Precision Recycling: Meeting Europe's Challenges and Demands for High-Quality, Compliant Plastics

CIMBRIA

An expert at your side.

FOR DECADES, EUROPEAN PLASTICS RECYCLING OPERATED ON THE SINGLE ECONOMIC PROMISE.

The promise was that when oil prices rose, fossil-based virgin plastics became more expensive, and recycled plastics would be the cheaper, more competitive option. This dynamic is what experts call the “oil price umbrella”, which protected recycler margins and allowed more sustainable materials to be offered without requiring widespread investment in advanced sorting or processing technologies.

Until the late 2010s (and in many cases into the early 2020s), European recycling was still largely a lower-tech, volume-driven operation. Sorting relied primarily on conventional optical and mechanical separation, supported by manual quality control. Washing processes focused on removing visible contamination, with limited capability to manage chemical residues, complex adhesives, or multi-layer packaging structures. Mixed or lower-purity inputs could still be processed because the market placed greater value on availability and throughput than on material precision. As long as large volumes of recycled plastics met basic physical specifications, the material could be sold at a discount to virgin plastics.

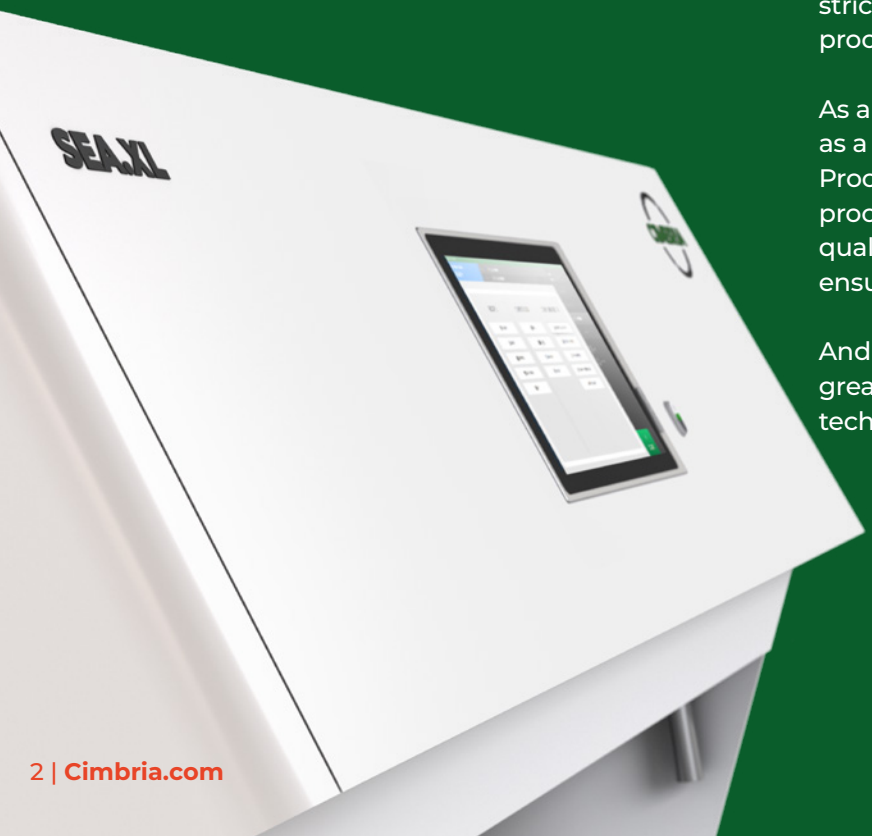
This model offered clear advantages at the time. It was relatively easy to scale, operationally predictable, and required significantly lower capital investment than today’s recycling infrastructure. While traceability, regulatory documentation, and end-use safety were present, they were not yet decisive market differentiators. Waste streams were more homogeneous, and many brand owners were satisfied with “recycled” as a sustainability claim rather than a tightly defined technical specification. In short, the system thrived on simplicity, allowing recyclers to prioritise throughput over high levels of precision, purity, compliance, and traceability.

But today, the conditions that supported this model are rapidly disappearing. Global supply dynamics are shifting, waste streams have become more complex and regulatory expectations are increasing across Europe. At the same time, the price relationship between virgin and recycled plastics has fundamentally changed, removing the economic and operational protections recyclers once relied on.

What was once a stable, volume-led system is now under pressure from low-cost imports, stricter compliance requirements, and rising processing costs.

As a result, recycling can no longer function as a simple extension of waste management. Processors must focus on advanced, value-driven processing technology that delivers consistent quality, purity, safety, and full traceability — and ensures lower processing and energy costs.

And the first step to getting there is through greater investments in advanced optical sorting technology and AI-driven processing.



THE CHALLENGES FACING EUROPEAN RECYCLING — AND WHAT THEY MEAN FOR RECYCLERS.

European recycling is frequently described as a success story.

The collection rate for PET bottles has surged past 60%[1], while regions utilising Deposit Return Schemes now report a **capture rate as high as 90%**[2]. To meet this influx, infrastructure has expanded at a record pace, with installed capacity reaching 13.5 million tons for all plastics in 2024[3].

On paper, everything seems straightforward. But in practice, the system is under mounting pressure from economic and it's European recycling processors feeling it the most.

1. Meeting Regulatory Targets.

Recyclers across Europe are required to produce more recycled content, at higher volumes and with greater consistency, all while competing against a global fossil-based virgin PET market that plays by very different rules.

Single-Use Plastics Directive mandates that PET beverage bottles contain at least 25% recycled content by 2025, increasing to 30% by 2030[4].

The forthcoming Packaging and Packaging Waste Regulation (PPWR) will extend these requirements across a wider range of PET packaging and place stronger emphasis on material quality, traceability, and food-contact compliance[5].

To meet these targets, recyclers will need roughly 5.4 million metric tons of recycled PET, recycled polyethylene and recycled polypropylene.

By 2040, demand is projected to more than double, reaching an estimated 11.5 million metric tons per year.

These numbers fundamentally change how recycling operations must function. **Recyclers can no longer rely on high-volume, low-precision approaches**. Every ton of output must now be consistent, auditable, and fully compliant with stringent quality and food-contact standards. PET intended for food use must have a contaminant level of 0.0025 µg per kg of body weight per day[6].

However, post-consumer PET inputs may contain 1-3 mg/kg of chemical residues, adhesives, or colourants[7], which must be reduced by over 99% during sorting and other processes to meet safety thresholds. Variability in quality and purity that was once tolerated now carries a commercial risk. **10-20% of sorted PET flakes are rejected or downgraded, and only 60-70% of input material reliably meets food-grade standards.**

For HDPE and PP, the figures are similar. Yields for high-purity, food-safe flakes often fall below 65%, with the remaining 35% going to lower-value applications, such as fibres for carpets, trash bags, and industrial crates.

[1] https://www.plasticsrecyclers.eu/publications/
[2] https://www.sensoneo.com/waste-library/deposit-return-schemes-overview-europe/
[3] https://www.plasticsrecyclers.eu/publications/
[4] https://environment.ec.europa.eu/topics/plastics/single-use-plastics_en
[5] https://environment.ec.europa.eu/document/download/63fd2c88-e85a-412c-bcf4-372eff99008a_en?filename=Slides%20for%20the%20SH%20event%2010122024.pdf
[6] https://efsa.onlinelibrary.wiley.com/doi/10.2903/j.efsa.2024.8879
[7] https://efsa.onlinelibrary.wiley.com/doi/10.2903/j.efsa.2024.8879

2.

Competing Against Cheap Virgin PET.

Global primary plastic production reached 450 million tons. Virgin PET accounted for a massive share of that volume. Global production is dominated by mega-plants from non-EU countries, which command 45% of total global capacity[8 9].

By leveraging massive economies of scale and direct integration with petrochemical hubs, these plants produce virgin resin at a very low cost, often independent of oil price. Again in 2025, **Asian virgin PET spot price dipped below €700 per ton**[10], effectively undercutting European food-grade recycled content and collapsing the price protection European recyclers once relied on.

For European recyclers, the costs are a different story. Producing pure, food-grade PET is more expensive, costing anywhere between **€1,350–1,500 per ton**, which makes it difficult to compete on price alone.

The result is a structural imbalance. Recycled content is becoming mandatory, but virgin material continues to set the market price. **Recyclers are asked to deliver higher quality, tighter compliance, and greater volumes**, while competing directly against cheaper material produced under very different economic and regulatory conditions.

3.

Processing Complex Post-Consumer Plastics.

Meanwhile, post-consumer waste streams are more complex than ever. Multi-layer packaging, mixed polymers, labels, adhesives, pigments, and visually similar plastics create a feedstock that is difficult and sometimes expensive to process.

Clear PET remains easier to recycle and can be reused in closed-loop applications, but colored PET and mixed materials reduce yield and lower the quality of the final output. Some polymers, such as PET and PVC, look nearly identical but behave very differently during recycling, where even minor contamination can ruin entire batches. **HDPE adds further complexity**. Carbon black pigmentation and visual similarity to other polyolefins make it harder to identify and separate reliably.

Together, these factors make **post-consumer waste unpredictable and difficult to process**. Recycled PET is generally much more energy-efficient than virgin PET, using roughly 30–60 MJ per kilogram compared with 80–125 MJ per kilogram for virgin material, which is about around 60-70% less energy[11].

However, the key is feedstock quality. Clean, simple feedstock maximises energy savings. **Mixed, layered, or contaminated plastics require extra work in sorting, washing, and drying**, steps that can make up 30–40% of the total recycling energy. As a result, the total energy needed per ton of high-quality recycled PET rises significantly when inputs are complex.

[8] https://unctad.org/system/files/official-document/ditcinf2025d6_en.pdf
[9] https://plasticseurope.org/knowledge-hub/plastics-the-fast-facts-2025/
[10] https://www.czapp.com/analyst-insights/asian-pet-resin-prices-hit-lowest-levels-since-2021
[11] https://www.sciencedirect.com/science/article/pii/S2949823624000722

4.

Delivering on Customer Expectations & Traceability.

Global brands and packaging companies don't just demand recycled content, but also reliable, high-purity, fully traceable material. And the numbers show it.

Compliance with EU recycling and recycled packaging requirements are driving brand commitments that far exceed today's average recycled content levels. Some major beverage and food companies have **pledged to increase recycled content by at least 50%**.

And industry analysis shows that 58% of brands required third-party certification for recycled PET suppliers to ensure traceability and documented quality — up from 33% the previous year.

Without traceable material, brands may face reputational risk, higher sourcing costs or long-term contract commitments just to secure reliable supply. This means **recyclers must deliver consistent recycled content quality** to ensure commercial success and profitability.

Many European packaging companies consider traceability, sustainability and transparency among their top three supplier selection criteria. This further highlights how central compliance and documented quality have become in the recycled plastics supply chain, and how **recyclers must look at their sorting and separation processes** — now and into the not-so-distant future.

THE SOLUTION IS OPTICAL SORTING AND AI PROCESSING.

To produce high-quality, food-grade recycled material while meeting operational, economic, regulatory, and customer demand, **European recyclers must look inside their own facilities** and consider investing in advanced optical sorting and AI-driven processes. Conventional, lower-tech, volume-focused recycling simply won't deliver on what they need.

However, investment is investment. And it's natural for recycling business owners to carefully evaluate high-capital expenditure.

Optical sorting and AI-powered processing solutions may look expensive, yet they unlock **measurable long-term value**. And deliver cleaner, more consistent output, reduce contamination, ensure traceability, and lower overall operational costs — all critical factors for meeting EU regulations and securing contracts with brands demanding certified, food-grade recycled content.

EVERYTHING YOU NEED TO KNOW ABOUT OPTICAL SORTING AND AI PROCESSING.

01 What is optical sorting?

Optical sorting is a modern recycling technology that uses sensors and cameras to automatically identify and separate different types of plastics. Unlike manual or mechanical sorting, which relies on human observation or simple mechanical properties, optical sorters can detect subtle differences in color, transparency, shape, and even chemical composition.
At its core, **an optical sorter "sees" plastics in ways humans cannot**.

02 How does AI optical sorting improve recycling?

AI-powered optical sorting systems analyse material streams in real time, adapting instantly to changing waste composition. This ensures consistent purity, reduces contamination risk, and optimises yield without requiring constant manual adjustments. **AI makes sorting smarter, faster, and more precise**, transforming recycling into a precision-driven process.

03 Why is optical sorting essential for high-quality rPET?

Producing food-grade, compliant recycled PET requires uniform, contaminant-free material. Optical sorting separates multi-layer plastics, labels, pigments, and visually similar polymers with unmatched accuracy. This **increases yield, lowers operational losses, and ensures the recycled material meets EU standards** for traceability, safety, and regulatory compliance.

04 What operational benefits can recyclers expect?

Beyond quality, optical sorting with AI improves efficiency and reduces costs. Automated sorting **minimises manual labor, optimises throughput, and lowers energy** use compared to conventional sorting methods. It also future-proofs recycling operations by enabling consistent, auditable output, even with increasingly complex post-consumer waste streams.

05 How does this help recyclers compete with virgin PET?

By producing high-purity, traceable, and compliant recycled plastics, recyclers can meet stricter regulatory requirements and deliver products that customers trust. While low-cost virgin PET dominates pricing, **precision sorting and AI allow recyclers to differentiate their material on quality** and compliance, not just price, unlocking higher-value markets and strengthening circular economy credentials.

MEET CIMBRIA'S AWARD-WINNING SEA.XL OPTICAL SORTER

Delivering XL Performance & AI Precision For Recyclers.

SEA.XL represents a strategic response to growing demands on the plastics recycling industry. By combining the latest optical sorting with intelligent AI-driven process capabilities, this innovative solution empowers recyclers to consistently deliver recycled PET material that meets strict standards for purity, compliance, and food safety, while also improving operational efficiency and yield.
Awarded First Prize for Technological Innovation at the World Nut & Dried Fruit Congress, SEA. XL is recognised for its breakthrough integration of advanced imaging and sorting technology, underscoring its status as one of the most innovative optical sorters for European recyclers on the market today.

DUAL VISION SYSTEM: XL Performance

SEA.XL's DUAL VISION SYSTEM transforms how recyclers handle complex plastic streams. Multi-angle, high-definition RGB cameras combined with hyperspectral infrared sensors deliver unmatched precision, identifying and separating every piece of plastic at the molecular level. Even the most challenging materials like multi-layer carbon black HDPE, colored PET, or PET blended with PVC.

Every batch is transformed into traceable, market-ready material, giving recyclers the efficiency, purity, and compliance needed to compete with virgin PET and succeed in today's European recycling market.

BRAIN™ AI: XL Precision

BRAIN™ brings the power of artificial intelligence into modern recycling processing lines. This system continuously optimises its sorting parameters in real time as material flows change, reducing the need for manual adjustments and allowing the system to respond instantly to variations in the input stream. Its consolidated polymer library enables the system to recognise even the most complex streams with extraordinary precision, turning variability into predictability. Together with the DUAL VISION SYSTEM, recyclers can consistently deliver on customer expectations and even the strictest EU standards, while staying prepared for tomorrow's post-consumer recycling challenges.

Delivering Value Across the Entire Recycling Industry

SEA.XL gives recyclers the confidence to supply high-quality, traceable, and compliant plastics for food, personal care, and other profitable applications. Facilities can optimise throughput, extract more value from waste streams and inject precision and purity into today's European recycling market. Processing reliable, high-grade material, while supporting the broader goals of the circular economy has never been easier.

More than 400 Cimbria optical sorters installed worldwide.

Utilises dry sorting for substantial energy savings.

Enables over 99% sorted plastic purity.

SEA.XL

XL Performance, AI Precision

SEA.XL is designed to adapt to your specific requirements. With multiple feeding chute configurations, it offers exceptional versatility, allowing you to process a wide range of products within the same system seamlessly.

FIND OUT
MORE HERE

				SEA.XL 2	SEA.XL 4	SEA.XL 6
						
Dimensions	Length	mm / inch		1330 / 52,36	1960 / 77	2590 / 102
	Width	mm / inch		1985 / 78,15		
	Height	mm / inch		1720 / 67,72		
Weight			kg	1100	1550	1650
			lbs	2425	3418	3640
Compressed air consumption (max value at 6 bar)			l/min	700	1400	2100
			m^3/h	42	84	126
Power supply/frequency			V/Hz	230V - 50/60 Hz (L + N + PE)		
Power absorption (A) Power consumption (Kw)			A - Kw	6,2 - 1,4	9,7 - 2,2	13,3 - 3,0

SCALABLE PERFORMANCE FOR EVERY OPERATION.

The SEA.XL series adapts to recycling operations of any size, from niche, specialized plants to high-volume production lines. With 2 to 6 chute configurations, operators can match capacity precisely to demand.

Designed for seamless integration, SEA.XL keeps material flowing, maximises throughput, and minimises downtime. Flexible chute layouts make it easy to process large volumes efficiently, empowering facilities to scale production and consistently deliver premium-quality recycled plastics.

Every SEA.XL shares the same robust, space-saving design, packed with advanced features: vibrating plates with optional aspiration, automatic cleaning, and intuitive controls. Built to withstand the demands of continuous high-volume operations, it guarantees reliable, consistent purity even under the most challenging conditions.

Globally certified — CE, UL, and CSA compliant — SEA.XL gives operators peace of mind on safety and product quality. Beyond performance, its precision sorting directly supports sustainability: by removing only targeted contaminants, it maximises recovery, minimises material loss, and helps recyclers fully embrace circular economy practices.

Remote Assistance: Always Connected, Always Supported

In plastics recycling, uptime is everything. SEA.XL is not only built for precision sorting, but also designed for continuous connectivity.

Through Cimbria's 24/7 remote assistance, operators have instant access to expert support, wherever their facility is located.

With real-time system data available via an intuitive HMI control panel, Cimbria specialists can:

- Diagnose and resolve issues remotely, minimizing downtime.
- Help fine-tune sorting recipes to match changing input streams.
- Provide real-time guidance, and ensure that every machine operates at peak efficiency, day after day.

Remote assistance transforms support, giving recyclers confidence that their SEA.XL system will deliver consistent performance, maximum yield, and future-proof reliability.

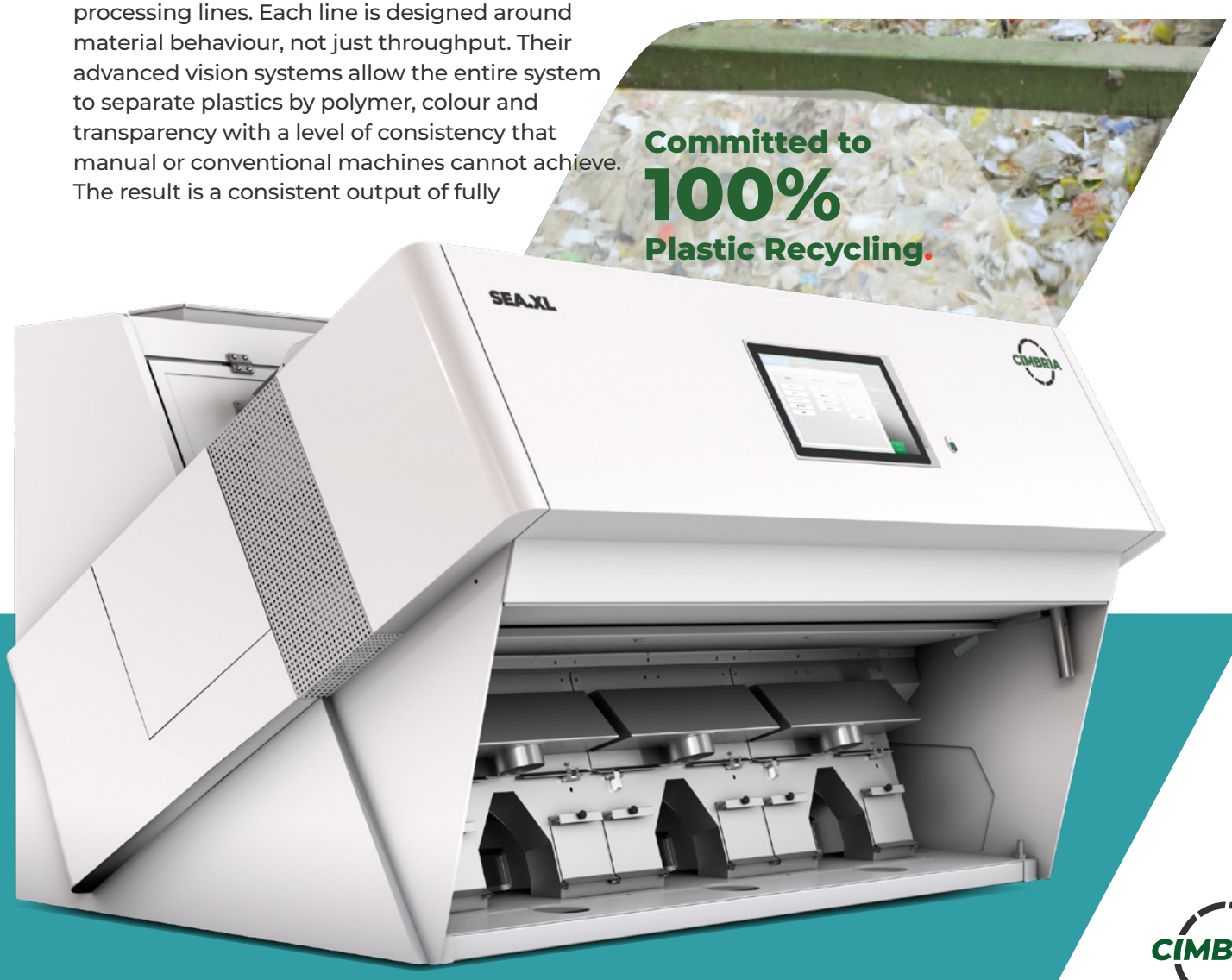
PROOF IN PRACTICE: ADVANCED OPTICAL SORTING AT VOGT-PLASTIC.

Read the full story here.

Optical sorting isn't treated as a supporting step in Vogt-Plastic's recycling process. It's the backbone of their operation.

Faced with increasingly complex post-consumer waste streams and rising expectations for purity, consistency and compliance, the company made a deliberate shift towards precision-driven processing as a core strategy.

Today, 19 optical sorters process roughly 200 tons of plastic per day across four dedicated processing lines. Each line is designed around material behaviour, not just throughput. Their advanced vision systems allow the entire system to separate plastics by polymer, colour and transparency with a level of consistency that manual or conventional machines cannot achieve. The result is a consistent output of fully transparent and fully white plastics — materials that meet stringent quality specifications and retain genuine market value. With this level of precision, contamination is no longer managed after the fact. It is effectively designed out of the process. Instead of correcting quality issues downstream, Vogt isolates and controls complexity at the earliest possible stage, protecting yield, efficiency, and compliance.



Our Commitment to the Plastic Recycling Industry.

Plastic is a valuable, energy-intensive material. Once produced, it should be preserved, recovered, and reused at the highest possible value for as long as possible. The future of plastics recycling depends on how effectively the industry can protect that value.

European recycling is entering a decisive phase. Regulatory requirements are tightening, waste streams are becoming more complex, virgin PET remains injected into the market, and customers are demanding proof of recycled content, safety, and traceability. In this environment, recycling can no longer function as a simple extension of waste management. It must operate as a precision manufacturing process, governed by consistency, control, and accountability.

The industry now faces a clear choice. It can continue to chase volume in increasingly volatile markets, or it can invest in approaches that prioritise material quality, process reliability, and documented compliance. Those that succeed will be the operators able to deliver recycled materials that are consistent, auditable, and fit for the most demanding applications — even as input streams grow more complex.

Our commitment is to support this shift. We believe the next chapter of plastics recycling will be defined by higher standards, smarter processes, and closer alignment with regulatory and customer expectations. By focusing on quality, traceability, and long-term value creation, the industry can strengthen the circular economy — not as a concept, but as a commercially viable reality.

Our SEA.XL optical sorter is the product of this commitment.

Let us show you how.

Contact us today >


CIMBRIA
An expert
at your side.