ToCoReRaM

# Tool for Complete Recovery of Raw Materials

Wolfsburg
20th 21th May 2026

# **Conference** Towards Complete Material Recovery

## **Report**

Material Recovery by Ecodesign

Solutions towards Material Recovery

Roundtable Talk on Raw Material Recovery

Material Science Center Heinenkamp

Ostfalia University of Applied Sciences

Ollscoil Teicneolaíochta an Atlantaigh
Atlantic Technological University

UNIVERSITÄT GRAZ
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Supported by:

Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety

based on a decision of the German Bundestag

*Let's rethink raw materials - together*

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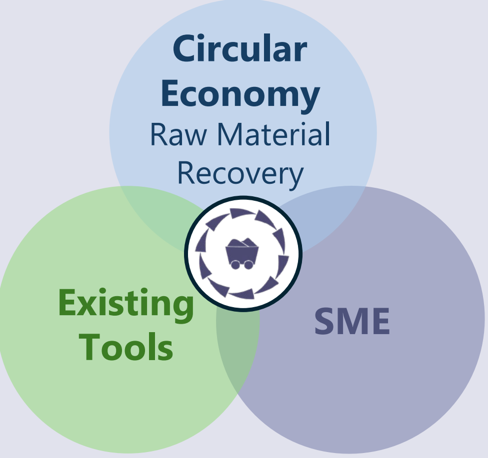
# 1. Project – Overview

ToCoReRaM

## Project Focus

Supporting SMEs in integrating raw material recovery (RMR) strategies in the product development process




## Project Mission

Advancing a circular European economy through increased raw material recovery, reduced environmental impacts and more sustainable product development.

## Project Activities

- Stakeholder research
    - Survey
    - Interviews
- Tool Development
    - Benchmarking of exiting Tools
- Awareness & Communication/Knowledge Exchange & Dissemination
    - Workshop
    - Conference
    - Scientific papers

## Key Outcomes

- Increased awareness of RMR
- Greater stakeholder engagement
- Recognition of the need for SME support tools
- Reduced knowledge–behaviour gap
- Increased policy-makers awareness
- Wider visibility of project results

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# 2. Conference Structure

### Overview

The international ToCoReRaM project conference brought together representatives from academia, industry, and policy-makers to present and discuss results and methodologies for comprehensive raw material recovery within the circular economy. A key outcome was the introduction of a collaboratively developed conceptual tool for RMR.

### Thematic Focus

Presentations on day 1 followed the material lifecycle and addressed circularity across the entire value chain. More information can be found on the next pages.

### Tool-Focused Roundtable

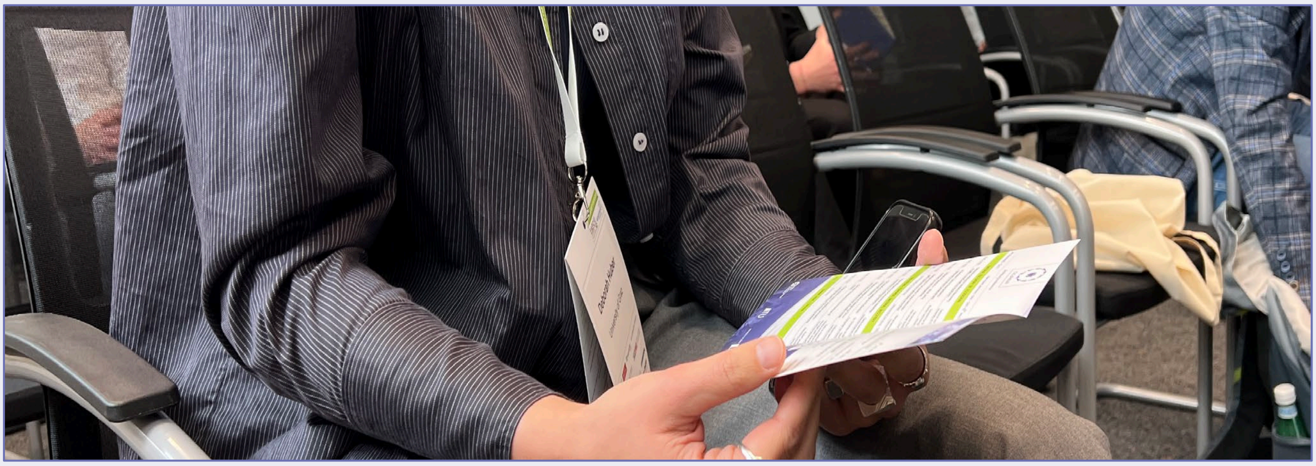
Discussions on day 2 focused on the structure, usability, and practical application of the developed tool, with particular emphasis on the needs and requirements of SMEs.

### Technical Excursion

On day 2 participants gained insights into mechanical plastics recycling processes and real-world industrial implementation at the Material Science Center Heinenkamp.

### Exhibition & Networking

The accompanying exhibition at the MobileLifeCampus and the closing event supported networking and dissemination between research and industry.



# 3. Conference Summary

## Cross-Cutting Findings

The conference contributions demonstrated that circularity must be embedded throughout the entire product lifecycle. From material transparency and circular design principles to manufacturing innovations, decision-support tools and material recovery strategies: the presented approaches collectively contribute to closing material loops and increasing resource efficiency.

A successful implementation requires collaboration between industry, research institutions and regional ecosystems, supported by practical tools and scalable circular business models.

## Conference Focus

| | |
|---|---|
| **Enablers & Collaboration** | • Roundtable Talk<br>• Networking Event |
| **Decision Support** | • Decision-Making for Material Recovery in SMEs<br>• Decision Tool for Raw Material Recovery |
| **Material Transparency** | • Material Passport |
| **Circular Design** | • Design for Circularity<br>• Waste is a Design Error |
| **Sustainable Manufacturing** | • Cooling System<br>• Circularity in Aircraft Industry |
| **Regional Circular Ecosystem** | • Circular Economy in Province of Styria<br>• Material Science Center Heinenkamp in Wolfsburg |
| **Material Recovery & Recycling** | • Closing the Loop in Additive Manufacturing (PLA) |

# 4. Conference Presentation

| Topic | Presenter |
| --- | --- |
| 1. Decision-Making for Material Recovery in SMEs: A Multi Method Approach<br>2. A Decision Tool for Raw Material Recovery in Product Development | ToCoReRaM |
| 3. Material Passports- What Why & When? An Irish Perspectives | IGBC IRISH GREEN BUILDING COUNCIL |
| 4. Designing for Circularity: Trane Technologies Approach to Sustainable Innovation | THERMO KING<br>TRANE TECHNOLOGIES |
| 5. From Efficiency to Circularity: Materials Innovation in Cooling Systems | HT MATERIALS SCIENCE |
| 6. Circularity from Design to Production in the Aircraft Industry | COMPRISETEC COMPOSITE AND POLYMER TECHNOLOGIES |
| 7. Waste is a Design Error: Designing Circular Product Systems That Actually Scale | SUPASO SUSTAINABLE PACKAGING SOLUTIONS |
| 8. Circular Economy in the Province of Styria | Das Land Steiermark<br>Abfall- und Ressourcenwirtschaft |
| 9. Closing the Loop in Additive Manufacturing: Recycling of 3D Printing Materials | RECYCLING FABRIK |

# 4. Presentations Abstracts

## 1. Presentation: Decision-Making for Material Recovery in SMEs: A Mixed Method Approach

Deborah Huber, University of Graz
Keywords: Material Recovery, Decision-Making, SMEs
Material recovery is a key strategy within the circular economy (CE), contributing to sustainability objectives and resource efficiency by reducing dependency on primary raw materials and closing material loops. Despite its promotion through European and national policy frameworks, the implementation of recovery strategies remains limited, particularly among small and medium-sized enterprises (SMEs). As SMEs are the majority of companies in Europe, they play a crucial role in the transition towards CE. However, decision-makers in SMEs face many economical, technical, and social barriers like limited resources and insufficient expertise. This research examines how knowledge, intention, and barriers are integrated into SMEs decision-making processes related to the adoption of RMR practices. Within the ToCoReRaM project, a multi-method research design was employed to investigate gaps and barriers in SME decision-making. The approach was structured into three phases, with data primarily collected in Germany, Austria, and Ireland. First, semi-structured interviews were conducted with different stakeholders to explore current practices, barriers, and enablers of material recovery in SMEs. Building on these findings, an online survey targeting manufacturing companies was developed to assess current raw material use and strategies, knowledge and intention regarding CE, and perceived barriers to implementation. Finally, an international multi-stakeholder workshop was held to discuss the results and reflect on SMEs decision-support needs in relation to policy frameworks, digital tools, and social awareness. The findings contribute to a deeper understanding of SME decision-making in the context of material recovery and help explain the uneven adoption of material recovery practices. Based on these insights, recommendations for targeted decision-support needs, increased social awareness, and improved policy design are discussed.

## 2. Presentation: A Decision Tool for Raw Material Recovery in Product Development

Suharshi De Silva, Atlantic Technological University
Raw-material recovery, decision support tool, product development process, end-of-life
Around 80% of a product's environmental and circularity performance is determined during the product development phase1, making early design decisions critical for circular raw-material use. This project focuses on RMR as a key component of circular material flows at the end-of-life stage. Through the ToCoReRaM project, specific requirements for a new decision support tool, such as the simplicity of the tool, embedded training, data security and digital product passport readiness, were identified to enable improved recovery of raw materials from end-of-life products. Different aspects required to support total raw-material recovery, including material, design, and lifecycle considerations are discussed. Particular attention is given to the indicators necessary to support decision-making within the early product development process including, material selection ensuring high secondary raw material content, product component design minimising contamination leading to efficient recovery processes, process selection including recovery processes without involving separate facilities for recovery, and other sustainable solutions. A case study is presented to demonstrate how the tool functions in practice.

## 3. Presentation: Material Passports- What Why & When? An Irish Perspective

Fernanda Rocha, Irish Green Building Council,
Keywords: Material Passports, Circular Economy, Circular Construction, Built Environment, Resource Efficiency

Material Passports are gaining momentum across Europe as a key enabler of circular construction, but what do they mean in practice? In collaboration with industry partners including Construct Innovate, IPUT (Irish Property Unit Trust), Kingspan, Walls Construction, Savills and BAM (Bataafsche Aanneming Maatschappij - Batavian Construction Company), IGBC (Irish Green Building Council) is advancing the practical implementation of Material Passports across Ireland’s built environment. This initiative moves beyond theory to test real-world applications, identify barriers, and unlock opportunities for value retention and carbon reduction. The project will deliver a Material Passport Business Case for Ireland factsheet, a data-gathering guideline, and a policy-makers and regulatory recommendations report, providing a clear pathway to accelerate adoption and support the transition to a circular built environment.

## 4. Presentation: Designing for Circularity: Trane Technologies Approach to Sustainable Innovation

Pierce Kennedy, Thermo King
Keywords: Circular Economy, Product Designing, Low-GWP Refrigerants, Product Life Cycle Emissions, Decarbonization

Trane Technologies is fully focused on sustainability and positioned to significantly reduce global emissions through our HVAC and transport refrigeration solutions. We are committed to helping customers cut greenhouse gas emissions by 1 gigaton by 2030 through improved efficiency, product electrification, and lower GWP refrigerants. Our circularity goals include doubling the use of circular materials and generating 10% of revenue from circular products and services by 2030. This session will outline how Thermo King, the transport refrigeration experts within Trane Technologies, will contribute to achieving these goals by embedding design for sustainability and circularity across the organization and measuring full product life cycle emissions from cradle to grave.

## 5. Presentation: From Efficiency to Circularity: Materials Innovation in Cooling Systems

Denis Kearney, HT Materials Science Ltd.
Keywords:Nanofluid Technology, Thermal Performance Enhancement, Circular Economy Implementation, Lifecycle Assessment (LCA), Cooling-Intensive Infrastructure

HT Materials Science (HTMS) develops advanced nanofluid technologies designed to enhance the thermal performance of cooling-intensive infrastructure. Its commercially deployed HVAC nanofluids improve the efficiency of existing systems without hardware replacement, reducing embodied carbon, extending asset life and supporting practical circular-economy implementation. Next-generation Direct Liquid Cooling (DLC) fluids are in advanced development for data-centre and EV battery applications, targeting similar system-level efficiency and durability gains.

By increasing heat transfer performance at very low particle loadings, HTMS formulations reduce electrical energy demand, mechanical stress and component wear. This enables longer service intervals, reduced maintenance interventions and deferred capital replacement. Lower coolant turnover and extended equipment lifespan reduce material throughput and waste across the operational lifecycle. Lifecycle Assessment (LCA) and third-party Environmental Product Declarations (EPDs) are embedded within HTMS’s product development strategy, aligning innovation with EU circular economy policy and sustainable-energy frameworks. Through retrofit optimisation and materials engineering, HTMS demonstrates how performance enhancement, rather than equipment replacement, can deliver measurable, scalable circularity in thermal management systems.

## 6. Presentation: Circularity from Design to Production in the Aircraft Industry

Dr. Christian-André Keun, CompriseTec GmbH
Keywords: Circular Economy, Aircraft Cabin, Bio-Based Composites, Thermoplastic Recycling, Life Cycle Assessment

The aviation industry faces increasing pressure to reduce its environmental footprint, with European targets demanding a 75% reduction in $CO_2$ emissions per passenger kilometer by 2050. While structural components account for approximately 85% of aircraft weight, the cabin, representing roughly 15%, is replaced every 4–8 years, making it a critical focus for circular economy strategies. However, the prevailing use of thermoset composites, multi-material assemblies, and adhesive bonding renders end-of-life treatment of cabin components particularly challenging.

This paper presents a holistic, phased strategy for integrating circularity into aircraft cabin design and production. In the short term, bio-based resins and natural fiber reinforcements are introduced using the DirectPreg technology, enabling scrap-free manufacturing and reduced carbon footprints, demonstrated through a bio-based catering trolley table achieving a 20% weight reduction. In the mid term, recycled carbon fiber sheet molding compounds (rcSMC) are applied to structural cabin components such as catering standard units within the KOBRA project, alongside the transition to fully thermoplastic panel systems enabling welded joints and recyclable inserts. In the long term, the FAIRcraft concept proposes a radical weight reduction to 5.1 kg per seat through cradle-to-cradle textiles, self-reinforced thermoplastic composites, and design for disassembly, saving over 1,000 kg per aircraft.

Life cycle assessment (LCA) according to DIN EN ISO 14040/44 is applied throughout all development stages to substantiate sustainability claims and guide material selection. Results indicate that meaningful circularity for composite-intensive cabin components is achievable through a combination of bio-based materials, thermoplastic processing, and systematic design for end-of-life.

## 7. Presentation: Waste is a Design Error: Designing Circular Product Systems That Actually Scale

Fabian Gems, SUPASO GmbH
Keywords: Circular Economy, Machine-as-a-Service, Upcycling, Distributed Manufacturing, Sustainable Packaging

The packaging sector accounts for a substantial share of European single-use material flows, with expanded polystyrene and corrugated board dominating thermal and protective shipping applications. A persistent inefficiency is structural: the companies generating wastepaper and the companies consuming insulation material are frequently the same actors, yet their material streams remain disconnected by geography and by the architecture of conventional recycling. The raw material required for high-performance insulation is exported from the very sites where it could be reintegrated into production.

This contribution presents the case of SUPASO GmbH, which has developed a patented upcycling process converting wastepaper into cellulose-based insulation inlays as a substitute for expanded polystyrene in cold-chain and protective packaging. The central element of the approach is not the material itself but the production model. Through a Machine-as-a-Service framework, compact micro-factories are deployed at partner sites — packaging producers, fulfilment centres, and paper mills — where wastepaper already accumulates as a by-product. Partners upcycle their own waste stream locally, which simultaneously eliminates inbound logistics for the raw material and outbound logistics for the finished inlays.

The presentation argues that circular product systems achieve scale only when the geography of production aligns with the geography of material availability. Centralised recycling tends to reproduce the long-distance flows characteristic of linear systems, whereas distributed micro-production reorganises them.

The contribution concludes with a broader proposition for circular product design: the circularity of a product is constrained by the weakest element in its logistical loop, and the decision of where the loop closes therefore belongs to product design itself rather than to downstream waste management.

## 8. Presentation: Circular Economy in the Province of Styria

Theo A. Friedrich, Waste and Resource Management, Styrian Provincial Government
Keywords: Waste Management, Circular Economy, Administration
The waste hierarchy, based on the European Waste Framework Directive and implemented in Austria through the Waste Management Act, is the central element of the circular economy. It is essential for a functioning circular economy that recycling actually takes place at the same material level and does not involve downcycling. In general, waste management is undergoing a transformation to ensure that more waste streams are diverted to material recovery in future; this can be steered in particular through legal requirements, as has recently been the case in Austria, for example, with a landfill ban on gypsum waste and, from 2027, a landfill ban on mineral wool waste. Such measures lead to the development of new recycling pathways, which might otherwise only gain ground against primary raw materials after a delay. A key question that frequently arises is whether certain waste streams that are generated should actually be regarded as waste, or whether they are so-called by-products. This is particularly relevant for subsequent use, as otherwise waste management regulations apply to downstream operators, and these explicitly require a waste collection/treatment licence. The Province of Styria implements various measures within its own jurisdiction to promote the circular economy; this applies in particular to construction residues, as construction and demolition waste, after excavated soil, represents the largest volume of waste generated. In addition to recycling, reuse is also a relevant approach, which the Province of Styria is seeking to promote. It is also essential in this context to take recyclability into account as early as the construction phase, or more generally during product development, in order to enable disassembly and repair.

## 9. Presentation: Closing the Loop in Additive Manufacturing: Recycling of 3D Printing Materials

Rudolf Leue, Recycling Fabrik GmbH
Keywords: Additive Manufacturing, 3D Printing, Filament Recycling, Polylactic Acid (PLA), Circular Economy, Decentralized Recycling, Material Recovery SMEs, Closed-Loop Systems, Polymer Recycling
Additive manufacturing is increasingly used by small and medium-sized enterprises (SMEs) as well as individual makers and small production facilities. However, a significant share of plastic waste is generated through failed prints, support structures and prototype iterations. These materials are typically not recovered within existing recycling infrastructures, leading to the loss of valuable raw materials. The Recycling Fabrik project addresses this challenge by establishing a decentralized recycling system for 3D printing materials. Instead of treating used

prints and filament waste as end-of-life products, they are collected, sorted and reprocessed into new filament suitable for additive manufacturing. The system integrates a return infrastructure for used prints and failed parts, a material identification process and a controlled recycling workflow designed to maintain consistent material quality. The approach focuses particularly on polylactic acid (PLA), one of the most widely used polymers in additive manufacturing. Returned materials are mechanically processed through shredding, cleaning and compounding before being re-extruded into filament. Quality assurance measures are implemented to ensure stable diameter tolerances and material properties suitable for reliable printing. Initial results indicate that recycling systems can significantly reduce material waste and lower the demand for virgin polymers in additive manufacturing. Furthermore, the project demonstrates how SMEs can implement circular material flows with relatively low technological barriers. The presentation will provide insights into the technical challenges of polymer recycling for additive manufacturing, practical experiences from operating a recycling infrastructure and the potential of such systems to support circular economy strategies in SMEs.

# 5. Round Table Talk: The ToCoReRaM Supporting Tool

As part of the ToCoReRaM project, a design support tool is under development to support the integration of material recovery and circularity principles within the early stages of product development. This tool is designed to address existing gaps in the product design process while providing a structured and practical approach for identifying improvement opportunities and supporting informed design decisions. The round table discussion was conducted to present the developed features of the tool to stakeholders and obtain their feedback regarding its effectiveness and potential improvements.

The round table discussion began with an introduction to the structure of the developed tool and its key components. A printed Gap Analysis assessment was provided to evaluate the status of a product in terms of RMR and circularity. A case study of glass bottle was used due to its simplicity and ease of understanding. Participants applied the tool to the case study and provided feedback on areas for improvement and further development. Further brief discussion was held on the Environmental impact assessment of the tool.

## Discussed Areas of the Proposed Tool

### GAP Analysis: Focus of the Discussion

This section evaluates the current level of circularity and RMR integration across key lifecycle stages, including material selection, product design, production, packaging, logistics, reuse, repair, disassembly, remanufacturing, recyclability, and end-of-life management. Based on user responses, the tool generates scores that help identify strengths and areas for improvement.

### Environmental Impact Analysis

Currently under development, this section will provide a simplified assessment of environmental impacts associated with design decisions. Users will be able to evaluate selected lifecycle stages and processes under their control, such as material use, manufacturing, and product design, to better understand environmental implications.

### Customised Design Guidelines

The tool provides tailored design guidelines linked to identified gaps, offering practical strategies and recommendations for integrating circularity principles into product development. At present, to tool is implemented in Excel.

## Case Study Based Discussion

To demonstrate the application of the GAP Analysis, a simple water bottle was used as an example product. The assessment considered the main product components, including the glass bottle, aluminium cap, and product label. Each component was evaluated against the GAP Analysis criteria, such as material selection, recyclability, disassembly, and end-of-life recovery. The example illustrated how the tool can identify potential barriers to circularity, such as material combinations or design features that may affect recycling and RMR, while also highlighting opportunities for improvement within the product design phase.

## Key Findings and Recommendations

Based on the assessment results, the tool generates targeted recommendations to improve product circularity and raw material recovery potential. Feedback on usability and application was gathered through round table discussions at the final conference and has been incorporated into ongoing development. Key areas for revision include the initial product analysis phase, with subsequent sections adjusted based on inputs provided at this early stage, alongside clearer identification of circularity potential and inclusion of definitions where relevant. Following the development phase, the tool will be validated within SMEs through qualitative and quantitative feedback methods. Future development could explore interactive dashboards and visualisations to enhance usability and user engagement.

# 6. Conclusion

The final conference of the ToCoReRaM project, held in Wolfsburg on 20th–21st May 2026, successfully brought together stakeholders from industry, academia, and policy-makers to discuss the future of raw material recovery and circular economy principles. The event provided a platform to present the ToCoReRaM supporting tool, gather critical feedback, and strengthen collaboration across the value chain.

## Key Outcomes:

1. **Tool Development Progress:** The ToCoReRaM supporting tool, currently implemented in Excel, was presented with its core components: GAP Analysis, Environmental Impact Analysis, and Customised Design Guidelines. A case study using a glass bottle demonstrated the tool's practical application in identifying circularity barriers and improvement opportunities.

2. **Stakeholder Feedback**: Round table discussions yielded valuable input for tool refinement. Key areas for revision include the initial product analysis phase, clearer identification of circularity potential, and inclusion of relevant definitions. This feedback has been incorporated into ongoing development.

3. **Participant Satisfaction:** Conference evaluation results were highly positive, with an overall satisfaction rating of 4.25/5 from 18 participants. The workshop was rated 4.61/5 for usefulness of presentations, and 4.17/5 for relevance to future decisions.

4. **Awareness & Commitment:** Participants showed strong awareness of raw material recovery benefits (4.06/5) and believe recovery is achievable for SMEs (4.61/5). Company representatives expressed willingness to implement best practices (4.27/5) and reshape product-development processes (4.33/5).

**Next Steps:** Following the conference, the tool will undergo validation within SMEs through qualitative and quantitative feedback methods. Future development may explore interactive dashboards and visualisations to enhance usability and user engagement. The project results will also inform regulatory framework discussions, with 4.00/5 of relevant participants indicating intent to draw on ToCoReRaM outcomes.

**Final Remarks:** The conference successfully achieved its goal of fostering collaboration and advancing the ToCoReRaM tool toward practical implementation. We thank all participants for their engagement and valuable contributions. Together, we are rethinking raw materials and moving towards complete material recovery

# Acknowledgements


We sincerely thank all participants for attending our final conference and all project partners and colleagues for their valuable collaboration throughout the project.

# Appendix A: Feedback from Conference Participants

(N = 18)

| General Conference Evaluation 4,25/5 | |
|---|---|
| The workshop was well-organized. | 4,61/5 |
| The presentations and information shared at this event were useful. | 4,17/5 |
| The information shared at this event is useful for future decisions or activities in my field. | 3,94/5 |
| Overall, I am satisfied with the conference. | 4,29/5 |

| Raw Materials Recovery – Knowledge & Awareness 4,06/5 | |
|---|---|
| I am aware of the environmental and/or economic benefits of the recovery of raw materials from EOL products. | 4,61/5 |
| I think that recovery of raw materials is achievable for SMEs. | 4,00/5 |
| The conference improved my knowledge and awareness regarding the recovery of raw materials. | 4,06/5 |
| There is a strong alignment between what I know about sustainability/material recovery and what is implemented in practice. | 3,56/5 |

| Company Representatives: 4,27/5 & Politicians 4/5 | |
|---|---|
| My company is willing to put (further) efforts to implement best practices of raw material recovery. | 4,2/ 5 (n=10) |
| My company is willing to reshape the product-development process to support complete recovery of raw materials. | 4,33/5 (n=9) |
| I intend to draw on the ToCoReRaM project results when working towards a regulatory framework. | 4,00/5 (n=4) |

# Appendix A: Feedback from Conference Participants

**(N = 18)**

Participant feedback demonstrates that the conference was perceived as a valuable and professionally organised event. Respondents reported a high level of overall satisfaction, particularly with regard to the conference organisation and the quality of the presentations delivered. The information and insights shared during the event were generally regarded as useful, both in terms of increasing understanding of RMR and supporting future activities and decision-making processes within participants' respective fields.

The results further suggest that attendees already possess a strong awareness of the environmental and economic significance of recovering raw materials from end-of-life products. At the same time, the conference contributed to strengthening participants' knowledge and understanding of current challenges and opportunities associated with implementing circular economy approaches in practice. A notable finding is the comparatively lower assessment of the alignment between sustainability-related knowledge and its practical implementation, indicating that barriers remain between theoretical understanding and real-world application.

Responses from stakeholder groups revealed a generally positive outlook towards future implementation efforts. Representatives from industry indicated a willingness to further invest in best practices for RMR and to adapt product development processes in support of more circular and recovery-oriented solutions. Political stakeholders likewise expressed an intention to consider and utilise the outcomes of the ToCoReRaM project when contributing to future policy and regulatory developments.

When asked about the most valuable elements of the conference, participants frequently highlighted the international perspective provided by industrial contributors, the opportunity to exchange experiences across sectors, and the diverse range of concise and practice-oriented presentations. The interaction between representatives from science, industry, and policy-makers was particularly appreciated, as were the breakout sessions and discussions that enabled deeper exploration of specific topics. Furthermore, participants valued the presentation of practical tools and approaches for circularity, as well as insights into ongoing industrial projects and experiences.

Suggestions for future editions focused primarily on enhancing interaction and practical engagement. Participants recommended increasing the number of speakers from industry, strengthening networking opportunities through more structured formats, and creating stronger links between workshops, discussions, and networking activities. Additional recommendations concerned logistical aspects, including improved accessibility of the venue by public transport and scheduling field visits separately from conference sessions to avoid overlap. At the same time, feedback also confirmed the overall success of the conference format, with one respondent explicitly recommending that the approach be maintained for future events.

Overall, the evaluation indicates that the conference successfully brought together relevant stakeholders from academia, industry, and policy-makers, creating a platform for knowledge exchange and discussion on raw material recovery. The positive ratings across most categories suggest that the event contributed to raising awareness, sharing practical experiences, and fostering dialogue on the transition towards more circular and resource-efficient systems.

# Appendix B: Why was ToCoReRaM established?

## A short Story of the Project

### The Urgency of Sustainable Product Development in the EU

The European Union has taken a decisive step toward a circular economy with the adoption of the Ecodesign for Sustainable Products Regulation (ESPR), which entered into force in 2024. This landmark legislation represents a paradigm shift in how products are designed, manufactured, used, and ultimately disposed of. It mandates that all products placed on the EU market—from electronics and textiles to furniture and machinery—must meet strict sustainability criteria throughout their entire life cycle. The regulation aims to reduce environmental impacts, promote resource efficiency, and ensure that products are durable, repairable, recyclable, and made from sustainable materials. At the heart of the ESPR lies the requirement to close material loops, a core principle of the circular economy. This means that raw materials must not be used once and discarded, but instead recovered, reused, and reintegrated into new products. The regulation also introduces Digital Product Passports (DPPs) and extended producer responsibility (EPR) schemes. This will especially challenge small and medium-sized enterprises (SMEs). ToCoReRaM is not just a technological innovation project, it is a strategic response to the challenges posed by the ESPR, offering SMEs a practical, scalable, and user-centered tool to embed sustainability into their Product Development Processes (PDP) and close material loops effectively.

### Motivation: What is the Driving Force?

Beside the political and legal restriction, the limited resources, especially in raw materials, threaten the European Market and all companies in Europe. Restrictions for the export of Critical Materials e.g. from China are showing how sensitive the European industry is regarding the import of raw materials. Closing the loop for materials is not only a step to a more sustainable production, it will also straighten the European economy against external influences and foster the European resilience. The idea for a totally closed loop of raw materials in Europe is the basic motivation for the project ToCoReRaM. At the end, only materials exported as products have to be replaced by new materials from outside EU.

### The Challenge: Why SMEs Struggle with the ESPR 2024

While large companies often have dedicated sustainability departments, R&D budgets, and compliance teams, SMEs face significant barriers in adapting to the new regulatory landscape. Key challenges include:

- Complexity of Life Cycle Assessment (LCA): SMEs often lack access to tools and expertise to conduct accurate LCAs, which are now mandatory under ESPR for many product categories.
- Limited access to secondary raw materials: Sourcing recycled or bio-based materials is difficult due to inconsistent supply chains, higher costs, and quality variability.
- High upfront investment in sustainable design and production: Retrofitting production lines or redesigning products for modularity and recyclability requires capital that SMEs may not have.
- Digital product passport (DPP) implementation: Creating and maintaining DPPs demands digital transformation, data management systems, and interoperability—resources often beyond SMEs' reach.
- Lack of standardized frameworks: Without clear, accessible guidelines tailored to SMEs, many struggle to know where to start.
- SMEs are limited not only in budget but also in staff. The new Challenge ESPR will cause more work and specific competences in the SMEs. Additional capacity building in all stages of education will be necessary to foster the process. These challenges are not just technical, they are economic and strategic. Without support, SMEs risk being excluded from the EU market, losing competitiveness, or facing penalties

## Implementing Sustainability in the Product Development

ToCoReRaM integrates sustainability into the core of the product development process, starting with design. The project will create a tool and a new way of thinking in the PDP. There have to be a Mindshift, to focus more on sustainability and a circular economy. This can get an advantage in design and production for European companies against other markets. To operationalize this shift, ToCoReRaM addresses sustainability and circularity across multiple stages of the Product Development Process, covering the following key areas:

- Product Design & Development (durability, modularity, recyclability)
- Material Selection & Procurement (sustainable and secondary raw materials)
- Production & Processes (resource efficiency, waste reduction)
- Use & Reuse (sharing, repair, refurbishment)
- Recycling & Material Recovery (end-of-life management, closed-loop systems)
- Political & Economic Frameworks (regulations, incentives, standards)
- Business and Economic Aspects (small and medium-sized enterprises, business models, value chains)
- Policy-makers and Regulatory Frameworks (regulations, incentives, standards)

Especially the aspect of Business and Economic Aspects is immanent for SMEs because of the more limited budget compared to bigger enterprises.

## ToCoReRaM: Mediator between Circular Economy, Existing Tools and Small to Medium Size Enterprises

Creating a new tool needs at first a benchmarking of existing tools in the market. Therefore, one aspect of the project is to check tools and literature of this topic. SMEs have some special requirements for using tools.

- Tools have to be simple to understand and handle. Special training of the staff has to be minimized.
- The cost of a tool and training sessions have to be limited.
- All information and technical data feed into the tool have to be secure. Cloud solutions are not so popular for SMEs, in particular if the servers are not located in the EU.

Circular Economy is interesting for SMEs if they can reach higher sales and profits, for example by creating higher acceptance among environmentally aware customers, using materials more efficient or developing new sustainable materials. These can cause new innovation and new markets for products. Of course, CE also poses risks due to increased bureaucracy and restrictions.

## Goals and Impacts: What are the goals and desired imparts of the Project?

Output: ToCoReRaM carries out a survey, interviews, creates a benchmarking of existing tools, conducting workshops and conferences and will publish scientific papers.

- Outcome: The Project will define requirement specifications for a tool to help SMEs efficiently use and recover raw materials in line with EU sustainability goals.
- Impact: ToCoReRaM tries to boost recycling and reuse of materials in the EU, not only by creating a tool but also by initiating a shift to a more sustainable thinking along the PDP.
- The goal of the project team is to support and motivate SMEs to work more sustainable and foster Circular Economy in Europe.

## How does ToCoReRaM approach this Goals?

The project team will perform the following activities to achieve these goals:

- Conducting interviews and surveys with SMEs in Germany, Ireland and Austria
- Analysing best practice and existing digital tools
- Creating a Literature review

Based on these results we want to understand what kind of support SMEs require to close raw material loops and create a list of requirements for a new tool. This is only the first step on the way to create a useful and effectively tool and technology to support SMEs on their way to a Circular Economy in Europe.

## Why ToCoReRaM Matters: Alignment with the UN Sustainable Development Goals (SDGs)

ToCoReRaM's impacts extends beyond compliance. It contributes directly to several UN Sustainable Development Goals (SDGs):

- SDG 12: Responsible Consumption and Production: By promoting durable, repairable, and recyclable products, ToCoReRaM reduces waste and resource depletion.
- SDG 9: Industry, Innovation, and Infrastructure: The project fosters innovation in sustainable manufacturing and supports the development of green industrial ecosystems.
- SDG 13: Climate Action: Through reduced material extraction, lower carbon emissions from production, and energy efficient processes, ToCoReRaM helps mitigate climate change.
- SDG 10: Reduced Inequalities: By empowering SMEs with accessible tools and knowledge, ToCoReRaM helps level the playing field in the green transition.

## Conclusion: A Blueprint for SMEs in the Age of ESPR 2024

The Ecodesign for Sustainable Products Regulation (ESPR) 2024 is not just a regulatory hurdle, it is a transformative opportunity to build a more sustainable, resilient, and inclusive economy. However, this transition will only succeed if SMEs are empowered to participate. The ToCoReRaM project provides exactly that: a practical, scalable, and user-centered framework that embeds sustainability into every stage of the product development process. By focusing on closed material loops, modular design, secondary raw materials, and digital traceability, ToCoReRaM enables SMEs to comply with the ESPR while improving competitiveness, reducing costs, and enhancing brand reputation.

As the EU moves toward a circular economy by 2030, projects like ToCoReRaM are not just helpful, they are essential. They represent a new model of innovation: one that is technologically advanced, socially inclusive, and environmentally responsible.

## Let's Rethink Raw Materials – Together

The future of manufacturing is circular. The future is sustainable. And the future is within reach, especially for SMEs who are supported by initiatives like ToCoReRaM.