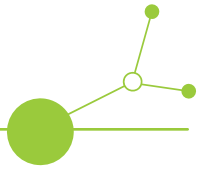
D2.4.1. Consolidation of business models



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A. Introduction

Purpose and Scope of the Deliverable

This deliverable consolidates the results of the CURIOST piloting activities into sector-specific circular business model patterns for four key industrial sectors: Mechanics & Mechatronics, Packaging, Plastics and Building & Construction.

The piloting activities were implemented in two stages through regional and transnational design thinking workshops focused on the development of sustainable and circular products (see Deliverable 2.3.2. Two stage pilot with prototype creation and testing, and business modelling). The Deliverable 2.4.1 synthesizes insights from 29 business cases, together with the challenges and business model impact areas identified throughout the piloting activities. These insights were developed jointly by SMEs and small midcaps, CURIOST project partners, Creative Heads and were subsequently consolidated within this deliverable.

The purpose of this deliverable is to transform company specific pilot actions into generalisable circular business model solutions and to provide SMEs and small midcaps with practical, actionable insights for implementing sustainable and circular product development. The outcome of this deliverable is a collection of circular business model patterns derived from individual business cases that SMEs and small midcaps can use to facilitate their transition to more circular business models.

Key Concepts and Approach

A business model is the rationale for how an organisation creates, delivers and captures value while generating social and environmental impact.

A business case is not separate from the business model; rather, it is a targeted intervention that modifies or tests a specific part of the business model.

- A business model describes how a company creates, delivers and captures value.
- A business case justifies a specific change to that model (e.g., the introduction of new materials, a new logistics system, or a new service model).

In this deliverable, the business model patterns are based on insights gained from the piloting activities while also integrating elements of circularity flow logic. As a result, CURIOST provides business model patterns that reflect the operational realities and practical experiences of SMEs and small midcaps. This approach ensures that the patterns are relevant, up to date, and readily applicable for adoption by a wider range of companies seeking to transition towards more circular business models.

B. Mechanics & Mechatronics Business Model Template

1. Sector introduction

The European mechanics and mechatronics sector is one of the most strategically important areas of the EU economy, a global leader in machinery exports, a key enabler of the green and digital transitions and a major source of high-quality industrial employment. At the same time, it is a sector under intense and multifaceted pressure.

Cyclical economic weakness, geopolitical disruption, a deepening talent shortage, the demands of digitalisation, sustainability imperatives and regulatory complexity are all combining to challenge established business models and require new approaches to product development, service delivery and value creation. SMEs and small midcaps, which form the backbone of the sector across Central Europe face all these challenges with fewer resources, less organisational capacity and less access to specialist expertise than their larger competitors.

Developing adaptable frameworks for sustainable and circular product development, tailored to the specific characteristics and constraints of mechanics and mechatronics companies, is therefore not an abstract exercise but an immediate practical priority for the sector's continued competitiveness and resilience.

It is precisely this combination of pressure and opportunity that makes this sector a priority target for the CURIOST project. By supporting SMEs and small midcaps in developing concrete business cases for circular and sustainable product development, CURIOST helps companies move from awareness of these challenges to actionable strategies that can position them for long term competitiveness in the transformed European mechanics and mechatronics landscape.

2. Common problems and drivers in the sector

Challenges in the Sector
The mechanics and mechatronics sector faces a series of structural and practical challenges that make the transition toward circular and sustainable product development particularly demanding as the sector reaches from components to specialized machinery. Companies find it difficult to introduce innovation in product design or to change long established development procedures.
The earliest stage of the product lifecycle is often seen as too sensitive to modify, and therefore remains largely untouched, even though this stage has the greatest potential to influence sustainability outcomes. As a result, many companies remain at the lowest transformation levels and lay behind other sectors in adopting circular economic practices. Traditional mindsets and slow adaptation of processes further hinder the uptake of new approaches.

Financial barriers add to these difficulties. Investing in innovative technologies is essential but often challenging due to high costs, economic uncertainties, market volatility and price pressure. In several regions, insufficient political support and lack of clear guidance or resources make it harder for companies to comply with new regulations. There is also limited acceptance and a general lack of knowledge regarding advanced technologies such as 3D printing or AI supported solutions.

Additional obstacles arise from high transportation costs and complex import and export regulations, which complicate the implementation of takeback systems. Companies also struggle with sourcing sustainable raw materials and supply chain dependencies make it even harder to implement sustainable practices.
At the same time, customer unwillingness to absorb additional sustainability related costs reduces incentives for companies to invest in circularity.

Drivers and Opportunities in the Sector
Despite these challenges, the sector benefits from strong drivers and opportunities that support its transition toward circular and sustainable product development: Innovation in sustainable product development opens new pathways for companies of all sizes to increase their corporate sustainability.
The sector's dependence on critical raw materials makes supply chain resilience particularly important, and the CURIOST focus on this issue directly strengthens operational stability. European support for research, innovation and material substitution encourages more efficient designs and reduces reliance on scarce inputs, which improves long term competitiveness.

There is also significant potential in early interventions such as designing products for recycling and repair, reducing material complexity and developing construction oriented for reuse. Best practice companies in the sector are already demonstrating the feasibility of these approaches.
The sector has a strong technological base, which supports the development of circular business models built around long product lifespans, energy efficient upgrades and integrated maintenance services.

Central Europe offers a strong manufacturing base and considerable potential for upgrading value chains through innovation and sustainability. Digital tools such as IoT, AI, Big Data and 3D printing further enhance resource efficiency and reduce waste, while additive manufacturing helps minimize material losses in metal production. The integration of IoT solutions for real time energy consumption tracking adds another layer of opportunity for companies aiming to improve their sustainability performance.

3. Consolidated solution patterns

Consolidation of solution patterns for mechanics and mechatronics sector is based on business cases of the following companies:

Adott Solutions Kft. – Hungary
Aigner GmbH - Austria
AquaCut Kft. - Hungary
F.T FAMAT S.R.L. - Italy
Hidrofilt Kft. - Hungary
jora.tech FlexCo - Austria
Juzni Prolaz d.o.o.- Croatia
Microsport GmbH & Co. KG - Germany
Oris srl - Italy
Weber Electrotechnic GmbH (supported by Chipsconnect) - Germany

Across the 10 companies, despite very different technologies, sizes, and markets, their circular transformations converge into five dominant circular business model patterns:

1. **Product life extension & refurbishment**
2. **Product-as-a-Service (PaaS) & rental model**
3. **Reverse logistics & take-back systems**
4. **Digital intelligence for circularity**
5. **Resource recovery & secondary component markets**

Each company contributes differently, but the patterns are consistent and mutually reinforcing.

1. Product life extension and refurbishment

In this pattern, companies like Microsport, Aigner, Južni Prolaz, Weber Electronic focus on keeping existing products and components in use for as long as possible. They refurbish benches, extraction devices and electronic components, often grading them into quality levels such as “like new” or lower function classes, and back this with warranties, fast repair and guaranteed spare parts.
This emerges because mechanical and mechatronic products are inherently durable, high value and repairable, and because competition from low-cost imports pushes European firms to differentiate through reliability and longevity.

For SMEs and small midcaps, the practical move is to start with one product line, define a clear refurbishment checklist across mechanics, electronics and software, and then sell refurbished units at a significantly lower price to reach more cost-sensitive customers while using refurbished stock to shorten delivery times and reduce dependence on volatile component supply.

2. Product-as-a-Service, rental and subscription

Here, Microsport, Aigner and Južni Prolaz shift from one-off product sales to ongoing access models such as rental, pay-per-use and uptime guarantees. Instead of customers owning the equipment outright, they pay a recurring fee for availability, performance and service, while the manufacturer keeps ownership of the asset. This pattern emerges because customers want lower upfront costs, reduced risk and guaranteed uptime, and because retaining ownership allows the producer to refurbish, reuse and redeploy equipment in multiple life cycles.

SMEs and small midcaps can begin with a single “rental-ready” product, introduce a simple monthly fee that includes maintenance and upgrades and use basic digital dashboards to track usage and plan service. Over time, this stabilizes revenue, deepens customer relationships and naturally feeds refurbished loops, since the company always gets its products back.

3. Reverse logistics and structured take-back

Microsport, Aigner, Weber Electronic converge around building predictable flows of returned products and components through buy-back schemes, deposits, take-back clauses and organized logistics. They label products with lifecycle information, offer repurchase or deposit value and set up channels to bring devices and parts back into their control. This pattern emerges because all other circular strategies, such as refurbishment, remanufacturing, reuse and recycling depend on having reliable access to used products. Without structured returns, circular business models stay small and ad hoc.

SMEs and small midcaps can start with voluntary take-back of old devices, offer financial incentives such as discounts or deposits, and track returned units in a simple registry. As returns grow, these streams become

the backbone for refurbished inventories and provide real world data to improve design for disassembly, repair and circularity.

4. Digital intelligence for circularity

Companies such as jora.tech, Aquacut, Aigner and Hidrofilt use digital tools to make circularity measurable and manageable. They apply dynamic life cycle assessment, predictive AI, digital product passports, traceability systems and remote monitoring to understand how products are used, how they age and what environmental impact they create. This pattern emerges because circularity is data dependent: to extend life, recover resources or guarantee uptime, firms need reliable information on condition, usage, material flows and performance.

SMEs and small midcaps can begin with a single key metric like energy use, uptime or CO_2 per cycle - and connect it to simple sensors, QR codes and digital logs. Gradually, they can embed this data into service contracts, predictive maintenance routines and product passports, turning digital intelligence into a lever for better design, longer life and verifiable circular KPIs.

5. Resource recovery and secondary component markets

Weber Electronic, Hidrofilt and FT Famat focus on recovering value from what used to be waste: electronic components, salts, chemicals, reusable water and other high value fractions. They test and recertify components, integrate them into marketplaces, and design modular systems that can treat industrial streams and extract reusable resources. This pattern emerges in response to supply chain volatility, component scarcity and regulatory pressure on waste and emissions; by recovering resources, companies reduce dependence on imports and open new revenue streams.

SMEs and small midcaps can apply this by mapping their material flows, identifying high value components or substances that could be recovered and partnering with specialized marketplaces or technology providers. Over time, resource recovery can lower procurement costs, create new product or service lines and strengthen resilience against price shocks and shortages.

How the 10 companies map to the five circular patterns

Circular pattern	Companies using this pattern	How they create value through this pattern
Product life extension & refurbishment	Microsport, Aigner, Južni Prolaz, Weber Electronic supported by Chipsconnect	These companies extend the life of machines, devices and components through refurbishment, repair, grading, recertification and guaranteed spare parts. Their products are durable and repairable, making life extension economically attractive and technically feasible.
Product as a service, rental & subscription	Microsport, Aigner, Južni Prolaz	They shift from selling equipment to offering rental, pay-per-use or uptime guarantee models. Retaining ownership enables multi cycle refurbishment and stable long-term customer relationships.
Reverse logistics & structured take back	Microsport, Aigner, Weber Electronic supported by Chipsconnect	These companies build predictable return flows through buy back schemes, take back logistics, deposits and lifecycle labels. Reliable returns are

		essential for refurbishment, reuse and component recovery.
Digital intelligence for circularity	jora.tech, Aquacut, Aigner, Hidrofilt	They use digital tools such as Life Cycle Assessment dashboards, IoT monitoring, predictive maintenance, digital product passports and traceability systems to manage circularity with real-time data.
Resource recovery & secondary component markets	Weber Electronic supported by Chipsconnect, Hidrofilt, FT Famat	These companies recover electronic components, chemicals, salts, reusable water or other high value fractions. They reduce dependency on volatile supply chains and create new revenue streams through recertification and marketplace integration.

When and why these patterns consolidate in mechanics & mechatronics

When products are durable and repairable → Product life extension & refurbishment
Mechanics and mechatronics companies converge here because their machines, benches, devices and components have long lifespans and high repairability. Refurbishment becomes economically attractive, technically feasible and strategically important in markets pressured by low-cost imports.

When customers want lower upfront costs → Product-as-a-service, rental & subscription
This pattern consolidates when SMEs and small midcaps prefer OPEX over CAPEX and demand predictable costs and guaranteed uptime. Companies shift to rental, "pay per use" or uptime-based models because they retain ownership, enable multi cycle refurbishment and stabilize revenue.

When companies need predictable product returns → Reverse logistics & structured take-back
Circularity cannot scale without reliable access to used products. This pattern emerges when companies require structured take back systems buy back schemes, deposits, lifecycle labels or logistics networks to feed refurbishment, reuse and component recovery loops.

When sustainability must be measurable → Digital intelligence for circularity
This pattern consolidates when companies need data to manage circularity. Dynamic LCA, IoT monitoring, predictive maintenance and digital product passports make environmental impact visible, track product condition and support service-based business models.

When supply chains are volatile → Resource recovery & secondary component markets
Companies converge here when component scarcity, price volatility or import dependency threaten production. Recovering electronic components, chemicals or materials stabilizes supply, reduces procurement costs and creates new revenue streams.

Despite their diversity, the 10 companies converge into five clear circular business model patterns that are practical, scalable, and directly applicable to the mechanics & mechatronics sector. These patterns form a sector wide circular transformation roadmap that any SMEs and small midcaps can adopt, starting small, building capabilities, and scaling circularity over time.

4. Challenges for business model

Based on the analysis of 10 business cases from the sector, the companies struggle primarily with:

1. High cost and risk of circular redesign
2. Lack of digital integration and data for circularity
3. Limited customer acceptance of new service-based models
4. Supply-chain rigidity and lack of circular-ready partners
5. Missing internal sustainability competencies
6. Regulatory and certification constraints slowing innovation.
7. Competition from low cost imports.

Companies in the mechanics and mechatronics sector struggle with their business models because they operate in an environment where precision, reliability, and certification requirements collide with the demands of circularity and sustainability. The CURIOST workshops show that these firms often want to innovate, but they are constrained by the nature of their products and the expectations of their customers.

For example, Austrian companies like Aigner GmbH openly expressed fear of investing in new service-based models because of the uncertainty associated with innovation and market acceptance, reflecting a broader hesitation across the sector. Their products are expensive to redesign, and even small changes can trigger new safety checks, new tooling or new certification cycles, which slows down experimentation and makes business model innovation feel risky.

At the same time, many companies lack the digital infrastructure needed to support circular models. They talk about the need for monitoring of critical parameters or AI-enabled control systems, but these capabilities are not yet in place. Without data, they cannot offer predictive maintenance, pay-per-use, or refurbishment-based services - all of which depend on knowing how equipment behaves over time. This creates a gap between what circular business models require and what SMEs and small midcaps can currently deliver.

Customer behaviour adds another layer of difficulty. Industrial buyers are used to purchasing machines outright, not subscribing to “clean air as a service” or similar models. Companies repeatedly note that customers are conservative, risk averse, and reluctant to change established processes. Even when a circular model is technically feasible, the market may not be ready for it, which discourages companies from moving forward.

Supply chains also hold them back. Mechanics and mechatronics products rely on specialised components, and SMEs and small midcaps often cannot find partners who can support modularity, take-back systems, or recycled materials. This forces them to shoulder the entire burden of circularity alone, which is rarely viable.

Finally, the workshops reveal a consistent lack of internal sustainability expertise. Many companies depend heavily on Creative Heads / Experts to perform materiality analyses, map circular opportunities, or define sustainability KPIs. They know sustainability matters, but they do not yet have the skills or structures to integrate it into their business models.

Together, these challenges create a situation where companies are motivated to innovate but constrained by cost, regulation, customer expectations, and missing capabilities. They are trying to move toward circularity, but the path is steep, and every step requires balancing technical feasibility with market acceptance and regulatory compliance.

5. Impact areas and expected benefits of business model

Companies in the mechanics and mechatronics sector expect business model innovation to generate impact primarily in operational efficiency, product lifetime extension, digitalisation, customer value, and environmental performance. Because their products are technical, long lived, and safety critical, even small improvements in design, monitoring, or modularity can create significant benefits.

Across the conducted workshops, companies repeatedly emphasise that improved monitoring, modularity and circular design would allow them to reduce waste, lower operating costs, and increase reliability. For example, Aigner GmbH explored how better to monitor critical parameters and modular components could reduce downtime and extend the life of air cleaning systems, while jora.tech focused on AI enabled control systems to improve consistency and reduce material losses in extrusion processes. These improvements directly translate into higher productivity, fewer failures, and more predictable maintenance cycles, which are essential benefits in this sector.

Another major impact area is customer value and new service opportunities. Companies see potential in shifting from one-time sales to service oriented models such as “clean air as a service” or predictive maintenance contracts. Although customers are still hesitant, firms recognise that such models could create stable revenue streams, stronger customer relationships and differentiation in competitive markets. The workshops show that companies expect these models to help them move from selling hardware to delivering outcomes such as uptime, air quality, or energy efficiency.

Business model innovation also supports resource efficiency and circularity, which is increasingly important due to EU regulations and material costs. Companies anticipate benefits from designing products that are easier to disassemble, refurbish or recycle. This is visible in discussions about modular components, reuse of regranulate and take-back systems. These changes help reduce raw material dependency and improve environmental performance, which companies recognise as both a regulatory requirement and a market advantage.

Finally, companies expect business model innovation to strengthen strategic resilience. By adopting circular flows, digital monitoring, and service-based offerings, they aim to reduce exposure to volatile material prices, labour shortages, and supply chain disruptions. The workshops show that firms believe these innovations will make them more adaptable and competitive in the long term, even if the transition requires significant effort.

6. Core enabler for successful circular transformation

Digital lifecycle intelligence
This means equipping products, components, and systems with data, traceability, and monitoring capabilities that allow SMEs and small midcaps to:

- know **how products are used**
- predict **when components will fail**
- understand **what can be repaired or upgraded**
- **track materials** for reuse
- and **design modular, long life systems**

Digital Lifecycle Intelligence in the mechanics and mechatronics sector is essentially the shift from selling static machines to managing living, data rich systems. When companies embed sensors, monitoring functions, traceability tools, and digital records into their components, they finally gain visibility into how their products behave over time. This allows them to understand how equipment is used in real conditions, anticipate failures before they happen, and identify which parts can be repaired, upgraded, or reused instead of replaced. It also enables them to track materials across the entire lifecycle, which is essential for circular strategies such as remanufacturing or component harvesting.

Across the CURIOST workshops, companies repeatedly discovered that without this kind of intelligence, circular business models remain theoretical. Aigner GmbH, for example, explored the need for monitoring critical parameters because without real time data, they cannot offer clean-air-as-a-service or guarantee performance. jora.tech's work on AI enabled extrusion control shows the same pattern: better data leads to more consistent quality, less waste, and more predictable maintenance. In every case, digital lifecycle intelligence becomes the technical backbone that makes long life, modular, repairable systems economically viable.

Once products become traceable and predictable, SMEs and small midcaps can move beyond one-time sales and start offering uptime guarantees, contracts based on performance, or subscription models. They can design components that stay in circulation longer, reduce material consumption, and cut operating costs for customers. In short, digital lifecycle intelligence transforms mechanical products from isolated hardware into connected assets that support repair, reuse, remanufacturing, and service-based business models - the very models that the CURIOST project aims to help companies adopt.

C. Packaging Business Model Template

1. Sector introduction

The packaging sector in the CURIOST project operates at the centre of Europe's transition toward circular and sustainable product systems. Companies in this sector face increasing pressure from customers, regulators, and supply chain partners to reduce waste, replace single use materials, and design packaging that can circulate through multiple lifecycles. The CURIOST piloting workshops showed that packaging SMEs and small midcaps are already experimenting with new materials, reusable systems, and service-based models, but they often struggle with fragmented supply chains, limited access to recyclable inputs, and the challenge of convincing customers to adopt unfamiliar circular solutions. At the same time, the sector is strongly influenced by upcoming EU regulations such as the Packaging and Packaging Waste Regulation (PPWR), which accelerates the need for traceability, recyclability, and measurable environmental performance. Within this context, business model innovation becomes essential.

Companies like HeroPAK, Termogas, UNIMER, and EZO.sk demonstrated that circular packaging is not only a matter of material substitution, but also of redesigning how value is created and delivered. Reuse systems require new logistics partnerships, digital tracking, and customer engagement strategies. Recyclable or bio-based materials demand new supplier relationships and quality control processes. Service based models such as Packaging-as-a-Service challenge traditional purchasing habits and require companies to rethink revenue streams, cost structures, and operational capabilities. Despite these challenges, the workshops revealed a strong appetite for innovation: SMEs and small midcaps see opportunities to differentiate themselves, reduce material dependency and build more resilient and sustainable business models.

The packaging sector in CURIOST is therefore characterised by both urgency and opportunity. It is a sector where circularity can be implemented quickly and visibly, but only if companies combine material innovation with new business model logic. This template supports that process by helping SMEs and small midcaps articulate how they create value, how circularity changes their operations, and how new models such as reuse loops, modular packaging or service-based offerings can become viable, scalable, and aligned with European sustainability goals.

2. Common problems and drivers in the sector

Challenges in the Sector
The CURIOST companies from the packaging sector struggle with a cluster of interconnected challenges that make circular and sustainable business model innovation difficult. Their difficulties are not only technical but also organisational, behavioural, and systemic and they appear consistently across the workshops in Austria, Croatia, Slovakia and Germany.

Across the CURIOST piloting sessions, packaging SMEs and small midcaps repeatedly confronted the reality that material choices, logistics constraints and customer habits strongly limit their ability to shift toward circularity. Many companies still depend on multi material structures or virgin plastics, and although they explore alternatives, they face uncertainty about performance, cost, and availability. The challenge is not only technical but also economic: switching materials often increases production costs while customers still expect low prices.

Another major struggle is the operational complexity of reuse systems. Companies discovered that introducing Packaging-as-a-Service requires logistics partners to change long established routines. The business cases show that logistics companies "are not used to this way of handling and thinking their processes," which reflects a broader resistance to new circular workflows. Reuse loops require tracking, cleaning, return logistics, and coordination across multiple actors - capabilities that most SMEs and small midcaps do not yet have.

The workshops also show that packaging companies lack data and traceability, which prevents them from proving circularity or managing packaging across multiple lifecycles. Without digital tracking, they cannot monitor return rates, material flows, or environmental impacts. This makes it difficult to comply with upcoming EU regulations such as PPWR – Packaging and Packaging Waste Regulations, which demand measurable recyclability and transparency.

Drivers and Opportunities in the Sector

The packaging sector is driven by a strong push toward circularity, regulatory compliance, and changing customer expectations. Companies across Austria, Croatia, Slovakia, Poland and Germany repeatedly emphasize that the traditional linear model of "produce-use-dispose" is no longer viable. Instead, they are being pushed to rethink materials, redesign packaging structures, and explore new business models. This shift is not only a response to external pressure but also an opportunity to innovate and differentiate. The ambition of companies focusing on introduction a Packaging-as-a-Service model shows how the sector is moving toward service-based value creation.

Regulation is another major driver. During the workshops companies in Croatia and Slovakia openly discussed the pressure created by reporting obligations, recyclability requirements, and EU circular economy directives. These rules are forcing companies to redesign products and simplify material structures, but they also open the door to innovation.

Customer expectations are shifting as well. Both B2B clients and consumers increasingly demand recyclable, reusable, or low impact packaging. This trend was visible in the Croatian workshop, where companies mapped out why their ideas could succeed, and customer acceptance of sustainable solutions appeared as a recurring theme.

These drivers create several opportunities for the sector:

- Reusable packaging systems, such as HeroPAK's PaaS model, which can reduce waste and create new revenue streams.
- Material innovation, including bio-based materials, mono material designs, and the integration of recycled content.
- Digitalization, enabling tracking, lifecycle monitoring, and optimized return logistics.
- Cross border collaboration, which can accelerate innovation through shared supply chains and joint R&D.
- Waste-to-resource loops, such as take-back systems and regranulation, which turn production scraps into valuable inputs

3. Consolidated solution patterns

Consolidation of solution patterns for packaging is based on business cases of the following companies:

EZO s.r.o. – Slovakia
HeroPAK (Peter Wilson E. Pu) – Austria
NET WORTH s.r.o. - Slovakia
TERMOGAS d.o.o. - Croatia
UNIMER d.o.o. - Croatia

Across the five business cases, the MVPs and transformation pathways consistently converge into **five circular business model patterns**:

1. Circular materials & packaging substitution
2. Process automation & resource efficiency
3. Circular supply chains & logistics optimization
4. Product-as-a-service (PaaS) & lifecycle management
5. Data-driven circularity & customer feedback loops

Each pattern emerges from different starting points but leads to **similar circular value creation mechanisms**.

1. Circular materials and packaging substitution
NETWORTH and EZO.sk both move toward packaging made from recyclable, biodegradable or reduced plastic materials, because they operate in product categories where packaging is the main environmental hotspot and where customers and regulators increasingly reject single use plastics. Their convergence is natural: both face pressure to reduce material intensity, both want to strengthen brand credibility, and both see material substitution as the fastest and most visible way to become more circular. The most practical insight is that companies do not need to redesign everything at once; they can begin by reducing plastic content, improving recyclability and sourcing materials from regional suppliers to cut transport emissions.

SMEs and small midcaps can apply this pattern by starting with one product line, choosing a simpler or lighter material, pairing it with minimalist eco design and clearly communicating the environmental benefits to customers who increasingly expect sustainable packaging.

2. Process automation and resource efficiency
Termogas and EZO.sk converge around the idea that circularity often begins with eliminating inefficiencies in packaging processes. Termogas invests in automated box filling equipment, while EZO.sk simplifies packaging formats to reduce material and energy use. They meet in the same pattern because both recognize that manual, inconsistent or material intensive processes create unnecessary waste, higher costs and scalability limits. The insight here is that automation and circularity reinforce each other: automation reduces errors and waste, while material optimization lowers operating costs and environmental impact.

SMEs and small midcaps can adopt this pattern by analysing where labour, energy or materials are being wasted, evaluating the cost benefit of automation and introducing simple performance indicators such as energy use, waste per unit or CO_2 savings to guide continuous improvement.

3. Circular supply chains and logistics optimization
UNIMER and HeroPAK converge in this pattern because both operate in logistics heavy environments where transport emissions, packaging waste and inefficiencies are major cost drivers. UNIMER shifts from road to rail to reduce CO_2 and increase shipment volume, while HeroPAK replaces single use stretch film with reusable transport packaging. Their convergence reflects a shared need to make logistics more efficient, predictable and environmentally responsible. The key insight is that logistics is often overlooked in circularity, even though it can deliver some of the largest emission reductions.

SMEs and small midcaps can apply this pattern by exploring hybrid transport models that combine rail and road, tracking cost and emission data to justify changes, and forming partnerships with carriers or retailers to consolidate shipments and reduce waste in transport packaging.

4. Product-as-a-service and lifecycle management
HeroPAK stands out as the company fully embracing Packaging-as-a-Service, where customers no longer buy packaging but instead pay for access to reusable logistics assets that HeroPAK maintains, repairs, tracks and recycles. This pattern emerges because PaaS aligns perfectly with circularity: the provider retains ownership, ensures reuse and manages the entire lifecycle, which prevents loss and waste. The insight is that customers often resist change unless they clearly see operational and financial benefits, so demonstrating cost savings and efficiency is essential.

SMEs and small midcaps can apply this pattern when they are ready to let their products circulate in closed loops, when customers prefer service over owning, and when traceability or compliance is important. By integrating tracking technologies and offering maintenance and end of life services, SMEs and small midcaps can turn packaging into a managed circular system rather than a disposable product.

5. Data-driven circularity and customer feedback loops
NETWORTH, HeroPAK and Termogas converge here because all three rely on data to validate circular decisions. NETWORTH gathers customer feedback on packaging usability and environmental perception, HeroPAK uses IoT tracking and carbon footprint analysis to manage reusable assets, and Termogas conducts impact studies to understand customer expectations. They converge because circularity cannot rely on assumptions; companies need evidence about how packaging performs, how customers react and where improvements are needed. The insight is that data enables iterative improvement, reduces risk and strengthens customer trust. SMEs and small midcaps can apply this pattern by testing new packaging through small pilots, collecting structured feedback, using simple digital tools to track performance and feeding the results into redesign cycles. This approach is especially valuable when introducing new materials, formats or behaviours that require customer acceptance.

How the five companies map to the five circular patterns

Circular pattern	Companies using this pattern	How they create value through this pattern
Circular materials & packaging substitution	NETWORTH, EZO	These companies redesign packaging by switching to recyclable, biodegradable or reduced-plastic materials. This involves testing new material blends, adjusting packaging formats and ensuring that the new materials still meet functional requirements

		such as strength, barrier properties and printability.
Process automation & resource efficiency	Termogas, EZO	These companies optimise production by automating packaging lines, reducing manual handling and simplifying packaging structures. This allows them to cut material waste, lower energy consumption and improve consistency in production, making circular packaging easier and cheaper to implement.
Circular supply chains & logistics optimization	UNIMER, HeroPAK	These companies redesign logistics systems to reduce waste and emissions. This includes shifting transport modes, replacing single-use transport packaging with reusable alternatives and coordinating return flows so that packaging circulates multiple times instead of being discarded after one use.
Product as a service & lifecycle management	HeroPAK	This company operate reusable packaging as a managed service. This means they track each unit, repair damaged items, organise returns and ensure that packaging stays in controlled loops. Their business model depends on keeping materials in circulation for as long as possible.
Data driven circularity & customer feedback loops	NETWORTH, HeroPAK, Termogas	These companies use data to guide circular decisions. This includes collecting customer feedback on packaging performance, using IoT tracking to monitor reuse cycles, analysing carbon footprints and conducting impact studies. The data helps them redesign packaging, prove environmental benefits and continuously improve circular performance.

When and why these patterns consolidate in packaging

When packaging is the main environmental hotspot → Circular materials & packaging substitution
Packaging companies converge here because most of their environmental impact comes from single use plastics and material intensity. Substituting materials is the fastest, most visible circular step and responds directly to customer expectations and tightening regulations.

When manual processes create waste and limit scalability → Process automation & resource efficiency
This pattern consolidates when labour intensive packaging steps cause over packaging, inconsistent quality or unnecessary energy use. SMEs and small midcaps adopt automation because it reduces waste, stabilizes quality and lowers operational costs.

When transport emissions dominate the footprint → Circular supply chains & logistics optimization

Companies converge here when logistics is a major cost and emission source. Shifting to rail, consolidating shipments or using reusable logistics packaging delivers large CO_2 reductions and improves efficiency across the supply chain.

When packaging circulates in closed loops → Product-as-a-service & lifecycle management
This pattern emerges when reusable packaging moves repeatedly between the same partners. SMEs and small midcaps adopt PaaS because it ensures reuse, reduces loss and shifts customers from CAPEX to predictable OPEX, making circular packaging financially attractive.

When circular decisions require evidence → Data driven circularity & customer feedback loops
This pattern consolidates when companies need proof that new materials, formats or reuse systems work. Data, IoT tracking or own tracking system and customer feedback reduce uncertainty, validate performance and guide iterative redesign.

4. Challenges for business model

Based on the analysis of the 5 business cases, companies from packaging sector struggle primarily with:

1. Shifting from product sales to service-based models
3. Balancing performance, cost and recyclability
4. Building reverse logistics systems for collection, cleaning, and reuse, which many SMEs and small midcaps currently try to incorporate
4. Managing regulatory pressure and compliance costs, especially for recyclability and reporting
5. Ensuring customer acceptance, since circular models often require new behaviors and workflows.

The packaging companies in the CURIOST piloting process face a similar set of challenges of their business models, even though they operate in different markets and countries. Their struggles with the shift toward circularity, which requires new revenue models, new operational capabilities, and new customer behaviors. For **TERMOGAS**, **NETWORTH**, **EZO**, **HeroPAK**, and **UNIMER**, the transition is not only technical but deeply strategic, affecting how they create value, deliver it, and capture it.

A central challenge is the shift from selling packaging products to offering service based or circular models. HeroPAK illustrates this most clearly: their Packaging-as-a-Service concept requires logistics companies to return, reuse, and track packaging instead of treating it as disposable. The workshop notes that logistics partners are “not used to this way of handling and thinking their processes,” which means HeroPAK must redesign customer workflows, incentives, and the entire value proposition. TERMOGAS and UNIMER face similar obstacles when exploring reusable or modular packaging systems customers must change routines, and the companies must build new service infrastructures.

Another major challenge is balancing performance, cost, and recyclability. NETWORTH and EZO both struggle with the tension between high quality packaging and the need to reduce material complexity. NETWORTH’s workshop explicitly mentions the need to “simplify the design of packaging to minimize material consumption,” yet customers still expect durability and visual appeal. EZO’s Doypack packaging faces the same dilemma: reducing plastic content improves sustainability but risks compromising product protection.

A third challenge is the lack of reverse logistics systems needed for circular packaging. UNIMER, which operates in packaging and waste related services, identified that they lack the infrastructure and data to manage take back, sorting, and reuse loops. TERMOGAS also highlighted missing processes and the absence of reliable information about material flows. Without collection, cleaning, and redistribution systems, circular business models remain theoretical rather than operational.

Regulatory pressure adds another layer of complexity. All five companies must navigate tightening EU rules on recyclability, reporting, and extended producer responsibility. NETWORTH and EZO, for example, must ensure that their packaging meets recyclability criteria while keeping costs manageable. Croatian companies expressed concerns about reporting obligations and the need to redesign products to comply with future regulations. These requirements reshape business models because they influence material choices, cost structures, and long-term strategic planning.

Finally, customer acceptance remains a persistent barrier. Circular packaging often requires customers to change behaviors; returning packaging, accepting new materials, or adapting to new service models. HeroPAK depends entirely on customer willingness to adopt reusable logistics packaging. TERMOGAS and UNIMER face similar issues: even if sustainable packaging is technically feasible, customers may resist higher prices, new workflows, or unfamiliar materials. This slows down adoption and complicates business model transformation.

5. Impact areas and expected benefits of business models

Business model innovation in the packaging sector primarily affects how companies create value through circularity, how they interact with customers, and how they manage materials across the entire lifecycle. The companies in Deliverable 2.3.2, TERMOGAS, NETWORTH, EZO, HeroPAK, and UNIMER show that the shift toward sustainable packaging opens several strategic impact areas with tangible benefits.

The first major impact area is **operational efficiency and resource optimization**. When companies redesign packaging for recyclability or reuse, they reduce material waste, lower production costs, and gain more control over their resource flows. For example, UNIMER and TERMOGAS identified that better tracking of materials and more efficient sorting processes would reduce losses and improve predictability. This leads to benefits such as lower raw-material dependency, reduced waste-handling costs, and more stable supply chains.

Another important impact area is customer value and service innovation. Circular business models, especially reusable systems allow companies to move from selling products to offering services. HeroPAK's Packaging-as-a-Service model is the clearest example. By offering reusable logistics packaging, they can provide customers with guaranteed availability, reduced waste, and simplified compliance. The expected benefits include stronger customer relationships, recurring revenue streams, and differentiation in a competitive market.

A third impact area is environmental performance and regulatory alignment. Companies that redesign packaging to be recyclable, reusable, or mono material reduce their environmental footprint and comply more easily with EU regulations. NETWORTH and EZO, for instance, expect that simplifying packaging structures will help them meet recyclability requirements and avoid future penalties. The benefits here include reduced compliance costs, improved sustainability reporting, and a stronger market position as regulations tighten.

Digitalization also emerges as a significant impact area. Tracking systems, data collection, and digital monitoring enable companies to manage circular flows more effectively. HeroPAK and UNIMER both explored digital tools to support return logistics and material tracking. The expected benefits include better transparency, improved decision-making, and the ability to offer data-driven services to customers.
Finally, business model innovation strengthens strategic resilience. Companies that adopt circular loops, diversify materials, or introduce service-based models become less vulnerable to price fluctuations, supply-chain disruptions, and regulatory changes. TERMOGAS and EZO, for example, expect that circular packaging solutions will reduce their exposure to volatile raw-material markets and help them adapt more quickly to new sustainability requirements.

In summary, the main impact areas and expected benefits include:

- **Operational efficiency** - reduced waste, lower material costs, and more predictable production.
- **Customer value and service innovation -** stronger relationships, recurring revenues, and differentiated offerings.
- **Environmental performance and regulatory compliance** - easier alignment with EU rules and improved sustainability metrics.
- **Digital enablement** - better tracking, transparency, and data-driven services.
- **Strategic resilience** - reduced exposure to material volatility and regulatory risk.

6. Core Enabler for successful circular transformation

Close cooperation & material traceability across the packaging value chain

Close Cooperation across the packaging value chain; especially alignment between suppliers, converters, SMEs and small midcaps, recyclers and customers, supported by clear material data and traceability – is the single enabler that unlocks every other circular practice in packaging.

It gives SMEs and small midcaps the shared information, transparency, and practical conditions needed to:

- switch to recyclable, bio-based or low-impact materials
- simplify packaging design and reduce material use
- ensure recyclability and compatibility with real recycling systems
- verify environmental impacts and CO_2 savings
- comply with PPWR, EPR and Digital Product Passport requirements
- build reuse, refill or take-back systems
- collaborate with customers and logistics partners on circular pilot

Close cooperation across the packaging value chain, supported by reliable material data and traceability is not just an operational improvement, it becomes a core structural element of the business model. For packaging SMEs and small midcaps, circularity only works when suppliers, converters, recyclers, logistics partners, and customers operate with shared information and aligned incentives. This enabler reshapes how value is created, delivered, and captured.

In a circular packaging business model, value creation depends on knowing exactly what materials are used, how they behave in real recycling systems, and how they move through the chain. Material traceability

allows companies to design packaging that is compatible with recycling, reuse, or regranulation. It also enables them to switch to bio-based or low impact materials without risking performance failures or regulatory non-compliance. Cooperation with suppliers and recyclers ensures that design decisions are grounded in real technical and market conditions rather than assumptions.

Value delivery also changes. When companies collaborate closely with logistics partners and customers, they can build reuse, refill, or take back systems that actually function. These systems require shared data on quantities, flows, contamination risks, and return rates. Without cooperation and traceability, reuse loops break down. With them, companies can deliver new service based offerings such as Packaging-as-a-Service, deposit-return systems, or closed-loop B2B packaging pools.

Value capture is strengthened because traceability provides the evidence needed to demonstrate CO_2 savings, recyclability, and compliance with PPWR, EPR, and Digital Product Passport requirements. This allows companies to justify premium pricing, secure long term contracts, and reduce regulatory risk. It also opens the door to new revenue streams based on data, reporting, or performance guarantees.

D. Plastics Business Model Template

1. Sector introduction

The plastics sector in CURIOST is undergoing a rapid shift as companies balance high technical performance with the need for circular and low impact solutions. Conducted workshops show that plastics SMEs and small midcaps are rethinking material choices, redesigning multilayer structures, and exploring ways to integrate recycled content without compromising quality. Circularity in plastics is technically demanding, and progress depends on close cooperation across the value chain; from polymer suppliers to converters, recyclers, and end users.

Companies such as Lenzing Plastics and MAINCOR demonstrated that even small changes in polymer composition or processing can significantly influence recyclability and environmental impact. This creates both pressure and opportunity: pressure to comply with evolving EU regulations, and opportunity to innovate through mono material design, take back systems for production scraps, improved regranulate quality, and digital monitoring of material flows.

Despite challenges such as complex material structures, inconsistent recycled feedstock, and regulatory uncertainty, the sector shows strong potential for circular transformation. This Business Model Template supports plastics companies in defining how circularity reshapes their value creation, operations, and long term competitiveness.

2. Common problems and drivers in the sector

Challenges in the sector

The plastics sector faces a set of interconnected challenges as it moves toward circularity. Companies must redesign products that traditionally rely on complex polymer structures, while ensuring that performance, durability, and cost remain competitive. Many SMEs and small midcaps struggle with the technical difficulty of replacing multilayer or composite plastics with mono material solutions that are recyclable in real systems. At the same time, access to consistent, high quality recycled feedstock remains limited, making it difficult to integrate regranulate without compromising product quality.

Regulatory pressure is intensifying, with EU requirements on recyclability, reporting, and material transparency pushing companies to adapt faster than their current systems allow. This is compounded by uncertainty about future standards and the need for precise material data. Operationally, companies must also rethink their production processes, manage scrap more efficiently, and collaborate more closely with recyclers and suppliers to ensure circular compatibility.

Overall, the sector's main challenges lie in balancing technical performance with circular design, securing reliable recycled materials, meeting evolving regulatory demands, and building the cross-value chain cooperation needed to make circular plastics viable at scale.

Drivers and opportunities in the sector

The plastics sector is being driven by a strong push toward circularity, material efficiency, and compliance with evolving EU regulations. Companies are motivated to redesign products, reduce dependency on virgin polymers, and integrate recycled content as regulatory expectations and customer demand for sustainable solutions increase. This shift is reinforced by rising material costs and the need for more resilient supply chains.

These pressures create significant opportunities. Mono material redesign, improved regranulate quality, and take back systems for production scraps open pathways to closed loop models. Digital tools for monitoring material flows enable better traceability and support compliance with future requirements such as the Digital Product Passport. Collaboration across the value chain between suppliers, converters, recyclers, and end users, allows companies to co-develope solutions that are both technically feasible and economically viable. As a result, plastics SMEs and small midcaps can strengthen competitiveness, reduce environmental impact, and position themselves as early movers in a rapidly transforming sector.

3. Cosolidated solution patterns

Consolidation of solution patterns for plastics is based on business cases of the following companies:

HAT-Trick j.d.g. - Poland
HM Okna a dvere s.r.o. - Slovakia
KLGS Sp. z o.o. - Poland
Lenzing Plastics GmbH & Co. KG - Austria
Maincor Rohrsysteme GmbH & Co. KG - Germany
Plastiz srl - Italy
RS Pharma s.r.o. - Slovakia
Sinterit Sp. z o.o. - Poland
Trafiplast srl - Italy

Across all nine plastics sector companies, circular transformation does not produce nine different business models. Instead, their linear models naturally converge into four robust circular business model patterns.

This convergence happens because companies face similar pressures (waste, material costs, regulation, customer expectations) and discover similar opportunities (resource recovery, recycled materials, digital traceability, reuse, service models).

The four consolidated circular business model patterns are:

1. **Circular materials & product innovation**
2. **Design-for-circularity & performance compliance**
3. **Resource recovery & closed-loop systems**
4. **Digital intelligence & circular solution partnerships**

1. Circular materials and product innovation
In this pattern, KLGS, Sinterit, Trafilplast, Plastiz and Lenzing Plastics all focus on turning waste and conventional plastics into higher value, circular materials and products. They converge here because their core competence is already in materials, compounding and product formulation, so circularity becomes a question of developing new grades and recipes rather than changing their whole business model.

KLGS restores the functional properties of engineering plastics, Sinterit turns used PA12 powder into a stable ECOe material, Trafilplast expands recycled PVC profiles, Plastiz combines recycled PS with certified layers to meet fire standards, and Lenzing Plastics redesigns multilayer films for future recyclability.
This pattern emerges when waste streams are technically recoverable, customers start asking for recycled content and regulations push for recyclability and lower CO_2. SMEs and small midcaps can apply it by identifying their largest plastic waste stream, developing one flagship recycled or upcycled grade with clear specifications, working with labs or universities for testing and using simple indicators like CO_2 per kilogram as a credible selling point.

2. Design-for-circularity and performance compliance
Plastiz, RS Pharma, HM Okná a dvere and Lenzing Plastics converge in a pattern where circularity is driven by strict performance and regulatory requirements. They operate in contexts where fire safety, hygiene, food contact, building codes or other standards cannot be compromised, so the challenge is to redesign products and packaging to be recyclable while still meeting all certifications.
Plastiz must keep recycled PS visible yet comply with EN 13501-1 fire class, RS Pharma simplifies and shifts to recyclable or biodegradable packaging, HM Okná a dvere introduces Grade B recycled PVC windows and "second life" solutions, and Lenzing Plastics rethinks multilayer films to avoid future recycling barriers.

This pattern appears when circularity must coexist with demanding technical performance and when companies want to enter regulated markets such as public buildings, HoReCa or construction. SMEs and small midcaps can apply it by auditing their top products for layers, adhesives and coatings, redesigning them as mono material or easily separable solutions, involving certifiers early in the process and using tools like Digital Product Passports to document both compliance and recyclability as part of a combined value proposition.

3. Resource recovery and closed-loop systems
MAINCOR, Lenzing Plastics, HM Okná a dvere and Trafilplast converge around building closed loops for clean, mono material plastic streams such as pipes, films, PVC profiles and window frames. They share the situation of generating predictable, valuable waste that is too important to simply discard, so circularity becomes a logistics and reverse-supply-chain challenge.
MAINCOR sets up collection of PE-RT pipe offcuts and reintegrates them into internal recycling, Lenzing Plastics uses Digital Product Passports to trace waste and enable reverse logistics, HM Okná a dvere dismantles windows into reusable components and recycled PVC, and Trafilplast feeds its own PVC waste into TRAFILGREEN profiles.

This pattern emerges when disposal costs rise, when customers want traceable recycled content and when companies seek feedstock independence. SMEs and small midcaps can apply it by mapping their waste streams, starting with internal scrap loops, then extending to customer take-back of offcuts or installation waste, partnering with installers, recyclers or logistics providers and creating product lines explicitly marketed as "made from your own waste" or "closed loop" solutions.

4. Digital intelligence and circular solution partnerships
HAT-TRICK, Lenzing Plastics, KLGS and Sinterit converge in a pattern where digital tools and collaboration turn them from simple product suppliers into circular solution partners. They recognise that circularity requires data, traceability and coordination across multiple actors, so they invest in systems and partnerships that connect materials, processes and information.
HAT-TRICK integrates ERP, MES, APS and CRM to track material efficiency and waste, Lenzing Plastics uses Digital Product Passports to trace waste and support reverse logistics, KLGS combines material development with process consulting and collaboration with universities, and Sinterit offers not just powder but also print profiles and process workflows.

This pattern appears when customers demand traceability for CO_2, recyclate content or compliance, and when companies want to sell services and know how alongside materials or equipment. SMEs and small midcaps can apply it by building simple dashboards for waste and CO_2, packaging their offer as "material plus process plus data", and using tools like Digital Product Passports or QR-based tracking to enable reverse logistics and participation in secondary material markets, thereby embedding themselves more deeply in their customers' circular strategies.

How the nine companies map to the four circular patterns

Circular pattern	Companies using this pattern	How they create value through this pattern
Circular materials & product innovation	KLGS, Sinterit, Trafilplast, Plastiz, Lenzing Plastics	These companies work directly with materials and compounding, so circularity becomes a material innovation challenge rather than a business-model shift. They innovate with recycled content, new formulations and recyclable material structures.
Design for circularity & performance compliance	Plastiz, RS Pharma, HM Okná a dvere, Lenzing Plastics	These companies operate in highly regulated environments where products must remain compliant (fire safety, hygiene, food contact, building codes) while becoming recyclable. Circularity therefore centres on redesigning products without compromising performance.
Resource recovery & closed loop systems	MAINCOR, Lenzing Plastics, HM Okná a dvere, Trafilplast	These companies generate clean, predictable mono-material waste streams (PVC, PE-RT, films). Circularity becomes a reverse-logistics and feedstock-independence strategy, enabling internal recycling and closed-loop systems.
Digital intelligence & circular solution partnerships	HAT-TRICK, Lenzing Plastics, KLGS, Sinterit	These companies use digital tools and integrated workflows to shift from product suppliers to circular solution partners. They enable traceability, CO_2 data, recyclate verification and cross-actor coordination.

When and why these patterns consolidate in plastics

When waste streams are technically recoverable → Circular materials & product innovation
This pattern consolidates when companies work directly with polymers, compounding or product formulation and can turn their own or external waste into new, high-performance materials. Firms like KLGS, Sinterit, Trafilplast, Plastiz and Lenzing Plastics converge here because circularity becomes a material innovation challenge rather than a business model shift. It emerges when customers demand recycled content, when regulations push for recyclability and when virgin material prices fluctuate, making recycled grades commercially attractive.

When circularity must coexist with strict performance requirements → Design-for-circularity & performance compliance
This pattern consolidates when companies operate in regulated environments such as construction, pharma, packaging or public spaces. Plastiz, RS Pharma, HM Okná a dvere and Lenzing Plastics converge here because they must meet fire safety, hygiene, food contact or building code requirements while still

improving recyclability. It emerges when circularity cannot compromise compliance and when entering new markets requires products that are both certified and recyclable by design.

When companies generate clean, predictable mono-material waste → Resource recovery & closed-loop systems

This pattern consolidates when firms like MAINCOR, Lenzing Plastics, HM Okná a dvere and Trafilplast produce large volumes of valuable, homogeneous waste such as PVC profiles, PE-RT pipes or multilayer films. Circularity becomes a reverse logistics challenge rather than a material challenge. It emerges when disposal costs rise, when customers want traceable recycled content and when companies seek feedstock independence by reintegrating their own waste into production.

When circularity requires data, traceability and coordination → Digital intelligence & circular solution partnerships

This pattern consolidates when companies need to prove recyclate content, CO_2 savings or material traceability and when customers expect more than just a product. HAT-TRICK, Lenzing Plastics, KLGS and Sinterit converge here because they use digital tools, DPPs, ERP–MES integration and collaborative workflows to deliver circularity as a service. It emerges when circularity depends on multi-actor coordination and when companies shift from selling materials to offering integrated material-process-data solutions.

4. Challenges for business models

Based on the analysis of nine business cases, the companies from the sector struggle primarily with:

1. **Dependence on complex materials**
2. **Limited access to high-quality recyclate**
3. **Regulatory pressure and compliance costs**
4. **High sensitivity to material price volatility**
5. **Insufficient material traceability**
6. **Fragmented value-chain cooperation**
7. **Operational constraints and limited internal capacity**
8. **Customer acceptance barriers**
9. **Uncertainty about future standards.**

Across the nine business cases, companies face a set of interconnected challenges that collectively hinder their transition toward circular plastics. Firms such as **Lenzing Plastics**, **MAINCOR**, and **Plastiz** remain heavily dependent on complex multilayer or high-performance polymers, making redesign for recyclability both technically demanding and financially risky.

At the same time, companies like **Trafiplast**, **Plastiz**, and **KLGS** struggle to secure stable supplies of high quality recyclate, limiting their ability to integrate regranulate into products and meet emerging recycled-content requirements. These material constraints are compounded by tightening EU regulations, particularly PPWR, ESPR, and sector specific targets which impose significant compliance and documentation burdens on organisations that often lack robust data systems.

Economic pressures further intensify these difficulties. SMEs such as **HAT-Trick** and **RS Pharma** are highly exposed to fluctuations in virgin polymer prices, making long term planning and investment in circular

solutions uncertain. Meanwhile, insufficient material traceability across most companies prevents reliable verification of recyclability, CO_2 savings, or environmental performance. Weak coordination across the value chain spanning suppliers, converters, recyclers, and brand owners slows progress on mono material redesign, take-back schemes, and closed-loop models, leaving companies like **HM Okna**, **Sinterit**, and **KLGS** without the collaborative structures needed to scale circular practices.

Internally, many SMEs and small midcaps face operational constraints, including limited staff capacity, technical expertise, and time to test new materials or adopt digital tools. Even when circular alternatives are technically feasible, customer acceptance remains a barrier, as buyers often resist changes in material properties, appearance, or price. Finally, persistent uncertainty regarding future recyclability criteria, reporting obligations, and digital passport requirements discourages companies from committing to new materials or processes, slowing strategic decision making across the sector.

5. Impact areas and expected benefits of business model

Circular transformation in the plastics sector creates impact across material use, production processes, and value-chain collaboration. As companies redesign products for mono materiality, integrate regranulate, or introduce take-back systems, they strengthen both environmental performance and operational efficiency. The CURIOST workshops show that even small improvements in polymer composition, layer structure, or scrap management can significantly reduce waste and lower dependency on virgin materials. This leads to more stable production costs and greater resilience against volatile raw material markets.

Business model innovation also improves customer value. By offering solutions such as closed loop systems, high quality recycled materials, or traceable polymer flows, plastics SMEs and small midcaps can differentiate themselves and build stronger, longer term partnerships. Digital tools for monitoring material streams further enhance transparency and support compliance with EU regulations, including PPWR and future Digital Product Passport requirements. This creates measurable benefits such as verified CO_2 reductions, improved recyclability claims, and easier reporting.

Overall, the plastics sector can expect benefits in:

- **Lower long term material costs and more stable supply chains**
- **New revenue streams and access to new markets**
- **Stronger competitiveness and customer loyalty**
- **Reduced CO_2 emissions and waste**
- **Easier compliance with EU rules and lower EPR fees**

6. Core enabler for succesful circular transformation

High quality recycled material flows enabled by value chain coordination
A stable flow of high-quality recycled plastics; enabled by strong coordination between collectors, recyclers, converters, SMEs and small midcaps and brand owners, is the single enabler that unlocks every other circular practice in the plastics sector.
It gives SMEs and small midcaps the material stability, quality assurance and market conditions needed to:

- integrate recycled content into products and packaging,
- design plastics for real recyclability, not theoretical recyclability,
- reduce dependence on volatile virgin material markets,
- secure predictable input quality for manufacturing,
- verify environmental impacts and CO_2 savings,
- comply with PPWR, ESPR and sector-specific recycled-content targets,
- scale circular business models (reuse, refill, take-back, repair).

High quality recycled material flows, made possible through strong coordination between collectors, recyclers, converters, SMEs and small midcaps, and brand owners; form the backbone of circular business models in the plastics sector. This enabler directly shapes the structure of the Business Model Template because stable, traceable, and quality assured recycled plastics determine what companies can design, produce, and offer to the market. When value chain actors share specifications, material data, and process requirements, SMEs and small midcaps gain the material stability and confidence needed to integrate recycled content, redesign products for real recyclability, and reduce dependence on volatile virgin polymer markets.

In the Value Proposition, this enabler allows companies to offer verified recycled content products, transparent CO_2 savings, and packaging or components designed for true circularity. In Key Activities, coordinated material flows support mono material redesign, regranulate integration, and take-back systems. In Key Resources, high quality recyclate and material data become strategic assets. In Key Partnerships, collaboration with recyclers, suppliers, and brand owners becomes essential for securing predictable input quality and meeting PPWR, ESPR, and sector-specific recycled-content targets.
Finally, in Revenue Streams and Cost Structure, stable recycled material flows reduce risk, lower material volatility, and enable scalable circular business models such as reuse, refill, take-back, and repair.

E. Building & Construction Business Model Template

1. Sector introduction

The construction sector in CURIOST is undergoing a structural shift as companies face rising demands for sustainability, material efficiency, and compliance with new European regulations. Construction SMEs and small midcaps operate in a traditionally resource intensive environment, where long lasting materials, complex supply chains, and on-site variability make circular transformation challenging. At the same time, the sector holds significant potential: even small improvements in material selection, waste reduction, and design for disassembly can generate large environmental and economic benefits.

Across the CURIOST workshops, companies highlighted the need to reduce construction waste, increase the use of recycled or low impact materials, and improve coordination between suppliers, contractors, and clients. Digital tools, modular design, and traceable material flows are emerging as key enablers that help firms comply with evolving EU requirements and strengthen competitiveness. As the sector moves toward circular construction models, new opportunities arise in reuse, refurbishment, and service based offerings that extend the life of buildings and components.

2. Common problems and drivers in the sector

Challenges in the sector

The building and construction sector faces some of the most complex barriers due to its scale, material intensity, and regulatory environment. One major challenge is the slow adoption of circular design principles, such as designing buildings for disassembly, reuse, or material recovery. The Austrian example in workshops notes that “documentation requirements are perceived as burdensome” and that slow implementation of EU directives creates uncertainty. Recycling construction and demolition waste remains difficult due to technological limitations, contamination, and low market demand for recycled aggregates. Economic reasons, especially a lack of financial resources, are observed as the most important internal barrier, while external barriers include low availability of recycled materials and lack of market demand.

Skills shortages also hinder progress. Many regions lack architects, engineers, and construction workers trained in circular principles, deconstruction techniques, or sustainable materials. Croatia’s analysis highlights that “training programs for architects and engineers on circular principles” are urgently needed.

Financial constraints are another obstacle. Circular construction often requires higher upfront investment, and SMEs and small midcaps struggle to access funding for renovation, digitalisation, or new materials. Finally, regulatory complexity and slow permitting processes discourage innovation. In Germany, for example, “complicated legal landscape” and “lengthy approval processes” make it difficult to launch recycling initiatives.

Drivers and opportunities in the sector

Despite the challenges described above, the building and construction sector has strong drivers pushing it toward circularity. EU legislation, especially the revised Energy Performance of Buildings Directive and the Construction Products Regulation, requires higher energy efficiency, digital building logbooks, and sustainability assessments. These rules create long term incentives for renovation, reuse, and low carbon

materials. Growing demand for energy efficient buildings and renovation services is another major driver. Many countries are launching renovation waves, one stop shops, and financial incentives to improve building performance. Technological innovation also creates opportunities.

Digital tools such as Building Information Modelling (BIM), material passports, and 3D printing support better planning, traceability, and resource efficiency. Recycled construction materials represent a significant opportunity. Bavaria's "Mission RC20/25" aims to increase the use of recycled aggregates by 20%, demonstrating strong political support for circular construction. Finally, the sector benefits from increasing awareness of climate impacts and the need to reduce embodied carbon. This encourages the use of biobased materials, modular construction, and design for disassembly approaches.

3. Consolidated solution patterns

Consolidation of solution patterns for building & construction is based on business cases of the following companies:

Freyler Industriebau GmbH - Germany
GOR-STAL Sp. z o.o.- Poland
JMA Partner Sp. z o.o.- Poland
MB - Bau Invest Kft - Hungary
RECIKLAZA MISIC d.o.o. - Croatia

Although the five building and construction sector companies operate in very different parts of the value chain - heritage renovation, industrial construction, insulation materials, PIR panel manufacturing, and recycling - they converge into four predictable circular business model patterns when transitioning away from linear models.

This convergence happens because they face shared pressures (waste, energy performance, certification, renovation demand, digitalisation) and discover similar opportunities (resource recovery, digital twins, lifecycle value, secondary materials).

The four consolidated circular business model patterns are:

1. **Resource and recovery and secondary raw material products**
2. **Circular design and high-performance building components**
3. **Digital twins and precision driven circular renovation**
4. **Circular service and platform models**

1. Resource recovery and secondary raw material products
In this pattern, JMA Partner, GÓR-STAL and Reciklaža Mišić all turn construction waste into new products instead of paying to dispose of it. JMA Partner transforms large volumes of used cellulose water filters into aerogel granulate and circular plasters that can later be crushed and reused as lightweight aggregate. GÓR-STAL converts hundreds of tons of PIR production waste into eco boards, and Reciklaža Mišić turns surplus mixed construction waste into garden paving slabs and other horticulture products. This pattern emerges when companies generate large, predictable waste streams, when disposal costs or virgin material prices rise and when recycled content becomes a selling point.

SMEs and small midcaps can apply it by mapping their main waste streams, identifying at least one non-structural product they can make from each, partnering with recyclers or labs to stabilise quality and building a clearly branded circular product line with documented CO_2 savings.

2. Circular design and high-performance building components
JMA Partner and GÓR-STAL converge in a pattern where circularity is built into the design of high-performance materials and components. JMA Partner designs EAG plasters that are vapour permeable for heritage buildings and fully recyclable back into lightweight aggregate, while GÓR-STAL develops eco boards with defined thermal and mechanical performance that still allow recyclability of binders and long term stability. This pattern emerges when products must meet strict performance standards such as fire safety, moisture control or heritage requirements and when companies want to enter premium markets like energy efficient retrofits or heritage renovation.

SMEs and small midcaps can apply it by redesigning existing materials to be mono material or easily separable, combining recycled cores with certified outer layers where needed, documenting composition and recyclability in Digital Product Passports and codeveloping solutions with certifiers to shorten approval times and avoid dead end prototypes.

3. Digital twins and precision driven circular renovation
MB-Bau, FREYLER and JMA Partner (through Digital Product Passports) converge around using digital tools to make renovation more precise and less wasteful. MB-Bau uses LiDAR scanning and BIM to cut unnecessary demolition and survey errors, FREYLER builds a digital platform that shows current and future building values and supports reuse planning, and JMA Partner embeds DPPs to track the lifecycle and recyclability of its EAG plasters. This pattern emerges when renovation and brownfield projects are central, when clients want to reduce risk and when EU policies like Energy Performance of Buildings Directive (EPBD), Ecodesign for Sustainable Products Regulation (ESPR) and Digital Passport (DPP) demand traceability.

SMEs and small midcaps can apply it by starting with one pilot building, creating a digital twin, offering clients a predesign circular audit that quantifies waste avoided, CO_2 saved and reuse potential, and standardising renovation workflows with LiDAR and BIM so that reuse decisions can be made before demolition begins.

4. Circular service and platform models
MB-Bau, FREYLER and converge in a pattern where circularity becomes a service and platform opportunity rather than only a product feature. MB-Bau turns its survey and modelling capabilities into a tiered, billable service, FREYLER evolves into a lifecycle partner offering subscription based digital services for optimisation and reuse planning. This pattern emerges when margins in traditional construction are under pressure, when digitalisation enables recurring revenue and when circularity opens new service niches such as reuse planning, lifecycle optimisation and material takeback.

SMEs and small midcaps can apply it by packaging circular offerings as services - such as a circular renovation package combining audit, digital twin and reuse plan - adding material take back or reuse planning as paid add-ons and gradually building local marketplaces or platforms for reclaimed components in collaboration with architects, municipalities and developers.

How the five companies map to the four circular patterns

Circular pattern	Companies using this pattern	How they create value through this pattern
Resource recovery & secondary raw material products	JMA Partner, GÓR-STAL, Reciklaža Mišić	These companies turn their own waste streams into valuable inputs for new products. This includes collecting predictable production residues, stabilising their quality, and processing them into new materials such as aerogel granulate, PIR-based eco boards or recycled horticulture products. Certifications and testing ensure that these recovered materials meet market expectations and can be sold with confidence.
Circular design & high-performance building components	JMA Partner, GÓR-STAL	These companies redesign materials so that high technical performance and recyclability coexist. This involves engineering components that meet strict standards fire safety, moisture control, heritage compatibility while still being recyclable at end-of-life. By doing so, they open access to premium renovation markets where both performance and circularity are required.
Digital twins & precision driven circular renovation	MB-Bau, FREYLER, JMA Partner	These companies use digital tools such as LiDAR scanning, BIM models and lifecycle data to plan renovation with high precision. This reduces unnecessary demolition, avoids errors and identifies which materials can be reused. Digital workflows also create new revenue streams, such as pre-renovation audits, modelling services and lifecycle optimisation for clients.
Circular service & platform models	MB-Bau, FREYLER,	These companies package circularity into services rather than only products. This includes offering digital renovation audits, lifecycle management, reuse planning, subscription-based digital platforms or branded circular product lines. By shifting toward services, they scale faster, build long-term customer relationships and generate recurring revenue.

When and why these patterns consolidate in construction

When companies generate large, predictable waste streams → Resource recovery & secondary raw material products

This pattern consolidates when construction firms handle significant volumes of PIR waste, cellulose filters or mixed construction debris that are too valuable to discard. JMA Partner, GÓR-STAL and Reciklaža Mišić converge here because waste becomes a low cost feedstock that can be transformed into new circular products such as eco boards, aerogel plasters or recycled paving slabs. It emerges when disposal costs rise,

when virgin materials become expensive and when recycled content becomes a market differentiator supported by certifications that build trust.

When products must meet strict performance requirements → Circular design & high-performance building components
This pattern consolidates when circularity must coexist with demanding standards such as fire safety, moisture control, thermal performance or heritage building requirements. JMA Partner and GÓR-STAL converge here because circularity becomes a design challenge where materials must be both high performance and fully recyclable. It emerges when companies want to enter premium markets like energy efficient retrofits or heritage renovation and when high performance circular materials unlock new revenue opportunities.

When renovation and brownfield projects dominate → Digital twins & precision driven circular renovation
This pattern consolidates when clients demand risk reduction, accurate predesign data and compliance with EU policies such as EPBD, ESPR and Digital Product Passports. MB-Bau, FREYLER and JMA Partner converge here because digital precision through LiDAR, BIM reduces demolition, errors and rework while enabling reuse decisions before construction begins. It emerges when digital twins become essential for planning, lifecycle analysis and creating new service-based revenue streams.

When circularity creates new service opportunities → Circular service & platform models
This pattern consolidates when traditional construction margins are under pressure and when digitalisation enables recurring revenue through audits, modelling, monitoring or reuse planning. MB-Bau, FREYLER converge here because services scale faster than physical products and circularity becomes a value proposition rather than just a compliance requirement. It emerges when companies package circular offerings as services, build platforms for reclaimed materials or offer lifecycle optimisation as subscription-based support.

4. Challenges for business model

Based on the analysis of five business cases, the companies from the sector struggle primarily with:

- Fragmented project-based value chains
- Low material traceability
- High construction waste generation
- Limited access to secondary materials
- Regulatory pressure and documentation burden
- Operational uncertainty and cost volatility
- Low digitalisation and limited internal capacity
- Customer resistance to circular alternatives.

Across the building & construction sector cases, companies face a series of interconnected challenges that collectively slow their transition toward circular business models. Firms such as Freyler and MB-Bau Invest operate within highly fragmented, project-based value chains that depend on numerous subcontractors and suppliers, making coordination difficult and hindering the adoption of circular practices like selective demolition or component reuse.

This fragmentation is compounded by low material traceability, as many companies lack reliable data on material composition and quantities, limiting their ability to document CO_2 impacts, meet regulatory requirements, or plan for reuse.

Companies such as GOR-STAL and KLGS also struggle with high construction waste generation, driven by on site variability, inconsistent sorting practices, and limited local infrastructure for recycling or reuse. At the same time, firms like RECIKLAŽA MIŠIĆ highlight the limited access to secondary materials, noting unstable supply and inconsistent quality of recycled aggregates or reclaimed components, which makes circular procurement risky and unpredictable.

Regulatory developments add further pressure. New EU requirements on CO_2 reporting, material passports, and circular procurement create a significant documentation burden, particularly for SMEs and small midcaps that lack the necessary data systems and administrative capacity. These challenges are intensified by operational uncertainty and cost volatility, as fluctuating prices of steel, insulation, and other key materials make long term circular investments difficult for companies operating on tight margins.

Internally, many firms face low digitalisation and limited capacity, lacking the digital tools needed for material tracking, disassembly planning, or documenting circular performance. Even when circular solutions are technically feasible, customer resistance remains a barrier, as clients often prioritise cost and speed over reuse, selective demolition, or low impact materials. Together, these factors create a complex environment in which SMEs and small midcaps struggle to scale circular construction practices.

5. Impact areas and expected benefits of business model

Circular business models bring a wide range of benefits to the construction sector. Because construction uses enormous quantities of materials and generates large volumes of waste, even small circular improvements can create significant, measurable positive impacts for companies, communities and the environment.

Environmentally, circular construction helps reduce the amount of waste that ends up in landfills. Digital renovation methods, PIR foam reuse, recycled aggregates and upcycled cellulose keep materials in circulation instead of being discarded. MB-Bau's LiDAR based surveys, for example, can prevent unnecessary demolition by up to 40%, dramatically cutting waste. Using recycled materials and avoiding demolition also lowers CO_2 emissions, since fewer new materials need to be produced. JMA's aerogel granulate illustrates how low-carbon alternatives can replace traditional insulation. By reusing materials such as PIR, concrete, cellulose and minerals, companies reduce the need for extracting new raw materials and help protect natural ecosystems.

Economically, circularity helps companies save money and unlock new business opportunities. When waste becomes a resource, disposal costs fall. GÓR-STAL, for instance, no longer pays to transport PIR waste but uses it as a free input for new boards. Reciklaža Mišić transforms previously unused mixed materials into products with real market value. Circularity also creates new revenue streams, including:

- **Digital survey and renovation services**

- **Lifecycle value platforms and digital tools**
- **Aerogel production and eco insulation materials**
- **Horticulture products and eco-boards**

Operationally, circular construction improves precision, reduces risk and makes material flows more efficient. Digital twins eliminate survey errors and reduce delays, redesigns and waste. Circular design and reverse logistics systems improve traceability and help companies use materials more effectively. Using recycled inputs also strengthens supply chain resilience by reducing dependence on volatile global markets.

On the market side, circular construction strengthens customer relationships and opens new opportunities. Eco boards, recycled aggregates and digital renovation services help SMEs and small midcaps stand out as sustainability leaders. Circular products and services also give companies access to new markets such as heritage buildings, landscaping, lifecycle focused investors or public renovation projects.

Circularity also makes regulatory compliance easier. It aligns naturally with major EU policies such as the ESPR, EPBD, Digital Product Passport and waste-framework rules. Companies that adopt circular practices early reduce their long term regulatory risk and gain a competitive advantage as new rules come into force.

Socially, circular construction brings benefits to communities. JMA's insulation enables energy upgrades in historic buildings where traditional materials cannot be used, helping preserve cultural heritage. Circular models also create new jobs in digital surveying, material recovery, testing and lifecycle analysis. Communities benefit from less demolition, less dust, less noise and fewer truck movements.

For construction SMEs and small midcaps, the overall advantages are clear:

- **Lower material and disposal costs**
- **New revenue opportunities**
- **Reduced project risk and higher precision**
  - Higher building value and stronger customer loyalty
  - Easier compliance with EU rules
  - A smaller environmental footprint

6. Core enabler for succesful circular transformation

Digitalisation of buildings, materials, and processes
Digitalisation - especially **LiDAR based surveying**, **BIM integration**, and **Digital Product Passports** - is the single enabler that unlocks every other circular practice in construction.

It gives SMEs and small midcaps the **accurate data, traceability, and lifecycle transparency** needed to:

- plan renovation instead of demolition
- reduce waste at design and execution stages
- document materials for future reuse
- evaluate lifecycle value and CO_2 savings
- support certification and regulatory compliance
- design buildings and components for disassembly
- operate circular services (digital twins, reuse planning, take-back schemes)

Digitalisation of buildings, materials, and processes, through LiDAR surveying, BIM integration, and Digital Product Passports, becomes a **core structural element** of the construction business model because it provides the accurate data, traceability, and lifecycle transparency that circular construction depends on. Without digital tools, SMEs and small midcaps cannot plan renovation instead of demolition, document materials for future reuse, or operate circular services such as digital twins or take-back schemes.

In the value proposition, digitalisation enables companies to offer verified lifecycle performance, CO_2 savings, and buildings designed for disassembly. Clients increasingly expect transparent documentation and digital records, which become part of the value delivered.

In key activities, digital tools support selective renovation planning, waste reduction strategies, material documentation, and circular design processes. Activities such as LiDAR scanning, BIM modelling, and digital passport creation become essential operational steps.
In key resources, digital models, material databases, and building level data become strategic assets that allow SMEs and small midcaps to comply with regulations, plan reuse, and manage lifecycle value.

In key partnerships, collaboration with architects, engineers, demolition firms, and digital tool providers becomes critical to ensure that data flows across the project lifecycle and supports circular outcomes.

In cost structure and revenue streams, digitalisation reduces waste related costs, improves planning accuracy, and enables new service-based offerings such as digital twins, reuse planning, and lifecycle documentation services.

F. Conclusion

The consolidation of business models shows that, despite operating in different sectors, SMEs and small midcaps across Central Europe face a shared reality: **circularity becomes possible only when business models evolve together with materials, processes, and value chain coordination**. The 29 business cases demonstrate that companies often begin with small pilot actions, such as introducing new materials, product redesigns, digital monitoring solutions, take-back schemes and gradually tranform these initiatives into more sustainable and circular business models. The business model patterns presented in this deliverable capture and generalise these transformation insights, providing SMEs and small mid-caps with practical examples of how individual circular actions can be scaled and integrated into broader business model innovation.

Across all four sectors, common challenges appear: limited digitalisation, unstable secondary material flows, fragmented value chains, regulatory uncertainty, and internal capacity gaps. Yet the pilots also reveal strong opportunities. Each sector has a clear enabler that unlocks circularity: **digital lifecycle intelligence** in mechanics & mechatronics, **high quality recycled material flows** in plastics, **reuse and traceability systems** in packaging, and **digitalisation of buildings and materials** in building & construction. These enablers are the structural foundations that make circular business models technically feasible and economically viable.

The expected benefits are consistent: longer product lifetimes, reduced waste, more stable material supply, new service based revenue streams, and measurable environmental performance. Together, these insights form a **blueprint for circular business model transformation** in Central Europe and provide the basis for the **CURIOST Deliverable 2.4.2. Solution - Methodology kit for the development of an economically successful, circular product**, which helps SMEs and small midcaps scale circular innovation in practice.

In short, CURIOST shows that **circularity is achievable when companies combine material innovation, digital intelligence, and sustainable business model logic,** turning isolated pilots into systemic, competitive, and resilient industrial transformation.