FutureBridge

CHEMICALS, MATERIALS & NATURAL RESOURCES

25

INNOVATIONS

YEARS TO NET-ZERO

A quarter century to build a better future

TECHNOLOGY SPOTLIGHT

Depolymerization: Unlocking the Future of Polyester Recycling

In this report, we explore the evolving landscape of polyester recycling via depolymerization technologies; highlighting key players, innovation trends, and market dynamics. Environmental drivers, policy developments, and the challenges facing commercial scale-up are also considered.

What if textiles become tomorrow's raw materials?

In a circular future, garments aren't discarded – they're decoded. Polyester is broken down to its molecular DNA and rebuilt endlessly. A circular world transforming fashion (and all textiles) into a living system of regenerative materials and high-value feedstocks.

Imagine if...

...Your clothes have a digital passport?

Every item carries a traceable lifecycle ID which enables automated take-back, resale, and molecular recycling – no fabric left behind.

...Landfills become the new oil fields?

Textile waste is mined by robots and repurposed into building blocks for everything from packaging to mobility solutions.

...Clothes are made locally again?

Some technologies generate virgin-quality recycled fibers. Imagine co-locating clothes factories – and so deglobalizing today's supply-chains while creating circular economic growth.

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1. A Waste Crisis Looming Over Textiles

As mechanical recycling hits quality and scalability limits, businesses are exploring chemical solutions to unlock higher-value recycling streams and protect brand sustainability targets. This section examines the commercial drivers, capex realities, and business development challenges of chemical recycling and sets the stage for why depolymerization is emerging as the most promising route to true polyester circularity.

From Landfills to Policy: What's Driving Change?

The textile industry is under growing pressure to reduce its environmental footprint. Unsurprising when *every second a truckload of textile waste* is created! The opportunity for recycling innovation is enormous.

92 million tonnes

of textile waste is generated globally each year – equivalent to a **truckload every second**

Less than 0.2%

of used clothing is recycled back into new garments (fiber-fiber recycling)

8-10%

of global CO_2 emissions are caused by the fashion industry

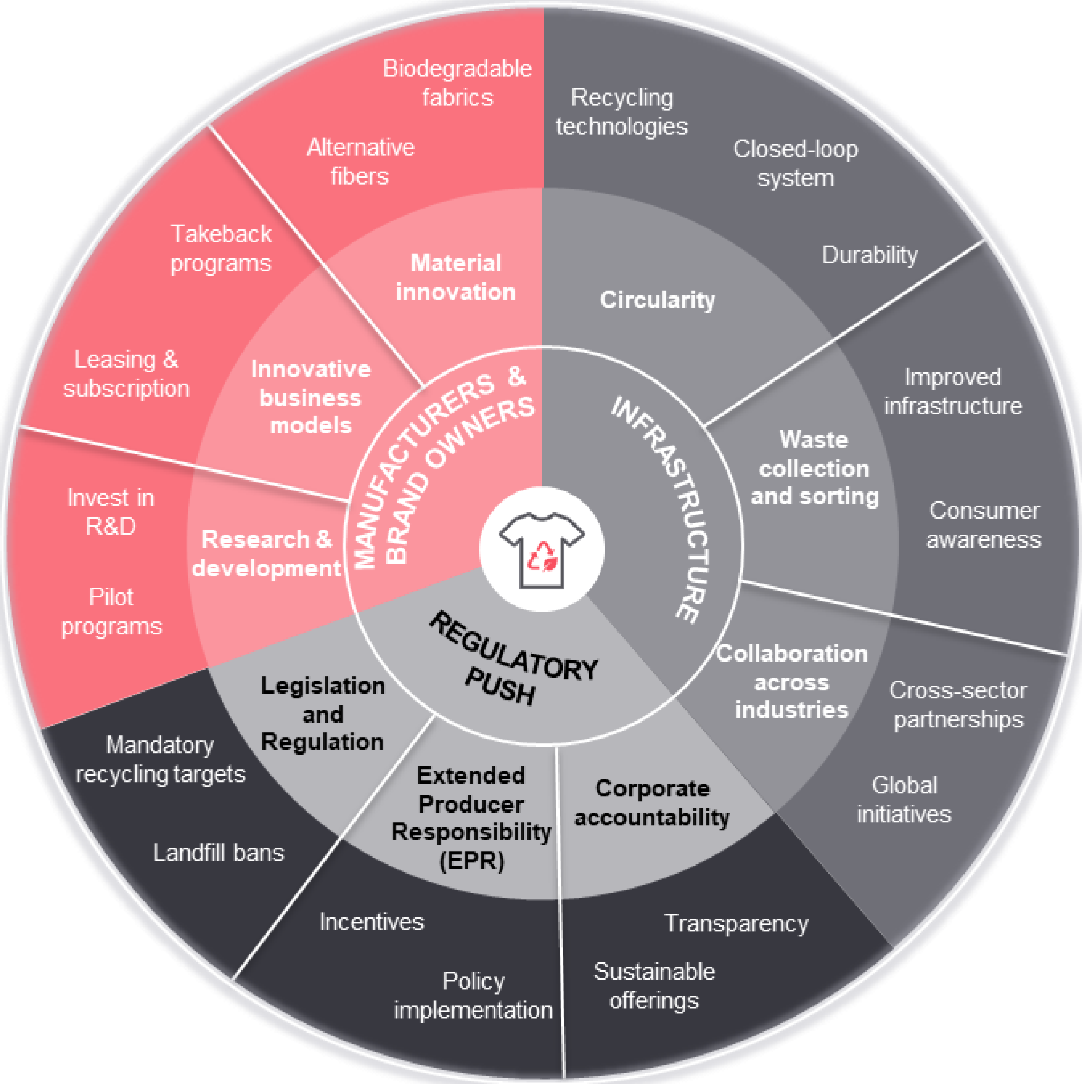
£88 million

Spent per year by UK public bodies to handle discarded clothing

Source: Ellen MacArthur Foundation) | UNEP | The Guardian/ Wrap)

Textile Waste Ecosystem: Innovation, Capex, and Strategies

Tackling textile waste requires high-capex innovation, regulatory support, and strategic infrastructure – paving the way for game-changing solutions like depolymerization.



Manufacturers

Invest in sustainable fibers, support capital-intensive recycling innovations, new pilots, and adopt circular business models.

Infrastructure

Focus on advanced recycling, build closed-loop systems, and collaborate across brands, recyclers, and governments.

Regulatory Push

Provide incentives, enforce EPR laws, mandate transparency, set recycling targets, and ban textile landfill disposal.

Current recycling solutions depend on local infrastructure

Textile recycling can be implemented across different sectors and scales in diverse ways, contributing to a circular supply chain.

1. Retailer Takeback Programs

Customers return used garments to any store location. Returned items are sorted: wearable clothing is resold or donated while non-wearable items are sent to recycling partners.

2. Fashion Industry Collaboration

Consortia of fashion brands collaborate to send their textile waste to ta facility where it is processed into new materials that can be used by any member brand.

3. Consumer Recycling Platforms

Online platforms for consumers to send unwanted textiles directly to recycling facilities. Consumers request a shipping label from the platform, send their items, and receive partner brand rewards.

4. Industrial Textile Recycling

Textile manufacturers partner with recycling companies to process waste and create a closed loop systems. Scraps and offcuts are collected and processed into fibers for new textiles.

5. Public Textile Recycling

Curbside textile recycling programs alongside existing recycling services for paper, plastic, and glass. Collected textiles are sorted and sent to recycling facilities where they are processed into raw materials.

6. Community-led Recycling

Non-profit community textile recycling centers, providing jobs, supporting local communities, and reducing waste. Wearable items are sold in thrift stores, and non-wearables are sent to recycling facilities.

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2. Momentum vs. Reality

Sustainability ambitions and market signals are fueling momentum in polyester recycling, but financial and technical realities still stand in the way. Knowing where these tensions lie is key for strategic investment.
This section focused on current ecosystem and market scenario, challenges, major regulations and outlook for textile recycling.

Cracks in the Circularity Plan

Polyester recycling is driven by environmental urgency, regulations, and economic potential, but faces structural barriers including high capex, technological limits, and cost imbalances. Understanding these forces is critical for companies evaluating where to invest, partner, or innovate, especially as the industry eyes transformative solutions like depolymerization.

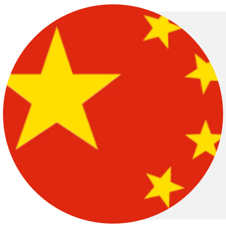
Key Drivers	Key Restraints
Environmental urgency Push to reduce carbon, water, and waste	**Limited infrastructure** Low collection & high sorting costs
Regulatory pressure: EU laws, EPR schemes, landfill bans	**Tech barriers** Low-quality output from mixed fabrics
Economic potential Cost savings, revenue from recycled inputs	**Cost imbalance** Virgin materials often cheaper
Sustainable branding Consumer & ESG demand for circularity	**Consumer habits** Fast fashion & low recycling awareness

Regulations will boost recycling volumes, but it will cost

Several countries have implemented textile recycling policies; EPR laws for textiles are taking shape in the EU and shall result in pushing recycling volumes and at the same time, increasing the cost of textile-based products.

State-Level EPR Laws: California has enacted the Responsible Textile Recovery Act of 2024. Washington introduced House Bill 1420 for textiles.

The textile waste segregation mandate that went live in Jan'25 as part of the EU waste framework directive, now in theory forces member states to ensure that textile waste is indeed segregated



China aims to recycle a quarter of its textile waste by 2025 and increase this to 30% by 2030, with a focus on producing recycled fibers for various industries.

The Union Ministry of Textiles is working to establish a comprehensive textile recycling infrastructure across India.

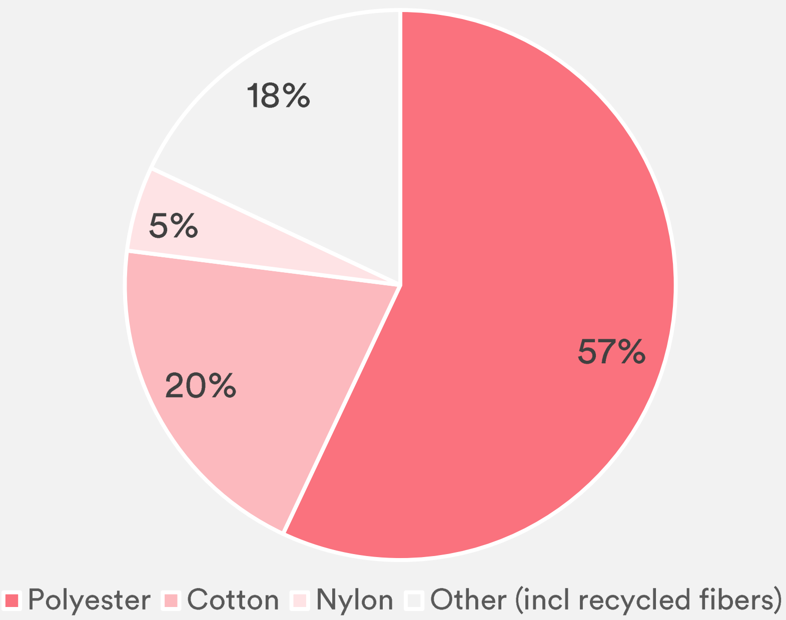
Brazil has no specific EPR law for textiles, but reverse logistics is encouraged under its waste policy. The 2024 Recycling Incentive Law offers tax benefits for textile recycling initiatives.

Radical Fiber Recycling Reform Essential To Meet Climate Goals

Global fiber production has more than doubled since 2000 (from 58m MT) and projected to reach 160m MT by 2030*. But, industry trends, including continued dependence on virgin fossil-based synthetics, and inadequate textile recycling infrastructure, jeopardize the sector's ability to meet its 1.5°C climate commitments.

Global Fiber Consumption, 2023*

NB. Total = 124 m MT



- Global fiber production 124m MT
- Polyester leads the market with more than half of the market share (55%).
- Cotton the second most popular fiber material, with 20% market share.
- Total recycled fibers accounted for 7.7% of the total market, dominated by polyesters with 93% of share.
- However, only about 2% of all recycled polyester (8.9m MT) came from fiber-to-fiber routes, whereas the rest by recycling PET bottles.

As the world's most widely used, and non-biodegradable-textile fiber, polyester demands urgent circular solutions to align with global regulations. This report analyzes scalable fiber-to-fiber recycling (chemical depolymerization) for pure polyester, leaving blended fabrics (e.g., poly-cotton) for subsequent publications.

Source: *Data collected from Textile Exchange Materials Market Report, 2024

Market outlook

Momentum is building in the textile recycling sector as legislation tightens and sustainability commitments rise. With the global market set for strong growth, now is the time for action. Innovation, policy support, and cross-sector collaboration will define success.

1. Rising Market Value: Predicted to yield an annual holistic impact of €3.5bn to €4.5bn in 2030.
2. Circular Mandates Growing: Regulations like EU's 2025 textile waste segregation rule will reshape industry standards.
3. Innovation is Crucial: Next-gen sorting and fibre to fibre focused chemical recycling will unlock scale & fiber quality.

Next Steps:

- Accelerate investment in advanced recycling technologies
- Build cross-industry partnerships for infrastructure and logistics
- Embed circularity into business models and design strategies

3. Choosing the Right Path for Polyester Recycling

As brands and recyclers confront regulatory pressure and rising sustainability targets, the focus is shifting from “which technologies exist?” to “which solutions justify investment and scale?” This section examines the technology options, their business viability, and why depolymerization is emerging as a strategic pivot point.

Recycling Technologies Compared

Recycling technologies differ in strengths and limits across fiber quality, costs, scalability, and sustainability. Businesses need to identify where solutions like depolymerization can overcome barriers and drive a more circular polyester value chain.

Type of Recycling		What & Why	Limitations	Applications
	Mechanical Recycling	Shreds and re-spins textiles without breaking polymers; commercially mature, low-cost for pure materials.	Fiber quality degrades; blended textiles difficult to handle.	Cotton | Polyester
	Enzymatic Recycling	Uses enzymes to break PET into monomers under mild conditions; mature and good for pure materials.	Slower and costly; enzymes need scale optimization.	Cotton | Polyester | Nylon
	Chemical Recycling: Glycolysis	Uses glycols to break PET into BHET for high-purity recycled PET and dye removal.	Needs clean PET inputs; costly separation and purification.	Polyester | PET
	Chemical Recycling: Methanolysis	Converts PET into DMT and ethylene glycol, producing virgin-grade feedstock even from contaminated PET.	High energy use and costly solvent recovery; capital-intensive.	Polyester | PET | Carpets
	Chemical Recycling: Hydrolysis	Depolymerizes PET into TPA and ethylene glycol, enabling separation from cotton in blends.	Produces chemical by-products; may need high temps or pressures.	Poly-cotton blends | Polyester | PET
	Thermal Recycling	Uses heat (pyrolysis, gasification) to turn textiles into fuels or chemicals, handling complex materials.	Downcycles instead of regenerating fiber; highly energy-intensive.	Mixed materials | Coatings | Polyester

Assessing the Business Case for Recycling Technologies

Each recycling technology offers distinct advantages but also comes with challenges in cost, capital investment, scalability, and material performance. Understanding these trade-offs is essential for strategic decision-making. Depolymerization, a chemical / enzymatic technology, is attracting significant interest for its potential to resolve many of the obstacles in achieving true circularity for polyester.

Comparing Major Textile Recycling Technologies:

Metric	Mechanical	Chemical	Enzymatic	Thermal
Fiber Quality Retention	Medium	High	High	Low
Material Flexibility	Low	Medium	High	High
Energy Efficiency	High	Low	Medium	Very low
Cost-Effectiveness	Low	High	Very High	Medium-High
Carbon Footprint Reduction	Medium	High	Very High	Variable
Scalability	High	Medium	Low	Medium

"Thanks to our breakthrough process, it will soon be possible to manufacture, on a large scale, t-shirts or bottles using polyester textile waste as raw material. This is a major breakthrough that gives value to waste that currently has little or no value.

Emmanuel Ladent, CEO – Carbios

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4. A Closer Look: Depolymerization

This section provides a snapshot of depolymerization, a chemical recycling approach that breaks polyester into core monomers for high-quality regeneration. Among chemical pathways like glycolysis, methanolysis, and hydrolysis, depolymerization stands out for its potential to solve quality and scalability challenges and enable true circularity in polyester recycling.

The Powers and Pitfalls of Polyester Depolymerization

Depolymerization breaks polyester like PET back into monomers that can be purified and rebuilt into virgin-quality fibers. Unlike mechanical recycling, it can tackle blends, contaminants, and colorants. While it offers a circular solution and high material quality, the process remains energy-intensive, capital-heavy, and in many cases still in early commercial stages.

Advantages	Disadvantages
♻️ Enables true fiber-to-fiber recycling	⚙️ Higher energy or pressure requirements
🧪 Effective on dyed, blended, or contaminated inputs	🧩 Feedstock prep and sorting still needed
💎 Delivers virgin-quality material	💰 Capital-intensive to scale-up commercially
🌍 Supports a circular economy across sectors	🧫 Some methods are still in pilot phase

Choosing the Right Depolymerization Pathway

Explore the key chemical and enzymatic methods to break down polyester, each offering unique routes to valuable monomers and shaping recycling feasibility, costs, and purity outcomes.

HYDROLYSIS
Breaking down polyester using water to afford TPA* and EG*

GLYCOLYSIS
Glycols are used to depolymerize polyester, resulting in BHET*

METHANOLYSIS
Polyester is broken down using methanol to produce DMT* and EG*

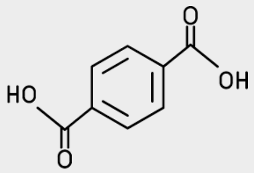
ENZYMATIC DEPOLYMERIZATION
Utilizes enzymes to break down the polyester into its monomers (still in the research phase)

OTHER PROCESSES
Depolymerization involves other processes IE. aminolysis, ammonolysis, etc.

*Details of the chemicals are on the next page

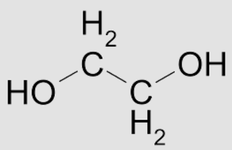
Recovered Chemicals Enabling Circular Polyester

See which key chemicals are retrieved through depolymerization and how they feed back into polyester production, helping drive circularity and reduce reliance on virgin raw materials.



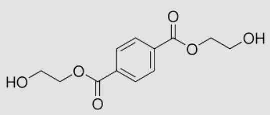
TEREPHTHALIC ACID (TPA)

Repolymerized with EG to make polyester



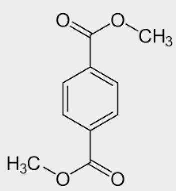
ETHYLENE GLYCOL (EG)

Repolymerized with TPA to make polyester



BIS (2-HYDROXYETHYL) TEREPHTHALATE (BHET)

Repolymerized with co-monomer creating polyester

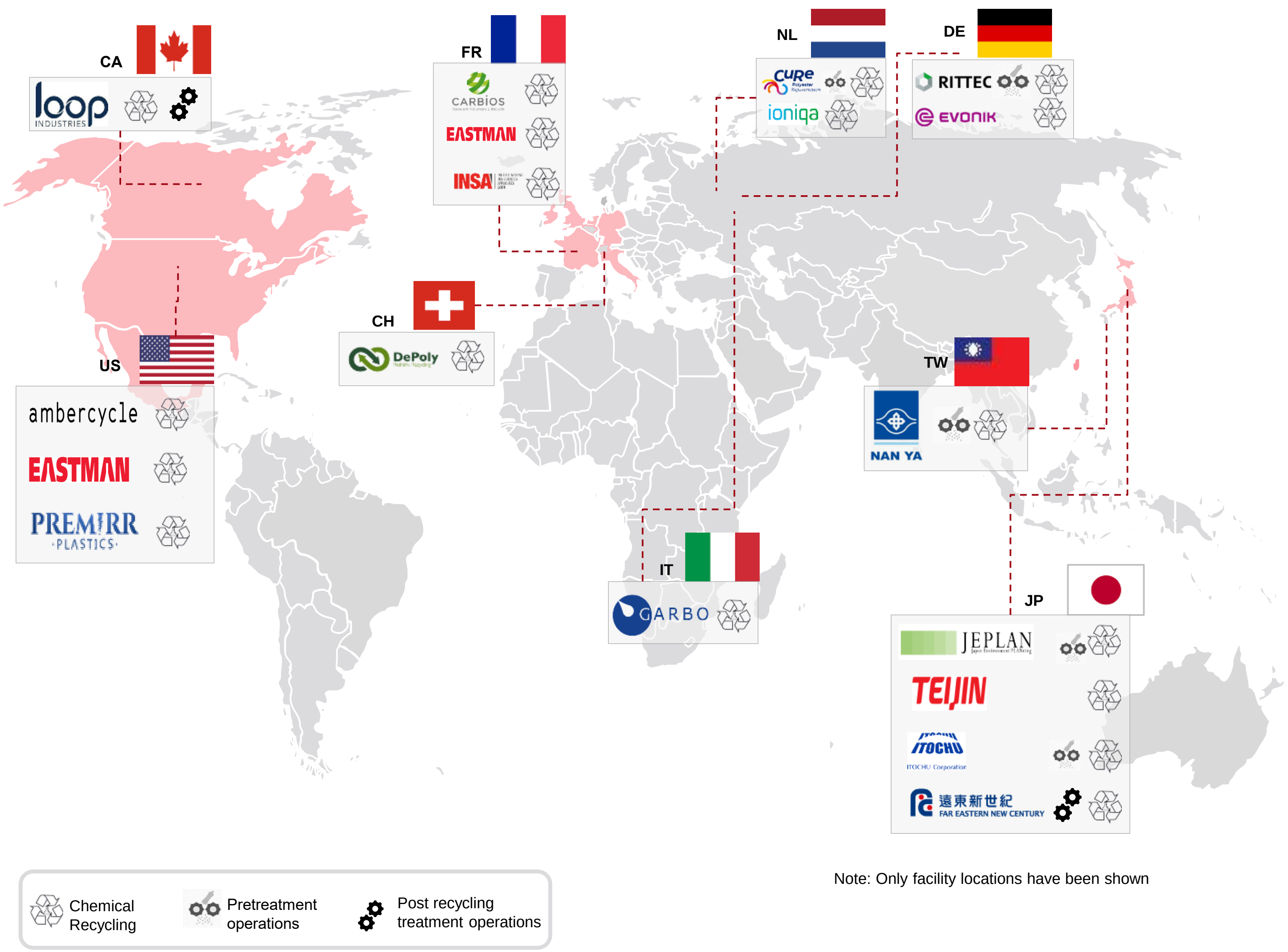


DIMETHYL TEREPHTHALATE (DMT)

Repolymerized with co-monomer to make polyester

Mapping Select Global Movers in Polyester Recycling

This map spotlights select innovators advancing polyester depolymerization across key regions. While not exhaustive, it reveals where technological momentum is building, and which players are shaping the path toward scalable circular solutions.



Note: Only facility locations have been shown

Leading Technology Developers (1/2)

Start-ups and established players are at the forefront of technology advancement. Their technologies are using various recycling routes and producing different recyclate monomers.

JEPLAN Japan Environment PLANning

Plant Location: Japan

Process: Glycolysis

Company: JEPLAN

HQ: Japan

Feedstock: Polyester textiles | Non-opaque bottles

Output: BHET

Business Model: Produce product and expand in other countries

TRL Status: Commercialized

ITOCHU

Plant Location: Japan

Process: Methanolysis

Company: ITOCHU

HQ: Japan

Feedstock: Polyester textiles

Output: DMT

Business Model: Partnership to develop and sell the license of technology

TRL Status: Commercialized

loop INDUSTRIES

Plant Location: India

Process: Methanolysis

Company: LOOP Industries

HQ: Canada

Feedstock: Polyester textiles | Rigid PET waste

Output: DMT

Business Model: Develop and sell the license of technology

TRL Status: JV for commercial operations in 2027

Leading Technology Developers (2/2)

Start-ups and established players are at the forefront of technology advancement. Their technologies are using various recycling routes and producing different recyclate monomers.

EASTMAN

Company: EASTMAN

HQ: USA

Feedstock: Polyester textiles | Rigid PET Waste

Output: BHET/DMT

Plant Location: USA, France

Process: Glycolysis | Methanolysis

Business Model: Produce product and expand in other countries

TRL Status: Commercialized

ambercycle

Company: ambercyle

HQ: USA

Feedstock: Polyester textiles

Output: Regenerated polyester

Plant Location: USA

Process Route: Solvent Process

Business Model: Produce product and expand in other countries

TRL Status: Pre-commercial – engaging in partnerships

POSEIDON PLASTICS

Company: Poseidon Plastics

HQ: UK

Feedstock: Polyester textiles | Rigid PET waste

Output: BHET

Plant Location: UK

Process Route: Glycolysis

Business Model: Develop and sell the license of technology

TRL Status: Pre-commercialized

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5. WHAT NEXT: TURNING BARRIERS INTO BREAKTHROUGHS

Despite significant innovation in textile recycling, real-world implementation still faces roadblocks, from complex blends and costly inputs to limited access to sorted feedstocks. As the regulatory spotlight intensifies, the companies that succeed will be those that anticipate these hurdles and build their strategies around overcoming them. FutureBridge helps unlock this next phase.

Addressing the Pain Points: Your Innovation Ally in Action

Each challenge in the textile recycling landscape, from high input costs to scale-up complexities can be mitigated with the right insight, partners, and roadmap. FutureBridge empowers clients to build cost-efficient, future-ready recycling strategies through tech foresight and end-to-end guidance.

Feedstock Gaps

Less than 1% of post-consumer textiles return as clothing.

FutureBridge enables sourcing strategies, digital passporting insights, and pre-sorting solution scouting.

Blended Material Complexity

Polycotton recycling costs 40–60% more than virgin fibers.

FutureBridge enables side-by-side tech evaluations for blend separation and ROI modeling.

High Energy & Cost

Depolymerization can consume up to 50 MJ/kg — more than virgin PET.

FutureBridge enables energy benchmarking, cost curve analysis, and optimal tech stack guidance.

High Production Costs

Recycled cotton costs ~2x more than virgin cotton.

FutureBridge enables tracking innovations in color sorting, industrial integration, and co-product revenue models.

Employing depolymerization methods typically costs **20–40% more than virgin material production** today — but with the right partners, policy signals, and innovations, clients can **future-proof their profitability**

Sources: McKinsey | IISD

From Cost Burden to Circular Opportunity

FutureBridge helps industry leaders turn textile recycling from a compliance cost into a competitive edge. Here's how we deliver real value:

🔍 1. Tech & Cost Intelligence

We track production costs of recycling technologies to forecast when they'll reach cost parity with virgin fibers — helping you time investments and spot profitability tipping points early.

🧪 2. Innovation Scouting

We track the startups and tech providers solving key recycling hurdles like fiber separation, enzyme engineering, and energy minimization – with curated watchlists and readiness scores.

📈 3. Circular Business Models

We help you assess the required ecosystems required to enable circular business models — including resale, take-back, co-product valorization, and cross-industry partnerships.

🌍 4. Policy & Funding Navigation

We decode evolving EU and global legislation and pinpoint public funding routes to support investment in circular infrastructure.

💡 5. From Insights to Activation

From strategy workshops to pilot partner matchmaking, FutureBridge helps you move fast — and scale with confidence.

Our Reputation

As the former Chief Scientist of Kimberly-Clark, I worked with FutureBridge as a client for over six years. Their approach consistently impressed me—combining personalized, value-oriented communication with deep industry expertise. They quickly earned our trust through transparency, practical insights, and a strong focus on outcomes.

FutureBridge stood out not only for its ability to understand the nuances of the consumer products space, but also for the clarity and integrity of its engagement model. Their reputation for innovation, data-driven decision-making, and collaborative culture made them an ideal partner.

That conviction led me to take the next step—not just as a client, but by joining FutureBridge as a Partner to help other companies unlock the same value and accelerate innovation with confidence.

Pete Dulcamara
Former Chief Scientist @Kimberly-Clark
Partner @FutureBridge

Our Chemicals, Materials & Natural Resources Team

Dr Sarah Hickingbottom

VP & Global Practice Head

Sarah joined FutureBridge to lead the Chemicals & Materials Practice in April 2024 bringing over 20 years of research, strategic consulting and hands-on innovation scale-up experience spanning the world's chemicals, fuels and agricultural industries.

Rajesh Kumar

Director

Rajesh is a materials expert with 16 years of diverse experience across manufacturing, consulting, and advisory services. With a strong technical foundation and strategic insight, he has successfully driven innovation programs, and business growth in leading organizations.

Click here to benchmark your recycling ROI.

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