could facilitate trade and improve market access (EXIM Bank of India, 2023).

6.3 Investment and Market Growth

There is growing interest in sustainable textiles and recycling technologies, creating opportunities for:

- Foreign investment
- Public-private partnerships
- Development of formal recycling systems



7. Conclusion

India's textile recycling sector combines significant industrial capacity and market potential with persistent structural, technological and regulatory barriers. The analysis presented in this article indicates that strengthening textile circularity will require coordinated progress in waste collection and sorting, feedstock traceability, certification, supply-chain formalisation and access to technologies capable of processing blended, contaminated and difficult-to-recycle textile streams. These conditions are also essential for Indian recyclers and manufacturers seeking closer integration with European value chains and compliance with increasingly demanding EU sustainability and circularity requirements.

The comparison with the PLASTICE textile demo-site highlights that technological innovation alone is not sufficient to enable replication. Effective implementation also depends on the interaction between waste-management systems, research and technology providers, fibre producers, textile manufacturers, regulatory frameworks and market actors. The complementary experience represented within the demo-site, from collection and reuse to recycling technology and industrial textile production, therefore provides a useful basis for assessing how PLASTICE solutions and practices could be adapted to the specific conditions of the Indian textile sector.

This article represents the first contribution in a broader series intended to provide an initial insight into one of the main outcomes of the PLASTICE replication studies. Rather than presenting the final results of the replication assessment, it introduces the Indian textile context, identifies the principal barriers and enabling conditions, and outlines the initial areas of alignment between India's circular-textile ecosystem and the experience generated within the PLASTICE textile demo-site. The article should therefore be understood as an initial step in a wider replication pathway, which will progressively examine the technical, regulatory, economic and market conditions required to transfer and adapt relevant PLASTICE solutions beyond their original demonstration environments.

In this perspective, India should not be regarded merely as a potential market for European recycling technologies. Its extensive textile manufacturing and recycling ecosystem also offers an opportunity for mutual learning, industrial cooperation and context-specific innovation. Future outputs from the PLASTICE replication studies will build on this preliminary analysis by providing a more structured assessment of replication conditions, potential implementation pathways and the actions required from industry, policymakers, research organisations and other value-chain stakeholders.



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